SIT-STAND DESKS AS A STRATEGY TO REDUCE SITTING AND INCREASE STANDING AND PHYSICAL ACTIVITY IN OFFICE-BASED EMPLOYEES: A PILOT RCT AND PROCESS EVALUATION OF A MULTICOMPONENT WORKPLACE INTERVENTION

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by

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Abstract

Current UK public health policy and research identifies potential health risks of physical inactivity and high levels of sitting. This is a particularly pertinent issue for office workers, who spend, on average, over two-thirds of the work day sitting. This thesis reports on the design and evaluation of a multicomponent sit-stand desk intervention, delivered within two not-for-profit office-based organisations in London, England. A mixed method study design was employed. A pilot randomised controlled trial examined the efficacy of the intervention on reducing sitting and increasing standing and physical activity, using wearable monitors to measure outcome variables at baseline, and at four additional timepoints up to 12-months following the onset of the intervention. A process evaluation, including in-depth qualitative interviews and participant observation, investigated the processes that influenced the feasibility, acceptability and efficacy of the intervention. Mixed-model ANOVA indicated that the intervention reduced workplace sitting, on average, by 38 minutes, however there was no significant influence on workplace physical activity, or any of the outcome variables across the whole day. The process evaluation revealed that discourses surrounding employee health and organisational effectiveness, and employees' health-focused occupational identities increased the acceptability of sit-stand desk provision, whereas monetary concerns, a centralised organisational structure and incompatibility of the sit-stand desks with the workplace environment negatively influenced implementation feasibility. The sit-stand desk design, expectations and outcomes related to health and productivity, and the organisational culture and interpersonal relationships positively and negatively influenced sit-stand desk experience to differing degrees between participants. Mixed method analyses of outcome and process data illustrated the potential for integrating findings to enhance understanding of 'what works' within behavioural intervention research. Sit-stand desks are not a one-size-fits-all solution to reducing sitting and increasing physical activity, however, they should be available to office-based employees as part of a wider workplace health strategy.

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List of abbreviations

ACSM	American College of Sport Medicine
ANOVA	Analysis of Variance
BCT	Behaviour Change Technique
BCW	Behaviour Change Wheel
BMI	Body Mass Index
CG	Control Group
CPM	Counts per Minute
CVD	Cardiovascular Disease
DoH	Department of Health
DoI	Diffusion of Innovations
EAT	Exercise Activity Thermogenesis
EE	Energy Expenditure
EOI	Expression of Interest
FITT	Frequency, Intensity, Time and Type
HSE	Health Survey for England
HRM	Heart Rate Monitor
ICC	Intraclass Correlation Coefficient
IG	Intervention Group
LPL	Lipoprotein Lipase
MCS	Macmillan Cancer Support
MET	Metabolic Equivalent
MMR	Mixed Method Research
MSD	Musculoskeletal Discomfort

MVPA	Moderate-Vigorous Physical Activity
NEAT	Non-Exercise Activity Thermogenesis
NHANES	National Health and Nutrition Examination Survey
NICE	National Institute of Clinical Excellence
PA	Physical Activity
PHE	Public Health England
RAMS	Risk and Method Statement
RCT	Randomised Controlled Trial
ROI	Return on Investment
SASA	Start Active Stay Active
SCT	Social Cognitive Theory
SEM	Socioecological Model
SES	Socio-economic Status
SS-MC	Sit-stand multicomponent intervention
SS-O	Sit-stand desk only intervention
ToD	Time of Day
TPB	Theory of Planned Behaviour
TTM	Trans-Theoretical Model of change

Chapter 1 – Introduction

1.1 Sitting, physical activity and the workplace: The public health agenda

A considerable policy effort is made by UK Government to support working-age adults into the workforce as reducing unemployment lessens strain on the welfare budget (e.g. Department for Work and Pensions, 2008). In addition, work can have significant benefits for the individual as it offers the chance of improved opportunities via remuneration and a sense of purpose, and employment and socio-economic status are tightly, positively correlated with health and wellbeing (Waddell & Burton, 2006). Despite the positive contribution of work to societies and individuals, work can create poor health and wellbeing for employees. For example, sitting and inactivity are negatively associated with health. Accordingly, work environments and cultures that encourage prolonged sitting and physical inactivity can harm employees' health and wellbeing (van Uffelen et al., 2010).

Physical activity (PA) is defined as "any bodily movement produced by skeletal muscles that results in energy expenditure (EE)" (Caspersen, Powell, & Christenson, 1985, p. 126). Thus, PA includes structured exercise but can also take the form of lifestyle activities, such as gardening. There is an established body of evidence in support of the health benefits of PA; whilst physical *in*activity has been identified as the fourth leading risk-factor for premature all-cause mortality (I. Lee et al., 2012). Public health policy and practice related to PA was, until recently, focused on increasing moderate-vigorous intensity PA (MVPA) and muscular strength. The current UK guidelines for adults (19-64 years) state that 150 minutes/week of moderate PA, or 75 minutes/week of vigorous intensity PA, in bouts > 10 minutes, is required to accumulate health benefits (Department of Health, 2011). In addition, adults should engage in activities that strengthen muscles, involving all the major muscles, on at least two days/week (Department of Health, 2011).

More recently, evidence from prospective cohort studies indicates that sedentary behaviour may be associated with negative health conditions, including cardiovascular disease (CVD), metabolic syndrome, depression and some cancers (de Rezende, Lopes, Rey-Lopez, Matsudo, & Luiz, 2014; Ekelund et al., 2016; van der Ploeg & Hillsdon, 2017). Sedentary behaviour is defined as any waking

behaviour that occurs in a sitting, reclining or lying posture, that does not increase EE markedly above resting levels (i.e. < 1.5 metabolic equivalents (METs); see section 2.1.1 for an explanation of METs (Tremblay et al., 2017). It has been hypothesised that metabolic changes occur due to the loss of contractile stimulation of skeletal muscles when sedentary for prolonged periods. For example, findings from experimental studies indicate that breaking up sitting time can attenuate postprandial excursion of glucose (Benatti & Ried-Larsen, 2015) and decline in endothelial dysfunction (Thosar, Bielko, Mather, Johnston, & Wallace, 2015); both risk factors for atherosclerosis and CVD (Dempsey, Owen, Biddle, & Dunstan, 2014). A review of sedentary behaviour and cardo-metabolic biomarkers provides evidence that the cellular processes initiated by prolonged sitting are distinct from the positive changes in cardo-metabolic risk markers resulting from engaging in MVPA (Healy, Matthews, Dunstan, Winkler, & Owen, 2011). Thus, being physically active may not negate negative health consequences associated with high levels of sedentary behaviour.

The potential for sitting to have detrimental health consequences, independent of meeting MVPA guidelines, has led to an increased scrutiny of people's physical behaviour during *all* waking hours, rather than only on time spent engaging in MVPA and completing muscular strength exercises. A recommendation to "minimise the amount of time being sedentary (sitting) for extended periods" has been added to the current iteration of the national PA guidelines (Biddle et al., 2010; Department of Health, 2011). A high proportion of waking hours can be spent within the workplace throughout adults' lives, which has led to the identification of the workplace as a priority setting for reducing sitting and increasing standing and PA.

This thesis focuses on addressing the sedentary nature of office-based occupations by developing and evaluating strategies designed to reduce sitting and increase PA in the office-based workplace (L. Smith, Hamer, et al., 2015). In the office, sitting is considered the culturally appropriate behaviour, as the nature of tasks (e.g. computer-based) and layout of the office-space, including the presence of seated chairs, compel employees to sit at a desk to undertake work. Many people conflate sitting at the desk with productivity (e.g. Bennie, Salmon, & Crawford, 2010) meaning that taking breaks from the desk to reduce sitting and increase PA can be viewed as incompatible with organisations' expectations that employees

maintain productivity during work hours. Giving office-based employees access to a sit-stand desk, i.e. a height-adjustable desk allowing employees a choice of desk-based working positions, may facilitate sitting reduction, whilst still permitting engagement in desk-based, productive work. The research contained within this thesis examines the suitability of sit-stand desks as a strategy for reducing sitting and increasing PA amongst office-based employees.

This research is underpinned by the socioecological model (SEM) which asserts that individual and external influences on different levels, e.g. interpersonal, environmental and organisational, interact dynamically to influence behaviour (Cochrane & Davey, 2008). An implication of this in relation to the design of behavioural interventions is that targeting behaviour on multiple 'levels' is likely to have a more substantial impact on reducing sitting and increasing PA than targeting one level only (M. Pratt et al., 2015); see section 2.4.4 for a detailed commentary on the principles of SEM and its application to sedentary behaviour and PA research. This research involves the development and evaluation of a multicomponent workplace intervention including sit-stand desk provision (environmental-level strategy), alongside individual and organisational-level strategies, aimed at reducing sitting and increasing standing and PA in office-based employees.

1.2 Evaluating a workplace sit-stand desk intervention: Research strategy

1.2.1 Evaluation of intervention efficacy

An important consideration when evaluating workplace interventions is investigating the influence the intervention has on the target outcomes. In addition, advancing knowledge of the efficacy of interventions will assist workplaces in the development of workplace health initiatives focused on reducing sitting and increasing PA. Randomised controlled trials (RCT) provide the most robust evidence of intervention efficacy (Oakley, Strange, Bonell, Allen, & Stephenson, 2006). Control groups do not receive the treatment (i.e. the intervention) but the target outcome is measured. Therefore, the inclusion of a control arm helps to isolate the influence of the intervention from any external factors; intervention efficacy can be established by subtracting any change in behaviour in the control group from that observed in the intervention group(s). In addition, random allocation between the

trial arms minimises potential bias arising from characteristics that might be associated with increased chance of success of the intervention, such as age and SES, by ensuring there are no systematic differences between intervention arms (NICE, 2012). A pilot RCT was employed within this research to examine the efficacy of a multicomponent sit-stand desk intervention compared to sit-stand desk provision only, and compared to no intervention (i.e. seated-desk control). Whilst it is anticipated that individual and organisational-level strategies alongside sit-stand provision will result in more substantial changes in behaviour, the inclusion of a sit-stand desk only group permits an understanding of whether this is the case.

An assessment of efficacy requires measurement of the target outcome. Self-report measures of sitting and PA are commonly utilised within behavioural intervention research, however they do not provide an accurate record of behaviour, as people frequently over-estimate their PA (J. Reilly et al., 2008). Accordingly, PA was quantified objectively using monitors that have been established to provide valid estimates of sitting and PA behaviours (Kang & Rowe, 2015). Another key consideration within behavioural intervention research is the length of the follow-up assessment. If behaviour is only measured for a short period following intervention onset, it is impossible to ascertain whether behavioural change is sustained. Previous research indicates that changes in sitting and PA measured at 6-months are not always sustained at 12-months (Foster, Hillsdon, Thorogood, Kaur, & Wedatilake, 2005; Healy et al., 2016). Therefore, the present research monitored behaviour up to 12-months following the onset of the intervention to allow investigation of the longer-term efficacy of the sit-stand desk intervention.

1.2.2 Evaluation of processes influencing intervention efficacy, feasibility and acceptability

The SEM draws on systems theory, which recognises that the outcome of an intervention is not universal, but rather is dependent on how intervention components interact with other influences on behaviour within the workplace context (A. Clark, Briffa, Thirsk, Neubeck, & Redfern, 2012). Therefore, it is important to understand not just whether an intervention works, but also the factors that impede and facilitate intervention efficacy within the delivery setting (Hesse-Biber, 2012). In addition, research investigating the organisational attitudes to sit-stand desk

interventions, and the feasibility of implementing sit-stand desk interventions in practice in organisations will facilitate an understanding of the appropriacy of the wider-scale implementation of the intervention across organisations (Wijk & Mathiassen, 2011). Process evaluations have the potential to address these wider considerations and thus play an important role in informing policy and practice (Moore et al., 2014). Process evaluations are largely focused on understanding: (1) issues surrounding intervention implementation, (2) mechanisms through which the intervention contributes to (behavioural) change, and (3) how contextual factors influence the delivery, acceptability and success of the intervention (Bauman & Nutbeam, 2014; Moore et al., 2015). The present study undertook a process evaluation of the sit-stand desk intervention to elicit an understanding of the social processes that influence intervention efficacy, feasibility and acceptability.

The process evaluation described within this thesis involved the use of in-depth interviews and participant observation. Whilst relatively underused in health behaviour change research, observational methods permit the collection of data on behaviour, events and interactions as they occur within the intervention delivery context (Morgan-Trimmer & Wood, 2016). This thesis aims to enhance understanding by combining naturalistic observation methods with qualitative interviews to examine complex social processes that influence the delivery, user experience and efficacy of the multicomponent sit-stand desk intervention.

1.3 The research questions and objectives

The broad aim of this thesis is to advance knowledge related to appropriate strategies to reduce sitting and increase standing and PA amongst office-based employees. Two specific research questions have been developed:

1. What is the efficacy of a multicomponent sit-stand desk intervention designed to reduce sitting, and increase standing and PA?
2. What are the processes that influence the feasibility, acceptability and efficacy of sit-stand desk implementation and use?

To address these research questions, the following objectives were set:

- To design and deliver two sit-stand desk interventions (multicomponent and single-component) aimed at reducing sitting and increasing standing and PA in two office-based workplaces
- To evaluate the efficacy of the intervention by conducting a pilot RCT, including objective measurement of sitting, standing and PA, during work hours and across the whole day, up to 12-months following intervention delivery
- To evaluate the processes influencing the feasibility, acceptability and efficacy of the intervention by employing a process evaluation, including in-depth qualitative interviews with participants and stakeholders, and participant observations

1.4 The mixed method approach

Mixed methods research (MMR) is defined as research that involves the combination of qualitative and quantitative approaches throughout the research process, for example during data collection, analysis and interpretation (Johnson, Onwuegbuzie, & Turner, 2007). The most widely cited purpose for combining methods is complementarity; different methods provide different types of knowledge which, when combined, can provide a more nuanced and complete understanding (Simons, 2007).Within the present study, the research questions dictate the use of mixed methods; a quantitative outcome analysis is employed to identify intervention efficacy, and a qualitative process evaluation is conducted to examine the processes that influence the feasibility, acceptability and efficacy of the intervention. The different components of the research offer different types of knowledge related to the sit-stand intervention research to enhance knowledge production. However, there are several potential limitations of MMR, including the apparent incompatibility of the dominant philosophical assumptions underpinning qualitative and quantitative approaches (B. Smith et al., 2012). Section 4.1 of this thesis discusses paradigm issues specific to mixed methods research and describes the philosophical position underpinning the use of mixed methods; critical realism. It is argued within section 4.1 that both qualitative and quantitative approaches are compatible with the critical realist approach (Zachariadis et al., 2013).

Outcome and process evaluations of behavioural interventions are usually analysed and reported separately (Lewin, Glenton, & Oxman, 2009). However, mixed method analyses have the potential to advance knowledge beyond that generated by the sum of the individual (outcome and process) parts (Fetters & Freshwater, 2015). In combination, the outcome and process components of the study can illuminate whether, and why, specific components of the intervention had an influence on specific outcome measures. Additionally, attendance to paradoxical findings emanating from the different methods can facilitate a deeper understanding. This thesis aims to contribute to the methodological literature on mixed methods, focusing on mixed method approaches to evaluating behavioural interventions. It intends to advance knowledge by illustrating two novel approaches to integrating the outcome and process evaluation data and findings, and analysing and comparing the potential of the approaches to enhancing the production of knowledge related to intervention efficacy, feasibility and acceptability. This mixed method analysis is presented in Chapter 7.

1.5 The structure of this thesis

Chapter 2 presents a review of literature to consolidate what is known about sitting, standing and PA behaviours from different study designs, disciplines and perspectives. It includes a conceptualisation of the behaviours and appraisal of the evidence linking them to health, an overview of measurement techniques, and an appraisal of different approaches to influencing sitting, standing and PA. Chapter 3 reviews literature related to the workplace setting, which includes the conceptualisation of organisational culture, occupational identity and the healthy workplace, as well as reviewing literature related to sitting, standing and PA in the workplace. In doing so, this chapter contextualises workplace interventions designed to reduce sitting and/or increase PA. The methodological approach and methods employed within this research are described in chapter 4. This chapter includes a position statement on the use of mixed methods, and provides detail on the study design, the development of the multicomponent intervention, recruitment and selection of organisations and participants, data collection methods and techniques, and data analysis.

Chapter 5 describes and discusses the findings from the outcome analyses, to examine the efficacy of the multicomponent sit-stand desk intervention on reducing sitting and increasing standing and PA. Findings from the process evaluation are presented and discussed in chapter 6 to advance understanding regarding the feasibility and acceptability of sit-stand desk installation and use. Chapter 7 provides two illustrative examples, based on the current research, of approaches to mixed methods, to deepen understanding of intervention efficacy and facilitate a discussion of the benefits and challenges of employing mixed methods to evaluate interventions. The thesis is concluded in chapter 8 where a summary of the findings is presented, along with recommendations for workplace practice and future research. The strengths and limitations of the study are also considered.

Chapter 2 - Understanding Behaviour: Sitting, Standing and Physical Activity

2.0 Introduction

The aim of this chapter is to review extant literature to provide a theoretical framework for the study. The first section (2.1) provides definitions of both PA and sedentary behaviour (sitting) and outlines current national guidelines. Literature related to the contribution of non-exercise activities to total energy expenditure (EE), the association between sitting, standing, PA and health, and individuals' daily activity profiles is also reviewed. Finally, this section describes a multidimensional profile approach to characterising PA. The second section (2.2) reviews common sitting and PA measurement techniques including direct and indirect calorimetry, objective activity monitors, and self-report. This review is focused on the extent to which different techniques can accurately capture the multidimensional aspects of behaviour across the whole day. The second half of the chapter reviews literature relevant to intervening to promote change in sitting, standing and PA behaviour. The third section (2.3) reviews mainstream behaviour change literature. First, the importance of theory in developing behaviour change interventions is described, then psychological approaches to changing behaviour are reviewed, before limitations of psychological behaviour change approaches are considered. The final section of the chapter (2.4) reviews extant literature that goes beyond the traditional behaviour change approach. First, the Social Determinants of Health model is examined. The chapter concludes by describing the socioecological model and considering the implications of this approach for promoting change in sitting, standing and PA.

2.1. Conceptualising sitting, standing and physical activity

2.1.1 Physical activity

PA is defined as "any bodily movement produced by skeletal muscles that results in energy expenditure" (Caspersen, Powell, & Christenson, 1985, p. 126). Exercise is most commonly defined as planned, structured and repetitive PA that is

performed with a direct, fitness-related purpose (Caspersen et al., 1985). Therefore, whilst the terms PA and exercise are often used interchangeably in research (Pugh & Hadjistavropoulos, 2011; Teixeira, Carraça, Markland, Silva, & Ryan, 2012) and everyday interaction (Ceria-Ulep, Tse, & Serafica, 2011), they are not synonymous. All exercise is PA, but not all PA can be classified as exercise.

Exercise can be categorised into aerobic, anaerobic and resistance-type exercises. The distinction between aerobic and anaerobic exercise primarily relates to exercise intensity (G. F. Fletcher et al., 2013; Knuttgen, 2007). Whilst aerobic and anaerobic exercises generally target the cardiovascular system, resistance-type exercises target muscular strength, power, and endurance (Howley, 2001). Non-exercise physical activities are commonly termed 'lifestyle PA', i.e. actions that you perform as part of daily living, such as doing household chores or gardening (Dunn, Andersen, & Jakicic, 1998; M. Pratt, 1999). Lifestyle activities occur as a consequence of other activities such as working and travelling, however, it is possible to adapt lifestyle behaviour to increase PA (Dunn, 2009; Pilutti, Dlugonski, Sandroff, Klaren, & Motl, 2014); for example, walking or cycling for transport, collecting printed documentation from the printer at more regular intervals, etc.

According to the FITT classification, there are four main dimensions of PA: frequency, intensity, time and type (FITT) (Montoye, 2000); all of which influence the amount of energy expended by being physically active (Barisic, Leatherdale, & Kreiger, 2011). The frequency domain indicates how often PA is performed. Intensity of PA is typically measured using metabolic equivalents (METs), which refers to the energy expenditure associated with the activity compared to resting metabolic rate (Barisic et al., 2011). One MET corresponds to an oxygen uptake of 3.5 ml/kg/min (B. Ainsworth et al., 1993). However, this classification is based on a 70kg male and is not universally accepted (Byrne, Hills, Hunter, Weinsier, & Schutz, 2005). Intensity classifications have been devised based on MET values: light-intensity (1.6-2.9 METs), moderate-intensity (3-5.9 METs) and vigorous-intensity (≥ 6 METs) PA (B. Ainsworth et al., 2011). The compendium of physical activities describes activities that are likely to fall within these intensity classifications. For example, window cleaning is categorised as light PA (3.2 METs) and running at 12mph is categorised as vigorous PA (19 METs) (B. Ainsworth et al., 2011). Time refers to the length of time or duration that PA is sustained for (Lindemann, Zijlstra,

Aminian, & Chastin, 2013), and type refers to the environmental and social context within which the activity is performed (Montoye, 2000). For example, football, aerobics, or gardening are all types of PA. Linked to the type and context of the activity, PA can be categorised into different domains: household, workplace, leisure and travel (Owen et al., 2011b; Sallis et al., 2006). Over recent years, sedentariness has emerged as a public health concern that is interrelated with, but distinct from, both PA and physical inactivity (de Rezende et al., 2014; Ekelund et al., 2016; Owen, Healy, Matthews, & Dunstan, 2010; World Health Organisation, 2010). Sedentary behaviour is defined next.

2.1.2 Sedentary behaviour

According to PA and health policy and literature, a person is classified as inactive if they do not engage in regular moderate-vigorous intensity PA (MVPA) (Carlson, Fulton, Pratt, Yang, & Adams, 2015; Gibbs, Hergenroeder, Katzmarzyk, Lee, & Jakicic, 2015; World Health Organisation, 2010). However, being physically inactive does not automatically constitute a person as 'sedentary'; physical inactivity and sedentary behaviour are conceptually different (Hamilton, Healy, Dunstan, Zderic, & Owen, 2008). A variety of definitions of sedentary behaviour have been postulated in the academic literature (Gibbs et al., 2015). Sedentary behaviour originates from the Latin '*sedere'* - to sit - and thus usually refers to any sitting or lying behaviour (Pate, O'Neill, & Lobelo, 2008; Tremblay, Colley, Saunders, Healy, & Owen, 2010). However, classification of sedentary behaviour is generally understood to be much more ontologically complex as it incorporates both metabolic rate and posture (S. Marshall & Merchant, 2013). Sedentary behaviour refers to sitting or lying behaviour that corresponds to an EE of less than 1.5 METs (Owen et al., 2011b; Pate et al., 2008). Some studies claim subjects are sedentary when sedentariness has not been measured (e.g. Melanson et al., 2009; Mullen et al., 2011). Instead, they measure inactivity, i.e. subjects do not meet a threshold of MVPA (Biddle, 2007; Sedentary Behaviour Research Network, 2012). Accurate and consistent classification of sedentary behaviour and physical inactivity is necessary to advance knowledge production regarding health risks and behavioural change. It is also important to distinguish sedentary behaviour from a sedentary lifestyle (i.e. high levels of sedentary behaviour) (Gibbs et al., 2015), as *some* sedentary behaviour

is inevitable and beneficial (e.g. sleep), whereas a sedentary lifestyle is associated with potential negative health outcomes; see section 2.1.5.

Whilst acknowledging the low EE associated with sedentary behaviour, sedentary behaviour will be referred to as 'sitting' throughout this thesis. Sitting has been defined as "the infinite ways that we sustain our bodies in a bent position ranging from squatting, kneeling, reclining, or the lotus position" (Keifer-Boyd, 1992, p.73), yet in the modern world, and particularly in the office-based workplace, people typically sit upright on chairs. Sitting commonly takes place when watching TV, using a computer and commuting, and thus regularly occurs in leisure, work, household and travel contexts (Owen, Bauman, & Brown, 2009; Owen, Salmon, Koohsari, Turrell, & Giles-Corti, 2014). Whilst PA can be purposeful or incidental, it is likely that most sitting is a corollary of engaging in a primary activity.

2.1.3 Current UK policy recommendations for sitting and physical activity

Governmental PA guidelines, including those set by the World Health Organisation, comprise recommendations for PA in relation to frequency, intensity, time and type (Cavill, Kahlmeier, & Racioppi, 2006). The current UK chief medical officer's guidelines state that adults should engage in 150 minutes of moderate PA or 75 minutes of vigorous PA - or a combination thereof - accumulated in bouts of at least 10 minutes per week. In addition, at least two resistance-based sessions should be undertaken (Department of Health, 2011). However, despite the well-established association between regular MVPA and health (see section 2.2.2) only a third of adults meet the guidelines for PA, and inactivity is most prevalent in older adults, women, people with disabilities and people living in deprived areas, amongst other social inequalities (Hallal et al., 2012; Public Health England, 2014). Therefore, raising population levels of PA is a public health priority.

Recommendations for limiting sedentary time have been included in the current national governmental guidelines; which state that adults should "minimise the amount of time spent being sedentary (sitting) for extended periods" (Department of Health, 2011). Thus, the guidelines do not stipulate that adults should eliminate sitting entirely – but rather, that a sedentary lifestyle should be avoided (Gibbs et al., 2015). Regardless, a population survey including 20 countries show that adults are highly sedentary, spending on average over 5 hours per day sitting, when measured

via self-report (Bauman et al., 2011). Objective accelerometer data from a nationally-representative sample of adults residing in the US indicate that adults engage in over 8 hours sitting per day, with women being fractionally more sedentary than men (8.5 hours/day and 8.35 hours/day, respectively), and total sedentary time increasing with age (Healy, Clark, et al., 2011). Therefore, in addition to increasing MVPA, reducing levels of sitting is a public health priority. Whilst the aforementioned guidelines recognise the importance of MVPA and sitting with regards to health, they do not make specific recommendations for reducing sitting time (e.g. frequency, duration) due to the relative infancy of the evidence base concerning the health risks of prolonged sitting (Gardner, Smith, & Mansfield, 2017). Nevertheless, a recent expert consensus statement regarding workplace sitting specifically recommends that office-workers should incorporate at least 2 hours/day of standing or light activity into work hours, progressing to 4 hours/day (Buckley et al., 2015). These recommendations are not based on high-quality evidence in terms of study design, study quality, and directness; criteria for judging the strength of a recommendation (Guyatt et al., 2008). The recommendation was primarily based on observational and uncontrolled lab-based studies (study design), that did not include objective measures of sedentary behaviour (study quality) and that were not focused on the workplace setting (directness). An appraisal of the literature regarding the potential health impacts of reducing sedentary behaviour and increasing light-intensity PA is considered next.

2.1.4 Accumulation of total daily energy expenditure

EE is composed of three basic components: basal metabolic rate (energy expended when lying at complete rest); thermic effect of food (energy expended to digest, absorb and store food) (Donahoo, Levine, & Melanson, 2004); and activity thermogenesis (Levine, 2007). Basal metabolic rate accounts for the majority of total daily EE (approximately 60-70%), whilst dietary induced thermogenesis contributes 10-15% (McCrady-Spitzer & Levine, 2012). Although basal metabolic rate accounts for a substantial contribution of total daily EE, it is largely predicted by lean body mass (Dériaz, Fournier, Tremblay, Després, & Bouchard, 1992) and thus there is very little intrapersonal variation in basal metabolic rate (Donahoo et al., 2004). Conversely, activity thermogenesis is highly variable both within and between individuals (Kotz & Levine, 2005; Levine, Vander Weg, Hill, & Klesges, 2006).

Activity thermogenesis can be separated into two components: exercise-related activity thermogenesis (EAT) and non-exercise activity thermogenesis (NEAT) (Levine, 2002). NEAT applies to "the energy expended for everything that we do that is not eating, sleeping or […] exercise" (Levine, 2004, p. 82) (i.e. lifestyle activity, see section 2.1.1) and thus includes a variety of types and intensities of non-exercise activities including fidgeting, standing, gardening etc.

The EE associated with activity thermogenesis is largely accumulated through NEAT; exercise thermogenesis is negligible in the majority of the UK population (Levine, 2004). However, the contribution of NEAT outweighs the contribution of exercise-related thermogenesis even in adults that meet the PA guidelines. For example, Turner, Markovitch, Betts, and Thompson (2010) instructed participants to perform 240 minutes of structured exercise each week, at 65% of their maximal oxygen uptake (i.e. 1.6 times the recommended PA guidelines). The authors reported that the structured exercise only constituted 15% of total activity thermogenesis, with the remaining 85% being accumulated via NEAT (Turner et al., 2010). However, participants were all middle-aged, previously inactive and overweight men, which limits the generalisability of the findings across genders, age groups and people with different activity profiles. Nevertheless, there is convincing evidence that variability in activity thermogenesis is predominantly due to fluctuations in NEAT (Dauncey, 1990; Levine, 2007; Pate et al., 2008; Thompson & Batterham, 2013). This calls into question the types and intensities of PA that provide the most important physiological stimulus (Thompson, 2013).

2.1.5 The relationship between sitting, standing, physical activity and health

There is well established evidence that MVPA can improve health (Bauman, 2004; Blair & Morris, 2009; Kohl 3rd et al., 2012; I. Lee et al., 2012; Warburton, Nicol, & Bredin, 2006). Systematic reviews of the literature indicate that PA is associated with reduced risk of developing various health conditions including cardiovascular disease (Li & Siegrist, 2012), diabetes (Al Tunaiji, Davis, Mackey, & Khan, 2014), osteoporosis (Howe et al., 2011), some cancers (Moore et al., 2016), cognitive decline (Sofi et al., 2011) and depression (Teychenne, Ball, & Salmon, 2008). Further, being active is associated with reduced risk of premature all-cause mortality; a meta-analysis of prospective cohort studies indicated a 24% risk

reduction in males (relative risk estimate of 0.76, 95% CI [0.71, 0.82]) and a 31% risk reduction in females (relative risk estimate of 0.69, 95% CI [0.56, 0.84]) for the moderate-intensity PA group compared to the inactive group (Lollgen, Bockenhoff, & Knapp, 2009). The risk reduction-PA intensity relationship is non-linear; larger reductions in risk are observed between light-moderate intensities than between moderate-vigorous intensities (Lollgen et al., 2009). I. Lee et al. (2012) estimated that inactivity (i.e. an activity level insufficient to meet current PA recommendations) is the cause of 6-10% of deaths worldwide from non-communicable disease.

Historically, research studies have privileged the examination of structured exercise (Tipton, 2006, 2014). However, more recently, studies designed to explicitly examine the impact of sitting, standing and light PA on health outcomes have been conducted. Experimental studies indicate that the underlying physiology of sitting and PA differ (Hamilton, Hamilton, & Zderic, 2007; Tremblay et al., 2010). For example, bed-rest studies in humans indicate that the processes regulating lipoprotein lipase (LPL), an enzyme involved in the breakdown of fat, differ depending on whether a person is active or sedentary (Tremblay et al., 2010). Therefore, it is plausibly possible that sitting may pose significant health risks, independent of participation in MVPA (Hamilton et al., 2008; S. Marshall & Ramirez, 2011; Spanier, Marshall, & Faulkner, 2006; Yates et al., 2011). However, epidemiological evidence relating to *independent* health risks of sitting is equivocal.

A number of systematic reviews evidence the association of high levels of sitting with increased risk of developing a number of health conditions including cardiovascular disease (Ford & Caspersen, 2012), diabetes (Wilmot et al., 2012), high blood pressure (P. Lee & Wong, 2015), metabolic syndrome (Edwardson et al., 2012), some cancers (Cong et al., 2014; Shen et al., 2014) and depression (Zhai, Zhang, & Zhang, 2014). Biddle et al. (2016) drew on the Bradford Hill criteria to examine the likelihood of a causal link between sedentary behaviour and premature all-cause mortality, based on epidemiological evidence. The strength of the evidence linking sedentary behaviour to all-cause mortality, when comparing the highest and lowest sedentary behaviour categories within studies, is low. However, all 18 included studies showed a significantly increased relative risk of all-cause mortality of >10 % in the ‘high’ sedentary behaviour category (Biddle et al., 2016), which is

comparable to the increased risk associated with a lack of MVPA, low cardio-respiratory fitness and smoking (Bouchard, Blair, & Katzmarzyk, 2015). A meta-analysis that synthesised the findings from six prospective cohort studies illustrates a dose-response relationship between sitting and premature all-cause mortality, with risk being 35% higher in adults that sit for more than 10 hours a day, when controlling for PA (Chau et al., 2013). There are a limited number of studies addressing the dose-response relationship of sedentary behaviour with all-cause mortality; however, the available evidence indicates a non-linear relationship (Biddle et al., 2016). There is evidence of a consistent relationship across different population groups and over time (Biddle et al., 2016), therefore it is conceivable that there is a causal relationship between sedentary behaviour and all-cause mortality.

However, legitimacy of the causal relationship between sedentary behaviour and all-cause mortality is confounded by the predominance of self-report methods for measuring sedentary behaviour (de Rezende et al., 2014; Ekelund, Tomkinson, & Armstrong, 2011), as adults cannot accurately recall time spent sitting; see section 2.2.3. Variables such as SES and diet may also confound the relationship between sedentary behaviour and negative health outcomes, particularly when TV viewing is utilised as a proxy for measuring sedentary behaviour (Bowman, 2006). Few studies have statistically adjusted for socio-economic correlates specific to particular types of sitting, such as TV viewing or occupational sitting (van der Ploeg & Hillsdon, 2017) which draws causality into question. Further, PA is often not controlled for, and when it is, the relationship between sitting and the measured health outcome(s) tends to lessen (de Rezende et al., 2014). Most studies examining the relationship between sedentary behaviour and health outcomes control for MVPA and not total PA, citing complete collinearity as the rationale due to the finite amount of time within which to be sedentary and active (van der Ploeg & Hillsdon, 2017). However, this argument is not valid if PA duration *and intensity* (i.e. estimated energy expenditure) is controlled for, as this is not finite (van der Ploeg & Hillsdon, 2017). Biswas et al. (2015) conducted a meta-analysis of 13 primary studies that examined the association between sedentary behaviour and all-cause mortality, and examined the influence of levels of PA. Hazard ratios indicated that whilst there was an overall 24% increased risk of premature all-cause mortality in the highest sedentary behaviour category, the increased risk was only 6% in the highest PA level category,

and 36% in the lowest PA level category (Biswas et al., 2015). A more recent meta-analysis concluded that 60-75 minutes/day of MVPA might circumvent the negative health consequences associated with prolonged sitting (Ekelund et al., 2016). However, as most individuals are not active to these levels, current evidence indicates reducing high levels of sitting is likely to be associated with positive health outcomes.

In addition to reducing total sitting time, breaks in sitting have been positively associated with biomarkers of metabolic health (Dunstan et al., 2012; Healy et al., 2008; Healy et al., 2011). A meta-analysis of 6 randomised cross-over trials that investigated the acute metabolic response to interrupting prolonged sitting, provides evidence that light-intensity PA breaks, but not standing breaks, produce positive significant changes in blood glucose (-17.42%) and insulin (-14.92%) (Chastin, Egerton, Leask, & Stamatakis, 2015). Breaks as short as two minutes have the potential to positively influence metabolic biomarkers (Bailey & Locke, 2014). However, changes in metabolic biomarkers tend to me more substantial when the breaks consist of higher-intensity PA (Chastin et al., 2015), meaning it is plausible that an increased PAEE, rather than breaks in sitting per se, is responsible for the positive metabolic response to breaking up prolonged sitting bouts.

A number of cross-sectional studies support an association between light-intensity PA and improved cardio-metabolic health (Carson et al., 2013; Ekblom-Bak, Ekblom, Vikström, de Faire, & Hellénius, 2014; Green et al., 2014; Healy et al., 2007; Howard et al., 2015; Khoja, Almeida, Chester Wasko, Terhorst, & Piva, 2016; J. Kim, Tanabe, Yokoyama, Zempo, & Kuno, 2013; Loprinzi, Loprinzi, Lee, & Cardinal, 2015). Within these studies, the benefits of light PA were largely independent of levels of MVPA. However, there were mixed findings regarding the size of the effect of light PA compared to MVPA. Some studies reported similar standardised coefficients for light PA and moderate PA and their association with disease risk (e.g. Khoja et al., 2016) whereas Carson et al. (2013) reported fewer and weaker associations between cardio-metabolic biomarkers and light PA (diastolic blood pressure) compared to MVPA (waist circumference, systolic blood pressure) amongst a sample of 1,731 U S adolescents. A systematic review of light PA intervention studies that were primarily focused on young adult males found that increasing light PA did not improve cardio-vascular disease markers including body

composition, glucose, insulin, high-density and low-density lipoprotein cholesterol, or triglycerides (Batacan, Duncan, Dalbo, Tucker, & Fenning, 2015). However, the included studies described interventions that generally composed small doses of light PA (Batacan et al., 2015). For a given duration of PA, cardio-metabolic health benefits of PA tend to increase with the intensity of the activity (Howard et al., 2015). However, experimental evidence indicates that light-intensity PA can be as or more beneficial than MVPA when total EE is matched (Duncan, Batacan, Fenning, Dalbo, & Connolly, 2016; Duvivier et al., 2013). Duvivier et al. (2013) instructed 18 healthy subjects to complete three activity regimes, each for 4 days, in a randomised, counterbalanced order. The regimes involved: 1) 14 hours sitting (sedentary control), 2) 13 hours sitting and 1 hour of MVPA (exercise), and 3) 8 hours sitting, 4 hours walking and 2 hours standing (minimal intensity PA). The most positive insulin profiles resulted from the minimal intensity PA regime; area under the curve was significantly lower in the minimal intensity PA regime than the exercise regime (1593.1 mU min/ml), measured via oral glucose tolerance test (Duvivier et al., 2013). This indicates that, when EE is matched, light PA may be more beneficial than MVPA, potentially due to the reduced time spent sitting.

Standing is a very low-intensity light PA (Howard et al., 2015). Whilst static standing is associated with a MET value of 1.3 which is just below the intensity classification for light PA (B. Ainsworth et al., 2011), standing involves fidgeting, shifting of weight and postural muscle activity, which raises EE above sitting levels, to a level associated with low-intensity light PA (MacEwen, MacDonald, & Burr, 2015; Torbeyns, Bailey, Bos, & Meeusen, 2014). A prospective cohort study of over 18000 adults found that increased standing was associated with reduced risk of premature mortality from all causes in inactive but not physically active adults (I. Lee & Paffenbarger, 2000). However, standing was captured via self-report, which weakens the trustworthiness of the association (see section 2.2.3). A systematic review of experimental studies provides evidence that short standing breaks may benefit health in physically inactive and type two diabetic individuals, but that activity-breaks of a higher intensity are necessary to induce positive metabolic changes in physically active individuals (Benatti & Ried-Larsen, 2015). Standing for longer durations may improve biomarkers associated with cardiovascular health in healthy adults (MacEwen et al., 2015). For example, Buckley, Mellor, Morris, and

Joseph (2014) found that post-prandial blood glucose excursion was attenuated by 43% following 185 minutes standing compared to 185 minutes sitting, when matched for steps. However, there are a number of limitations that reduce the credibility of the findings; the differences in post-prandial glucose excursion were not significant, the conditions were not randomised, and post-prandial glucose excursion is not straightforwardly indicative or a risk factor for chronic disease. More experimental studies of this nature, with more participants and stronger designs are necessary to support the claim that standing instead of sitting can attenuate health risks. Nevertheless, sitting, standing and light PA, as well as MVPA, may be independently associated with health. The implications of this for individuals' daily behavioural patterns are considered next.

2.1.6 Variation in physical activity throughout the day

Individuals are likely to engage in behaviour that is associated with both beneficial and detrimental health outcomes. For example, following an empirical study of minute-by-minute physical behaviour of 100 young adult males over 7 days, Thompson and Batterham (2013) reported that whilst some dimensions of PA were tightly correlated (e.g. moderate PA and total daily EE; $r = 0.96$), other dimensions were found to have little, if any, relationship with each other. For example, there was only a weak correlation ($r = 0.25$) between total daily EE and time engaged in vigorous bouts of PA of at least 10 minutes in duration (Thompson & Batterham, 2013). Further, there is no significant association between levels of sitting and meeting the PA guidelines (Craft et al., 2012; Finni, Haakana, Pesola, & Pullinen, 2014). This literature indicates that few individuals inhibit a cluster of activity that is likely to benefit health (i.e. low levels of sitting, high levels of light PA and more than 30 minutes of MVPA) or be associated with health risk (i.e. high levels of sitting, minimal light PA and no MVPA) (Peacock et al., 2015).

Whilst sitting and PA might be considered to be opposite ends of the scale in terms of the associated EE, they are separate and distinct concepts (Hamilton et al., 2008) as being physically active and sedentary are not mutually exclusive. An individual could have a sedentary lifestyle whilst simultaneously meeting the PA guidelines (Owen et al., 2010). An example of this might be an individual with an office-based occupation who cycles to and from work daily. Further, it is also

possible to do less than the recommended amount of PA, whilst engaging in low amounts of sedentary behaviour. An example of this may be a waitress who spends most of the day engaged in light PA. This individual would have a high daily PA EE, but as activity is accrued in long, low-intensity bouts she would be classified as 'inactive' according to Department of Health (2011) guidelines (Thompson et al., 2009). Whilst not meeting the national PA guidelines, such activity patterns are likely to be associated with health benefits similar to the aforementioned sedentary individual that *does* meet the PA guidelines (Duvivier et al., 2013).

2.1.7 Conceptualising physical activity: Towards a multidimensional profile approach

A focus on purposeful exercise within research neglects the majority of daily PA (Tremblay, Esliger, Tremblay, & Colley, 2007). In addition, different types and intensities of activity including sitting, standing, light PA, and MVPA may have independent health impacts (Thompson, 2013) and individuals' daily activity is likely to include behaviours that are associated with both health benefits and health risks (Peacock et al., 2015). Accordingly, a multidimensional profile approach that recognises levels and patterns of sitting and PA across the whole day - rather than just participation in MVPA - is recommended for promoting physical behaviour change in individuals (Bussmann & van den Berg-Emons, 2013; Das & Horton, 2012; Manns, Dunstan, Owen, & Healy, 2012; Pettee Gabriel, Morrow, & Woolsey, 2012). Acknowledging the multidimensional nature of behaviour permits individuals a much wider choice of activities rather than a "one size fits all" recommendation (Thompson, Peacock, Western, & Batterham, 2015). Further, population-level failure to meet PA recommendations indicates that engaging in 150 minutes of moderate-intensity PA may not be an achievable target for many individuals (Weed, 2016). Replacing sitting with light PA - rather than MVPA - may be more acceptable to some individuals (Barreto, 2015; L. Smith, Ekelund, & Hamer, 2015). Thus, research studies should aim to capture the multidimensional nature of behaviour (Esliger & Tremblay, 2007). Intervention research should determine the impact of interventions on not just MVPA or exercise (Tudor-Locke & Myers, 2001), but also on sitting, standing and light PA across the whole day. Sitting, standing and PA variables were included as relevant outcomes in evaluating the efficacy of the

intervention delivered as part of the present study; see chapter 4. The next section reviews techniques for measuring aspects of sitting, standing and PA.

2.2 Measuring sitting, standing and physical activity

2.2.1 Direct and indirect calorimetry

Selecting a measurement technique usually depends on a variety of factors including reliability and validity, sample size, time and cost restrictions, and the research purpose (Butte, Ekelund, & Westerterp, 2012; Hardy et al., 2013; Strath et al., 2013). Calorimetry calculates EE via measuring heat produced by the human body. Direct calorimetry, a direct measure of heat, requires the subject to be in an enclosed, insulated chamber (Seale, Rumpler, Conway, & Miles, 1990). Thus, this technique is not suitable for measuring free-living behaviour (Levine, 2005). In contrast, indirect calorimetry *estimates* heat production and thus can be utilised within free-living environments (Levine, 2005; S. Roberts, Coward, Schlingenseipen, Nohria, & Lucas, 1986). Doubly labelled water (an indirect calorimetry technique) estimates EE via carbon dioxide production (Shephard & Aoyagi, 2012; J. Warren et al., 2010), which is measured by calculating the difference in elimination rates of oxygen and hydrogen isotopes (Schoeller, 1999). Whilst calorimetry is the gold standard for calculating EE (Dishman, Washburn, & Schoeller, 2001; Westerterp, 2009), EE is the physiological response to PA (Lamonte & Ainsworth, 2001) not the activity itself. Further, calorimetry does not provide information regarding the FITT dimensions (Dishman et al., 2001); it does not examine activity pattern across the day, postural position, or the type of activity. Therefore, calorimetry is generally only used to validate other approaches to measuring PAEE (Prince et al., 2008). However, the adoption of DLW as the "gold standard" in validity and reliability studies privileges the EE component of physical behaviour (Kelly, Fitzsimons, & Baker, 2016). Given the complex nature of PA and SB, Kelly, Fitzsimons, and Baker (2016) argue that it is important to consider which dimension(s) of PA a technique is valid or reliable *for* (e.g. EE, type, duration), and the relevancy of these dimensions and the degree of reliability and validity deemed acceptable for the type of investigation (e.g. population surveillance, intervention effectiveness).

2.2.2 Wearable activity monitors

Pedometers were the first device-based tools used to measure PA (Wilhelm & Perrez, 2013). Use of pedometers for assessing steps and distance has been traced back to the 18th Century (Shephard & Aoyagi, 2012). Accelerometers are the most commonly utilised activity monitor within research (Dowd, Harrington, Bourke, Nelson, & Donnelly, 2012). Accelerometers calculate movement (acceleration and deceleration, i.e. change in speed across time) in gravitational acceleration units (1g = 9.81 m/s^2) (Chen & Bassett, 2005). Whilst accelerometers have been used for engineering and aerospace purposes since the 1920s (I. Lee & Shiroma, 2014), the first accelerometer designed to measure PA was developed in 1981 (Wong, Webster, Montoye, & Washburn, 1981). The 1990s and 2000s saw a propagation of new accelerometer devices (Troiano, McClain, Brychta, & Chen, 2014).

Criteria upon which to assess the strengths and weaknesses of device-based technology include cost, participant burden, acceptability of use and adherence, the number of dimensions of PA and SB that the devices capture and the relevancy of these to the study design and purpose, and the reliability and validity of the device in capturing these behavioural dimensions (Perry et al., 2010; Strath et al., 2013). Early accelerometers were large, expensive, and had small memory and storage capacities (I. Lee & Shiroma, 2014). However, recent technological advances mean that accelerometers are now small, portable and can record and store data for extended time periods (Atkin et al., 2012; Freedson, Pober, & Janz, 2005; Lyden, Keadle, Staudenmayer, & Freedson, 2014; Masse et al., 2005; Troiano et al., 2008). Thus, they are suitable for use in real-world contexts. Whilst there were concerns regarding the reliability and validity of data generated from early models of accelerometer (Montoye et al., 1983; Troiano et al., 2014), newer models provide highly accurate estimates of sitting and PA (Kang & Rowe, 2015). Further, accelerometers are able to capture the multidimensionality (i.e. frequency, intensity and time) of activity and the data is time-stamped which permits examination of daily patterns of behaviour (Ekelund et al., 2011; Esliger & Tremblay, 2007; Melanson, Freedson, & Blair, 1996; Strath et al., 2013). For example, it is possible to ascertain daily minutes of MVPA accumulated in bouts ≥ 10 minutes. Activity monitors that contain an inclinometer can distinguish between sitting and standing (Y. Kim, Barry, & Kang,

2015). Specific information relating to the mechanics, validity and reliability of the activity monitors utilised within this research are provided in section 4.5.1.

Limitations of accelerometers include an inability to assess EE associated with incline and load bearing (I. Lee & Shiroma, 2014; Silsbury, Goldsmith, & Rushton, 2015; Terrier, Aminian, & Schutz, 2001). Multisensory methods, such as accelerometry combined with heart-rate measurement, may help overcome these limitations (Strath et al., 2013). Further, whilst accelerometers capture much of the multidimensionality of PA they are unable to assess the type of activity, and so extra methods are usually employed to examine this dimension (Esliger & Tremblay, 2007). There is evidence to suggest that the addition of a wearable camera may be a feasible approach to capturing the type and context of episodes of PA identified via accelerometry (Doherty et al., 2013). A multisensory monitor combining accelerometry with Global Positioning System technology is another potential future direction which would permit the assessment of frequency, time, time and type/context of PA using one device (Westerterp, 2009).

2.2.3 Self-report techniques

The most common self-report techniques for measuring sitting, standing and PA are questionnaires and activity diaries (B. Ainsworth, Cahalin, Buman, & Ross, 2015). Strengths of self-report techniques for measuring behaviour are that they are cost-effective, convenient, and are able to capture the multidimensionality of behaviour including relevant contextual information (Helmerhorst, Brage, Warren, Besson, & Ekelund, 2012; Silsbury et al., 2015). Activity diaries permit hour-by-hour assessment of behaviour and are particularly suited to gathering social and physical contextual data, whilst questionnaires permit estimation of intensity and duration of PA (Strath et al., 2013). Diaries are generally completed whilst activity is being performed, whereas questionnaires typically involve recall of past behaviour relating to specific activities, such as average time spent in MVPA during the last seven days (B. Ainsworth et al., 2015). There are a vast number of PA questionnaires; a recent systematic review identified 130 questionnaires for which reliability and/or validity studies had been conducted (Helmerhorst et al., 2012). The International PA Questionnaire is the most commonly used self-report tool for assessing PA as there are multiple versions that differ in language and

comprehensiveness (Silsbury et al., 2015). Whilst comprehensive self-report tools permit a more in-depth assessment of the complexity of behaviour, simpler questionnaires (which capture less of the complexity of behaviour) more reliably predict total PA EE (Shephard, 2003).

A disadvantage of self-report measures of sitting, standing and PA is that they produce biased results (Prince et al., 2008; J. Reilly et al., 2008; Schuna, Johnson, & Tudor-Locke, 2013). Inaccurate reporting may be intentional (due to social desirability bias) or unintentional (due to recall bias or lack of comprehension) (Dishman et al., 2001; Ekelund et al., 2011; Helmerhorst et al., 2012; Troiano et al., 2008). A recent review reported that some PA questionnaires demonstrate good or excellent test-rest reliability (Silsbury et al., 2015). However, self-report questionnaires lack validity when compared to doubly-labelled water and accelerometry techniques; low-moderate correlations are consistently reported in systematic reviews (Helmerhorst et al., 2012; P. Lee, Macfarlane, Lam, & Stewart, 2011; Prince et al., 2008; Silsbury et al., 2015; Skender et al., 2016). Whilst questionnaire development has intended to minimise bias (Skender et al., 2016), there is little difference in the validity of older and newer questionnaires (Helmerhorst et al., 2012). A systematic review comparing direct vs. self-report measures for assessing PA found that some self-report tools overestimate PA whilst others underestimate PA, with no clear pattern emerging to explain the differences (Prince et al., 2008).

Similarly, individuals are unable to accurately recall sitting time; adults tend to underestimate sitting time compared to more objective estimates (Atkin et al., 2012; Busschaert et al., 2015; B. Clark et al., 2015; Jefferis et al., 2016; van Cauwenberg, van Holle, De Bourdeaudhuij, Owen, & Deforche, 2014). The validity of self-report tools designed to assess total sitting time are poor, however this may be partially explained by lack of a gold standard criterion method for assessing sedentary behaviour (Helmerhorst et al., 2012). However, there are also specific issues with the items used in questionnaires. For example, the time spent watching TV is the most commonly utilised self-report indicator of non-occupational sedentary time (B. Clark et al., 2009; S. Marshall & Ramirez, 2011). Research has shown that TV time is an unsatisfactory proxy for sitting time (Atkin et al., 2012; Biddle, Gorely, & Marshall, 2009; Martinez-Gomez et al., 2012). Individuals engage

a number of other sedentary behaviours, and TV viewing is not always a sedentary activity, as portable electronic devices permit TV viewing whilst simultaneously engaging in tasks such as gym-going, housework, etc. (Atkin et al., 2012). Further, most sedentary behaviour questionnaires are unable to capture sitting patterns and the behavioural contexts that encompass sitting (Kang & Rowe, 2015). Whilst a small number of context-specific sedentary behaviour questionnaires have been developed, such as the Multi-Context Sitting Time Questionnaire (Whitfield, Pettee Gabriel, & Kohl, 2013), the test-retest reliability and validity of these questionnaires compared to device-based measures is poor (A. Marshall, Miller, Burton, & Brown, 2010; Rosenberg et al., 2010; Salmon, Owen, Crawford, Bauman, & Sallis, 2003; Whitfield et al., 2013).

One single measurement technique is unlikely to capture the complexity of PA (Powell & Paffenbarger, 1985; Skender et al., 2016; J. Warren et al., 2010) Given the validity concerns associated with self-report techniques for assessing sitting, standing and PA, such techniques should be used only in addition to device-based monitoring of behaviour to capture context-specific information, when device-based monitoring is feasible (Lubans et al., 2011; Shephard, 2003). Accurate assessment of sitting, standing and PA across the whole day will assist in the development of interventions that are efficacious at reducing sitting and increasing standing and PA. The second half of this chapter reviews approaches to intervening to change behaviour.

2.3 Understanding lifestyle behaviour and behaviour change: Insights from psychology

2.3.1 The importance of theory in behaviour change interventions

In the context of understanding behaviour and behaviour change, theories identify constructs that influence behaviour (R. Davis, Campbell, Hildon, Hobbs, & Michie, 2015; Prestwich, Webb, & Conner, 2015). There are two relevant classes of behavioural theory when considering designing behaviour change interventions; explanatory theory and change theory (R. Davis et al., 2015; Glanz & Bishop, 2010). Explanatory theories identify influences on behaviour that explain or predict differences in the observed behaviour between individuals (T. Webb, Joseph, Yardley, & Michie, 2010) whereas change theories identify processes that contribute

to behaviour change (Brug, Oenema, & Ferreira, 2005; Schwarzer, 2008). Behavioural influences and change processes are interrelated meaning that many behavioural theories refer to both explanation and change (Brug et al., 2005; R. Davis et al., 2015; Glanz & Bishop, 2010). Models and frameworks differ from theory in that they do not make predictions regarding behavioural outcomes (Nilsen, 2015).

The utilisation of theories and models/frameworks within the design of behaviour change interventions is recommended within the Medical Research Council guidance for developing and evaluating complex interventions (Craig et al., 2008). Targeting validated antecedents of behaviour and change processes should increase the likelihood of intervention efficacy (R. Davis et al., 2015; Kristén, Ivarsson, Parker, & Ziegert, 2015). In addition, an understanding of how and why interventions are, or are not, successful can be elucidated if relevant theoretical constructs are examined (Cane, O'Connor, & Michie, 2012; Michie, Carey, et al., 2016; Michie et al., 2013; Nilsen, 2015). Knowledge of the mechanisms of effective interventions can be applied to inform intervention development in different contexts, settings or groups (Cane et al., 2012; Dombrowski, Sniehotta, Avenell, & Coyne, 2007). Most PA interventions in research, policy and practice are based on psychological theories of behaviour (Linke, Robinson, & Pekmezi, 2014; Mansfield, Anokye, Fox-Rushby, & Kay, 2015; Schwarzer, 2008).

2.3.2 Psychological theories and behaviour change science

Psychological behaviour and behaviour change theories

A scoping review by R. Davis et al. (2015) identified 82 theories in the published literature that were relevant to behaviour and behaviour change, the majority of which originate in psychology. The aim here is not to describe each of these theories in detail, but rather to outline the general principles of psychological behavioural theories, using examples drawn from PA research. Psychological behaviour theories describe individually-oriented constructs that interact to predict behaviour. One example of a psychological construct is self-efficacy, which refers to "the conviction that one can successfully execute the behaviour required to produce the outcome" (Bandura, 1977, p. 193), i.e. a task-specific form of confidence. Self-efficacy was originally formulated as part of Social Cognitive Theory (SCT)

(Bandura, 1986) but has since been included in a number of other theories, including the Trans-Theoretical Model of change (TTM) (Prochaska & DiClemente, 1986) and the Theory of Planned Behaviour (TPB) (Ajzen, 1985). Other constructs commonly included in psychological theories include attitude (Sniehotta, Presseau, & Araújo-Soares, 2015), perceived behavioural control (Gourlan et al., 2016) and motivation (Deci & Ryan, 2000). Many psychological theories only include individually-oriented constructs, predicting that behavioural intention directly tracks onto actual behaviour (Ajzen, 1985; Sniehotta et al., 2015). However, some theories, including the SCT (described later in this section), incorporate external factors, such as social support and the physical environment (Bandura, 1999; Linke et al., 2014).

Most behavioural theories were not devised to specifically explain participation in PA, but have subsequently been applied to PA. For example, the self-determination theory was devised as a general theory of motivation (Deci & Ryan, 2000), but has since been applied to PA, health and wellbeing (R. Ryan, Patrick, Deci, & Williams, 2008; Sebire, Standage, & Vansteenkiste, 2009; Standage, Gillison, Ntoumanis, & Treasure, 2012). The TTM was specifically developed to explain addictive behaviours; smoking and alcoholism (DiClemente et al., 1991) before being applied to understanding and predict PA (S. Marshall & Biddle, 2001). PA is the most common behaviour that behavioural theories have been applied to, accounting for 26% of the articles included in a recent scoping review of primary research focusing on behaviour (change) *and* theory with a descriptive, intervention, evaluative or review focus (R. Davis et al., 2015). Whilst a vast number of psychological theories exist, a select few are popular amongst researchers, which have been repeatedly and frequently applied to developing interventions. R. Davis et al. (2015) reported that 63% of the articles included in their scoping review discussed one of four theories; the TTM, the TPB, the SCT and the Information-Motivational and Behavioural Skills model. Similarly, in a review of articles published in 1999-2000, the most frequently cited theories were the SCT and the TTM (Glanz & Bishop, 2010).

The SCT is predominantly an explanatory theory. Proponents of SCT assert that there is a triadic, reciprocal relationship between the environment, personal factors (cognitive, affective and biological events) and behaviour (Bandura, 1998; Linke et al., 2014). In other words, the environment and personal factors influence

behaviour, which in turn influences the environment and personal factors (Bandura, 1989). The constructs outcome expectancy, self-efficacy expectancy and outcome value mediate the relationship between environmental factors, personal factors and behaviour (Bandura, 1977; Glanz & Bishop, 2010). The SCT has been applied to understand PA behaviour. For example, L. Rogers et al. (2004) applied the SCT to understand views and experiences of PA in a group of breast cancer patients, and found that perceived increase in chances of survival (outcome expectancy) was linked to increased PA, whereas fatigue hindering perception of ability to be active (self-efficacy expectancy) was linked to reduced PA. A systematic review and meta-analysis of 44 studies that tested the predictability of SCT reported that SCT accounted for 31% of variance in PA (Young, Plotnikoff, Collins, Callister, & Morgan, 2014). There are also elements of change in SCT. For example, SCT asserts that increasing PA self-efficacy predicts engagement in PA (Bauman et al., 2012; Dzewaltowski, McAuley & Blissmer, 2000; French, Olander, Chisholm, & Mc Sharry, 2014; Noble, & Shaw, 1990). Bandura advocated the use of observation, of both a person's own past experiences and the observation of others, as a strategy to increase self-efficacy (Bandura, 1977). Therefore, proponents of SCT may implement strategies to increase self-efficacy via observation-based techniques, to increase PA (Anderson, Winett, Wojcik, & Williams, 2010).

An important consideration for interventions aiming to reduce sitting and increase standing and PA is whether interventions should focus exclusively on one of these behaviours or integrate techniques targeted at influencing sitting, standing *and* PA behaviours. Two systematic reviews investigating the effectiveness of interventions to reduce sitting time in adults both reported that greater reductions in sitting were observed in interventions that focused singularly on sedentary behaviour, rather than focusing singularly on PA, or sedentary behaviour and PA in combination (Gardner, Smith, Lorencatto, Hamer, & Biddle, 2016; Prince, Saunders, Gresty, & Reid, 2014). Interventions focused on one behaviour may be more comprehensible to participants and thus result in more substantial behavioural change (Nigg & Long, 2012). However, findings from a systematic review indicate that, whilst TV viewing was inversely associated with leisure-time MVPA, total sitting time and computer use were not (Rhodes et al., 2012). Thus, an intervention that focuses purely on sitting may result in the substitution of one type of sedentary

behaviour for another (Lappalainen & Epstein, 1990) as PA and sitting have different behavioural correlates (Biddle, Gorely, & Stensel, 2004). To observe changes in sitting *and* PA, it may be necessary to target both behaviours.

Are behaviour change interventions based on psychological theories effective?

There is some evidence to suggest that theoretically informed interventions are more effective than a-theoretical interventions. For example, a meta-regression of internet-based interventions to promote health behaviours indicated that more extensive use of theory weakly, but significantly predicts increased efficacy of interventions (ß = 0.22, $t = 2.00$, $p = .049$). However, there are inconsistencies in the literature regarding the efficacy of theory in improving the effectiveness of interventions (Prestwich et al., 2014; Prestwich et al., 2015). A systematic review of reviews of dietary and PA interventions reported mixed findings; whilst one review found no association between intervention effectiveness and theory use, two reviews found that theoretically informed interventions specifically focusing on 'self-regulatory' techniques were more effective than interventions with no theoretical basis (Greaves et al., 2011). In addition, interventions promoting health behaviour change, in general, tend to have small effects, and there is a high level of heterogeneity with regards to intervention effectiveness between studies (R. Davis et al., 2015; Dombrowski et al., 2012; Michie, Carey, et al., 2016; Rhodes, Kaushal, & Quinlan, 2016).

Several potential explanations for the limited effectiveness of interventions have been considered in the literature. One explanation is that researchers are not making adequate use of theory in intervention development. For example, a systematic review of dietary and PA interventions targeted at obese adults found that less than half (44%) of the included studies reported theoretically informed interventions (Dombrowski et al., 2007). Similarly, a review of interventions to reduce adults' sitting reported that 42% of interventions were based on theory (Gardner et al., 2016) and a review and meta-analysis of general health behaviour interventions found that just over half (56%) of the interventions were theoretically informed (Prestwich et al., 2014). In addition, Prestwich et al. (2014) found that interventions based on multiple theories were less effective than those based on a single theory. It is plausible that combining theories with contradictory principles

may confound intervention effectiveness (Prestwich et al., 2015). Further, Dombrowski et al. (2007) reported that only 67% of studies reporting interventions with a theoretical basis explained why the theory was chosen, and not one of the included studies described how theory shaped the intervention development process. These findings indicate that interventions tend to be theoretically inspired rather than rigorously and systematically theoretically informed (Michie, Carey, et al., 2016).

An additional, but interrelated explanation for the limited effectiveness of interventions is poor intervention reporting within manuscripts (Hoffmann et al., 2014; Wood et al., 2016). Word restrictions imposed by scientific publication outlets prohibit the provision of detailed and specific information regarding the delivered intervention (Abraham & Michie, 2008). Such omission hinders the advancement of intervention development as it complicates intervention replication (Michie & Johnston, 2012; Wood et al., 2016). Improved reporting of theoretical application would permit an understanding of whether theoretically informed interventions are no more effective than a-theoretical interventions, or if they lack additional effectiveness due to inadequate *application* of theory. Recruitment issues, including being unable to recruit an adequate representation of participants from groups that might benefit most from the intervention (e.g. the least active and / or most highly sedentary, and ethnic minority groups) can also negatively impact trial effectiveness (Foster et al., 2011). The next subsection describes the evolution of a systematic 'behaviour change science' that was developed in view of the challenges of intervention development and reporting.

The evolution of a systematic 'behaviour change science'

Over the last decade several leading health psychologists have conducted a programme of work to systematise the development of behaviour change interventions. In 2008 the first taxonomy of behaviour change techniques (BCTs) was published (Abraham & Michie, 2008). A BCT is a "systematic procedure included as a potentially active component of an intervention designed to change behavior" (Michie, Johnston, & Carey, 2016, p. 1). In other words, BCTs refer to the *content* of interventions. Examples of BCTs include self-monitoring, goal setting and motivational interviewing (Michie, Ashford, et al., 2011). The original 26-item 'toolbox' of BCTs was compiled via an inductive process that involved consultation

of theories applicable to health behaviour change (Abraham & Michie, 2008). Thus, BCTs cut across multiple psychological theories and each technique is explicitly linked to psychological constructs (Kok, Bartholomew, Parcel, Gottlieb, & Fernández, 2014; Michie, Abraham, Whittington, McAteer, & Gupta, 2009). A process of independent coding of intervention content from three systematic reviews indicated that the toolbox of BCTs can be reliably used to identify intervention content (Abraham & Michie, 2008). In subsequent years the taxonomy was refined to refer specifically to PA and diet behaviour change (Michie, Ashford, et al., 2011) and in 2013, a taxonomy of BCTs (the BCTTv1) applicable to general behaviour change (i.e. not limited to health behaviour) was published (Michie et al., 2013).

A rationale for devising a taxonomy of BCTs was to permit an examination of *how* and *why* an intervention is successful or unsuccessful via identifying and targeting theoretical mediators such as self-efficacy and motivation (Michie, Carey, et al., 2016; Michie & Johnston, 2012; Wood et al., 2016). The inclusion of BCTs within interventions is associated with effectiveness; a meta-analysis of weight management interventions found that an additional 4.5kg weight-loss was achieved in interventions that incorporated BCTs compared to those that did not (Greaves et al., 2011). Meta-analyses of behaviour change interventions permit the quantification of the efficacy of specific techniques (Michie, 2008). A meta-analysis of diet and PA interventions revealed that including self-monitoring as a BCT is associated with increased success of the intervention (effect size = 0.42 vs. 0.26 when including and excluding self-monitoring, respectively) (Michie et al., 2009). In agreement, a more recent meta-analysis of diet and PA interventions targeted at obese adults, found that self-monitoring was an effective BCT (Dombrowski et al., 2012). Other BCTs found to enhance the effectiveness of interventions include provision of instructions, relapse prevention and prompting practice (Dombrowski et al., 2012).

A toolbox of techniques permits the incorporation of various theories that target different mediators of behaviour within interventions (Kok et al., 2014). Targeting a variety of constructs *appropriately* (i.e. selecting a variety of constructs that are not based on contradictory premises) may result in a larger increase in the desired outcome behaviour than utilising one theory (Kok et al., 2014; Michie, van Stralen, & West, 2011). However, a meta-analysis conducted by Dombrowski et al. (2012) provided only partial support for this hypothesis. Whilst an increased number

of BCTs was linked to increased effectiveness for weight-loss outcomes, with the number of BCTs explaining 16% of between-study heterogeneity, there was no evidence of a relationship between number of included BCTs and PA outcomes (Dombrowski et al., 2012). It has been hypothesised that linking BCTs to theoretical constructs may facilitate improved selection and reporting of intervention content (Abraham & Michie, 2008; Michie et al., 2009). However, there has been limited improvement in the characterisation and design of interventions since the publication of the BCT taxonomy (Hoffmann et al., 2014). Further, it is important to report characteristics of interventions including the setting, population, and mode of delivery (Greaves et al., 2011; Hoffmann et al., 2014). Therefore, comprehensive frameworks for designing and reporting interventions, with a wider focus than intervention content, have been devised. One such framework is the Behaviour Change Wheel (BCW) (Michie, van Stralen, et al., 2011).

The BCW was devised via synthesising 19 behaviour change frameworks identified via a systematic review process (Atkins & Michie, 2013; Michie, van Stralen, et al., 2011). The BCW is composed of three layers; sources of behaviour (inner layer), intervention functions (middle layer) and policy categories (outer layer) (Michie, van Stralen, et al., 2011). The core component of the BCW contains the COM-B model, which refers to the influence of capability, opportunity and motivation on behaviour (C. Wilson & Marselle, 2016). COM-B synthesises 83 theories and 1659 theoretical constructs and is claimed to incorporate all behavioural determinants (Michie, Atkins, & West, 2014; Ogden, 2016). The middle layer (intervention functions) identifies nine aims of interventions including education, persuasion, and environmental restructuring, whilst the outer layer (policy categories) identifies seven strategies to deliver the intervention including legislation and environmental planning (Atkins & Michie, 2013; Michie, 2014; Michie, van Stralen, et al., 2011). Specific BCTs have been linked to intervention functions (Atkins, 2015; Cane et al., 2012; Fulton, Brown, Kwah, & Wild, 2016; Sinnott et al., 2015). Thus, the framework can be used alongside the BCTTv1 to assist in the characterisation and design of interventions. Michie, Atkins, et al. (2014) outlined an eight-step intervention development process based on the BCW, to assist in identifying what needs to change, and identifying intervention options relating to

policy categories, mode of delivery, and intervention functions and content (Sinnott et al., 2015; J. Webb, Foster, & Poulter, 2016).

Recently, several papers outlining the intervention development process using the BCW have been published, including an intervention to increase use of smoking cessation services (Fulton et al., 2016) and an intervention to encourage health professionals to deliver very brief PA advice to people affected by cancer (J. Webb, Foster, et al., 2016). Pilot data indicate that the latter intervention was feasible and acceptable to health professionals, and increased the delivery of PA advice at 12-weeks ($p < .01$) (J. Webb, Hall, Hall, & Fabunmi-Alade, 2016). Psychological approaches have been widely adopted in research, practice and policy, however, such approaches have also been critiqued in the academic literature (Linke et al., 2014; Mansfield et al., 2015; Ogden, 2016). Limitations of adopting a psychological approach to developing behavioural interventions are considered next.

2.3.3 Limitations of psychological approaches

Most psychological theories of behaviour are only associated with small to modest effects and outcomes of interventions are highly heterogeneous (R. Davis et al., 2015; Dombrowski et al., 2012; Rhodes et al., 2016). Critical commentaries of psychological theory and the systematic behaviour change science approach are helpful in explaining the limited success of behaviour change interventions. Psychological theories of behaviour (change) have been critiqued for being too limited in scope. Some theories, such as the TPB, predict that behavioural intention tracks directly onto behavioural outcome(s), and thus, these theories heavily rely individual determinants (R. Davis et al., 2015; Ogden, 2016; Yancey et al., 2004). This implies that individuals are capable of changing their behaviour and places ultimate responsibility on individuals for their health (Maguire, 2007; McDermott, 2011; Nettleton, 2013). However, evidence from a meta-analysis of studies reporting behavioural interventions that included measures of both intention and behaviour suggests that behaviour cannot be fully predicted by intention (T. Webb & Sheeran, 2006); rather, there are many external contextual factors that could cause a person to *not* perform a behaviour, even when they desired to do so (Ogden, 2016). Whilst psychological constructs do influence behaviour, they cannot fully explain behaviour (Sniehotta et al., 2015; Speake et al., 2016). It is, however, worth noting

that some psychological theories do account for external factors (Linke et al., 2014). For example, the SCT asserts that environmental and personal factors interact to predict behaviour (Bandura, 2001). Similarly, the 'opportunity' domain of the COM-B model refers to contextual factors (Michie, van Stralen, et al., 2011; C. Wilson & Marselle, 2016). However, psychological theories treat context as a 'variable' that influences behaviour; they do not acknowledge the connectedness of individuals and context in behavioural change (Baum & Fisher, 2014; G. Williams, 2003).

Psychological approaches to designing and evaluating interventions assume the existence of a "closed system ontology" whereby there is a regular, causal relationship between interventions and outcomes (Cruickshank, 2012, p. 74). In reality, behaviour takes place in an open system, and thus is influenced by context (Gorski, 2013; Morgan-Trimmer, 2014). Interventions do not *determine* behaviour, and the level of influence of interventions varies in different contexts (Glasgow, Lichtenstein, & Marcus, 2003; Morgan-Trimmer, 2015). In other words, behaviour cannot be predicted in the manner that psychological approaches assume. In addition, recent attempts to systematise intervention design have been critiqued for removing the creativity from behaviour change science (Ogden, 2016). Innovative ideas are unlikely to emerge when following a predefined approach to intervention development (Ogden, 2016). The limitations described in this section illustrate the importance of exploring other approaches to understanding behaviour (Hawe, Shiell, & Riley, 2009; Krumeich, Weijts, Reddy, & Meijer-Weitz, 2001; Rhodes et al., 2016; Yancey et al., 2004).

2.4 Understanding lifestyle behaviour: Beyond behaviour change

2.4.1 Insights from the social determinants of health model

Social inequalities of health were first brought to public attention via the publication of the Black Report in 1980 (Kay, 2016). Since then, a plethora of research on the social inequalities of health has been conducted, which provides further evidence that social structural factors such as SES, ethnicity and gender influence health-related risk, health outcomes and mortality rates (Landstedt et al., 2009; Marmot, 2005; Marmot et al., 2011; Nakray, 2011; Shareck, Frohlich, &

Poland, 2013; S. Williams, 1995). A lower SES is associated with lower quality of life, increased health conditions and reduced mortality than having a higher SES (Marmot et al., 2011; Office for National Statistics, 2013). In 2010, the Government commissioned the Marmot review; an updated strategic review of Health Inequalities in England post 2010, based on both academic research and an extensive consultation process (Marmot et al., 2011). The primary focus of the Marmot review is SES; however, it also draws on other facets of health inequality, including gender and ethnicity (Bambra, Smith, Garthwaite, Joyce, & Hunter, 2011). The Marmot review emphasises that inequality is not limited to the poorest in society; there is a health gradient which spans the extremes of poverty and wealth (Hawe & Shiell, 2000; Nettleton, 2013). Additionally, economic health inequalities exist in every country regardless of the country's overall economic status (Kay, 2016).

Lifestyle behaviours, which are known to influence health (Ford, Zhao, Tsai, & Li, 2011; May et al., 2015), are also socially patterned. Specifically, socially disadvantaged or marginalised groups are more likely to engage in behaviours associated with health risk (smoking, inactivity etc.) and are less likely to perform 'health enhancing' behaviours (PA, healthy eating, etc.) (Humphreys & Ogilvie, 2013; Laverack, 2004; R. Lee & Cubbin, 2009; Malone, 2014). Large inter-country variation exists regarding sitting time and PA participation; for example, a representative population survey including 20 countries reported median sitting times of < 180 minutes/day in countries including Brazil and Portugal, and median sitting times > 360 minutes/day in counties including Norway, Taiwan and Saudi Arabia (Bauman et al., 2011). A likely explanation for inter-country variation in sitting time lies in cultural and socio-demographic differences between countries. Cross-sectional research has illustrated an association of social structural and contextual factors including SES, gender, ethnicity, religion, occupation and the built environment with prolonged sitting (Owen et al., 2014; Rhodes, Mark, & Temmel, 2012) and PA participation (Anokye, Pokhrel, Buxton, & Fox-Rushby, 2013; R. Hunter, Boeri, Tully, Donnelly, & Kee, 2015; Trost, Owen, Bauman, Sallis, & Brown, 2002). In addition, behaviour change interventions are typically less effective for socially disadvantaged individuals (Baum & Fisher, 2014). Whilst programmes aimed at increasing PA my increase overall health, they may also, inadvertently, perpetuate social inequalities (Humphreys & Ogilvie, 2013).

Social stratification of lifestyle behaviour provides a partial explanation for the social inequalities of health (Malone, 2014) as it indicates that structural and contextual factors constrain and shape behaviour (Burke, Joseph, Pasick, & Barker, 2009; Kay, 2016; G. Williams, 2003; S. Williams, 1995). In other words, human agency, which comprises the capacity to think, feel and act independently of social structures and relationships (Abel & Frohlich, 2012; Huot & Rudman, 2010; Spencer & Doull, 2015), is limited. Factors relating to individuals' circumstances can condition how individuals 'choose' to act and how they respond to sitting and PA interventions (Davison, Smith, & Frankel, 1991; Kay, 2016; R. Lee & Cubbin, 2009). It has been theorised that individuals reproduce social structures through their conduct (Blacksher & Lovasi, 2012) as beliefs and behaviours are largely shaped by socialisation processes (Baum & Fisher, 2014; Holman & Borgstrom, 2016). It is through this mechanism that social inequalities are proposed to be maintained (Frohlich, Corin, & Potvin, 2001; Shareck et al., 2013). However, individuals can transform structural inequalities (Frohlich et al., 2001; Ivory et al., 2015). Ability to exert influence is "unequal, multidimensional and dynamic" (Mansfield et al., 2015, paragraph 4). Empowerment theory postulates that it is possible for the capacity of less powerful, more disadvantaged individuals to take control over their actions to be increased (Rissel, 1994). Empowerment involves a psychological aspect (i.e. enhanced sense of control) and a community aspect (i.e. social and political action) (Laverack, 2004; Lord & Hutchison, 2009). Promoting a redistribution of power involves capacity building (Laverack, 2004). Improving capacity to engage in health enhancing behaviours might involve developing knowledge and skills, and intervening at the level of structures and processes (Rissel, 1994), for example via strengthening relationships between local communities, health promotion practitioners and organisations that provide funding for health-related initiatives (Mansfield, 2016). Such capacity building to redistribute power resources enables the practice of healthier behaviours and improved health via increasing individuals' control over their actions (Malone, 2014).

This section has illustrated the importance going beyond traditional behaviour change approaches to better understand sitting and PA behaviours. Recognising wider social science literature is necessary for considering how to promote change in sitting, standing and PA behaviours in real world contexts.

However, psychological constructs are valuable as they mediate the relationship between wider structural factors and behaviours (Holman & Borgstrom, 2016). The final section of this chapter outlines a theoretical approach to understanding sitting and PA behaviour that incorporates individual *and* structural/contextual constructs.

2.4.2 The socioecological model: A multidimensional approach to understanding and promoting change in sitting, standing and physical activity

The social and psychological aspects of behaviours are highly interconnected (Chappell, Ernest, Ludhra, & Mendick, 2014). Recognition of this within the health promotion field has prompted researchers to advocate for an approach that integrates the individual and the social, to more comprehensively recognise the range of influences on behaviour (e.g. Blacksher & Lovasi, 2012; Glanz & Bishop, 2010; Laverack, 2004; Merzel & D'Afflitti, 2003). The socioecological model (SEM) has grown in popularity in recent decades (Linke et al., 2014). The SEM represents a framework to examine the multitude of interconnected factors that influence health behaviours (R. Lee & Cubbin, 2009).

Principles underpinning socioecological approaches

SEMs represent a convergence of developments in disciplines including sociology, psychology, public health and biology (Richard, Gauvin, & Raine, 2011). The first SEM was proposed by McLeroy, Bibeau, Steckler, and Glanz (1988), however, many different versions of the SEM have since have been articulated in relation to both specific and general health behaviours (Glanz, Rimer, & Viswanath, 2008). For example, Sallis et al. (2006) proposed a SEM specific to PA, and Owen et al. (2011a) developed a SEM of sedentary behaviour. The aim here is not to provide a comprehensive account of the development of SEMs, but to describe the principles underpinning the socioecological approach, and to consider the implications of SEMs for designing and evaluating interventions to change sitting, standing and PA.

Systems theory principles underpin the socioecological approach (Hawe et al., 2009). Systems theory recognises that human behaviour is embedded within complex real-world ‘systems’ (Golden & Earp, 2012). Any attempt to change behaviour will not have a direct causative influence on behaviour but rather the behavioural outcome will be a product of the interaction of the intervention with all

other elements present within the system (Carey & Crammond, 2015; Paton, Sengupta, & Hassan, 2005). Therefore, the SEM posits that to understand health-related behaviours including sitting and PA, it is necessary to examine them in the context of individuals' lives (Casey, Eime, Payne, & Harvey, 2009). SEMs also draw on settings approaches (Shareck et al., 2013); there are individual and environmental influences on behaviour that "dynamically interact" (Cochrane & Davey, 2008; Glanz et al., 2008). However, the environment itself is multi-layered (Burke et al., 2009; Golden & Earp, 2012); different SEMs have described different 'levels' of influence on behaviour. Bronfenbrenner (1979) first characterised micro-, meso-, exo-, and macro-system influences on behaviour (Richard et al., 2011), which was the foundation for the five levels of influence in the first SEM: intrapersonal, interpersonal, organisational, community, and public policy (McLeroy et al., 1988). Visual depictions of the SEM usually place individual factors in the centre of a series of nested circles of influence, however SEMs do not specify an 'order' of influence (Linke et al., 2014; Richard et al., 2011). Rather, the different layers are proposed to have a dynamic and cumulative influence on behaviour. Certain environments influence people differently depending on other aspects of their lives and their belief system (Golden & Earp, 2012). In addition, most SEMs emphasise reciprocal causation (Richard et al., 2011); whilst there are various external influences on behaviour, people's actions can, in turn, influence the social context of their lives (Glanz & Bishop, 2010; A. Nelson, Abbott, & Macdonald, 2010; Sallis et al., 2006)

Implications and applications of the socioecological approach

Socioecological approaches infer that attempts to reduce sitting and increase PA should involve environmental adaptation, in addition to directly targeting individuals (Paton et al., 2005), as individuals' actions are embedded within contexts. Thus, it is important to target settings, as well as individual actions, to influence behaviour (Wall et al., 2009). Proponents of the SEM argue that targeting multiple 'levels' of external influence is likely to be more effective than targeting only one level of influence (Cleary, Gross, Zaslavsky, & Taplin, 2012; Glanz & Bishop, 2010; M. Pratt et al., 2015). Some authors acknowledge the impracticality of targeting all levels of influence and thus recommend focusing on at least two levels (Golden & Earp, 2012). In addition, SEMs advocate for the evaluation of social

processes that influence behaviour, to examine how intervention components interact with the setting to produce outcomes (Richard et al., 2011).

The SEM recognises the conditionality of human behaviour, which is not simply a theoretical issue but rather has practical and political implications (Dunning & Hughes, 2013). Health promotion discourse positions individual as the main agent of change, and 'blames' them when they engage in behaviours such as excessive alcohol consumption and smoking (Krumeich et al., 2001; Smith-DiJulio, Windsor, & Anderson, 2010; Wray, 2007). Health should be a "co-responsibility" – individuals, organisations, communities and governments should be involved in PA and health promotion (Blacksher & Lovasi, 2012). A further, yet related, implication of SEMs is that interventions should be sensitive to the delivery context, by being tailored to the setting and needs of the target group (Ewart-Pierce, Mejía Ruiz, & Gittelsohn, 2016). This may involve co-creation, i.e. incorporating key stakeholders' views into intervention development (Speake et al., 2016).

Several qualitative research investigations and reviews aimed at understanding health behaviours provide support for SEMs as they identify multiple and interacting influences on behaviour in context (Casey et al., 2009; Frohlich, Potvin, Chabot, & Corin, 2002; Haines-Saah, Oliffe, White, & Bottorff, 2013; Ivory et al., 2015; Krumeich et al., 2001; A. Nelson et al., 2010; Wray, 2007). For example, Casey et al. (2009) found that various gendered interpersonal and organisational factors, including the support of PE teachers, influenced girls' perceived sporting self-competence, which was instrumental to their participation. Ivory et al. (2015) reported that interactions between the physical environment (connectedness of road networks), social structural factors (SES; car ownership), and personal factors (preference of PA) interacted to influence residents' access to PA provision in non-local places. These qualitative examples provide support for designing and evaluating interventions using the guiding principles of the SEM.

Findings from several reviews of the intervention literature suggest that behaviour change approaches that are underpinned by the SEM, and that target multiple levels of influence, may be more effective than interventions that target individual behaviour only (Biddle, Braithwaite, & Pearson, 2014; Cleland, Tully, Kee, & Cupples, 2012; Ewart-Pierce et al., 2016; Mehtälä, Sääkslahti, Inkinen, &

Poskiparta, 2014; M. Pratt et al., 2015; Shareck et al., 2013). However, a review of behaviour change interventions identified that whilst 95% of the included interventions included individual-level strategies, only 39% included institutional-level strategies and 6% included policy-level strategies (Golden & Earp, 2012). Researchers should continue to test interventions to strengthen the evidence for involvement of strategies focused on the outer layers of the SEM, as well as different behaviours, settings, and target groups (Cleary et al., 2012; Rowley et al., 2015).

One critique of SEMs is that they fail to fully acknowledge the role of *social* structural factors that govern behaviour (Richard et al., 2011), being primarily rooted in individually focused theories and change techniques (Burke et al., 2009; Golden & Earp, 2012). For example, whilst gender and age are included in some SEMs these are categorised as 'biological' rather than 'social' and thus SEMs fail to account for the social influences of gender and age on behaviour (Kay, 2016). Factors including the sociocultural environment and structural factors such as gender, ethnicity and SES should be more adequately incorporated into socioecological approaches by drawing on the Social Determinants of Health model (Kay, 2016). This would permit a greater focus on altering the structural conditions that shape health behaviour (Kay, 2016). Future intervention research should aim to include strategies beyond the level of the individual and thus recognise the multiple and interacting factors that influence sitting and PA behaviours.

2.5 Concluding remarks

The literature reviewed in this chapter highlights the complex and multifaceted nature of PA; sitting, standing, light PA and MVPA are all valuable components of a multidimensional PA profile that intervention evaluation research should seek to capture. A further implication of the literature reviewed in this chapter is that efforts to reduce sitting and increase PA should go beyond traditional behaviour change approaches, that largely fail to recognise health inequalities and the social patterning of behaviour. Given the identified role of delivery context in shaping behaviour and intervention efficacy, the next chapter reviews extant literature relevant to the context of the present study; workplace health.

Chapter 3 – The Culture and Context of Workplace Health

3.0 Introduction

The aim of this second literature review chapter is to examine literature related to the culture and context of workplace health. The processes that influence behaviour involve interconnections between individuals and contexts, and culture represents a powerful regulatory mechanism concerning how individuals are expected to think, feel and behave (J. Martin & Siehl, 1983; Schein, 1990). Therefore, workplace culture and context have implications for understanding employee sitting and PA, and the success of interventions designed to change these behaviours. The first section (3.1) provides an overview of the development of work, the workplace and work organisations, and then provides a critical account of two theoretical approaches to understanding employees' feelings and behaviour; organisational culture and employee identity theory. The second section (3.2) examines how employee health and wellbeing have been implicated in work, which includes an overview of the healthy workplace model. The final section (3.3) positions sitting and PA as behaviours related to workplace health. This includes reviews of literature focused on the efficacy, feasibility and acceptability of workplace interventions designed to reduce sitting and increase PA. The provision of sit-stand desks as a potential intervention strategy to reduce sitting and increase PA is reviewed in detail.

3.1 Understanding work and workers

3.1.1 The dynamic nature of work, the workplace, and organisations

"Work" is commonly understood to be paid employment (Hämmig, 2014, p. 160; Haworth & Veal, 2005, p. 2); however, the conceptualisation of work is complex. Paid employment incorporates full-time and part-time roles, fixed-term, permanent and zero-hour contracts, different industries (science and technology, manufacturing, service, etc.), different purposes (profit, charity, etc.), and roles that require different sets and levels of skill, knowledge and experience which are

associated with varying levels of responsibility and remuneration. In addition, it has been recognised that domestic, childcare, and community activities, alongside unpaid employment, are also forms of work (Haworth & Veal, 2005, p. 2). This thesis is concerned with work within the labour market, which is an important component of individuals' wider identities. Work is central to SES; higher status jobs are not only higher paid, but also more secure (Siegrist, 2014, p. 21). Those with lower status jobs are subject to precarious job situations including zero-hour contracts, unpaid and unregulated employment, and less favourable work environments (Haworth & Veal, 2005, p. 15; Pyper & McGuiness, 2013; Whitehead & Phippen, 2015).

Notions of work have also varied throughout history. For example, pre-industrial work was organised around the household, with individual family members being allocated different tasks, such as producing textiles and growing produce to sell at a market (Pahl, 1988, p. 12). Whilst work represented productive labour for survival, people did not work for organisations, but rather they had concentrated lifestyles in which work, family and leisure activities were interwoven. This changed with industrialisation, which created new forms of work activity (e.g. factory jobs), and separated work spatially and temporally from other aspects of everyday life (G. Clark, 1994; Haworth, 2005, pp. 21-26; K. Thomas, 1964). Changes in the content and structure of work have continued since, and in the mid-late 20th Century the nature of employment was heavily influenced by advancements in information technology (Church et al., 2011; Siegrist, 2014, p. 17); a substantial portion of the population transitioned from production and agricultural work to sedentary, office-based jobs. The 1980s were characterised by an enterprise culture, in which individuals worked longer and harder to achieve individual success and extrinsic rewards, in corporate, office and desk-bound spaces (Cooper, 1998). The intensification of work continued into the 21st Century alongside an increase in job complexity, continuous organisational restructuring, increased emotional and social demands on workers, and reduced job security and stability (Bauer & Hämmig, 2014, p. 2; Siegrist, 2014, p. 2). Economic crises also contributed in varying degrees to changes in the nature of work, alongside changes in the demographic composition of the workforce, including growths in the proportions of older, more highly educated, and female workers (Bauer & Hämmig, 2014, p. 2; C. Chu et al., 2000). The increase in women in the workplace, for example, has been associated with a

rise in part-time employment that enables mothers to balance work and parenting roles (Hämmig, 2014, p. 156), but is also associated with gender inequalities, characterised by management and higher salary roles being disproportionately held by men (Abendroth, Melzer, Kalev, & Tomaskovic-Devey, 2016; Cha & Weeden, 2014; Fernandez-Mateo & Fernandez, 2016).

The physical space or location within which work takes place is termed the workplace, which might include an office (for an office-worker), a restaurant (for a waitress), a school (for a teacher), or a construction site (for a joiner, bricklayer, etc.), for example. However, work might also take place outside the primary workplace which complicates the categorisation of workplaces. Workplace flexibility is a defining characteristic of contemporary office-based organisations (Siegrist, 2014, p. 17), which is defined as "the degree to which workers are able to make choices to arrange core aspects of their professional lives, particularly regarding where, when and for how long work is performed" (Jeffrey Hill et al., 2008, p. 151). Workplace flexibility has challenged the traditional understanding of the work*place* as a physical space that an organisation provides for desk-based employees to work within (i.e. an office); the existence of virtual workplaces is becoming increasing prevalent and desired (Cascio, 2000). Workers telework, often from their home, and thus communicate with colleagues primarily electronically (Cascio, 2000). Allowing the worker to exercise autonomy is claimed to enable workers to more effectively meet and integrate their professional, personal, family and community needs, and can enhance work motivation and engagement (Jeffrey Hill et al., 2008).

Work organisations can be understood as groups of people that are organised around a particular purpose, and the relationships that occur between them; they are not fixed entities (Buchanan & Huczynski, 1997; Parker, 2000). Nevertheless, organisations are powerful and can exert control over their employees. For example, the industrial revolution was characterised by institutionalisation and regulation of work; processes initiated primarily by management to structure and control work, workers and organisations. Institutionalisation of work involved restrictive working practices; working conditions were characterised by long hours and hard, monotonous work (G. Clark, 1994). Nevertheless, organisations are fluid as they adapt to the influence of their members and the dynamic of external environments

(Bennis, 2002; Tuttle & Chen, 2012). Despite the controlling aspects of employment, organisations are subject to societal pressure to be more equitable to employees (Dauber, Fink, & Yolles, 2012). In the 19th Century, for example, political movements were established to address the problems of employer exploitation (Haworth, 2005, p. 25). Today, macro-structural regulatory frameworks such as health and safety laws, national and international labour and social policies, and the recognition of trade unions, shape working conditions for all and are a standard feature of the contemporary work environment (Black, 2008; Siegrist, 2014).

3.1.2 Understanding workplaces: organisational cultural theory

The changing nature of work and organisations has influenced employees' experiences of it, its meaning and significance to them, and their feelings and behaviour in the workplace. Organisational culture guides how people think, feel and act (Alvesson, 2002), by offering an "interpretation of an institutions history that members can use to decipher how they will be expected to behave" (J. Martin & Siehl, 1983, p. 52). Culture has been a central focus of academic study since the late 19th century when anthropologists sought to understand the beliefs and habits of indigenous populations (Brown, 1998; Girginov, 2010; Hatch, 1993; Sands, 2002). Culture is considered as both a product of, and an influence on, human interaction (Hogg & Vaughan, 2011). Culture is not an observable entity, rather it is manifest in the values and behaviours of groups (Alvesson, 2002, p. 1; Parker, 2000), including organisations (P. Smith, Bond, & Kâğłtçłbaşł, 2006). Early work on organisational culture stemmed, in part, from Kurt Lewin's studies of work environments that emphasised how informal social structures can influence organisational behaviour (Bellot, 2011; Brown, 1998; Mannion et al., 2008). Studies of organisational culture are, typically, premised on an assumed relationship between culture and organisational success (Brown, 1998; W. Smith & Lewis, 2011).

Conceptualising organisational culture

Organisational culture is intangible; it describes organisational realities that are not readily ascertainable but that represent an interpretation of the "richness and variation" of the organisation (Alvesson, 2002, p. 3); it resides in relations between people (Alvesson, 2002, pp. 3-6; Guldenmund, 2000; Nel & Martins, 2014; Schein, 2010, p. 18) and is developed through shared and contested values. Given the range

of disciplines that have adopted the culture concept (Alvesson, 2002, p. 3; Parker, 2000, p. 7) and its inherent ambiguity, there is no single agreed upon definition (Mannion et al., 2008); over 164 distinct definitions of organisational culture have been articulated in the literature (Edwards, Davey, & Armstrong, 2013). A commonly cited definition is "the patterns of shared basic assumptions learned by a group… taught to new members as the correct way to perceive, think and feel" (Schein, 1990, p. 111). By this definition, organisational culture is functional; it represents a regulatory mechanism concerning how workers are expected to behave (Cunha & Cooper, 2002; Guldenmund, 2000; J. Martin & Siehl, 1983). However, culture is also shaped *by* the actors within the organisation that are influenced by it (Girginov, 2010). Culture is characterised by a dynamic set of processes; developing in response to both the historical and everyday context of the organisation (Alvesson, 2002, p. 6; Parker, 2000, pp. 3-17). More specifically, organisational culture reflects the interplay of macro-organisational impacts such as the economy, regulations, and occupations, and micro-organisational factors including the organisations history, and actions of employees (Alvesson, 2002, p. 145; Brown, 1998; Schein, 2010, p. 145). The 'differentiation' perspective (J. Martin, 1992) asserts that there is an 'umbrella' organisational culture within which various interlocking subcultures reside, and that different subcultures coincide and diverge from the overall culture to varying degrees (Mannion et al., 2008; J. Martin & Siehl, 1983; Schein, 2010, p. 55). An alternative view is the 'fragmentation' perspective (J. Martin, 1992), which emphasises the ambiguity and uncertainty of organisational culture (Bellot, 2011; Mannion et al., 2008); an organisation consists of various cultural positions that are loosely connected and fluid in nature (J. Martin, 1992, p. 153). Drawing on the shared, differentiated *and* fragmented views may facilitate a more comprehensive understanding of organisational culture (J. Martin, 1995).

In a review of literature focused on culture and organisational analysis, Smircich (1983) distinguished between 'variable' and 'metaphor' conceptions of organisational culture; culture is viewed as something that an organisation *has*, or *is*, respectively (Alvesson, 2002, pp. 24-27; Girginov, 2010; Mannion et al., 2008; Nel & Martins, 2014; Parker, 2000, p. 16). The variable-metaphor distinction points to differences in underlying epistemological assumptions (Alvesson, 2002, p. 27). The variable view of culture stems from a positivist stance (Sparkes, 1992, pp. 16-18)

whereby culture is examined in the same empirical, verifiable way as natural processes (Cruickshank, 2012; Erickson, 2011), i.e. using quantitative methods (Mannion et al., 2008). Utilising quantitative methods may lead to the examination of climate rather than culture, i.e. an index or surface manifestation of culture (Glendon & Stanton, 2000; Guldenmund, 2000; Schein, 1990). In addition, chapter 2 argued that social processes are highly dependent on contextual factors (Baum & Fisher, 2014; Schein, 2010, p. 117; Sparkes & Smith, 2013, p. 14); see section 2.3.3. Accordingly, culture is positioned as a metaphor within this thesis, as this view emphasises the situatedness of cultural processes (Parker, 2000, p. 16). Cultural knowledge is socially constructed (Glendon & Stanton, 2000) and rather than being a measurable feature of the organisation, culture is the context within which organisational interpretations are formed (Alvesson, 2002, p. 26; Hatch & Schultz, 1997; Mannion et al., 2008). Whilst culture-as-variable perspectives tend to view culture as a singular entity, culture-as-metaphor perspectives recognise the multiplicity and contradiction present within organisational culture (Smircich, 1983). Given the contextually-bound nature of organisational culture, analysis should not seek to make generalisations regarding culture, however cultural analysis can build on and improve models of organisational culture (Geertz, 1973, pp. 24-27).

Organisational cultural models and theories

Schein's cultural model, which originated in the 1980s, has been commonly applied to cultural analysis (Dauber et al., 2012; Hatch, 1993). Schein articulated three domains of cultural manifestation; artefacts, values and basic assumptions (J. Martin & Siehl, 1983; Schein, 1984, 1990; 2010, pp. 23-28), which are reciprocally deterministic. Artefacts are observable, tangible aspects of an organisation such as the structures and processes, physical layout of the office, employees dress, company statements and reports, and how employees interact and behave. Whilst artefacts are readily identifiable, interpretation to understand cultural meaning requires deeper analysis (Alvesson, 2002, p. 4; Schein, 1984; 2010, p. 23). Values represent the identified rules that shape artefacts (Schein, 1990). For example, organisational strategy is reflective of espoused values (Dauber et al., 2012). Schein considers assumptions to be taken-for-granted, unobservable premises that determine group values, beliefs and behaviour, that are difficult to decipher and change as they are deeply embedded (Parker, 2000, p. 5; Schein, 1990; 2010, p. 28). However, Schein's

model is limited in *explaining* the dynamic relationship between artefacts, values and assumptions (Dauber et al., 2012; Hatch, 1993). Hatch (1993) advanced and reformulated Schein's cultural model by describing processes that link the cultural constructs (assumptions, values, artefacts) and contribute to cultural stability and change; manifestation, realisation, symbolisation and interpretation; a depiction of Hatch's cultural dynamics model is presented in Figure 3.1.

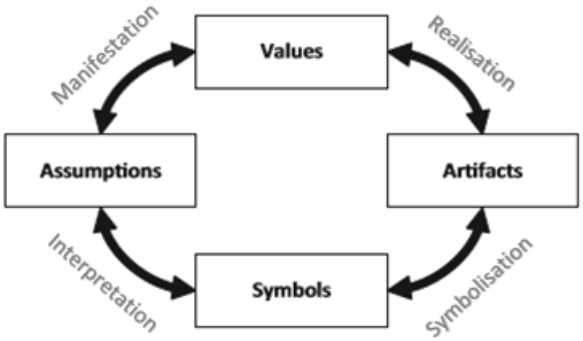


Figure 3.1. *A cultural dynamics models of organisational culture, adapted from Hatch (1993)*

The cultural dynamics perspective also differs from Schein's model in that it includes symbols as a fourth cultural domain, to emphasise the socio-symbolic, subjective nature of culture. Symbols represent the meaning of artefacts to employees (Hatch, 1993). Several principles underpin the cultural dynamics model. Firstly, each process is bi-directional. For example, manifestation processes involve the integration of taken-for-granted assumptions into identifiable values. However, values can also retroactively manifest as assumptions, for example via the introduction of new values by leaders (Brown, 1998, pp. 177-180; Hatch, 1993). Secondly, the cultural dynamics model assumes that the organisation exists in an open-system. There is no hierarchical relationship between the constructs but rather the processes co-occur and interact to guide cultural stability and change (Hatch, 1993). Accordingly, expected outcomes of a given process are not directly observable. For example, it is unlikely that an artefact can be explained by the realisation of a single value. A further implication is that culture change can be instigated, purposefully or organically, via any of the four processes. For example, less senior employees can instigate culture change by initiating informal conversations and enacting the desired change (i.e. change in artefacts) (Bate, 2004), which may become realised in organisational values.

More recently, Dauber et al. (2012) articulated the configuration model as a framework for analysing organisational culture. The configuration model considers processes that link the external environment to organisational culture (Dauber et al., 2012). This aspect of the configuration model is a useful addition to the cultural dynamics model for analysing culture within this thesis, as macro-organisational factors influence organisations (Sagiv & Schwartz, 2007; Schein, 2010, p. 275). Dauber et al. (2012) separates the external environment into the task environment and the legitimisation environment. The task environment concerns the reproduction of, and influence on, the external environment by organisational actions, and adaptations to organisational actions in response to market feedback (Dauber et al., 2012). The principle underpinning the reciprocal influence of the legitimisation environment on organisational culture is that organisations are validated by, and need to justify, their actions to various groups including employees, beneficiaries, and society. Thus, societal pressure and employee values link societal values to organisational culture (Dauber et al., 2012). For example, recruitment processes may reproduce organisational culture by choosing employees that 'fit' the culture (Schein, 1990). However, new and existing employees also introduce beliefs that shape the organisational culture (Dauber et al., 2012; Schein, 2010, p. 287) and, in turn, organisational culture shapes employee identity (Brown, 1998).

3.1.3 Understanding workers: Employee identity theory

Conceptualising identity

Work is deeply meaningful and is therefore part of a process of identification (Gini, 1998). Identity refers to people's concepts of who they are and how they relate to others (Christiansen & Bryan, 1999; Hogg & Abrams, 1988; Phelan & Kinsella, 2009). There are many ways of conceptualising identity. For example, positivist conceptualisations posit that identity is relatively unchanging (Lahberte-Rudman, 2002). Self-identity refers to an individuals' perception and classification of the self (R. Jenkins, 2000), and social identity refers to self-identification with pre-existing social categories, such as gender, age, ethnicity, and occupation (Haslam, 2014; Hogg & Ridgeway, 2003; Stets & Burke, 2000). Identity is an attribute of the individual (i.e. a 'variable') that can be measured.

Interpretivist conceptualisations posit that identity is fluid (Huot & Rudman, 2010). Symbolic interactionism, developed by Mead in the 1930s, has been highly influential on developments of the identity concept (Adams & Marshall, 1996; Christiansen & Bryan, 1999). Identity is considered to be an active, ongoing process (Lahberte-Rudman, 2002), expressed and developed through daily activities and interaction in social contexts (Adams & Marshall, 1996; Hesse-Biber, Leavy, Quinn, & Zoino, 2006; Rhodes et al., 2016; Watson, 2008). Identity involves a balance of sameness and difference and is only meaningful relative to others (R. Jenkins, 2000). For example, a senior employee can only be viewed as such in relation to a less senior employee. Thus, interpretive conceptualisations of identity do not distinguish between self and social identity, as identity is viewed as being inter-individual; individuals cannot be separated from society (Dunning & Hughes, 2013). In addition, the interpretive perspective considers identity to be socially constructed (Phelan & Kinsella, 2009). Reflexive thought is considered to be an internalised 'snapshot' of identity which, in turn, influences feelings, behaviours and interactions (Christiansen & Bryan, 1999).

Occupational identity

Identity is produced and reproduced through 'doing' (Rudman & Dennhardt, 2008) and thus the identity concept has featured prominently within the occupational science literature. Occupations are defined as meaningful activities, which includes, but is not limited to, work and employment (Huot & Rudman, 2010; Lahberte-Rudman, 2002; Unruh, 2004). Other occupations might include gardening, playing sport, or craft activities, for example. Christiansen and Bryan (1999) proposed that occupations are key to both developing and expressing identity. Occupations shape identity, and in turn, identity shapes what people do (Huot & Rudman, 2010; Phelan & Kinsella, 2009). Whilst the occupational identity literature comprises diverse perspectives, earlier theoretical discussions tended to focus on the individual and have positivist underpinnings (Dickie, Cutchin, & Humphry, 2006). Such conceptualisations de-emphasised the role of contextual factors in shaping occupational identity (Rudman & Huot, 2013). However, more recent conceptualisations have emphasised the interaction between doing and the wider structural context in developing and expressing identity (Unruh, 2004), and embody

an interpretivist perspective. For example, Unruh (2002) defined occupational identity as:

> the expression of the physical, affective, cognitive, and spiritual aspects of human nature, in an interaction with the institutional, social, cultural and political dimensions of the environment, across the time and space of a person's life span, through the occupations of self-care, productivity and leisure (p. 12)

This definition stipulates that occupations are embedded within contexts (Rudman & Huot, 2013). In further advancing identity theory, Huot and Rudman (2010) described how identity is 'performed' through occupation, and how individuals adapt their 'performance' based on the social situation. More recently, Rudman and Huot (2013) emphasised that the production and reproduction of occupational identity involves a dynamic interplay between structural and agentic factors. Similar to structural influences that govern behaviour described in chapter 2 (see section 2.4.1) individuals do not simply choose their identity, as it is constrained and enabled by social circumstance and cultural context (Holman & Borgstrom, 2016; Phelan & Kinsella, 2009). Individuals think, feel and act according to a taken-for-granted belief system that is developed through socialisation (Baum & Fisher, 2014; Veenstra & Burnett, 2014; S. Williams, 1995). Thus, whilst reflexivity gives the impression of complete free-will, beliefs about the self and expression of identity are also governed by social structure (G. Williams, 2003). Whilst identity is reproduced through choosing occupations based on one's view of oneself, identity constantly evolves via complex interactions within the social context (Lahberte-Rudman, 2002). For example, work-related factors are likely to influence employees' identities (Brown, 1998; Gini, 1998; Parker, 2000).

Employee (work) identity

Identity is constructed, developed and expressed through the social context of work (Gini, 1998; Haworth & Veal, 2005, p. 3; M. G. Pratt, Rockmann, & Kaufmann, 2006). The theorisation of work identity is well documented in management literature (e.g. Gini, 1998; Popova-Nowak, 2010; Ravasi & Canato, 2013; van Dick, 2004; van Knippenberg, 2000; Walsh & Gordon, 2008; Watson, 2008). Whilst the literature comprises diverse views regarding the work identity concept, there has been a recent shift to a more interpretive perspective (Watson,

2008). Walsh and Gordon (2008) defined work identity as the processes that shape how employees feel and act when working. This view recognises that expression of identity at work is shaped by both work and non-work-related identity processes (Popova-Nowak, 2010; Walsh & Gordon, 2008). Professional occupational identity processes refer to the integration of skills and capabilities specific to a particular occupation into work activities (Popova-Nowak, 2010). Organisational identity processes refer to individuals' interpretation of organisational culture(s) (van Knippenberg, 2000; Walsh & Gordon, 2008); cultural aspects of work are made meaningful to individuals via being incorporated into work identity formation and expression (Popova-Nowak, 2010; van Dick, 2004). For example, professionalism may be a cultural value that employees embody via managing their behaviour and emotions (Hochschild, 2003; Watson, 2008).

Employees' orientation towards work influences the extent to which work shapes identity (Zou, 2015). Historically, the work-leisure dichotomy positions work as a necessary means to enjoy non-work aspects of life (Primeau, 1996). This negative attitude towards work is reflected in the biblical construction of work as Adam's punishment for committing sin, in contrast to partaking in recreational activities in the Garden of Eden (Haworth, 2005, pp.16-17; K. Thomas, 1964). Employees that view work in this way (i.e. as a job; work to attain external rewards), are unlikely to perceive their employment as a key part of their identity. Conversely, employees who have career or calling orientation towards work value the intellectual fulfilment, task mastery, and creative self-expression opportunities that work can provide (Demerouti, Bakker, & Fried, 2012; Walsh & Gordon, 2008; Zou, 2015) and, accordingly, are likely to define themselves almost exclusively in relation to their work (Walsh & Gordon, 2008). In addition, strength of identification with the organisation is thought to be shaped by the perceived congruency between the organisational culture and one's perception of their identity (van Dick, 2004; Walsh & Gordon, 2008). Employees that strongly identify with organisational values are more likely to exhibit behaviours that reflect those values.

3.2 Work, organisations and employee health and wellbeing

3.2.1 Employee health and wellbeing as features of work

As the nature of work and organisations, and collective and individual employee attitudes towards work, have evolved, so have the implications of work for employee health and wellbeing. It has been argued that participating in work is critical to maintaining positive mental, physical and social health and wellbeing (Lahberte-Rudman, 2002; Nel & Martins, 2014; Waddell & Burton, 2006; Wilcock, 2007). Work provides people with meaning and purpose and thus is a basic human need (Haworth, 2005, p. 168; Lahberte-Rudman, 2002; Rudman & Dennhardt, 2008; Wilcock, 1993). However, work is not unproblematically associated with improved health and wellbeing. In fact, work can negatively impact employee health and wellbeing (Margolis & Walsh, 2003). For example, there is some emerging evidence about the possibility of physical working conditions, such as seated desk-based workspaces, contributing to poor musculoskeletal and cardiometabolic health (Buckley et al., 2015). In addition, a number of systematic reviews of the literature indicate that aspects of the psychosocial work environment, such as job insecurity, low social support, and high job demands, are associated with mental health disorders including stress and depression (e.g. Bonde, 2008; Nieuwenhuijsen, Bruinvels, & Frings-sen, 2010; Stansfeld & Candy, 2006).

A common goal for most organisations is organisational success via enhanced efficiency and attainment of organisational outcomes (Kalliath & Kalliath, 2012). Throughout history, changing ideologies and workplace practices relating to organisational efficiency have implicated employee health and wellbeing (Karlsson, 2010). For example, scientific management, an early but enduring theory of organisational efficiency, contributed to the changing nature of work in the 19th and early 20th Century (Berridge, 1992; D. Nelson, 1974). Taylor's scientific management approach predominantly focused on the standardisation and mechanisation of work procedures, a consequence of which was the de-skilling and reduced autonomy of workers (Deadrick & Stone, 2014; Grachev & Rakitsky, 2013). Economic efficiency was emphasised at the *expense* of worker health and wellbeing (Deadrick & Stone, 2014). A growing recognition of the value of human resources with regards to maximising organisational efficiency emerged throughout the 20th

Century (Berridge, 1992). Human Resources Management gained acceptance in academia and in practice in organisations; an approach that prioritises "the moral and social needs of human beings in the design of work" (Marciano, 1995, p. 223). Maslow's and McGregor's social psychological theories, for example, purport that employees' needs, behaviour and motivation are central to organisational success (Hämmig, 2014; Sorensen & Minahan, 2011; I. Wilson & Madsen, 2008). Contemporary approaches, therefore, recognise that key to improving organisational efficiency is supporting employees' health and wellbeing (Browne, 2000).

National and international policies set standards for workplaces in supporting employee health. A healthy workplace has been defined by the World Health Organisation (2010) as "one in which workers and managers collaborate to use a continual improvement process to protect and promote the health, safety and wellbeing of all workers and the sustainability of the workplace" (p. 6). The political discourse, therefore, positions the development of a healthy workplace as being beneficial for both individual employee health and organisational efficiency (Lindberg & Vingård, 2012; M. Wilson, DeJoy, Vandenberg, Richardson, & McGrath, 2004) In addition, it advocates a holistic approach to worker and workplace health, in contrast to past regulations that focused on minimising harm through restrictions on working hours, for example (Browne, 2000). The Workplace Wellbeing Charter is a tool available to organisations registered in England to accredit themselves against a set of wellbeing standards, in order to "maximise the potential of their staff" and have "large impacts on staff health" (Health@Work, 2014, p. 4). Thus, organisations that commit to the charter are directly influenced by the healthy workplace political discourse. One example of an innovative company whose philosophy aligns with the political discourse is Google. Google has strategically designed policies and practices to challenge and engage 'Googler's' whilst minimising distractions of daily life. This includes a flat management structure, Google University (development opportunities), and access to free onsite healthy meals, massages, bicycles, dry cleaning, and video games (Business in the Community, 2009; Google, 2015). Google's low turnover rate of 5% is attributed to the company focus on employee wellbeing (Business in the Community, 2009).

3.2.2 The healthy workplace model

Over 74 % of UK adults aged 16-64 are employed (Office for National Statistics, 2017) and organisations have infrastructures which enable health promotion. Accordingly, the workplace has been identified by researchers (e.g. C. Chu et al., 2000; Danna & Griffin, 1999; Kuoppala, 2008) along with policymakers, as a priority setting for promoting employee. Within the organisational literature, a healthy workplace refers to the characteristics of organisations that can impact employee health and wellbeing and organisational outcomes (Grawitch et al., 2006; Kalliath & Kalliath, 2012; Lindberg & Vingård, 2012; Sauter, Lim, & Murphy, 1996; M. Wilson et al., 2004); see diagram 3.2. Academic research has investigated the nature or characteristics of a healthy workplace, and the strength of the relationship between developing a healthy workplace, and employee health and organisational success.

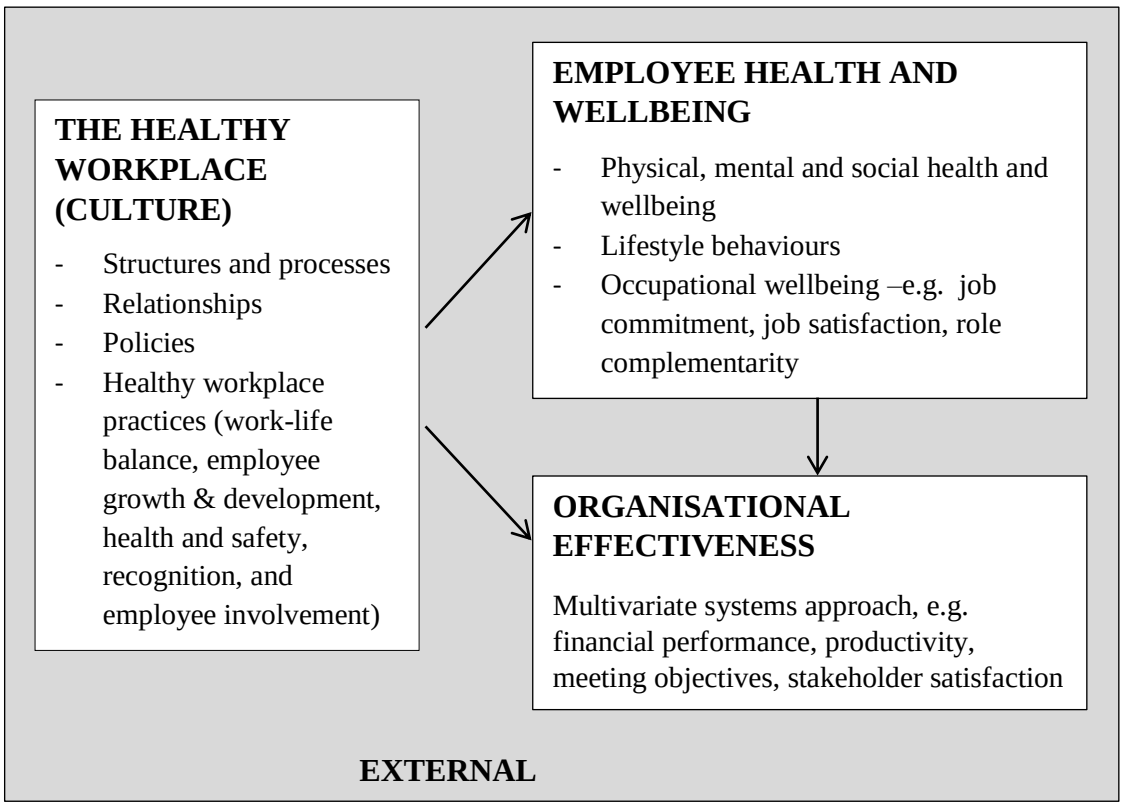


Figure 3.2. *The healthy workplace model, adapted from Grawitch, Gottschalk, and Munz (2006, p. 133)*

The healthy workplace model is theoretically consistent with the SEM; a theoretical approach to understanding and changing behaviour described in section 2.4.2, as it recognises the range of factors, on different levels, that influence

behaviour. However, the healthy workplace model is complementary to the SEM - which can be applied within and across settings - as it has a more specific focus; the workplace setting, whilst also recognising how factors outside the workplace can influence work-related behaviours and outcomes. The healthy workplace model postulates a relationship between organisational conditions, employee behaviour, employee health and organisational outcomes, which is particularly useful for understanding the effect of health-related interventions within and upon the workplace setting.

The healthy workplace (culture)

Research studies have attempted to characterise the healthy workplace (Wadsworth, Chaplin, Allen, & Smith, 2010). A systematic review identified five healthy workplace practice categories: work-life balance, employee growth and development, health and safety, recognition, and employee involvement (Grawitch et al., 2006). The five categories are not all-encompassing; other features of a healthy workplace include teamwork, role complementarity, programme management and leadership (Eriksson, Axelsson, & Axelsson, 2011; Karlsson, 2010; Lin & Lin, 2014; Lindberg & Vingård, 2012). In addition, different practices have been shown to generate varying levels of success within different organisations (Fitz-enz, 1993), and it has been recognised that there should not be a static set of practices that constitutes a healthy workplace in all circumstances (Jáimez & Bretones, 2011; M. Wilson et al., 2004). A healthy workplace culture is positioned as encapsulating health workplace practices and interventions, and the wider workplace culture (Pronk, 2012; Pronk, Allen, & Pronk, 2009). In other words, healthy workplace practices are not separate from the workplace culture and context (C. Chu et al., 2000). Thus, if practices or interventions are inconsistent with the organisational culture they are unlikely to be successful (Hoebbel, Golaszewski, Swanson, & Dorn, 2012; K. Jenkins, Fakhoury, Marzec, & Harlow-Rosentraub, 2014; Pronk, 2012). Conversely, if health is valued by the organisation it is likely to be reflected in shared organisational structures, processes and behaviours (Lin & Lin, 2014)**.**

The healthy workplace and employee health and wellbeing

Health is described as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” (World Health

Organisation, 2006), and subjective wellbeing consists of life satisfaction, worthwhileness, happiness and anxiety (Shenton, Siegler, Tinkler, & Hicks, 2012). Health and wellbeing are also positioned as a thing that people *do* and maintain via engaging in lifestyle behaviours such as PA and healthy eating (Campbell, 2007; McDermott, 2011). Workplace health promotion has evolved in line with wider evolving conceptualisations of health and wellbeing (Grawitch et al., 2006). Initial efforts to enhance employee health, arising in the early 1970's, were concerned with minimising poor health rather than maximising positive health and wellbeing (C. Chu et al., 2000), whereas more recent approaches are holistic; recognising various interacting influences on workplace health and wellbeing (Eriksson et al., 2011). It is valuable to distinguish between general health and wellbeing and work-related wellbeing (Jáimez & Bretones, 2011). Work-related wellbeing is concerned with how people feel about themselves in relation to their job, and involves dimensions such as job satisfaction, burnout, and work engagement (Rothmann, 2008). Work-related wellbeing may be enhanced via being part of a healthy workplace (Kamel & Hashish, 2015), and is also linked to improved work performance (Cotton & Hart, 2003). However, general health and wellbeing are also linked to organisational efficiency via for example reduced sickness absence.

The healthy workplace and organisational effectiveness

Organisational effectiveness is a multidimensional concept (Herman & Renz, 1999; Martz, 2013; Redshaw, 2000); a variety of organisational outcomes including productivity, absenteeism, turnover and service quality influence organisational effectiveness and success (Grawitch et al., 2006). The empirical 'healthy workplace' literature largely assumes that the primary goal of an organisation is to maximise profits, but this overlooks the objectives of public and charitable organisations. Although there are financial indicators of effectiveness for non-profit organisations, such as fundraising efficacy and fiscal performance (Ritchie & Kolodinsky, 2003), this is not the ultimate function of the organisation. It may be more appropriate to evaluate the effectiveness of non-profit organisations in moral or value terms, to align with organisational objectives (Herman & Renz, 1999). The effectiveness of non-profit organisations is not reducible to a univariate measure (Herman & Renz, 1999; Ritchie & Kolodinsky, 2003) and thus a holistic approach to examining the impact of healthy workplaces on organisational effectiveness should be adopted.

Empirical literature supports a direct relationship between healthy workplaces and organisational effectiveness (Karakolis & Callaghan, 2014; Samad, Reaburn, Davis, & Ahmed, 2015; Wang, 2008), and an indirect relationship via improved employee health and wellbeing (Karlsson, Björklund, & Jensen, 2010; M. Wilson et al., 2004). For example, a prospective study of 2095 employees from 4 companies within Sweden provides evidence that the relationship between psychosocial work factors and production loss, measured via sickness absence and presenteeism, is mediated by employee health by varying degrees for different aspects of the psychosocial work environment (Karlsson, Björklund, & Jensen, 2010). However, the prospective study design is not capable of providing evidence of a *causal* relationship between the work environment, employee health and organisational effectiveness. More widely, the empirical literature relating to the organisational benefits of healthy workplaces is subject to limitations that reduce the adequacy of the healthy workplace model. Research studies are often of low methodological quality; they lack control groups, are non-randomised, consist of small samples, and rarely examine organisational context (Grawitch et al., 2006). Further, much of the literature has been produced in the USA, and thus the healthy workplace model may not be representative of UK organisations (Lindberg & Vingård, 2012). Notwithstanding these issues, the healthy workplace model is a valuable tool for appraising workplace health interventions.

Most recent workplace health interventions have been framed by wider public health concerns about population levels of sedentary behaviour (Ekelund et al., 2016); chapter 2 identified potential health-risks associated with sitting, and the health benefits associated with PA (see section 2.2.2). Office-based workplace environments are conducive to prolonged sitting. Observational studies have consistently shown that office-workers sit for over two-thirds of the working day (Parry & Straker, 2013; Ryde, Brown, Gilson, & Brown, 2013; L. Smith, Hamer, et al., 2015). Therefore, attempts to reduce sitting and increase PA at work can be positioned as workplace health interventions, as such interventions may be expected to improve employee health and lead to organisational benefits.

3.3 Promoting physical activity and reducing sitting in the workplace

3.3.1 Effectiveness of workplace interventions to reduce sitting and increase physical activity

Establishing the effectiveness of workplace interventions to increase PA has been the primary aim of a number of systematic reviews, to assist practitioners in selecting strategies to implement (Loitz, Potter, Walker, McLeod, & Johnston, 2015). Several systematic reviews have included a meta-analysis and thus have quantified the effect of workplace interventions on PA outcomes. Earlier reviews reported a small non-significant effect of workplace interventions on PA (Dishman, Oldenburg, O'Neal, & Shephard, 1998; A. Marshall, 2004). However, more recent meta-analyses have revealed small significant effects of PA interventions; overall effect sizes were 0.21 (Conn, Hafdahl, Cooper, Brown, & Lusk, 2009; N. Taylor, Conner, & Lawton, 2012) and 0.23 (Abraham & Graham-Rowe, 2009). The difference in findings between the earlier and more recent reviews may reflect the methodological quality of the included studies; only 10 of the 26 studies included in the review by Dishman et al. (1998) met the inclusion criteria for the review by Abraham and Graham-Rowe (2009). An additional explanation is that more recent interventions are more effective due to advancement in knowledge regarding effective strategies to increase PA in the workplace context (Dugdill, Brettle, Hulme, McCluskey, & Long, 2008). However, the systematic reviews are subject to various limitations. Indirectness affects the quality of the reviews conducted by Abraham and Graham-Rowe (2009) and Conn et al. (2009); both reviews aim to understand the effect of workplace interventions on employees' PA, but then exclude interventions from the review that include employees with pre-existing health conditions, who represent approximately 20% of the European workforce (Corral, Durán, & Isusi, 2014). In addition, the reviews lack transparency regarding the screening process for excluding papers generated by the database searches, including whether cross-checking occurred and whether and how discrepancies between reviewers were resolved (Abraham & Graham-Rowe, 2009; Conn et al., 2009).

The small but positive effect of workplace interventions on PA mirrors the findings of PA and public health interventions more broadly (Hutchinson & Wilson, 2012); see section 2.3. However, the meta-analyses reported significant

heterogeneity in PA outcomes between interventions. For example, whilst Abraham & Graham-Rowe (2009) reported an overall small but significant effect of the included interventions on PA outcomes (ES = 0.23), individual effect sizes of interventions ranged from -0.04 to 0.95. The heterogeneity index (I^2) reports the percentage of variation between studies not due to chance (Gagnier, Moher, Boon, Beyene, & Bombardier, 2012); within the review by Conn et al. (2009) this was between 61% and 92% for PA outcomes, depending on study design. The value of calculating an overall effect size across diverse interventions (clinical heterogeneity) and research studies (statistical heterogeneity) is questionable (J. Fletcher, 2007). Rather, it may be more useful to understand the characteristics of workplace interventions associated with increased effectiveness.

Interventions that have different functions, such as a focus on information provision compared to environmental restructuring, and that are delivered to different groups in different workplace settings are likely to result in different PA outcomes (Gorski, 2013; Linke et al., 2014). Walking (Abraham & Graham-Rowe, 2009; Dugdill et al., 2008), education (Hutchinson & Wilson, 2012; Malik, Blake, & Suggs, 2014), social support (Hutchinson & Wilson, 2012), motivational strategies including goal setting and self-monitoring (Dishman et al., 1998; A. Marshall, 2004), and counselling (Kwak et al., 2014; Malik et al., 2014) have all been identified as effective strategies to increase PA in reviews of workplace intervention studies. Chapter 2 highlighted the value of incorporating theory into intervention development and evaluation. A meta-analysis by N. Taylor et al. (2012) revealed that workplace PA interventions that explicitly incorporated theory into intervention development were more effective than implicit theory use or a-theoretical interventions (ES = 0.34, 0.18 and 0.21, respectively). The majority of workplace PA interventions are based on psychological theories (Hutchinson & Wilson, 2012); the TTM being the most widely cited theory in the literature (Malik et al., 2014). Thus, workplace PA interventions are largely individually-oriented. There has been a limited focus on contextual factors that may influence effectiveness of workplace PA interventions, even though factors such as age, gender, SES, and environmental and organisational level factors are known to influence intervention effectiveness (Baum & Fisher, 2014; Greaves et al., 2011); see section 2.4.

Interventions to reduce workplace sitting are a relatively recent focus as the potential health risks associated with prolonged sitting are less established than the health benefits of PA (Healy et al., 2012). However, there has been a proliferation of intervention studies that include sitting as a primary or secondary outcome in the last decade. Chau et al. (2010) conducted the first systematic review of the effectiveness of workplace interventions to reduce sitting, concluding that workplace interventions did not yield reductions in sitting. Whilst the interventions were heterogeneous, involving components such as counselling, pedometers, walking route information, and email support, they all targeted the individual level only (Chau et al., 2010). More recently, a meta-analysis of pooled effect of 21 intervention studies on sedentary behaviour in white-collar workers reported a significant sitting reduction of 39.6 minutes/8-hour workday across the studies (A. Chu et al., 2016). However, the analysis was subject to large, significant heterogeneity ($I^2 = 83.6\%$) meaning there is little value in knowing the pooled effect of the included studies. Whilst individually-oriented approaches still dominate in the workplace literature (Kwak et al., 2014), recent systematic reviews targeting workplace sitting reduction reveal that interventions have started to include environmental changes (A. Chu et al., 2016; Shrestha et al., 2016). A. Chu et al. (2016) reported that 100% (n = 6) of environmental change interventions significantly reduced sitting (sitting reduction in individual studies ranged from 140.1 – 28.8 minutes/8-hour workday), compared to only 20% (n = 15) of interventions focused on educational/behavioural strategies. Meta-analytic data indicates that there is weak evidence that workplace interventions combining environmental changes and counselling can reduce workplace sitting by 24%, whereas policy and mindfulness strategies were not associated with intervention effectiveness (Shrestha et al., 2016). These findings provide support for incorporating environmental changes, such as sit-stand desk provision, to improve the effectiveness of workplace interventions.

3.3.2 Sit-stand desks as a workplace health strategy

Sit-stand desks are commercially available and thus represent potential workplace health adaptions (Dunstan et al., 2013). Sit-stand desks may facilitate reduced workplace sitting, as they permit regular postural change (Parry, Straker, Gilson, & Smith, 2013). Sit-stand desks are largely considered a health and safety

practice, as they may facilitate the prevention, management and treatment of potential health risks and conditions (Wadsworth et al., 2010).

Sit-stand desks and workplace sitting and physical activity

Evidence from systematic reviews indicate that provision of sit-stand desks reduces workplace sitting, however sitting reduction varies between studies, from 30 to 143 minutes per 8-hour workday (Neuhaus, Eakin, et al., 2014; Shrestha et al., 2016; Tew, Posso, Arundel, & McDaid, 2015; Torbeyns et al., 2014). Further, some sit-stand desk intervention studies that were not included within these systematic reviews, due to not meeting study quality inclusion criteria or being outside of the date range of the systematic reviews, have reported intervention effects outside the range of 30 to 143 minutes reduction in sitting per 8-hour work day (e.g. Gorman et al., 2013). The heterogeneity in sitting reduction between studies is explored in detail in chapter 5 (see section 5.3.3). However, one important factor is whether the sit-stand desk was employed as a standalone intervention or as part of a wider intervention. In some studies, (Healy et al., 2013; Neuhaus, Healy, Dunstan, Owen, & Eakin, 2014), sit-stand desk provision comprised part of a multicomponent intervention aimed at reducing sitting in the workplace. For example, Neuhaus, Healy, et al. (2014) compared a multicomponent intervention (including sit-stand desk provision alongside individual and organisational level strategies), to sit-stand desk provision only and a usual seated desk control. Sitting time was reduced by an extra 56 minutes in the multicomponent intervention group than the sit-stand desk only group. Thus, in line with a socioecological approach (see section 2.4.2), inclusion of multiple strategies at different levels is likely to result in greater reductions in sitting (Shrestha et al., 2016).

Standing at a sit-stand desk may encourage more incidental PA at work (Tudor-Locke, Schuna, Frensham, & Proenca, 2013). In support of this hypothesis, Straker, Abbott, Heiden, Mathiassen, and Toomingas (2013) found that it took 10 minutes less to accumulate five minutes of walking when working at a sit-stand desk compared to a usual seated desk. However, most field-based studies that have examined the contribution of sit-stand desks to workplace PA have reported no change in PA outcomes, including steps (Chau, Daley, Dunn, et al., 2014; Chau et al., 2016; Dutta, Koepp, Stovitz, Levine, & Pereira, 2014; Graves, Murphy,

Shepherd, Cabot, & Hopkins, 2015; Healy et al., 2016; Healy et al., 2013; Pronk, Katz, Lowry, & Payfer, 2012), light PA (Crandall, Zagdsuren, Schafer, & Lyons, 2016; Miyachi et al., 2015) and MVPA (Crandall et al., 2016; Danquah et al., 2016). However, there is some evidence of an initial increase in steps (Alkhajah et al., 2012) and light and MVPA (Mansoubi, Pearson, Biddle, & Clemes, 2016), that is not maintained over time. Additional strategies may be required to encourage sustained increases in workplace PA. A small number of field-based sit-stand desk intervention studies that have utilised accelerometers to estimate EE have reported a small but significant increase in EE (Dutta et al., 2014; Miyachi et al., 2015). Given that these studies reported no change in steps, it is plausible that the additional EE was accumulated via increased standing. This is supported by a number of controlled experimental studies that report a slight increase in EE when standing compared to sitting (Tudor-Locke et al., 2013).

Sit-stand desks and employee health and wellbeing

Field-based studies that have examined the influence of sit-stand desk provision on physiological health have observed either only slight positive changes (Alkhajah et al., 2012; Graves et al., 2015; Healy et al., 2013) or no changes (Carr, Swift, Ferrer, & Benzo, 2016; Gorman et al., 2013) in cardio-metabolic risk factors. For example, Healy et al. (2013) reported that whilst there was a significant, positive change in blood glucose following a sit-stand desk intervention, there was a weak adverse effect on triglycerides. Cardio-metabolic changes are more pronounced in experimental studies whereby standing is enforced (e.g. Buckley et al., 2014; Thorp et al., 2014). Thus, sitting reduction following sit-stand desk provision may not be sufficient to produce meaningful physiological changes. Two systematic reviews concluded that sit-stand desks have no effect on anthropometric measures including body mass index and waist circumference (MacEwen et al., 2015; Tew et al., 2015). However, one study that provided sit-stand desks alongside other strategies found significant reductions in body fat percentage (Danquah et al., 2016).

Static postures are associated with MSD (Korhonen et al., 2003; Manchikanti, 2000). Possible mechanisms include an increased load on the spinal column (prolonged sitting) muscle fatigue (prolonged standing), and little variation in intra-disc pressure (lack of movement) (Garcia, Läubli, & Martin, 2015; Kraemer,

1995). Sit-stand desks may reduce MSD by permitting frequent postural change. A recent review revealed that, in 6 of the 7 studies that met the inclusion criteria, sit-stand desk use was associated with MSD reduction (Karakolis & Callaghan, 2014). The effect of sit-stand desks on subjective wellbeing is unclear; studies have reported both positive changes (Dutta et al., 2014; Pronk et al., 2012) and no changes (Husemann, Von Mach, Borsotto, Zepf, & Scharnbacher, 2009). Whilst Dutta et al. (2014) and Pronk et al. (2012) reported on natural experiments in the workplace environment, the study conducted by Husemann et al. (2009) was a controlled experiment and thus it is plausible that the laboratory environment confounded any potential wellbeing benefits (Elliott, Carr, & Savage, 2004; Gauvin, Rejeski, & Norris, 1996).

Sit-stand desks and organisational outcomes

PA and public health researchers have examined the impact of sit-stand desks on productivity in controlled and natural settings, as organisational benefits represent a business case for employers to install sit-stand desks within their offices (Gilson, Straker, & Parry, 2012; Pronk & Kottke, 2009). A recent review of empirical studies that have examined the relationship between sit-stand desks and productivity reveals mixed findings; some studies report a small increase in productivity whilst others report no change (Karakolis & Callaghan, 2014). It is likely that differences in productivity outcomes are partially due to differences in how productivity is defined and measured. For example, different measures of productivity have been utilised in research, such as volume of work completed (e.g. K. Davis, Kotowski, Sharma, Herrmann, & Krishnan, 2009), absenteeism (e.g. Nerhood & Thompson, 1994), worker self-reported productivity (e.g. Alkhajah et al., 2012) and quantitative tests that assess cognition, memory and attention (e.g. Ohlinger, Horn, Berg, & Cox, 2011). Whilst sit-stand desk provision does not appear to increase productivity, it is a complex phenomenon as many jobs do not have a clearly defined and measurable output (Mattke, Balakrishnan, Bergamo, & Newberry, 2007). Further, investigations into the effect of sit-stand desk provision on organisational outcomes is limited as it focuses on a single predictor (i.e. productivity) of organisational success (Karakolis & Callaghan, 2014). On the contrary, organisational success is a multidimensional construct that depends on a number of interrelated internal and external factors (Herman & Renz, 1999; Martz, 2013; Redshaw, 2000).

3.3.3 The feasibility and acceptability of reducing sitting and increasing physical activity in the workplace

Workplace interventions to reduce sitting and increase PA can be effective, and providing sit-stand desks may be particularly efficacious. However, intervention effectiveness varies in different contexts (Gilson et al., 2012; Gorski, 2013). Workplace interventions are not isolated events but rather sit within the context and wider practices of the organisation and employees' lives (Such & Mutrie, 2016). Consequently, it is necessary to investigate the processes that influence sitting and PA behaviour at work, and the feasibility and acceptability of workplace interventions, from the perspectives and lived experiences of employees (Cooley, Pedersen, & Mainsbridge, 2014; Dixon, 2009; Morgan-Trimmer, 2015).

Employee perceptions of increasing physical activity in the workplace

Many research studies oriented within the exercise psychology discipline have adopted a motivational theory lens to identity barriers and facilitators to increasing PA at work in a number of different public and private office-based organisations (e.g. Bennie et al., 2010; Bredahl, Særvoll, Kirkelund, Sjøgaard, & Andersen, 2015; Dixon, 2009; Edmunds, Hurst, & Harvey, 2013; G. M. Fletcher, Behrens, & Domina, 2008; Tavares & Plotnikoff, 2008; W. Taylor et al., 2013). Some reported barriers and facilitators to PA in the workplace setting are consistent with those recognised in the broader exercise psychology literature (Trost et al., 2002). Such barriers include a lack of knowledge of the benefits of PA, self-consciousness, and a lack of discipline and motivation, and facilitators include social support and external motivators including appearance and weight-loss (Dixon, 2009; G. M. Fletcher et al., 2008; Tavares & Plotnikoff, 2008). However, many workplace specific factors have also been identified. For example, employees perceive that unsupportive policies, short work breaks and a high work load limit the feasibility of incorporating PA into the working day (Bennie et al., 2010; Tavares & Plotnikoff, 2008). Dixon (2009) reported that some employees perceive rigid work structures as an immovable barrier to workplace PA, whereas other employees felt able to negotiate power relations and contest rigid work schedules to integrate PA into their working day. Working mothers considered being active at work "indulgent" as PA was prioritised beneath both working and parenting (Dixon, 2009). It has been

suggested that women feel less ‘entitlement’ to engage in physically active leisure pursuits than men (Kay, 2000); mothers can more easily negotiate spending time and money on their children’s wellbeing than their own (Miller & Brown, 2005).

Supportive management such as modelling PA behaviour and allowing flexible lunch hours increases the acceptability of workplace PA (Dixon, 2009; Tavares & Plotnikoff, 2008; W. Taylor et al., 2013). However, Bort-Roig et al. (2014) and Cole, Tully, and Cupples (2015) reported that many employees prefer to engage in PA outside of the working day. It is implicit in the culture of many organisations that work should be prioritised; employees perceived that a consequence of taking time away from the desk to do PA would be being viewed as less hardworking than their colleagues (Bort-Roig et al., 2014; Bredahl et al., 2015; Edmunds et al., 2013). Rossing and Jones (2015) conducted observations and qualitative interviews with workers partaking in a worksite PA programme and found that, for less skilled exercisers, their exercise identity conflicted with their professional identity of a ‘competent’ worker. Other employees constructed the worksite PA programme as being health and productivity enhancing, and thus contributory to their professional identity, as a justification for being active during work hours (Rossing & Jones, 2015).

Employee perceptions of reducing sitting and increasing standing in the workplace

Some employee perceptions of the feasibility and acceptability of workplace PA are also relevant to sitting reduction, including a high workload limiting employees’ ability to take frequent breaks (Hadgraft et al., 2016; Mackenzie, Goyder, & Eves, 2015). This reveals organisational cultural assumptions regarding the value of prioritising work (Daley et al., 2016; Such & Mutrie, 2016). There is social pressure to sit for prolonged periods during work hours, as productivity is conflated with being at the desk (Cole et al., 2015; De Cocker et al., 2015; Gilson, Burton, van Uffelen, & Brown, 2011). Employees perceive that management support is required to elicit the normalisation of taking breaks away from the desk to reduce workplace sitting (Gilson, Burton, et al., 2011). Research has highlighted the habitual nature of sitting in office-based workplaces, and that standing is perceived as ‘weird’ in the office-based workplace context (De Cocker et al., 2015; Hadgraft et

al., 2016). Particularly in Asian cultures, standing can be perceived as aggressive (C. Waters et al., 2016). Self-consciousness and social discomfort limit the acceptability of standing in the workplace (Biddle et al., 2017; Chau et al., 2016). However, some studies found that sitting reduction interventions can elicit a change in perception regarding the necessity of sitting at work (Cooley et al., 2014).

Whilst some studies illustrate that employees are aware of the potential health risks of prolonged sitting, this is usually in academic departments that conduct research in this area (e.g. C. Waters et al., 2016). A lack of understanding of the potential physiological risks of prolonged workplace sitting may be a contributory factor to why sitting is the norm in office-based workplaces (Biddle et al., 2017). In fact, from employees' perspectives, the primary rationale for reducing workplace sitting is to relieve occupational concerns, particularly MSD (Bort-Roig et al., 2014; Cole et al., 2015; De Cocker et al., 2015). Research studies have identified that some employees believe that replacing prolonged sitting with prolonged standing could be detrimental to health (De Cocker et al., 2015; Gardner, Smith, et al., 2017). Office-based employees feel that the nature of their work prohibits them from taking standing or active breaks from their desk, as the majority of work tasks involve using a computer (Biddle et al., 2017; Cole et al., 2015; Cooley et al., 2014; De Cocker et al., 2015; Hadgraft et al., 2016; Mackenzie et al., 2015; Such & Mutrie, 2016). The provision of sit-stand desks may be a solution to reduce employees' sitting without compromising time spent engaged in desk-based work (Parry et al., 2013).

Employee and employer perceptions of sit-stand desks in the workplace

Grunseit, Chau, van der Ploeg, and Bauman (2013) reported two main categories of employee justification for initiating use of the sit-stand desk; anticipated health benefits and experimentation with no real expectations. Those that perceived potential health benefits were both "early adopters" and more likely to report sustained use of the sit-stand desk (Grunseit et al., 2013). Further inquiry into sit-stand desk use has identified that employees employ different strategies to prompt themselves to switch between sitting and standing throughout the day, including physical discomfort, initiating a new task, scheduling at set times, and seeing others standing (Chau, Daley, Srinivasan, et al., 2014; Graves et al., 2015; Probst et al., 2013). Previous research has also identified a number of factors that restrict sit-stand

desk use, including poor sit-stand desk design, privacy concerns, a desire to minimise distraction to colleagues and reduced concentration when standing compared to sitting (Chau, Daley, Srinivasan, et al., 2014; Dutta et al., 2014; Graves et al., 2015; Grunseit et al., 2013). However, Dutta et al. (2014) and Grunseit et al. (2013) also reported that standing increases energy and alertness compared to sitting for some employees. In addition, Grunseit et al. (2013) found that whilst sit-stand desk use reduced MSD for some employees, other employees indicated that standing increased discomfort. Sit-stand desks are more likely to cause physical discomfort when they are incorrectly set up and when employees stand for extended periods (Hadgraft et al., 2016). Interventions should include an educational component regarding correct desk setup, and optimal standing durations, to minimise the risk of physical discomfort (Grunseit et al., 2013; Hadgraft et al., 2016).

The feasibility and acceptability of providing sit-stand desks in office-based workplaces is largely influenced by the views of the employer. No studies in the extant literature have specifically investigated employer perceptions of the provision of sit-stand desks, however Gilson et al. (2012) and Hadgraft et al. (2016) reported employer and practitioner perceptions of sit-stand desks as part of exploratory studies focused on reducing workplace sitting time. Occupational health and safety practitioners working in Australia expressed that, to convince employers to purchase sit-stand desks, there needs to be a stronger business case demonstrating a clear relationship between sit-stand desks and increased productivity, reduced absenteeism and, consequently, increased profit (Gilson et al., 2012). Hadgraft et al. (2016) reported findings pertaining to the organisational acceptability of providing sit-stand desks, which included a perception that sit-stand desks are a more suitable strategy for employees with pre-existing occupational health concerns, than as a preventative health strategy. The cost of sit-stand desks was cited as a major barrier, however there was a recognition that the feasibility of purchasing sit-stand desks would increase as their costs reduce (Hadgraft et al., 2016). Examining employers' perceptions of the feasibility of installing sit-stand desks, alongside actual provision, is necessary to understand the potential for the wider adoption of sit-stand desks across organisations (Wijk & Mathiassen, 2011).

3.4 Concluding remarks

The literature reviewed in this chapter focused on the context of work and organisations for understanding employee sitting, PA and health. The literature review indicated that sit-stand desks, combined with additional strategies, may be particularly efficacious in reducing workplace sitting. However, the chapter highlighted that intervention efficacy varies depending on delivery context. Research should examine the processes that influence the effectiveness of sit-stand desk interventions, to understand their feasibility and acceptability. Whilst the studies reviewed in the final subsection of this chapter identified some key feasibility and acceptability issues of installing sit-stand desks, the studies are mostly descriptive and lack scientific rigour due to their absence of a strong theoretical basis. Theories add explanatory value, providing an understanding of how and why people behave in particular ways (Johnson & Christensen, 2008). Good quality research should interweave both empirical observation and theoretical reasoning (Dunning & Hughes, 2013, p. 190; Hughes, 2013). To enable a more comprehensive understanding of the efficacy, feasibility and acceptability of workplace sit-stand desk interventions, the present study integrates theoretical perspectives throughout the research process. The next chapter outlines the research design, methods and methodological approach taken within this thesis.

Chapter 4 – Methods and Methodology

4.0 Introduction

The aim of this chapter is to provide an explanation of the methods and methodology adopted to address the research questions. A concise overview of the research protocol has been published in BMC Public Health (Hall, Mansfield, Kay, & McConnell, 2015); this chapter is a development of the published work.

This research project involved a partnership with two external organisations, Macmillan Cancer Support (Macmillan) and Public Health England (PHE). The multicomponent intervention was delivered in both these organisations. The researcher undertook a three-month internship in the PA team at Macmillan prior to the commencement of her PhD research, and thus had an established relationship with several employees in the PA team, including the team lead. Macmillan were initially approached regarding participating in this research as the PA team lead expressed an interest in Macmillan piloting the use of sit-stand desks within their head office. Macmillan suggested PHE as a second partner organisation and gave an initial introduction to the Healthy Adults lead within the Health and Wellbeing division. A comprehensive multicomponent workplace intervention, which included the provision of sit-stand desks, was implemented and evaluated as part of this research. The research approach and methods were developed in consultation with key stakeholders at Macmillan and PHE. The research approach is cross-disciplinary, including a pilot randomised control trial (RCT) to explore intervention efficacy, and a process evaluation to identify processes that influenced the feasibility, acceptability and efficacy of sit-stand desk implementation and use.

The sections that follow first provide a position statement on the use of mixed methods (section 4.1) and explain and justify the study design (section 4.2). The design and delivery of the sit-stand desk intervention is described (section 4.3) before an account of the recruitment and sampling processes (section 4.4). An overview and justification for the research methods and analysis process employed as part of the behavioural intervention are provided (sections 4.5 and 4.6, respectively). The final section of the chapter covers considerations pertaining to research quality, reflexivity and the writing process.

4.1 Mixed methods: Position statement

Johnson et al. (2007) attempted to establish a thorough and agreed-upon definition of MMR, by asking experts in the field to provide their understanding of the definition of MMR, and synthesising the common and key elements of their responses. The responses were diverse in terms of where the mixing occurs, the extent of the mixing and the purpose of mixed methods (Cameron, 2011). However, the authors developed the following definition:

> *Mixed-methods research is the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative approaches (e.g. viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration* (Johnson et al., 2007, p. 123).

The combination of quantitative outcome measures and qualitative interviews and participant observation methods means that this project can be classified as MMR. In the social sciences, there is a long history of MMR occurring in fieldwork, particularly when conducting in-depth case studies, which typically combine interview, observation and survey methods (Johnson & Onwuegbuzie, 2004; Pearce, 2012). However, it was not until the 1970s that an MMR *paradigm* began to emerge (Johnson et al., 2007), and over the past 15 years there has been an insurgence of academic writing and practice of MMR. Increasingly, MMR has been endorsed by major professional societies, funding agencies and institutions (Denzin, 2010).

4.1.1 The purpose of utilising mixed methods

The historical argument for combining different methods within one research project is triangulation; to offset bias of different methods and strengthen the validity of the research via corroboration of findings (Greene, Caracelli, & Graham, 1989; Johnson et al., 2007; Tritter, 2013, p. 423). However, triangulation has been widely criticised as different methods are unlikely to be tapping into the same aspect of a phenomenon and thus it is unlikely that the results will conform (Bryman, 1992, p. 64; Hesse-Biber, 2012). An alternative rationale for using mixed methods is ‘complementarity’ (Greene et al., 1989); seeking enhancement and interpretability of a research area (Bryman, 1992, pp. 59-61; Greene et al., 1989). A study of health researchers’ uses of MMR found that complementarity was the most widely cited purpose for combining methods (O'Cathain, Murphy, & Nicholl, 2007). Within this

approach, it is assumed that different methods produce different types of knowledge about a phenomenon that can be combined to further advance knowledge (Simons, 2007) and that divergence of findings can uncover new questions and thus a more complex and sophisticated understanding of the research problem (Hesse- Biber, 2012).

Various typologies of mixed methods study designs have been proposed within the MMR literature (Tritter, 2013). Choice of study design can influence the added value of using MMR, and is usually carefully selected based on the purpose of mixing-methods and the research questions (Biesta, 2010, p.99). Types of MMR vary according to: (1) the interdependence of methods used, (2) the (in)equality amongst methods, and (3) whether different study procedures occur concurrently or in sequence (Greene, 2008).

4.1.2 The philosophical position underpinning the use of mixed methods

As a result of the paradigm wars of the 1970-80s and the rise in importance of the 'meta-physical paradigm' (i.e. questions of ontology and epistemology dominating methodological debate) (Morgan, 2007), the conceptualisation of mixed methods became inextricably tied to methodology (Creswell, 2010, p. 51; Denzin, 2010). The philosophical underpinnings of MMR are arguably the most controversial, highly debated, and most often written about aspect of MMR (Greene, 2008; Morgan, 2007). Approaches differ on two fundamental levels; (1) the importance of philosophical assumption in guiding research methodology, and (2) whether differing underpinning philosophies can be combined (Greene, 2008; Tashakkori & Teddlie, 2010b, p. 16). An overview of the philosophical stances commonly adopted by mixed method researchers is provided in Table 4.1.

The importance of philosophical assumptions in guiding research methodology

Stances in which the philosophical assumptions are considered important in guiding the conduct of research adopt a 'top-down' approach (B. Smith, Sparkes, Phoenix, & Kirkby, 2012; Tashakkori & Teddlie, 2010b, p. 12). Conversely, in 'bottom-up' approaches the practical demands of the research are valued over pre-conceived value-orientations (Buchanan & Bryman, 2007; Johnson & Onwuegbuzie, 2004).

Table 4.1. Philosophical stances taken within MMR. Adapted from Greene and Hall (2010, p. 122)

Stance	**What is the importance and role of philosophical assumptions in inquiry practice?**	**Can assumptions from different philosophical traditions meaningfully inform the study?**
Purist	High: assumptions importantly guide and direct inquiry decisions	No: assumptions from different traditions are incompatible
Dialectic	High: assumptions guide and direct inquiry decisions	Yes: assumptions from different traditions can be respectably and dialectically engaged in dialogue towards enhanced, reframed or new understandings
Aparadigmatic or 'everyday pragmatism'	Low: inquiry practice is more directly informed by theory, context, and the research question	One can mix assumptions from different traditions, but they exert little influence on inquiry decisions
Single paradigmatic approach	High: assumptions important guide and direct inquiry decisions	Because aparadigmatic approaches present a coherent system of thought, there is no mixing of assumptions from different traditions

Moses and Knutsen (2007) contend that the researcher, "like a good craftsperson… can determine which toolbox [methodology] and tool [method] is best suited for the job" (p. 290). Thus, philosophical orientations are de-emphasised (or even disregarded) and emphasis is placed on "flexibility and adaptiveness" to determine the 'best' approach for a given research problem (Greene et al., 1989). A number of academics have urged against an unreflexive, ad hoc approach to combining methods that could result from a 'bottom-up' approach (Greene & Hall, 2010, p. 131; Lipscomb, 2008). Whilst it is clearly possible to conduct research that does not stem from a thoroughly considered philosophic vantage-point (Onwuegbuzie, Johnson, & Coluns, 2009; Tashakkori & Teddlie, 2010a, p. 819), this approach overlooks the influence of both the (implicit) assumptions of researchers, and the ineliminable assumptions attached to methods (Lipscomb, 2008; Maxwell & Mittapalli, 2010, p. 146). For example, implicit in the adoption of an RCT is the assumption that researchers should strive for objectivity. Mixing methods without reflection on these assumptions is somewhat problematic (Lincoln, 2010) and may hinder knowledge generation (Maxwell & Mittapalli, 2010, p. 131).

The compatibility of differing philosophical assumptions

According to the dialectic stance, different philosophical assumptions can be combined to reveal different "slices" of a phenomenon, and points of disagreement

between the approaches can be utilised to enhance knowledge (De Loo & Lowe, 2011; Johnson & Gray, 2010, p. 72). However, many mixed method researchers believe that positivist and interpretivist paradigms are incompatible and should not be combined (Maxwell & Mittapalli, 2010, p. 146). For example, it is illogical to believe that the social world is real *and* that the social world is constructed (Greene & Hall, 2010, p. 123). Practically, it is not possible to be a passionate participant and a disinterested scientist (B. Smith et al., 2012). A single-paradigmatic approach is often preferred, as it is guided by one unified philosophical position (Greene, 2008).

4.1.3 The mixed method approach in this research

The aim of this research is to examine strategies to reduce sitting and increase PA in office-based workplaces. Two separate research questions were developed:

1. What is the efficacy of a multicomponent sit-stand desk intervention designed to reduce sitting, and increase standing and PA?
2. What are the processes that influence the feasibility, acceptability and efficacy of sit-stand desk implementation and use?

Qualitative and quantitative approaches within this research were employed to answer distinct but interrelated parts of the research questions. Therefore, mixed methods were utilised for complementarity. Within this project, the conduct of the outcome and process evaluation was concurrent (Leech & Onwuegbuzie, 2009) as they both occurred at regular intervals over the data collection period. Whilst the pilot RCT and process evaluation were largely conducted independently, the data collection timepoints were planned strategically to allow preliminary findings from one method to inform subsequent data collection, and so there was an element of interdependence. The different components of this study were afforded equal status to avoid perpetuation of the privileging of objective, quantitative study designs within intervention research (Hesse-Biber & Johnson, 2013; Simons, 2007); see section 4.2.2.

This research takes the view that philosophical assumptions *do* matter, and thus we need to critically engage in philosophical discussion to enhance understanding of the assumptions underpinning the practice of MMR. This research has been conducted on the basis that distinct philosophical paradigms are incommensurable. Therefore, a single paradigmatic approach was adopted. Within

this approach, the conduct of MMR is accepted as it is guided by a unified philosophical position; critical realism.

Critical realism

Critical realism, as presented by Bhaskar (1979) and advanced by (Sayer, 1992, 2000) emerged as an anti-positivist movement within the social sciences (Denzin & Lincoln, 2013; Houston, 2001) and is often positioned between the two extremes of positivism and interpretivism (Zachariadis, Scott, & Barrett, 2013). Interpretivism gained in popularity as a critical reaction to the dominant positivist approach within social science research in the late 20th Century (Denzin & Lincoln, 2013; Pearce, 2012; Sparkes, 1992, pp. 9-10; Sparkes & Smith, 2013, p. 11). However, in opposing the positivist philosophy and method, interpretivists represented polar opposite views; objective knowledge became universal relativism whereby no one version of social reality is any more 'truthful' or 'adequate' than another (Sayer, 2000, p. 47). Critical realism moves beyond the positivist-interpretivist dichotomy to provide a more nuanced account of the nature of reality (Bergin, Wells, & Owen, 2008; Zachariadis et al., 2013). Both qualitative and quantitative methods are compatible with the ontological and epistemological assumptions of the critical realist approach (Bergin et al., 2008; Lipscomb, 2008; Zachariadis et al., 2013).

Critical realism accepts that knowledge is not value-free. The "perceptual experience that individuals have are not uniquely determined by the images on their retinas" as what we see is affected by past experience (Chalmers, 1999, p. 6). Therefore, it is not possible to ascertain a 'God's eye view of the world', independent from our experiences within it. Thus, whilst critical realism asserts that there is an objective reality, it rejects the notion that we have unmediated access to it as we can only understand it from within a particular discourse (Maxwell & Mittapalli, 2010, pp. 146-150). Thus, qualitative methods can be adopted without succumbing to 'judgemental realism' whereby no one account of a phenomenon can be judged to be more adequate, and quantitative methods can be utilized without committing to the notion that knowledge is objective and value-free (Lipscomb, 2008). Rather than having a 'go to' methodological approach, critical realists select methods to answer particular research questions based on the "capability and

complementarity of different methods to convey different kinds of knowledge about generative mechanisms" (Zachariadis et al., 2013, p. 10). Qualitative and quantitative approaches have been used within this research to comprehensively address the research questions. Chapter 7 contains a critical discussion MMR which reflects on the collection, analysis and interpretation of findings within the present study (see section 7.3). The next section describes the study design.

4.2 Study design: A combined outcome and process evaluation

This section provides a justification for the study design that was adopted to address the research questions; a combined outcome and process evaluation of a complex workplace intervention (Cavill, Roberts, & Rutter, 2012; Craig et al., 2008). See Figure 4.1 for an overview of the study design and major study components.

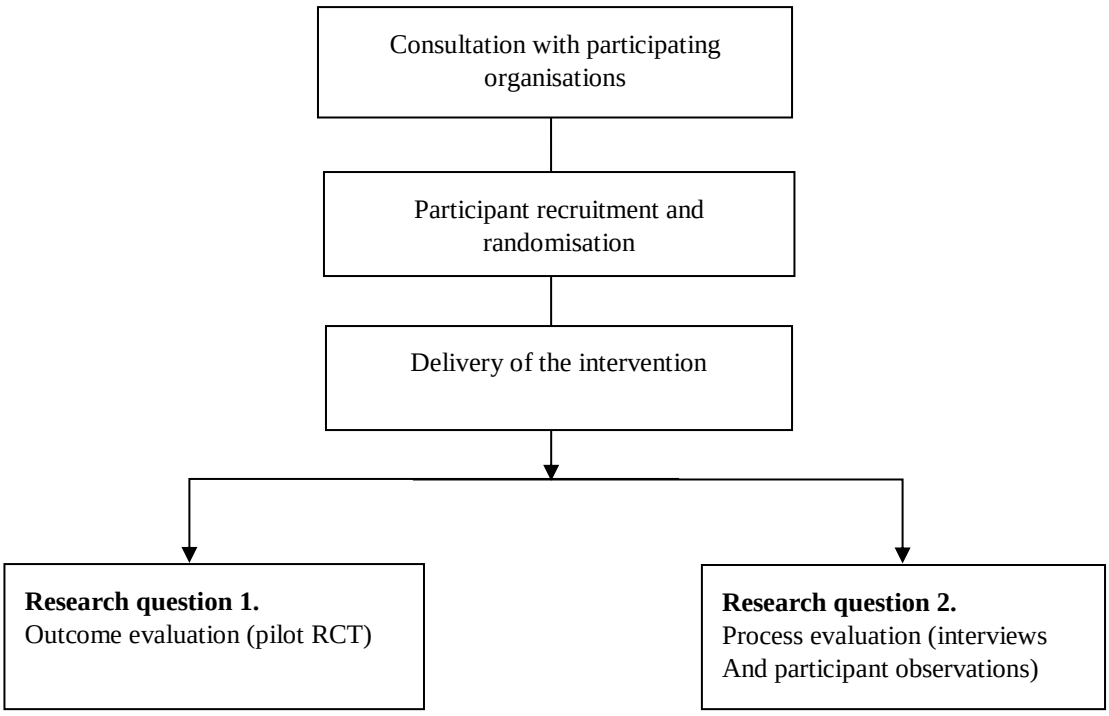


Figure 4.1. *An overview of the study design and major study components employed within this research*

4.2.1 Pilot randomised controlled trial

An outcome evaluation was conducted to examine the efficacy of the multicomponent sit-stand desk intervention designed to reduce sitting, and increase standing and PA. An RCT was identified as the most appropriate study design to

answer the research question. An evidence-based medicine approach argues that RCTs are the 'gold-standard' study design for evaluating outcomes of interventions as they provide the most credible evidence that an intervention 'works' (Hesse-Biber, 2012; Oakley et al., 2006; Wells, Williams, Treweek, Coyle, & Taylor, 2012). RCTs are almost always placed at the top of rankings of study designs, including the National Institute of Clinical Excellence (NICE) guidelines, Cochrane Guidelines, and the American College of Sport Medicine (ACSM) guidelines (Haskell et al., 2007; Higgins & Green, 2011; NICE, 2012) as they are judged to be higher-quality than quasi-experimental and observational study designs. Quality criteria for RCTs include high internal validity, reduced susceptibility to bias due to randomised group allocation, and the inclusion of a control group to increase the certainty that any changes in outcome variables are the result of the intervention rather than any other, external influences (NICE, 2012). RCTs are considered higher quality when delivered across multiple populations and settings as this reduces the likelihood of bias (Evans, 2003); findings are more likely to be attributable to the intervention than organisational contextual factors when the analysis spans more than one organisation.

In this study, the pilot RCT employs two intervention arms: (1) a multicomponent sit-stand desk intervention (SS-MC); and (2) sit-stand desk only (SS-O). A control arm (CG) for usual desk-based working practice (no sit-stand desk) was also included. This design enables an investigation of both whether having a sit-stand desk influences sitting, standing and PA compared to having a usual seated desk, and whether being part of a multicomponent sit-stand desk intervention influences sitting, standing and PA to a greater degree than the provision of a sit-stand desk alone. An overview of the development and content of the multicomponent sit-stand desk intervention is provided in section 4.3 of this chapter. The research was conducted with office workers across two study sites (organisations), with randomisation occurring at the individual level, in accordance with Cochrane recommendations (Higgins & Green, 2011). Details pertaining to the outcome measures can be found in section 4.5.1.

Challenges and limitations of conducting a pilot randomised controlled trial

Three separate interrelated issues are associated with this pilot RCT; (1) practical issues of blinding and the randomisation approach (2) the underlying philosophical assumptions of RCTs and the transferability of the method to real world settings, and (3) the limited nature of the knowledge attained when utilising a pilot RCT research design.

(1) Blinding and exposure to other intervention groups: RCTs were devised for use within controlled, laboratory-based settings, whereas this research project implemented an RCT with human participants within a natural setting; the workplace. Thus, there were practical issues that prevented optimal usage of the RCT approach. For example, an RCT is more methodologically rigorous if participants are blinded to the intervention arm that they have been randomised into (Higgins & Green, 2011). Participants were blinded to the intervention arm prior to agreeing participation in the study, however, given the nature of the intervention, i.e. the fact that participants may or may not receive a sit-stand desk, in a field-based setting it was not possible to blind participants to arm allocation once data collection commenced. This increased the chance of bias as participants may have (consciously or subconsciously) behaved differently as a result of being randomised into a particular group. For example, upon finding out that they would not be receiving a sit-stand desk, participants in the CG may have taken their own measures to help increase PA at work, such as purchasing a wearable activity tracker. Further, it was not possible to blind the researcher to group allocation due to the research being conducted by a single researcher who was responsible for delivering the multicomponent intervention and conducting participant observation within the workplaces.

In this study, randomisation occurred at the individual level, rather than the organisational (cluster) level. Cluster randomisation was not utilised as participants within clusters cannot be treated as independent, which reduces the overall power. In addition, there is a higher risk of selection bias, i.e. differences in confounding factors across treatment groups, in cluster randomisation due to the smaller number of clusters being randomised compared to randomising at the individual level (Torgerson, 2001). However, the risk of 'contamination of treatment' between the

intervention groups, i.e. participants being exposed to elements of the SS-O or SS-MC intervention when they were not part of these intervention arms is a limitation of individual-level randomisation (Melis, Teerenstra, Olde Rikkert, & Borm., 2011). For example, participants in the control group may have had access to a sit-stand desk when the 'owner' of the sit-stand desk was absent. Contamination was minimised via designing the multicomponent intervention in such a way that it was targeted exclusively at participants in the SS-MC arm (see section 4.3), and instances of contamination were identifiable through the process evaluation (see section 4.2.2).

(2) RCTs in real world settings: Historically, RCTs are based on a positivistic notion of natural science and thus assume that observable events are a direct consequence of the delivered intervention; a regularity view of causation (Sayer, 2000, p. 94; Simons, 2007). As such, RCTs are set up to be objective, controlled and replicable (Sparkes & Smith, 2013). RCTs were intended to be conducted in controlled, experimental, lab-based conditions, and may not be appropriate when applied to complex interventions in 'real-world settings' (Holmes, Murray, Perron, & Rail, 2006; Maxwell, 2004; Maxwell & Mittapalli, 2010; Wells et al., 2012). This is because, unlike the artificial lab-based setup, the natural and social worlds are 'open systems'; it is not expected for A to produce B, as it does in experimental conditions, as there will be several other structures and mechanisms present that interact with the tendencies of A to produce an outcome (Connelly, 2001; Cruickshank, 2012; Gorski, 2013). This means that the 'outcome' measured is not the direct result of the intervention but the result of many interacting tendencies within the setting, *including* the delivered intervention (Cruickshank, 2012; Pawson & Tilley, 2004; Sayer, 2000, p. 14; Wells et al., 2012). In other words, there are other, uncontrollable influences, separate from the delivered intervention but that interact with it, on employees' sitting and PA. Context plays an integral role *within* the causal mechanism, rather than being something that can be controlled for (A. Clark et al., 2012; Maxwell & Mittapalli, 2010, p. 156; Sayer, 2000, pp. 114-118). Interventions are events within a system, and any observed outcome is a result of a person-place-time interaction (Hawe et al., 2009). Within the present research, this limitation was minimised by including a process-oriented approach that recognises how the context interacts with the intervention to produce outcomes.

(3) Limits of knowledge in RCTs: RCTs provide valuable information regarding the efficacy of interventions as they permit a "credible link" between the intervention and the outcome (Wells et al., 2012). Thus, RCTs advance knowledge of whether an intervention works (Oakley et al., 2006) and, as such, can help inform policies and guidelines. However, there is no universal 'outcome' of an intervention (Pawson & Tilley, 2004); RCTs only tell us whether an intervention works in a particular setting, at a particular time, with a particular group of people. It is important to understand how, why and for whom the intervention was successful, to allow a greater appreciation of the transferability of the intervention. Utilising a process-oriented approach alongside a pilot RCT facilitates elucidation of the processes by which an intervention works or does not work (Boeije, Drabble, & O'Cathain, 2015; Grant, Treweek, Dreischulte, Foy, & Guthrie, 2013; Hesse-Biber, 2012). The process evaluation approach taken within this research project will be discussed in the next section.

4.2.2 Process evaluation

A systematic and rigorous process evaluation ran parallel to the pilot RCT (Craig et al., 2008). Within the health sciences, process evaluation is typically understood as "the evaluation of a process of change that an intervention attempts to bring about in order, at least in principle, to explain how outcomes are reached" (Morgan-Trimmer, 2015, p. 2). Process evaluations are largely focused on understanding: (1) issues surrounding intervention implementation (2) mechanisms through which the intervention contributes to (behavioural) change and (3) how contextual factors influence the delivery, acceptability and success of the intervention (Moore et al., 2015).

There is a growing body of support within both the health and social sciences, for conducting process evaluations of complex interventions (e.g. Hesse-Biber, 2012; Mansfield et al., 2015; Maxwell & Mittapalli, 2010; Moore et al., 2014; Morgan-Trimmer, 2015; Oakley et al., 2006; Wells et al., 2012). Process evaluations can be complementary to RCTs as the two approaches produce different types of knowledge about a phenomenon that can be combined to further advance knowledge (Simons, 2007). Section 4.2.1 identified how the inclusion of a process evaluation addresses the limitations associated with implementing RCTs in real-world settings,

by identifying how intervention efficacy is shaped by contextual factors. However, understanding whether an intervention works is not the only valuable question within behavioural intervention research (Boeije et al., 2015). The feasibility and acceptability of implementing and using sit-stand desks are important considerations as, alongside questions about efficacy, they shape the appropriateness of sit-stand desks as a strategy for reducing sitting and increasing PA in the office-based workplace. Further, process evaluations involve interaction with key stakeholders at all stages of the research, and thus can help bridge the research-practice gap (Huby, Hart, McKevitt, & Sobo, 2007). A process evaluation was utilised within this project to address the research question "what are the processes that influence the feasibility, acceptability and efficacy of sit-stand desk implementation and use?"

Attempts have been made to formalise process evaluations with varying levels of effect. For example, guidelines for conducting process evaluations within public health tend to encourage evaluation of the intervention in isolation from the context within which it was delivered and evaluate different components of the intervention separately (Grant et al., 2013; Lewin et al., 2009; Morgan-Trimmer, 2015). An example of this is the RE-AIM framework, which advocates evaluation of the reach, effectiveness, adoption, implementation and maintenance of the intervention (Glasgow, Vogt, & Boles, 1999) and has been used to evaluate PA interventions (e.g. Eakin, Brown, Marshall, Mummery, & Larsen, 2004; Stathi & Sebire, 2011). Conversely, process-oriented approaches within the social sciences typically pay credence to the integral role of context in influencing intervention effectiveness (Morgan-Trimmer, 2015). Examining the social and cultural context of an intervention and focusing on identifying social processes permits an understanding of the context of the intervention as critical and integral to the feasibility, acceptability and efficacy of the intervention (Maxwell & Mittapalli, 2010, p. 156). Process evaluation guidance recognises that intervention fidelity, i.e. whether the intervention was delivered as intended, is implicated in the interpretation of RCT findings, as RCTs can only assess outcomes associated with the delivered intervention, not the intended intervention (Moore et al., 2015). Process evaluations within the social sciences are better positioned to examine "causal explanation" as they can link the delivered intervention, contextual factors and processes with outcomes (Hesse-Biber, 2012; Maxwell & Mittapalli, 2010; Morgan-Trimmer,

2015). That is, process evaluations can illuminate how the delivered intervention contributes to behavioural change.

Social scientists assert that, to fully understand the impact of an intervention, it is necessary to utilise in-depth, qualitative methods (Hawe et al., 2009). Social structures do not exist independently of the beings they act upon, but rather there is a reciprocal relationship between structure and agency (Porter, 1993; Porter & Ryan, 1996; Toohey & Rock, 2011). Structure and agency co-exist and the social world is "reproduced and transformed in daily life" (Porter, 1993, p. 593). Behaviour cannot be predicted as people's behaviours and emotions act back on the structures and processes of social life (Porter & Ryan, 1996). In other words, people are conscious beings that attach meaning to experiences, and meanings are implicated within causal processes (Maxwell & Mittapalli, 2010, p. 156; Sayer, 2000, p. 17) Accordingly, it was important to understand the lived experience of participants, via the utilisation of qualitative methods, to gain a fuller understanding of the processes that influenced feasibility, acceptability and efficacy of the sit-stand desk intervention.

The qualitative methods of participant observation and in-depth semi-structured interviews with pilot RCT participants and other key stakeholders were adopted within this research project to examine the processes that influenced the feasibility, acceptability and efficacy of the intervention. These methods allow appreciation of how sitting, standing and PA are embedded within the cultural context of the workplaces within which the intervention was delivered (Krumeich et al., 2001). Further, this approach facilitates direct observation of the interacting structures and processes that give rise to the feasibility, acceptability and efficacy of the intervention, and thus permits an examination of causal explanation (Morgan-Trimmer & Wood, 2016; Zachariadis et al., 2013).

Challenges and limitations of conducting a process evaluation

Within the MMR community it has been noted that there is an "assumed kinship" between qualitative and quantitative approaches (Tashakkori & Teddlie, 2010a, p. 820). However, in practice, the quantitative methods are often afforded higher status within the MMR design (Holmes et al., 2006; O'Cathain, Nicholl, & Murphy, 2009; Shah & Chung, 2009). Accordingly, when process evaluations are

conducted alongside RCTs, the process evaluation is often viewed as an 'add on' rather than an integral part of the research and the quality of reporting of the qualitative elements of trials is inadequate (Lewin et al., 2009). Process evaluations are valuable not because they assist in "facilitating interpretation of the trial findings" (O'Cathain, Thomas, Drabble, Rudolph, & Hewison, 2013, p. 12) but because they generate substantial findings in their own right. Consequently, B. Smith et al. (2012) advise that qualitative researchers should not simply and unquestioningly offer to collaborate with quantitative researchers; this may result in the qualitative element being a 'servant' to the quantitative element, preserving the hierarchy of research evidence (Pearce, 2012). Although this mixed method study was conducted by a single researcher, it was important that the qualitative and quantitative dimensions of this study were complementary and were afforded equal status to avoid perpetuation of the paradigmatic hegemony existent within intervention research (Hesse-Biber & Johnson, 2013; Simons, 2007). This was achieved by devising a schedule of data collection that did not compromise either the qualitative and quantitative methods and being continuously reflexive throughout the data collection, analysis and the writing process. The next section outlines the theoretical basis, design and delivery of the intervention that was the focus of this research evaluation.

4.3. Design and delivery of the multicomponent intervention

This research compared sitting, standing and PA between participants that received a multicomponent intervention (SS-MC arm) to those that received a sit-stand desk only (SS-O arm) and those that did not receive any intervention and used their usual seated desk (CG arm). This section describes the development of the multicomponent intervention entitled 'Take a Stand for Workplace health' that was delivered to participants in the SS-MC arm of the pilot RCT; see Figure 4.2 for a graphical depiction of the intervention (Perera, Heneghan & Yudkin, 2007). The description of the intervention includes the information outlined in the Template for Intervention Description and Replication (TIDieR) guide (Hoffmann et al., 2014).

Due to the open-system nature of reality, there are multiple and interacting influences on behaviour (Connelly, 2001; Houston, 2001). Further, influences on

behaviour exist on different levels (Sayer, 2000, p. 99), such as the biological, psychological, environmental and sociocultural. A socioecological approach was taken within this research project to devise the multicomponent intervention. The socioecological approach proposes that targeting multiple levels of influence on behaviour is more likely to result in a change in behaviour than targeting one level of influence alone (Hawe et al., 2009; and see section 2.4.2).

Time line	Sit-stand desk only (SS-O)	Multi-component sit-stand desk (SS-MC)	Seated desk control (CG)
Randomisation			
Baseline (time 0)		(a)	
2 weeks		[b]	
3 weeks	(d) (d)	[c] [c]	
5 weeks		(a)	
8 weeks		[b]	
12 weeks		(a)	
16 weeks		[b]	
21 weeks		(a)	
6 months		[b]	
12 months	Measurement of outcomes		

(a)	'Motivational interviewing' phone call to support participants to use their sit-stand desk to reduce sitting and increase PA
[b]	Emails from organisation managers sent to participants to express organisational support for the intervention
[c]	Sit-stand desk provision
(d)	Verbal instruction on correct ergonomic posture for sitting and standing

Figure 4.2. *A graphical depiction of the SS-O and SS-MC interventions*

Thus, it was hypothesised that the multicomponent intervention within this research project would have a greater influence on participant's sitting, standing and

PA than the singular-component intervention (SS-O). This multi-level approach to developing a 'healthy workplace' is recognised by the World Health Organisation (Burton, 2010). The multicomponent intervention targeted individual, environmental and organisation level influences on sitting, standing and PA. The intervention is multi-disciplinary, incorporating social and behavioural theory.

4.3.1 Organisational level procedures

Behaviour is grounded within specific cultural contexts (Krumeich et al., 2001; Tharp, 2007). In a workplace context, employees may be more likely to reduce the amount of time spent sitting and increase time spent being physically active if the organisational culture is supportive of these behaviours. Therefore, organisation level procedures were designed to enhance the participants' perceived level of organisational support for the sit-stand desk intervention. The procedures consisted of four emails to participants from organisational managers who are responsible for workplace wellbeing. At Macmillan, the emails were sent by the Human Resources Director, and at PHE they were sent by the Staff Wellbeing Lead. The emails included statements regarding the organisations commitment to creating a healthy working environment (which includes the provision of sit-stand desks) and the potential associated benefits. The content of these emails was developed and finalised in collaboration with the workplace wellbeing managers and key stakeholders from the participating organisations. This aspect of the intervention is limited as it involves individually targeted emails about the organisational culture rather than organisational level changes to the organisational culture itself (Goetzel, Ozminkowski, Pelletier, Metz, & Chapman, 2007). Organisation-wide intervention strategies were not delivered to reduce the likelihood of contamination bias, given that participants from all three intervention arms were present in the participating organisations (see section 4.2). Although the emails were delivered to individuals, the content was focused on the organisation context and thus had the potential to alter the participants' views of the culture of their organisation in relation to PA and wellbeing at work. All management emails were sent to participants as illustrated in Figure 4.2 and information on the content of the emails is provided in table 4.2. A copy of the four emails can be found in appendix A.

4.3.2 Environmental level procedures

The environmental level procedures involve changes to the physical environment that are expected to facilitate reduced sitting and increased PA (Dunstan et al., 2013; Owen et al., 2014). A sit-stand desk, i.e. height-adjustable desk allowing employees a choice of desk-based working positions was provided to participants for 12-months. Participants had the choice between two models of desk (Ergotron Workfit-A or Workfit-D, www.ergotron.com). The lead researcher explained the differences between the two desks at a recruitment workshop, a flyer was given to participants, and they had the opportunity to 'test out' a desk before they chose their preferred desk. Participants received verbal instruction on the correct ergonomic posture for standing upon installation of the desks. All the sit-stand desks were installed over a period of two days at Macmillan, and one day at PHE. Participants received verbal instruction on the correct ergonomic posture for both sitting and standing as soon as they were available following the sit-stand desk installation. This component of the intervention was delivered to participants within the SS-MC and SS-O arms; see Figure 4.2 for details on timing.

4.3.3 Individual level procedures

Individual level strategies that target psychological constructs have been shown to influence behaviour change (Noar, Benac, & Harris, 2007; T. Webb et al., 2010); see chapter 2). The psychological strategies used in this intervention are not based on one psychological theory, such as the theory of planned behaviour, but are adapted from a list of behaviour change techniques (Michie, van Stralen, et al., 2011) which targets constructs of multiple theories. Targeting multiple constructs from more than one theory of behaviour may more substantially influence behaviour (Kok et al., 2014; Michie, Johnston, et al., 2014). Participants received four brief telephone calls from the researcher who is experienced in motivational interviewing and employed a motivational interviewing technique (Levensky, Forcehimes, O'Donohue, & Beitz, 2007). Motivational interviewing was employed to enhance participants' "intrinsic motivation to change, by exploring and resolving ambivalence" (Rollnick & Miller, 1995, p. 25). These telephone calls were designed to engage participants in conversations related to their sit-stand desks and PA. The telephone calls followed the principles of engaging, guiding and evoking to motivate

Table 4.2. *An overview of the content and BCTs employed within the multicomponent intervention. * BCTs as described in Michie, Ashford, et al. (2011)*

Strategy	**Level**	**Behaviour Change Strategies / Content**
Phone call 1 (baseline - time 0)	Individual	*Motivational Interviewing** – phone calls conducted according to motivational interviewing principles of engaging, guiding and evoking *Providing information of consequences of physical activity and sedentary behaviour** – discussed the health risks of prolonged sedentary behaviour and the benefits of physical activity *Barrier identification** – participants were asked if they could anticipate any barriers with using their sit-stand workstation. Challenges were discussed and minimised where possible
Management email 1 (2 weeks)	Organisational	*Strategy*: illustrate organisational commitment to sit-stand workstation use at work and wider staff wellbeing *Content*: organisation wish to create a 'healthy' working environment, sit-stand workstations potentially create a healthier working environment
Sit-stand workstation installation, ergonomic briefing and demonstration (3 weeks)	Environmental	*Environmental restructuring** – usual seated desks converted into, or replaced by sit-stand workstations (Ergotron workfit-A or workfit-D) *Model / demonstrate the behaviour** – A researcher physically demonstrated how to use the sit-stand workstation *Provide instruction on how to perform the behaviour** – A researcher verbally provided instructions on how to use the sit-stand workstation
Phone call 2 (5 weeks)	Individual	*Motivational Interviewing** - phone calls conducted according to motivational interviewing principles of engaging, guiding and evoking *Barrier identification** - participants were asked if they could have experienced any barriers with using their sit-stand workstation. Challenges were discussed and minimised where possible *Provide instruction on how to perform the behaviour** – Participants were given tips on 'how to stand' including: regular switching between sitting and standing, taking breaks from the computer, wearing comfortable footwear, and correct posture *Goal setting (outcome or behaviour)** – Participants were given the opportunity to set goals of their choice (e.g. reducing sitting by 2 hours a day)
Management email 2 (8 weeks)	Organisational	*Strategy*: illustrate organisational commitment to sit-stand workstation use at work and wider staff wellbeing *Content*: physical and psychological health of employees is a priority for the organisation, a poster providing information on how using sit-stand workstation (and reducing sedentary behaviour and increasing physical activity) could benefit health at work
Phone call 3 (12 weeks)	Individual	*Motivational interviewing** - phone calls conducted according to motivational interviewing principles of engaging, guiding and evoking *Prompt review of (behavioural or outcome) goals** – Where set, participants were asked whether they had met their goals *Prompt self-monitoring of behaviour / Prompt practice** – participants were advised to prompt and monitor their behaviour using a method of their choice (Outlook email calendar and mobile phone apps were offered as suggestions)
Management email 3 (16 weeks)	Organisational	*Strategy*: illustrate organisational commitment to sit-stand workstation use at work and wider staff wellbeing *Content*: development of healthy and supportive work environment can lead to healthier workforce and organisational improvements including improved productivity and enhanced outcomes, the philosophy of the organisation is aligned with Governmental workplace health policies
Phone call 4 (21 weeks)	Individual	*Motivational interviewing** - phone calls conducted according to motivational interviewing principles of engaging, guiding and evoking *Relapse prevention** – A discussion of how participants can avoid 'breaking the habit' of using their sit-stand workstation, especially after spending prolonged time away from the workplace / workstation *Prompt generalisation of a target behaviour** – A discussion of how to incorporate less sedentary behaviour and more physical activity into other areas of life and work activities
Management email 4 (6 months)	Organisational	*Strategy*: illustrate organisational commitment to sit-stand workstation use at work and wider staff wellbeing *Content*: societal shift towards reducing prolonged sitting in the workplace, organisation as a pioneer of this societal shift, encouragement for participants to advocate the approach

and support participants to reduce sitting and increase standing and PA, primarily within the workplace.

Participants were emailed three weeks in advance of the week that each telephone call was planned to take place to schedule a suitable date and time for the phone call. If participants did not respond to this email, a reminder email was sent one week before the telephone call was planned to take place. The researcher called all participants at the time that has been scheduled with them. If participants were unavailable or uncontactable at that time, up to four further phone call attempts were made at different times of the day during that week. If participants did not reply to either email, five attempts were made to contact them via telephone, at different times of day, during the week that the phone calls were planned to take place. The timing of the phone calls is illustrated in Figure 4.2, and the content and BCTs employed within the phone calls are detailed in table 4.2.

4.4 Recruitment and sampling

Recruitment for this project occurred in two phases; the first phase involved the recruitment of two organisations to take part in the research project, in accordance with Cochrane recommendations (Higgins & Green, 2011) and the second phase involved the recruitment of participants from the participating organisations. In describing the recruitment process issues in sampling and recruitment for mixed method studies are also examined.

4.4.1 Recruitment of organisations and study sites

Two organisations, Macmillan and PHE, provided use of workplaces (one per organisation) and employees as participants for the study. Macmillan is a large charitable organisation, founded in 1911, that provides support for people living with and affected by cancer within England, Scotland, Wales, the Isle of Man and Northern Ireland. The UK Office, i.e. the 'head office' of Macmillan, based in Central London, UK, was the worksite selected for this study. At the time of recruitment, the UK Office was split over several floors of a high-rise building, and was the base for approximately 900 Macmillan employees whose roles related to services, policy and research, external affairs, fundraising, and corporate resources.

PHE is a large national governmental organisation responsible for protecting and improving the nation's health and wellbeing and reducing health inequalities. PHE, an executive agency of the Department of Health and Social Care in the UK, began operation in April 2013. One central PHE worksite in Central London was selected by PHE for use in this study. The workplace setting was a high specification office building that was the base for over 1000 PHE employees, however only the health and wellbeing directorate participated in the study. The health and wellbeing directorate programmes included alcohol and drugs, cancer screening, dental public health, NHS health check, tobacco, sexual health, nutrition and healthy food, screening programmes, national health marketing campaigns, offender health, public mental health, and wellbeing and mental health. Consent to participate within the research project was obtained from senior management within both organisations (see appendix C) and a key project contact within both organisations was established. The key contact at PHE changed part way through the research due to the original contact leaving the organisation. Organisational restructuring was ongoing in both organisation throughout their participation in the research.

4.4.2 Sample size

Sample size is a contentious issue in MMR as the qualitative and quantitative approaches have different standards and norms (Collins, 2010, p. 361). Thus, there are tensions within MMR as sampling in a way that favours one approach can lead to reduced legitimation of the other approach (Collins, 2010, p. 370).

Within quantitative research, power analyses are conducted to determine a lower threshold of participants required to detect a significant change in outcome measures when there is a real effect (Field, 2013, p. 70). However, since this is a pilot study, a formal power analysis was not performed (Arain, Campbell, Cooper & Lancaster, 2010). Three factors were involved in determining the sample size (N = 30) for the pilot RCT: (1) sample sizes of previous sit-stand desk intervention pilot studies that reported significant effects (e.g. Alkhajah et al., 2012; Healy et al., 2013) (2) balancing the quantitative and qualitative elements of the research, and (3) funding and equipment restrictions; the sit-stand desk providers could donate a limited number of sit-stand desks for the trial. Qualitative research methods tend to employ smaller sample sizes than quantitative approaches, due to the focus upon in-

depth understanding of complex issues as opposed to prediction and generalisation (Marshall, 1996). Accordingly, the qualitative interviews in this project were conducted with a sub-sample of participants (n = 15) that took part in the quantitative data collection (see section 4.4.4).

4.4.3 Recruitment of pilot randomised controlled trial intervention participants

Participants were recruited via internal advertisement. At PHE, this involved an email sent to all employees at the chosen worksite. At Macmillan, this involved an email sent to all employees at the chosen worksite, alongside their standard internal communication channels (Yammer page, posters). Promotional recruitment material can be found in appendix D. All potential participants were required to attend a 45-60-minute recruitment workshop at their organisation. If they were unable to attend a workshop, they were required to engage in a 30-minute telephone conversation with the lead researcher to discuss the study requirements to be eligible to formally apply to take part in the research. The agenda for the recruitment workshop is detailed in appendix E. A total of 68 employees engaged in a recruitment workshop or phone call (45 from Macmillan, 23 from PHE).

Following the recruitment workshop, potential participants were given a participant information sheet (appendix F) and were invited to complete a consent form and an expression of interest (EOI) form (appendix G) that asked questions regarding age, gender, ethnicity, and disability status, what interested them about sit-stand desks, and whether they, or a close friend or family member, had ever had a cancer diagnosis. The questions relating to cancer diagnoses were included as funding acquired for this study required that some of the participants to have been affected by cancer; via a personal cancer diagnosis and/or a close friend or family member being diagnosed with cancer. A total of 43 employees consented and completed the EOI form (29 from Macmillan, 14 from PHE): consent forms were completed prior to EOI forms as information collected via the EOI form was treat as study data and used within the analysis.

Eligibility/inclusion criteria

Participants were required to be full-time employees on a permanent or fixed term contract until the anticipated study end date, with no plans to leave the organisation, or be absent for an extended period (≥ 4 weeks). Participants were

included if they worked primarily in the office-based setting, were present at the worksite ≥ 4 days a week, and were at least 18 years of age. Participants were excluded if they used a sit-stand desk at work in the four weeks prior to baseline data collection, and if they have ever been advised to avoid prolonged standing by a health professional or are unable to stand. Certain work teams at one of the participating organisations were excluded owing to the sensitivity of their work and current desk configuration; the current desks would have required substantial adaptation to accommodate the sit-stand equipment.

Pilot randomised controlled trial intervention participant selection

Of the potential participants that attended a recruitment workshop and completed the EOI form, those that did not meet the eligibility criteria were excluded immediately (n = 3). Thirty participants were then selected strategically to take part in the research; the selected sample is representative of the range of characteristics on the EOI form. Eighteen participants were selected from Macmillan and twelve from PHE. This was to ensure that participants from Macmillan and PHE could be equally split into the three study groups, i.e. six in each group from Macmillan, and four in each group from PHE. Quantitative approaches are inclined to favour a homogenous sample to enhance internal validity (Glasgow et al., 2003). Conversely, researchers adopting a qualitative methodology are less concerned with internal validity issues and thus tend to purposely select participants to yield information-rich accounts relevant to the research question (Coyne, 1997), and whom represent a diversity of views that characterise the complex phenomenon under study. A fairly heterogeneous sample was selected to take part in the pilot RCT, as practically, it was evident from the pool of potential participants that a homogenous sample (in terms of age, gender, and ethnicity) would not be possible to achieve. Further, internal validity was already substantially compromised since the research is being conducted in a real-world setting (Glasgow et al., 2003), and thus it was deemed more appropriate to include a range of employees that better represent the diversity within the organisations under study. This would allow a diverse range of participants to be interviewed as part of the qualitative process evaluation, as detailed below (section 4.4.4).

The participants who were not selected were put on a waiting list in case of drop-outs. It was agreed that any participants that dropped out before February 2015 would be replaced; replacing participants after this data would not be feasible within the project time-scales. Five participants dropped out before the commencement of the intervention or data collection (3 from Macmillan, 2 from PHE), and one participant from PHE dropped out following the commencement of the intervention, but before February 2015. Thus, six employees from the waiting list joined the research project. An employee from the Macmillan waiting list took the place of a PHE employee drop-out as all of the participants from the PHE waiting list had already been recruited. This meant that the final participant sample included an uneven number of participants in each group from each organisation. See Figure 4.3 for an illustration of participant recruitment into the pilot RCT.

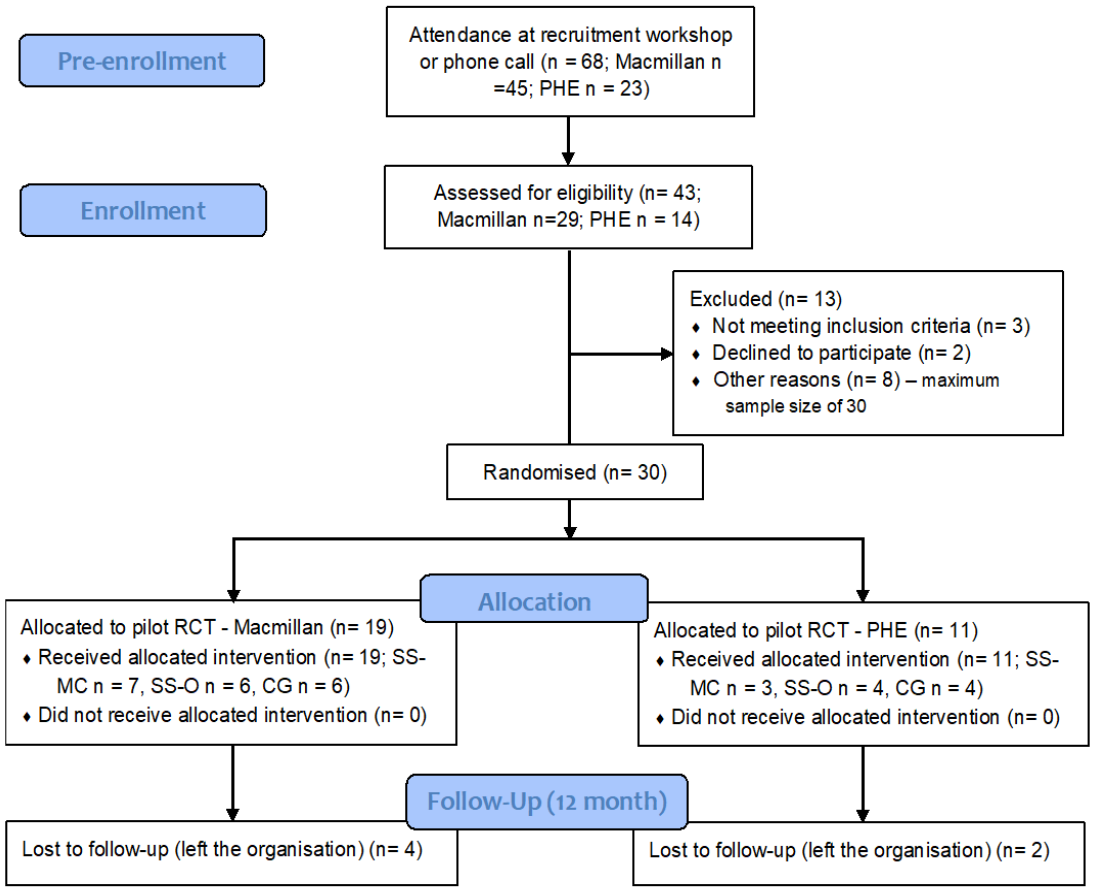


Figure 4.3. *Consort diagram of participant recruitment into the pilot RCT*

Randomisation

Participants were allocated randomly to one of three arms using an online randomisation programme (www.randomizer.org). Participants from the two participating organisations were randomised separately, to achieve an equal number in each study arm in both organisations. Given the nature of the intervention, i.e. the fact that participants may or may not receive a sit-stand desk, it was not possible to blind participants or researchers to arm allocation. However, concealment allocation was implemented (Higgins & Green, 2011).

4.4.4 Recruitment of participant and stakeholder interviewees

Recruitment of participant interviewees. The qualitative interviews in this project were focused on gaining an in-depth understanding of the participants' experiences of the sit-stand desk intervention, to provide data regarding the processes that influenced feasibility, acceptability and efficacy. Interviewees were purposely selected to ensure representation of a diversity of views, according to gender, age categories, ethnicity, job role and seniority, intervention arm, organisation, and experience of using the sit-stand desk. Knowledge of participants' experience of using the sit-stand desk was attained through systematic participant observation, and ongoing informal conversations with participants. Seventeen intervention participants were invited to take part in an interview, of which two declined. Thus, 15 participants were interviewed. An overview of the characteristics of the participant interviewees can be found in appendix H.

Recruitment of stakeholder interviewees

Stakeholder interviewees were employed within the participating organisations but did not participate in the intervention study. Rather, their work roles and responsibilities were deemed relevant to assessing the feasibility, acceptability of the sit-stand desk project. For example, health and safety advisors were able to provide insight into whether the adoption of sit-stand desks is compatible within the organisations current health and safety policies and practices. Stakeholder interviewees were identified via brainstorming relevant occupations, roles and individual employees with the key contact within each organisation. Stakeholder interviewees included employees working in a variety of roles across the organisation at various levels of seniority. Overall, 10 stakeholder interviewees from

Macmillan and 14 from PHE were recruited. Further, two key stakeholders from Ergotron, the desk suppliers, were also interviewed. See table 4.3 for an overview of the stakeholder interviewee's roles within the organisations.

Table 4.3. *Job roles and categorisation of the stakeholder interviewees. *Employees who fall into more than one of the stakeholder categories*

Stakeholder interviewee categories	**Roles: Macmillan**	**Roles: PHE**	**Roles: Ergotron**
Senior Employees and middle-management	Corporate Resources Director Head of Procurement* Human Resources Director* Physical Activity Programme Lead Working Through Cancer Programme lead	Consultant in Public Health Medicine Consultant Occupational Physician* Corporate Director of Human Resources* Deputy Director – Corporate Risk and Insurance*	
Workplace Wellbeing	Human Resources Director* Human Resources Manager Human Resources Advisor	Consultant Occupational Physician* Corporate Director of Human Resources* Internal Communications Officer (Health and Wellbeing) Staff Wellbeing Lead (x2) Strategic Human Resources – Equality and Diversity Lead Workplace Wellbeing Champion	Ergonomic and Wellness Research Manager
Operational staff	Facilities Manager Head of Procurement* Health and Safety Advisor Physical Activity Project Officer	Assistant Category Manager (Furniture) Business and Performance Manager Deputy Director – Corporate Risk and Insurance* Deputy Estates and Facilities Manager (Operational) Lead Category Manager – Corporate Services Project Sponsor (Estates)	Territory Account Manager

4.5 Project evaluation: Research methods

The research design is underpinned by the standard evaluation framework for PA programmes and the MRC guidelines for evaluating complex interventions, incorporating both outcome and process evaluation data collection (Cavill et al., 2012; Craig et al., 2008); see section 4.2 for a more comprehensive overview of this approach and Figure 4.4 for detail on the timing of data collection alongside intervention delivery. A detailed study timeline can be found in appendix I. This section will discuss the research methods utilised within the pilot RCT and process evaluation.

Time line	Sit-stand desk only (SS-O)	Multi-component sit-stand desk (SS-MC)	Seated desk control (CG)
Randomisation			
-2 weeks	Measurement of outcomes		
-4 to -1 weeks	Participant observation		
Baseline (time 0)		a	
2 weeks		b	
3 weeks	c d	c d	
4 weeks	Measurement of outcomes		
5 weeks		a	
8 weeks		b	
4-10 weeks	Stakeholder interviews		
12 weeks		a	
14 weeks	Measurement of outcomes		
16 weeks		b	
16-20 weeks	Participant observation		
21 weeks		a	
6 months		b	
	Measurement of outcomes		
7-8 months	Pilot RCT participant interviews		
10 months	Participant observation		
12 months	Measurement of outcomes		

Figure 4.4. *An illustration of the study design including timings of data collection and the delivery of the intervention. A, b, c and d are components of the delivered interventions; see Figure 4.2 for a description of these components*

4.5.1 Pilot randomised controlled trial research methods

Participant profile data

Profile data was collected, through the EOI form (detailed in section 4.4) and a short survey undertaken at a monitoring training session, before the installation of the sit-stand desks. Questions on the short survey included participants' height, weight, job title, household composition, personal monthly income, level of education, and sexuality. A copy of the survey can be found in appendix J.

Outcome measures

The main components of PA are frequency, intensity, time and type (Montoye, 2000 and see section 2.1.1) and the important dimensions of sedentary behaviour are frequency, interruptions, time and type (Tremblay et al., 2010). To understand the impact of the sit-stand intervention on sitting, standing and PA, it was desirable to measure these behaviours accurately; see table 4.3 for a full list of outcome variables. This section discusses the equipment and techniques used to quantify sitting, standing and PA within this research. As the 'type' of behaviour is contextual, this component of both PA and sedentary behaviour was examined as part of the process evaluation and is described in section 4.5.2.

Equipment and techniques. Wearable activity monitors were selected for this research study as they are more accurate than self-report and observational measures and are able to capture the multi-dimensionality and daily pattern of PA and sedentary behaviour (Ekelund et al., 2011; Esliger & Tremblay, 2007; Strath et al., 2013). Accelerometers were used within this research project to measure PA, which is the most commonly utilised type of activity monitor within PA research (Dowd et al., 2012). Accelerometers measure movement (acceleration and deceleration, i.e. change in speed across time) in gravitational acceleration units ($1g = 9.81\ m/s^2$) (Chen & Bassett, 2005). This is possible as accelerometers contain a piezoelectric sensor and a seismic mass which, when undergoing acceleration, interact to cause a displaced charge to build up. This charge generates an output signal that is proportional to the acceleration (Chen & Bassett, 2005; Esliger, Copeland, Barnes, & Tremblay, 2005; Sherar et al., 2011). Gravitational acceleration units are then transformed into 'counts' to predict energy expenditure and classify activity intensity, (usually into categories of sedentary, light, moderate and vigorous; (Atkin et al., 2012; Welk, 2005), duration and frequency. The Actigraph GT3X+ (ActiGraph, Pensacola, FL, USA) was selected; it is a triaxial accelerometer that accurately classifies PA intensity (Ozemek, Kirschner, Wilkerson, Byun, & Kaminsky, 2014); it is referred to subsequently as GT3X+. Compared to uniaxial accelerometers, a more comprehensive examination of body movements is permissible with triaxial accelerometers (Chen & Bassett, 2005). Actigraph accelerometers are the most validated commercially available accelerometers (Plasqui, Bonomi, & Westerterp, 2013). Counts per minute, measured via the

GT3X+, are significantly correlated with oxygen consumption (Kelly et al., 2013; McMinn, Acharya, Rowe, Gray, & Allan, 2013). Further, a high inter-instrument reliability has been reported in both laboratory conditions (Ozemek et al., 2014) and the free-living environment (Aadland & Ylvisaker, 2015). However, inter-monitor reliability is reduced for vigorous and very vigorous intensity physical activities (Jarrett, Fitzgerald, & Routen, 2015).

It is possible to combine accelerometers with heart rate monitors to improve the accuracy of activity intensity estimation. For example, the added intensity of walking upstairs rather than walking the same distance on a flat surface would be recognised when an accelerometer is combined with a heart rate monitor (HRM) (Anastasopoulou et al., 2014). However, it is unlikely that the addition of an HRM significantly improves the accuracy of PA intensity estimation (Plasqui et al., 2013). Thus, given the higher cost and substantially higher participant burden (Atkin et al., 2012), it was deemed inappropriate to utilise an HRM alongside the accelerometer. Instead, an inclinometer device was worn alongside the GT3X+. This is because accelerometers in isolation are unable to accurately classify sedentary behaviour as they only detect movement, not posture (Dowd et al., 2012; Gardner et al., 2016; Y. Kim et al., 2015; Plasqui et al., 2013). Thus, standing still would be classified as 'sedentary' using an accelerometer (Edwardson et al., 2016). This is particularly important for intervention studies that might expect a replacement of static sitting time with static standing time, as this change in behaviour would not be detected by an accelerometer.

Inclinometer devices measure postural positioning; thus, it is possible to distinguish between sitting and standing) (Y. Kim et al., 2015). The GT3X+ does contain an inclinometer function, however, a number of validation studies have reported that it inaccurately classifies sedentary behaviour when compared to direct observation (Y. Kim et al., 2015). The GT3X+ only correctly classified posture 70% of the time (Carr & Mahar, 2012), and was unable to accurately detect sit-stand transitions (absolute and rate per hour) (Lyden, Kozey-Keadle, Staudenmayer, & Freedson, 2012; Ryde, Gilson, Suppini, & Brown, 2012) and reductions in sitting (Kozey-Keadle, Libertine, Lyden, Staudenmayer, & Freedson, 2011). The GT3X+ tends to overestimate both sitting time and the number of breaks (Judice, Santos, Hamilton, Sardinha, & Silva, 2015). Thus, a separate inclinometer, the ActivPAL3™

micro monitor (PAL Technologies Limited, Glasgow, UK), referred to subsequently as ActivPAL, was utilised alongside the GT3X+. The data derived from the ActivPAL is continuous and based on the incline of the thigh, static and dynamic acceleration (Edwardson et al., 2016; Kang & Rowe, 2015). Thus, it categorises behaviour across time as either sitting/lying, standing or stepping. The ActivPAL provides accurate measures of sitting time and sit-to-stand transitions in free-living environments (Y. Kim et al., 2015; Kozey-Keadle et al., 2011; Lyden et al., 2012; Ryde et al., 2013) and is considered the 'gold-standard' device for measuring sedentary behaviour (Loudon & Granat, 2015). For example, Ryde et al. (2013) reported that direct observation was highly correlated with the ActivPAL for both sitting time (r^2=0.99) and sit-to-stand transitions (r^2=0.93). Thus, the ActivPAL device was utilised to quantify sitting within this research. Whilst sedentary behaviour was also quantified using the GT3X+, this was only utilised as a comparison with the ActivPAL measure. The ActivPAL is also a valid and reliable measure of step count and cadence (Ryde et al., 2012).

Data collection protocol. The GT3X+ was worn on the right hip via an elastic belt (Ward, Evenson, Vaughn, Rodgers, & Troiano, 2005) during waking hours only, excluding time spent engaged in water-based activities. Thirty GT3X+ monitors were used within this project. Raw data was collected at a frequency of 30Hz. The ActivPAL was worn continuously on the centre of the right thigh, following insertion into a nitrile sleeve and wrapping in a waterproof dressing. Participants were given extra materials to change the dressing when required. Thirty ActivPAL monitors were used within this project. The average number of deployments of each GT3X+ and ActivPAL monitor was five. Activity count data was collected at a frequency of 20Hz. Both monitors were set to record data from midnight and were worn for 7 days at each data collection timepoint to obtain sufficient data to provide a valid estimate of habitual PA (Hart, Swartz, Cashin, & Strath, 2011). The day before the commencement of each data collection phase, the researcher met with each participant face to face to give them their monitoring equipment along with a guidance sheet on how to wear the monitors (see appendix K). Prior to the first data collection phase, participants were required to attend a workshop to learn how to wear the monitors and complete the activity diary (see section 4.4.2). There were five data-collection timepoints; baseline (approximately

one month before sit-stand desk installation) and then two-weeks, 3-months, 6-months and 12-months following desk installation. These timepoints were selected to enable evaluation of both the short-term impact and medium-term sustainability of the intervention (Hutchinson & Wilson, 2012; Malik et al., 2014). It was anticipated that 150 data sets would be generated in total. This would result in 1050 days of activity monitor data (2010 days of monitor data in total). However, some data was missing or excluded due to participant drop-out, illness, or not meeting the validity criteria; further details on the amount and type of valid, invalid and missing data can be found in section 4.6. See Figure 4.4 for an illustration of how this monitoring was scheduled in relation to both the process evaluation and intervention delivery.

Outcome variables

Sitting and standing were assessed using ActivPAL and dimensions of PA were assessed using GT3X+. Outcome variables are outlined in table 4.4.

Table 4.4. *Study outcome measures taken at baseline, 2-weeks, 3-months, 6-months and 12-months *Included as comparison to minutes spent sitting (ActivPAL)*

ActivPAL3^{TM} activity monitor ***(PAL Technologies Limited, Glasgow, UK)***	**ActiGraph GT3X+ activity monitor** ***(ActiGraph, Pensacola, FL, USA)***
Sitting minutes	Sedentary minutes*
Standing minutes	Light PA *(i.e. physical activity) minutes*
Stepping minutes	Moderate PA minutes
Number of steps	Vigorous PA minutes
Number of sitting bouts *(i.e. periods spent sat down)*	MVPA *(i.e. moderate-vigorous physical activity) minutes*
Number of sitting bouts lasting 0-30 minutes *(i.e. short periods of sitting)*	Number of MVPA bouts lasting ≥ 10 minutes *(i.e. Number of times engage in MVPA for at least ten minutes)*
Number of sitting bouts lasting > 30 minutes *(i.e. prolonged periods of sitting)*	Minutes spent in MVPA bouts lasting ≥ 10 minutes *(i.e. minutes engaged in MVPA that occurred in bouts of MVPA lasting at least ten minutes)*
Minutes in sitting bouts lasting 0-30 minutes	Axis 1 CPM *(Axis 1 = forwards-backwards acceleration; counts are an activity monitor-derived estimate of energy expenditure)*
Minutes in sitting bouts lasting > 30 minutes	Vector Magnitude CPM *(i.e. the vector magnitude of acceleration in all three axes; up-down, forward-backward and left-right)*
Number of sit-to-stand transitions and number of sit-to-stand transitions/total sitting time *(i.e. postural changes from sitting to standing)*	Attainment of the PA guidelines *(i.e. 150 minutes. of moderate PA or 75 minutes. of vigorous PA – or a combination thereof – per week, accumulated in bouts of ≥10 minutes; assessed over whole day only)*

4.5.2 Process evaluation research methods

Activity diaries

Activity diaries were used to record the behaviour to facilitate understanding of the factors that influence sitting, standing and PA in the workplace context. The activity diaries are complimentary to the activity monitors (Greene et al., 1989) as they foster an understanding of different aspects of the behaviour, including the type, reason for performing the behaviour, whom with, and in which domain (i.e. work, leisure, travel, household). Thus, the monitors and diaries, in combination, permit a more comprehensive understanding of the behaviour (Hesse-Biber, 2012). Participants were asked to record the behaviour that they spent the most time doing during each hour, during each 7-day data collection period. Time spent in the workplace and activity monitor non-wear time were also recorded in the activity diary. Participants were given a hard-copy of the activity diary at each data collection timepoint, and also had the option of completing the diary electronically. A text message, reminding participants to complete their activity diary, was sent to participants once daily throughout each data collection period. Text message models have shown success in increasing compliance to data collection (Anhøj & Møldrup, 2004). A copy of the activity diary is provided in appendix L. The total number of completed diaries was 127; baseline = 29, 2-weeks = 26, 3-months = 25, 6-months = 27 and 12-months = 20. Reasons for missing diary data include participant drop-out (n = 9), being unable to complete the monitoring phase due to illness (n = 1) and loss of diary / failing to complete the diary for an unknown reason (n = 13).

Qualitative interviews

Qualitative interviews enable explorations of perceptions and meaning to increase understanding of a phenomenon (C. Warren & Karner, 2005). Qualitative interviews were undertaken with both intervention participants and key stakeholders from the participating organisations to understand the processes that influenced the feasibility, acceptability and efficacy of the sit-stand desk intervention.

There are a number of different types of qualitative interview; structured, semi-structured, open-ended and focus groups (Britten, 1995). Whilst structured interviews involve a fairly rigid schedule of interviews and unequal power dynamics between the interviewee and interviewer, open-ended interviews are interviewee-led

and only a general theme for the interview is set by the interviewer prior to the commencement of the interview (Britten, 1995; J. Thomas, Nelson, & Silverman, 2011, p. 350). This research project adopted a semi-structured interview approach. Semi-structured interviews have a schedule of questions but are flexible and allow the interviewer to deviate from the guide and probe responses to seek clarification and elaboration (Qu & Dumay, 2011). Thus, whilst being interviewer-led to acquire specific research-relevant information (Cohen & Manion, 1989, p. 307), semi-structured interviews allow the interviewees to describe their specific perceptions and experiences. This approach was taken as, whilst it was important to allow deep and realistic insights to be uncovered (Randall & Phoenix, 2009), there was a very specific agenda to the interviews and so a completely open-ended approach was deemed unsuitable. Whilst a conversational style was adopted, the researcher maintained control to ensure certain topics were covered satisfactorily (Britten, 1995). The interview guides were both theoretically and empirically informed. For example, PA, organisational culture and occupational identity theory shaped the topics and questions. However, questions also differed depending on the organisational role of stakeholders and observations of participants within the work environment. For example, it was possible to refer directly to previous conversations and challenge responses that contradicted observations.

Piloting interviews

It is important to conduct pilot interviews to ensure the questions elicit information that is relevant to addressing the research question (Braun & Clarke, 2013, p. 85). It is possible to reflect on the appropriateness of the language, and potential omissions and/or unnecessary themes, to assist in the refinement the interview guide (J. Kim, Tanabe, Yokoyama, Zempo, & Kuno, 2011; Sampson, 2004). Two pilot participant interviews were conducted with Brunel University London employees; one that has a sit-stand desk and another that has a seated desk within an open-plan office (average length 50 minutes). Three pilot stakeholder interviews were conducted with a Workplace Wellness Manager, a Health and Safety Manager and a senior leader employed at Brunel University London (average length 51 minutes). The interview guides were modified following the pilot interviews to include the addition of questions regarding sit-stand desks and productivity, however the guides were not then fixed. Rather, they were continually crafted throughout the

data collection process (Braun & Clarke, 2013, p. 85; Moore et al., 2015). Examples of both participant and stakeholder interview guides can be found in appendix M.

Intervention participant interviews

Participant interviews were conducted to understand employees' experiences of taking part in the intervention. Interviews took place with 15 participants (details of participant interviewees can be found in section 4.4.4), approximately 7 months following the installation of sit-stand desks within their organisation. The interviews were 38 minutes on average, the shortest being 20 minutes and the longest being 57 minutes. The total amount of participant interview data is 565 minutes (9.4 hours). The interviews were mainly conducted face to face within a meeting room in the interviewee's workplace or at a nearby café. However, three interviews were conducted over the telephone, upon the request of the interviewee.

Brief exit interviews also took place with all 30 participants, following completion of the intervention, either in a workshop setting with other participants or individually via telephone. These allowed participants to choose an activity related incentive as a thank you for taking part in the research (a copy of the flyer detailing the incentive options, terms and conditions can be found in appendix N), receive feedback on their activity monitor data from across the project, and provide any additional views about being part of the research project.

Stakeholder interviews

Stakeholder interviews were conducted to examine organisational culture and working practices that influenced the feasibility and acceptability of the sit-stand desk intervention. These interviews took place with 26 stakeholders (details of stakeholder interviewees can be found in section 4.4.4), approximately two months following the installation of the sit-stand desks. The interviews were 42 minutes on average, the shortest being 18 minutes and the longest being 64 minutes. The total amount of stakeholder interview data is 1091 minutes (18.2 hours).

Participant observation

A deeper understanding of the research problem was possible via the combination of qualitative interviews with participant observation (Watson, 2011). Participant observation was conducted to gain further insight into the feasibility,

acceptability and efficacy of the sit-stand desk intervention within the organisations. Ethnography is a research tool for describing a culture that originates from cultural anthropology (Sands, 2002) and is concerned with lived experience and understanding cultures within their natural settings (Hammersley & Atkinson, 2007; Ravasi & Canato, 2013; Watson, 2011). The researcher must immerse herself within the setting to understand both the particularities and regularities of behaviour. This approach is suited to investigating the complex interactions between interventions and the contexts they are delivered within (Morgan-Trimmer, 2015; J. Roberts, 2014). Thus, it is possible to understand how interventions can be perceived differently and have differing impacts in different situations (Huby et al., 2007). Ethnographic research is characterised by the study of 'other', unfamiliar cultures (Rosen, 1991) and an extended period of immersion (usually many years) within the research setting (Ravasi & Canato, 2013; Sands, 2002, p. 42). This research project involved a much shorter period of formal involvement with a relatively familiar culture. Therefore, ethnography was not conducted, but rather ethnographic principles, including immersion and participation within the organisational setting, taking a collaborative approach, and utilising introspection and reflexivity (Sands, 2002; Spradley, 1980, pp. 57-61), guided short periods of participant observation.

Ethnography in physical activity and organisational research

Despite the potential of ethnographic research, it has only occasionally been utilised within PA research (e.g. Frey, Buchanan, Rosser Sandt, & Taylor, 2005). However, whilst still dominated by positivist frameworks, ethnography has been utilised within the management and organisational literature (Watson, 2011). The Hawthorne studies of the 1920s and 1930s that were concerned with work effectiveness, were amongst the first to utilise ethnographic methods in the workplace (Neyland, 2008, p. 4). Organisational research has recognised the need to understand the complexities of organisations. In fact, Watson (2011) argues that it is only possible to glean meaningful information about organisations by studying them ethnographically. He argues that "a degree of talking to people, watching them, and sharing tasks with them over an extended period of time in various settings… might be expected before we can convincingly claim that we know what we are talking about" (Watson, 2011, p. 204). Further, the ethnographic approach fosters a longitudinal, process-oriented understanding of research issues (Rosen, 1991). Thus,

observational data complements interview data by providing a more comprehensive understanding of the culture and context.

Participant observation within this research project

Participant observation is the central tool of ethnographic research (Ravasi & Canato, 2013; van Maanen, 2011). Researchers observe both the activities of participants and the setting within which the activities take place (Angrosino & Rosenberg, 2013). One of the initial steps involved in engaging in participant observation is gaining access to the group or community under investigation (Sands, 2002, pp. 37-38). Initial access is usually granted via a 'gatekeeper' from within the setting. However, access to engage in participant observation within this project was granted alongside access to complete the entire research project in collaboration with the organisations (see section 4.3). Within this project the researcher undertook a volunteer role within the two workplaces that the intervention was implemented, to engage in participant observation and be a 'participant' (employee) within the workplace. Engaging in behaviours appropriate to the setting, rather than simply observing, can facilitate a more nuanced understanding of meanings attached to behaviours (Spradley, 1980, p. 61). Observations involved three formal phases, each consisting of 9-13 'working' days, within each workplace. Additionally, informal participant observations and interactions have occurred, been recorded and utilised in the analysis throughout the duration of the interaction with both organisations.

Making observations, record keeping and 'artefacts'

The observations made within this research focused upon activities, employees' behaviours and interactions, and the workplace setting (Spradley, 1980, p. 78). Initially, it was important to treat the setting as 'strange' and to engage in continuous introspection about taken-for-granted activities, so as not to overlook any potentially relevant aspects (Neyland, 2008, pp. 101-102). This was most crucial at Macmillan given the researcher's previous involvement within the setting. Initial, more general observations of the workplace setting and context shaped more detailed and specific observations as the data collection progressed. Later observations focused on how the workplace culture and context influenced employee attitudes and behaviours related to workplace sitting, standing, PA and health. It was important to blend the role of 'insider' (employee) and 'outsider' (researcher) in generating

observational field notes, and to acknowledge the role of the researcher in shaping what was observed and recorded; see section 4.7.3.

A comprehensive and accurate record of participant observations from both the formal volunteering role and informal correspondence was kept. The field notes were characterised by 'thick description', as advised by Geertz (Neyland, 2008, p. 64). Using a computer to record field notes whilst at the organisation was the most practical and efficient means to do so. The researcher would often make notes throughout the working day, however, would sometimes feel uncomfortable that other employees could see the notes, especially when using a large or a dual screen, and at other times did not have the time during the day to make lengthy field notes. Consequently, the researcher would make condensed notes or prompts throughout the day and expand the notes at the end of the working day (Spradley, 1980, pp. 69-70). See appendix O for an example of an observational data collection sheet. In total, 147,616 words (314 pages) of field notes were recorded based on the formal participant observation phases, and 37, 750 words (56 pages) of field notes were recorded based on informal participant observations and interactions.

Whilst field notes were the main source of data collected from participant observation, 'artefacts' (Spradley, 1980, p. 63) were also collected and utilised within this research project. Artefacts included organisational documents, including policies, emails to all staff and departments, and floor plans, were collated. Documentary analysis is a useful component of ethnographic research as documents provide information about the culture and context of organisations (Fitzgerald, 2007), and reflect the official discourse of an organisation, or groups within an organisation. Thus, organisational documents provided information on organisational perspectives on relevant topics, such as workplace wellbeing and hot-desking.

4.6 Data processing and analysis

This research project involves the processing and analysis of both outcome and process data. The different components were analysed independently, i.e. a parallel analysis (Teddlie & Tashakkori, 2009, p. 266). This next section will provide an overview of the analysis of the outcome evaluation and process evaluation data.

4.6.1 Outcome evaluation: GT3X+ and ActivPAL data processing and analysis

Valid wear time criteria

Variation in valid wear time criteria is known to impact the final sample size and study findings (Masse et al., 2005). Valid wear time criteria included a minimum number of hours per day and a minimum number of valid days. Since this research is primarily concerned with sitting, standing and PA during working hours, it was also necessary to include criteria for a minimum number of working hours on weekdays, and a minimum number of valid weekdays. Although there is debate within the literature (Pedisic & Bauman, 2015), studies within an adult population suggest that at least 3-4 valid days are required to achieve inter-monitor reliability (an Intraclass Correlation Coefficient (ICC) of 0.8) using accelerometers (Matthews, Hagströmer, Pober, & Bowles, 2012; Scheers, Philippaerts, & Lefevre, 2012; Trost, McIver, & Pate, 2005), and 4-5 days to achieve an acceptable degree of repeatability using ActivPAL (Edwardson et al., 2016). Further, a minimum of 10-12 hours activity data per day is recommended as a valid estimate of daily PA (Herrmann, Barreira, Kang, & Ainsworth, 2013; Matthews et al., 2012). However, previously published studies have adopted valid day criteria ranging from two to sixteen hours (Herrmann et al., 2013). Valid wear criteria were developed based on a compromise between acceptable standards regarding validity, and preservation of the sample size (Rich et al., 2013; Toftager et al., 2012). For example, it may be advantageous to allow a minimum of three valid days, if the majority of files contain at least three valid days and this substantially increases the sample size (Esliger, Sherar, & Muhajarine, 2012; Toftager et al., 2012). Criteria were developed based on the GT3X+ data as it is documented that adherence to the ActivPAL protocol may be higher due to the 24-hour continuous wear protocol (Edwardson et al., 2016; Tudor-Locke et al., 2015), however the criteria were applied to both the GT3X+ and ActivPAL data for consistency. To develop the criteria, the number of valid files according to a range of different potential criteria were calculated using KineSoft v. 3.3.75 software (KineSoft, Saskatchewan, Canada). The number of participants that would be eligible for inclusion in a 5 timepoint (baseline – 12-months) and 4 timepoint (baseline – 6-months) statistical analysis was determined for each potential validity criteria combination. This information is detailed in appendix P. Following

comparison of the number of eligible participants between the different potential validity criteria combinations, the following criteria were selected:

- a minimum of nine hours wear per day
- a minimum of four hours wear during work hours (9am – 5pm) on weekdays
- a minimum of two valid days
- a minimum of one valid weekday.

GT3X+ data processing

1. *Downloading data and epoch:* Data was downloaded and processed using ActiLife 6.10.3. The raw data was summarised into activity counts, i.e. an average of the raw data over a given time-period (epoch) (Chen & Bassett, 2005; Esliger & Tremblay, 2007). The epoch selected can affect the interpretation of the data as it determines the degree of resolution of activity bouts and averaging of intensities (Ayabe, Kumahara, Morimura, & Tanaka, 2014; Chen & Bassett, 2005; Gabriel et al., 2010; Orme et al., 2014; Trost et al., 2005). A 15 second epoch was selected in this study as PA in the workplace is typically brief and sporadic (L. Smith, Hamer, et al., 2015). Thus, if a longer duration epoch was selected, short bursts of PA would be more likely to be averaged alongside sedentary behaviour and thus classified inaccurately (Ayabe et al., 2014; Gabriel et al., 2010).
2. *Removal of invalid data:* Using ActiLife, an algorithm was applied to distinguish between monitor wear and non-wear. Sixty or more minutes of zero counts, with up to two minutes of interruptions (i.e. non-zero counts) was classified as non-wear (Troiano et al., 2008). The valid wear criteria detailed above were also included in this calculation. ActiLife produces graphs illustrating wear and non-wear according to this algorithm. Every data file was cross-checked with the activity diary information, and any data that had been clearly misclassified using the algorithm was reinstated. The data set was also screened for spurious values, i.e. those outside the limits of biological possibility (Esliger et al., 2005). The files excluded and included within the analysis are detailed in Figure 4.5.
3. *Data scoring:* Cut-points are important for delineating the duration and frequency of activity spent in different intensities of PA (Esliger & Tremblay, 2007). However, a multitude of different cut-points that have been developed and

the selection of cut-points can markedly influence findings (Esliger & Tremblay, 2007; Orme et al., 2014). Thus, it is important that the cut-points selected are appropriate and validated for the population group under study. Time spent in light, moderate and vigorous activity was calculated by classifying vector magnitude counts according to the cut-points developed by (Troiano et al., 2008). Light activity is considered 101 to 2019 counts per minute, moderate activity is considered 2020 – 5998 counts per minute, and vigorous activity ≥5999 counts per minute. These cut-points have been validated in the general adult population (Troiano et al., 2008). A two-minute interruption in PA bouts of at least 10 minutes in duration was permitted as habitual PA is known to be intermittent (Ayabe et al., 2014). This scoring was conducted for all the valid data, and for a filter of 9am-5pm on weekdays.

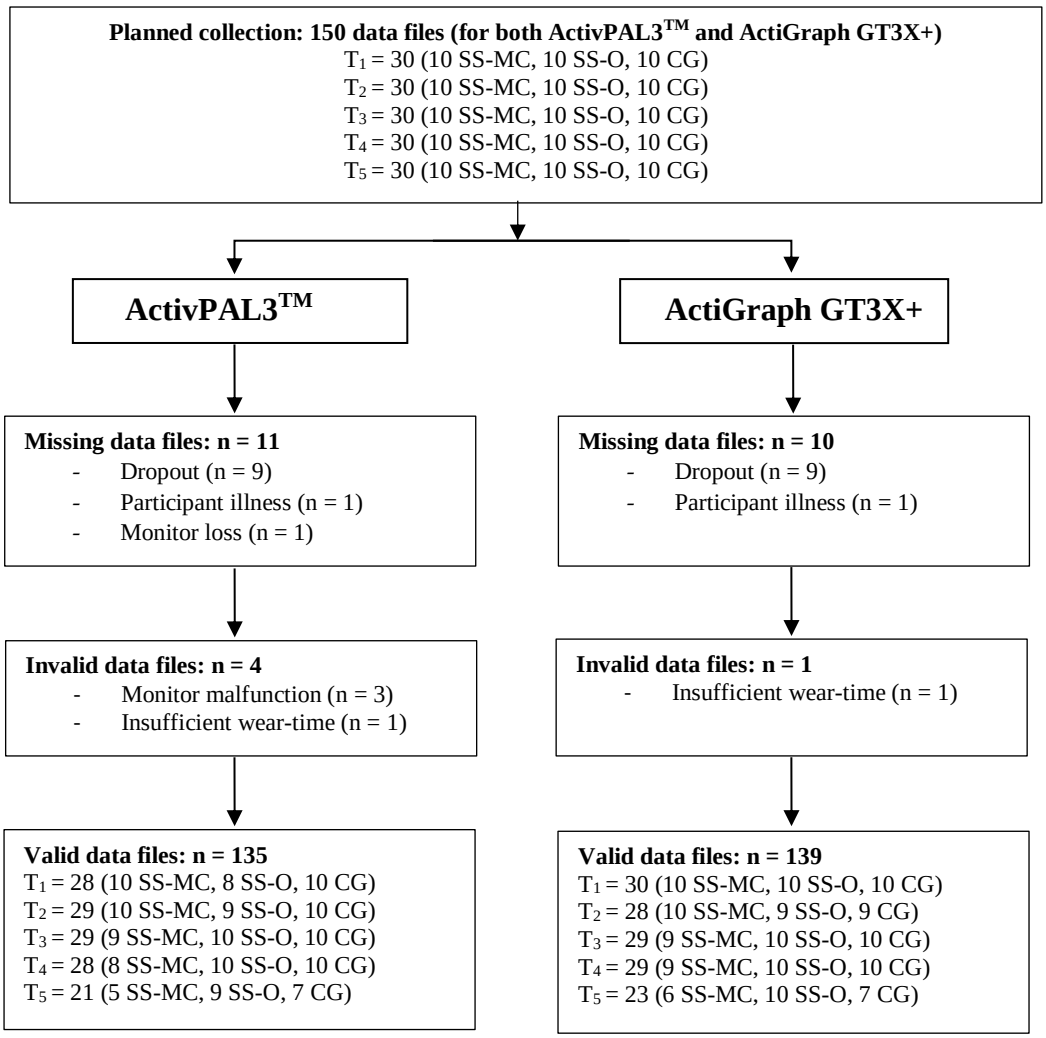


Figure 4.5. *Missing and invalid data, and the valid data included in the analysis, according to monitor type, intervention group and data collection timepoint*

ActivPAL data processing

1. *Downloading files and data correction*: Files were downloaded for each participant using ActivPAL proprietary software. The activities are presented as the exact duration of each bout of sitting (or lying), standing, and stepping. In a minority of cases (eight) the participant had worn the monitor upside down for all or part of the data collection time-period. It is possible to invert the data using ActivPAL software (Edwardson et al., 2016) and so this was performed for these cases. For those that had worn the monitor upside down (seven) for only part of the monitoring period, the correct parts of the original and inverted .csv files were merged manually.

2. *Removal of invalid data*: Initially, an algorithm was run using STATA software to distinguish between monitor wear and non-wear/sleep, which included conditions such as the longest continuous period of either sitting/lying, standing or stepping being classified as invalid each day and a day with fewer than 500 recorded steps being classified as invalid. The algorithm was developed by Bodicoat, Bakrania, and Edwardson (2016), based on the principles of isolating waking hours, and that sleep can occur at any time – or not at all – during a 24-hour period (Winkler et al., 2016). Thus, the algorithm adopts a person-orientated approach to defining a day (i.e. from one wake time to the next wake time), and thus waking hours, rather than a standard cut-off such as 7am – 11pm. The person-oriented approach reduces the likelihood of valid data being classified as invalid and removed because they occur outside arbitrary time limits (Edwardson et al., 2016). When compared to usual practice there was an almost perfect agreement (kappa 0.94) in the classification of each second, and a slight overestimation of daily wear-time, within a sample of Australian adults (Winkler et al., 2016).

   To facilitate cross-checking of wear and non-wear/sleep calculated via the algorithm with the information contained in the activity diaries, heat-maps[1] of included and excluded data were produced using SAS software (see appendix Q

[1] Heat maps are a visual, time-stamped representation of the data according to sitting/lying (red), standing (yellow) and stepping (green) for one 7 day period for one participant. Each bar represents 24 hours. The 'valid' heat map represents that data that is included within the analysis, whilst the 'invalid' heat map represents the data that have been removed because it is either invalid, non-wear or sleep.

for example heat maps). Every heat map was cross-checked with the activity diary information, and any data that had been clearly misclassified using the algorithm was corrected. Days that did not meet the minimum daily wear time of 9 hours, and 4 hours during work hours, also had to be manually removed via this process. The files included in the analysis are detailed in Figure 4.5.

3. *Data scoring*: Outputs based on valid data only were created in STATA. The code creates outcomes for the following time filters: all day, morning (6am-12pm), afternoon (12pm-6pm), evening (6pm-12am), weekdays, weekend days, work hours (weekdays 9am-5pm) and hour by hour data. For each of those time filters, the code produces findings from the data based on the following variables: total number of and time spent in sitting/lying bouts lasting 0-30 minutes, 30+ minutes and 60+ minutes, total number of sitting/lying bouts, total number of sit-stand transitions, total sitting/lying, standing, stepping and wear time, averages across the valid waking wear day for all of the variables, and number of valid wear days. All of the code used to process the ActivPAL data was written by Bodicoat et al. (2016) and has been approved for use within this project. The data scoring code has been adapted to include a weekday 9am-5pm filter, and sitting/lying bouts lasting 30+ minutes variables.

Descriptive and statistical analysis

Analysis of Variance (ANOVA) were conducted using SPSS to examine changes from baseline in all calculated variables; see table 4.3. Data were screened for outliers and 30 extreme values were removed. Further, skewness and kurtosis checks were undertaken to ensure that the data met the parametric assumptions that underlie ANOVA. Data that did not meet these assumptions were transformed using Ln, Sqrt, Ln reverse or Sqrt reverse transformations, depending on the direction of skewness and/or kurtosis.

The dependent variables were assessed using a 3 (study group) x 4 (timepoint) mixed-model ANOVA. These ANOVAs included the baseline, 2-week, 3-month and 6-month timepoints. The 12-month timepoint was excluded to preserve the sample size. Separate 3 (study group) x 2 (timepoint) ANOVAs were conducted to assess changes in dependent variables from baseline to 12-months and 6 to 12-months. Separate ANOVA were conducted for the work hours and non-work hours

'time of day' (ToD). ANOVA comparing pooled intervention groups (SS-MC and SS-O) to the CG were performed when no differences were found in the 3-group ANOVA, to enhance the statistical power. Further, repeated-measures ANOVA were conducted to assess differences in changes in dependent variables between the two timeframes; work hours (9am-5pm) and across the whole day. Greenhouse-Geisser corrections were applied to *F* tests in cases where Mauchly's test of sphericity was violated. Bonferroni-corrected post-hoc analyses were conducted in instances where significant main and interaction effects were observed. Pearson product-moment correlation coefficient analyses were also performed to assess associations between the change in ActivPAL and GT3X+ variables during work hours, and between the work hours and non-work hours ToD. Significance was set at the $p < 0.05$ level.

Differences in wear-time and sedentary behaviour variables as measured by the GT3X+ and ActivPAL monitors were assessed using paired-sample t-tests (one tailed). Pearson Chi Square tests were utilised to assess any differences between study group and across time, in whether PA guidelines were met.

Stepwise multiple linear regression analyses were conducted to assess whether any demographic, organisational or desk-related independent variables were significant predictors for the outcome variables. However, the data largely violated the assumption of multicollinearity, which meant that all but one predictor had to be removed from the model. Further, the assumptions of homoscedasticity and normally distributed errors were violated in some of the analysis. Therefore, the regression analyses are unreliable (Field, 2013) and thus have not been reported. Instead, Spearman's rho correlation analyses are reported. The data meet the assumptions of ordinal, interval or ratio level variables and there being a monotonic relationship between the variables. Spearman's rho analyses were conducted for each outcome variable (e.g. minutes spent sitting, minutes spent standing) both at baseline, and change from baseline at 3-months, to assess whether any independent variables were associated with intervention efficacy. Thus, CG participants were removed from the 3-month change from baseline correlation analyses. The independent variables included in the correlation analyses are presented in Table 4.5; categories within some independent variables, that were originally nominal variables, were collapsed into ordinal level variables with two levels, to meet the assumptions of Spearman's rho analyses and because the *n* within some categories was small.

Table 4.5. *Independent variables (organisational, desk-related, and demographic) included in the Spearman's rho correlation analyses*

Independent Variable	Type
Organisation	Ordinal (PHE or Macmillan)
Sit-stand desk model	Ordinal (Workfit-A or Workfit-D)
Age	Ordinal (16-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59 years)
Gender	Ordinal (Female or Male)
Income	Ordinal (£870-£1500, £1500-£2400, £2400-£3900, £3900+)
Qualification	Ordinal (Educated to degree level, or other)
Sexuality	Ordinal (Heterosexual or other)
Ethnicity	Ordinal (White or other)
Body Mass Index (BMI)	Ratio

Data are displayed as mean (± SE) in the text and tables. Due to the large number of statistical tests performed, the majority of those that did not reach statistical significance are not reported in the outcome evaluation results chapter.

4.6.2 Process evaluation – Data analysis: Thematic analysis

Qualitative analysis is a process embarked upon by the researcher via immersion within the data. A thematic analysis was utilised within this research project to collectively analyse all the process evaluation data; participant and stakeholder interview transcripts, formal and informal ethnographic participant observation field-notes, and organisational documents. Because of the multi-disciplinary and mixed method nature of the project, a single qualitative analytic approach helped to synthesise the data to address the research questions. Thematic analysis reports detail-rich data by identifying, analysing and interpreting *patterns* within the data (Braun & Clarke, 2006). It has been argued that most qualitative analysis is thematic in nature as it involves categorising raw data to theoretically describe and explain a phenomenon (Vaismoradi, Turunen, & Bondas, 2013). However, unlike some approaches that tend to be conducted within a particular theoretical approach, for example narrative analysis assumes a social constructionist stance, thematic analysis can and has been conducted from a variety of epistemological and theoretical orientations (Braun & Clarke, 2006). In other words, the thematic technique is distinct from the epistemological orientation of the research

(Braun & Clarke, 2014). This section will describe the thematic approach taken within this research project.

Induction-deduction

One of the key considerations when analysing qualitative data is where the approach lies on the inductive-deductive continuum; whether the analysis is data (empirically) or theory driven (Braun & Clarke, 2006; Tracy, 2013). An inductive approach is often equated with grounded theory as theory is generated from, and grounded in, systematically and empirically obtained research data (Charmaz, 1990; Corbin & Strauss, 1990; Goulding, 1999). The approach taken within this research project placed emphasis on both empirical data and theoretical constructs to differing degrees throughout the analytic process. There was a primary focus on the data which was then related to theoretical constructs, as this type of data-theory interplay permits new knowledge and insights to be generated (Dunning & Hughes, 2013). Further, theoretical insights generated from an inductive approach are arguably more congruent with the empirical data (Charmaz, 1990). However, Miles and Huberman (1994) describe the challenge of being "explicitly mindful of the purposes of your study and of the conceptual lenses you are training on it – whilst allowing yourself to be open to and re-educated by things that you didn't know about or expect to find" (p. 56). Thus, it was important to recognise that the analysis was not taking place in a vacuum and to think reflexively about the interplay between the research question, the theoretical underpinnings, and the empirical data throughout the analytic process.

Theoretical underpinnings of the thematic analysis

The qualitative data was primarily collected to answer the second research question: "what are the processes that influence the feasibility, acceptability and efficacy of sit-stand desk implementation and use?" Therefore, primary importance was placed on data that directly corresponded to one or more aspects of this research question. The analysis was guided by the SEM model, meaning the analysis was conducted with the intention of identifying processes from across various levels including the individual, environmental organisational (Connelly, 2001; Hawe et al., 2009). The analysis was also guided by organisational cultural theory and was predicated on the assumption that there is a reciprocal relationship between culture and behaviour (Dauber et al., 2012; Girginov, 2010; J. Martin & Siehl, 1983; Schein,

2010; Tharp, 2007). Organisational cultural theory guided thinking on specific organisational factors that shaped attitudes and behaviours – which represent one 'level' on the SEM – but which warrant a particular focus due to the intervention being delivered within the workplace setting and context.

Critical realist, complexity and systems principles which underpin the SEM (Golden & Earp, 2012), including the open-system nature of reality, guided the conduct of the analysis. Thus, the researcher openly sought to identify the interplay between contextual factors and various influences on the feasibility, acceptability and efficacy of the sit-stand desk intervention (Cruickshank, 2012, p. 14; Næss & Jensen, 2002; Porter & Ryan, 1996; Sayer, 2000; Wells et al., 2012). Thematic analysis permits an understanding of the context within which the empirical data has been generated (Vaismoradi et al., 2013). This research assumed that whilst there is an objective reality, it is only accessible via socially constructed language and meaning-making (Lipscomb, 2008; Maxwell & Mittapalli, 2010, pp. 146-150). Thus, it was important to look beyond what participants said to understand the context within which the participants spoke and acted (Alldred & Burman, 2005; Perryman, 2012). Examining the discourses present within the context of the workplace allowed for a more process-oriented understanding of participants and stakeholders accounts (S. Ainsworth & Hardy, 2004; Alldred & Burman, 2005; Springer & Clinton, 2015), and thus of the feasibility, acceptability and impact of the intervention.

Thematic analysis process

The analysis of the qualitative data occurred throughout the research process, not just at the end, as early data shaped ongoing data collection and findings were refined during the writing process (Corbin & Strauss, 1990; Onwuegbuzie & Combs, 2010). However, the substantial period of data analysis took place following the completion of data collection using NVivo 10 software. NVivo is a data organisation software that allows the researcher to analyse data more systematically, comprehensively and effectively (Watling, James, Briggs, & Briggs, p. 283). Utilising software to assist the analysis of qualitative data has been criticised on the basis that it could distance the researcher from the data and lead to a focus on quantity rather than quality (Braun & Clarke, 2013; Seidel, 1991). The researcher was mindful of these criticisms and fully immersed herself within the data. There are

clearly defined guidelines for conducting thematic analysis, however the approach is flexible and non-prescriptive (Braun & Clarke, 2006, 2013) The thematic analysis process within this research followed the steps outlined by Braun and Clarke (2006).

Stage 1 – Data familiarisation: Interview data was recorded using an Olympus LS-11 Dictaphone and transcribed *ad verbatim*. All data (interview, participant observation, organisational documents and activity diary) was read and re-read in full in order to become fully immersed with the depth (details and specifics) and breadth of content (Johnson & Christensen, 2012, p. 362). *Stage 2 – Generate initial codes:* A code is a basic, brief description of the essence of the raw data (Theron, 2015). Thus, this stage involved organisation rather than interpretation (Braun & Clarke, 2006). Data were read and coded line by line. For example, "I've just got used to sitting down all the time" was coded as 'the normalisation of sitting'. Examples of coded transcripts and field notes are available in appendix R. *Stage 3 – Searching for themes:* This stage is interpretive. During this stage, the codes were analysed, involving consideration of how different codes combine to form overarching themes (Braun & Clarke, 2013). *Stage 4 – Reviewing and refining themes:* This stage involved an assessment of whether the themes 'work' individually (i.e. whether the codes align with the theme) and whether the themes are collectively congruent (i.e. the relationships between the themes and in the context of the whole data set). Themes were refined based on this process (Braun & Clarke, 2013). *Stage 5 – Defining and naming themes:* To name the themes, the researcher identified the meaning of each theme (Braun & Clarke, 2006). Development of the thematic framework that comprised Stage 4 and 5 of the thematic analysis process is illustrated within appendix S. *Stage 6 – Producing the report:* This involved clearly and accurately reporting the findings of the research, and is discussed in section 4.7.

4.7 Research quality, ethical considerations, reflexivity and the writing process

4.7.1 Research quality

The quality of qualitative and quantitative research is usually judged according to separate criteria. For example, quantitative research is typically judged

as to how valid and reliable the findings are likely to be. Thus, there are a number of 'characteristics' that improve the quality of quantitative research, such as having a large sample size, and controlling for extraneous variables (Chalmers, 1999, p. 46; Sparkes, 1992, p. 18). There is much less consensus concerning the judgement of the quality of qualitative research (O'Cathain, Murphy, & Nicholl, 2010; Qu & Dumay, 2011). However, as a minimum, qualitative researchers are expected to engage in a rigorous process of data collection, and provide a transparent and detailed account of the research process (Corbin & Strauss, 1990). It is beyond the scope of this section to provide a wider discussion of quality issues within qualitative and quantitative research; such detailed accounts can be found in research methods texts (e.g. Braun & Clarke, 2013; Sparkes & Smith, 2013). The remainder of this section will discuss research quality within MMR.

Whilst there is no commonly accepted criterion for judging the quality of MMR (Tashakkori & Teddlie, 2010a, p. 811), the majority of mixed methods researchers assert that traditional (qualitative and quantitative) quality judgements should not be minimised (Greene, 2008; O'Cathain et al., 2010, p. 535). However, further quality issues can arise when combining qualitative and quantitative methods. One such criteria is integrative rigor (O'Cathain et al., 2010; Onwuegbuzie & Johnson, 2006), as this directly relates to the integration of the qualitative and quantitative findings. It is suggested that, to improve the quality of the research findings, (a) it should be clear which method(s) each inference is based on, (b) that inferences adequately incorporate both qualitative and quantitative findings, and (c) that explanations are suggested for inconsistencies between inferences (O'Cathain et al., 2010, pp. 457-458). The researcher consciously sought to convey integrative rigor within the write-up of the MMR presented in this thesis (see section 4.7.4)

A further quality concern specific to MMR is the talent or skill of the researcher concerning *both* qualitative and quantitative methods (Brannen, 1992, p. 20). To be a connoisseur of methods, an in-depth understanding of and proficiency in both approaches are required (Cameron, 2011). However, it is common for researchers to become practiced in one set of skills through their (undergraduate, postgraduate etc.) training which can result in low quality research being conducted for one element of a mixed methods study (Brannen, 1992, p. 20; Denzin, 2010; Teddlie & Tashakkori, 2012). Working in a team where researchers have different

but complementary areas of expertise is one solution to this issue (Lieber & Weisner, 2010, p. 563); although all members of the team should have a 'minimum level of competency' in all research approaches, to heed against communication barriers and methodological tensions (Tashakkori & Teddlie, 2010b, p. 30). However, notwithstanding the input of the expert multi-disciplinary supervisory team engaged in this project, a mixed methods PhD project necessitates a PhD researcher that is knowledgeable in both qualitative and quantitative research methods. Having a background, largely, in quantitative research, it was necessary for the researcher to engage in extensive training in qualitative methods and techniques before embarking on data collection. This involved partaking in a weekly qualitative research reading group to develop knowledge and understanding, and undertaking practical training by working on external projects including training in making observations and writing field notes, and conducting and analysing interview data.

4.7.2 Ethical considerations

Empirical research revealed that academic researchers conflate ethical issues with the ethical approval process (Brosnan, Cribb, Wainwright, & Williams, 2013). Indeed, ethical approval is extremely important as it safeguards research participants by diminishing the unequal power relationship between the researcher and the researched. For example, the ethical approval process usually stipulates that participants must know the risks and benefits of taking part in the research and are aware that they are free to withdraw at any time (Angrosino & Rosenberg, 2013). As the research project was longitudinal and some participants were asked if they would like to engage in various different research elements across a prolonged period, participants were reminded throughout the project that they were under no obligation to take part in each research element and declining an interview, for example, did not mean that they had to forfeit their place in the intervention. Participants were also periodically reminded (usually when scheduling data collection) that they were free to withdraw from the project at any time. Ethical approval to conduct this research project was granted by Brunel University London local research ethics committee prior to the recruitment of participants and commencement of data collection (see appendix T). All participants received a participant information sheet, which details their ethical rights, and provided written informed consent following attendance at a recruitment workshop and prior to any data collection taking place (see appendix U).

Further, the conduct of this study followed the extended CONSORT guidelines for randomised pilot and feasibility trials (Eldridge et al., 2016). However, the ethical conduct of research should not be limited to attaining ethical approval; consideration of ethical issues should be part of the everyday practice of doing research (Guillemin & Gillam, 2004) and thus continually reflected upon. It is beyond the scope of this section to describe every ethical dilemma that was faced throughout the conduct of this research. Instead, two pertinent examples are discussed.

(C)overt participant observation

The participant observation was, primarily, conducted overtly (Sands, 2002, p. 110). The 'gatekeeper' (usually a research participant) within each work team I was sat within was informed of the purpose of my volunteering, and this was, to varying extents, conveyed to the rest of the team. Further, I was open about the research with anyone within the organisation that enquired about my role. There were no objections to the research taking place at either organisation. However, not every person working within each study site was made aware of my research. This is primarily because it would have been impractical to inform each and every employee; I would typically see over 100 employees throughout one participant observation visit. It is accepted within social research that it may not be feasible or desirable to gain consent from every person that is observed (Sixsmith & Murray, 2001).

Anonymity and confidentiality

An ethical conflict that emerged during the write-up process was one of privacy and anonymity. Maintaining the privacy and anonymity of research participants is of great importance, however, removing all information that could potentially identify research participants sometimes comes at the loss of valuable explanatory information, which can also impact perceived trustworthiness and quality of findings (Sixsmith & Murray, 2001). This occurred throughout stakeholder interviews whereby stakeholders made role-specific statements that would be readily identifiable, even when using a pseudonym and withholding the employee's job title. Thus, the explanation of certain research findings and themes was jeopardised to maintain participant and anonymity.

4.7.3 The self: reflexivity, involvement and detachment

Traditionally, social science research was conducted in a positivist manner whereby an effort was made to standardise observations and minimise researcher influence (Neyland, 2008, p. 43; Sands, 2002, p. 13). Consequently, the values, emotions and characteristics of the researcher were marginalised from the research process in pursuit of value-free, objective 'truth' (Hammersley & Atkinson, 2007, p. 14). However, qualitative research underwent a 'crisis of representation' in the 1980s, which resulted in the emergence of 'the self' in research (Denzin & Lincoln, 1994, p. 3). The researcher always has prior knowledge and expectations and thus is not independent from the research process (Rock, 2001; Watson, 2011). Thus, social researchers should practice reflexivity (Hammersley & Atkinson, 2007, p. 17).

Reflexivity involves critically reflecting on the influence of the 'self' on the research process and findings (Angrosino & Rosenberg, 2013; Brackenridge, 1999; De Loo & Lowe, 2011; Delamont, 2009; Hammersley & Atkinson, 2007; Sands, 2002, p. 15). The researcher identifies as a white British, able-bodied, heterosexual woman in her late twenties. She engages in physically active leisure pursuits and sports, but is largely sedentary when 'working' (conducting her PhD research). However, she has a sit-stand desk which enabled her to incorporate standing into her working day throughout the PhD process. These factors are, to varying extents, likely to have influenced the conduct and analysis of the research (Brackenridge, 1999; Chappell et al., 2014; De Loo & Lowe, 2011) as they shaped her personal values and beliefs regarding sitting, standing and PA.

Another important consideration within *observation* research is the balance and blend of involvement-detachment, or insider-outsider status, of the researcher (Neyland, 2008, p. 80; Rock, 2001). Participation within the study setting, as opposed to a purely observational role, is likely to produce greater understanding (Spradley, 1980, p. 61). However, ever-shifting power relations within the research setting dictate that the researcher is never an absolute insider or outsider (Naples, 1996; Spradley, 1980, p. 57). Involvement is characterised by interpretations of the social world based on personal assumptions, whereas detachment requires self-distancing from personal values (Mansfield, 2007). The concept of involvement-detachment stipulates that varying degrees involvement and detachment should be

blended throughout the research process (Dunning & Hughes, 2013, p. 140; Elias, Mennell, & Goudsblom, 1998, p. 28; Mansfield, 2007). The perspective gained from 'involvement' within the research community should be balanced with self-distancing and an acknowledgement of personal ideals in order to produce 'reality-congruent' knowledge (Mansfield, 2005). The researcher blended her role as 'employee' with maintaining focus on the research endeavour. She took notice of the surroundings and interactions, asked questions related the research questions and wrote observation notes, alongside completing formal volunteering tasks. This dual insider-outsider role allowed her to maintain involved-detachment throughout the research process. Further, there were substantial periods of time outside of the workplaces in between observation phases which permitted reflection on involvement (Spradley, 1980, p. 54). The researcher became more and more of an outsider following the completion of data collection, which was critical for ensuring the qualitative analysis was reality-congruent and theoretically-informed, rather than a reflection of her own experiences within the settings.

4.7.4 Interpretation and writing process

The interpretation, written record and dissemination of social research is crucially important as social theory interacts with social reality (Porter, 1993). In other words, the research findings are not independent of the researched and will have an impact on the attitudes and behaviour of the participating employees and organisations. Thus, it was important to provide a clear, detailed and accurate portrayal of the research findings to best guide the participating organisations as to a suitable approach for supporting employees to reduce sitting and increase PA.

The interpretation and write-up of findings can be particularly challenging within MMR, given the need to develop a coherent written narrative, linking the qualitative and quantitative approaches to convey an interpretation of the mixed methods findings (Lieber & Weisner, 2010, p. 566). A review of the use of qualitative methods alongside RCTs found that only 8 of the 30 studies integrated the qualitative and quantitative findings (Lewin et al., 2009). Within this thesis, the outcome and process evaluation are presented in separate chapters (chapters 5 and 6, respectively), but are then interwoven within an additional findings chapter (chapter 7) and within the overall conclusions (chapter 8) to enhance knowledge generation

(Fetters & Freshwater, 2015). Specifically, chapter 7 presents two novel approaches to mixed methods; an approach which focuses on an integrated interpretation of outcome and process evaluation findings, and a case-oriented approach which combines mixed method data from a single participant. The chapter also critically discusses the use of mixed methods within behavioural intervention research, drawing on the two illustrative approaches to mixed method integration and, more broadly, the entire research process.

4.8 Concluding remarks

This chapter has outlined the methods and methodology employed to address the two research questions: (1) "What is the efficacy of a multicomponent sit-stand desk intervention designed to reduce sitting, and increase standing and PA?" and (2) "What are the processes that influence the feasibility, acceptability and efficacy of sit-stand desk implementation and use?" The chapter included a position statement on the use of mixed methods, and a discussion of the study design, design and delivery of the multicomponent intervention, recruitment and sampling, research methods, data analysis and the writing process. The next chapter presents the findings from the outcome evaluation.

Chapter 5 – Outcome Evaluation

5.0 Introduction

This chapter presents (Part A) and discusses (Part B) findings from a pilot randomised control trial (pilot RCT) assessing the efficacy of a multicomponent sit-stand desk (SS-MC) intervention. The intervention was designed to reduce sitting, and increase standing and PA, compared to providing a sit-stand desk only (SS-O), and receiving no intervention (control group; CG). Further, this chapter compares the influence of the intervention on sitting, standing and PA between specific times of day (ToD), i.e., work hours and non-work hours. Organisational and demographic factors that were associated with intervention efficacy are also examined.

A number of sitting, standing and PA variables were included in the analysis. Data from the ActivPAL was used to determine average sitting, standing and stepping minutes, number of steps, number of sitting bouts (total, bouts 0-30 minutes in duration, and bouts > 30 minutes in duration), minutes in sitting bouts (bouts 0-30 minutes, and > 30 minutes in duration), and the number of sit-to-stand transitions (the average number of times that the participant transitioned from the sitting to the standing position). Data from the GT3X+ was used to determine average sedentary, light PA, moderate PA, vigorous PA, and moderate-vigorous PA (MVPA) minutes, the number of and minutes spent in MVPA bouts ≥ 10 minutes, and Axis 1 and Vector Magnitude CPM (estimates of energy expenditure; EE).

This chapter presents data from 30 participants; 10 in the SS-MC group, 10 in the SS-O group and 10 in the CG. Group allocation was randomised. Some participants were excluded from *some* statistical analyses due to missing and/or invalid data (see section 4.6.1). The first section overviews monitor wear time and a description of participants' sitting, standing and PA patterns before the delivery of the multicomponent sit-stand desk intervention.

5.1 Part A – Outcome findings

5.1.1 Monitor wear time

Monitor wear time is the daily waking minutes (of a possible 24 hours) and number of days (of a possible 7), of monitor data for each participant that is included in the analysis. Average monitor wear time is compared across time and groups, between the work hours and whole day ToD, and between the ActivPAL and GT3X+ monitors.

Significantly more ActivPAL data was included in the analysis than GT3X+ data. There were no significant differences in the number of days between groups or across time for either the ActivPAL or the GT3X+; see Table 5.1. During work hours, average ActivPAL minutes was almost 7 minutes lower at the 12-month timepoint compared to the 6-month timepoint, which was most pronounced in the SS-MC group (19 minutes fewer; $p = .002$).

Table 5.1. *Average wear-time in relation to total days' wear-time, daily minutes' wear-time, and total minutes' wear-time for both monitors, on average, and for the 5 monitoring phases, SE = standard error, *p < .05 (fewer daily minutes than other timepoints)*

		Average	**Baseline**	**2-week**	**3-month**	**6-month**	**12-month**
		mean (SE)	**mean (SE)**	**mean (SE)**	**mean (SE)**	**mean (SE)**	**mean (SE)**
Total days	**GT3X+**	6.40 (0.94)	6.63 (0.14)	6.56 (0.13)	6.30 (0.24)	6.30 (0.19)	6.51 (0.16)
	ActivPAL	6.60 (0.08)	6.34 (0.16)	6.71 (0.15)	6.50 (0.24)	6.40 (0.23)	6.83 (0.13)
Daily minutes	**GT3X+**	861.96 (5.42)	853.11 (12.28)	853.11 (12.28)	844.72* (12.33)	870.51 (10.91)	867.68 (12.44)
	ActivPAL	940.71 (4.50)	952.57 (11.38)	938.32 (11.17)	929.96 (13.95)	945.78 (9.00)	945.08 (12.12)
Total minutes	**GT3X+**	5530.34 (84.44)	5819.28 9151.600	5609.16 (151.22)	5349.74 (240.52)	5496.82 (189.93)	5635.07 (166.60)
	ActivPAL	6221.32 (83.78)	6330.24 (180.94)	6298.69 (170.06)	6046.34 (244.72)	6069.64 (239.47)	6465.06 (169.35)

The percentage of daily minutes was higher during work hours than across the whole day for the GT3X+ (work hours = 97.56 (0.61)%, whole day = 89.70 (1.09)%; $p < .001$). There were no significant differences in percentage of daily minutes between work hours and the whole day for the ActivPAL.

5.1.2 Baseline characteristics

This section describes participant characteristics, and the sitting, standing and PA patterns of the participants at baseline, i.e. before the delivery of the intervention.

Activity patterns during work hours and non-work hours are described, and comparisons between ToD are made.

Participant characteristics

Of the 30 pilot RCT participants, 18 were female, 24 were white British, 26 had a university degree, 22 were heterosexual and one reported a disability. Participants ranged from 24 to 59 years. The participants were employees at Macmillan (n = 19) or PHE (n = 11). Correlational analyses indicated that none of the participant characteristics were statistically correlated with intervention group allocation; see Table 5.2 for an overview of participant characteristics according to randomised intervention group allocation.

Table 5.2. Participant characteristics according to randomised intervention group allocation

		Total	**SS-MC**	**SS-O**	**CG**
Gender	*Female*	18	4	8	6
	Male	12	6	2	4
Age (years)	*16-24*	1	0	0	1
	25-29	7	2	3	2
	30-34	6	2	1	3
	35-39	8	3	2	3
	40-44	1	1	0	0
	45-49	3	1	2	0
	50-54	1	1	1	0
	55-59	3	0	1	1
Ethnicity	*White*	24	9	7	8
	Mixed ethnic background	2	0	1	1
	Asian/Asian British	1	0	1	0
	Black/Black British/African/Caribbean	1	0	1	0
	Other ethnic group	1	0	0	1
	Prefer not to say	1	1	0	0
Disability	*Yes*	1	1	0	0
	No	29	9	10	10
Personal monthly income before deductions (£)	*870-1500*	1	0	0	1
	1500-2400	8	4	2	2
	2400-3900	16	6	5	5
	3900+	5	0	3	2
Highest qualification	*First or higher degree*	26	8	8	10
	Other technical or professional qual.	1	0	1	0
	A Level / AS Level / O Level / CSE / GCSE	3	2	1	0
Sexuality	*Heterosexual or straight*	22	6	8	8
	Gay or lesbian	5	3	2	0
	Bisexual	3	1	0	2
BMI (kg/m^2)	*Underweight (<18.5)*	1	0	1	0
	Normal weight (18.5 – 24.9)	17	5	6	6
	Overweight (25 – 29.9)	9	4	2	3
	Obese (>30)	3	1	1	1

Baseline sitting, standing and PA: Work hours

Baseline minutes spent sitting, standing and engaged in PA during work hours are presented in Figure 5.1. The average number of sitting bouts during work hours was 27.40 (2.01); 11% were > 30 minutes in duration. On average, 161.31 (10.18) minutes were spent in sitting bouts lasting 0-30 minutes and 155.14 (16.06) minutes were spent in sitting bouts lasting > 30 minutes. The average number of sit-to-stand transitions during the working day was 26.75 (2.01). Participants engaged in 0.44 (0.10) and spent 5.70 (1.38) minutes in MVPA bouts ≥ 10 minutes.

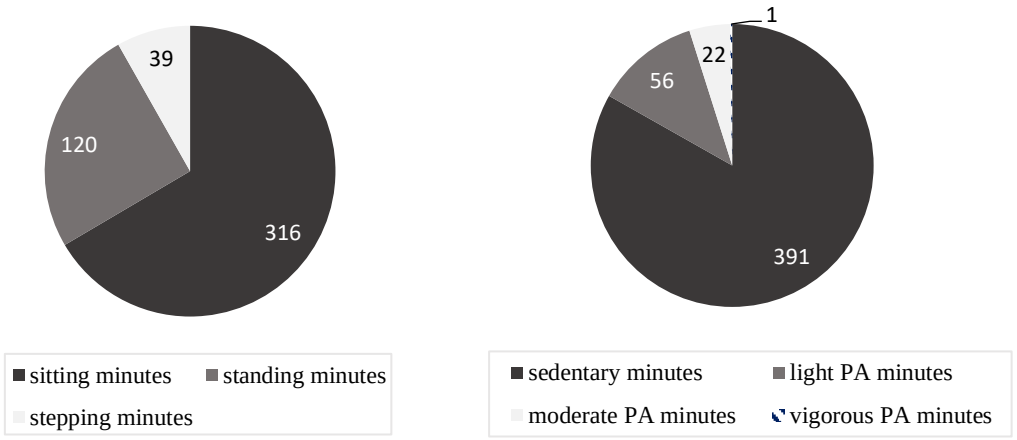


Figure 5.1. *Proportion of the workday spent sitting, standing and stepping measured via ActivPAL, n= 28 (left) and proportion of workday spent in sedentary, light, moderate and vigorous PA measured via GT3X+, n = 30 (right) at baseline*

Baseline sitting, standing and PA: Whole day

Baseline minutes spent sitting, standing and engaged in PA across the whole day are presented in Figure 5.2. The average number of sitting bouts across the whole day was 51.07; 10% of these were > 30 minutes in duration. On average, 270.70 (15.01) minutes were spent in sitting bouts lasting 0-30 minutes and 284.33 (20.99) minutes were spent in sitting bouts lasting > 30 minutes. Over the whole day, the average number of sit-to-stand transitions was 50.82 (2.60). Participants engaged in 1.47 (0.22) MVPA bouts lasting ≥ 10 minutes and spent 24.58 (3.45) minutes in MVPA bouts lasting ≥ 10 minutes. Fourteen of the 30 participants met the UK chief medical officer 2011 PA guidelines.

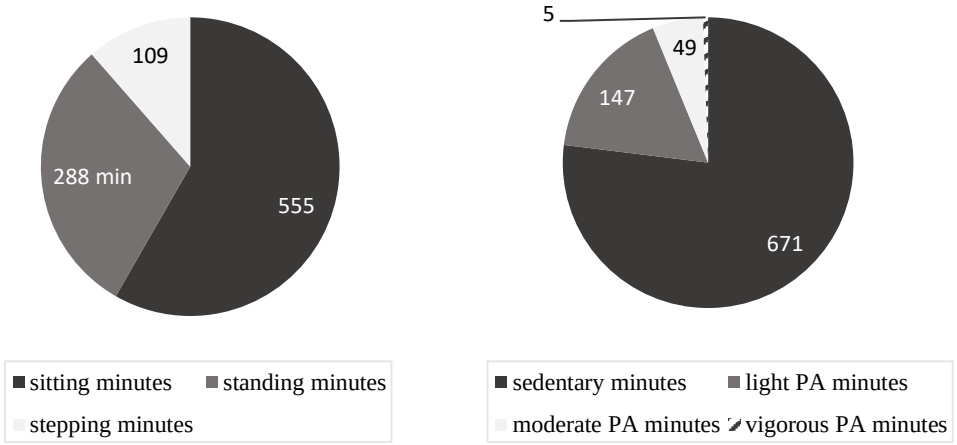


Figure 5.2. *Proportion of the time spent sitting, standing and stepping measured via ActivPAL, n = 28 (left) and proportion of time spent in sedentary, light, moderate and vigorous PA measured via GT3X+, n = 3 (right) across the whole day at baseline*

The proportion of daily sitting, standing and PA behaviours taking place during the work hours and non-work hours ToD are presented in Figure 5.3.

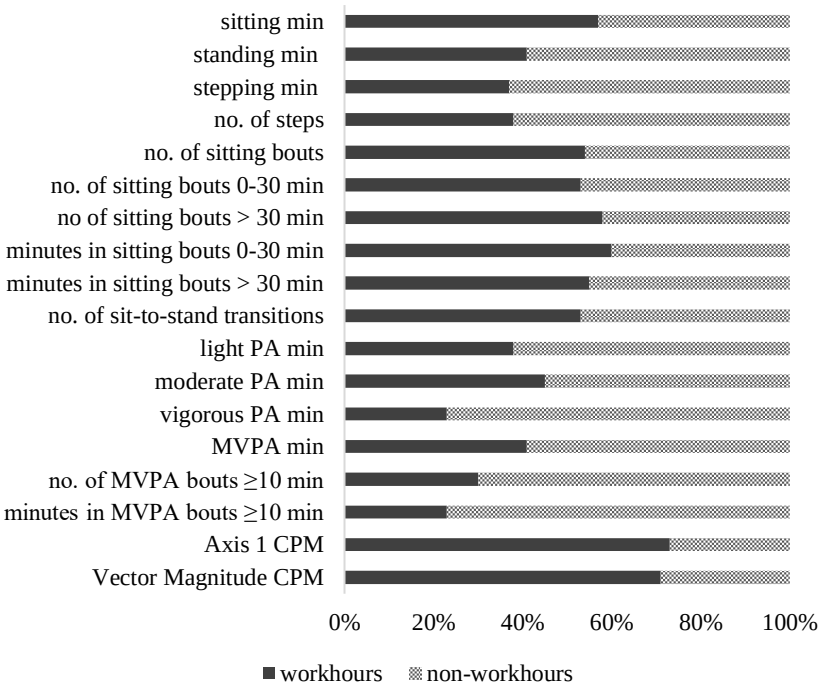


Figure 5.3. *Proportion of sitting, standing and PA accumulated during work (9am-5pm) and non-work (awake time excluding from 9am-5pm) hours, n = 28 for ActivPAL-derived variables, n = 30 for GT3X+-derived variables*

There were no significant differences in any outcome variables between the SS-MC, SS-O and CG at baseline; appendices W and Y provide information on baseline outcomes during work hours and across the whole day, respectively, according to group allocation.

5.1.3 Delivery of the multi-component intervention

The multi-component intervention consisted of sit-stand desk provision, four emails from management and four motivational phone calls; see section 4.3. Participants received verbal instruction on the correct ergonomic posture for both sitting and standing on the day that their sit-stand desk was installed. However, five participants were absent from the workplace on the day that their sit-stand desk was installed. Four of these participants received verbal instruction on ergonomic posture within seven days of their desk being installed, and one participant only received written instruction (via email). All management emails were delivered, and 32 of the 40 planned phone calls took place (80%); see Table 5.3. Phone calls lasted between 5 and 20 minutes.

Table 5.2. *An overview of the motivational phone calls that did and did not take place with SS-MC arm participants. *n/a as withdrawn from the research. MCS = Macmillan Cancer Support; PHE = Public Health England*

Participant identification	**MCS1**	**MCS2**	**MCS3**	**MCS4**	**MCS5**	**MCS6**	**MCS7**	**PHE1**	**PHE2**	**PHE3**
Phone call 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Phone call 2	✓	✓	X	✓	✓	X	✓	✓	✓	X
Phone call 3	✓	✓	✓	✓	✓	X	✓	n/a*	✓	✓
Phone call 4	✓	✓	X	✓	✓	X	✓	n/a*	✓	✓

5.1.4 The influence of the intervention on sitting, standing and physical activity during work hours

To assess whether the sit-stand intervention influenced sitting, standing and PA during work hours, and whether the multicomponent intervention was more efficacious than a sit-stand desk only, changes in sitting, standing and PA variables during work hours were compared across time and between intervention groups.

Sitting and standing variables

There was a non-significant tendency for a reduction in sitting minutes in the SS-MC group and SS-O group and an increase in sitting in the CG averaging across the 2-week, 3-month and 6-month timepoints. At the 12-month timepoint, average

sitting minutes was significantly lower than baseline when SS-MC and SS-O were pooled into a single intervention group (IG; 55.90 minutes, p = .010). Standing minutes increased significantly by 34.63 minutes in the IG compared to a 21.36-minute reduction in the CG (p = .012) averaging across the 2-week, 3-month and 6-month timepoints. Post-hoc analyses revealed significant increases in standing in the IG compared to the CG at 2-weeks and 3-months (p = .018). At the 12-month timepoint, average standing time was 46.48 minutes higher than at baseline in the IG (p = .021); see Figure 5.4. There were no significant differences in standing in the SS-MC group compared to the SS-O group.

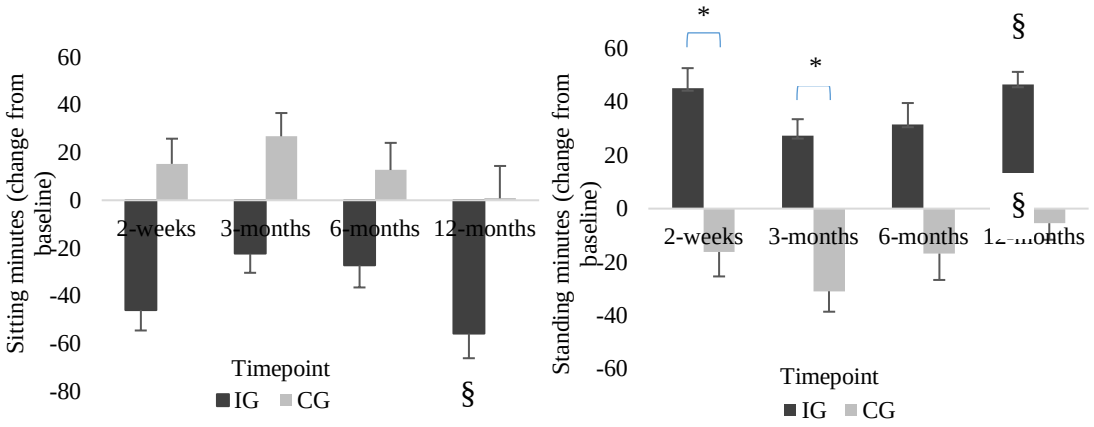


Figure 5.4. *Average change in minutes spent sitting (left) and standing (right) according to timepoint and group (IG and CG), during work hours, * p < .05 (differences between groups), § p < .05 (change from baseline), n = 25 (2-weeks, 3-months, 6-months); n = 21 (12-months)*

Averaged across the 2-week, 3-month and 6-month timepoints, change in the number of sitting bouts lasting > 30 minutes differed significantly between the SS-O and CG (*p* = .039); see Figure 5.5.

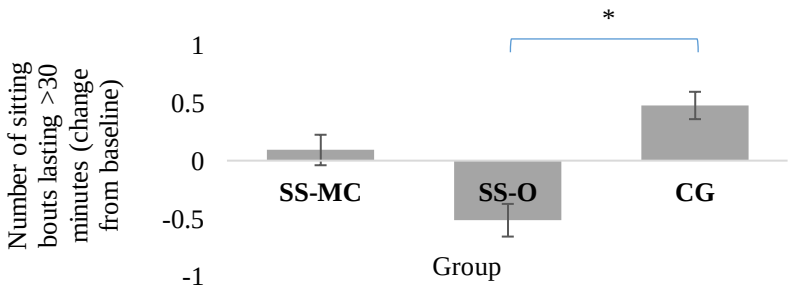


Figure 5.5. *Average change in no. of sitting bouts >30 minutes during work hours, according to group, averaged across 2-week, 3-month and 6-month post-intervention measurement time points, * p < .05, n = 25*

Change in the total number of sitting bouts was significant in the SS-MC group (p = .009), and differed between the SS-MC (-11 bouts) and the CG (+4 bouts) (p = .027), at 12-months. Similar patterns for the number of sitting bouts 0-30 minutes, and the number of sit-to-stand transitions, are displayed in Figure 5.6.

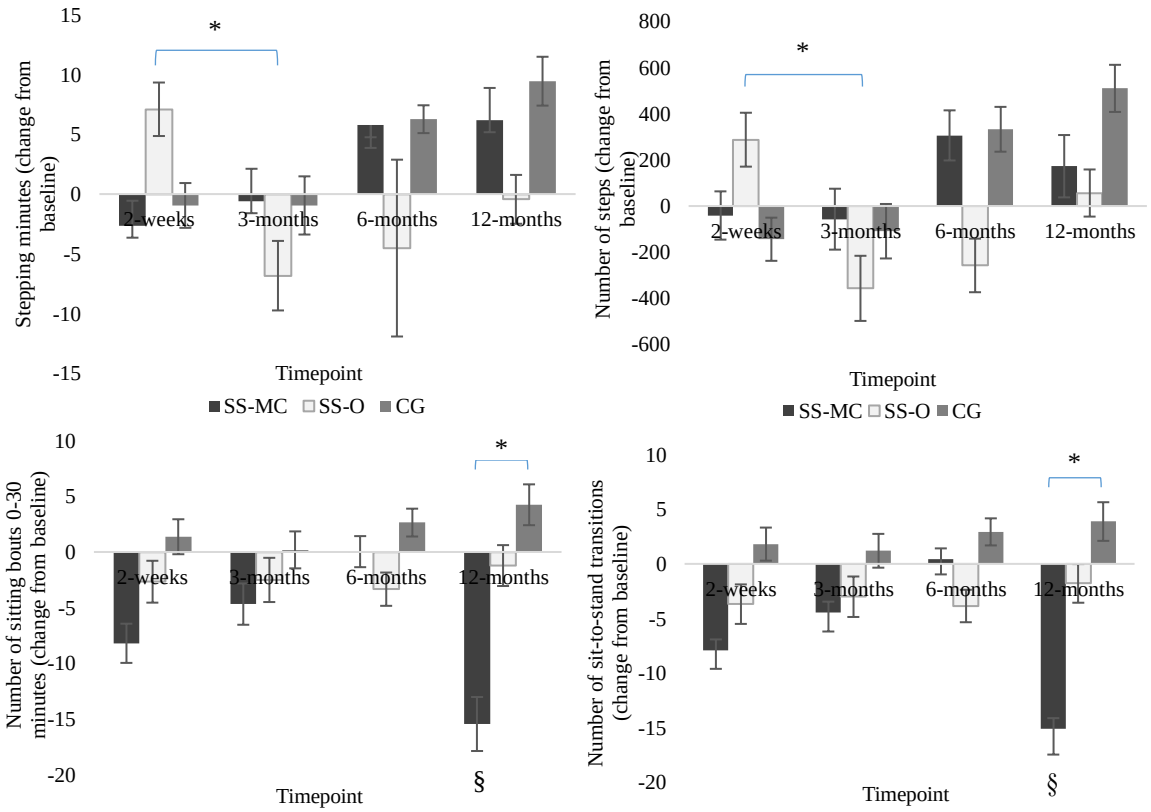


Figure 5.6. *Change in stepping minutes (top left), number of steps (top right), number of sitting bouts 0-30 minutes (bottom left) and number of sit-to-stand transitions (bottom right) during work hours, according to timepoint and group, * p < .05 (difference between groups and across time) § p < .05 (change from baseline), n = 25 (2-weeks, 3-months, 6-months); n = 21 (12-months)*

Changes in some sitting and standing variables during work hours were correlated. A reduction in sitting was associated with an increase in standing (p = .002) and a reduction in prolonged sitting bouts was correlated with an increase in sitting bouts lasting 0-30 minutes (p = .017) and the number of sit-to-stand transitions per sitting hour (p = <.001). See Appendix V for a full overview of correlations of variables derived from the ActivPAL monitor.

Physical activity variables

Average stepping minutes and number of steps were higher than baseline values at 12-months, across all groups (5.19 minutes; p = .048, 171 steps, p = .050). Further, stepping minutes (p = .024) and number of steps (p = .042) decreased from

2-months to 3-months in the SS-O group; see Figure 5.6. There were no main effects for any of the GT3X+-derived PA variables across the 5 timepoints or between the three groups. However, post-hoc analyses of group*time interaction effects revealed many significant changes. There were group differences in the change in vigorous and MVPA minutes at 2-weeks and 12-months. Change in vigorous PA was 5.18 minutes higher in the pooled IG compared to the CG (p =.044), and change in MVPA was 3.36 minutes higher in the SS-O group than the CG (p = .017) at 2-weeks. However, change from baseline was more positive in the CG compared to the pooled IG at the 12-month timepoint with regards to vigorous PA (CG = +1.03 minutes, IG = +0.04 minutes; p = .044) and MVPA (CG = +4.62 minutes, IG = -0.16 minutes, p = .025). All other significant changes in PA, across time and between groups, are illustrated in Figure 5.7. See appendix W for a full overview of sitting, standing and PA outcomes during work hours, across time and between groups.

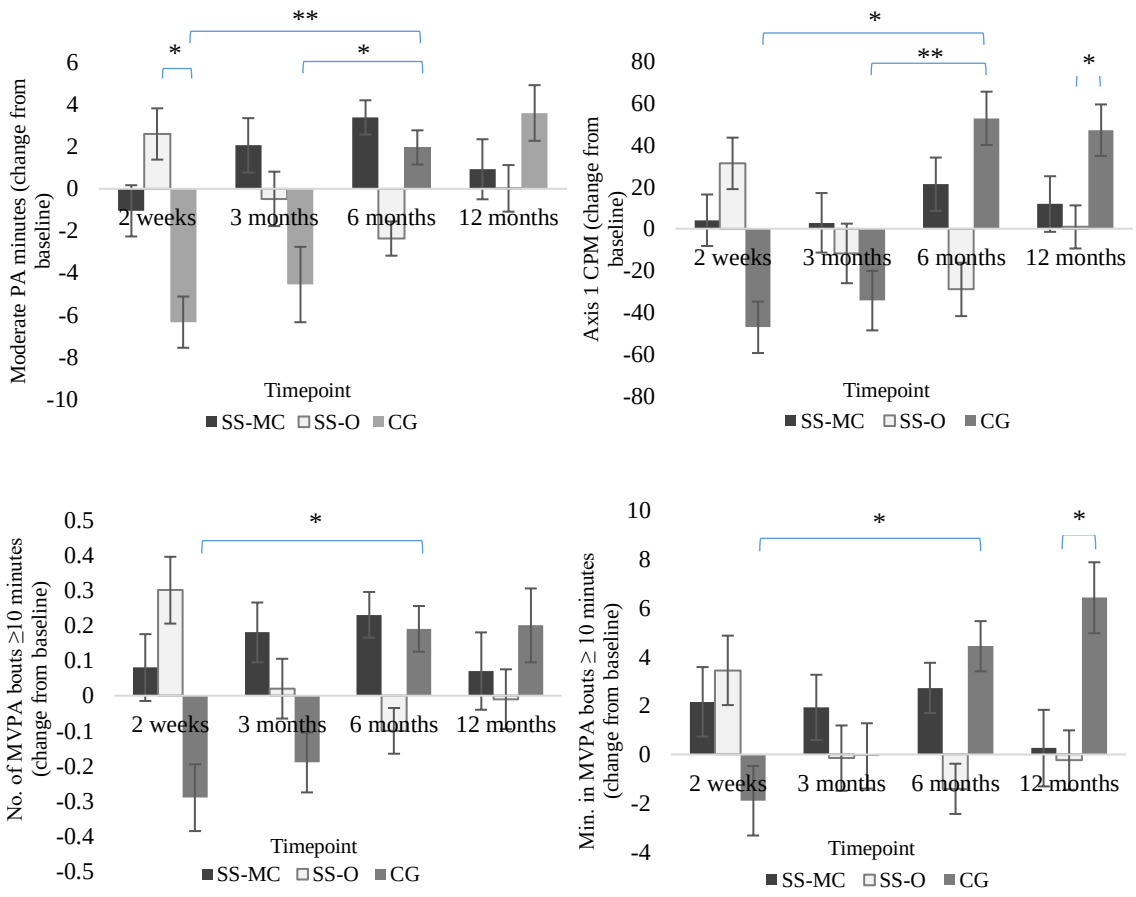


Figure 5.7. *Change in minutes of moderate PA (top left) and Axis 1 CPM (top right), number of MVPA bouts ≥ 10 minutes (bottom left) and minutes in MVPA bouts ≥ 10 minutes (bottom right) during work hours, according to time point and intervention group, * p < .05, ** p < .01, n = 27 (2-weeks, 3-months, 6-months); n = 23 (12-months)*

There were many significant correlations between changes in PA variables. For example, an increase in moderate PA was associated with an increase in MVPA ($p < .001$), Axis 1 CPM ($p < .001$), Vector Magnitude CPM ($p < .001$), the number of MVPA bouts ≥ 10 minutes ($p < .001$) and minutes in MVPA bouts ≥ 10 minutes ($p < .001$). See appendix V for a full overview of correlations between PA variables derived from the GT3X+ monitor. Further, changes in some sitting and standing variables were correlated with changes in some PA variables during the work hours ToD. For example, a reduction in sitting minutes was correlated with an increase in MVPA ($p = .017$). See Appendix V for a full overview of these correlations.

5.1.5 The influence of the intervention on sitting, standing and physical activity across the whole day

To assess whether the sit-stand intervention influenced sitting, standing and PA across the whole day, and whether the multicomponent intervention was more efficacious than a sit-stand desk only, changes in sitting, standing and PA variables across the whole day were compared across time and between groups.

Sitting and standing variables

There was a tendency for sitting minutes to be reduced and standing minutes to be increased from baseline in the pooled IG (SS-MC and SS-O) across the whole day, however there were no significant changes across time or between any of the three groups; see Figure 5.8.

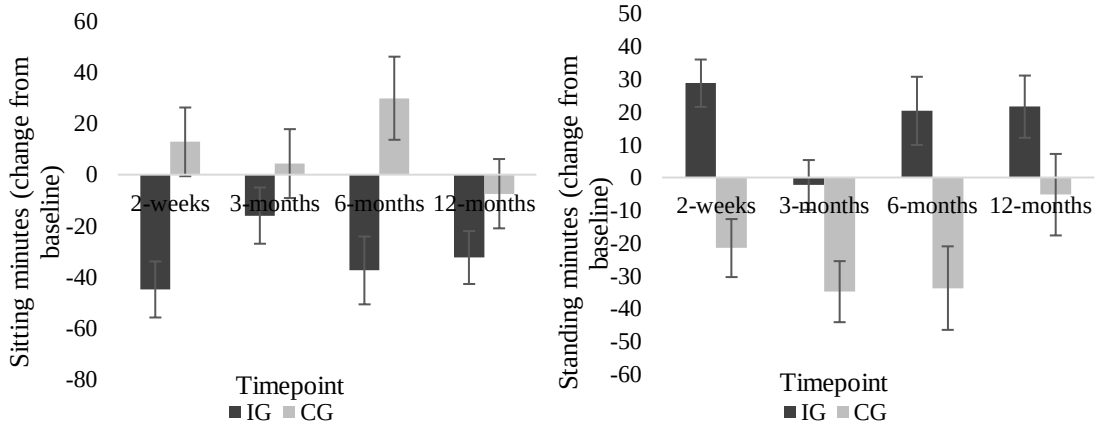


Figure 5.8. *Change in sitting minutes (left) and standing minutes (right) according to timepoint and group, across the whole day, n = 25 (2-weeks, 3-months, 6-months); n = 21 (12-months)*

There were no main effects of group for any of the sitting and standing variables across the whole day. However, there were several main effects of time and

group*time interaction effects. Change in the total number of sitting bouts differed from 2-weeks to 6-months (2-weeks = -2.70 bouts, 6-months = +3.49 bouts, p = .003) and 3-months to 6-months (3-months = -1.96 bouts, 6-months = +3.49 bouts, p = .027), across all three groups. Change in the total number of sitting bouts was 13.15 bouts higher at 6-months compared to 2-weeks in the SS-MC group (p < .001). The total number of sitting bouts decreased by 7.04 bouts from 6 to 12-months across all three groups (p = .015) and by 12.50 bouts from baseline to 12-months in the SS-MC group (p = .038). Figure 5.9 illustrates similar changes for the number of sitting bouts lasting 0-30 minutes and number of sit-to-stand transitions. Further, fewer minutes were spent in sitting bouts lasting 0-30 minutes at the 12-month timepoint compared to baseline in the pooled IG (-39.82 minutes, p = .011), which was accompanied by a 12.39-minute increase in the change in time spent in prolonged (> 30 minutes) sitting bouts from 6-months to 12-months (p = .015).

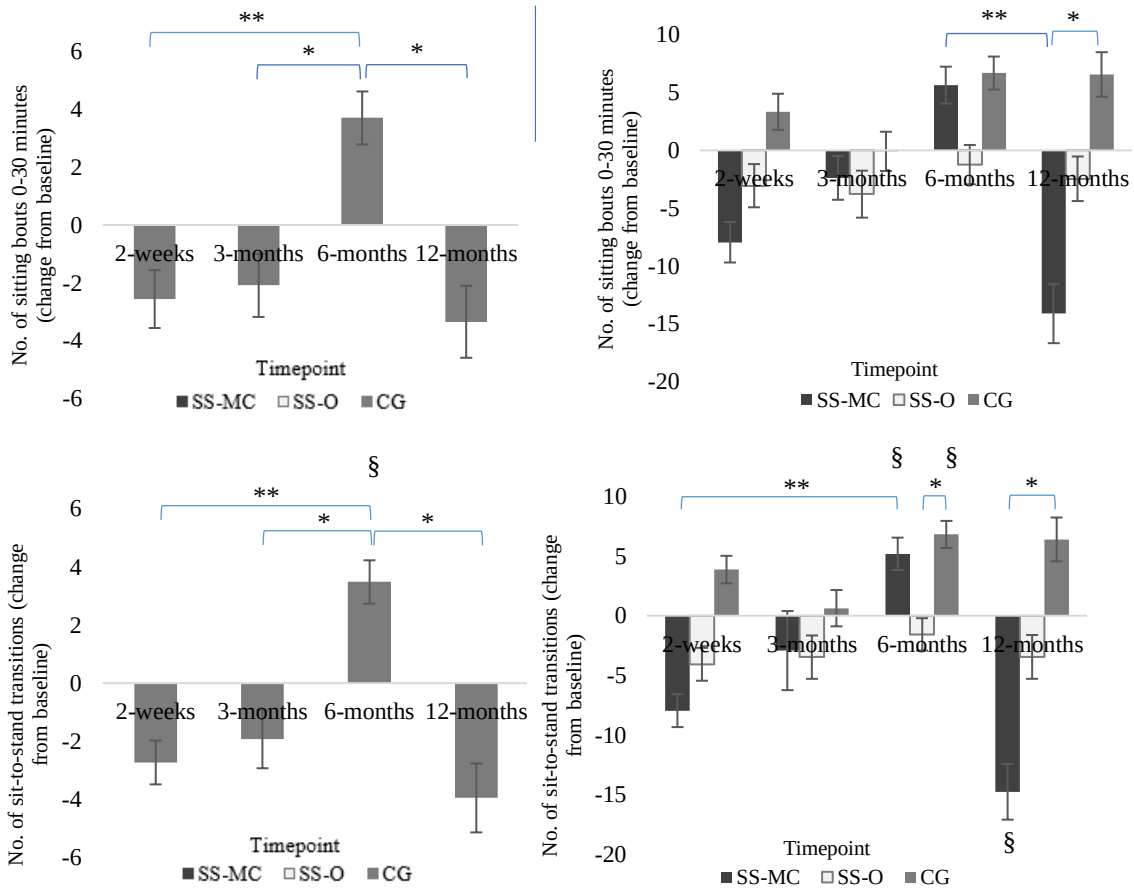


Figure 5.9. *Change in the number of sitting bouts lasting 0-30 minutes, averaged across all three groups (left) and according to SS-MC, SS-O and CG (right), and change in the number of sit-to-stand transitions, averaged across all three groups (left) and according to SS-MC, SS-O and CG (right) according to timepoint, * p < .05, ** p < .01 (change between groups and over time), § p < .05 (change from baseline), n = 25 (2-weeks, 3-months, 6-months); n = 21 (12-months)*

GT3X+ variables

There was a main effect of time for light PA, which was 19.04 minutes higher at 6-months than 3-months (p = .036) and 9.03 minutes lower at 12-months compared to 6-months (p = .035). Change in stepping minutes was lower at 12-months compared to 6-months across all three groups (-1.97 minutes; p < .001) and in the SS-MC group specifically (-20.19 minutes; p < .001). Further, change in the number of steps differed between 6-months (+302.34 steps) and 12-months (+102.88 steps) across all groups (p = .007) and in the SS-MC group specifically (6-months = +1010.69 steps, 12-months = -329.51 steps; p = .005). There were no other changes between groups or across time for any other PA variables for the whole day ToD, including attainment of UK chief medical officer PA guidelines. See appendix X for a full overview of sitting, standing and PA outcomes, across time and between groups, for the whole day ToD.

5.1.6 Comparison of changes between work hours and non-work hours' time-of-day

Change in sitting, standing and PA from baseline, at 2-week, 3-month, 6-month and 12-month, across time and between intervention group (SS-MC and SS-O), were compared between the work hours and non-work hours ToD. There were no main effects of ToD for any of the sitting or standing variables. However, change in sitting minutes between the work hours and non-work hours ToD was negatively correlated (r = -.627, p = .007). Change in standing minutes between the two ToDs were also negatively correlated (r = -.598, p = .011). Further, an increase in standing during work hours was correlated with an increase in sitting minutes (r = .647, p = .005), the number of sitting bouts lasting > 30 minutes (r = .389, p = .047), and minutes spent in sitting bouts > 30 minutes (r = .513, p = .035), and a reduction in the number of sit-to-stand transitions per total hours spent sitting (r = -.571, p = .017), during non-work hours. A ToD*timepoint interaction revealed significant differences in the total number of sitting bouts (p = .030), the number of sitting bouts lasting 0-30 minutes (p = .029) and the number of sit-to-stand transitions (p = .040) between the two ToDs at the 6-month timepoint; see Figure 5.10. Further, change in minutes spent in prolonged sitting bouts differed according to ToD in the CG at 6-months (work hours = +12.28 minutes, non-work hours = -56.26 minutes, p = .044).

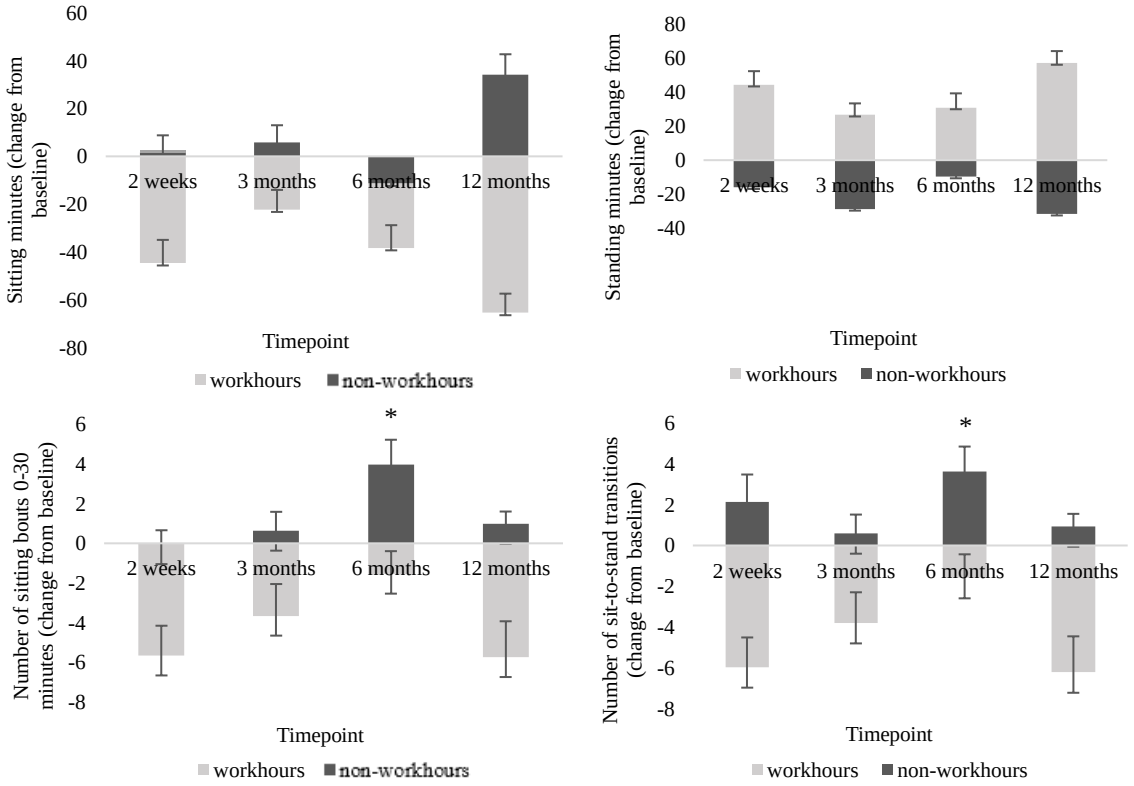


Figure 5.10. *A comparison between work hours and non-work hours time-of-day for sitting minutes (top left) standing minutes (top right), number of sitting bouts lasting 0-30 minutes (bottom left) and number of sit-to-stand transitions (bottom right) for SS-MC and SS-O group participants, * p < .05, n = 25 (2-weeks, 3-months, 6months); n = 21 (12-months)*

There were no significant differences between work hours and non-work hours in change in any of the PA variables. However, an increase in the number of, and minutes spent in, sitting bouts lasting 0-30 minutes, and the number of sit-to stand transitions during work-hours, was moderately correlated with an increase in moderate PA, MVPA, number of and minutes spent in MVPA bouts ≥ 10 minutes, and Axis 1 and vector magnitude CPM during non-work hours at 3-months (all $p <$ .05). Change in sitting minutes was correlated with light PA over the whole day at 6-months (r = -.504, p = .049).

5.1.7 Correlations between work-related or demographic factors and change in sitting, standing and physical activity variables at 3-months

Spearman-rho correlation analyses were performed to examine associations between the participants age, income, qualification level, household composition, BMI, sit-stand desk model and organisation and the change in sitting, standing and PA variables at the three-month timepoint; see Table 5.4.

Table 5.4. *Correlations between organisational and demographic variables and change in outcome measures at 3-months in SS-O or SS-MC group participants. * p < .05, ** p < .01, n = 17 (ActivPAL-derived variables); n = 19 (GT3X+-derived variables)*

	Org. ***(PHE)***	**Workfit type** ***(A)***	**Age**	**Income**	**Qual.** ***(Degree)***	**Household** ***(Family)***	**BMI**
Sitting min.							
Work-hours	-.142	-.050	-.293	.495*	.447*	-.026	-.152
Whole day	.191	.276	-.179	.415*	.298	.000	-.130
Standing min.							
Work-hours	-.226	.327	-.128	-.464*	-.410	-.237	.208
Whole day	.255	-.257	.380*	-.451*	-.447*	.211	.248
Stepping min.							
Work-hours	.170	.427*	.357	.086	-.261	.000	.475*
Whole day	.170	.427*	.128	-.335	.075	.211	.098
No. of steps							
Work-hours	.113	.503*	.310	.124	-.261	.026	.424*
Whole day	.085	.427*	.035	-.335	.149	.316	-.093
No. of sitting bouts							
Work-hours	-.411	.163	-.291	-.291	.000	.000	.082
Whole day	-.198	.251	-.232	-.277	.298	.211	-.333
No. of sitting bouts 0-30 min.							
Work-hours	-.396	.176	-.252	-.298	.000	.026	.037
Whole day	-.283	.251	-.277	-.343	.335	.158	-.402
No. of sitting bouts 30+ min.							
Work-hours	.198	.075	-.022	.468*	.335	-.079	.044
Whole day	.397	.000	.116	.635**	.093	.053	-.120
Min. in sitting bouts 0-30 min.							
Work-hours	-.368	.025	-.336	-.283	.075	-.026	-.044
Whole day	-.396	.251	-.544*	-.590*	.186	-.105	.047
Min. in sitting bouts 30+ min.							
Work-hours	.198	-.025	.088	.613**	.186	-.026	-.056
Whole day	.396	-.025	.211	.628**	.112	.079	-.083
No. of sit-to-stand transitions							
Work-hours	-.411	.163	-.291	-.291	.000	.000	.082
Whole day	-.198	.201	-.250	-.295	.335	.211	-.355
Light PA min.							
Work-hours	.041	.279	.095	-.226	-.026	.000	.251
Whole day	-.186	.558*	-.256	-.098	.158	-.087	.009
Moderate PA min.							
Work-hours	.331	.399*	.069	-.005	-.211	-.175	.534**
Whole day	-.103	.538*	-.309	.138	.158	-.087	.153
Vigorous PA min.							
Work-hours	.276	-.122	-.075	.323	-.116	-.157	-.059
Whole day	-.248	-.279	.558*	-.035	.053	-.458*	-.196
MVPA min.							
Work-hours	.351	.319	.137	-.010	-.237	-.196	.491*
Whole day	-.124	.239	-.336	-.083	.105	-.087	.137
No. of MVPA bouts							
Work-hours	.334	.242	.170	.199	-.266	-.110	.498*
Whole day	.103	.349	-.277	-.097	.026	.109	.186
Minutes in MVPA bouts							
Work-hours	.414*	.180	.291	.302	-.290	.022	.466*
Whole day	.041	.319	-.295	-.111	.026	-.022	.196
Axis 1 CPM							
Work-hours	.372	.259	.145	.085	-.211	-.240	.474*
Whole day	-.041	.219	-.327	-.127	.211	-.131	.047
Vector Magnitude CPM							
Work-hours	.331	.319	.064	.103	-.132	-.131	.474*
Whole day	.000	.359	-.355	-.031	.132	-.175	.195
Meet PA guidelines	.338	-.012	.753**	-.032	-.215	.459*	-.058

Changes in sitting, standing and prolonged sitting bouts were significantly correlated with participant's income; see Figure 5.11.

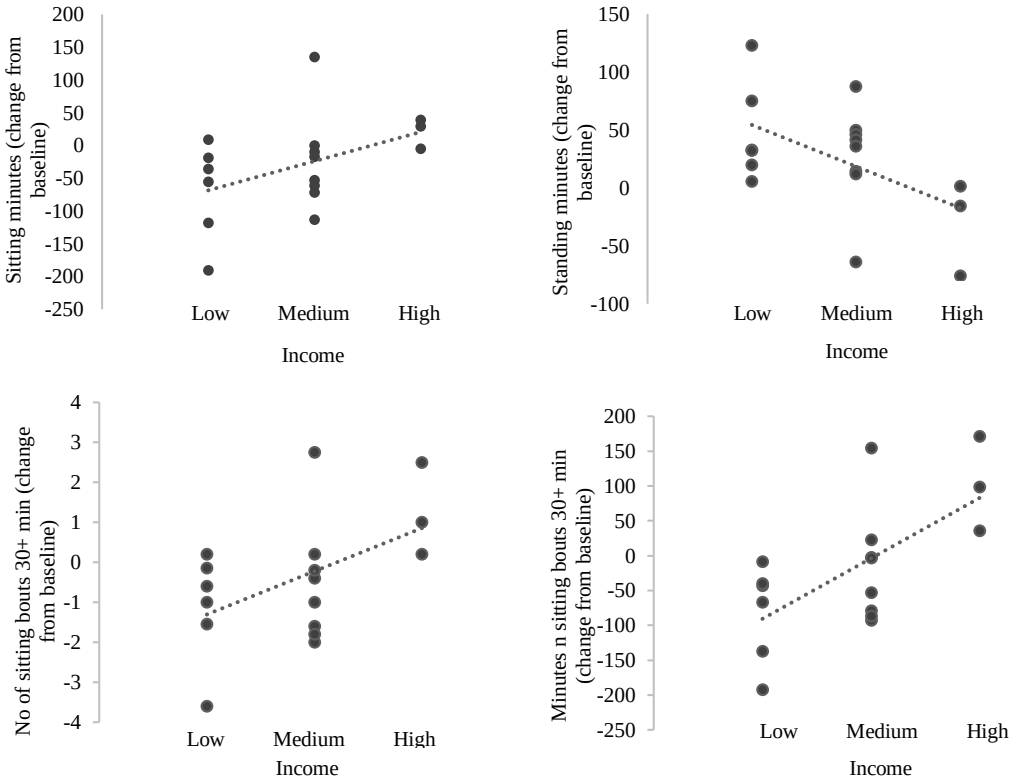


Figure 5.11. *Significant correlations between income and (1) sitting minutes (p = .002; top left), (2) standing minutes (p = .030; top right), (3) number of sitting bouts lasting 30+ minutes (p = .029; bottom left), and (4) minutes in sitting bouts lasting 30+ minutes (p = .004) at three months. Low income = £1500-£2400, Medium income - £2400-£3900, High income = £3900+ per month, before deductions, n = 17*

5.1.8 Comparison of the ActivPAL and GT3X+ for measuring sedentary behaviour

Average sedentary minutes, estimated by the GT3X+, were significantly higher than the average sitting minutes as measured by the ActivPAL; ($p < .001$) for both work hours and the whole day ToD; see Figure 5.12.

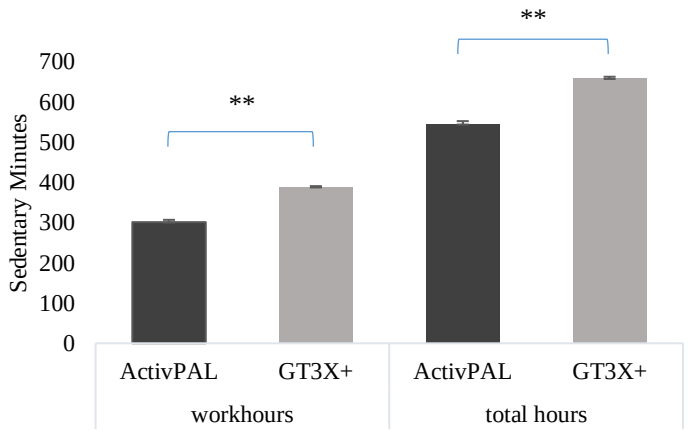


Figure 5.12. *The average number of sedentary minutes during work hours and across the whole day, as measured by the ActivPAL and the GT3X+, ** p < .01, n = 21 (ActivPAL); n = 23 (GT3X+)*

5.2 Part B – Discussion of outcome findings

5.2.1 Summary

The pilot RCT compared the efficacy of a multicomponent sit-stand desk intervention (SS-MC) designed to reduce sitting, and increase standing and PA, to receiving a sit-stand desk only (SS-O) and a no-intervention control (CG). The SS-MC group was no more efficacious than the SS-O group; see Table 5.5 for a summary of key outcomes. However, when the data from these groups were pooled into a single intervention group (IG), there was a tendency for a reduction in sitting and a significant increase in standing in the IG compared to the CG during work hours. The differences between the IG and CG were non-significant across the whole day 'time of day' (ToD); the reduction in sitting and increase in standing during work hours was moderately correlated with an increase in sitting and reduction in standing during non-work hours. A lower income was associated with a reduction in sitting during work hours. None of the GT3X+ PA variables increased in the IG compared with the CG. Thus, the data suggest that access to a sit-stand desk, as part of a multicomponent intervention or not, increases standing during work hours, but does not influence PA.

Table 5.5. *A summary of change from baseline in key outcome variables during work hours and across the whole day, averaged across the 2-week, 3-month, 6-month and 12-month post-intervention time-points, according to intervention group*

	Sitting minutes	**Standing minutes**	**Minutes sitting for > 30 minutes**	**Light PA minutes**	**MVPA minutes**	**Minutes MVPA > 10 minutes**
Work hours (change from baseline)						
SS-MC	-34.36	+32.86	+0.55	+1.59	+0.67	+1.77
SS-O	-41.45	+42.33	+1.47	-4.06	-0.06	+0.42
CG	+13.89	-17.39	+9.32	-1.56	-0.62	+2.24
Whole day (change from baseline)						
SS-MC	-35.99	+12.11	-9.89	-0.09	+2.94	+4.07
SS-O	-29.44	+4.63	-9.85	-7.44	+2.54	+2.64
CG	+9.91	-23.89	-3.10	4.54	-0.32	+2.25

5.2.2 Sitting, standing and physical activity at baseline

Baseline sitting and standing patterns

Participants sat for 66% and stood, without stepping, for 25% of work hours. This is comparable to cross-sectional research in office-based employees; reports of workplace sitting range from 66-75% of work hours (Clemes et al., 2016; Clemes, Patel, Mahon, & Griffiths, 2014; De Cocker, Duncan, Short, van Uffelen, & Vandelanotte, 2014; Kazi, Duncan, Clemes, & Haslam, 2014; C. G. Ryan, Dall, Granat, & Grant, 2011; Ryde et al., 2013; Toomingas, Forsman, Mathiassen, Heiden, & Nilsson, 2012) when assessed via wearable devices. There is a dearth of cross-sectional literature examining standing prevalence during work hours in office-based employees. However, it has been reported both that 19% (Mansoubi et al., 2016) and 21% (Chau et al., 2016) of work hours were spent standing at baseline, measured via ActivPAL, in intervention studies designed to reduce sitting and increase standing.

On average, participants sat for longer than 30 minutes three times a day, and spent over 2.5 hours in prolonged (> 30 minutes) sitting bouts during work hours. Ryde et al. (2013) reported 3.1 prolonged sitting bouts during work hours in office-based employees, and Chau et al. (2016) reported 2.2 prolonged sitting bouts during work hours in call centre workers. One interpretation of this is that office workers have less opportunity to break up prolonged sitting than call-centre workers. Participants transitioned from sitting to standing 27 times during work hours, averaging just over three transitions/hour. Ryde et al. (2013) reported 37.7 transitions during work hours. The more frequent transitions might be expected given that the employees spent a higher proportion (71%) of work hours sat down (Ryde et al., 2013).

Participants sat for an average of 9.25 hours a day. This is similar, but slightly lower than the 10.6 hours/day of sitting, measured via ActivPAL, reported by L. Smith, Hamer, et al. (2015) in a sample of 164 office-workers based in South-East England. The daily sitting reported by L. Smith, Hamer, et al. (2015) may be an overestimate of actual sitting, as the arbitrary classification of waking hours as 7am-11pm infers that any sleep within these hours is misclassified as sitting (Edwardson et al., 2016). Schuna et al. (2013) reported a daily average of seven hours' sedentary behaviour, measured using wearable activity monitors, from 3725 participants taking

part in the US National Health and Nutrition Examination Survey (NHANES). Participants reported a range of occupations, which, taken with the data from the present trial and L. Smith, Hamer, et al. (2015), suggests that office-based employees exhibit particularly high levels of sitting. The majority (57%) of daily sitting took place during work hours whereas the majority (59%) of daily standing took place outside work hours. This is comparable to previous research that has reported a higher proportion of work hours spent sitting, and a higher proportion of non-work hours spent standing (Clemes et al., 2016; Healy et al., 2016; Kazi et al., 2014; L. Smith, Hamer, et al., 2015) and is unsurprising given the computerised nature of most office-work (Hadgraft et al., 2016; Healy et al., 2012). Whilst the majority of sitting takes place during work hours, office workers also engage in high amounts of sitting outside of work, and so leisure and travel domains should also be targeted to reduce daily sitting in office-based employees (Mansoubi et al., 2016).

Baseline PA patterns

Nine percent of work hours were spent stepping. This is within the range (5-9%) reported in the extant literature (Chau et al., 2016; Healy et al., 2016; Mansoubi et al., 2016; Neuhaus, Healy, et al., 2014). Participants engaged in light, moderate and vigorous PA for less than a fifth of work hours. This is comparable to previous studies that report between 14-25% light PA and 3-4% MVPA during work hours (Clemes, O'Connell, & Edwardson, 2014; Mansoubi et al., 2016; Ryde et al., 2013). Less than a quarter of workplace MVPA was accumulated in bouts ≥ 10 minutes. This suggests that most MVPA during work hours is short, incidental activity (such as stair climbing) rather than structured exercise (such as attending the gym during lunch-breaks). Cole et al. (2015) found that employees typically preferred to engage in structured PA during leisure time. Barriers to MVPA at work are considered further in chapter 7 (see section 7.1.2).

Almost half of the participants met the UK chief medical officer's PA guidelines of 150 minutes of MPA or 75 minutes of VPA – or a combination thereof – per week, accumulated in bouts of ≥ 10 minutes. National estimates indicate that 67% of men and 55% of women meet the PA guidelines (Townsend, Wickramasinghe, Williams, Bhatnagar, & Rayner, 2015) and Kazi et al. (2014) reported that 22% of 504 UK employees from a range of occupations met the PA

guidelines. However, these studies are not directly comparable with the present findings due to their wider focus on different occupational groups. Evidence from Australia indicates that office-based workers may engage in more leisure-time PA than individuals in more active jobs (Chau, van der Ploeg, Merom, Chey & Bauman, 2012), which may help explain the high proportion of individuals meeting the PA guidelines in the present study. In addition, participants in the present trial are in paid employment (at a health-focused organisation); all but one earns > £18,000 per annum, are young (ranging from 18-55 years, with 70% of participants aged between 25-39 years), 80% identify as white and 87% are educated to degree level. These characteristics are associated with an increased likelihood that a person is physically active (Anokye et al., 2013; Heath & Fentem, 1997; R. Hunter et al., 2015; Trost et al., 2002; E. Williams, Stamatakis, Chandola, & Hamer, 2011). Furthermore, Townsend et al. (2015) reported that adults residing in south-east England are more active than those residing in other parts of the UK, which could partially explain the high proportion of employees meeting the PA guidelines in the present study. London's transport system facilitates low levels of car ownership and use, and high levels of active travel in London-based adults compared to adults in the rest of the UK (Greater London Authority, 2015). In fact, around a quarter of Londoner's meet the PA guidelines through active travel alone (Greater London Authority, 2015).

Variation in sitting, standing and physical activity

There was high inter-individual variability with regards to sitting, standing and PA, which is also present in some extant literature (e.g. C. G. Ryan et al., 2011; Toomingas et al., 2012). A higher BMI was associated with less sitting, more standing, and fewer prolonged sitting bouts during work hours. This is in direct contrast to cross-sectional research on over 1000 office-based employees that found a higher BMI was associated with higher levels of sitting at work (Kazi et al., 2014) and over the whole day (Clemes et al., 2016). The finding in the present study should be interpreted with caution due to the low sample size and narrow range of BMI. A higher income was associated with moderate PA during work hours. There is limited published literature regarding associations between workplace PA and income, however this finding aligns with evidence on the association between socio-economic status and PA levels (Meader et al., 2016; Trost et al., 2002). Given the variability between employees in sitting and PA at work it may be apt to tailor

interventions to the specific needs and patterns of groups or individuals (Gilson, Burton, et al., 2011).

These baseline data add to the evidence-base that office workers predominantly sit, and engage in minimal PA, during work hours. Possible explanations for these findings relating to the nature of office-based work are contained within section 6.2.3. Given the negative health consequences associated with prolonged sitting and physical inactivity (Biswas et al., 2015; Ekelund et al., 2016), the office-based workplace is an important context for intervening to reduce sitting, and increase standing and PA. There is evidence to suggest that both reducing the total amount of sitting, and breaking up sitting bouts, can have positive health effects (Benatti & Ried-Larsen, 2015; Chastin et al., 2015; MacEwen et al., 2015). The office workers in this study appear to regularly interrupt sitting, but engage in a high total amount of workplace sitting. This indicates that it may be important to focus on a reduction in total sitting time, for which the provision of sit-stand desks may be a particularly appropriate strategy (Ryde et al., 2013).

5.2.3 The sit-stand desk intervention: time spent sitting and standing during work hours

Averaging across the post-intervention timepoints, sitting reduced by 38 minutes in the pooled IG. There were no significant changes from baseline at 2-weeks, 3-months or 6-months, indicating that neither the SS-MC or SS-O intervention reduced sitting. However, there was a significant, 60-minute reduction in sitting in the IG at 12-months. Standing during work hours significantly increased by 35 minutes across the 2-week, 3-month and 6-month timepoint, and by 47 minutes at the 12-month timepoint in the pooled IG. However, the SS-MC intervention was no more efficacious than the SS-O intervention. As might be expected, a reduction in sitting was significantly correlated with an increase in standing in the IG; these findings are compatible with previous workplace intervention evaluations which typically report that sitting is predominantly replaced with standing following the provision of a sit-stand desk (Healy et al., 2012).

Sit-stand desk intervention: standing during work hours

The change in standing during work hours differed significantly between the pooled IG and the CG by 61 minutes at 2-weeks, and by 58.2 minutes at 3-months.

This is consistent with previous sit-stand desk intervention studies that have reported increases in standing from baseline and/or differences in standing between a sit-stand desk and a control condition of 19-130 minutes/eight-hour workday. Therefore, the present study adds to the evidence that sit-stand desks may be a viable strategy to increase standing in office-based work environments.

Sit-stand desk intervention: sitting during work hours

In the present study, the influence of the intervention on sitting at 2-weeks, 3-months and 6-months (i.e. a non-significant, 32-minute reduction in sitting) is small compared to reductions in sitting reported in previous sit-stand desk intervention studies. Recent reviews have reported that workplace interventions including the provision of sit-stand desks significantly reduce sitting by 30 to 143 minutes per 8-hour work day compared to baseline and/or a control group (Shrestha et al., 2016; Tew et al., 2015; Torbeyns et al., 2014). Whilst Gilson, Suppini, Ryde, Brown, and Brown (2011) reported no significant change in workplace sitting following the provision of sit-stand desks, the desks were available as shared hot desks rather than provided to each employee. There are a number of possible explanations for the smaller, non-significant effect of the sit-stand desk intervention on sitting in the present study, including the more accurate measurement of sitting using ActivPAL (Y. Kim et al., 2015; Ryde et al., 2013). A number of previous studies (e.g. Dutta et al., 2014; Graves et al., 2015; Grunseit et al., 2013; Ognibene, Torres, von Eyben, & Horst, 2016; Pronk et al., 2012) measured sitting using a self-report instrument. It is well established that people are unable to accurately recall sitting, standing and PA behaviour and that self-report measures underestimate sitting (Atkin et al., 2012; Silsbury et al., 2015). Other studies (e.g. Chau et al., 2016; Gilson, Suppini, et al., 2011; Mackey et al., 2015) estimated sitting and standing via an accelerometer such as the GT3X+. Accelerometers do not accurately classify sedentary behaviour as they only detect movement, not posture (Dowd et al., 2012; Plasqui et al., 2013). Regardless, previous studies that employed the ActivPAL have seen sitting reductions of over an hour (e.g. Alkhajah et al., 2012; Carr et al., 2016; Healy et al., 2013).

Another explanation for the smaller reductions in sitting in the present study could be the nature of the organisations and the employees involved. Typically,

previous interventions have taken place in academic institutions with staff from departments that focus on PA and / or sedentary behaviour (Tew et al., 2015) who might arguably be more motivated to reduce their sitting at work due to specialist knowledge regarding the potential health risks associated with sedentary behaviour and physical inactivity. Whilst Macmillan and PHE are health-focused organisations, few of the participants' roles were directly related to PA or sedentary behaviour. A sit-stand intervention in a call centre setting, where job roles are entirely unrelated to PA and health, reported even more modest reductions in sitting than the present study (Straker et al., 2013).

Further, much of the sit-stand desk intervention literature to date has utilised low quality designs including uncontrolled and / or un-randomised designs and thus the findings from these studies should be interpreted with caution (Shrestha et al., 2016). Another possible explanation for the smaller effect and non-significant changes in sitting in the present trial compared to previous studies may be due to publication bias; authors choosing not to publish and / or journals being more likely to reject studies that report null and non-significant findings and thus the published literature is unrepresentative of all completed studies (Gardner et al., 2016; Rothstein, Sutton, & Borenstein, 2006). There is evidence of potential publication bias within the PA and sedentary behaviour intervention literature (Conn et al., 2009; A. Martin et al., 2015; Shrestha et al., 2016). A recently published intervention study with a similar sample size to the present study – eight participants in the intervention groups and 7 in the control group – also reported non-significant reductions in sitting in the sit-stand intervention group (Crandall et al., 2016). This suggests that larger sample sizes are required to ensure the study is adequately powered to detect significant differences (Field, 2013; Neuhaus, Eakin, et al., 2014; Shrestha et al., 2016). Further possible explanation for the relatively small effect of the sit-stand desk intervention on workplace sitting are considered in sections 7.1.1 and 7.2.2 of the mixed method analysis chapter.

Fluctuation in sitting and standing during work hours

In the present study, there was a tendency for changes in sitting and standing to be less pronounced at 6-months compared to 2-weeks (see Figure 5.4). This is consistent with published literature; sit-stand desk intervention studies lasting ≥ 3-

months that include more than one post-intervention measurement point tend to report that changes in sitting and standing become less pronounced over time (Alkhajah et al., 2012; Chau et al., 2016; Danquah et al., 2016; Graves et al., 2015; Mansoubi et al., 2016). For example, Danquah et al. (2016) reported that sitting reduced by 71 minutes/workday and standing increased by 64 minutes/workday relative to the control at one month, but that these changes were over 30% less pronounced at 3-months. Further, published sit-stand desk intervention studies that only include one post-intervention timepoint tend to report more substantial changes in sitting and standing when the behavioural measurement takes place soon after the installation of the sit-stand desks. Chau, Daley, Dunn, et al. (2014) and Healy et al. (2013) reported 73 and 122 fewer sitting minutes and 65 and 121 more standing minutes, respectively, following a 4-week sit-stand desk intervention. Conversely, smaller changes have been reported when outcome measurement took place 4-6-months following sit-stand desk provision (Gao, Nevala, Cronin, & Finni, 2016; Gorman et al., 2013).

However, in the present trial, there were significant reductions in sitting and increases in standing at 12-months in the pooled IG (see Figure 5.4). This indicates that whilst sit-stand desk use may decrease over the short term (i.e. up to 6-months) it may increase over the medium and long-term. These fluctuations in workplace sitting and standing are discussed alongside relevant process evaluation data in section 7.1.1 of the mixed method analysis chapter. There is a dearth of literature examining the effectiveness of sit-stand desk interventions over time-periods > 6-months. However, Healy et al. (2016) recently found that sitting and standing were significantly altered by -45 and +43 minutes/eight-hour workday, respectively, at 12-months. Thus, the present study adds to the limited amount of literature suggesting that sit-stand desks may be efficacious at influencing sitting and standing at 12-months.

5.2.4 The sit-stand desk intervention: sitting patterns during work hours

There was a tendency for a reduction in the number of workplace sitting bouts and sit-to-stand transitions in the sit-stand desk intervention groups relative to the CG (see Figure 5.6). This is a paradoxical finding as it suggests that sitting bouts are broken up less frequently following the intervention delivery. However, it is

likely that the employees transitioned between sitting and standing less frequently due to the reduction in total sitting time, rather than sitting being accumulated in longer bouts, as there were no significant reductions in the number of sit-to-stand transitions when accounting for total workplace sitting minutes.

Few published studies have examined changes in sitting patterns following the provision of a sit-stand desk. Similar to the present study, Carr et al. (2016) reported a non-significant trend for a reduction in sit-to-stand transitions, and Straker et al. (2013) reported no differences in transitions from sitting per hour, or the average duration of uninterrupted sitting. Conversely, Danquah et al. (2016) and Healy et al. (2013) reported a significant increase in sit-to-stand transitions, whilst accounting for total sitting time, and a reduction in the number of prolonged sitting bouts, following the delivery of the intervention. In other words, sitting patterns were favourably altered following the provision of the sit-stand desk, independently of the total reduction in sitting time during work hours. Within these studies, the sit-stand desk was delivered as part of a more comprehensive intervention involving a number of strategies designed to reduce and break up sitting. Thus, it may be that the sit-stand desk provision alone has a limited effect on breaking up prolonged sitting but that it *can* be efficacious when delivered as part of a more comprehensive intervention. Whilst a multicomponent intervention was delivered in the present study, there were no significant differences between the SS-MC and SS-O groups, indicating that the additional strategies implemented as part of the SS-MC intervention provided no additional benefit (discussed in further detail in section 5.3.7). In fact, the SS-O group, and not the SS-MC group, significantly reduced the number of prolonged (> 30 minutes) sitting bouts compared to the CG. At baseline the number of prolonged sitting bouts was highest in the SS-O group and thus the larger reduction in prolonged sitting bouts in the SS-O group could be due to a greater capacity to improve than the SS-MC group and CG (Hetsroni, 2014). A reduction in sitting was significantly correlated with a reduction in prolonged sitting bouts. Breaking up prolonged periods of sitting has been linked to health improvements independently of reducing total sitting duration (Dunstan et al., 2012). Thus, the present study provides partial support to the limited existing evidence that provision of a sit-stand desk could positively influence sitting patterns during work hours.

5.2.5 The sit-stand desk intervention: Physical activity during work hours

The findings suggest that there was a slight increase in workplace PA following the provision of the sit-stand desk, that was not maintained over time (see Figures 5.6 and 5.7), and thus the sit-stand desk had a limited influence on PA during work hours. Aside from change in light PA, all the PA variables were highly correlated, which suggests that changes following the sit-stand desk intervention were relatively similar across PA variables.

A number of intervention studies in the extant literature have reported the effect of a sit-stand desk intervention on stepping via self-report, as well as device-based (usually ActivPAL) measures. Consistent with the findings of the present study, most of these studies did not report a beneficial effect of sit-stand desks on stepping (e.g. Chau, Daley, Dunn, et al., 2014; Chau et al., 2016; Dutta et al., 2014; Graves et al., 2015; Healy et al., 2016; Mansoubi et al., 2016; Miyachi et al., 2015). Danquah et al. (2016) reported a significant increase in steps, however the participants already had a sit-stand desk at work before the commencement of the trial. The intervention incorporated strategies to support employees to use their desk in the standing position and increase PA at work, and thus the increase in steps was not due to the provision of a sit-stand desk *per se*. Few published studies have examined the effect of sit-stand desks on light, moderate, or vigorous PA at work. However, the available evidence suggests that sit-stand desks have a limited influence on PA. Crandall et al. (2016) reported no change in light PA or MVPA in the sit-stand intervention group compared to the control. Consistent with the initial peak in PA variables in the IG in the present trial, Mansoubi et al. (2016) reported an increase in light PA and MVPA one-week following the provision of sit-stand desks, but not at 6-weeks and 3-months. However, Mansoubi et al. (2016) did not include a control group, and so it is uncertain whether the increase in PA was due to the sit-stand desk provision.

Dutta et al. (2014) reported accelerometer-measured EE to be 11% higher in the intervention group than the control group 4 weeks following the provision of sit-stand desks. Since the present study, and most of the extant literature, support the notion that using a sit-stand desk does not substantially increase PA during work hours, an increase in standing may be a contributing factor to increased EE. Standing

is associated with fidgeting, shifting of weight and postural muscle activity, which may raise EE above sitting levels (Torbeyns et al., 2014). In the present study, the activity-monitor derived estimates of EE (i.e. Axis 1 and Vector Magnitude CPM) did not significantly differ from baseline in the IG. Dutta et al. (2014) instructed sit-stand desk users to stand for 50% of the working day, and reported good compliance to this recommendation, whereas only modest increases in standing were observed in the present study. This could partially explain why a significant increase in EE was observed by Dutta et al. (2014), but not in the present study. Indeed, laboratory-based research supports the assertion that standing at a sit-stand desk increases EE beyond resting levels, although only by a small amount (Tudor-Locke et al., 2013). Other types of active desks, such as treadmill or elliptical desks, are associated with more substantial increases in EE (Tudor-Locke et al., 2013). However, treadmill and elliptical desks tend to be less acceptable than sit-stand desks to employers and employees (Straker et al., 2013; Straker, Levine, & Campbell, 2009). Further, treadmill and elliptical desks are associated with higher costs and reduced work productivity (MacEwen et al., 2015; Neuhaus, Eakin, et al., 2014).

The sit-stand desk intervention had limited influence on workplace PA. The intervention in the present study targeted sitting, standing and PA within the same behaviour change techniques and delivery modes. Meta-analytic evidence suggests that greater reductions in sitting occur when intervention strategies focus purely on reducing sitting, compared to intervention strategies that focus on increasing PA (Prince et al., 2014). This suggests that sitting and PA are independent behaviours (Craft et al., 2012; Finni et al., 2014) and have different determinants (Owen et al., 2011b). Thus, intervention strategies with a specific focus on PA are likely more efficacious at increasing workplace PA.

5.2.6 Compensation effect outside work: The influence of the workplace intervention on sitting, standing and physical activity across the whole day

There was a compensatory increase in sitting and reduction in standing outside work hours, which resulted in non-significant changes in sitting and standing across the whole day (see Figure 5.8).

Previous sit-stand desk interventions that have measured sitting and standing during both work hours and non-work hours support the notion of a compensatory

increase in sitting and reduction in standing during non-work hours (Alkhajah et al., 2012; Chau, Daley, Dunn, et al., 2014; Dutta et al., 2014; Healy et al., 2016; Mansoubi et al., 2016). However, these studies typically still report beneficial changes across the whole day. For example, Dutta et al. (2014) found that whilst sitting was reduced by 21% during work hours, the overall daily reduction was only 14%. Mansoubi et al. (2016) report a 62-minute reduction in standing minutes during non-work hours from baseline to three months, which, consistent with the changes in standing in the present study, accounts for over 50% of the increase in standing during work hours. Whilst there are only small differences in EE between sitting and standing (Tudor-Locke et al., 2013), the findings provide partial support to the "ActivityStat Hypothesis"; that EE remains relatively stable across time (Gomersall, English, Rowlands, Maher, & Olds, 2013). Further considerations related to compensatory effects during non-work hours, based on comparison of the outcome and process evaluation data, are reported in section 7.1.4. Reduction in workplace sitting during work hours are unlikely to benefit health unless the reduction is sustained across the whole day.

Conversely, an increase in the number of sit-to-stand transitions during work hours was correlated with an increase in a number of PA variables outside work. This suggests that participants that were more likely to break-up sitting bouts during work hours were also more likely to increase PA outside work. However, aside from changes in light PA discussed below, there was no significant change in any of the PA variables during non-work hours compared to work hours. This is consistent with Mansoubi et al. (2016) who reported no change in PA outside work hours following the delivery of a sit-stand desk intervention. As suggested in the previous section, it is likely that intervention strategies specifically focused on increasing PA - not just reducing sitting - are necessary to influence PA levels.

An unexpected finding was that sitting was non-significantly reduced from baseline during *non-work hours* at 6-months. Further, there was a significantly higher number of short-duration sitting bouts and sit-to-stand transitions at the 6-month timepoint during non-work hours compared to work hours, and compared to all other post-intervention measurement timepoints across the whole day. Light PA was significantly raised at 6-months compared to all other post-intervention timepoints, and was significantly correlated with reduced sitting time at 6-months,

across the whole day. Thus, it is plausible that increases in light PA directly replaced sitting and led to an increase in the number of transitions from sitting to standing. Unlike the 2-week, 3-month and 12-month measurement timepoints, the 6-month timepoint occurred during the summer months, and so it is plausible that seasonal fluctuation in activity contributed to fluctuations in non-work hours sitting patterns across time (O'Connell, Griffiths, & Clemes, 2014; T. Reilly & Peiser, 2006). Future research should further investigate how changes in sitting, standing and PA following a sit-stand desk intervention are accumulated during work and non-work hours, and how this fluctuates over time, as well as exploring seasonal influences.

5.2.7 Multicomponent intervention vs. sit-stand desk provision only

It was hypothesised that the provision of a multicomponent intervention, including sit-stand desk provision alongside psychological level and organisational level strategies, would influence sitting, standing and PA to a greater extent than the provision of a sit-stand desk alone. However, change in most sitting, standing and PA variables, including time spent sitting and standing during work hours and across the whole day, did not differ significantly between the SS-MC and SS-O groups. This suggests that the sit-stand multicomponent intervention was no more efficacious than providing a sit-stand desk alone.

There were some minor differences in outcomes between the SS-O and the SS-MC groups. For example, workplace stepping reduced over time in the SS-O group, whereas a number of PA variables, including stepping, increased non-significantly over time in the SS-MC group (see Figures 5.6 and 5.7). In addition, sitting reduction was largest at 12-months in the SS-MC group, whereas in the SS-O group sitting reduction waned over time. These differences indicate that incorporating other strategies alongside sit-stand desk provision may be important for supporting *sustained* behaviour change. Healy et al. (2016) recently reported a sustained reduction in sitting and increase in standing at 12-months-post the delivery of SS-MC intervention. However, Healy et al. (2016) did not include a SS-O group so it was not possible to assess the effectiveness of sit-stand desk provision compared to the SS-MC intervention.

Despite the aforementioned differences in *some* outcomes at *some* timepoints between the SS-MC and SS-O group, overall, the provision of a SS-MC intervention

did not appear to beneficially influence sitting, standing and PA, compared to the provision of a sit-stand desk only. Published evaluations of SS-MC interventions have concluded that such interventions are effective at reducing sitting and increasing standing, however these studies have not included SS-O comparison groups (Danquah et al., 2016; Healy et al., 2016; Mackey et al., 2015). Nevertheless, Neuhaus, Healy, et al. (2014) found that the employees who received a multicomponent intervention that included a sit-stand desk reduced their sitting almost three-fold compared to employees that received a sit-stand desk only.

Given that the social world is an open-system, there are multiple and interacting influences on human behaviour (Cruickshank, 2012; Pawson & Tilley, 2004). Thus, the SS-MC intervention was expected to be more efficacious than the provision of a sit-stand desk only, as it targets multiple behavioural tendencies on different levels (individual, environmental, organisational) (Hawe et al., 2009). The SS-MC intervention evaluated by Neuhaus, Healy, et al. (2014) incorporated strategies that targeted the individual, environmental and organisation level, and was found to be more effective than solely providing sit-stand desks. In the present study, phone calls targeted the individual level, and sit-stand desk provision altered the physical environment. However, the organisational element did not involve actual organisational change, but rather sought to demonstrate the organisation's commitment to developing a healthy workplace and sit-stand desks via email support from management. In other words, it endeavoured only to alter individual employees' *perception* of the organisation. Organisational health culture, shaped by the underlying assumptions and values within the organisation, is a strong predictor of employee health behaviour (Golaszewski, Hoebbe, Crossley, Foley, & Dorn, 2008; Pronk, 2012; Pronk et al., 2009). Therefore, the limited additional efficacy of the multicomponent sit-stand desk intervention, compared to sit-stand desk provision only, could be because organisational-level change in workplace health culture was not incorporated into the design of the intervention.

The reason that the SS-MC intervention did not include strategies focused on actual organisational change is because participants from the SS-O group and CG were employed at the same organisation (and in the same physical workplace) and thus it would not be possible to expose only the SS-MC group to these intervention strategies. This element of the research design provides an additional potential

explanation for the lack of efficacy of the SS-MC intervention compared to receiving a sit-stand desk only; the SS-O group participants could have been indirectly exposed to components of the SS-MC intervention; for example, via conversations with SS-MC group participants. Therefore, it is plausible that the SS-MC intervention provided some benefit to the SS-O and CG's, which may have masked the influence of the intervention strategies on the SS-MC group. Other potential explanations for the lack of additional influence of the multicomponent sit-stand desk intervention, which draw on process evaluation findings, are considered in sections 7.1.3 and 7.2.4 of the mixed method analysis chapter.

5.2.8 Changes in sitting, standing and physical activity: Potential health implications

A higher amount of sedentary behaviour is associated with increased risk for various health outcomes, including all-cause mortality (Biswas et al., 2015; Chau et al., 2013; de Rezende et al., 2014; Ekelund et al., 2016). Given the apparent dose-response relationship between total daily sitting and health, a 33-minute reduction in daily sitting might be expected to slightly improve health. However, it is unclear whether such a modest reduction in sitting is clinically beneficial. Regardless, a reduction of this magnitude *might* have beneficial effects at a population level if every office-based employee sat for 33 minutes less each day (Straker et al., 2013). Breaking up prolonged sitting bouts, independently of the total amount of sitting, is also associated with beneficial health outcomes (Dunstan et al., 2012; Healy et al., 2008). Whilst the participants in the present study broke up sitting bouts frequently during work hours at baseline (over three times an hour, on average), the intervention had limited impact on prolonged sitting bouts. Future interventions should encourage regular, short breaks from sitting as well as reducing the total amount of sitting.

It is unclear whether sitting influences health *entirely* independently of PA. Based on meta-analytic evidence, Ekelund et al. (2016) recently reported that 60-75 minutes of moderate intensity activity, daily, can circumvent the negative health consequences associated with prolonged sitting. However, the average person does not accumulate an hour of moderate PA each day. In the present study, participants engaged in an average of 49 minutes of moderate PA and 4.6 minutes of vigorous

PA, which was unchanged following the delivery of the intervention. Thus, it could be argued that even if sedentary behaviour is not entirely independent of PA, most office-based employees do not engage in enough PA to ameliorate the potential health risks associated with high levels of sitting.

In the present study, the reduction in sitting was predominantly replaced with standing. Review-level evidence indicates that current understanding of any potential health benefit of standing is incomplete (Benatti & Ried-Larsen, 2015; Chastin et al., 2015); whilst some experimental evidence suggests that replacing sitting with standing can cause beneficial acute changes in metabolic biomarkers (e.g. Thorp et al., 2014), other evidence indicates that such changes occur when sitting is replaced with light PA, but not standing (e.g. Bailey & Locke, 2014). Both intra- and inter-individual variation in total PA energy expenditure is predominantly due to variation in non-exercise activity thermogenesis (NEAT, i.e. light PA) (Levine, 2007; Thompson & Batterham, 2013), which suggests that it is advantageous to replace sitting with light PA. However, there is also a well-established relationship between increased MVPA, increased cardiorespiratory fitness, and physical health (Haskell et al., 2007; Janssen, 2012; I. Lee et al., 2012). The sit-stand desk intervention had limited impact on light, moderate *and* vigorous PA over 12-months. Given the contribution that different components of PA contribute to health (L. Smith, Ekelund, et al., 2015; Thompson et al., 2015), interventions should attempt to encourage increased movement of different intensities, as well as standing, to maximise potential health benefits.

5.2.9 Association between sit-stand desk efficacy and participant income

IG participants with a higher income were less likely to reduce total sitting time, increase total standing time, and reduce the number of and minutes in prolonged sitting bouts following the intervention; see Figure 5.11. Similarly, Gorman et al. (2013) reported that administrative staff reduced sitting and increased standing to a greater extent than academic staff following the implementation of sit-stand desks in a University workplace setting. A potential explanation for this finding, drawing on process evaluation data, is explored in chapter 7 (see section 7.2.2). Lower paid, less educated individuals are likely to be less physically active than their higher paid, more educated counterparts (Trost et al., 2002). Thus, it may

be valuable to target lower-paid employees with regards to sit-stand desk provision, given that this trial suggests they may benefit the most with regards to reducing sitting and increasing standing. However, cross-sectional data on sitting patterns in office workers suggest that employees with higher incomes engage in more occupational sitting than employees with lower incomes (Clemes et al., 2016; De Cocker et al., 2014; Proper, Cerin, Brown, & Owen, 2007), which could be partly due to longer working hours (Feldman, 2002). Therefore, other strategies that consider the nature of work roles may be required to support higher paid employees reduce sitting at work.

5.2.10 Unexpected findings in the control group: Did they really receive no intervention?

As expected, the CG did not reduce sitting or increase standing during work hours. However, unexpectedly, there was a significant increase in some PA variables over the course of the 12-months, and a significant reduction in prolonged sitting bouts in non-work hours compared to work hours in the CG. Nevertheless, the CG participants *volunteered* to take part in a workplace intervention that was designed to reduce sitting and increase standing and PA, which indicates that they are motivated to reduce sitting and/or increase standing and PA at work.

At the 6-month timepoint, the CG spent an average of almost an hour less in prolonged sitting bouts outside work hours, compared to baseline (whilst there was no reduction during work hours). As detailed in section 5.3.6, the 6-month timepoint occurred during the summer months, and so seasonal variation in activity may have led to a reduction in sitting outside work (O'Connell et al., 2014; T. Reilly & Peiser, 2006). However, a reduction in sitting *outside* work, but not *during* work hours, in the CG supports the assertion that changes to the workspace (e.g. provision of a sit-stand desk, standing desk, or treadmill desk) are necessary to support a reduction in sitting in the workplace (Buckley et al., 2015). CG participants increased PA during work hours, which suggests that, in the absence of a sit-stand desk, it may be more practicable for office-based employees to incorporate a small amount of PA into their working day than substantially reducing sitting. Possible explanations for the positive changes in the CG, supported by process evaluation data, are considered in section 7.1.5 of the mixed method analysis chapter.

5.2.11 ActivPAL vs. GT3X+: Sedentary behaviour measurement

Participants' adherence to the data-collection protocol was high. This may be attributable to developing a rapport with, and commitment from, participants at the start of the study by holding various workshops for participants to attend and offering an incentive (worth £100) for completing the data collection.

The GT3X+ estimate of both workday and total daily sedentary behaviour was significantly higher than the ActivPAL estimate. As explained in Section 4.5.1 the GT3X+ categorises activity as sedentary, light, etc. based on the intensity of the activity, rather than posture (Dowd et al., 2012; Edwardson et al., 2016). Thus, static standing will have been misclassified as sedentary behaviour by the GT3X+. The wear-time and sedentary behaviour comparison data from the present trial suggests that the ActivPAL is more likely to be representative of daily patterns of sitting than the GT3X+.

5.3 Concluding remarks

In conclusion, the provision of a sit-stand desk significantly increased standing and reduced sitting, but had no influence on PA at 12-months. The present study is one of the first to compare the efficacy of a SS-MC intervention to sit-stand desk provision only. The provision of a SS-MC intervention was no more efficacious than providing a sit-stand desk only. However, the multicomponent intervention in the present study was limited, as it did not include strategies designed to influence the organisational culture. The next chapter presents findings from the process evaluation component of the research, to address factors that influence the feasibility and acceptability of implementing and using sit-stand desks, within the participating organisations.

Chapter 6 – Process Evaluation

6.0 Introduction

This chapter presents and discusses findings from a process evaluation of a multi-component sit-stand desk intervention. Processes influencing the feasibility and acceptability of designing for, implementing and using sit-stand desks in the office-based workplace are considered. Feasibility refers to the ease with which sit-stand desk interventions can be designed and implemented. Interconnected with feasibility, acceptability refers to whether workplace stakeholders consider sit-stand desk interventions to be appropriate, possible and permissible.

An extensive amount of qualitative data was collected throughout the data collection period, including interview data with 15 trial participants (i.e. employees that took part in the intervention) and 26 stakeholders (i.e. employees with roles relevant to sit-stand desk provision) and observational data from both workplaces. Participant employees mostly spoke of their personal experiences, and stakeholder employees mostly spoke from an organisational perspective, however these boundaries were blurred. The data were analysed collectively and are presented together in this chapter by synthesising theory and evidence in a narrative account of the participants' experiences. It draws on the principles of representing people through ethnographic-type work.

The chapter examines the influence of organisational culture on employee health beliefs and behaviours. The first theme (section 6.1) discusses how organisational discourses influence the feasibility and acceptability of sit-stand desk interventions. The impact of the culture, context and structure of the organisation, and employees' occupational identities are considered. The second theme (section 6.2) describes employees' experience of using a sit-stand desk. The section explores how employees' interaction with the sit-stand desk, and workplace culture and interpersonal relationships, influence the feasibility and acceptability of use.

A third theme, relating to the impact of the sit-stand desk intervention, considers the processes that influence the efficacy of the sit-stand desk intervention on sitting, standing and PA. Findings from the third theme are presented and discussed within Chapter 7 alongside pilot RCT findings. Figure 6.1 illustrates the process evaluation findings, conceptualising (1) how the themes link to the research

questions, (2) relationships between the themes, and (3) how the findings map onto the SEM.

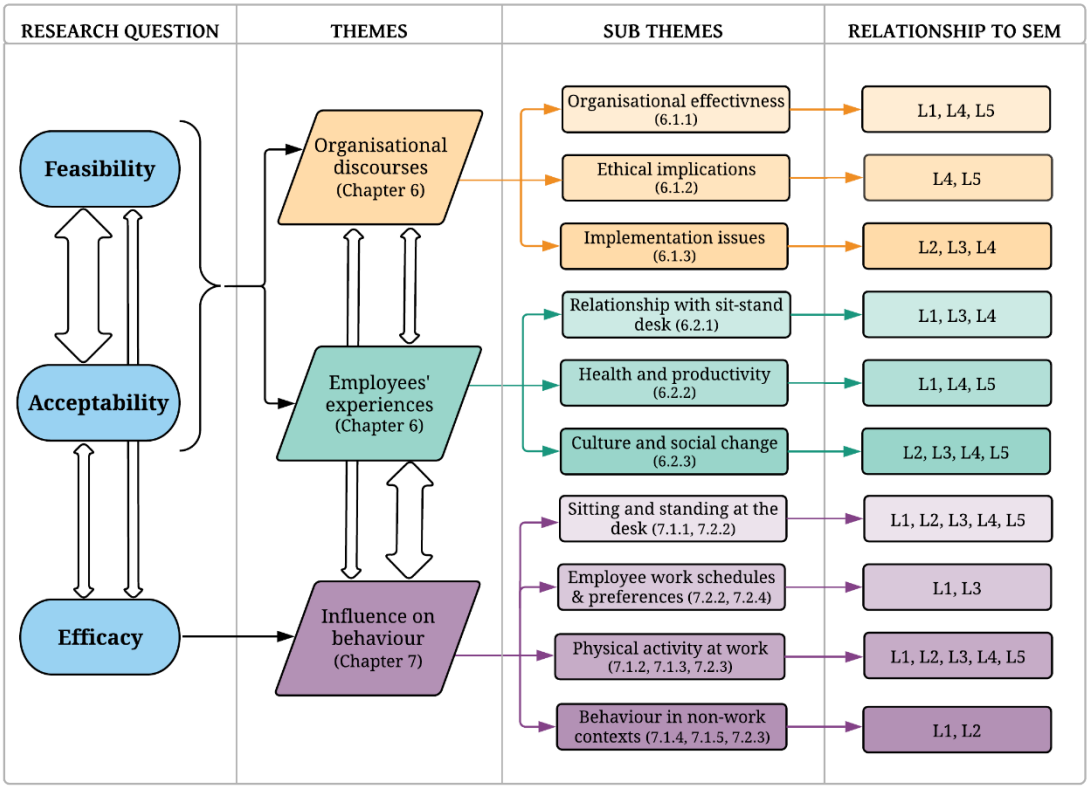


Figure 6.1. *Process evaluation findings: conceptual framework and mapping to SEM. SEM = Socio-ecological model. L1 =Individual (physical, psychological, structural); L2 = interpersonal (relationships); L3 = Physical environment; L4 = Organisational (context, culture, policies and practices); L5 = Societal (norms, values, policies)*

6.1 Sit-stand desks and organisational discourses

This theme examines organisational discourses pertaining to the implications for employee health and organisational effectiveness (6.1.1), ethical considerations (6.1.2) and viability (6.1.3) of designing and delivering sit-stand desk interventions.

6.1.1 The *smart* thing to do? Expanding and challenging the healthy workplace model

> *We [Macmillan employee and I] got on to talking about the price of sit-stand desks and I told her that the clamp version was around £350. She seemed shocked as she said she thought they were more like £1000 and said, 'well surely everyone should be provided with one then, for improving health and productivity' and that spending money on sit-stand desks will actually be beneficial for the organisation. She genuinely seemed to believe that (Research notes, Macmillan, 12th Aug. 2015)*

Perceptions of how sit-stand desks might increase organisational effectiveness

Employees voiced that the pursuit of organisational success guides business operations and decisions, including whether to invest in employee health initiatives. For example, Jill reasoned that "if our y'know, reason for being is to help improve the lives of everyone living with cancer then if we can improve our own lives and service to them, then that should help improve their lives too" (Jill, Macmillan, middle-manager/workplace wellbeing stakeholder). Interviewees perceived that supporting employee health would contribute to achieving the organisations official aims and outcomes; a position that surfaced throughout official documentation:

> At Macmillan Cancer Support, we know that the best way to achieve our nine outcomes and support people affected by cancer is to have a healthy, happy and engaged workforce. Macmillan advocates proactive prevention of issues linked to wellbeing as well as fast and effective treatment and support for new/on-going issues (Online information, Macmillan, 16th Sept. 2014)
>
> The health and wellbeing of our staff is an important corporate priority, supporting our staff to be healthy and productive is fundamental to PHE's ability to deliver our corporate priorities and objectives" (Internal communication, PHE, 11th May 2015)

These views are aligned with the healthy workplace discourse that favourably positions employee health initiatives, such as sit-stand desk interventions, as strategies to generate organisational benefits, e.g. reduced sickness costs, increased productivity, and improved reputation.

Interviewees identified several pathways by which they perceived that supporting employee health might contribute to organisational effectiveness. Firstly, it was articulated that increased employee health and wellbeing might enhance organisational effectiveness via increased productivity and reduced costs resulting from reduced employee sickness and absence:

> If you have improved physical health… you will also be more productive. If you are absent from work, then obviously, you are not productive. But even if you are in work and you're not well then you will be less productive than someone else who is feeling great (Finn, PHE, workplace wellbeing stakeholder)
>
> I think that there is enough of a… body of evidence, to say that a healthier workforce is a more productive workforce, is a happier workforce, is a more motivated workforce. So then therefore you reduce workplace sickness and absence, we reduce long-term illness and stress… we spend a lot of money

> on occupational health within HR… there is a big reason why it is important there (Jayne, Macmillan, senior leader/workplace wellbeing stakeholder)

The data supports the healthy workplace discourse which posits that reduced absenteeism and presenteeism, and increased work motivation increase productivity via improved employee health and wellbeing (Wadsworth et al., 2010). Interviewees also positioned sit-stand desks as an aspect of competitive advantage, voicing a perception that employees seek out job opportunities that not only offer suitable roles and competitive pay, but also wider benefits including staff wellbeing initiatives:

> If we need a say, a Microsoft dynamics developer, we are competing with a huge range of organisations that are also looking for exactly the same skilled resource. And therefore, the bit that potentially makes us look more attractive are things like the 34 1/2-hour week… it's about those benefits that says actually come and work for Macmillan because we care about you as a person (Drew, Macmillan, operational stakeholder)

> There was all this stuff about you know if you stand up on the tube it's better for you…but you know actually bringing it into the workplace and having specially adapted desks, you know I was pleased that we were doing something that felt a little bit ahead of maybe our competitors (Jayne, Macmillan, senior leader/workplace wellbeing stakeholder)

As a strategy to increase competitive advantage, investing in sit-stand desks could facilitate the recruitment and retention of the most sought-after employees, as organisations that exhibit social responsibility are more attractive to potential applicants (Greening & Turban, 2000). In addition, employees identified a need for the organisation to "practice what they preach" externally (Craig, Olivia, Jim and Samantha; PHE and Macmillan; senior leader, middle management, operational and workplace wellbeing stakeholders):

> We need to make sure that we are exemplar health and wellbeing employers for our own staff, because otherwise why on earth would anybody listen to us when we say this is best practice… if we're not doing it ourselves (Richard, PHE, senior leader/workplace wellbeing stakeholder)

The organisations' external programmes of work are oriented around improving the lives of people affected by cancer (Macmillan), and protecting and improving the nation's health and wellbeing (PHE); for both organisations, this includes promoting and supporting people to engage in healthy lifestyle behaviours. Thus, interviewees perceived that it is necessary to support staff health and wellbeing internally, to appear a credible source of information and support to stakeholders and the public. Sit-stand desks were described as a "visible" (Craig, PHE, senior leader/workplace

wellbeing stakeholder), “innovative” (Alexandra, PHE, operational stakeholder) and “forward thinking” (David, Macmillan, operational stakeholders) representation of the organisations commitment to developing a healthy workplace.

The perception that sit-stand desks are associated with organisational benefits increases the acceptability of workplace sit-stand desk interventions as the pursuit of employee productivity and organisational success is a taken-for-granted priority of most organisations, and guides organisational operations (Piggin, 2015; Such & Mutrie, 2016). Employees’ rationale for the linkage between supporting employee health and improved organisational effectiveness align with extant theory and empirical literature related to the healthy workplace model (Grawitch et al., 2006), which posits that organisational benefits such as increased profits, productivity, and meeting aims and objectives arise following the introduction of healthy workplace practices, because of improved employee health and wellbeing (see section 3.2.2). Empirical studies examining the healthy workplace concept largely adopt a measure of financial performance as a proxy for organisational effectiveness (e.g. Griffeth, Hom, & Gaertner, 2000). This highlights an assumption within the literature that the primary goal of an organisation is to maximise profits, yet the present study of two non-profit organisations revealed that employee perceptions of organisational success were oriented around achieving organisational aims and outcomes which were not about commercial profit but about supporting people affected by cancer (Macmillan) and protecting and improving the nation’s health and wellbeing (PHE).

The healthy workplace model explicates an indiscriminate relationship between employee health initiatives and organisational effectiveness across organisations. The present findings reveal nuanced and context-specific processes by which supporting employee health might be connected to achieving organisational outcomes. Evidence relating to enhancing the credibility of work programmes indicates that employee health initiatives may be more strongly tied to organisational effectiveness when the nature of the organisation is health-focused. Thus, the health-focused nature of the participating organisations garnered additional support for, and increased the perceived acceptability of, investing in sit-stand desks in the present study. Organisation-level influences on behaviour and health are recognised within the middle-outer layers of most iterations of the SEM; see Figure 6.1. The healthy workplace model should recognise how complex organisational contextual factors

such as the nature of the organisation, geographic location and associative legislation, and employees' occupations can influence the processes that underpin, and the type and strength of the relationship between, employee health initiatives and organisational success.

The influence of organisational culture and employee identity on perceptions of the relationship between sit-stand desks and organisational effectiveness

Employees' health-based values influenced their attitudes regarding sit-stand desks. Employee beliefs regarding the importance of supporting employee health were guided by organisational cultural assumptions. The health-related nature of both organisations engendered taken-for-granted assumptions about the importance of health and wellbeing and healthy lifestyles:

> We've got the tag line now, of protecting and improving the nation's health. It's literally on every email you send, it's on every headed letter so it should be in your eye line *laughs* every single day… [Health is] a commitment… this is who we are (Annabel, PHE, workplace wellbeing stakeholder)

Valuing health was embedded throughout the organisations and reflected in organisational materials, which led to a shared understanding amongst employees that "healthy living are [sic] generally better for you and you know, give you better [health and wellbeing] outcomes" (Steph, Macmillan, advisor, sit-stand desk user). Organisational cultural health values likely compelled employees to voice attitudes related to the sit-stand desk intervention that reflect the healthy workplace discourse.

However, some interviewees held negative perceptions regarding sit-stand desks that challenge the compatibility of sit-stand desks with the healthy workplace discourse. For example, Dorothy questioned "what benefit there is, health wise [to using a sit-stand desk]? Because standing... is not good. Standing for long periods is not good, because you get stagnation of blood… varicose veins" (Dorothy, PHE, operational stakeholder). Some interviewees thought that the potential health risks would outweigh the potential health benefits of using a sit-stand desk, which indicates a lack of value or understanding of the potential health benefits of reducing sitting. In addition, some interviewees viewed sit-stand desks as a luxury rather than as a preventative health measure that should be made available to all employees:

> I think it's quite different to something like, you know a laptop or an iPhone, which is essential to conducting our business… [but] certainly if there was a

> physical issue or health reason…. from that point of view, we have no objection to this and we would be supportive. Anything that helps the health of wellbeing of individuals we are interested in (Tarak, PHE, operational stakeholder)

Tarak expressed an opinion that sit-stand desks should only be offered as an occupational health solution for employees that may benefit from standing due to a physical health condition, which provides further indication that some interviewees do not personally value preventative health and the promotion of healthy lifestyle behaviours which are values embedded throughout the culture of both organisations.

The present analysis supports the theoretical proposition that organisational culture comprises various contested and opposing values and behaviours (Mannion et al., 2008; J. Martin, 1992, p. 153; J. Martin & Siehl, 1983; and see section 3.1.2). The occupations of many Macmillan and PHE employees indirectly contribute to the core aims of the organisation and, consequently, are not health-focused. The interviewees that held the negative perceptions regarding sit-stand desks tended to be employed in such operational, non-health-focused occupations. Empirical evidence indicates that identity-organisational culture fit arbitrates the extent to which culture guides values and behaviours (Lin & Lin, 2014; van Dick, 2004; Walsh & Gordon, 2008). An earlier chapter introduced the concept of occupational identity; the idea that what people do - including in the work setting - and their values and behaviours are mutually reinforcing (Huot & Rudman, 2010; and see section 3.1.3). Therefore, in the present study, it is plausible that operational interviewees do not view sit-stand desks as beneficial for employee health and organisational effectiveness as their occupational identity more strongly predicts their attitudes and behaviours than the dominant organisational culture. This analysis indicates that organisational cultural contradictions can arise due to differing occupational identities:

> She [health-focused PHE employee] vented her frustrations regarding the current procedure, saying ‘we have to have a [health] problem, a symptom, a justification to request a sit-stand desk at PHE, which goes against all the work we are trying to do nationally’ (Research notes, PHE, 19th Sept. 2014)

Seated desks as standard office equipment, and the notable absence of any activity-permissive desk equipment (e.g. sit-stand desks, treadmill desks, elliptical desks) was symbolised by employees with health-related occupations as the organisation

not investing in the health of their staff, which undermines and contradicts the organisations dominant cultural value of preventative health.

This analysis implies that a factor reducing the likelihood of health-related organisations investing in sit-stand desks is that operational staff are primarily responsible for choosing, organising and managing office equipment, including desks. Thus, advocates of sit-stand desks need to convince the employees that are influential in the decision-making process of their value. One approach would be to increase decision-makers' understanding of how sit-stand desks might contribute to employee health, to enable them to understand and sympathise with the business rationale underpinned by the healthy workplace model. For example, interviewees' concerns that sit-stand desks may lead to health risks are not unfounded, as prolonged standing has been associated with both varicose veins and musculoskeletal discomfort (MSD; e.g. low back pain) (Tüchsen, Krause, Hannerz, Burr, & Kristensen, 2000; T. Waters & Dick, 2015). It should be clearly articulated to relevant workplace stakeholders that sit-stand desks should be used to facilitate the replacement of prolonged sitting with intermittent sitting, standing, and light PA, which is associated with improved health outcomes (Karakolis & Callaghan, 2014); see section 2.1.5. However, an alternative approach to increase the acceptability of sit-stand desks would be to demonstrate their harmony with the pre-existing, non-health-related occupational values and concerns of employees responsible for managing desk equipment. For example, Harry identified that sit-stand desks could facilitate flexible working:

> We are promoting an eight to ten desk ratio… the implication is that the desks are unassigned… [so] you should arguably provide a high degree of flexibility in the way those desks can be adjusted. Height is an obvious one… You've got adjustable chairs so why not have adjustable desks (Harry, PHE, operational stakeholder)

The compatibility of sit-stand desks with flexible working practices may favourably alter how sit-stand desks are perceived by staff whose work-related attitudes and behaviours are guided by societal trends towards offering staff more flexible work opportunities (Jeffrey Hill et al., 2008). Rather than promoting solely the health-focused justification for how sit-stand desks might contribute to the organisational effectiveness, public health practitioners might more effectively convince employers

of the value of sit-stand desks by expanding the rationale and appealing to wider potential avenues by which sit-stand desks might be beneficial for the organisation.

Financial resourcing considerations that complicate the relationship between sit-stand desks and organisational effectiveness

Cost-effectiveness analyses objectively compare the beneficial (health) outcomes and costs of interventions or policies to determine value for money (Bertram et al., 2016); cited anticipated benefits of sit-stand desk interventions include a reduction in sitting and improved general health and wellbeing. In comparison, return on investment (ROI) is focused entirely on the monetary return associated with investment in interventions. Interviewees identified that evidence of cost-effectiveness and ROI would be required to justify any future investment in sit-stand desks:

> If there is going to be any kind of, *any* kind of investment, in things that invoke a significant cost, there would have to be significant evidence that it would make a substantial difference (Olivia, PHE, workplace wellbeing stakeholder)

> There needs to be definite proof… that any investment internally [on sit-stand desks], you'd get the money back eventually I guess (Samantha, Macmillan, workplace wellbeing stakeholder)

Finn commented, "PHE is all about the evidence base.... employees especially are always like, well what's the evidence base. Because that's what people work with, all day" (Finn, PHE, workplace wellbeing stakeholder). The cultural value of evidence-based practice guides PHE employees' beliefs and behaviour at work. Consequently, the evidence-base was a particularly strong influence on perceptions of sit-stand desks amongst PHE employees. Employee beliefs regarding the potential organisational benefits of sit-stand desks are only likely to manifest as assumptions, and reflect in practices, once they have been empirically validated (Schein, 2010, p. 25). The current dearth of evidence supporting cost-effectiveness and/or an ROI from sit-stand desks (Buckley et al., 2015) undermines the healthy workplace rationale and limits the possibility of wider adoption of sit-stand desks within the organisations.

Interviewees expressed concern regarding a potential negative reaction of employees and the public to the organisation spending money on sit-stand desks. At

PHE, the organisational economic climate influenced stakeholders' attitudes towards spending money on sit-stand desks:

> You have got to take cost into account the organisation is going through a very cataclysmic set of budget cuts. I think 20% budget reduction… I think it would be difficult to argue to replace perfectly functional desks with 600-pound ones (Fiona, PHE, workplace wellbeing stakeholder)

The governmental stipulation to reduce organisational spending incited restructuring, job losses and increased workload at PHE. Reacting to the news of a colleague being repositioned within the organisation, Bridget commented "…that's awful, it's awful, there's so much of it happening, I'm worried I might have to, I think that's why I've got a rotten cold, the stress of it all…" (Research notes, PHE, 19 April 2015). Organisational conditions fostered low need satisfaction, which engendered negative attitudes towards formal employee health provision amongst employees:

> Employees see these [employee health] initiatives as 'add-ons', 'not getting at the root cause', 'putting over a plaster' – so not *solving* the problems inherent within the organisation – long hours, email culture, constant restructuring and job insecurity (Researcher notes, PHE, 25th Nov. 2015)

Spending money on employee health initiatives, such as sit-stands, was perceived by some employees as a feeble attempt to minimise negative impacts on staff wellbeing caused by organisational conditions. This was recognised by stakeholders:

> It would be quite difficult to weigh up if you went for a carte blanche and spent thousands and thousands because… y'know you're in a better place and you work more productively, and yet we're cutting staff…. so, it would be a delicate balance for senior management to actually promote that.... in the current climate (Ivy, PHE, operational stakeholder)

This data concurs with extant empirical literature that suggests that employee wellbeing initiatives are viewed unfavourably by employees if the organisation does not successfully safeguard employees' basic needs (Spence, 2015). Employees' disapproval of organisational actions might negatively impact their work motivation and output. Concern that substantial expenditure on sit-stand desks might exacerbate negative feelings amongst employees towards employee health initiatives engendered a perception that spending money on sit-stand desks is not justifiable.

Interviewees expressed concern that expenditure on sit-stand desks, and media outlets reporting of such expenditure, might negatively influence members of the public's attitude towards the organisation:

> You'd have to be accountable for spending public funds… and certainly as a taxpayer I would be pretty annoyed (Dorothy, PHE, operational stakeholder)

> It [investing in sit-stand desks] must pass the Daily Mail test and you know, we're always conscious that someone will get hold of expenditure of this nature and ridicule it. Erm... and it's very easy to ridicule something without putting it into context and knowing what it's done for and everything else (Aidan, PHE, operational stakeholder)

These concerns were likely exacerbated by the charity and public nature of the participating organisations, as there can be increased scrutiny of spend, and a greater sense of accountability to external stakeholders, in non-profit organisations compared to private organisations (Dhanani, 2009; Milofsky & Blades, 1991). Expenditure that does not clearly contribute towards organisational outcomes, from the perspective of the public, could damage the reputation of the organisation and contribute to a reduction in the number and size of donations (C. Ryan & Irvine, 2012); both negative organisational outcomes. Contextual factors (such as the nature of the organisation or working conditions) factor into, and complicate, the relationship between employee health initiatives and organisational effectiveness, and influence employers' attitudes regarding sit-stand desks.

6.1.2 The *right* thing to do? Ethical dilemmas related to sit-stand desk provision

I think there is a responsibility for employers to care for their employees. Because if you're at work... we're lucky we do about 34 and a half hours [a week]… it takes a lot of time out of your life so you might not have a lot of time to exercise and fit in all of your stuff. So, I think, making that [sit-stand desks] available to people… I think there is a responsibility to do that (Christina, Macmillan, sit-stand desk user)

Challenging the ethics of the healthy workplace model

Employees spoke of an ethical responsibility of the employer for supporting employee health, in part due to the nature of their organisation:

> I think a responsible employer… their core philosophy has to be look[ing] after their employees…. we are Public Health England… it would be wrong if such an organisation would not have that type of philosophy, if we were generating overworked, stressed out people just about to break (Bridget, PHE, sit-stand desk user)

The data highlights a view that employers have a responsibility not to *contribute* to reduced employee health and wellbeing via physical or psychosocial working conditions (Renton, Lightfoot, & Maar, 2011). Within this view, sit-stand desks may

offset potential health risks (i.e. physiological/MSD-related risks) incited by the working conditions imposed by the employer (i.e. desk-based working/prolonged sitting). Positioning organisational strategies which allow employees the opportunity to reduce prolonged sitting as a duty of office-based organisations increases the acceptability of sit-stand desks in office-based workplaces.

However, deeper analysis of interview and observation data illustrate that employees would not expect their organisation to support their health without there also being benefits for the organisation. For example, Cath commented that sit-stand desks to support employee health are "the *right* thing to do" yet later remarked that "businesses are businesses, and they look at the bottom line" (Cath, Macmillan, operational stakeholder). The underlying corporate motives question whether supporting employee health should be positioned as being socially responsible (Holmqvist, Företagsekonomiska, Stockholms, & Samhällsvetenskapliga, 2009), and interviewees recognised that employee health initiatives *can* be used in ethically dubious ways. For example, Finn described attempts of "tech[nology] companies" to, in his view, overtly regulate the behaviour of their employees. Discussing a recent visit to one such technology company, Finn described how "everything you need is within the building so you never need to leave. They have a gym, they have breakfast, they have everything. Food all day basically. So, they keep them there…. terrible" (Finn, PHE, workplace wellbeing stakeholder). In addition, there was a feeling amongst the workplace wellbeing interviewees that *imposing* health behaviours on employees represents an abuse of the organisations' power. Regarding employee eating habits, Jayne remarked "why should we be prescriptive with people about what they do in their own time, what they put in their mouth… we haven't got a right to do that" (Jayne, Macmillan, senior leader/workplace wellbeing stakeholder). Rather, interviewees expressed a belief that the organisation should be supportive of health by not restricting, but equally not enforcing, health behaviours amongst employees. Annabel envisaged this involving "putting things out on a plate that's right in front of people, so if you are up for it, then it's really easy for them, but if they don't want to, that's okay too" (Annabel, PHE, workplace wellbeing stakeholder). Accordingly, interviewees perceived that employees should be given a choice regarding their desk (i.e. whether it is a conventional seated desk or a sit-stand desk). Dorothy commented that the decision to use a sit-stand desk "should

come from the bottom up, because otherwise it is almost being imposed on people" (Dorothy, PHE, operational stakeholder).

Underlying corporate motives raise the issue of employee health initiatives as a means for the organisation to - wittingly or unwittingly - manipulate and control employees' health-related attitudes and behaviour (Haunschild, 2003; Vander Schee, 2008). In the present study, such concerns reduced the suitability of providing sit-stand desks for all the organisations' employees. However, offering employees the choice of a sit-stand desk or seated desk was considered an appropriate strategy, as interviewees felt that such an approach increases employees' capacity for agency over their health behaviours at work. Nevertheless, this view has been challenged in the literature, given the moral connotations of, and virtues (e.g. discipline, self-responsibility) connected to, health behaviours (Petersen & Lupton, 1996; Verdonk, Seesing, & de Rijk, 2010). Placing value on employee health can lead to the development of a normative power which may compel individuals to partake in healthy behaviours and workplace initiatives (Goss, 1997; Zoller, 2003), even when participation is construed as voluntary by the organisation. Thus, societal values, recognised within the outermost layer of most forms of the SEM; see Figure 6.1, may contribute to a negative perception of sit-stand desk installation amongst organisational stakeholders.

6.1.3 The *viable* thing to do? Processes influencing the implementation of sit-stand desks within organisations

I think they [PHE] need, also, the practical side of it, the evidence of how these [sit-stand desks] can be integrated within the workplace, that it's appropriate for that organisation…. I guess it's about the practical application evidence as well as the actual evidence of health benefits that has to be demonstrated (Faye, PHE, workplace wellbeing stakeholder)

The commitment and capacity of relevant employees to installing sit-stand desks

To deliver the sit-stand trial, initial interest in sit-stand desks from a senior employee capable of gaining organisational approval was required. Stakeholder employees' accounts also revealed that the feasibility of sit-stand desk provision depends on the organisation having a dedicated staff member with capacity and

commitment to lead the installation, supported by employees from relevant teams, including health and safety, facilities, occupational health and human resources:

> Where would be the natural home? Would it be facilities? Would it be occupational health? Would it be human resources?... which team would be most appropriate to deliver and support this? So, it doesn't become a Pilates ball - an expensive Pilates ball - pushed in the corner. Facilities may only be tasked with setting the desks and moving desks around… Communicating how people benefit, somebody else might have to do this (Violet, PHE, workplace wellbeing stakeholder)

A lack of commitment of key teams reduced the feasibility of installing sit-stand desks within PHE. Conversely, a clear understanding of, and dedication to, fulfilling project requirements was instrumental to the ease of installation at Macmillan:

> I have been trying to get approval to remove the monitor stands, to allow the sit-stand desks to be installed, for three months! I have sent the same email so many times, but it just goes around in circles… no-one is taking ownership of the tasks (Research notes, PHE, 5th Sept. 2015)

> My role has been to liaise with you guys to make sure we've got the right areas for people to have [sit-stand] desks… to be the point of contact for Ergotron to come in and to deliver the right kit and for them to know where they're going to install it all. And also, being responsible for making sure that the kit actually fits into the spaces…it just seemed quite organised… and it was all fine (Jim, Macmillan, operational stakeholder)

Stakeholder interviewees' accounts revealed that the perceived capacity to dedicate time to sit-stand desk installation influenced attitudes related to assisting with the delivery of the project. Katie stated that the proportion of her work hours that she dedicated to the project was "between a fifth and a quarter… it hasn't been *too* much" (Katie, Macmillan, operational stakeholder). Her commentary indicated that the incorporation of the project into her job role enabled her to prioritise the installation of the sit-stand desks. Conversely, those with less capacity were more likely to express frustration regarding installation-related tasks:

> I thought 'What? I'm ordering leads? Really? How daft!... I am trying to organise huge training events and get across the country to do them, and I'm ordering IT leads… those sorts of things are seemingly petty… but for us… it's about how easy is it for an organisation to include these [sit-stand desks], well actually it is quite difficult because you need to think about all these other bits and pieces (Faye, PHE, workplace wellbeing stakeholder)

Organisational restructuring, and the nature of organisations' structure, influenced the capacity and commitment of employees to support the project. Many employees involved in the installation could not offer *sustained* commitment due to their job

roles changing because of ongoing restructuring processes: “Key staff in the installation process keep getting re-deployed so the contact person is changing constantly…it is a little bit of a logistical nightmare…” (Research notes, PHE, 5 Sept 2015). The lack of consistent support from PHE employees reduced the ease of installation. In addition, the extent of centralisation within the organisation - a key element of organisational structure which guides operations (Nooraie, 2012) - shaped employees’ commitment to the installation of the sit-stand desks:

> [Team manager] flew back from his holiday today… I can sense that his team have been looking forward to him coming back, as the list of things that they need to get his approval for has been building up, which is holding up their work. I am in the same boat with wanting to find out whether the demo desk can go to Macmillan (Research notes, PHE, 9th Dec. 2014)

> [At PHE] there were four or five people that needed to be making the decisions whereas, at Macmillan, it felt like once we'd got… the higher-level people on board it was just handed down to Jim…. And I guess one person is easier to deal with than multiple (Ben, Ergotron stakeholder)

Centralisation refers to the extent to which decision-making authority is reserved for senior leaders (high centralisation) or permeated through all levels of the organisation (low centralisation) (Fredrickson, 1986). Macmillan has a less centralised structure than PHE, as continued and extensive involvement with technical aspects of the installation was required by fewer employees from different teams, which enabled one key employee to commit to assisting the delivery of the project. This increased the ease of the sit-stand desk implementation at Macmillan compared to PHE.

Observations revealed that employee time required to support the installation of sit-stand desks depended on the degree of formalisation (Nooraie, 2012); a feature of the organisational structure which refers to the presence of rules, policies and procedures that stipulate organisational operations and decisions (Pertusa-Ortega, Zaragoza-Sáez, & Claver-Cortés, 2010). PHE has a formalised organisational structure, having produced various internal policy and procedure documents on matters ranging from procurement to organisational change, and I heard employees comment, on multiple occasions, that they were “just following the rules” (Research notes, PHE, 4 Dec 2014) when they were displeased with an action or statement they felt compelled to make. Procedural necessities challenged the efficiency of the sit-

stand desk planning and installation processes at PHE. For example, form-filling requirements almost led to the postponement of the installation:

> PHE told us last week that we have to complete a RAMS (Risk and Method Statement) form. I was a little frustrated as the form is lengthy and contains elements that seem tangential to installing sit-stand desks. The install is due to take place next week, and if Ergotron are unable to complete all elements of the form by then (all their employees are away at their annual general meeting), estates and facilities at PHE have said that no work can take place on site (Research notes, PHE, 11th Jan. 2015)

A concept interlinked with formalisation is organisational (bad) red tape, which has been described as a "bureaucratic pathology. Organisational (bad) red tape refers to instances when formalised rules and processes designed to increase efficiency actually contribute to *in*efficiency in new or non-standard situations (Bozeman & Scott, 1996, p. 3). In the present study, a higher level of formalisation and red tape at PHE was found to impede the efficiency with which tasks connected to the sit-stand installation, a non-standard situation, could be completed. High formalisation limits decision making discretion (Fredrickson, 1986), which led PHE employees to strictly adhere to procedures which may not be wholly necessary, or indeed adequate, for sit-stand desk installation. Conversely, a less formalised structure at Macmillan enabled the swift completion of tasks related to the project delivery. The amount of time that employees can dedicate to sit-stand desk installation is finite; employees must manage and prioritise time spent on the project within the context of competing responsibilities, tasks and deadlines (Claessens, van Eerde, Rutte, & Roe, 2007; Gonzalez & Mark, 2004). Consequently, the findings indicate that a less formalised organisational structure positively influence employees' experiences of implementing sit-stand desks within the workplace.

However, Macmillan indicated that low levels of organisational structural formalisation can have negative implications for organisational efficiency:

> I know some organisations... just have very good processes, and people are important but not critical, so people coming in new would be able to pick it up very quickly. But we, we are not so systematic… we have become dependent on people… often when people leave you think 'there's two years' knowledge gone out of the wind' (Simon, Macmillan, senior leader)

Rather than following set procedures, relevant employees made key decisions regarding the sit-stand desk installation at Macmillan, which may reduce the ease of

future implementation of sit-stand desks if key employees were to change. The extant literature indicates that highly formalised structures *can* improve efficiency, and one condition linking formalisation with efficiency is task repetition (Bozeman & Scott, 1996). Thus, if sit-stand desk provision became more routine within PHE, organisational scrutiny and learning might trigger the adaptation of current procedures or development of new policies and procedures to suit tasks (DeHart-Davis, Chen, & Little, 2013). That is, more formalised organisational structures may be associated with increased efficiency of sit-stand desk implementation over time.

Communication between relevant parties

Close and open communication amongst the various parties involved was critical to the effective planning for and implementation of the sit-stand desks. Katie commented that "having a close relationship between us has helped everything run its course really well" (Katie, Macmillan, operational stakeholder), thus, effective communication positively influenced employees' perception of the feasibility of installing sit-stand desks. One explanation for the effective communication at Macmillan is the small number of key employees that were involved in the technical aspects of the sit-stand desk installation, which may have made close and open communication more manageable. A contextual factor that impacted communication effectiveness at PHE was the ongoing organisational restructuring. The restructure involved many existing employees leaving, or changing roles within the organisation, and new employees being brought in on "short, fixed-term contracts" (Research notes, PHE, 18 Dec 2014). The extent and speed of change led to ambiguity amongst employees regarding other employees' job roles and the composition of the organisations departments and teams:

> He [PHE employee] made a comment to his colleague that he couldn't remember the name of a particular work stream, and his colleague replied saying "no wonder, there's so many of them, there will probably be double by the time I come back from leave" (Research notes, PHE, 7th May 2015)

> I asked Violet who to speak to and she asked Laura for an IT contact, but Laura says that she doesn't know anyone in IT so will have to log a request… Violet kept referring to her lack of experience and knowledge of PHE… and how everything links together (Research notes, PHE, 5th Sept. 2015)

These findings are consistent with taxonomies of organisational uncertainty, which posit that employee uncertainties regarding the organisation structure, such as the

function and composition of different teams, arise following organisational structural change (Bordia, Hobman, Jones, Gallois, & Callan, 2004). Ambiguity resulting from organisational change was, in part, responsible for communication barriers between PHE employees involved in the sit-stand desk installation process.

Sit-stand desk-workplace compatibility

The compatibility of the sit-stand desks with the office environment influenced the feasibility of sit-stand desk provision. Amongst other compatibility issues, the installation of some sit-stand desks required adaptations to be made to the organisations standard equipment, such as "sawing a curve into two desks to enable the sit-stand desk to be securely attached" (Research notes, Macmillan, 25 Oct. 2014) and the sit-stand desks did not include a power socket, which is a necessary requirement for PHE employees to power their laptops.

The lack of compatibility of certain aspects of the sit-stand desks with the workplace environment led to some unexpected costs for the organisation, which restricted the feasibility of the sit-stand desk installation. For example, it became evident that it was necessary for the organisation to purchase longer cables to ensure that desk equipment could be powered when the desk was raised. The sit-stand desks were not compatible with some of the original desk equipment at Macmillan, which led to unexpected time demands placed on some operational employees when sit-stand desk users required their desk to be relocated within the office; "when I asked [Susan] if she'd had chance to have a look at moving Steph's sit-stand desk to her new location, she said not yet, that she'd been "bloody busy this week to be honest" (Research notes, Macmillan, 20 Feb. 2015). These unexpected cost and time demands challenged the perceived feasibility of sit-stand desk provision within the office-based workplace.

The need to make adaptations to organisational equipment to accommodate the sit-stand desks also negatively influenced interviewees' attitudes:

> … it seemed as though they [sit-stand desk supplier] thought that PHE should adapt to be able to use that desk, rather than the desk working for us … and I think that is something that needs some thinking about, otherwise you are going to start off with already some negative thinking… it just seemed quite cumbersome and difficult" (Faye, PHE, workplace wellbeing stakeholder)

However, most interviewees described compatibility, and interrelated time and cost barriers, as surmountable. For example, Harry described unexpected challenges through the installation process as a "learning exercise in understanding the scope of what's required… not an obstacle" (Harry, PHE, operational stakeholder). Experiences of sit-stand desk installation in the present study permit a greater appreciation of the wider factors to consider when planning to install sit-stand desks, including careful consideration of which sit-stand desk products best meet the needs of the organisation, and the approximate employee time and costs that are required to install sit-stand desks and provide ongoing support for sit-stand desk users.

This section has considered the implications of organisational discourses on the feasibility and acceptability of planning for and implementing sit-stand desks in office-based workplaces. Perceived organisational benefits, the organisational context and occupational identities, ethical issues, and factors related to the delivery process were illustrated as being instrumental in shaping views regarding sit-stand desk provision from an organisational perspective. The next section discusses findings based on employees' lived experiences of the sit-stand desk intervention.

6.2 Sit-stand experience: Processes that restrict and facilitate sit-stand desk use

The physical and emotional experience of using a sit-stand desk influences feasibility and acceptability and reveals barriers and facilitators to desk use. This theme explores the ways in which aspects related to the design of the sit-stand desk and how employees utilise it (6.2.1), employees' expectations and outcomes related to health and productivity (6.2.2) and organisational culture and interpersonal relationships (6.2.3) influence employees' experience of using a sit-stand desk.

6.2.1 Employees' relationship with their sit-stand desk

You've got your keyboard in front of you and then you've got another piece [tray component of the sit-stand desk], obviously, I was putting stuff on there, the more you put on it, it actually starts to affect the mechanism doesn't it. Mine kept dropping, and I think it was... basically it was my fault, and it's kind of operator error, of putting too many... too much weight on it. So, I've stopped doing that, and of course it was alright [stopped dropping] (Joan, PHE, sit-stand desk user)

Sit-stand desk design and usability

Design features, which varied between sit-stand desk models, influenced participants' experience and use of the desks. Sit-stand desk users could choose between two versions of sit-stand desk: (1) a platform that attaches onto a seated desk (workfit-A), or (2) a full sit-stand desk (workfit-D); see Figure 6.2.

Figure 6.2. *Depiction of Ergotron Workfit-A (left) and Ergotron Workfit-D (right)*

Whilst some employees thought the sit-stand desks were aesthetically appealing, others were dissatisfied with their appearance. Cristina commented that the workfit-D "just felt really old fashioned… clunky and just quite plasticky, metally… cheap" (Cristina, Macmillan, sit-stand desk user). However, most employees preferred the appearance of the workfit-D to the workfit-A. Steph commented, "the second one [workfit-A] looks like a bit of a crazy transformer as well, I don't know if it's a bit more medical looking, yeah... just cos it's a big kind of robotic thing whereas the other one [workfit-D] was basically just a desk (Steph, Macmillan, sit-stand desk user). Product design literature asserts that aesthetic experience comprises aspects of pleasure, meaning and emotion (Hekkert, 2006). Some employees considered the workfit-A to be aesthetically displeasing as it did not conform to their expectations of what a desk should look like; the desk was symbolised as non-standard and peculiar. The look and feel of the desks elicited emotional reactions amongst employees, which influenced their attitudes towards using them. For example, Steph assigned the two desks opposing personalities; "The first one [workfit-D] is friendly and the second one [workfit-A] is a bit more like, mean" (Steph, Macmillan, sit-stand desk user). Employees preferred a more standard looking desk, which led to the evaluation of the workfit-A as more aesthetically harmful than the workfit-D.

The ease with which desks could be used was significant in shaping participant's views of their feasibility. Interviewees described the procedure for transitioning the desk between positions suitable for sitting and standing as efficient and user friendly. Caroline voiced that "it was just very simple, lift it up when you stand up and bring it down when you sit down… it's very simple to operate" (Caroline, Macmillan, sit-stand desk user). However, other aspects related to the sit-stand desk design including the size of the desk, instability of the keyboard tray (workfit-D), and the size and instability of the work surface (workfit-A), impeded use of the sit-stand desks for completing work effectively and efficiently:

> I really, really hate the size of the desk [workfit-D], it could just be because I'm used to having a really big desk but… you can only have like two bits of paper and your phone and I think its significantly smaller than the other one [original seated desk]. And also… the key board is placed, it's really low, so I have to put the keyboard on the desk (Anita, Macmillan, sit-stand desk user)

> The only thing was that it [workfit-A] bounced quite a bit… not quite feeling like a firm table. That was another one of the reasons why I thought maybe the table [workfit-D] would have been better (Sean, PHE, sit-stand desk user)

Design literature indicates that the perceived usability of a product, which incorporates efficiency, effectiveness and ease of use, strongly shapes employees' attitudes towards the product (Desmet & Hekkert, 2007). The ease of transitioning the desk for sitting and standing positively influenced employees' acceptance and use of the sit-stand desk. Whilst the central purpose of sit-stand desks is reducing sitting and encouraging movement, it must also support employees to complete tasks by providing a flat and sufficiently large surface to place and utilise objects that are fundamental to the completion of those tasks, such as a computer and papers. Consistent with previous empirical research (e.g. Dutta et al., 2014; Graves et al., 2015) the findings indicate that design features including the sit-stand desk size and instability hinder the ease of use and effectiveness of the desks for supporting completion of work. These issues reduced the feasibility of using the sit-stand desk for completing work compared to employees' original seated desk.

The impact of using the sit-stand desk on employee experience

Users' experiences of the sit-stand desk were affected by their own practices. For example, employees who put more pressure on the keyboard when typing reported that the workfit-A surface felt unstable, which reduced the ease of use:

> The biggest issue (in Craig's opinion) is that the arm moves down whilst people are typing! He says that the workforce at PHE is quite 'old' and they 'don't have many people that did GCSE ICT' and so they 'prod' the keys heavily, which is probably putting quite a lot of weight on it, and exacerbates the issue of instability (Research notes, PHE, 5th Sept. 2015).

Employees that expressed a preference or requirement for working with hard copies of documents - rather than electronic versions - were more likely to identify the size of the desk as an issue. Conversely, PHE employees were less likely to note the desk size as a limitation due to the enforcement of an organisation-wide clear-desk policy:

> [I thought] Oh my God, that's so small *laughs*… when I realised how small it was, I was a bit freaked out… like I've got so many papers, and different things so I need more space… it's the way I prefer to work, but yeah, I do think that as an assistant you tend to have more papers (Carol, Macmillan, sit-stand desk user)

> I have a bit less space on the desk… I think that's a benefit, because it does make you… you can't hoard things… I mean, having that smaller working space on the desk…. I am conscious of having a cleaner desk (Melissa, PHE, sit-stand desk user)

Some employees were willing to adapt the way they work; for example, by finding an alternative space to work when a larger desk space was required, or using fewer papers on the sit-stand desk surface. Additionally, some employees could mentally overcome sit-stand desk design issues, which improved their sit-stand experience:

> I've had to adapt the way that I work [to the smaller desk size], so I won't spread things out… [or] if there's a quiet room I've gone and done that there (Nadia, PHE, sit-stand desk user)

> It's about being adaptable isn't it. You can either carry on moaning, and I had my whinges… [but] I'd rather be able to have the option of being able to stand… so I'm pleased I persevered, I would have really regretted it otherwise (Carol, Macmillan, sit-stand desk user)

Conversely, other employees were unwilling or unable to adjust their working style to improve the ease of working at the sit-stand desk, which resulted in sit-stand desks being considered impractical. One employee withdrew from the study as she was unable to adapt to her sit-stand desk:

> I purposely gave it sometime, thinking... I'm gonna get used to this. You know, because you can get used to anything...in the end. But, it wasn't like green tea, I got used to green tea, now I like it. But it… it didn't get any better for me. I got used to it in terms of I wasn't swearing at it anymore, but

> it wasn't like I got used to it and thought actually I quite like this. It was never gonna be like that (Cristina, Macmillan, sit-stand desk user)

Employees that placed value on their health were less likely to succumb to barriers to using the sit-stand desk to stand:

> When I asked how his colleagues reacted to the sit-stand desk, he said some people have commented that his desk slightly restricts access to a meeting space, then he said, 'but that's an issue to them not me, my desk and my health is more important' (Research notes, Macmillan, 2nd Oct. 2014)

> She told me that she wore her winter boots yesterday and that they have a slight heel, and that she found that she couldn't really stand for long with them on as it wasn't very comfortable. So, she said that she would not wear them anymore, she is altering her wardrobe to be suitable for the sit-stand desk as she wants to stand more and takes her own wellbeing incredibly seriously…. so, she will sacrifice things to be able to do that (Research notes, PHE, 4th Nov. 2015)

Standing at the desk was prioritised over multiple issues that arose from using a sit-stand desk amongst employees that voiced strong health motives for reducing sitting. In agreement with extant literature (e.g. Grunseit et al., 2013) valuing health was associated with sit-stand desk acceptance and use.

Employees described different strategies that they adopted to encourage regular postural change at the desk, including task-based (choosing to stand for some tasks and sit for others, or changing posture following the completion of a given task), bodily cues (switching position upon experiencing physical discomfort or mental tiredness) or time-based (changing posture after a given length of time, or standing at certain times of day):

> If I've got a report or if I've got a big chunk of emails…In my diary I would, I wouldn't put sit-stand, but for me I knew…. For me it seems to be more around the types of work. That seems to be sticking more for me (Melissa, PHE, sit-stand desk user)

> Like this morning, I started at half past 8, standing up, but after a couple of hours I do tend to get tired, and then I'll just sit down (Caroline, Macmillan, sit-stand desk user)

> I would do an hour or two in the morning, and then sit down, and then again in the afternoon before I go home I would do an hour or two hours (Brett, PHE, sit-stand desk user)

Aspects related to the desk design and organisational context influenced the feasibility of different strategies for encouraging use of the desk. For example,

employees whose roles require them to frequently work with lots of paper were more likely to exhibit a task-based strategy and stand when multiple papers were not required, given the difficulty of standing and working with paper. Caroline commented, "using your arms to sort of hold the papers up for half an hour, it could be a bit tiring, so it just feels a bit more comfortable to sit down and have it in your hands" (Caroline, Macmillan, sit-stand desk user). Thus, whilst three main strategies (task-based, bodily cues, time-based) were adopted to facilitate frequent postural change, there is no most effective strategy as sit-stand desk users indicated different preferences depending on their unique experiences and work context. Extant literature has also reported that employees utilise different techniques to prompt themselves to change posture at the desk (Dutta et al., 2014; Graves et al., 2015).

These examples of factors that influence employees' relationship with their sit-stand desk provide empirical support for design theory which postulates that product experience represents an interaction between the product and the user within a particular context (Hekkert & Desmet, 2007; Sanders, Stappers, Visser, & van der Lugt, 2005); it is wider and more nuanced than the user's perception of the product. The user, product and context are not fixed and separate but rather there is a relationship between them which signifies product experience (Chamorro-Koc, Popovic, & Emmison, 2009). In the present study, people's actions and experiences were influenced by the desk features (e.g. size, stability) and organisational context (e.g. organisational policies, job-related tasks). However, some employees, notably those that prioritised their health, could overcome such limitations by adapting their environment and the objects within it to improve their experience of using the sit-stand desk. These findings provide empirical support to the SEM, introduced in section 2.4.2, as they indicate that a variety of complex and overlapping factors at the individual, environmental and organisational level shape employees' emotional and behavioural response to sit-stand desk provision and use. See Figure 6.1 for an illustration of how the factors identified within the employee experience sub-themes map onto the SEM.

The next section provides a narrative account of how employees' expectations and experiences related to the impact of sit-stand desks on their health and productivity restrict and facilitate sit-stand desk use.

6.2.2 Aspirations and outcomes related to employee health and productivity

I think just being able to sometimes, particularly when energy is flagging throughout the day, and say there has been a lot of sitting in meetings… I enjoy [standing]. It's not even about 'am I mitigating my risk?' It's not. At that point when it's four o clock and everybody is flagging and getting coffee, I can just move, I can mix it up and I can move and stand (Melissa, PHE, sit-stand desk user)

Sit-stand desks and employee health

Most employees that volunteered to participate in the sit-stand desk trial expressed a desire to use a sit-stand desk to reduce prolonged sitting to prevent or manage occupational health issues. The occupational health concerns that employees voiced were primarily musculoskeletal. Some employees had experienced MSD in the lower body and back that they attributed to sitting at the desk, or voiced that existing health issues, including a shoulder injury and artificial hip, were aggravated by prolonged workplace sitting. Other participants had not experienced occupational health problems, but were wary of risks associated with prolonged workplace sitting:

> I've had a shoulder injury from years ago and I've been having physio and they mentioned that if I could ever get a stand-up desk… that it would be really ideal because you're sitting in a very straight position otherwise at your desk a lot (Steph, Macmillan, sit-stand desk user)

> My mums got a bad back and other members of my family… I'm going to be susceptible to it, and then not make it any better myself through the way that I sit… [so] I thought maybe actually by standing up, I would get some health benefits out of that (Grace, Macmillan, control group)

In practice, using a sit-stand desk led to a variety of physical responses, including increased and decreased MSD. Employees that experienced MSD because of, or exacerbated by, prolonged workplace sitting tended to report that using the sit-stand desk reduced discomfort. For example, Nadia commented "when I'm standing it's made a big difference [reduced back pain]. It's really, really improved. I mean noticeably improved… Immediately it's sort of made me more aware of my posture" (Nadia, PHE, sit-stand desk user). Conversely, those that did not report pre-existing occupational health issues were more likely to experience MSD when standing:

> After long periods... I mean it sort of goes all the way up your back, this bit of strain… and not in a good sense, like when you've been doing lots of PA and it's a good strain and a good aching… that was uncomfortable, I found…

> I thought maybe standing up would be, would be better (Sean, PHE, sit-stand desk user)

> I've been getting a pain in my calf, which was weird… and I hadn't expected that, but probably I think it was that I was standing for so long without moving. I mean now I at least try doing some movement within my ankles and my feet during those standing periods… but yeah, it was three, four hours and it was quite fatiguing (Melissa, PHE, sit-stand desk user)

The physical responses to standing at the desk influenced subsequent use; reduced MSD prompted regular use whereas increased MSD negatively influenced employees' sit-stand desk use. Physical responses reflect an individual-level influence on behaviour consistent with the SEM; see Figure 6.1. The findings illustrate that physical discomfort can be caused by standing statically for too long, which concurs with review-level evidence that prolonged workplace standing can lead to adverse health outcomes including MSD (T. Waters & Dick, 2015). A recently published expert statement recommends that employees avoid prolonged, static standing postures (Buckley et al., 2015). However, there is a perception amongst the public that this recommendation is unclear and contradictory when positioned alongside guidance to use a sit-stand desk to reduce prolonged sitting (Gardner, Smith, et al., 2017). Similarly, employees in the present study did not act upon the regular postural switching advice given during the sit-stand desk ergonomic assessment, which led to the occurrence of MSD and negatively influenced some employees' experience.

Despite physical health concerns being the primary driver, some employees also referred to the potential *physiological* health risks of high levels of, and uninterrupted, sitting as a reason for wanting to use a sit-stand desk to reduce sitting:

> Having had that sort of, um, knowledge about it, the actual impact of sitting for several hours, being inactive... All that that potentially does to the inflammatory response system that then sort of made me think I need to be standing (Nadia, PHE, sit-stand desk user)

Caroline commented that she was interested in the concept of sit-stand desks, as she "had become aware that sitting all day isn't particularly good for you, I've read stuff in the media about the negative effects on your health from sitting a lot and being sedentary" (Caroline, Macmillan, sit-stand desk user). The publication of workplace sitting guidelines has received substantial media attention (Gardner, Smith, et al., 2017), alongside various national campaigns to increase awareness of the health risks

of sitting (Knox et al., 2015). Previous literature has reported some (C. Waters et al., 2016), and little (Biddle et al., 2017) awareness amongst office-workers regarding the potential health risks of sitting. It is plausible that the time-period during which data were collected influenced employees' awareness; Biddle et al. (2017) collected data from 2010-2013 whereas the data reported by C. Waters et al. (2016), and in the present study, were collected throughout 2014 and 2015. The recent proliferation of evidence and knowledge exchange regarding the potential health risks of sitting is likely to positively influence employees' attitudes towards using sit-stand desks to reduce and break up sitting.

There was also a lack of prior awareness, and confusion amongst employees surrounding the risks of prolonged sitting *independent* of PA. For example, during a telephone conversation as part of the multicomponent intervention, Melissa voiced that "she was shocked to hear that sitting may be bad for you regardless of how active you are outside of work… she told her colleagues and she said they too were quite alarmed to hear that" (Research notes, PHE, 18 Dec. 2014). Other employees did not value reducing sitting per se, but rather reducing sitting was viewed as beneficial in the context of increasing PA:

> You're not necessarily being active by doing it [standing at a sit-stand desk], but you know, it's a start isn't it… but I think what I might find more beneficial was being able to move while we work and these sort of, it's a stupid expense, unfortunately, it's very expensive but the treadmill desks… if you're able to move rather than being static (Sean, PHE, sit-stand desk user)

Such commentaries are illustrative of a general lack of clarity and understanding amongst office-workers regarding the distinction between sitting and inactivity and the associated health risks, which is unsurprising as many national marketing campaigns conflate reducing sedentary behaviour within increasing MVPA (E. Knight, Intzandt, MacDougall, & Saunders, 2015). Employees primarily viewed sit-stand desks as a tool to facilitate workplace sitting reduction but not to increase PA, which weakens the value employees place on using sit-stand desks to prevent physiological health issues.

Sit-stand desks and employee productivity

Employees varied in whether they felt the sit-stand desk allowed them to be more, equally, or less productive in work. For example, some employees found they

were better able to concentrate when standing compared to sitting, and reported that standing increased their energy and alertness, which had a positive effect on work:

> If I'm feeling a bit fatigued, once I stand I feel more alert. So, if I've got written work to finish, that [standing] really does help me and I think it does give me that impetus [to complete work] (Melissa, PHE, sit-stand desk user)

Other employees, however, reported that they found standing more distracting than sitting, which had a negative impact on their work efficiency:

> I'm defaulting to sitting down more now. Um, I think that's mainly because of the, certain pieces of work I've been doing require concentration… it's easier to concentrate sitting down (Sean, PHE, sit-stand desk user)

> Everybody was coming over, 'Oooh you're standing'… so I could be standing for an hour and I'd have at least 4, 5 people having a 5-minute conversation with me so then it was like, well… no work is done, and you just pick up a lot of noise and movement when you're standing. It's really weird... I think when I'm not busy I can stand because then you know I don't mind the distraction (Anita, Macmillan, sit-stand desk user)

Extant literature has also reported mixed employee views regarding the relationship between sit-stand desk use and productivity (Grunseit et al., 2013). The impact of using a sit-stand desk on work productivity was a particularly salient issue as employees universally described an organisational norm of intense work and maximising productivity. Macmillan employees' desire for efficiency was driven by an internal motivation to support people affected by cancer, whereas PHE employees' high workload stemmed from governmental cost-saving measures:

> I just think they're so intense in what they do…. people genuinely enjoy working hard for Macmillan. A lot of it is about giving something back, like we all have a cancer story… (David, Macmillan, operational stakeholder)

> We're still in the process of going through a restructure and that kind of stuff - and everyone, some of us have done the job of two or three people so you're so focused on coming to work, doing your work, doing as much as you can and go home (Brett, PHE, sit-stand desk user)

One participant described dropping out of the study due to a detrimental impact of the sit-stand desk on her ability to work:

> I would've liked to have been able to continue doing sit-stand. But I couldn't work in that space… and I think the space takes privilege over being stood up. I was really pleased, I mean really pleased seriously when I got my old desk back. I was like, wow, I can really feel the difference, I'm just working a lot better because of it (Cristina, Macmillan, sit-stand desk user)

A recent systematic review of studies using quantitative measures of productivity concluded that there is no influence of sit-stand desk use on productivity (Karakolis & Callaghan, 2014), however measuring productivity is complex; see section 3.2.2. The findings from the present study support the proposition that there is no overall positive or negative impact of standing at a sit-stand desk on productivity *across* employees. However, the findings do indicate nuance and complexity *amongst* employees; employees had unique experiences related to the impact of sit-stand desks on productivity, which were contingent on how they interacted with the desk and the organisational context. Given the strong organisational norm of maximising productivity, the influence of using the sit-stand desk on work efficiency was strongly associated with sit-stand desk use; employees chose to stand more if they felt standing has a positive impact on productivity, whereas a reduction in productivity prompted employees to stand less, and in some instances deterred employees from using the sit-stand desk at all.

The next section situates employees' sit-stand experiences by examining cultural and interpersonal factors that restrict and encourage sit-stand desk use.

6.2.3 Workplace culture, interpersonal relationships and social change

One attendee was particularly negative about the whole thing [sit-stand desk project]. He made comments such as 'if everyone around the people with the [sit-stand] desks are sat, wont this just mean the people with the desks sit too as they're in the habit of it and there is nothing to break that habit – see you don't need to spend the £20 000' (Research notes, PHE, 23rd June 2014)

The influence of workplace culture on sit-stand experience

The present analysis positions organisational culture as a guiding influence on employee health-related behaviour, and draws on cultural models, described in section 3.1.2, that cite assumptions, values, artefacts and symbols as domains of cultural manifestation (e.g. Dauber et al., 2012). In addition, cultural and organisational cultural influences on behaviour and health are recognised within most SEMs; see Figure 6.1. Observations of working life at the Macmillan and PHE offices indicated that both workplaces are sedentary environments. Employees described being personally "seated in one position for 8 hours a day, 9 10 hours a day" (Brett, PHE, sit-stand desk user), and described the office environment as "a

sea of sitting" (Anita, Macmillan, sit-stand desk user). Employees spoke of being compelled to sit at, and limit breaks from, the desk:

> Nobody makes people do it [sit and work through lunch]. I suppose there's always the subtle peer pressure of... people... if that's what everyone - you know - if you're new, and you have a very strong view that you should have between one and two [o'clock] off, cos you're entitled to it, but nobody else did, I'm sure that'd be very very hard to maintain, yeah? it's a... I suppose - a strong workplace code (Joan, PHE, sit-stand desk user)

> I signed up for the gym downstairs in January [six months before interview]. I haven't used it. Because I'm here and working constantly. The workload is so intense… you sit down, and you carry on and before you know it it's four o'clock… I haven't had lunch [today] either. It's what, quarter to five? It's just finding the time Jennifer (Nadia, PHE, sit-stand desk user)

The pursuit of employee productivity and organisational success is a taken-for-granted characteristic of most organisations, and guides organisational operations (Piggin, 2015; Such & Mutrie, 2016). Section 6.2.2 indicated that Macmillan employees' personal investment in supporting people affected by cancer, and governmental pressures to reduce spending resulting in increased workload for employees at PHE, perpetuate cultural assumptions regarding maximising productivity. As such, employees were compelled by a normative power to limit breaks from the desk for fear of being perceived as unproductive by their colleagues:

> When you're managing your own time... when you've got work that needs to be done… it [taking a lunch break] can look like, 'we've got loads to do, why're you going off for an hour'?... or if you said, 'I'm really stressed, I'm really busy' and then went off for 10 minutes, they would be like, 'what are you doing' (Grace, Macmillan, control group)

The data illustrates that office-based employees conflate productivity with sitting at the desk. Hence, valuing productivity perpetuates cultural beliefs and behaviours related to workplace sitting. Contrary to research evidence that taking short breaks from work activities can facilitate *increased* productivity (e.g. Henning, Jacques, Kissel, Sullivan, & Alteras-Webb, 1997; E. Hunter & Cindy, 2016), employee discourse symbolises taking breaks as time-wasting. The amalgamation of work prioritisation values with worker autonomy (i.e. employees being responsible for managing their own time) can invoke employee behaviours such as working long hours without breaks.

Interviewees also described how the physical environment (seated desks and meeting tables), work tasks (desk based, computerised, dependence on email), and leaders' behaviour reinforced shared values regarding being present at the desk:

> The work environment [is oriented] around the functional things like your computer and your telephone... In the olden days people would have got up, they would have had to go to a filing cabinet, they... do you know what I mean? It's all - I mean - when I first started working I would spend time going and getting journals from a library. So, you'd physically go to a library... now, you just click on something [on your computer] ... so you're sat the whole time (Bridget, PHE, sit-stand desk user)

> Generally, I'm here before 9 and I leave after 5 and I don't take a lunch break… I see my director pretty much at her desk a lot of the time. So, it [the predominance of desk-based sitting] is kind of because of the culture almost (Samantha, Macmillan, workplace wellbeing stakeholder)

The presence of seated desks and computerised work tasks, and employee adherence to social and behavioural rules implicit within such physical objects and work activities, contributed to the reproduction of sitting at the desk at work as an organisational cultural assumption. In the context of the present study, doing and being at work centred around sitting at the desk. Such cultural norms regarding being permanently present at the desk, led employees to express positive attitudes towards sit-stand desks, compared to other potential strategies to reduce workplace sitting:

> Having the [sit-stand] desk would allow me to, to change positions and still do my work and not take distraction away from work (Reece, PHE, control group)

These findings indicate that the suitability of sit-stand desks as a strategy to reduce workplace sitting is enhanced in workplace contexts whereby productivity is operationalised with sitting at the desk, as sit-stand desk use does not prevent engagement in productive work, and does not necessitate leaving the desk.

The influence of social discomfort and interpersonal relationships on sit-stand experience

Whilst cultural assumptions regarding desk-based work and productivity led employees to view sit-stand desks favourably compared to other strategies to reduce workplace sitting that involve leaving the desk, cultural norms regarding workplace, and particularly desk-based sitting, also negatively influenced some employees' sit-

stand desk experience. Specifically, workplace sitting norms incited the shared symbolisation of standing at the desk as abnormal by employees:

> Genuinely people are… 'why would you want to stand?'… people just think it's a bit strange (Mark, Macmillan, sit-stand desk user)
>
> I've seen other people do it [standing] and kind of thought, oh you do look really weird when you're the only one…. I kind of might have been a bit, really stupidly and like for no reason but like embarrassed to be the one who was like standing up when everyone else [was sat down] ... (Grace, Macmillan, control group)

Being perceived as 'strange' or 'weird' by colleagues engendered social discomfort and feelings of self-consciousness for some sit-stand desk users, which reduced their acceptance of standing and further compelled employees to conform to the shared norm of sitting at the desk. The decision to sit or stand is also conditioned by other social rules related to interactions between people. For example, school teachers and university lecturers typically stand, whereas their students will sit. The act of sitting and standing is symbolised in terms of power differentials; being physically elevated represents authority over others (W. Knight, Keifer-Boyd, & Amburgy, 2004). Consequently, some sit-stand desk users felt that standing in the workplace gave the impression of looking down on colleagues, which made them feel uneasy:

> They… [made] comments about really practical things like 'Oh, you're overlooking me' and… or 'I feel like there's a shadow over me'… so probably 90% of the time I don't use it other than to stretch my legs maybe for five or ten minutes (Mark, Macmillan, sit-stand user)
>
> Someone remarked that it [standing at the sit-stand desk] was a bit like a headmistress looking over everyone (Research notes, PHE, 23rd April 2015)

The shared meaning attached to individuals' choice of postural and physical positioning in social (work) spaces can dissuade employees from using the sit-stand desk to stand when their colleagues are all sat. Empirical research indicates that standing at work is perceived as "aggressive" and "domineering" by employees (C. Waters et al., 2016, p. 5). Work organisations are inherently hierarchical and permeated with relations of power; sit-stand desk users with more senior positions may feel uneasy highlighting their seniority, and those with more junior positions may experience social discomfort as a result of contradicting the formal organisational power hierarchy by standing whilst more senior colleagues are sat.

Nevertheless, standing at the desk can facilitate conversation between the sit-stand desk user and other employees by permitting interaction on one level:

> If somebody comes to speak to me and I'm sat down, I stand up because otherwise it diminishes my power… its body language, you know... you can converse much more at your peer level than if you're sat down... if you're already stood you're already inviting that person to communicate with you at that level and you get on (Bridget, PHE, sit-stand desk user)

Walking and speaking to colleagues that are standing at their sit-stand desk may be more amenable than standing and speaking to colleagues that are sat at their desk, due to the implied power differentials between the two postures. Thus, the use of sit-stand desks in the office environment may encourage light-intensity PA (i.e. walking and speaking to colleagues at their desk instead of emailing) amongst all employees.

Some participant employees were wary of potential disruption to colleagues caused by them standing or transitioning between sitting and standing. However, any initial distraction soon diminished:

> I was trying not to cause too much distraction, up and down… [but] now my team are used to me up and down during the day and I can see that even the person next to me, she'll still be doing what she's doing on her screen (Melissa, PHE, sit-stand desk user)

The data shows that, whilst employees *feared* that using the sit-stand desk would be a cause of disruption to colleagues, which contributed to discomfort amongst sit-stand desk users, disruption did not materialise upon use of the desk. Nevertheless, the somewhat unsubstantiated concern that using a sit-stand desk would affect colleagues' ability to work may negatively impact employees' decision regarding whether they would like to use a sit-stand desk to stand at work.

Sit-stand desk users also sensed a perception of privilege amongst colleagues. Interviewees identified that their colleagues thought they had been given a superior desk which was not accessible to other employees, which led some sit-stand desk users to experience feelings of guilt. For example, some interviewees reported feeling guilty for sitting at their sit-stand desk when they knew their colleagues were envious of their opportunity to stand:

> I do have to remind people that it was open to everybody!... I just answered, they could have answered if they'd have wanted to, you know. So, I always make sure they know it's not a privilege. But people see it as that! (Joan, PHE, sit-stand desk user)

> We have a couple other people [in our team] who play a lot of sports, who're really into PA, so they just got, not jealous but I think they just had like really envious eyes…. when I first got mine [the sit-stand desk] that definitely was the first feeling, like why have you got a standing desk if you're not going to use it…. definitely I felt guilty when I wasn't using it properly (Anita, Macmillan, sit-stand desk user)

The perception amongst other employees that sit-stand desk users had been privileged by the organisation in receiving a sit-stand desk might have negative implications for employee wellbeing and organisational effectiveness, as extant literature indicates that unequal working practices and favouritism can result in reduced job satisfaction amongst the workforce (Arasli & Tumer, 2008). The data reveal that colleagues' perception of special treatment directly influenced sit-stand desk users' emotions. An immediate consequence of feeling guilty is that employees may feel compelled to stand more frequently and for longer, meaning that experiencing feeling of guilt can enhance the influence of sit-stand desks on sitting reduction. However, ultimately, such an emotional response is likely to elicit a negative evaluation of sit-stand desks by employees.

Feelings of social discomfort, including self-consciousness, embarrassment and guilt, were engendered by social norms and rules related to sitting and standing, and the perception of sit-stand desks being superior to standard desks. Yet, sit-stand desk users indicated that the extent of social discomfort associated with standing at a sit-stand desk may be influenced by the physical positioning of the sit-stand desk in the office and the proportion of other sit-stand desk users in the vicinity:

> I was a tad [self-conscious] … It [standing] draws attention to yourself … [but] if everyone is doing it, it takes the spotlight off one person (Sean, PHE, sit-stand desk user)

> One of the downsides of this you do look a bit peculiar, standing there, but because of the position in the office, where I'm at the edge of the office it's... I feel less… odd (Bridget, PHE, sit-stand desk user)

Social discomfort did not affect sit-stand desk users equally as certain conditions were found to minimise discomfort. For example, Sean believed that a larger sit-stand desk/user presence would somewhat curtail social discomfort. This finding lends support to psychological theories introduced in section 2.3.2, such as the SCT, which posit that social influence mediates behaviour change (Linke et al., 2014). Bandura (2004) conceived that the observation of others can alter thoughts and actions. Observing colleagues standing in the workplace can reduce anxieties

regarding standing, and increase the feasibility of using a sit-stand desk, via standing being perceived as less unusual.

Whilst workplace cultural norms favoured sitting at the desk, one senior employee was instrumental in normalising standing within her work team. Jade voiced that employee health and wellbeing, and, therefore, minimising prolonged sitting, is "a value… it's certainly something that we do in our team… I've been standing… but it's not being implemented anywhere else within the department" (Jade, Macmillan, workplace wellbeing stakeholder). A supportive manager and team culture positively influenced Rebecca's experience of standing at her desk:

> I think certainly being… with a group of people who are, erm, aware and supportive, *particularly* having a boss who is very very supportive, umm... and likes to try new things and be imaginative and is *incredibly* supportive… [standing at the desk] has just felt normal really, it hasn't been a challenge (Rebecca, Macmillan, sit-stand desk user)

The data suggests that the attitudes and behaviours of both team and senior leaders are instrumental in shaping employees' sit-stand desk experience, and that a shift in culture via team leaders supporting and role-modelling standing would increase the feasibility and acceptability of using a sit-stand desk amongst office-based employees. Champions and leadership support are instrumental in shaping the effectiveness of workplace health interventions (Edmunds & Clow, 2016). This interpretation provides additional support for existing evidence which indicates that workplace interventions are more successful if they incorporate organisational cultural change.

The influence of the sit-stand desk intervention on organisation culture: A change in attitudes, behaviours and practices related to sitting and standing

The sit-stand desk intervention impacted the awareness, attitudes and behaviours of Macmillan and PHE employees other than those participating in the trial. The installation of sit-stand desks initiated a process of normalisation of standing within the organisations. The presence of the sit-stand desks prompted informal conversation amongst sit-stand desk users and other employees:

> People wanted to know a lot more about it in terms of the experience of it… People in the office, random, well not random but even people I don't know from the office will come over and ask. It's been quite a talking point, and

> I've got a bit evangelical about it now. I think everybody, if the option was there would be interested to try it (Melissa, PHE, sit-stand desk user)

> I think, they just heard me swearing... a lot. And going, ouch, ouch, every so often. And I think, a lot of them agreed that the design was quite clunky, and they couldn't work like it (Cristina, Macmillan, sit-stand desk user)

An increased awareness of, and desire to utilise, a sit-stand desk spreading throughout members of the organisation via communication across employees represents a process of the Diffusion of an Innovation (DoI) (E. Rogers, 1976), whereby the innovation is both a product (sit-stand desk) and a practice (workplace sitting reduction) (Greenhalgh, Robert, Macfarlane, Bate, & Kyriakidou, 2004). DoI theory posits that there are numerous factors that influence the chance and rate of adoption of a given innovation, including ease of use (Greenhalgh et al., 2004). The above quotes from Melissa and Cristina illustrate that sit-stand desk users shared their opinions and experiences of the ease of using a sit-stand desk with their colleagues, which influenced other employees' views. Whilst some sit-stand desk users, including Cristina, contributed to others' negative evaluations of sit-stand desks, most sit-stand desk users positively influenced other employees' views. Accordingly, there was an increased demand for sit-stand desks amongst a wider range of employees within Macmillan and PHE:

> People [are] saying to people, 'oh how do you get one of them' [sit-stand desks] … but actually you know, that that is a major by-product… a positive by-product, building a change in attitudes and building an appetite (Alexandra, PHE, operational stakeholder)

In addition, sit-stand desks were used by other employees when the owner was absent from the office, and some sit-stand desk users directly influenced the standing habits of other employees:

> I think that initially I actually had people asking me if they could use the desk, while I'm not in the office and that's fine, no problems… When I've come in the next day it's been adjusted, so I know someone's been using it whilst I've been away (Nadia, PHE, sit-stand desk user)

> He sent a calendar invite for a recurring meeting to his team, and the location said 'standing somewhere'. It's interesting to see that Peter, as a manager, may be influencing his team's sitting and standing habits… some participants are leading with it [standing at work] and introducing the idea to others that hadn't experienced it before and planting the seed that it is something that they could do (Research notes, Macmillan, 23rd Feb 2015)

Bottom-up cultural processes contributed to the normalisation of standing and increased receptivity towards using a sit-stand desk amongst a wider range of employees; the sit-stand desk intervention influenced the sitting and standing behaviour of employees not directly participating in the sit-stand trial. However, it is unlikely that the impact was widespread or substantial, notwithstanding employees' increased desire to reduce workplace sitting, as most employees did not have unrestricted access to a sit-stand desk.

Widespread sit-stand desk provision would require top-down cultural change. Stakeholder employees' accounts indicated that the installation of sit-stand desks contributed to a positive attitudinal shift of relevant teams and senior employees, and consideration of alteration to policy and procedures, that would be instrumental in the organisation providing a greater number of sit-stand desks:

> It feels like the organisation is a little more in tune and feels as though it's [sit-stand] a little more normal. It's been supported by Facilities… having that buy-in, I think has made a real difference. And them understanding it and them seeing that it's not too challenging, will help us come over a massive hurdle (Jade, Macmillan, workplace wellbeing stakeholder)

> I visited our York office last Wednesday. We have a new office manager there… and I said have you heard of sit-stand desks and she had never heard of them and of course a year ago I hadn't… and I said, I think they are the future... The display screen equipment policy which gets reviewed annually doesn't mention sit stand work stations. It will do, obviously, the next time it's reviewed (David, Macmillan, operational stakeholder)

DoI theory posits that the fit between the context within which an innovation is introduced, and the innovation itself, substantially influences the likelihood and rate of adoption (Greenhalgh et al., 2004). Thus, the chances of widespread adoption and use of sit-stand desks across organisations will be enhanced by positive changes in leaders' and key employees' attitudes, and sit-stand desk friendly changes to policy.

Interviewee accounts and researcher observations indicate that the sit-stand desk project has been instrumental in strengthening an organisational commitment to developing more opportunities for employees to reduce sitting at work:

> Whilst I have… been on the outskirts of those conversations [about employee health] … it just sort of feels as though the door's opening, and the study has made a big difference (Jade, Macmillan, workplace wellbeing stakeholder)

> The sit-stand project is helping to push the wellbeing agenda within the organisation. One thing they are doing is 10-minute PA/stretching sessions at

> lunch times… They are also looking for wellbeing champions and the first call for them went out recently (Research notes, Macmillan, 19th June 2015)

Organisational health culture is a particularly pertinent influence on employee health behaviour (e.g. Lin & Lin, 2014; Pronk et al., 2009; and see section 3.1.2). Cultural factors restrained employees' use of the sit-stand desk (i.e. sitting being the norm; see section 6.2.2), however the sit-stand desk intervention was reciprocally influential on facilitating a change in workplace culture. Complex processes that incorporate various interacting factors underpin cultural change. Factors such as the increased national and international media attention on the health risks of prolonged workplace sitting (Gardner, Smith, et al., 2017), likely interacted with the delivery of the sit-stand desk intervention, to elicit top-down cultural change processes within Macmillan and PHE. Thus, the sit-stand desk intervention *contributed* to (a) a process of normalisation of standing in the office-based workplace, (b) an increased acceptance of sit-stand desks by on-the-ground employees and leaders, and (c) policy change related to sit-stand desks and wider employee health considerations.

6.3 Concluding remarks

This chapter presented an analysis of in-depth, qualitative data to examine the processes that influence the feasibility and acceptability of sit-stand desk interventions in office-based workplaces. Section 6.1 examined the significance of the healthy workplace model in explaining the connection between employee health initiatives and organisational success. The findings indicate that the organisational culture and context, and employees' occupational identities, are instrumental in shaping organisational discourses regarding sit-stand desk provision. Section 6.2 provided a narrative account of various factors - beyond the level of the individual - that shaped employees' individual experience of using a sit-stand desk. Multiple, interacting processes influence behaviour, and whilst individuals utilise agency in their decisions about sitting and standing, they are constrained by structural forces. Figure 6.1 illustrates how factors identified within the process evaluation map onto the SEM. The next chapter presents an integrated analysis of some of the outcome findings (presented in chapter 5) and process evaluation findings, to enhance understanding of the efficacy of sit-stand desk interventions to reduce sitting and increase PA in office-based employees.

Chapter 7 – Understanding intervention efficacy: A Mixed Method Analysis

7.0 Introduction

This chapter illustrates approaches to integrating the outcome and process components of the study, providing a contrast to separate presentations of the data in the previous two chapters. Chapter 5 reported on the outcome analysis of the pilot RCT designed to examine the efficacy of a sit-stand desk intervention, whereas chapter 6 presented a narrative account of employees' experiences of sit-stand desk implementation and use, to examine the processes that influenced the feasibility and acceptability of the sit-stand desk intervention. The chapters addressed distinct research questions, and the sum of knowledge gained is more comprehensive than if only one research question had been addressed. However, integration of the outcome and process components of the research has the potential to elicit a more complete, nuanced and critical understanding than the sum of the individual parts (Fetters & Freshwater, 2015). Justifications for conducting mixed method research (MMR) include complementarity, corroboration, and heightened understanding through interrogation of paradoxes (Greene, 2008).

This chapter illustrates two approaches to integrating methods to facilitate discussion of differing rationales for adopting mixed methods. The approach within section 7.1 involves an independent analysis and interdependent interpretation of findings stemming from the outcome analyses and process evaluation. Within section 7.1, subsections refer to specific questions of interest; for example, changes in sitting and standing, and any relevant findings are included regardless of whether they originate from the outcome or process evaluation. Section 7.2 illustrates a case-oriented approach to integration. In this approach the outcome and process findings for a selected participant provide the data for the case study. An integrated analysis of activity monitor, diary, interview and observational data are drawn on in the case-orientated approach (O'Cathain et al., 2010). This chapter integrates outcome and process data related to efficacy. For the process evaluation, this largely draws on data from the theme 'influence on behaviour' which was *not* covered in Chapter 6, however references to data presented in Chapter 6 are also made. Figure 7.1

illustrates how the process evaluation sub-themes map onto the pilot RCT findings. Section 7.3 examines and compares the two different approaches to mixed methods analysis, and using examples from this research, highlights considerations involved in conducting mixed method research.

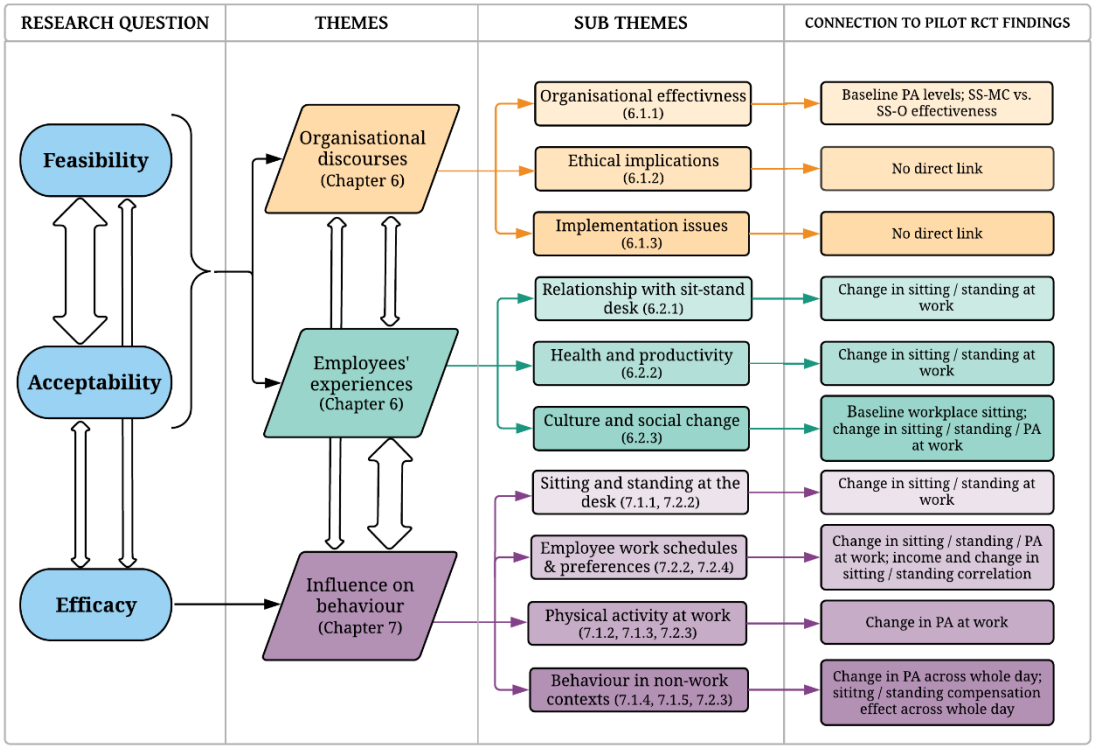


Figure 7.1. *Conceptual linkages between the process evaluation and pilot RCT findings.*

7.1 The efficacy of the sit-stand desk intervention: A mixed interpretation of qualitative and quantitative findings

This section integrates pilot RCT and process evaluation findings to deepen understanding of intervention efficacy. It discusses workplace sitting and standing (section 7.1.1), workplace PA (see section 7.2.2), the efficacy of the SS-MC compared to the SS-O intervention (section 7.1.3), and sitting, standing and PA across the whole day (section 7.1.4). The influence of wider research activities on outcome variables are also examined (section 7.1.5).

7.1.1 Changes in workplace sitting and standing

The outcome evaluation revealed that the sit-stand desk intervention reduced sitting and increased standing during work hours in the intervention groups (IGs);

there were significant changes in sitting at 12-months, and in standing at 2-weeks, 3-months and 12-months (see section 5.1.4). Process evaluation data corroborate the outcome findings as they provide additional evidence that utilising the sit-stand desk was the primary means of accomplishing these changes. The sit-stand feature of the desk provides choice and flexibility with regards to postural position and thus allows users to alternate between sitting and standing whilst working at the desk. Joan commented, "I like the sit-stand thing [feature of the desk], 'cos I can use it [i.e. stand] or not use it [i.e. sit], it suits me..." (Joan, PHE, sit-stand desk user). Sit-stand desks are a product of social design (Janzer & Weinstein, 2014) as they are intended to facilitate change (reduced total and prolonged sitting) to alleviate social issues (prolonged workplace sitting, MSD and physiological health conditions). Interviewees' accounts indicate that sit-stand desks can contribute to behavioural change by challenging the habituated and routinely performed practice of sitting at the desk to work. Steph explained "it's so obvious that it is a different desk… you know you're sitting at it and you sort of look down and go 'oh yeah, I could stand up'…" (Steph, Macmillan, sit-stand desk user). For most office-based employees, seated desk-based working is a subconscious practice. The presence of a sit-stand desk can disrupt habituated sitting by constantly alerting attention to the opportunity to stand, which weakens the link between the object (desk), meaning (doing productive work) and behaviour (sitting) that constitute the practice (Reckwitz, 2002). The installation of sit-stand desks can contribute to changing practices; standing at the desk to work.

Interviewees' accounts reveal that the sit-stand desk intervention also had an *indirect* influence on the work-related sitting and standing of employees. Several employees reported that they had started standing when working from home, utilising height-appropriate surfaces such as kitchen surfaces as a 'desk':

> When I'm [working from] home… at least two days a week… I've got a kitchen worktop, I've been testing that. I've worked upstairs in the bedroom with the ironing board as well, just to stand up. And I've never done that before [having sit-stand desk], hadn't even thought about it… so it [sit-stand desk intervention] has had some impact (Nadia, PHE, sit-stand desk user)

Some of the increase in standing during work hours was not a direct consequence of using the sit-stand desk provided as part of the intervention. However, employees that created a workspace suitable for standing in their home attributed this action to a

positive experience of standing at the desk in the workplace, that they wished to replicate at home. This process evaluation data offers additional understanding, as it is not possible to ascertain via the outcome analysis the mode or motive for increases in standing. Standing when working from home may have substantially increased the impact of the intervention on reducing sitting amongst PHE employees especially, as PHE employees reported being encouraged by management to work from home regularly due to the 10 employees to 8 desks ratio in the PHE offices.

Outcome findings indicated that the average daily changes in sitting and standing during work hours were relatively modest (38 minutes); see section 5.1.4. Although products have the potential to exert influence by making certain behaviours possible, they do not control behaviour (Tromp, 2013; Tromp, Hekkert, & Verbeek, 2011). Sit-stand desks *permit*, but do not necessitate employees stand and work at the desk, as an alternative to sitting. Thus, the outcome data helps constrain interpretation of the process findings that support the efficacy of sit-stand desks for reducing sitting. Section 6.2 provided an account of personal and contextual factors that negatively influenced employees' physical and emotional experience of standing and which, consequently, will have restricted employees' use of the sit-stand desk to stand, which helps explain the modest changes in standing.

The activity monitor-derived data showed that changes in sitting and standing were less substantial at the 6-month timepoint compared to the 2-week timepoint (see section 5.1.4). These findings indicate a novelty effect of the sit-stand desks, i.e. regular use initially, which can diminish over time (Graves et al., 2015; Grunseit et al., 2013), which was supported by interviewee accounts. For example, Melissa described "[initially], it was a bit of a novelty, you know… I'd stand for like three, four hours" (Melissa, PHE, sit-stand desk user). After the initial novelty effect diminishes, employees needed to make a conscious effort to develop a practice of standing at the desk. Some participants reported that standing at the desk became habitual, relying less on deliberate strategies of use (e.g. time-based, task-based, or comfort-based; see section 6.2.1) over time. However, others still had to exert conscious effort after 7-8 months of being given the desk:

> It took me a while to use it, [but] once you've used it, it just becomes, you don't even think about standing and working any more (Nadia, PHE, sit-stand desk user)

> So, it's still, I still haven't quite got into a pattern [of using the sit-stand desk]. I'm still consciously I suppose, thinking during the day. And I was thinking even this morning (Melissa, PHE, sit-stand desk user)

The empirical findings regarding the requirement for conscious habit-making contest the application of nudge theory to the influence of sit-stand desks on behaviour, which posits that users may alter their behaviour in response to the options provided by the product somewhat automatically, subverting a more complex decision-making process, and without conscious effort (Kosters & Heijden, 2015). Although this ensued at first, behaviour change was not sustained. Developing a sustained standing practice, whereby alternating between sitting and standing at the desk is habitually performed, requires deliberate effort on behalf of the sit-stand desk user. It is plausible that increases in standing at the 12-month timepoint (see section 5.1.4) were attributable to the development of a habitual standing practice. In this example, the outcome and process evaluation findings are complementary as the qualitative data revealed pathways by which behaviour change occurred at 12-months. This analysis supports the proposition that the emergence of new practices, and thus sustained behaviour change, involves an interplay between structural and agentic factors (Frohlich et al., 2001; Scott, Bakker, & Quist, 2012). Products (and other environmental changes) do not have an isolated influence on behaviour, but rather employees engage their reflexivity to choose whether and how to respond to the sit-stand desk, whilst their choices are disposed by the various other structural factors, described in section 6.2, that enable or impede using the sit-stand desk.

7.1.2 Changes in workplace physical activity

The outcome analysis showed that some PA variables were raised at the 2-week timepoint in the IGs, compared to the control group (CG), and compared to the 3-month timepoint (see section 5.1.4). In accordance, some interviewees voiced that the sit-stand desk could encourage slightly more activity around the office:

> You are more prone, once you are standing, to think ‘oh, I'll print this, and I'll quickly go and get this’… you might say to someone ‘oh, I'm up already, do you want a cup of coffee?’... once you're seated behind your screen… you're just doing your own thing (Brett, PHE, sit-stand desk user)

The process data supports the outcome finding that PA was raised at the 2-week timepoint, but also provides a deeper understanding of *how* sit-stand desks can contribute to increased PA. However, the longitudinal outcome data suggests that the

tendency to move more when standing may be a product of the novelty of using the sit-stand desk, as the initial increase in PA was not maintained over time.

There were no significant changes in variables that represented sustained bouts of PA (i.e. MVPA ≥ 10 minutes), meaning any increases in PA consisted of sporadic movement. Process evaluation findings validate and explicate this finding as interviewee accounts revealed a perceived lack of time to incorporate sustained bouts of PA into the working day:

> I wouldn't have the time to go to the gym for an hour… I wouldn't get everything done in my job, so I think having a sit-stand desk means that I could incorporate some sort of low-level activity with work, which is good (Paul, Macmillan, control group)

Employees are compelled to limit breaks from the desk during the workday due to cultural assumptions regarding being at the desk and productivity (see section 6.2.3). In addition, employees expressed a view that some workplace practices contradict the efforts of the organisation to promote PA. For example, the expectation that employees should be available to attend meetings over lunchtime limits the opportunity to partake in workplace PA initiatives:

> There are things and you look at them and you go that would be nice but… you can't do things at lunchtime because you have meetings over lunch and You can't leave at 5.30 to go and do Pilates on the fourteenth floor because actually some bugger has put a meeting in 5 till 6… if the working practices change, those things [workplace initiatives] would mean more (Mark, Macmillan, sit-stand desk user)

Workplace interventions that do not align with the existing organisational culture are unlikely to be effective (K. Jenkins et al., 2014; Such & Mutrie, 2016). The process data shows that workplace norms and practices impeded employee engagement in structured PA initiatives, which helps explain limited influence of the intervention on increasing longer bouts of PA.

Additionally, there was no main effect of the sit-stand desk intervention on workplace PA, which may be a result of inter-participant variations in PA changes. For example, at the 3-month timepoint workplace stepping varied from a 63-minute increase to a 70-minute reduction from baseline. Whilst some employees expressed a view that standing at the desk increased movement, others indicated that using the sit-stand desk could reduce movement around the office as standing negates the need to walk away from the desk to take a break from sitting:

> I've heard a couple of people say that on occasions where they think… oh I've been sat for a long time… by changing posture, that's enough… they don't actually need to go and take a break from the desk (Carol, Macmillan, sit-stand desk user)

These insights suggest that, contrary to the headline outcome finding that there was no change in PA, the sit-stand desk *did* have a direct impact on employees' workplace PA. Yet, the directionality of change being inconsistent; the sit-stand desk intervention beneficially impacted PA for some employees, encouraging short bouts of light-intensity PA around the office, whilst for other employees it had a negative effect. Inter-individual variation in response to PA interventions has been reported in the extant literature (e.g. Bryan et al., 2011; Eves, Webb, & Mutrie, 2006).

7.1.3 The efficacy of the multicomponent intervention

The multicomponent intervention was implemented and delivered as intended, however, the intervention did not achieve the intended reach. Whilst all organisational emails were delivered, only 80% of the planned individual phone calls took place due to participants being uncontactable (see section 5.1.3); 4 of the 10 participants in the SS-MC group did not receive the full intervention (see table 5.3). Suboptimal reach helps explain the limited efficacy of the SS-MC intervention compared to receiving a sit-stand desk only (see section 5.2.7).

In addition, interview data stipulates that the lack of, and attitudes towards, health and wellbeing initiatives impeded the potential additional impact of the multicomponent intervention. Interviewees voiced that, whilst Macmillan provided a limited selection of activities, the organisation did not prioritise employee wellbeing:

> There are things going on, there are lots of sports clubs. But there isn't what I would call a proper health and wellbeing programme… [human resources'] work on sort of mental health was just literally putting up a poster saying take a lunch break…. it just seems as though the more I get into the world of health the less healthy the organisation seems to be, without realising what an impact that has on our behaviours (Jade, Macmillan, middle-manager)

Conversely, PHE has an established employee wellbeing programme, which includes initiatives to increase PA and is supported full-time by two members of staff, and on a volunteer basis by over 100 employee wellbeing champions whose role is to facilitate awareness of the programme and embed it within the organisation:

> My role [wellbeing champion] is focused around, erm, my team specifically, obviously making sure that they know about all the initiatives that are going on, because there's a lot of things… you might not realise that we've got Headspace or the Big White Wall…. encouraging people to take part in the PA challenge which is the eight-week challenge which is going on at the moment as well (Annabel, PHE, workplace wellbeing stakeholder)

However, findings related to organisational discourses, presented in section 6.1.1, highlighted a shared dissatisfaction with PHE's approach to promoting employee wellbeing. Specifically, employees reasoned that the organisation offered wellbeing initiatives to minimise the consequences of failing to meet their basic needs, and felt that a more appropriate means to support their wellbeing would be to improve organisational conditions (e.g. job security, workload), to facilitate basic need satisfaction. The management emails that comprised the organisational-level part of the intervention conveyed that the organisation supports employee health. Thus, employees' views that employee health provision is inadequate (Macmillan) and that organisational conditions undermine the employee wellbeing programme (PHE) contradict the content of the management emails. If an intervention contradicts employees' beliefs, it is unlikely to be effective (Spence, 2015). Thus, process evaluation findings enable a deeper, context-specific understanding of the modest additional influence of the multicomponent intervention.

7.1.4 Changes in sitting, standing and physical activity across the whole day

Interviewees' accounts revealed that the sit-stand desk increased employees' awareness of how sedentary and inactive they are. For example, Cristina commented, "it [sit-stand desk] just reminds you that you spend a lot of time sat on your bum. Not walking around… It definitely makes it more apparent about how much we sit down" (Cristina, Macmillan, sit-stand desk user). For some employees, increased awareness translated into a reduction in sitting and increase in standing outside work. For example, Melissa described introducing standing into her daily commute:

> Before this, it's so funny I would have seen a seat on the bus or the tube and I would have gone for that and I've found myself recently thinking… I'll stand. I'll see a seat there, but I'll still stand (Melissa, PHE, sit-stand desk user)

However, accounts of increased standing in non-work contexts contradict findings from the outcome analysis; the sit-stand desk intervention had no influence on sitting and standing across the whole day, and there was a tendency for an increase in sitting

during non-work hours (see section 5.1.5). A possible interpretation of these paradoxical findings is that compensating for reducing work-related sitting outside work is subconscious. The finding that many employees did not reduce overall daily sitting, despite their perceptions that they did, also supports existing evidence of a lack of validity of self-report measures of sitting (e.g. Busschaert et al., 2015).

GT3X+ data provided evidence that the sit-stand desk intervention had no influence on PA across the whole day (see section 5.1.5). Some employees reported no impact of the intervention on PA due to family responsibilities:

> My daughters… they do their exercises every day, and they are constantly saying to me 'mum you need to get up and do x,y,z!' *sigh*… I always say to them 'you guys are not cooking and shopping and cleaning and washing...You take over those responsibilities then I'll have more time!'… I know I don't do enough PA and I don't know if its [the project] made any difference to be honest (Nadia, PHE, sit-stand desk user)

By reason of the open-system nature of reality (Cruickshank, 2012), external factors shaped the influence of the intervention on PA. The demands of juggling work, household and familial responsibilities impeded potential positive changes in PA in non-work contexts for some employees. However, there was a large standard error associated with change in non-work PA variables (see section 5.1.5), meaning that some participants did increase PA across the whole day. Process findings provide a nuanced account of various ways in which the intervention led to increased PA. For example, one employee remarked that standing at the sit-stand desk alleviated musculoskeletal pain and in doing so, improved her capability to perform PA:

> I do like going on hikes and that, and I had to stop because I would get severe pain, and now I can do my walks again… and I can walk to the office… so it [the sit-stand desk] has really helped (Carol, Macmillan, sit-stand desk user)

A different interviewee voiced that standing during the day prevented fatigue in the evening, which facilitated engagement in activity after work:

> When I sit for hours I do just get really lethargic and tired… and I'll be a bit sleepy tired so I'll stand up, and it means that when the day ends, I'm not completely exhausted, which means that when I get back home I can hook my bicycle up to the indoor trainer, and do some miles on that versus I've been sat for 7 or 8 hours, your legs are knackered and you're so tired, and you go back and you just sit (Mark, Macmillan, sit-stand desk user)

Health conditions, including musculoskeletal pain and injury, and a lack of energy, have been cited as barriers to PA in the extant literature (e.g. Salmon, Owen, Crawford, Bauman, & Sallis, 2003; Trost et al., 2002). The process evaluation findings contradict the headline outcome finding by suggesting that sit-stand desks *can* influence PA in certain employees, by lessening restraints on PA. Positive changes in PA are more likely in employees that report fewer family responsibilities. Sit-stand desks do not determine change, but are tied up in complex processes that can, but will not always, engender changes in employees' PA.

7.1.5 The influence of wider research activities on changes in outcome variables

Qualitative data indicates that the behavioural monitoring was instrumental in heightening employees' awareness of their sedentariness, and had an impact on employees' sitting, standing and PA levels:

> You could think of yourself as a fairly active person, but [doing the monitoring] … you think about sitting down to have dinner, sitting down on the tube, sitting down to watch TV… gosh, it really kind of opens your eyes to the fact that even if you go to the gym a few times a week you can spend a lot of other time… just sitting (Caroline, Macmillan, sit-stand desk user)

> I think filling out the diaries...it's definitely shown how lethargic [sedentary] most of my outside of work activities are... It's at least planted the seed in my mind that physical activities need to be part of your social activities. So, I've been trying to organise that (Sean, PHE, sit-stand desk user)

These findings highlight that the sit-stand desk intervention was not solely responsible for employee behavioural change, as changes in sitting and PA were also conditioned by wider aspects of the research (i.e. the behavioural monitoring) that did not form part of the intervention itself. Completion of the participant diary, for example, obligated participants to pay attention to the activities that they completed during each waking hour of the day. The presence and experience of using the sit-stand desk, and undertaking the behavioural monitoring, likely had a cumulative influence on awareness of, and change in, behaviour. This complicates, and makes it harder to discern the degree of impact of the sit-stand desk intervention itself.

Some interviewees indicated that monitoring caused them to alter their behaviour during the monitoring period only:

> There were a couple of times where I was doing the monitoring… I had like, gym classes booked in, you know… and I might have been 'oh I'm a bit tired I can't be bothered' and then I thought no actually I probably should go cos I wanna kind of write down the activity and not just put an 'I'm on the sofa' (Steph, Macmillan, sit-stand desk user)

Interviewees' accounts imply that changes in behaviour resulting from being monitored can be somewhat transient, which has implications for the reliability of sedentary behaviour and PA monitoring (i.e. behavioural reactivity; Kang & Rowe, 2015). However, most interviewees voiced an awareness that the monitoring phases are meant to represent normal behaviour, and indicated that the monitoring prompted a more sustained impact on attitudes and behaviour:

> I was really conscious not to do extra walking, because I didn't want to like skew the results, but over time I found that I was progressively walking more anyway and so, like I wasn't skewing the results… because this is what I am doing, and then I think over time I've done more. So, it influenced me in… encouraging or keeping it on my mind (Grace, Macmillan, control group)

Self-monitoring is an established behaviour change assessment technique (Michie et al., 2009). Participants' explanations illustrate that monitoring can draw peoples' attention to their levels of sitting and PA, which causes them to contemplate, and sometimes alter, their habitual behaviour. Whilst the impact of the behavioural monitoring is positive, participants in all three study groups partook in this component of the research. Thus, it represents an additional factor underpinning the modest changes in sitting, standing and PA in the IGs compared to the CG, and the lack of additional influence of the multicomponent intervention. Utilising mixed methods enables a fuller, context specific understanding of intervention effectiveness.

7.2 The efficacy of the sit-stand desk intervention: A case-oriented analysis of qualitative and quantitative data

This section integrates data originating from the outcome and process components of the study for a single participant: Joan. The case study is an established research design within the social sciences that permits an in-depth and multifaceted understanding of complex phenomena (Crowe et al., 2011). Case studies may be a valuable reporting approach within MMR as the various data

sources directly correspond to a specific employee, which also permits the exploration of complementarity and contradiction of and between data sources within a single case. Joan was selected as due to the wholeness of her data set; she fully completed all five diary and device-based activity monitoring phases, all ActivPAL and GT3X+ data met the inclusion criteria, she partook in an interview, and the researcher spent time within Joan's team during the observation phases. In addition, preliminary analyses revealed instances of both complementarity and paradox between data sources. The case example is not intended to be representative, but rather, it enables detailed examination of specific demographic characteristics, sociocultural circumstances and experiences of individuals on the suitability of sit-stand desks as a strategy for reducing sitting and increasing PA. This section includes a discussion of Joan (section 7.2.1), her sitting and standing behaviours (section 7.2.2), the type and frequency of her PA (section 7.2.3) and her views of the multicomponent intervention (section 7.2.4). Discussion of these topics permits further investigation of the efficacy of the sit-stand desk intervention.

7.2.1 Joan: Demographic and study-related information

Joan was a participant in the SS-O intervention group and chose an Ergotron workfit-A. At the start of the project, Joan reported that she was aged between 55-59, and lived with her partner and two grown up children. Her BMI was in the healthy range. She was employed in a senior role, earning over £3900 per month before any deductions. Prior to receiving study recruitment emails that included content on the potential negative health impacts of sedentary work, and despite being employed in an office-based role for over 15 years, Joan had not consciously considered that she sat for prolonged periods at work. She remarked "that's just what work was" (Interview data). This is consistent with findings from an experimental study suggesting that people are more likely to acknowledge the higher-order components of behaviour (i.e. engaging in work), than the lower-order, procedural aspects (i.e. sitting) (Gardner, Dewitt, & Smith, 2017).

7.2.2 Changes in sitting and standing

Observational and interview data give the impression that, as a result of using the sit-stand desk, Joan reduced sitting and increased standing at work substantially:

> I told the lady that just arrived that I was working on the sit-stand project and she said ‘what?’ so Joan said ‘sit-stand’ and pointed to her desk. She said ‘oooh, we don’t think of them as sit-stand, just standing desks, as Joan only ever stands at it!’ (Research notes, 18th May 2015)
>
> I got the sense of 'use it as you want to', but I expected to use it half the time… I use it more than that .... probably three quarters [of the work day], I would say (Interview data)

However, the process data contradicts ActivPAL data, which revealed an average sitting reduction across the post-intervention monitoring phases of only 16 minutes/day. Average post-intervention standing time was 174 minutes/day, which equates to 36% of the work day (see Figure 7.2).

The paradox between the outcome and process evaluation data facilitated further exploration of Joan’s workplace sitting and standing. A prerequisite for sit-stand desks to directly exert influence on behaviour is that the employees are based at the desk during work hours; conversely, diary, observational and interview data all indicated that Joan spent a large proportion of the workday away from the desk, in meetings:

> It varies, you know, I'll... tomorrow I’m chairing a meeting; I'll be sitting down all day in a different room (Interview data)
>
> Joan did stand all day, probably for an hour before her 11am meeting, and then she was in and out of meetings all day, in fact she was probably in meetings for almost half of the day and thus spent half of the day sat down (Research notes, 18th May 2015)

Time	Type of behaviour	Reason for behaviour
5-6pm	standing	emails
4-5pm	standing	emails
3-4pm	sitting	meeting
2-3pm	sitting	meeting
1-2pm	sitting	meeting
12-1pm	sitting	meeting
11-12pm	standing	emails and report writing
10-11am	sitting	meeting
9-10 am	standing/sitting	computer/meeting

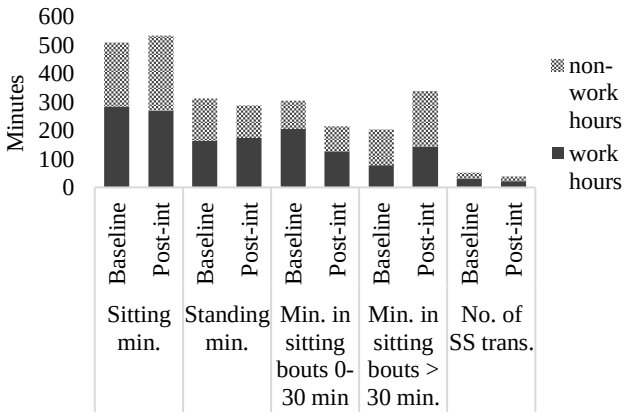


Figure 7.2. *Joan’s sitting and standing variables, segregated into work-hours and non-work hours, at baseline and post-intervention (average of the 2-week, 3-months, 6-months and 12-months timepoints) (right) and an extract from Joan’s activity dairy: diary 3 (3 months), day 1 (a weekday) (left)*

Evidence that Joan sat in meetings for a large portion of her workday provides a partial explanation for the apparent contradiction between the ActivPAL data, showing minimal reductions in sitting following the sit-stand desk intervention, and the qualitative evidence indicating that Joan *only* stands (i.e. does not sit) at her desk. Diary data illustrates that a particularly high volume of meetings during the 3-month monitoring phase confounded workplace sitting reduction; average workplace sitting was only 5 minutes/day less at 3-months compared to baseline (see Table 7.1). A recent study of University employees' experiences of standing in meetings identified that the furniture (i.e. seated meeting tables and chairs), and layout of the meeting rooms, reinforced the normalisation of sitting in that context (Mansfield et al., 2017). This highlights the criticality of environmental support, such as sit-stand desks and meeting tables, in improving the feasibility of reducing office-based sitting. The provision of sit-stand meeting tables in meeting rooms may be advised, given the high proportion of work hours some employees spend in meetings. The integration of various data sources within this case study suggest that the correlation between income and intervention efficacy (see section 5.1.7) may be connected to work tasks commensurate with different levels of seniority and income, rather than there being a direct relationship between employee income and behaviour change.

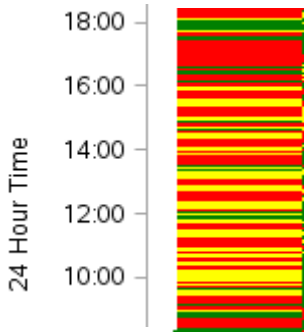
However, attendance at meetings does not fully account for the contradiction between the low increase in standing measured via ActivPAL and the claim that Joan always stands at her sit-stand desk, as Joan spent around half of the day at her desk which should allow for an average sitting reduction of considerably more than 15 minutes/day. Direct observations helped further clarify the paradoxical findings:

> Towards the end of the afternoon, Joan had not put her sit-stand desk down but did sit a few times to write under it… I noticed that Lynn was actually sat down [at her desk] from about 4pm onwards (Research notes, 22nd May 2015 & 25th Nov 2015)

> She told Ben that she always has it [the sit-stand desk] in the up [standing] position, literally never puts it down… She said that if there is something, like reading a long intensive document, that she feels she needs to sit for, then she will move to a spare desk somewhere else to do that, rather than putting down her sit-stand desk (Research notes, 23rd April 2015)

The visibility of the sit-stand desk set at a standing height may have contributed to a (false) perception amongst Joan's colleagues that she always stood at her sit-stand desk, as the researcher directly observed Joan sitting on more than one occasion.

In addition, Joan's relatively high level of standing and sit-to-stand transitions at baseline (164 minutes standing and 33 transitions/day, compared to 120 minutes standing and 27 transitions/day average across all participants) reduces the extent to which she can utilise the sit-stand desk to increase standing during work hours, which helps explain the limited efficacy of the intervention according to the ActivPAL data. Diary and ActivPAL data indicate that high baseline standing may be a consequence of attending meetings (see figure 7.3):



Time	Type of behaviour	Reason for behaviour
5-6pm	sitting at desk	emails
4-5pm	sitting at desk	emails
3-4pm	sitting - phone conference call	phone call to colleague
2-3pm	sitting in meeing room	phone call to colleague
1-2pm	sitting in meeting / walk for lunch	meeting with colleagues/eating
12-1pm	sitting at computer	emails and reports
11-12pm	sitting in meeting	meeting with colleagues
10-11am	sitting	meeting with colleagues
9-10 am	sitting at computer	emails at desk

Figure 7.3. *Joan's temporal ActivPAL data (left) and corresponding diary data (right), diary 1/baseline, day 2/weekday. ActivPAL colour code: red – sitting, yellow – standing, green – stepping*

It is probable that Joan broke up sitting and increased standing and PA by travelling to meetings, as the ActivPAL data shows Joan was standing and moving around the time-period of attendance at meetings recorded in the diary. This interpretation could not have been reached without bot, 7.2.2h sets of data.

The extent of workplace sitting reduction, measured via the ActivPAL, varied between the post-intervention timepoints. In fact, at 6-months, Joan *increased* workplace sitting compared to baseline levels (see Table 7.1).

Joan's 6-month diary data was commensurate with the activity monitor data as all entries that refer to completing desk-based work also note that Joan is sitting. Joan did not use the sit-stand desk during this monitoring period as she had sustained a knee injury, that she suspected occurred whilst running, which required her to sit:

> Joan has injured her knee. She said that she much prefers standing (she's said this to me so many times before) but that she is being forced to sit at the moment as she is limping around (Research notes, 15th July 2015)

Table 7.1. *Sitting, standing and PA variables (daily average) at baseline, 2-weeks, 3-months, 6-months and 12-months for Joan*

		Baseline	2-weeks	3-months	6-months	12-months
ActivPAL						
Sitting Minutes	*WH*	283.79	206.48	278.53	361.12	226.76
	Whole day	507.65	436.01	514.09	644.03	538.8
Standing Minutes	*WH*	163.98	225.25	165.53	87.92	216.4
	Whole day	311.82	379.44	291.1	175.25	300.44
No. of Steps	*WH*	1622.2	2705.5	1790.6	1590.8	1853.25
	Whole day	5122.43	5345.33	4267.57	2831.43	3558.67
Minutes in sedentary bouts 0-30min	*WH*	205.2	115.97	101.62	155.55	129.75
	Whole day	304.15	199.56	197.46	264.42	199.59
Minutes in sedentary bouts 30+min	*WH*	78.59	90.51	176.91	205.57	97.01
	Whole day	203.5	316.45	316.63	379.61	339.21
No. of sit-stand trans. per sedentary hours	*WH*	32	17.25	20.4	28.8	24.5
	Whole day	52	37.67	35.14	44.29	40.67
GT3X+						
Light PA Minutes	*WH*	63.5	68.15	59.2	46.05	60.85
	Whole day	193.43	188.07	172.75	118.29	151.55
Moderate PA Minutes	*WH*	17.8	29.3	21.3	20.3	19.95
	Whole day	46.71	55.68	42.14	31.92	39.65
No. of MVPA bouts ≥ 10+min	*WH*	0	0.6	0	0	0
	Whole day	0.57	1.29	0.57	0	0.2
Minutes in MVPA bouts ≥ 10+min	*WH*	0	11.26	0	0	0
	Whole day	20.11	30.36	11.71	0	2.36
Meeting PA Guidelines		No	Yes	No	No	No

The diary and observational data support the quantitative data and facilitate an understanding of why Joan's use of the sit-stand desk, and concomitant levels of sitting and standing, fluctuated over time. The subjective data highlight that the 6-month monitoring phase was not representative of Joan's habitual behaviour, which provides a further explanation for the contradiction between the average, ActivPAL derived post-intervention change in sitting and Joan's own interpretation of how much she utilises the sit-stand desk. Excluding the 6-month timepoint, Joan sat for an average of 38 minutes/day less than she did at baseline.

Notwithstanding contention regarding *how much* the sit-stand desk facilitated an increase in standing, Joan regularly stood at her sit-stand desk. Joan did not experience any social discomfort when using the sit-stand desk; she found standing to be more physically comfortable than sitting; and voiced that desk-design issues did not impede her ability to work and prompted her to stand *more*:

> I keep standing, cos I... it's as comfortable as sitting - and probably more comfortable actually - than sitting down (Interview data)

> Joan raised the fact that the sit-stand desk doesn't sit flush with the desk [in the seated position], but she said it is not too much of an issue as she just stands anyway (Research notes, 5 Feb 2015)

Joan was, therefore, unaffected by `many of the barriers that impeded use of the sit-stand desk (see section 6.2). The activity monitor, diary, interview and observational data all provide different types of evidence that, when combined, reveal how and why the sit-stand desk had a positive influence on Joan's sitting and standing.

7.2.3 Changes in physical activity

GT3X+ data show that the sit-stand desk intervention had no substantial influence on Joan's PA levels; on average, Joan reduced light-intensity PA and increased moderate-intensity PA by 5 minutes during work hours, and there was a slight reduction in most PA variables across the whole day (see Figure 7.4).

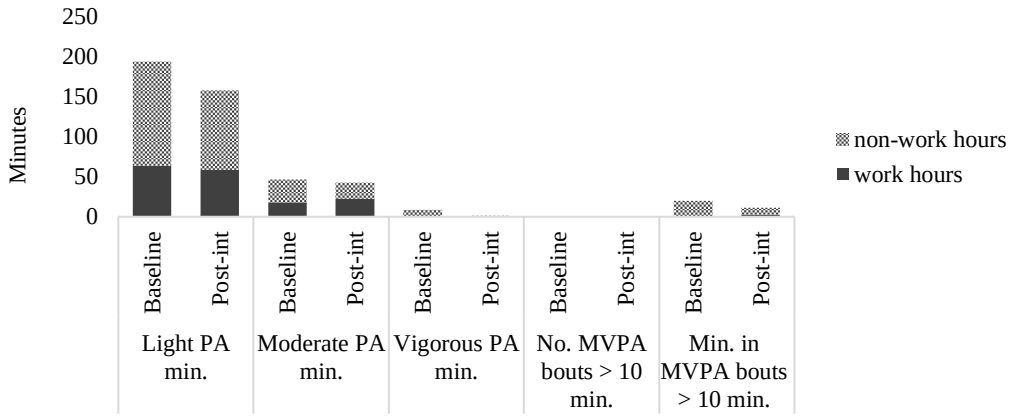


Figure 7.4. *PA variables, segregated into work-hours and non-work hours, at baseline and post-intervention (average of the 2-week, 3-months, 6-months and 12-months timepoints)*

Exclusion of the 6-month timepoint (given its lack of representativeness; see section 7.2.2) leads to most post-intervention PA variables being equivalent to baseline. Joan was active prior to, and following the intervention. Joan's diary records strengthen the validity of the GT3X+ data as it provides an additional source of evidence that Joan engaged in structured PA prior to and throughout the sit-stand desk intervention. It also complements the GT3X+ data, which provides information on intensity and duration of activity, by illustrating the context of the activity, i.e. running, attending dance classes; see table 7.2.

Table 7.2. *Joan's diary extracts, illustrative examples of PA*

Timepoint	Day	Time	Type of behaviour	Reason for behaviour	Duration	Who with
baseline	Saturday	10-12pm	jogging/walking	exercise	60	alone
baseline	Tuesday	8-10pm	sitting/dancing	driving/dancing	60	family
2 weeks	Saturday	12-1pm	walking/jogging	exercise	60	partner
3 months	Tuesday	8-10pm	sitting/dancing	driving/class/relaxing	60	partner
12 months	Wednesday	8-9am	standing/jumping	exercise class	60	friends

GT3X+ data show that Joan did not meet the PA guidelines pre- or post-intervention, as whilst she engaged in an average of 55 minutes of MVPA/day pre-intervention and 44 minutes MVPA/day post-intervention, only 20 and 11 minutes, respectively, occurred in MVPA bouts > 10 minutes (see Figure 7.4). This is supported by Joan's self-reported activity diaries which each included up to three physical activities lasting >10 minutes, and by Joan's description of her PA:

> I just want to do [run] 5k [kilometres]. I can now do it 2 or 3 times a week… I don't want to do it any faster, I don't want to do it any longer, I just want to be able to maintain that (Interview data)

Three, 5 kilometres runs per week is insufficient to meet the PA guidelines of 150 minutes MVPA in bouts > 10 minutes, per week.

Interview data facilitates a deeper understanding of how and why the sit-stand desk intervention influenced Joan's PA levels. Joan reported volunteering to take part in the study as part of a broader attempt to adopt a healthier lifestyle:

> I was quite keen to be part of the project… it was part of a general recognition that I'm in late middle age… [and] I've actually done no physical exercise at all for *decades*... my oldest is 21 now, I didn't do anything in all that time… [so] I need to make sure that I kinda keep fit… I was also doing stuff outside of work to increase my PA at the same time (Interview data)

Joan had already made changes to her lifestyle, including being more physically active, before the commencement of the sit-stand desk intervention, and thus during the baseline monitoring phase. The sit-stand desk did not have a direct and causative influence on her activity levels, but rather there was a reciprocal relationship between Joan's attitudes and behaviour and the sit-stand desk intervention; a desire to adopt a healthier lifestyle prompted sit-stand desk use, and the sit-stand desk intervention reinforced attitudes and behaviours regarding activity and health:

> …. [the sit-stand desk] is part of it [maintaining PA attitudes and behaviours], it hasn't done it on its own, umm... but I suppose it's like a lot of things that they become, umm... incremental, don't they (Interview data)

Given evidence that many people struggle to maintain lifestyle changes, and that the beneficial effects of interventions deplete over time (Hutchinson & Wilson, 2012; Marcus et al., 2000), this interpretation of Joan's outcome and process evaluation data indicates that whilst the sit-stand desk intervention did not increase PA, it did have a positive influence on sustaining levels of recently-initiated activity.

Employees who are already considering making changes to their lifestyle may respond especially positively to sit-stand desk interventions.

7.2.4 Joan's views of the multicomponent intervention

Qualitative data illustrated that Joan was happy to be in the SS-O group, as she felt that the supportive phone calls and emails that comprised the multicomponent intervention were unnecessary:

> He [Joan's colleague] asked about the different groups in the study so I explained the difference between the SS-O and the SS-MC group, saying that Joan was in the sit-stand only group. Joan then said, 'I think I'm in the best group to be honest for me, you know when I did dry January they were sending me all these emails and I was just like delete, delete, delete…funny isn't it' (Research notes, 18th May 2015)

For employees that are already motivated and capable of using their sit-stand desk, additional support provided via a multicomponent intervention may be counterproductive if it is perceived as annoying or time-wasting. It is plausible that there were no significant differences between the SS-MC and the SS-O group (see section 5.2.7), as the multicomponent intervention only had a positive impact on a select group of employees that lacked confidence, and/or experienced considerable barriers to using the sit-stand desk, and considered the phone calls and emails to be useful. However, ActivPAL data showed that Joan increased sitting during non-work hours, and broke up prolonged sitting less frequently following the intervention (see Figure 7.2). It is likely that these behaviours were subconscious as Joan self-reported sitting less following the sit-stand desk intervention. Prompts to increase awareness of behaviour in non-desk contexts may have prevented Joan from subconsciously sitting more outside of work, and may have motivated Joan to increase PA.

This case study examined the efficacy of the sit-stand desk intervention within the context of Joan's wider attitudes to PA, health and wellbeing, and included an account of current and life course factors that influenced Joan's experience. In addition, the case study allowed both consistencies and discrepancies between Joan's subjective account and the wearable monitor data to be identified.

7.3 Using mixed methods in intervention evaluation research

By opening up dialogue with their participants regarding their experiences…researchers can shift their methodological perspective on outcomes from a binary one to a more multifaceted one that gathers a much more nuanced sense of what works and under what conditions (Hesse-Biber, 2012, p. 883)

The two previous sections provided contrasting examples of approaches to analysing and reporting MMR. This section now reflects critically on reasons for conducting MMR including seeking complementarity and corroboration (sections 7.3.1 and 7.3.2), approaches to integration (7.3.3), and benefits and challenges of MMR (7.3.4). The discussion draws on examples from the approaches presented earlier in the chapter (section 7.1 and 7.2), and from the conduct of the research more broadly. Section 7.3.5 concludes by arguing that researchers should move beyond the qualitative-quantitative divide by integrating multiple methods to enable a more comprehensive, nuanced and critical intervention evaluation.

7.3.1 Complementarity of methods: Towards a more comprehensive understanding of intervention efficacy

Conducting mixed methods for the purpose of complementarity indicates that different methods can produce different types of knowledge about a phenomenon which, combined, elicit a more comprehensive understanding (Greene et al., 1989). The mixed method approaches within sections 7.1 and 7.2 were scattered with illustrative examples of how data or findings linked to different methods can be interwoven in a complementary way. Section 7.1 integrated different types of evidence concerning intervention efficacy across participants. For example, outcome data showed *that* there was an increase in standing during work hours, and the process evaluation revealed *how* and *why* (i.e. primarily sit-stand desk use, habit formation over time); see section 7.1.1. Section 7.2 intertwined different forms of data from a single case (Joan) to examine intervention efficacy, and found, for example, that process data helped elicit an understanding of the reasons underpinning Joan's low levels of workplace standing at 3 and 6-months. Barriers to standing included a high volume of meetings and a knee injury (see section 7.2.2). These examples illustrate that utilising mixed methods within intervention research enables an understanding of the linkage between interventions, processes and outcomes. The quantitative aspect of the research describes the outcome(s) of the

intervention, whereas the qualitative aspect of the research elucidates the conditions, mechanisms or processes that are tied up in the production of those outcomes (Maxwell & Mittapalli, 2010, p. 156). Utilising mixed methods to achieve such wholeness represents a retroductive approach to research (i.e. explaining *how* outcomes are produced), which is advocated by critical realism (Næss & Jensen, 2002).

One of the hallmarks of critical realism is its approach to causation; rather that advocating a regularity view of causation, which underpins positivism, the approach supports an open-system view of causation (Sayer, 2000, p. 14; and see section 4.1.2). An open-system view infers that the outcome of an intervention is dependent on how the intervention interacts with the presence of other behavioural influences (A. Clark, 2013). For example, section 7.1.3 described organisation-specific factors, including an inadequate employee health programme (Macmillan) and an organisational culture that undermined employee health (PHE), impeding the impact of the intervention. There is no universality to the outcome of an intervention, as its power to elicit change is context dependent (Zachariadis et al., 2013). In other words, outcome findings are not generalisable, which minimises their utility without an accompanying process evaluation. Combining methods to conduct an outcome and process evaluation make it possible to identify mechanisms or conditions that are instrumental in shaping the outcome of an intervention. For example, section 7.1.2 hypothesised that a lack of influence of the intervention on MVPA bouts ≥ 10 minutes in duration is related to the organisational cultural norm of not taking breaks, which is linked to the desire to be (perceived as being) productive. Whilst the behavioural outcome depends on the other objects present within the delivery context, such findings are generalisable in that a cultural norm of not taking breaks is likely to impede the influence of the intervention on bouts of MVPA at work.

Within the wider implementation science literature, greater value is often placed on outcome analyses compared to process evaluations of interventions. For example, a systematic mapping review of the utilisation of qualitative methods within RCTs reported that such methods are valuable in "facilitating interpretation of the trial findings" (O'Cathain et al., 2013, p. 12), which places them in a supplementary position to the trial / quantitative methods. In addition, a systematic review of process evaluations of worksite health promotion interventions excluded

studies that did not also conduct an outcome evaluation (Wierenga et al., 2013). The mixed method approaches taken within this chapter have value beyond demonstrating the complementarity of the qualitative and quantitative components of intervention evaluations. They also provide illustrative evidence that the process evaluation is as, if not more, insightful and meaningful than the outcome analysis, due to the lack of generalisability of the outcome findings. It has been argued that researchers should afford equal status to qualitative and quantitative approaches within intervention evaluations to avoid perpetuation of paradigmatic hegemony, and to maximise the potential for knowledge generation (Hesse-Biber & Johnson, 2013; Simons, 2007).

7.3.2 Corroboration vs. contradiction: Enhancing research quality or deepening understanding via mixed methods

Strengthening the validity of findings via corroboration between multiple methods is the most commonly cited justification for conducting MMR (Bazeley & Kemp, 2012). The mixed method approaches within sections 7.1 and 7.2 included *some* examples of corroboration. For example, section 7.1.1 described how an increase in standing during work hours (outcome finding) was supported by self-reported use of the sit-stand desk to stand during work hours (process evaluation), and section 7.2.3 described how multiple methods provided evidence that Joan was active prior to, and throughout the sit-stand desk intervention.

However, sections 7.1 and 7.2 contained as many cases of contradiction between methods as there were corroboration, which casts doubt on the justification for using MMR to strengthen conclusions. For example, Figure 7.3 illustrated a paradox between baseline self-report diary data, which indicated that Joan sat at her desk and in meetings all day, and corresponding baseline activity monitor data, which suggested that Joan intermittently sat and stood throughout the day (see section 7.2.1). Evidence hierarchies privilege the quantitative; RCTs and quantitative methods are positioned as generating stronger, more valid and more convincing evidence than qualitative methods due to the assumed kinship between quantitative data, positivism and objectivity (Borgerson, 2009; Evans, 2003). However, subjective decisions are made consciously and subconsciously, throughout the research process, based on prior theory or researcher assumptions (Chalmers, 1999,

p. 6). For example, in the present study the processing of GT3X+ data included making decisions regarding wear-time criteria, epoch length and intensity cut-points, all of which affect PA outcome data (Orme et al., 2014). Thus, knowledge inquiry, whether via qualitative or quantitative methods, is incapable of accessing an objective 'reality' as knowledge generation is dependent upon human subjectivity (Holmes et al., 2006; Johnson & Gray, 2010, p. 82). When faced with paradoxical findings, researchers should not automatically give predominance to quantitative findings over qualitative findings.

Inconsistency of data collection and analysis procedures between methods reduce the likelihood of achieving triangulation of findings. For example, activity monitor data is minute-by-minute, whereas the activity diary typically only contributes one activity entry per hour, which may explain the apparent contradiction between the data sources illustrated in Figure 7.3. In addition, seeking conformity of findings may be a futile endeavour given the irreconcilability of assumptions inherent within different methodological approaches (Bryman, 1992, p. 64). Examples from the present research support this contention. For example, section 7.1.4 described paradoxical findings regarding the influence of the intervention on daily PA; the outcome analysis indicated no influence, whereas the process evaluation uncovered complex processes whereby sit-stand desk use was instrumental in increasing PA for some employees, and reducing PA in others. The outcome findings are based on statistical analyses of (average) change in pre-specified outcome variables *across* employees. Conversely, qualitative approaches emphasise individuals' experience. The divergent findings are a product of the conflicting methodological assumptions underpinning the different components of the study. Accordingly, contradiction between findings generated from different methods does not mean that one finding is 'right' and the other 'wrong', but that the methods provide different *types* of evidence. This interpretation dictates that the focus of MMR should shift away from seeking corroboration of findings.

Nonetheless, it does not follow that findings generated from different methods should not be compared. For example, conflict between activity monitor data reporting that Joan increased her standing by only 16 minute/work day and interview and observational data suggesting that Joan only stood at her sit-stand desk, prompted further analysis. This revealed complexity regarding Joan's

workplace standing, including, for example, that Joan attended frequent meetings that limited the overall impact of sit-stand desk use on the total volume of standing, despite Joan infrequently sitting at the sit-stand desk (see section 7.2.2). This example supports the argument that the identification of paradoxes can guide interpretation and lead to a deeper, more nuanced understanding than when findings from different methods are analysed and interpreted separately (O'Cathain et al., 2010).

7.3.3 Integration within mixed method research: Where should it occur?

A criterion of MMR is that integration of methods must occur at some stage during the research process (Bazeley, 2012; Onwuegbuzie & Combs, 2010, p. 398). However, integration of qualitative and quantitative components of intervention evaluations occurs rarely (Lewin et al., 2009) and dialogue surrounding different approaches to integration within the MMR literature is somewhat scarce (Bazeley, 2010, p. 432). The present chapter has demonstrated two possible approaches to integration; an integrated interpretation of findings following parallel analyses (section 7.1) and an integrated analysis of data from a single case (section 7.2). The examples provide illustrative evidence that *both* approaches can generate a more complete and nuanced understanding than the sum of the individual parts, and that both approaches increase understanding of the linkages between the intervention, social processes and the behavioural outcomes.

A strength of the approach taken in section 7.1 is that it utilises rigorous and recognised analytic procedures including statistical analysis of outcome data and thematic analysis of process data. The findings from the different components of the study can be judged based on accepted quality criteria for data collection *and* analysis (Creswell, 2010, p. 59). As described in section 7.3.2, evidence hierarchies position RCTs as providing the strongest evidence of effectiveness (Borgerson, 2009); valuation of effectiveness depends on the result of statistical analyses that compare outcomes between the CG and the IGs. Integration at the interpretation stage does not interfere with the statistical analysis, and thus should not alter policy-makers', or other researchers' perceptions of the strength of evidence generated.

However, such statistical analyses are not representative of individual participants' responses to an intervention (Sniehotta, Presseau, Hobbs, & Araújo-

Soares, 2012). The outcome analysis found that average change in sitting and standing had a large standard error (see section 5.1.4), indicating that there was substantial variation in sit-stand desk usage between employees. Changes in sitting ranged from a 191-minute reduction to a 134-minute increase, which explains the small, *average* reduction in sitting and increase in standing at work. Process evaluation data supports the outcome data by demonstrating that employees were exposed to and affected by different barriers and facilitators to differing degrees which, in turn, explains why some participants used the sit-stand desk much more frequently, and for longer, than others (see section 6.2). However, integration at the interpretation stage entails some discordance between the outcome and process findings as, although the process findings are thematic, they still represent individuals' experience, as qualitative data cannot be 'averaged' in the same way as quantitative data. Consequently, a strength of the case-oriented approach to integration, demonstrated in section 7.2, is that it focuses on individuals, rather than an 'average' which does not correspond to any of the participants' actual experience or behavioural change (McDonald et al., 2017). The various data sources intertwine more effectively than in the approach taken in section 7.1 as they correspond to the same subject. In addition, the case-oriented approach to integration permits multiple data sources to be analysed collectively (Baxter & Jack, 2008; O'Cathain et al., 2010), which, in section 7.2 included activity monitor, activity diary, interview and observational data. By integrating at the level of analysis, the mixing of methods is arguably more significant and less artificial than mixing at the interpretation stage only (Bazeley, 2012). Providing multiple case examples was beyond the scope of this thesis, however, doing so would also permit investigation of within-participant processes and, thus, the generalisability of conclusions (McDonald et al., 2017).

Whilst this chapter has largely focused on the integration of data and findings, integration can also occur prior to and during the data collection stages of the research process. For example, chapters 2 and 3 comprised a cohesive overview of relevant qualitative and quantitative studies to provide a comprehensive review of the literature related to sitting, PA, behaviour change, workplace culture and interventions. In addition, the outcome and process evaluations were not conducted in isolation. For example, process evaluation data revealed that, midway through the study, the activity monitoring was becoming a burden for participants:

> Some people are waning in their commitment as we progress through the data collection phases - which can be expected considering how intensive the data collection is. This was evident as two people didn't show up to collect their [monitoring] packs… earlier [in the study] people would have let me know if they couldn't make it (Research notes, Macmillan, 21st April 2015)

The protocol for the quantitative data collection was consequently adapted to relieve the participant burden and enhance the quality of the activity monitor data. Thus, early qualitative findings were utilised to modify and improve the research protocol. Whilst the potential for integration largely depends on the research question and study design, the present chapter evidences the feasibility of mixing methods in the data collection, data analysis and interpretation stages of intervention evaluations.

7.3.4 Benefits of adopting mixed methods

This chapter has already discussed some of the benefits (e.g. eliciting a deeper and more comprehensive understanding of the research question) and challenges (e.g. contradictions between methods and integrating qualitative and quantitative components) of conducting MMR. However, undertaking this study exposed various other benefits of incorporating a process evaluation alongside a pilot RCT to examine intervention efficacy.

Quantitative analyses are limited to pre-specified outcome measures; the outcome analysis in the present study investigated the efficacy of a sit-stand desk intervention on sitting, standing and PA. However, the inclusion of qualitative methods facilitates a more comprehensive exploration of the wider impact of the sit-stand desk intervention. For example, the process evaluation revealed that the sit-stand desk influenced individual employees' productivity and health (see section 6.2.2), and was instrumental in shaping the normalisation of standing within the participating organisations (see section 6.2.3). Thus, qualitative process evaluations allow original material to be produced, and theories to be developed, which can be investigated further in future research (Pope & Mays, 1995).

In addition to their primary focus, process evaluations can be used to examine the quality and acceptability of research components. For example, process evaluation data revealed a lack of representativeness of some of the behavioural monitoring phases (see section 7.2.2) and the occurrence of behavioural reactivity (see section 7.1.5), which impacted the validity of the activity monitor and diary.

Interview and observational data also provided useful insight regarding employees' attitudes towards the activity monitors, including usability issues:

> If I'm going out on a Saturday night… its uncomfortable, so I just won't wear it… or if I, I had a smart meeting the other day… work dresses are normally quite fitted or what have you, and I went through about four in my wardrobe, but it kept sticking out of all of them... I came very close to saying sod it, I'm not doing it anymore... I don't think it's been particularly well designed for a woman's body, because I find that as I move it naturally moves up to the smallest part of your body, your waist (Anita, Macmillan, sit-stand desk user)

Most interviewees felt that the ActivPAL was more usable than the GT3X, and found the 24-hour wear protocol less onerous than the GT3X+ wear requirements:

> Having the ActivPAL on, when that's on it's done. But with the belt [GT3X+], it's, yeah, remembering to put it on in the morning (Nadia, PHE, sit-stand desk user)

Forgetting to replace the GT3X+ immediately following sleep and water immersion, in addition to usability issues associated with the GT3X+, likely contributed to the lower average wear-time for the GT3X+ than the ActivPAL (see section 5.1.1). This monitor acceptability data is useful for assessing monitoring options for future studies, and lends support to the ActivPAL for measuring sitting, as a higher wear-time improves reliability (Edwardson et al., 2016; Herrmann et al., 2013).

The qualitative aspects of the research were instrumental in the development of rapport with research collaborators and participants (Bryman, 1992). For example, after being interviewed, a research partner remarked, "you're the first researcher who has taken a really… deliberate time to ask me these questions and it impresses me no end and I'm pleased that you did this" (Chloe, Ergotron stakeholder). Developing a good relationship with collaborators increases the potential for ongoing research partnerships. The ethnographic approach was also instrumental in ensuring the smooth running of the intervention delivery and evaluation. For example, a closer relationship between the researcher and participants, resulting from the involved approach, helped build participants' commitment to completing the activity monitoring. In addition, the researcher's status as an official volunteer employee within each organisation enabled her to swiftly enter the buildings with an employee access pass, have access to participants' work calendars, and to book meeting rooms - for data collection purposes - using both organisations' online booking systems.

However, the participant observation also brought additional challenges to the research process. For example, process evaluation data suggests that the researcher presence in the workplace influenced the behaviour and verbal responses of employees. Participants made comments such as "Oh my god, you've caught me sitting, I've been stood all day!" (Research notes, 20th Feb 2015) and some voiced feeling pressure to stand when the researcher was working nearby. It is important that the influence of the researcher on the researched is recognised (Hammersley & Atkinson, 2007, p. 17); the presence of the researcher within the workplace setting may have reduced the legitimacy of activity monitor, interview *and* observational data, as these data all capture participants' behaviour and/or speech.

7.3.5 Shifting focus from the qualitative-quantitative divide in mixed method evaluations of interventions

'Qualitative' and 'quantitative' are often presented as binary approaches to research, however, focusing on the distinction between them can be divisive (Gorard, 2010, p. 243; Pearce, 2012). Methods cannot always be neatly defined as either qualitative or quantitative. For example, a qualitative visualisation of quantitative activity monitor data, presented in Figure 7.3, permits an appreciation of behavioural patterns (Loudon & Granat, 2015) and aids comparison with diary data. Utilising mixed methods requires more creative means of collecting, analysing and presenting data, whereby the boundaries between qualitative and quantitative are blurred.

A focus on the dichotomy between qualitative and quantitative approaches also obscures research complexity (Hammersley, 1992, p. 51), including the form and extent of 'mixing' taking place. Methodological literature on the 'MMR paradigm' stems from the social sciences (Maxwell, 2016), and thus reflects researchers' experiences of mixing multiple, typically *subjective* methods, such as interviews and surveys, within a study rooted in a specific, socially-oriented discipline. However, intervention research has the potential to expand the meaning of MMR beyond mixing qualitative and quantitative methods. Health intervention research typically seeks to influence behaviour, which inescapably draws on both the natural and the social world. The body is an entity that exists in a physical sense, and sitting, standing and PA behaviours are emergent from having a physical body (S. Williams, 1999). Therefore, the research described within this thesis employed

device-based methods (i.e. GT3X+, ActivPAL) to measure behaviour. However, behaviour is not irreducible to the body, and it is influenced by various factors on different social 'strata' (Sayer, 2000, p. 99). Accordingly, subjective methods (i.e. interviewing, participant observation) were also employed to examine the social processes that influenced behaviour. A consequence of behaviour being influenced by factors on various levels, including the physical, psychological, cultural and structural, is that behavioural intervention research must inevitably draw upon multiple disciplines. This research project incorporated knowledge and understanding stemming from public health, physiology, sociology, and psychology.

This research also combined naturalistic and experimental methods. Whilst ethnographic participant observation and interviewing are both considered to be primarily qualitative methods, observation is embedded with social settings and thus provides the researcher with direct access to participants' behaviour, interactions and social processes (Morgan-Trimmer & Wood, 2016), whereas interviewing is an artificial process. A deeper understanding of the research problem was possible via the combination of interviews with participant observation (Watson, 2011). For example, observational and interview data reveal different perspectives regarding the feasibility and acceptability of the sit-stand desk installation process:

> He [Jim] seemed very stressed out… I heard him swearing under his breath… he arrived at 5am on the second day to ensure that everything was ready for when the installers arrived (Research notes, 25th Oct 2014)
>
> There was a couple of hairy moments here and there with the implementation but that's just part of the implementation, that happens, it wouldn't have made any difference if we were installing a normal desk or a sit-stand desk… the guys came on time and did what they had to do and, and it was all fine (Jim, Macmillan, operational stakeholder)

Alone, the observations suggest that the sit-stand desk installation was fraught with difficulties for Jim. However, a formal interview with Jim facilitated contextualisation of the installation within the organisational circumstances; the experienced challenges were expected and accepted. Utilising only one data collection technique - interviews or observations - would have only uncovered a partial perspective of the feasibility and acceptability of the installation process. This example illustrates that it is not always necessary to combine qualitative and

quantitative methods to gain a more complete and nuanced understanding. The type and extent of mixing should be guided by the research question.

7.4 Concluding remarks

This chapter has discussed the use of mixed methods to evaluate behavioural interventions, drawing on the research conducted as part of this thesis. Whilst researchers are increasingly employing process evaluations of interventions, alongside outcome evaluations (Morgan-Trimmer, 2015), the two components of the study are typically reported in parallel, as in chapters 5 and 6 of this thesis. The present chapter has demonstrated that there is potential for integrating the outcome and process elements of the study at various points throughout the research process, including during data collection, analysis and interpretation, which can advance knowledge beyond that gleaned from the individual outcome and process components. Mixed method reporting could occur as an adjunct to, or instead of, separate reporting of findings based on methods, depending on the specific details and context of the research. MMR can produce complimentary and contradictory evidence, both of which can deepen understanding. Researchers should consider mixing methods - including objective and subjective methods, different qualitative methods, qualitative and quantitative methods, multiple disciplines, etc. - to gain a more complete and nuanced understanding of the complexity of human behaviour.

Chapter 8 - Conclusion

8.0 Introduction

This chapter summarises the findings of this study, and presents implications for workplaces and research. The research employed an innovative mixed method design which comprised an outcome and process evaluation of a 12-month sit-stand desk intervention aiming to reduce sitting and increase standing and PA, delivered in two UK office-based workplaces. The efficacy of a multicomponent intervention was examined using wearable devices to measure sitting, standing and PA. In-depth interview and observational methods were used to examine the processes that influenced the feasibility, acceptability and efficacy of the intervention. The aim of this thesis was to examine strategies to reduce sitting and increase PA in office-based workplaces. Two research questions framed the study:

1. What is the efficacy of a multicomponent sit-stand desk intervention designed to reduce sitting, and increase standing and PA?
2. What are the processes that influence the feasibility, acceptability and efficacy of sit-stand desk implementation and use?

The sections that follow first summarise the research findings by describing how the outcome analysis and process evaluation address the research questions (section 8.1) and how mixed methods analyses can contribute to the advancement of knowledge (section 8.2). The implications of the findings for policy and practice are then identified (section 8.3). The chapter reflects on the strengths and limitations of the research and suggests potential future research directions (section 8.4), before offering an overall conclusion to the study (section 8.5).

8.1 Understanding the efficacy, feasibility and acceptability of the sit-stand desk intervention: A summary of findings

This section presents a summary of key findings. Section 8.1.1 summarises findings related to intervention efficacy, and section 8.1.2 summarises findings related to the feasibility and acceptability of sit-stand desk installation and use.

8.1.1 Understanding intervention efficacy

The pilot RCT indicated a significant, 35 minute/day increase in standing during work hours across the pooled intervention groups (IGs), averaged across the post-intervention time points. Therefore, this thesis adds to existing evidence that sit-stand desks can be efficacious in increasing standing in the office-based environment. Changes in workplace sitting and standing were most substantial at 12-months; on average, standing was increased by 47 minutes/day and sitting was reduced by 56 minutes/day during work hours at the 12-month timepoint, across the pooled IGs. Interview data suggests that whilst there was an initial novelty effect of using the sit-stand desk, deliberate use of prompts (e.g. task-based; standing for certain tasks and sitting for others) facilitated the formation of a subconscious standing habit over a more substantial period, i.e. 6-12-months following sit-stand desk provision. Thus, this thesis advances knowledge regarding the potential for sit-stand desk interventions to facilitate sustainable changes in workplace sitting and standing behaviour.

Average changes in sitting and standing across the whole day were less substantial than during work hours, as, on average, pooled IG participants increased sitting by 8 minutes/day during non-work hours. There was a significant negative correlation between changes in sitting during work hours and non-work hours (r = -.627, p = .007). Interviewees' accounts indicate that compensatory increases in sitting outside work were subconscious, as employees tended to self-report positive changes in sitting and standing in non-work contexts. An original finding of this research is that lower paid employees were likely to reduce sitting and increase standing at work to a greater degree than higher paid employees. Job roles commensurate with higher salaries usually necessitate a busier work calendar, meaning that less time is spent at the desk, which limits the capacity of employees to stand at their sit-stand desk. Thus, this thesis advances knowledge by identifying types of (office-based) job roles that might most benefit from sit-stand desk provision. Targeting lower-paid employees who are usually more 'desk-bound' could contribute to reducing, or at least not exacerbating, existing health inequalities between higher and lower paid workers.

The findings within this thesis build on existing evidence that sit-stand desk interventions have no influence on PA variables. However, the in-depth qualitative work within this thesis extends existing evidence by unpicking the processes that restrict intervention efficacy related to PA. Namely, within the participating organisations, there was a shared cultural assumption that being present at the desk was required to undertake productive work, which restricted employees' opportunities to increase PA in the workplace. In addition, the content of the multicomponent intervention emails contradicted employees' perceptions of the organisational culture, which may have caused employees to view this aspect of the intervention negatively, and consequently reduce the overall efficacy of the multicomponent intervention. These findings provide novel evidence that alignment with pre-existing organisational cultural assumptions and values is likely to enhance the impact of workplace interventions aimed at reducing sitting and increasing PA.

8.1.2 Understanding intervention feasibility and acceptability

Organisational perspective

An innovative aspect of this research was the incorporation of stakeholders' voices within the process evaluation of the intervention, which led to the identification of factors that influence organisations' inclination to invest in sit-stand desk interventions. Stakeholders articulated arguments consistent with the healthy workplace discourse as a rationale for investing in sit-stand desks. However, not all interviewees held positive attitudes towards sit-stand desks. Interview data indicated that the alignment of employees' views with the healthy workplace discourse was somewhat dependent on their occupational identity; those employed in health-focused roles were more likely to be sympathetic to the discourse underpinning the healthy workplace model, whereas those in non-health-related roles were more likely to consider whether sit-stand desk provision aligned with the beliefs and priorities underpinning their specific occupation or job role. Contextual factors were also identified that strengthened or compounded employees' views of whether sit-stand desks would contribute to achieving organisational outcomes. The health-focused nature of the participating organisations led to an increased acceptance of sit-stand desk provision within the workplace, due to a view that 'practicing what they preach' in external work programmes internally (via the provision of sit-stand desks) would

enhance the organisations' credibility. Conversely, the public and charity nature of the participating organisations complicates the relationships between investing in sit-stand desks and improved organisational outcomes as interviewees voiced that spending charity or public money on sit-stand desks might be viewed negatively by employees and external stakeholders and damage the organisations' reputation.

Organisational contextual factors that impeded or facilitated the sit-stand desk implementation process were also identified. A higher degree of structural centralisation and formalisation and ongoing organisational re-structuring processes restricted the ease of implementation. Factors found to facilitate implementation feasibility included greater employee capacity for the project delivery via incorporating the project into employees' job roles and choosing models of sit-stand desks that are compatible with the workplace environment. Thus, this thesis provides new evidence of organisational processes that restrict or facilitate the perceived feasibility and acceptability of implementing sit-stand desk interventions, which may assist organisations in selecting appropriate workplace health interventions and/or improving the ease and acceptability of sit-stand desk provision.

Employee perspective

There was substantial inter-individual variation in changes in sitting and standing at work across intervention group participants. The in-depth qualitative exploration permitted an examination of factors related to employees' lived experiences that contributed to the variation in use. Factors that influenced employees' attitudes towards sit-stand desk use included the influence that using the sit-stand desk had on physical and social comfort, health, and work efficiency, which all varied between participants. The impact on work efficiency was a particularly salient influence on sit-stand desk use, due to employees' strong work ethic.

This thesis extends current understanding of how sit-stand desk design issues contribute to reduced acceptability of sit-stand desks by drawing on product design theory to conceptualise and provide a more nuanced account of sit-stand desk experience as being dependent on the interaction between the product and the user within the workplace setting (Chamorro-Koc et al., 2009; Desmet & Hekkert, 2007). For example, employees that identified that their job role was conducive to working with lots of papers were more likely to identify the size of the sit-stand desk as

restricting the feasibility of using the sit-stand desk. It is argued that there are no intrinsically 'good' or 'bad' design features, particularly in relation to usability, as perceptions and experiences are influenced by individual and contextual factors.

8.2 Advancing knowledge via mixed method analysis

The research within this thesis required the use of mixed methods, combining a pilot RCT and process evaluation to comprehensively address the research questions. This thesis created innovative approaches to mixed method analyses to examine the potential to enhance understanding, by integrating outcome and process data and findings, beyond knowledge generated by the sum of the individual parts (Fetters & Freshwater, 2015). An approach that involved an integrated interpretation of separate outcome and process evaluation findings to deepen understanding of intervention efficacy was first presented. A case-oriented approach that involved an integrated analysis of activity monitor, diary, interview and observational data pertaining to a select participant, Joan, was secondly presented.

The illustrative examples and ensuing discussion contributed to knowledge production regarding different ways of analysing and interpreting MMR. Both the integrated interpretation approach and the case study approach provided illustrative evidence that outcome and process findings produce different types of knowledge about a phenomenon which can elicit a more comprehensive understanding of intervention efficacy, which is summarised in section 8.1.1. Specifically, the outcome evaluation addressed whether the intervention was efficacious, and the process evaluation identified processes that influenced intervention efficacy within the workplace context. For example, the interview and observational data suggested that organisational cultural assumptions regarding prioritising work, and the conflation of productivity with desk-based work shaped the outcome finding that the sit-stand desk intervention did not increase PA. The different approaches to mixing methods also demonstrated that understanding can be enhanced via the interrogation of paradoxical findings. For example, the paradox between Joan's activity monitor data, which indicated small changes in workplace standing, and Joan self-reporting always standing at the sit-stand desk, led to the identification of seniority and work

schedules as a noteworthy influence on employees' capability to increase standing via using the sit-stand desk.

Whilst both approaches to integrating methods enhanced understanding, a strength of the approach that mixes methods at the level of interpretation is that research quality is not compromised as it does not interfere with the rigorous analysis procedures including statistical analysis of outcome data and thematic analysis of process data. A strength of the case-oriented approach is that the data sources intertwine more effectively as they correspond to a single participant. This thesis provides evidence that integrating data and findings from different methods can enhance value beyond the sum of the individual parts. Thus, it advocates for researchers to attempt to integrate findings from different methods when evaluating behavioural workplace interventions to enhance knowledge production. Within behavioural intervention research this can include mixing objective and subjective methods, qualitative and quantitative methods, and different disciplines, to better understand the complexity of human behaviour and behaviour change.

8.3 Policy and practice implications for workplaces

The views of the office-based employers and employees contained within this thesis indicate that reducing time spent sitting at work *is* an important consideration, given that high levels of workplace sitting are strongly tied to the working conditions (seated-desk work) imposed by the employer. Productivity is implicitly valued within the work context, and productivity is synonymous with 'being at the desk', which helps explain workers' reluctance to reduce sitting and/or engage in physical activity away from the desk. The findings contained within this thesis indicate that sit-stand desks may be an appropriate solution to reduce desk-based sitting for *some* employees within *some* organisations.

This section presents three broad implications from the research for workplace practice: (a) sit-stand desks can be offered by workplaces as part of a wider strategy for reducing sitting and increasing PA (section 8.2.1), (b) sit-stand desks are not a one-size-fits-all solution for reducing sitting and increasing PA (section 8.2.2), and (c) a clear strategy for commissioning sit-stand desk working is

required to realise acceptability and feasibility of provision (section 8.2.3). The ordering within this section is not indicative of importance; it is anticipated that different elements of the presented implications will be perceived as more relevant and important for different stakeholder groups.

8.3.1 Sit-stand desks can be offered by workplaces as part of a wider strategy for reducing sitting and increasing physical activity

Overall, the findings relating to the efficacy of the sit-stand desk intervention on reducing sitting and increasing standing and PA infer that, (a) sit-stand desks can play a role in facilitating behaviour change, but (b) they should not be a stand-alone strategy, as their impact on physical activity is limited. It is important that workplaces do not adopt sit-stand desks as their *sole* strategy for promoting healthier physical behaviour patterns amongst their employees as higher intensities of PA are more closely linked to health benefit and a high dose (intensity and frequency) of physical activity may offset the detrimental health impact associated with prolonged sedentary behaviour (Ekelund et al., 2015).

Additional strategies for workplaces to reduce sitting and increase PA include:

- Encourage employees to persist with consciously utilising strategies to facilitate postural change at the sit-stand desk, to encourage habit formation
- Encouragement to take regular, short light-intensity PA breaks from sitting to increase PA and positively influence sitting patterns (i.e. a higher number of shorter bouts)
- Promote sitting reduction in non-desk workplace contexts, such as meetings
- The inclusion of strategies with a specific focus on increasing MVPA, such as lunch-time sport, exercise or walking sessions, or walking meetings, and challenging judgemental attitudes towards taking breaks from the desk
- The inclusion of strategies that focus on reducing sitting and increasing PA in travel and leisure contexts; for example, offering a cycle to work scheme or discounted gym membership, to minimise the compensation effect associated with workplace interventions
- Aligning intervention strategies with the organisational culture, by utilising a participatory approach to intervention development, which involves employees

in the identification of suitable intervention strategies to enable the intervention to be tailored to the specific context (Dugan et al., 2016; Øen & Stormark, 2013)

- Implementing organisation-level intervention strategies aimed at cultural change, to encourage the normalisation of standing, taking breaks from the desk and increased PA. This could include a sit-stand desk policy, policies that support agile working, leadership role-modelling taking breaks, facilitating informal conversations around health, etc.

8.3.2 Sit-stand desks are not a one-size-fits all solution for reducing sitting and increasing physical activity in office-based workplaces

Contextual and occupational factors influence organisational attitudes towards sit-stand desk provision. In addition, contextual and individual factors contribute to differing experiences of using sit-stand desks amongst employees, which indicates that sit-stand desks are not a one-size-fits-all solution for reducing sitting, and increasing standing and PA, amongst office-based employees. Employers should consider the suitability of sit-stand desks as a workplace health strategy within the context of their organisation, and if deemed appropriate, employees should be given a choice of whether they would like a sit-stand desk.

To improve organisational acceptability towards sit-stand desk provision:

- Employees in health-related roles should champion sit-stand desks to convince employees in non-health-related roles of the benefits of supporting employee health, including the preventative health benefits of sit-stand desks
- Employees in health-related roles (for example, human resources) should be involved alongside facilities employees in the procurement of desk-based equipment, to increase the likelihood of employee health considerations being incorporated into desk selection
- Develop a communication strategy to inform employees and external stakeholders of why sit-stand desks are a positive investment, to reduce the likelihood of reputational damage and negative employee attitudes
- Alternatively, consider potential lower-cost options, e.g. investing when a refurbishment is required, investing in a small number of sit-stand desks, seeking sit-stand desk donations or explore external funding avenues

- If only investing in a small number of sit-stand desks, consider which employees should receive them. Potentially acceptable options include; less senior employees (who are based at their desk for a larger proportion of the day), placing sit-stand desks as hot-desks either as a cluster within break-out areas, or one within every work team
- Provide sit-stand desks for employees that want one, focusing on alternate strategies for reducing sitting for employees who express negative attitudes towards sit-stand desks

To improve employees' experience of using sit-stand desks:

- Offer different sit-stand desk models to employees, and ensure that employees have seen and trialled a demonstration sit-stand desk before it is installed, to facilitate the selection of a desk that is most usable for the employee
- Tailor sit-stand desk provision to individuals' needs and preferences; for example, provide a side table for employees whose job roles dictate that they work with lots of paper
- The factors identified as *negatively* influencing attitudes towards using a sit-stand desk in the present research can be used to refine workplace interventions; for example:
    - Ensure there is more than one sit-stand desk within each team, to prompt each other to stand, and encourage senior leaders to utilise sit-stand desks and be accepting of team members using sit-stand desks, to minimise social discomfort
    - Clearly articulate that prolonged workplace sitting at the desk should be replaced with intermittent sitting, standing, and light PA, to reduce the chances of experiencing MSD because of prolonged static standing
    - Include culturally specific adaptations to encourage use of sit-stand desks; for example, educate employees that using a sit-stand desk is not associated with reduced in efficiency, given the organisational cultural assumptions regarding productivity

8.3.3 A clear strategy for installing sit-stand desks will improve the feasibility of provision

The process evaluation indicated that the feasibility of sit-stand desk provision is somewhat dependent on relatively fixed organisational structural and contextual factors. However, certain conditions that might improve the feasibility of implementing sit-stand desks within organisations were also identified and are outlined below.

To improve the ease of sit-stand desk implementation within organisations:

- Provide leadership by a relevant department; for example, occupational health
- Incorporate sit-stand desk provision into the job role of at least one employee, to increase capacity for investing time into sit-stand desk provision
- Form a project team to support the lead, involving employees from other relevant departments including health and safety, IT, facilities, communications, etc. The project team should be small to facilitate open and close communication
- Allocate an agreed budget for sit-stand desk provision, and monitor budget over time
- Extensively research sit-stand desk options and select models that are compatible with the workplace environment.
- Conduct a site survey with potential sit-stand desk suppliers to recognise the specific requirements of the organisation for successfully installing sit-stand desks
- Develop organisation-specific policies and processes for sit-stand desk provision, based on the organisational context and early experiences of sit-stand desk provision, to improve the efficiency of sit-stand desk provision over time

8.4 Strengths, limitations and future research directions

This section discusses the strengths and limitations of the study design and methods (section 8.4.1), and the theoretical underpinnings of the study (section 8.4.2). Potential future research directions that build on the approach and findings presented within this thesis are articulated.

8.4.1 Research design and methods

The outcome analysis

Strengths of the outcome evaluation include the pilot RCT design, and the 12-month follow-up period, which permitted assessment of whether behaviour change is sustained. However, the small sample size meant that the pilot RCT was not sufficiently powered to detect meaningful effects. Further research is needed to confirm the effectiveness of workplace sit-stand desk interventions on reducing sitting. The primary outcome should be sitting reduction across the whole day at 12-months, as the pilot RCT reported in this thesis indicates that there may be a compensation effect during non-work hours. A reduction in workplace sitting is unlikely to have a health benefit unless the sitting reduction is maintained across the whole day. Whilst the minimum reduction in sitting that would yield a positive change in metabolic outcomes is unclear, there is evidence for a dose-response relationship between sitting, metabolic health outcomes and all-cause mortality (Biswas et al., 2015; Edwardson et al., 2012). Until a clinically meaningful difference is determined through experimental research, future studies might conservatively define the minimum difference of interest as 90 minutes/day.

In the pilot RCT reported within this thesis, six (20%) of the participants dropped out of the study between the 6-month and 12-month time points, due to leaving their organisation; a longer follow-up is likely to be even more affected by sample attrition. Thus, whilst future studies should include longer follow-up periods to examine sustainability, additional participants should be recruited at baseline to account for expected sample attrition due to employees leaving the organisation, and/or the study should take an intent-to-treat approach. Further, future RCT's should blind researchers, where possible, to group allocation.

Sitting, standing, and different intensities of PA all influence health outcomes (L. Smith, Ekelund, et al., 2015; Thompson et al., 2015). Thus, the inclusion of a variety of PA outcome variables, alongside the use of device-based technology, was a strength of the present research. Further, a person-centred approach was adopted to classify waking hours, which is more valid than selecting an arbitrary cut-off (e.g. 7am-11pm) (Edwardson et al., 2016). However, work hours were classified as 9am-5pm. Whilst these are the official work hours of the participating organisations,

participants may have slightly different work patterns on different days. Future studies might take a person-centred approach to classifying work hours to increase the accuracy of the time of day analyses.

The process evaluation

This research included a qualitative process evaluation which permitted examination of the potential processes that influenced the feasibility, acceptability and efficacy within the intervention delivery context. Whilst extant literature has investigated managers' and practitioners' attitudes towards *hypothetical* sit-stand desk provision (Gilson et al., 2012; Hadgraft et al., 2016) this thesis interviewed relevant stakeholders following, and regarding, the sit-stand desk *implementation process*. This approach permitted the examination of organisational contextual and structural factors that influenced sit-stand desk implementation feasibility, however the generalisability of these findings is uncertain as they are based on a study of only two workplaces. Investigation into organisational contextual factors that impede and restrict the sit-stand desk implementation process within varied organisational settings would help strengthen and extend the evidence generated within this thesis. A detailed map of relevant organisational contextual factors and the processes that link them to the ease of implementation would permit an assessment of how feasible sit-stand desk implementation is likely to be for a given organisation.

A limitation of the participant interview component of the study is that interviewees are predisposed to positive attitudes towards sit-stand desks, as they self-selected to partake in a workplace intervention that included sit-stand desk provision. Findings from a study of responses to workplace sitting reduction guidelines suggest that some people have intense negative feelings regarding the provision of sit-stand desks to office-based employees (Gardner, Smith, et al., 2017). Future intervention studies could interview employees that actively chose not to participate in the intervention, to gain a more rounded view of the acceptability of sit-stand desks. Doing so would also permit a first-hand account of the impact of others' sit-stand desk use on employees that do not have one, or do not wish to use one. Interviewing non-sit-stand desk users would help to develop, or contest, some of the findings with the present study. For example, it would permit examination of sit-stand desk users' suggestion that other employees may feel coerced into using a

sit-stand desk against their will due to the connotations connected to health behaviours (e.g. discipline); see section 6.1.2.

Process evaluation guidance indicates that intervention fidelity should be assessed, to determine whether the intervention was delivered as intended, as RCTs can only assess outcomes associated with the delivered intervention, not the intended intervention (Moore et al., 2015). A limitation of the process evaluation in this study is that intervention fidelity was not assessed. Future process evaluations of workplace sit-stand desk interventions should assess intervention fidelity by, for example, recording intervention phone calls.

This study contributed to methodological advancement of approaches to conducting process evaluations of workplace sit-stand desk interventions by combining interviews with participant observation. Conducting observations was particularly valuable for examining organisational culture and contextualising interview data, as it involves the collection of data within the naturalistic setting and enables direct access to organisational processes and employee interactions (Morgan-Trimmer & Wood, 2016). Utilising these methods also permitted an examination of the impact of the intervention on the organisational setting (Golden & Earp, 2012), including organisational cultural change related workplace sitting and PA. Future workplace intervention research should incorporate observational techniques to study different organisational settings and cultures to examine how they influence, and are influenced by, behavioural workplace interventions.

8.4.2 The theoretical implications of the research

Chapter 2 identified the importance of theory in developing and evaluating behavioural interventions (e.g. Moore et al., 2015; Nilsen, 2015; and see section 2.3.1). The design and evaluation of the sit-stand desk intervention were underpinned by the socioecological model (SEM) and organisational cultural theory. The findings strengthened evidence in support of the strong guiding influence of organisational culture on attitudes and behaviour. For example, this thesis argued that the perceived impact of sit-stand desk use on productivity strongly predicts future use due to a shared organisational cultural assumption regarding the importance of productivity. However, a limitation of the intervention evaluated in this thesis is that it sought to change employees' *perception* of the organisational culture as changing the

organisational culture itself would impact employees in the sit-stand only and control groups, as well as the targeted multicomponent intervention group. Future intervention research should adopt cohort designs whereby participants for different intervention groups are recruited from separate workplaces, to permit the delivery and evaluations of interventions that seek to modify organisational culture.

A systematic review identified that only 36% of process evaluations of workplace health interventions utilised a theoretical framework (Wierenga et al., 2013). A noteworthy strength and original aspect of the present study compared to existing evaluations of sit-stand desk interventions is the *theoretical* analysis of intervention efficacy and acceptability. The process evaluation findings provide support for utilising the SEM within behavioural intervention research, as the evaluation identified a range of influences, on different 'levels', that interacted to influence sit-stand desk experience and behaviour change. The findings support the assertion that efficacy is not straightforwardly inherent within interventions, but rather the magnitude and direction of changes depend on the interaction of the intervention with other influences on behaviour within the intervention context. For example, employees' personal characteristics and circumstances, and differing job roles and work conditions shaped the influence of the sit-stand desk intervention on sitting, standing and PA. Given that different factors reduce the acceptability of sit-stand desks for different employees, future research could assess the effectiveness of workplace interventions that allow participating employees to select additional intervention components, from a smorgasbord of options, that they perceive would be most appropriate to their preferences and circumstances.

Findings within this thesis extend knowledge by challenging the simplicity of the healthy workplace model. This thesis identifies various organisational cultural and contextual factors that complicate the relationship between sit-stand desk provision and organisational outcomes. Thus, there is scope for the healthy workplace model to be extended to provide a more accurate and nuanced depiction of the complexity of the relationship between employee health initiatives and organisational outcomes within different organisational contexts and settings.

8.5 Concluding remarks

This thesis extends knowledge of the suitability of sit-stand desks as a strategy to reducing sitting and increasing standing and PA in office-based employees. The pilot RCT provides evidence that sit-stand desks can be an efficacious strategy for reducing sitting and increasing standing at work, but that they have a limited influence on PA. The process evaluation was central to the generation of knowledge that sit-stand desk intervention feasibility, acceptability and effectiveness are dependent on an interaction between a range of influences, including but not limited to individual-factors, within the organisational context. It also highlights the importance of organisational culture on guiding employee and organisational attitudes towards sit-stand desks and sit-stand desk use. The novel approach to mixed method analysis provided a unique, comprehensive and nuanced account of the appropriateness of sit-stand desk interventions as a workplace health strategy. Research is needed to build on the example approaches to integrating outcome and process evaluations of interventions by, for example, presenting a comparison of multiple in-depth case studies, to explore how knowledge generation from mixed method analyses can be broadened further.

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Appendices

Appendix A

Content of emails that comprised the organisation-level component of the multicomponent sit-stand desk intervention

Macmillan email 1, week 3

Subject: Take a Stand for Workplace Health: sit-stand workstation project

Dear all

I hope you are looking forward to receiving your sit-stand workstation next week as part of the Macmillan-Brunel University 'Take a Stand for Workplace Health' project.

The 'Take a Stand for Workplace Health' project is aligned with Macmillan's Wellbeing Model in which the physical and psychological health of employees is a key component. Macmillan wish to create a working environment that minimises unhealthy behaviours and promotes healthy behaviours.

Switching between sitting and standing at your desk is a convenient way to reduce prolonged sitting in the workplace. Avoiding static behaviours and, thus, encouraging movement in the workplace can optimise your wellbeing at work. Incorporating sit-stand workstations into Macmillan's offices has the potential to produce a healthier working environment.

Many thanks for your continued engagement with this project. Please get in touch with Jennifer Hall (lead researcher; Jennifer.Hall@brunel.ac.uk) or [officer name] (Physical Activity Officer; [officer email address]) if you have any further questions now or at any stage during this project. Otherwise, I hope you make the most of this exciting opportunity to sit and stand!

Many thanks

[manager name and signature]

PHE email 1, week 3

Subject: Take a Stand for Workplace Health: sit-stand workstation project

Dear all

I hope you are looking forward to receiving your sit-stand workstation next week as part of the Public Health England-Brunel University 'Take a Stand for Workplace Health' project.

The 'Take a Stand for Workplace Health' project is aligned with PHE's wellbeing approach in which the physical and psychological health of employees is a key

component. PHE wish to create a working environment that minimises unhealthy behaviours and promotes healthy behaviours.

Switching between sitting and standing at your desk is a convenient way to reduce prolonged sitting in the workplace. Avoiding static behaviours and, thus, encouraging movement in the workplace can optimise your wellbeing at work. Incorporating sit-stand workstations into PHE's offices has the potential to produce a healthier working environment.

Many thanks for your continued engagement with this project. Please get in touch with Jennifer Hall (lead researcher; Jennifer.Hall@brunel.ac.uk) if you have any further questions now or at any stage during this project. Otherwise, I hope you make the most of this exciting opportunity to sit and stand!

Many thanks

[Manager name and signature]

Macmillan email 2, week 9

Subject: Take a Stand for Workplace Health: sit-stand workstation project

Dear all

I hope your transition to sit-stand working is developing well and that you are getting used to your new sit-stand workstation.

Macmillan is involved with and supportive of 'Take a Stand for Workplace Health' as the physical and psychological health of Macmillan employees is one of our key priorities. The attached information sheet explains how using a sit-stand workstation could benefit your health at work, and provides some useful references for further reading.

Many thanks for your continued engagement with this project. Please get in touch with Jennifer Hall (lead researcher; Jennifer.Hall@brunel.ac.uk) or [officer name] (Physical Activity Officer; [officer email address]) if you have any further questions now or at any stage during this project. Otherwise, I hope you make the most of this exciting opportunity to sit and stand!

Many thanks

[Manager name and signature]

PHE email 2, week 9

Subject: Take a Stand for Workplace Health: sit-stand workstation project

Dear all

I hope your transition to sit-stand working is developing well and that you are getting used to your new sit-stand workstation.

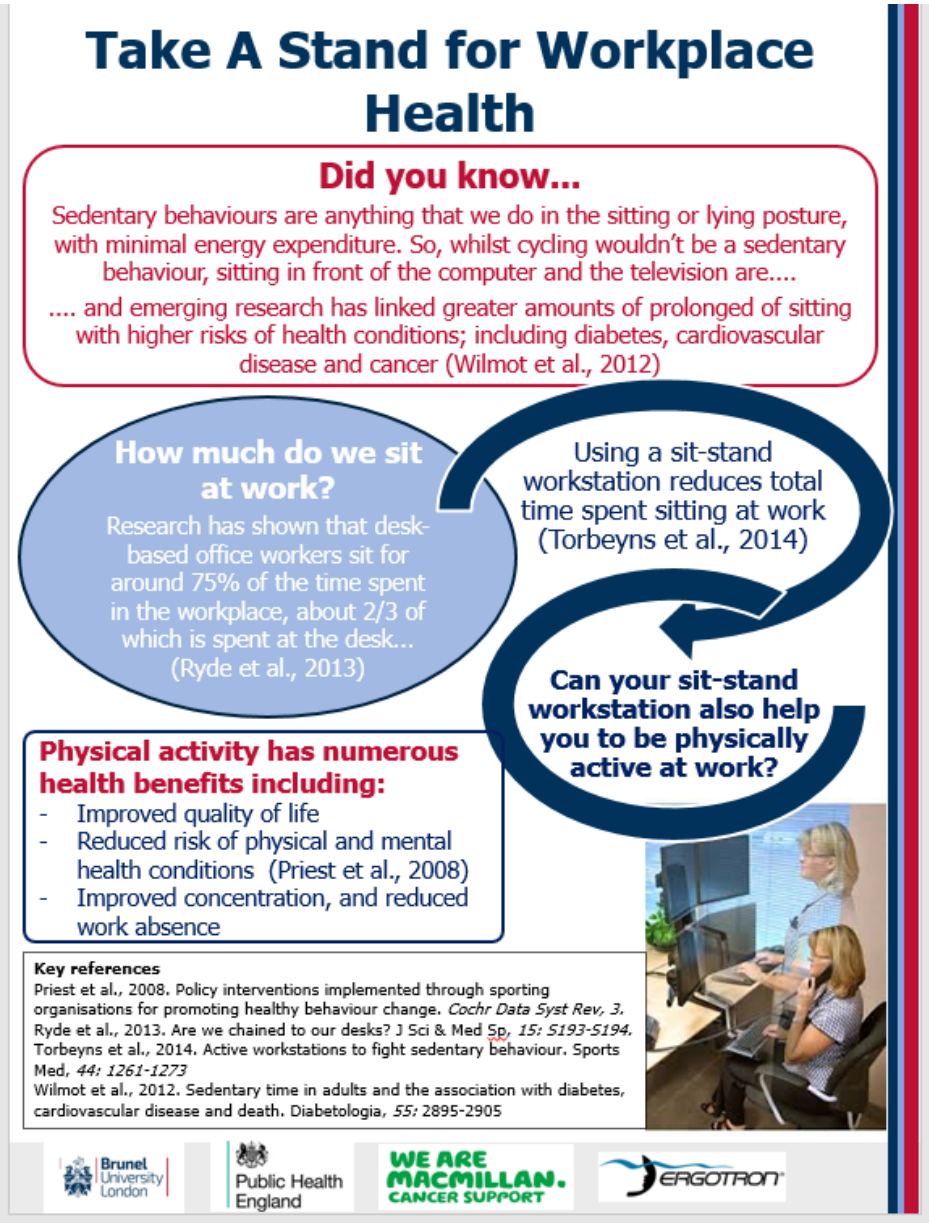
PHE is involved with and supportive of 'Take a Stand for Workplace Health' as the physical and psychological health of our employees is one of PHE's key priorities. The attached information sheet explains how using a sit-stand workstation could benefit your health at work, and provides some useful references for further reading.

Many thanks for your continued engagement with this project. Please get in touch with Jennifer Hall (lead researcher; Jennifer.Hall@brunel.ac.uk) if you have any further questions now or at any stage during this project. Otherwise, I hope you make the most of this exciting opportunity to sit and stand!

Many thanks

[Manager name and signature]

Information sheet, attached to Macmillan and PHE week 9 emails



Macmillan email 3, week 17

Subject: Take a Stand for Workplace Health: sit-stand workstation project

Dear all

It is now just over three months since you received your sit-stand workstation. I hope that you have now been able to successfully integrate sit-stand into your working day, and that you are benefitting from the opportunities to be more active.

Reducing prolonged sitting and increasing activity throughout the day may have a positive impact on your health and wellbeing. Macmillan believes the development of a healthy working environment makes for a healthier workforce, which leads to organisational improvements including reduced sickness absence and improved organisational efficiency. Macmillan's philosophy is therefore aligned with current Governmental Priorities around health at work, such as the Workplace Wellbeing Charter.

We think an important way to achieve our Macmillan objectives, and to support people affected by cancer, is to create an environment in which we feel supported ourselves. By ensuring we maximise our own health and wellbeing at work, we will be in the best position to perform our jobs effectively and thus make the biggest impact to people affected by cancer.

Many thanks for your continued engagement with this project. Please get in touch with Jennifer Hall (lead researcher; Jennifer.Hall@brunel.ac.uk) or [officer name] (Physical Activity Officer; [officer email address] if you have any further questions now or at any stage during this project.

Many thanks
[Managers name and signature]

PHE email 3, week 17

Subject: Take a Stand for Workplace Health: sit-stand workstation project

Dear all

It is now just over three months since you received your sit-stand workstation. I hope that you have now been able to successfully integrate sit-stand into your working day, and that you are benefitting from the opportunities to be more active.

Reducing prolonged sitting and increasing activity throughout the day may have a positive impact on your health and wellbeing. PHE believes the development of a healthy working environment makes for a healthier workforce, which leads to organisational improvements including reduced sickness absence and improved organisational efficiency. PHE's philosophy is therefore aligned with current Governmental Priorities around health at work, such as the Workplace Wellbeing Charter.*We think an important way to achieve our objectives, and to protect and improve the nation's health and wellbeing, is to create an environment in which we*

feel supported ourselves. By ensuring we maximise our own health and wellbeing at work, we will be in the best position to perform our jobs effectively.

Many thanks for your continued engagement with this project. Please get in touch with Jennifer Hall (lead researcher; Jennifer.Hall@brunel.ac.uk) if you have any further questions now or at any stage during this project.

Many thanks
[Manager name and signature]

Macmillan email 4, week 27

Subject: Take a Stand for Workplace Health: sit-stand workstation project

Dear all

It is now six months since you received your sit-stand workstation. I hope that you are benefitting from the opportunities to be more active which have been provided by the sit-stand workstation project.

At Macmillan, we think that the UK is currently in the midst of a real societal shift towards understanding the risks of prolonged sitting in the workplace, and encouraging solutions to break up sitting time and integrate activity into the working day. You may have seen the "On Your Feet Britain" campaign on the news, which encourages employers to support their employee's health by providing opportunities for them to be more active at work. As well as supporting the provision of sit-stand workstations, the campaign provides other recommendations to help employees be active in the workplace, including:

- Standing and taking a break from your computer every 30 minutes
- Having standing or walking meetings
- Eating your lunch away from your desk
- Walking to your colleague's desk instead of phoning or emailing them
- Standing at the back of the room during presentations

Macmillan are proud to be pioneers of this approach. We are driving change within Macmillan to support the wellbeing of our own staff, whilst also encouraging other organisations to make similar changes. I hope that you will advocate the sit-stand approach to colleagues inside the organisation, and friends and family that work elsewhere, as a result of your experiences of being part of the sit-stand workstation project at Macmillan.

This will be the final email that I will send to you in relation to the "Take a Stand for Workplace Health" project. However, if you have any other questions about anything that we are doing in HR to support the health and wellbeing of our staff, then please do not hesitate to get in touch. Alternatively, please contact Jennifer Hall (lead researcher; Jennifer.Hall@brunel.ac.uk) or [officer name] (Physical Activity Officer; [officer email address]) if you have any further questions about the sit-stand project.

Once again, thanks for your continued engagement with this project.

Many thanks
[Manager name and signature]

PHE email 4, week 27

Subject: Take a Stand for Workplace Health: sit-stand workstation project

Dear all

It is now six months since you received your sit-stand workstation. I hope that you are benefitting from the opportunities to be more active which have been provided by the sit-stand workstation project.

At PHE, we think that the UK is currently in the midst of a real societal shift towards understanding the risks of prolonged sitting in the workplace, and encouraging solutions to break up sitting time and integrate activity into the working day. You may have seen the "On Your Feet Britain" campaign on the news, which encourages employers to support their employee's health by providing opportunities for them to be more active at work. As well as supporting the provision of sit-stand workstations, the campaign provides other recommendations to help employees be active in the workplace, including:

- Standing and taking a break from your computer every 30 minutes
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- Walking to your colleague's desk instead of phoning or emailing them
- Standing at the back of the room during presentations

PHE are proud to be pioneers of this approach. We are driving change within PHE to support the wellbeing of our own staff, whilst also encouraging other organisations to make similar changes. I hope that you will advocate the sit-stand approach to colleagues inside the organisation, and friends and family that work elsewhere, as a result of your experiences of being part of the sit-stand workstation project at PHE.

This will be the final email that I will send to you in relation to the "Take a Stand for Workplace Health" project. However, if you have any other questions about anything that we are doing to support the health and wellbeing of our staff, then please do not hesitate to get in touch. Alternatively, please contact Jennifer Hall (lead researcher; Jennifer.Hall@brunel.ac.uk) if you have any further questions about the sit-stand project.

Once again, thanks for your continued engagement with this project.

Many thanks
[Manager name and signature]

Appendix B

Semi-structured scripts for the phone conversations that comprised the individual-level component of the multicomponent sit-stand desk intervention

Phone call 1, week 1

Introductions

Introduce self and ask if OK to talk, if happy to proceed then explain the purpose of the multicomponent intervention (extra support and encouragement for using sit-stand desk and increasing PA), and of this phone call in particular (thinking about activity, and expectations about sit-stand desk). Ask if they have any questions so far, before proceeding with questions

How active are you?

How active are you at work? Do you find that you are able to integrate movement into a sedentary office job? Is it important to you?

Would you say you are an active person outside of work? Do you want to be more active?

Barriers/facilitators

Introduction - There is a big push now in public health towards trying to reduce sedentary time. This is because sitting for prolonged periods has been linked to poorer physical and cardio-metabolic health, and poorer psychological well-being. People are trying to find ways to reduce sitting, especially in sedentary workplace environments like the office. Sit-stand desks are one way to do this as they allow you to break up sitting time with standing. Although it is recommended to sit and stand for a maximum of 2 hours at a time, we advocate an approach that you should do what feels right for you.

Can you think of anything that might be a barrier to you standing at your desk or being more active at work? (Prompts - feeling tired, self-conscious, uncomfortable)

Do you think there is any way that you may be able to overcome [barrier]? (encourage them to think of own solutions, but assist them if they cannot)

Can you think of anything that you think would encourage you to stand more or be more active at work? Is there anything that we at Brunel or Macmillan/PHE as an organisation could do to support you?

Goals for the project

Why did you initially apply to take part in the project?

So, you want to [goal]?... how do you think you might achieve that?

Ask them if they would like to set targets to achieve goal

Bring to a close

Thank employee for their time, state that you hope the call has been useful for them, ask them if they have any other questions about the intervention or the research before closing the call

Phone call 2, week 6

Introductions

Introduce self and ask if OK to talk. If happy to proceed, remind of the purpose of the phone calls

How are you finding your sit-stand desk so far?

How much are you using it in the standing position?

Is there anything stopping you using it more or are you happy with the level you are using it?

Any challenges? [explore how challenges can be overcome / minimised]

Tips for standing.

Explain:

- Regular switching between sitting and standing, movement is key
- Take breaks from your monitor
- Wear comfortable shoes
- Posture – standing straight (S-curve), legs hip distance apart

Goal setting / self-monitoring

Encourage completion of the sitting calculator to track their levels of daily sitting, ask if want to set goals and monitor progress, assist them in selecting goal(s) and method for monitoring progress

Bring to a close

Thank employee for their time, state that you hope the call has been useful for them, ask them if they have any other questions before closing the call

Phone call 3, week 13

Introductions

Introduce self and ask if OK to talk. If happy to proceed, remind of the purpose of the phone calls

How are you finding your sit-stand desk since our last call?

How much are you using it in the standing position? Is there anything stopping you using it more or are you happy with the level you are using it?

Review goals– have you managed to meet them? Why/why not?

Did you complete the sitting calculator? How did it make you feel? did it prompt you to stand more? [encourage to complete sitting calculator if have not done it]

Review standing tips if appropriate - Regular switching between sitting and standing, movement is KEY**;** Take breaks from your monitor**;** Wear comfortable shoes**;** Posture – standing straight (S-curve), legs hip distance apart

Prompts

Some of the feedback that we've had is that people would actually like prompts to stand, as you can go a long time sitting just without realising that you've not stood. I have some suggestions of software and methods that you might like to try to prompt you to stand at your desk *If they express interest, explain how they work and email over the details*

Bring to a close

Thank employee for their time, state that you hope the call has been useful for them, ask them if they have any other questions before closing the call

Phone call 4, week 22

Introductions

Introduce self and ask if OK to talk. If happy to proceed, remind of the purpose of the phone calls

How are you finding your sit-stand desk since our last call?

Review goals if set them – have you managed to meet them? Why/why not?

Review use of prompts – have they worked to encourage increased use of sit-stand desk? If not, why not? Can any other strategies be trialled?

Relapse prevention

Thinking how you can try and help yourself to continue using the desk. Sometimes events, like going away for a long holiday or being on sick leave, can disrupt habits, , or you might just gradually stand less

Can you think of anything you could do to counteract this happening? (prompts – make a conscious effort to stand whilst on leave; leave the sit-stand desk in the upright position before taking leave; pre-set reminders / prompts in your diary before you leave; ask your colleagues to remind you if they notice you have not been stood for a few days.

Bring to a close

Thank employee for their time, state that you hope the call has been useful for them, ask them if they have any other questions before closing the call, remind them that I am available via email or phone if they have any questions at any time

Appendix C

Organisational consent documentation

Macmillan organisational content letter

Macmillan Cancer Support
89 Albert Embankment
London SE1 7UQ
tel 020 7840 7840
fax 020 7840 7841

WE ARE MACMILLAN. CANCER SUPPORT

Take a Stand for Workplace Health

'Take a Stand for Workplace Health' is a workplace intervention programme that will take place over two worksites. Macmillan Cancer Support is invited to participate as one of the participating workplaces. The study will evaluate the contribution of a sit-stand workstation intervention to total physical activity. Our findings will help inform future provision of sit-stand workplace interventions.

By signing below Macmillan Cancer Support is agreeing to participate in this research as a study site, and co-operate with researchers on all elements outlined in the study proposal.

Further, by signing below Macmillan Cancer Support is confirming that the UK Office worksite conforms to relevant health and safety and risk-assessment legislation.

Name: RUTH CARLYLE
Signature:
Job title: HEAD OF SUPPORT & WELL-BEING
Date: 21 March 2014

Name: ANGY WRIGHT
Signature:
Job title: FACILITIES MANAGER.
Date: 4/4/14.

Questions about living with cancer? Call free on 0808 808 00 00 or visit macmillan.org.uk

PHE organisational consent letter

Take a Stand for Workplace Health

'Take a Stand for Workplace Health' is a workplace intervention programme that will take place over two worksites. Public Health England is invited to participate as one of the participating workplaces. The study will evaluate the contribution of a sit-stand workstation intervention to total physical activity. Our findings will help inform future provision of sit-stand workplace interventions.

By signing below Public Health England is agreeing to participate in this research as a study site, and co-operate with researchers on all elements outlined in the study proposal.

Name: Dr Justin Varney

Job title: Consultant in Adult and Older People's Health and Wellbeing, Public Health England

Signature: 

Date: 07/04/2014

Appendix D

Promotional recruitment materials

Recruitment email sent to all Macmillan and PHE staff eligible to participate in the research

Subject: Take a Stand for Workplace Health: a sit-stand workstation evaluation project

RESEARCH PARTICIPATION OPPORTUNITY – SIT-STAND WORKSTATIONS

[Organisation] are supporting a research project on the effect of sit-stand workstations on daily physical activity.

Would you like to take part?

Brunel University are looking for volunteers to take participate in this research. A **participant information sheet** is attached to this email. **Lunch and learns** are taking place at [organisation] to meet those who might be interested, discuss the study and answer any questions you may have. If you are interested in taking part you will be able to fill in the expression of interest and consent forms at the lunch and learn. These are taking place on:

- [date, room number]
- [date, room number]

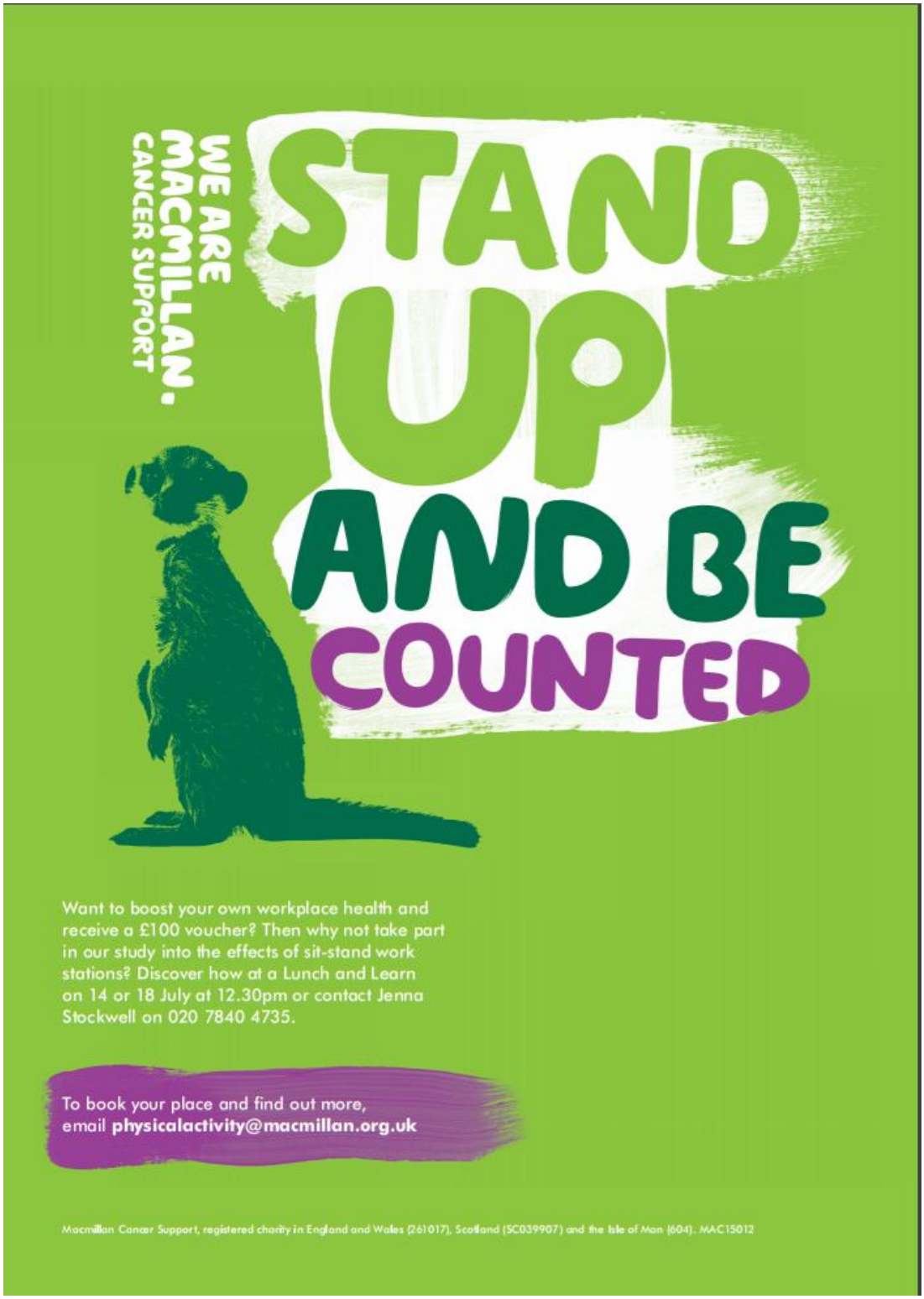
Please email Jennifer Hall, the lead researcher, on Jennifer.hall@brunel.ac.uk or call 07887356891 to book onto one of these workshops.

If you are unable to attend a workshop but you are interested in taking part in the study, please contact Jennifer using the email and/or contact number above and she can discuss the study with you, answer your questions and provide you with an expression of interest form if you required one.

Many thanks

Jennifer Hall

A recruitment poster displayed in the stair wells, lift areas and communal spaces within the workplace



Appendix E

Recruitment workshop agenda

TAKE A STAND FOR WORKPLACE HEALTH: A SIT-STAND DESK PROJECT EVALUATION

1. Welcome (5 min)

- Thank you for your time today and interest so far in the study
- Questions: Shout out as go along and/or opportunity to ask at the end
- Context and aim of the study: How do sit-stand desks contribute to total PA?

2. Study details (5 min)

- Randomised controlled design – 2/3 of participants will receive a sit-stand desk
- £100 'activity voucher' incentive for completing all elements of *evaluation* - suggestions?

3. Evaluation details (10 min)

- GT3X and ActivPAL: 6x 7 consecutive days (demonstrate monitors)
- Activity diary: 6x 7 consecutive days (example of activity diary)
- Interviews and ethnographic work

4. Screening process (10 min) - why we ask these questions and who will see the info.

Inclusion Criteria	**Screening questions (diversity)**
Must have their **own desk** (i.e. does not hot desk)	Age (categories)
Must engage in primarily **desk-based** work	Gender
Must be a **full-time,** employee on **a fixed term contract** for the duration of the study	Ethnicity
Must be primarily **office based** (i.e. not working from home), based at **Macmillan UKO, 89 Albert Embankment, Vauxhall**	Disability
Excludes Macmillan Support Line (**MSL**) staff (owing to workstation configuration)	What appeals to you about sit-stand workstations?
Must have **no plans to leave** the organisation for an extended period (e.g. holiday > 4 weeks, secondment) or finitely before the anticipated study end date (31st November 2015)	Have you ever had a cancer diagnosis? (optional)
Must not have engaged in standing-based desk work in the month prior to the start of the study	Have you ever been personally affected by cancer? (e.g. family member / friend had cancer) (optional)
Must not have been advised against standing by a health professional; or be unable to stand	
Must be 18 years of age or above	

5. Q&A (10 min)

6. Completion of forms (15 min)

- Expression of interest and consent form

Appendix F

Participant information sheets

Participant information sheet for intervention participants

Brunel University, Kingston Lane, Uxbridge, UB8 3PH

Take a Stand for Workplace Health: A sit-stand workstation evaluation project

Information for Participants

The sit-stand workstation project

'Take a Stand for Workplace Health' is a workplace intervention programme taking place over two worksites in central London. You have been invited to participate as an employee of one of the participating workplaces. The project will assist understanding of the use of sit-stand workstations. Our findings will help inform future provision of sit-stand workplace interventions.

Who can take part in the research?

Participants must be full-time employees on a fixed term contract until the anticipated study end date at the [organisation name, specific office address]. Participants must be employed in desk-based work, be office-based (i.e. not work from home) and have their own desk (i.e. do not hot desk). [Particular department] employees are excluded owing to workstation configuration and sensitivity of their work. Participants should also have no plans to leave the organisation for an extended period (e.g. holiday longer than 4 weeks or a secondment) or finitely before the anticipated study end date (31st October 2015). Participants must not have engaged in standing-based desk work at least one month prior to study commencement. Finally, participants must not have been advised to avoid prolonged standing by a health profession; or be unable to stand.

What are participants expected to do?

1. **Use a sit-stand workstation:** Participants will be allocated at random to one of three study groups. For participants in two of the three study groups, usual workplace workstations will be exchanged for sit-stand workstations that offer height-adjustable equipment for computer screens and keyboards that allow a choice of working positions

Figure 1. Ergotron WorkFit-D (left) and WorkFit-S (right)

2. **Take part in the research** to help us to understand the use of sit-stand workstations and learn about participants' views on sit-stand workstations in the workplace.

You will be involved in some or all of the following:

Research Activity	Description
Objective measures of physical activity	You will be required to wear two activity monitors (GT3X and ActivPAL) for seven consecutive days, at six timepoints over 13-months. The GT3X (figure 2) is worn around the waist via a belt and the ActivPAL (figure 3) is attached to the thigh using double-sided tape. The monitors measure sitting, standing and physical activity intensity and duration.  Figure 2. GT3X  Figure 3. ActivPAL
Activity diaries	You will be required to complete activity diaries for seven consecutive days, at six timepoints over 13-months. This will involve recording the type and context of activities performed, the time you arrive at and leave work, and any monitor non-wear time. A text message reminder to complete the diary entry will be sent each day throughout the data collection periods.
Interviews	You will be invited to at least two interviews with the lead researcher over the course of the study. These will focus on your perceptions of physical activity and inactivity; and factors that influence your use of a sit-stand workstation.
Focus Groups	You may be invited to participate in a focus group with other participants, facilitated by the lead researcher, to discuss the barriers and facilitators to physical activity in your workplace.

Are there any benefits to participating in the study?

You may enjoy using a sit-stand workstation and/or feel healthier; and continue to use the workstation after project completion. You will receive a voucher valued at £100 entitling you to a variety of 'activity related' products or services upon completion of all elements of the research project (details available upon request).

What are the possible disadvantages and risks of taking part?

Sit-stand workstations carry a low risk of musculoskeletal injury if a user's posture remains static for a prolonged period of time. This can be avoided by altering working posture if, or before, any discomfort is experienced.

Your activity monitors are required to be worn for 24 hours a day, for a 7 day period. It is possible, but very unlikely, that you may experience skin irritation due to the tape holding the ActivPAL in place. If you find continuous wear causes skin irritation you can remove the monitor for non-wake hours and record this in the activity diary.

There is a very low risk of experiencing negative emotions when talking about activities you personally engage in and attitudes to workplace activity in focus groups and interviews.

Will my taking part in this study be kept confidential?

None of the information we collect will identify people personally. Participants will have a study identity number and/or a different study name. Only the lead researcher will be able to match ID number to original names. No names will be given in any research reports or presentations.

In accordance with data protection requirements, the information from the research will be stored at Brunel University for a period of 5 years and will not be released without written permission or unless required by law.

What happens if I change my mind about participating?

You are free to withdraw from the study at any time, without giving a reason, but you won't be eligible to receive the £100 voucher. You will not be penalised by your employer for not completing the study.

Who is organising and funding the research?

The research is organised by researchers at Brunel University through a PhD bursary allocated to Jennifer Hall, the lead researcher. Equipment is funded by Macmillan Cancer Support and Ergotron.

What if I have any further questions?

If you have any questions about the project please contact the lead researcher Jennifer Hall by email at Jennifer.Hall@brunel.ac.uk or by telephone on 07887356891.

How can I get information about the study findings?

Information about the study findings will be made available to you, upon request, following the completion of the study.

Compensation arrangements for negligent and non-negligent harm.

Brunel University has an insurance policy (NHE-01CA29-0013) with public and products liabilities of £30m

Who should you contact if you wish to make a complaint about the study?

You can contact the head of the research ethics committee: Dr Richard Godfrey, Richard.Godfrey@brunel.ac.uk; tel: 01895 266473.

This research project has been approved by the School of Sport & Education Research Ethics Committee (Application number RE45-13).

Participant information sheet for stakeholder participants

Brunel University, Kingston Lane, Uxbridge, UB8 3PH

Take a Stand for Workplace Health: A sit-stand workstation evaluation project

Information for Participants: Interviewees

The sit-stand workstation project

'Take a Stand for Workplace Health' is a workplace intervention programme taking place over two worksites in central London. The project involves the implementation of sit-stand workstations (See Figure 1) within desk-based open-plan offices, to assist understanding of use and compliance. We are interested in the views and opinions of a range of employees that are implicated in the programme.

Figure 1. Ergotron WorkFit-D (left) and WorkFit-S (right)

What are participants expected to do?

You will be invited to at least one interview with the lead researcher over the course of the study (December 2014-January 2016). Interviews will focus on your views and opinions of sit-stand desks in open-plan office-based workplaces.

Who can take part in the research?

Any employee implicated in the implementation of sit-stand workstations, and any employee that has positive or negative views and opinions on the use of sit-stand workstations, will be invited to participate. Stakeholders do not have to be employees of the organisations participating in the sit-stand workstation programme.

Are there any benefits to participating in the study?

You will be given the opportunity to express your views and opinions about the use of sit-stand workstations in office-based workplaces, and thus informing future provision of sit-stand workplace interventions.

What are the possible disadvantages and risks of taking part?
There is a very low risk of experiencing negative emotions when talking about attitudes to sit-stand workstations.

Will my taking part in this study be kept confidential?
None of the information we collect will identify people personally. You will have a study identity number and/or a different study name. Only the lead researcher will be able to match ID number to original names. No names will be given in any research reports or presentations.
In accordance with data protection requirements, the information from the research will be stored at Brunel University for a period of 5 years and will not be released without written permission or unless required by law.

What happens if I change my mind about participating?
You are free to withdraw from the study at any time, without giving a reason. You will not be penalised (by your employer or otherwise) for not completing the study.

Who is organising and funding the research?
The research is organised by researchers at Brunel University through a PhD bursary allocated to Jennifer Hall, the lead researcher. Equipment is funded by Macmillan Cancer Support and Ergotron.

What if I have any further questions?
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How can I get information about the study findings?
Information about the study findings will be made available to you, upon request, following the completion of the study.

Who should you contact if you wish to make a complaint about the study?
You can contact the head of the research ethics committee: Dr Richard Godfrey, Richard.Godfrey@brunel.ac.uk; tel: 01895 266473.

This research project has been approved by the School of Sport & Education Research Ethics Committee.

Appendix G

Expression of interest form

BC•SHaW Brunel Centre *for* Sport, Health and Wellbeing

Take a Stand for Workplace Health: A sit-stand workstation evaluation project

EXPRESSION OF INTEREST

Name:

We are delighted that you are interested in being a participant in the sit-stand workstation study. We are only able to include 30 participants across two organisations. We will select participants who differ in gender, age and ethnic background. Ass such we kindly request that you fill out the questions below.

Please tick which you are.

- ☐ **Male**
- ☐ **Female**
- **Transgender**
- ☐ **Other**

Please tick what age group you are in.

- ☐ **16 to 24 years**
- ☐ **25 to 29 years**
- ☐ **30 to 34 years**
- ☐ **35 to 39 years**
- ☐ **40 to 44 years**
- ☐ **45 to 49 years**
- ☐ **50 to 64 years or**
- ☐ **65 or more years**

What is your ethnic group?

- ☐ **White**
- ☐ **Mixed ethnic background**
- ☐ **Asian/Asian British**
- ☐ **Black/Black British/ African/Caribbean**
- ☐ **Other ethnic group**
- ☐ **Prefer Not to Say**

Do you have a long-standing illness or disability?

- ☐ **Yes**
- ☐ **No**
- ☐ **Prefer not to say**

Please describe, in a couple of sentences, what appeals to you about sit-stand desks?

.....
.....
.....
.....
.....

Many thanks for your support so far, we will be in touch by the 1st July.

BC•SHaW Brunel Centre for Sport, Health and Wellbeing | Public Health England | WE ARE MACMILLAN. CANCER SUPPORT | ERGOTRON | Brunel UNIVERSITY LONDON

Appendix H

A summary of participant interviewee characteristics

Name	Workplace	Study group	Gender	Age	Ethnicity	Personal monthly income before tax	Sexual orientation
Mark	Macmillan	SS-MC	Male	35-39	White	£3900+	Heterosexual
Julia	Macmillan	SS-O	Female	30-34	White	£2400-£3900	Heterosexual
Carol	Macmillan	SS-O	Female	50-54	White	£1500-£2400	Heterosexual
Anita	Macmillan	SS-O	Female	25-29	Black/Black British/ African/Caribbean	£1500-£2400	Heterosexual
Caroline	Macmillan	SS-O	Female	45-49	White	£2400-£3900	Heterosexual
Paul	Macmillan	CG	Male	35-39	White	£2400-£3900	Heterosexual
Grace	Macmillan	CG	Female	16-24	White	£870-£1500	Bisexual
Cristina	Macmillan	n/a	Female	30-34	White	£1500-£2400	Other
Bridget	PHE	SS-MC	Female	55-59	White	£1500-£2400	Heterosexual
Melissa	PHE	SS-MC	Female	40-44	White	£2400-£3900	Gay/Lesbian
Brett	PHE	SS-MC	Male	35-39	White	£2400-£3900	Gay/Lesbian
Nadia	PHE	SS-O	Female	45-49	Asian/ British Asian	£3900+	Heterosexual
Sean	PHE	SS-O	Male	25-29	White	£2400-£3900	Heterosexual
Joan	PHE	SS-O	Female	55-59	White	£3900+	Gay/Lesbian
Reece	PHE	CG	Male	30-34	Other ethnic group	£2400-£3900	Heterosexual

Appendix I

Detailed timeline of data collection

Organisation	Type of data collection	Timing (relative to sit-sand desk installation)	Dates
Macmillan	Participant observation	Pre-desk install	9 days in Sept 2014
Macmillan	Activity monitoring	Pre-desk install	7 days (22nd Sept)
Macmillan	Activity monitoring	1 week following install	7 days (3rd Nov 2014)
Macmillan	Stakeholder interviews	1 month following install	During Nov 2014
PHE	Participant observation	Pre-desk install	9 days during Dec 2014
PHE	Activity monitoring	Pre-desk install	7 days (17th Nov)
PHE	Activity monitoring	1 week following install	7 days (19th Jan 2015)
Macmillan	Activity monitoring	3 months following install	7 days (19th Jan 2015)
PHE	Stakeholder interviews	1 month following install	Jan 2015
Macmillan	Participant observation	4-5 months following install	12 days during Feb/March 2015
PHE	Activity monitoring	3 months following install	7 days (13th April 2015)
Macmillan	Activity monitoring	6 months following install	7 days (20th April 2015)
Macmillan	Participant interviews	7 months following install	During May 2015
PHE	Participant observation	4 – 5 months following install	12 days during May/June 2015
PHE	Activity monitoring	6 months following install	7 days (13th July 2015)
Macmillan	Activity monitoring	9 months following install	7 days (WB 15th July)
PHE	Participant interviews	7 months following install	During Aug 2015
Macmillan	Participant observation	10-11 months following install	12 days during Aug/Sept 2015
PHE	Activity monitoring	9 months following install	7 days (12th Oct 2015)
Macmillan	Activity monitoring	12 months following install	7 days (19th Oct 2015)
Macmillan	Participant exit workshop	12 months following install	During Oct 2015
PHE	Participant observation	10-11 months following install	12 days during Oct / Nov 2015
PHE	Participant exit workshop	12 months following install	During Jan 2016
PHE	Activity monitoring	12 months following install	7 days (11th Jan 2016)

Appendix J

'Questions about you' survey

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Questions about you.

1. Please fill in the table below for ALL members of your household excluding yourself:

Age	Relationship to you (e.g. daughter, landlord, friend)

2. Which of these groups represents your **personal monthly** income from all sources (including any benefits or pensions), before any deductions for income tax, national insurance etc?

- ☐ **less than £870**
- ☐ **£870 to less than £1,500**
- ☐ **£1,500 to less than £2,400**
- ☐ **£2,400 to less than £3,900**
- ☐ **£3,900 and above**
- ☐ **don't know**

3. Which highest qualification do you have?

- ☐ **First or Higher Degree (e.g. BA, BSc, MSc, PhD)**
- ☐ **Other technical or professional qualifications**
- ☐ **A Level, AS Level, O Level, CSE, GCSE**
- ☐ **Foreign qualifications**
- ☐ **Other qualifications**

4. Please tick which option best describes how you think of yourself.

- ☐ **Heterosexual or straight**
- ☐ **Gay or Lesbian**
- ☐ **Bisexual**
- ☐ **Other**
- ☐ **Prefer not to say**

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Appendix K

Activity monitor protocol - guidance sheet for participants

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The Activity Monitor Guide

The monitors should be worn for 7 consecutive days. The monitors will record movement data from 12am on the first Wednesday to 12am on the second Wednesday.

A. The ActiGraph (GT3X+)

Figure 1. GT3X+

Figure 2. GT3X+ worn on the right hip

Instructions:

- The ActiGraph should be worn on the right hip (See Figure 2) either under or over clothing
- The button (see Figure 1) should be facing downwards, i.e. to the floor
- The ActiGraph **is not** 100% waterproof and so **must** be removed for any water-based activities (e.g. swimming, showering) and during **all non-wake hours**
- Non-wear time should be recorded in the activity diary

B. The ActivPAL (ActivPAL3™)

Figure 3. ActivPAL3™

Figure 4. ActivPAL3™ worn on the right thigh

Instructions:

- Role the nitrile sleeve over the ActivPAL from the connector end
- Attach the ActivPAL to the middle of the right thigh (directly to the skin), curve upwards (see Figure 3), using a 10cm x 10cm strips of waterproof dressing (see Figure 4)
- The attachment should be reviewed daily. The dressing should be replaced if there are any problems, such as peeling away or irritation (additional dressings provided)
- The monitor **is** 100% waterproof and so does not need to be removed during the 7 days. Any non-wear time (e.g. due to irritation) should be recorded in the activity diary

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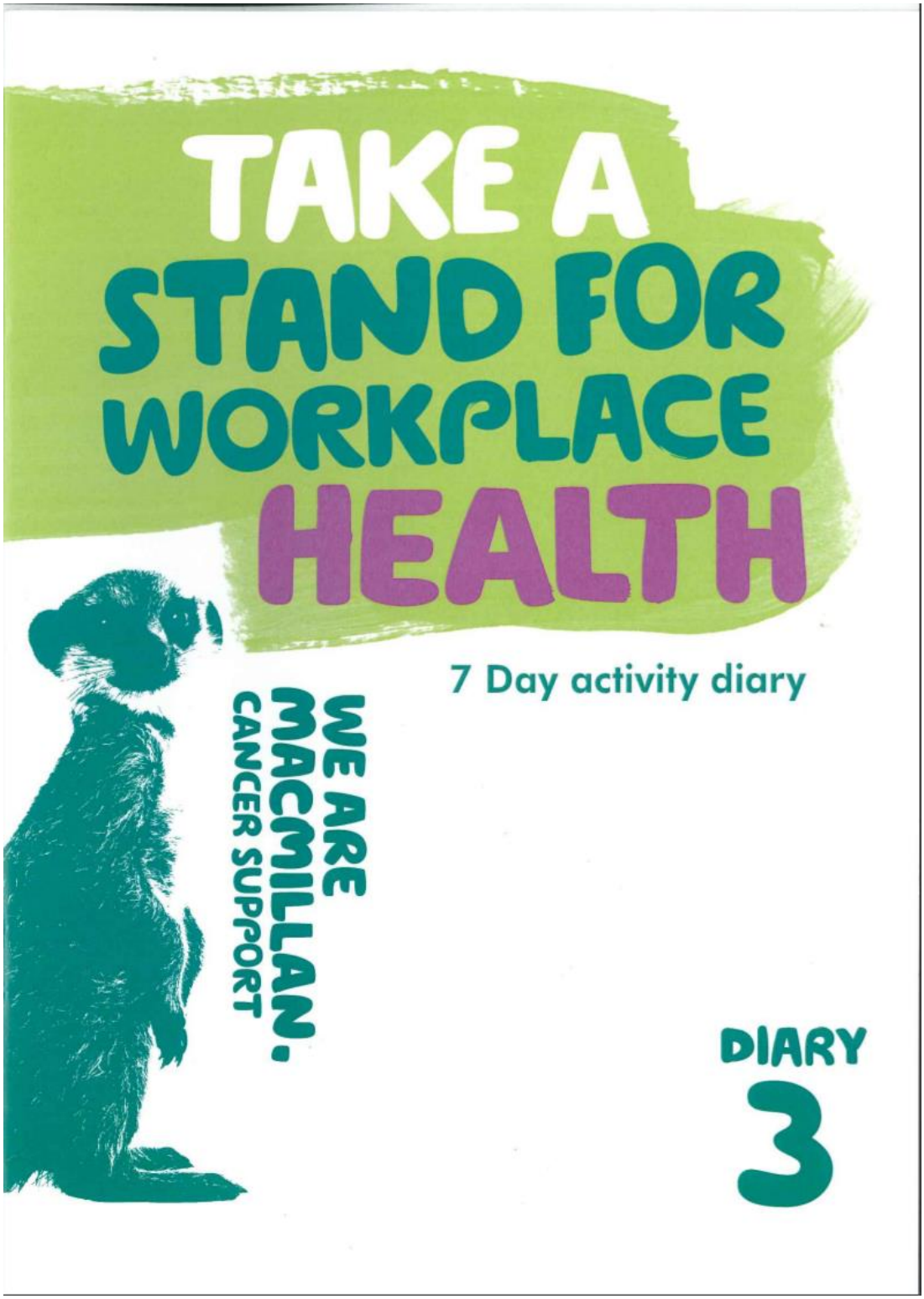
Appendix L

Example activity diary



7 Day activity diary: **Diary 3**

Take a Stand for Workplace Health: A sit-stand workstation evaluation project

Study ID number:

Date:

Thank you for continuing to take part in our study. Your input and co-operation is really important to us.

This daily activity diary should be completed for 7 days to record types of physical activity and sedentary behaviour. You should complete the diary every hour throughout the day. There are no right or wrong answers; documenting what you did as accurately as possible is most important. When you have completed the diary, the researcher who gave it to you will come to your workplace to collect it. The activity diary task will be repeated 6 times throughout course of the study. The completion periods will be at baseline (before sit-stand workstation installation), 1–2 weeks following installation, and then 3, 6, 9 and 12 months following installation.

All your responses will be confidential and used only for research purposes. If you decide not to complete this activity diary there will be no impact on your job role. The 'activity voucher' incentive is payable upon successful completion of the activity diary and any other research requirements.

This research has received approval from Brunel University Research Ethics Committee (School of Sport and Education).

If you have any questions about this activity diary, please contact Jennifer Hall, Tel: **07887 356891**, Email: **Jennifer.Hall@brunel.ac.uk**

Part A: **Activity day 1**

Please document **both active and sedentary activities** at hourly intervals throughout the day. For each time interval, you should only document the activity that you spent the **most amount of time doing.**

Type and reason: Here are some examples to help you complete these categories:

- Sitting at computer (type) as writing a report (reason)
- Walking (type) to buy lunch (reason).

Duration: State the approximate amount of time (in minutes) that you spent doing that active or sedentary activity.

Domain: State whether the activity was performed during 'Work' (W), 'Travel' (T) 'Leisure' (L) or 'Household' (H).

Who with: State who you did the activity with, such as family, friends, colleagues or alone.

Time	Type	Reason	Duration (min)	Domain	Who with
AM					
6–7					
7–8					
8–9					
9–10					
10–11					
11–12					
PM					
12–1					
1–2					
2–3					
3–4					
4–5					
5–6					
6–7					
7–8					
8–9					
9–10					
10–11					
11–12					

Part B: **Time spent at the workplace**

Work start time: ..... Work end time: .....

Please tick the responses below that apply:

☐ Not at workplace because it is a weekend day

☐ Not at workplace for another reason

Please specify reason (eg *illness, conference*): .....

Part C: **Activity monitor non-wear time**

Please record in the table below, any time that you removed either of the activity monitors.

Please note that the ActiGraph (hip) should be removed during **non-wake hours** and for **all water-based activities** such as showering and swimming. Please replace the monitor as soon as possible upon waking and following water-based activities.

The ActivPAL (thigh) is waterproof and so does not need to be removed at all throughout the data collection period. Additional adhesive dressings have been provided so that you can change the dressing if necessary.

Please remove either monitor if it is uncomfortable, irritating, etc. and replace as soon as possible.

ActiGraph (hip)		
Time replaced	**Time removed**	**Reason for removal**
eg 9pm	eg 9.30pm	eg to take a shower

ActivPAL (thigh)		
Time removed	**Time replaced**	**Reason for removal**

Part A: **Activity day 2**

Please document **both active and sedentary activities** at hourly intervals throughout the day. For each time interval, you should only document the activity that you spent the **most amount of time doing.**

Type and reason: Here are some examples to help you complete these categories:

- Sitting at computer (type) as writing a report (reason)
- Walking (type) to buy lunch (reason).

Duration: State the approximate amount of time (in minutes) that you spent doing that active or sedentary activity.

Domain: State whether the activity was performed during 'Work' (W), 'Travel' (T) 'Leisure' (L) or 'Household' (H).

Who with: State who you did the activity with, such as family, friends, colleagues or alone.

Time	Type	Reason	Duration (min)	Domain	Who with
AM					
6–7					
7–8					
8–9					
9–10					
10–11					
11–12					
PM					
12–1					
1–2					
2–3					
3–4					
4–5					
5–6					
6–7					
7–8					
8–9					
9–10					
10–11					
11–12					

Part B: **Time spent at the workplace**

Work start time: ..... Work end time: .....

Please tick the responses below that apply:

☐ Not at workplace because it is a weekend day

☐ Not at workplace for another reason

Please specify reason (eg *illness, conference*): .....

Part C: **Activity monitor non-wear time**

Please record in the table below, any time that you removed either of the activity monitors.

Please note that the ActiGraph (hip) should be removed during **non-wake hours** and for **all water-based activities** such as showering and swimming. Please replace the monitor as soon as possible upon waking and following water-based activities.

The ActivPAL (thigh) is waterproof and so does not need to be removed at all throughout the data collection period. Additional adhesive dressings have been provided so that you can change the dressing if necessary.

Please remove either monitor if it is uncomfortable, irritating, etc. and replace as soon as possible.

ActiGraph (hip)		
Time replaced	**Time removed**	**Reason for removal**
eg 9pm	eg 9.30pm	eg to take a shower

ActivPAL (thigh)		
Time removed	**Time replaced**	**Reason for removal**

Part A: **Activity day 3**

Please document **both active and sedentary activities** at hourly intervals throughout the day. For each time interval, you should only document the activity that you spent the **most amount of time doing.**

Type and reason: Here are some examples to help you complete these categories:

- Sitting at computer (type) as writing a report (reason)
- Walking (type) to buy lunch (reason).

Duration: State the approximate amount of time (in minutes) that you spent doing that active or sedentary activity.

Domain: State whether the activity was performed during 'Work' (W), 'Travel' (T) 'Leisure' (L) or 'Household' (H).

Who with: State who you did the activity with, such as family, friends, colleagues or alone.

Time	Type	Reason	Duration (min)	Domain	Who with
AM					
6–7					
7–8					
8–9					
9–10					
10–11					
11–12					
PM					
12–1					
1–2					
2–3					
3–4					
4–5					
5–6					
6–7					
7–8					
8–9					
9–10					
10–11					
11–12					

Part B: **Time spent at the workplace**

Work start time: ..... Work end time: .....

Please tick the responses below that apply:

☐ Not at workplace because it is a weekend day

☐ Not at workplace for another reason

Please specify reason (*eg illness, conference*): .....

Part C: **Activity monitor non-wear time**

Please record in the table below, any time that you removed either of the activity monitors.

Please note that the ActiGraph (hip) should be removed during **non-wake hours** and for **all water-based activities** such as showering and swimming. Please replace the monitor as soon as possible upon waking and following water-based activities.

The ActivPAL (thigh) is waterproof and so does not need to be removed at all throughout the data collection period. Additional adhesive dressings have been provided so that you can change the dressing if necessary.

Please remove either monitor if it is uncomfortable, irritating, etc. and replace as soon as possible.

ActiGraph (hip)		
Time replaced	**Time removed**	**Reason for removal**
eg 9pm	eg 9.30pm	eg to take a shower

ActivPAL (thigh)		
Time removed	**Time replaced**	**Reason for removal**

Part A: **Activity day 4**

Please document **both active and sedentary activities** at hourly intervals throughout the day. For each time interval, you should only document the activity that you spent the **most amount of time doing.**

Type and reason: Here are some examples to help you complete these categories:

- Sitting at computer (type) as writing a report (reason)
- Walking (type) to buy lunch (reason).

Duration: State the approximate amount of time (in minutes) that you spent doing that active or sedentary activity.

Domain: State whether the activity was performed during 'Work' (W), 'Travel' (T) 'Leisure' (L) or 'Household' (H).

Who with: State who you did the activity with, such as family, friends, colleagues or alone.

Time	Type	Reason	Duration (min)	Domain	Who with
AM					
6–7					
7–8					
8–9					
9–10					
10–11					
11–12					
PM					
12–1					
1–2					
2–3					
3–4					
4–5					
5–6					
6–7					
7–8					
8–9					
9–10					
10–11					
11–12					

Part B: **Time spent at the workplace**

Work start time: ..... Work end time: .....

Please tick the responses below that apply:

☐ Not at workplace because it is a weekend day

☐ Not at workplace for another reason

Please specify reason (eg *illness, conference*): .....

Part C: **Activity monitor non-wear time**

Please record in the table below, any time that you removed either of the activity monitors.

Please note that the ActiGraph (hip) should be removed during **non-wake hours** and for **all water-based activities** such as showering and swimming. Please replace the monitor as soon as possible upon waking and following water-based activities.

The ActivPAL (thigh) is waterproof and so does not need to be removed at all throughout the data collection period. Additional adhesive dressings have been provided so that you can change the dressing if necessary.

Please remove either monitor if it is uncomfortable, irritating, etc. and replace as soon as possible.

ActiGraph (hip)		
Time replaced	**Time removed**	**Reason for removal**
eg 9pm	eg 9.30pm	eg to take a shower

ActivPAL (thigh)		
Time removed	**Time replaced**	**Reason for removal**

Part A: **Activity day 5**

Please document **both active and sedentary activities** at hourly intervals throughout the day. For each time interval, you should only document the activity that you spent the **most amount of time doing.**

Type and reason: Here are some examples to help you complete these categories:

- Sitting at computer (type) as writing a report (reason)
- Walking (type) to buy lunch (reason).

Duration: State the approximate amount of time (in minutes) that you spent doing that active or sedentary activity.

Domain: State whether the activity was performed during 'Work' (W), 'Travel' (T) 'Leisure' (L) or 'Household' (H).

Who with: State who you did the activity with, such as family, friends, colleagues or alone.

Time	Type	Reason	Duration (min)	Domain	Who with
AM					
6–7					
7–8					
8–9					
9–10					
10–11					
11–12					
PM					
12–1					
1–2					
2–3					
3–4					
4–5					
5–6					
6–7					
7–8					
8–9					
9–10					
10–11					
11–12					

Part B: **Time spent at the workplace**

Work start time: ..... Work end time: .....

Please tick the responses below that apply:

☐ Not at workplace because it is a weekend day

☐ Not at workplace for another reason

Please specify reason (*eg illness, conference*): .....

Part C: **Activity monitor non-wear time**

Please record in the table below, any time that you removed either of the activity monitors.

Please note that the ActiGraph (hip) should be removed during **non-wake hours** and for **all water-based activities** such as showering and swimming. Please replace the monitor as soon as possible upon waking and following water-based activities.

The ActivPAL (thigh) is waterproof and so does not need to be removed at all throughout the data collection period. Additional adhesive dressings have been provided so that you can change the dressing if necessary.

Please remove either monitor if it is uncomfortable, irritating, etc. and replace as soon as possible.

ActiGraph (hip)		
Time replaced	**Time removed**	**Reason for removal**
eg 9pm	eg 9.30pm	eg to take a shower

ActivPAL (thigh)		
Time removed	**Time replaced**	**Reason for removal**

Part A: **Activity day 6**

Please document **both active and sedentary activities** at hourly intervals throughout the day. For each time interval, you should only document the activity that you spent the **most amount of time doing.**

Type and reason: Here are some examples to help you complete these categories:

- Sitting at computer (type) as writing a report (reason)
- Walking (type) to buy lunch (reason).

Duration: State the approximate amount of time (in minutes) that you spent doing that active or sedentary activity.

Domain: State whether the activity was performed during 'Work' (W), 'Travel' (T) 'Leisure' (L) or 'Household' (H).

Who with: State who you did the activity with, such as family, friends, colleagues or alone.

Time	Type	Reason	Duration (min)	Domain	Who with
AM					
6–7					
7–8					
8–9					
9–10					
10–11					
11–12					
PM					
12–1					
1–2					
2–3					
3–4					
4–5					
5–6					
6–7					
7–8					
8–9					
9–10					
10–11					
11–12					

Part B: **Time spent at the workplace**

Work start time: ..... Work end time: .....

Please tick the responses below that apply:

☐ Not at workplace because it is a weekend day

☐ Not at workplace for another reason

Please specify reason (eg *illness, conference*): .....

Part C: **Activity monitor non-wear time**

Please record in the table below, any time that you removed either of the activity monitors.

Please note that the ActiGraph (hip) should be removed during **non-wake hours** and for **all water-based activities** such as showering and swimming. Please replace the monitor as soon as possible upon waking and following water-based activities.

The ActivPAL (thigh) is waterproof and so does not need to be removed at all throughout the data collection period. Additional adhesive dressings have been provided so that you can change the dressing if necessary.

Please remove either monitor if it is uncomfortable, irritating, etc. and replace as soon as possible.

ActiGraph (hip)		
Time replaced	**Time removed**	**Reason for removal**
eg 9pm	eg 9.30pm	eg to take a shower

ActivPAL (thigh)		
Time removed	**Time replaced**	**Reason for removal**

Part A: **Activity day 7**

Please document **both active and sedentary activities** at hourly intervals throughout the day. For each time interval, you should only document the activity that you spent the **most amount of time doing.**

Type and reason: Here are some examples to help you complete these categories:

- Sitting at computer (type) as writing a report (reason)
- Walking (type) to buy lunch (reason).

Duration: State the approximate amount of time (in minutes) that you spent doing that active or sedentary activity.

Domain: State whether the activity was performed during 'Work' (W), 'Travel' (T) 'Leisure' (L) or 'Household' (H).

Who with: State who you did the activity with, such as family, friends, colleagues or alone.

Time	Type	Reason	Duration (min)	Domain	Who with
AM					
6–7					
7–8					
8–9					
9–10					
10–11					
11–12					
PM					
12–1					
1–2					
2–3					
3–4					
4–5					
5–6					
6–7					
7–8					
8–9					
9–10					
10–11					
11–12					

Part B: **Time spent at the workplace**

Work start time: ..... Work end time: .....

Please tick the responses below that apply:

☐ Not at workplace because it is a weekend day

☐ Not at workplace for another reason

Please specify reason (*eg illness, conference*): .....

Part C: **Activity monitor non-wear time**

Please record in the table below, any time that you removed either of the activity monitors.

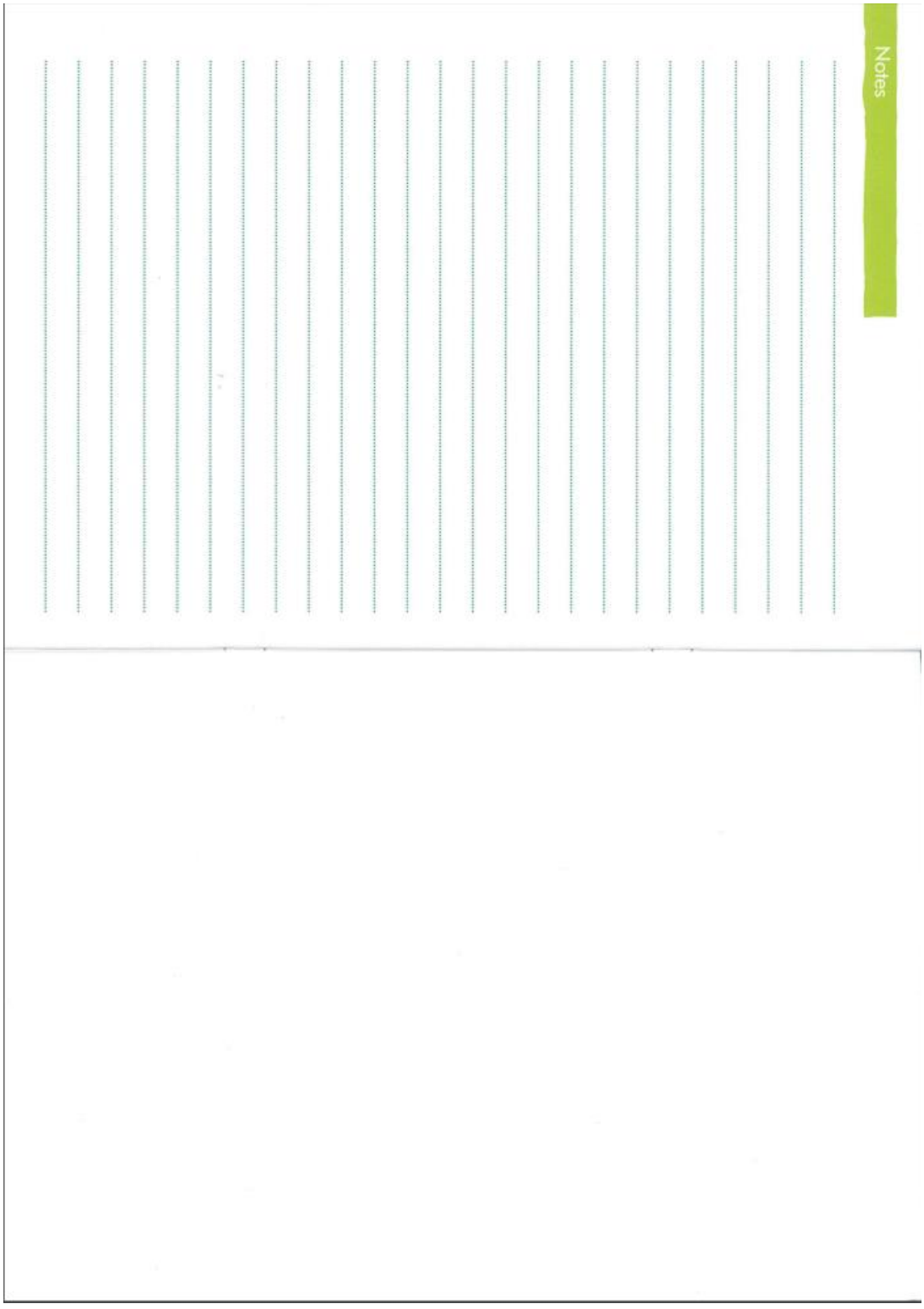
Please note that the ActiGraph (hip) should be removed during **non-wake hours** and for **all water-based activities** such as showering and swimming. Please replace the monitor as soon as possible upon waking and following water-based activities.

The ActivPAL (thigh) is waterproof and so does not need to be removed at all throughout the data collection period. Additional adhesive dressings have been provided so that you can change the dressing if necessary.

Please remove either monitor if it is uncomfortable, irritating, etc. and replace as soon as possible.

ActiGraph (hip)		
Time replaced	**Time removed**	**Reason for removal**
eg 9pm	eg 9.30pm	eg to take a shower

ActivPAL (thigh)		
Time removed	**Time replaced**	**Reason for removal**


Notes

At Macmillan, we know how a cancer diagnosis can affect everything and we're here to support people through. From help with money worries and advice about work, to someone who'll listen if people just want to talk. We help people make the choices they need to take back control, so they can start to feel like themselves again.

Together, we are Macmillan Cancer Support.

Printed using sustainable material. Please recycle.

Macmillan Cancer Support, registered charity in England and Wales (261017), Scotland (SC039907) and the Isle of Man (604). MAC15104

Appendix M

Example interview guides

Example intervention participant interview guide

Why did you initially apply to take part in the sit-stand project? (PROMPTS: become more active, health problems, work reasons, influence of colleagues) - Is being physically active important to you*?* (PROMPTS: social, physical benefits; are you active outside work?)

What are your views on being active at work?
- Should you be/ have you been given the opportunity to be active at work?
- Do you feel that PHE value and promote your activity and health at work?
- Is there anything that makes it easier or harder to be active at work?
- Is it appropriate to reduce sitting in the workplace?
- is your activity and health at work a priority to you?

What is your role at PHE? (Prompts: typical work day, desk, work, meetings, travel)
- Does the type of work you do impact on your sitting, activity and health at work?

Did you have any expectations about your sit-stand desk? (PROMPTS: the workstation itself, how much you would use it, any benefits or challenges, how did you select a desk? What were the reasons behind your choice?)

Were you there on the install day? If yes, what do you remember from this day? (PROMPTS**:** What did you feel? Initial reaction to your workstation? Did your feelings change over time? Was the install disruptive to you/colleagues? Were you happy with how it was installed? Did someone show you how to use it and was this helpful? Did you feel confident in knowing how to use it?)

What influences your use of yours sit-stand desk? (PROMPTS: What prompts you to switch positions? Any work-related, social, physical factors that make you use it more or less?)

Do other people at Macmillan influence how much you use your workstations or what you think or feel about it? (PROMPTS: pressure to use it, are there any other people around you that have a workstation, disrupting others
- Have you had an impact on others?

Has being part of the project influenced your views on how you think about your lifestyle in relation to activity, inactivity and health? (PROMPTS: Influenced your

activity in non-work contexts or non-desk based work contexts, importance of PA/health, awareness; monitoring and diaries?)

Do you have anything else that you wanted to say about the project, your experience of using the workstation, or activity, inactivity and work in general?

Example stakeholder participant interview guide (health and safety staff member)

About the interviewee and job role
- What is your role within the organisation (PROMPTS: how does it fit into organisation aims, what do you do day-to-day)
- How does your job role relate to the sit-stand project? (PROMPTS: Do you see it as having an impact on your work stream? Do you have any specific roles or responsibilities as part of this project?

Understanding the culture of the organisation in relation to sit-stand desks and workplace health
- Are there any H&S policies/training related to sitting, standing and moving (restricting or encouraging movement/activity)
- Do you feel that employees have opportunities to reduce sitting and increase activity in the workplace?
- Does the sit-stand desk intervention fit with Macmillan's health, safety and wellbeing approach? (PROMPTS: Will any amendments need to be made to current policy / guidelines to accommodate sit-stand working? Have you learnt anything so far from your experience with sit-stand working? Does the management style/priorities of senior leaders influence your role in delivering health, safety and wellbeing programmes?)

Healthism / responsibility of organisation
- Do you feel there is a desire within the organisation to promote health of employees? (PROMPTS: How much of a priority is it? Does Macmillan have a responsibility to employees to promote their health? If so, why? (e.g. organisational benefits, nature of organisation, ethically) What about reducing sitting specifically?)

Planning and implementation of sit-stand project
- What do you think went well in the planning phases of this project? What could we have done better? How could we have done it better?
- Can you anticipate any challenges over the next year?
- What do you think would need to happen for Macmillan to consider a wider adoption of sit-stand desks? Would there be any special considerations from a health and safety perspective

Appendix N

Flyer detailing project incentive options

Take a Stand for Workplace Health – Activity Voucher Options

To say thank you for your continued engagement with the Take a Stand for Workplace Health project, we would like to offer you a gift, worth £100*

Please select a gift from the following options:

1. Fitbit Wireless Activity + Sleep wristband **
2. Garmin Forerunner 10 - Running GPS watch **
3. Macmillan Yoga/Pilates /Zumba classes***
4. Halfords Voucher
5. Sports Direct Voucher
6. JD voucher – to use in JD, JD Pro, Millets, Ultimate Outdoor, Blacks, Ark, or Tessuti
7. Contribution towards fitness centre membership, classes, or personal training

Please email Jennifer Hall (Jennifer.Hall@brunel.ac.uk) to discuss any of these options, and state which gift you would like to receive. If there is something (activity related) that you would like, that is not on this list, then please contact Jen and we will do our best to accommodate this.

WE ARE MACMILLAN. CANCER SUPPORT

Public Health England

ERGOTRON

Brunel University London

* £100 for completion of all 5 data collection time-points, £75 for 4, £50 for 3; ** The stated models apply to the £100 activity voucher, participants eligible for the £50 or £75 voucher would receive an alternate model; ***Macmillan employees only

Appendix O

Observational data record sheet

BC•SHaW Brunel Centre *for* Sport, Health and Wellbeing

Take a Stand for Workplace Health: A sit-stand workstation evaluation project

Observation Template

Date of Observation	
Time	
Observation phase	
Organisation	
Any relevant context information	
(team working with, work completing, etc)	
Observation Notes	
Place / Space (Describe in detail the place, the way space is organised, how the space is organised for the activities)	
Activities (Describe in detail all the activities, objects, how objects are used, the timing of activities)	
People (Who are the people, where do they place themselves, how do they engage with the activities, what feelings are evident, how do feelings affect activities?)	
Emerging Issues?	
Brief Notes (If this observation session prompted any additional views about general patterns/themes/issues that are emerging in this project, use this space to record them if you wish)	

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Appendix P

Developing the inclusion criteria for the activity monitor data

Inclusion criteria for the whole day ToD

This table identifies the number of participants that would included in a 4 timepoint analysis (baseline, 2-weeks, 3-months, 6-months) and a 5 timepoint analysis (baseline, 2-weeks, 3-months, 6-months, 12-months) based on various hours per day (6 hours, 7 hours, 8 hours, 9 hours and 10 hours) and total valid days (1 day, 2 days, 3 days, 4 days and 5 days) minimum inclusion criteria.

0-6m = 4 timepoint analysis, 0-12m = 5 timepoint analysis.

The shaded criteria (8 hours a day, 2 valid days; 8 hours a day, 3 valid days; 9 hours a day, 2 valid days; 9 hours a day, 3 valid days; 10 hours a day, 2 valid days) were selected for further processing due to the relatively high sample size and stringent criteria.

	6 hours		**7 hours**		**8 hours**		**9 hours**		**10 hours**	
	0-6m	**0-12m**	**0-6m**	**0-12m**	**0-6m**	**0-12m**	**0-6m**	**0-12m**	**0-6m**	**0-12m**
1 day	28	22	28	22	28	22	28	22	28	22
2 days	28	22	28	22	28	22	28	22	28	22
3 days	28	22	27	22	27	21	27	21	24	18
4 days	26	20	26	20	25	19	25	19	23	17
5 days	25	19	25	19	24	17	20	13	18	11

Inclusion criteria for the work hours ToD

This table identifies the number of participants included in a 4 timepoint analysis (baseline, 2-weeks, 3-months, 6-months) and a 5 timepoint analysis (baseline, 2-weeks, 3-months, 6-months, 12-months) based on various hours per day (8 hours, 9 hours and 10 hours), total valid days (2 days, 3 days), hours during working hours, i.e. 9-5pm on weekdays (2 hours, 4 hours, 6 hours) and total valid weekdays (1 day, 2 day) minimum inclusion criteria.

0-6m = 4 timepoint analysis, 0-12m = 5 timepoint analysis.

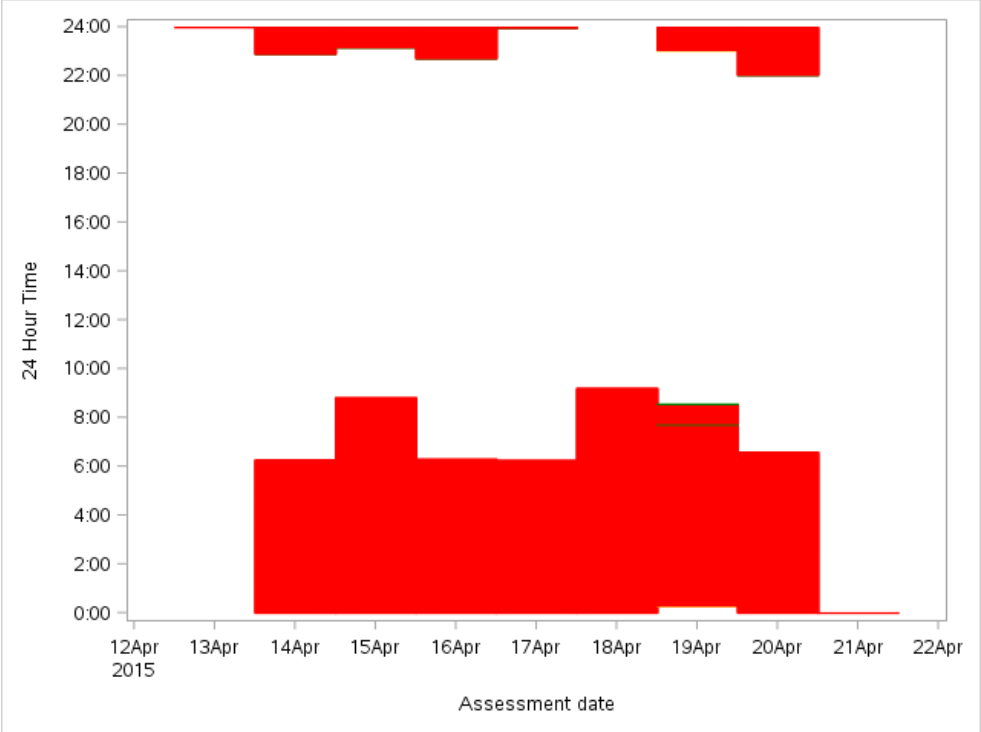
The shaded criteria (9 hours a day, 2 valid days, 2 hours during work hours, 1 valid weekday; 9 hours a day, 2 valid days, 4 hours during work hours, 1 valid weekday; 10 hours a day, 2 valid days, 2 hours during work hours, 1 valid weekday; 10 hours a day, 2 valid days, 4 hours during work hours, 1 valid weekday) were all considered as the criteria to be adopted due to the relatively high sample size and stringent criteria. The criteria shaded in orange (9 hours a day, 2 valid days, 4 hours during work hours, 1 valid weekday) was selected.

	8 hours, 2 days		8 hours, 3 days		9 hours, 2 days		9 hours, 3 days		10 hours, 2 days	
	0-6m	**0-12m**	**0-6m**	**0-12m**	**0-6m**	**0-12m**	**0-6m**	**0-12m**	**0-6m**	**0-12m**
1 weekday, 2 work hours	28	22	26	21	28	22	26	21	28	21
1 weekday, 4 work hours	27	22	26	21	27	22	26	21	27	21
1 weekday, 5 work hours	26	21	25	20	26	21	25	20	25	19
1 workday, 6 work hours	25	20	22	17	25	20	22	17	22	18
2 weekdays, 2 work hours	-	-	26	21	-	-	26	21	-	-
2 weekdays, 4 work hours	-	-	26	21	-	-	26	21	-	-
2 weekdays, 5 work hours	-	-	25	20	-	-	25	20	-	-
2 workdays, 6 work hours	-	-	20	15	-	-	20	15	-	-

Appendix Q

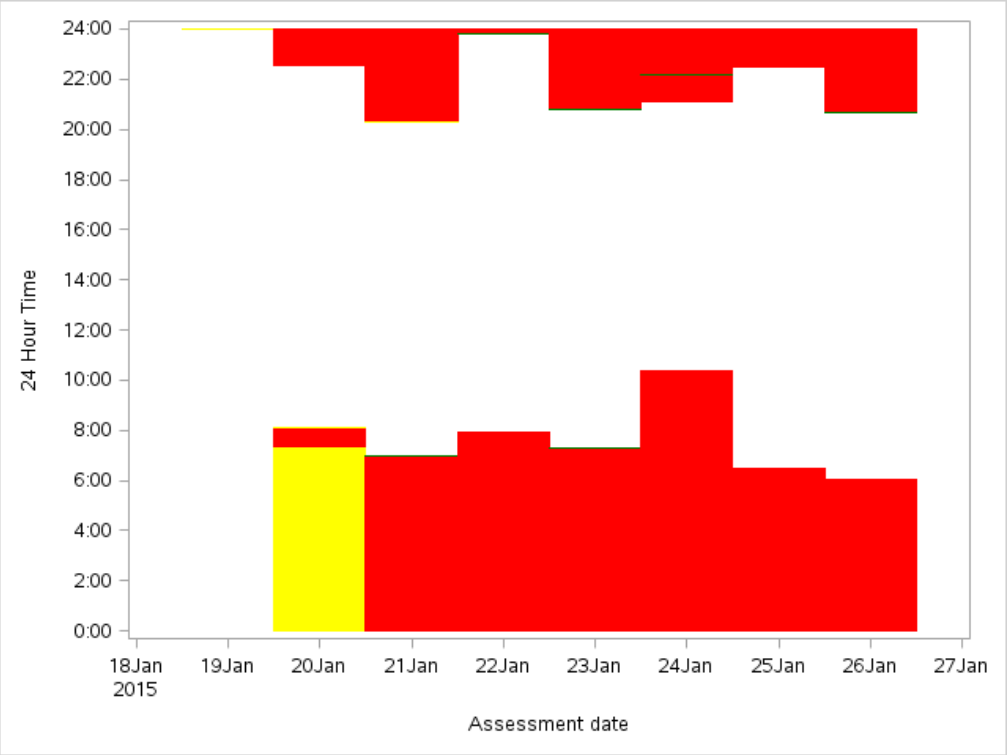
Example heat maps

Example 1: (a) Removed data

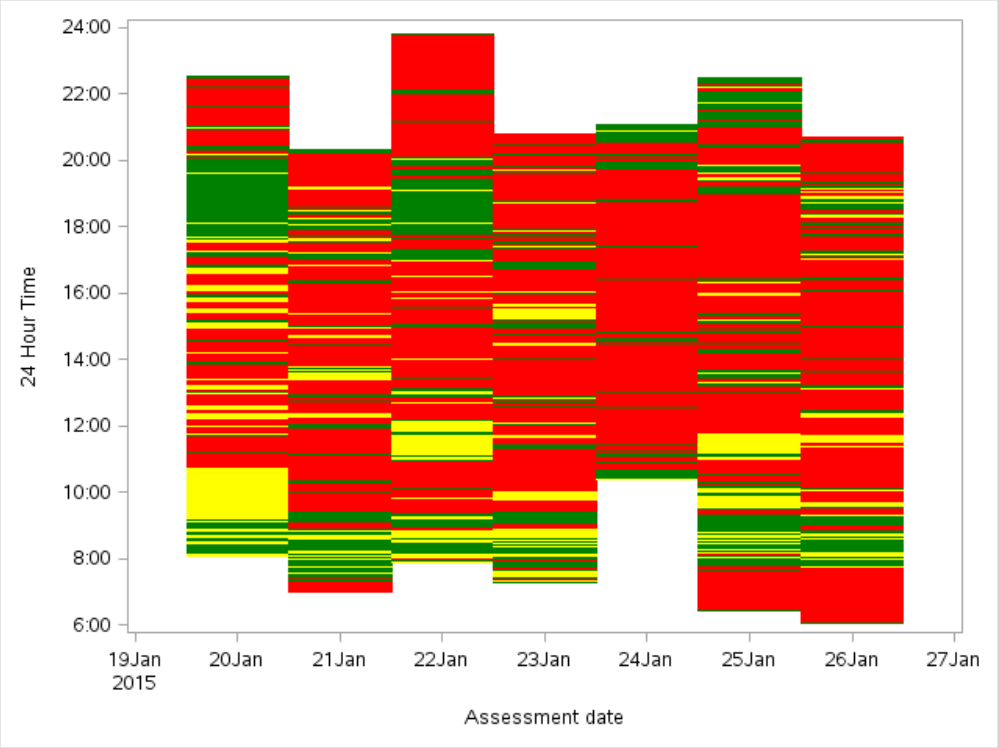


(b) included data

Example 2: (a) removed data



(b) included data



Appendix R

Coded transcript and field notes – open coding

1. Pilot RCT participant transcript

[00:00:00.00] Interviewer: Why you wanted to take part in the first place?

[00:00:05.29] Interviewee: Funnily enough just before the study started I was reading something online which was a study about bus drivers and conductors in the 1950's and err, it kind of got stuck in my head and I'd been pestering somebody about the whole thing of we should do more standing meetings or that sort of stuff. So then it was kind of a good timing. So that was it basically, just on the basis that I kind of knew that it was good for you in theory, erm, and just seemed a good chance just to not sit around.

[00:00:33.21] Interviewer: Yeh. So it was actually about breaking up sitting time.

[00:00:36.23] Interviewee: Yeh that was it. Purely health benefits, erm, I'm just quite conscious of it as the study proved. It's so hard to not end up sitting down in this place weirdly enough it's just that lifestyle of just sitting in meetings and sitting at desks reading stuff.[1] So, to try and see whether actually I could break that up, with a bit of help.

[00:00:58.17] Interviewer: Yeh, yeh. And so, in terms of what you do at work, I'm mean you've just said really you're just sat down at your desk and sat in meetings, erm, is that typically, erm, sort of your day-to-day, do you incorporate any activity into it?

[00:01:15.11] Interviewee: You know what, it's the first job I've ever had where I'm literally just sitting down non-stop in front of a computer. But then also we've got this awful culture of meetings and, just, the only time you ever really get to not sit down is when you're running from one meeting to the next. It's, you know, in a seven or eight-hour day you're probably talking about six and a half hours sitting down somewhere. It's not ideal.[2]

[00:01:36.12] Interviewer: Yeh. So what sort of thing were you doing before, before [redacted]

[00:01:42.05] Interviewee: In terms of work?

[00:01:42.05] Interviewer: Yeh.

[00:01:42.05] Interviewee: I used to [redacted], erm, but kind of running around [redacted] so I kind of, it felt a lot more active, it felt less like being based at a desk and a lot of travelling to, that's the thing here everything's based in the same building so there's not that thing of right I've got to dash to this building or a meeting there, so just really conscious that I just feel trapped in a little box and being like oh, isn't this fun.[3]

[00:02:08.24] Interviewer: Yeh, so did you, how long have you been at [redacted]

[00:02:09.23] Interviewee: Er, [redacted], more or less.

[00:02:11.23] Interviewer: OK. So did you feel, so you'd probably been here about [redacted]

[00:02:20.06] Interviewee: Yeh about [redacted] the time that trial, yeh. And by that point yeh I was really conscious of this lifestyle that people led and was shocked actually even little things, I, you know, make a point of getting out of the office for lunch and I make a point of trying to leave on time and things like that and try not to have many meetings but I was quite conscious of a different culture from what I was used to here which was, yeh people sitting quietly at desks and, you know, there wasn't, not even people walking around to have a chat about work. It was just, people will email people two desks away which is kind of different to the real world.[4]

[00:02:54.21] Interviewer: Yeh. Do you think that that happens across [redacted] or do you think it's just maybe the...?

[00:02:59.01] Interviewee: It's the [redacted] that I've been in. So, I've been [redacted] and I suppose once you get out of [redacted] it's going to be very different. And I'm sure there are other [redacted] where people do different types of work but just yeh, the nature of this email based, desk based, everything's on a screen all the time type work that we do, erm, and, and yeh, just the fact that we love having two-hour meetings and things like board tables, so I hope it's not like that everywhere, but, hope so.[5]

[00:03:31.25] Interviewer: When you said you make a point of going out for lunch, do other people not?

[00:03:39.03] Interviewee: Yeh it's quite strange, there's quite a lot of people who get pestered by me for, erm, just sitting and having a sandwich in front of their desk. In terms of this culture it becomes acceptable and then you find people just lazily doing it and I, I, yeh can't quite get that. I think I've got lots of bad habits since I arrived here but that's maybe the last one in terms of trying to use my legs at least to walk to a park or something like that.[6]

[00:04:05.13] Interviewer: So what bad habits do you think that you have got since...?

[00:04:07.21] Interviewee: I'm terrible. I'm terrible. Even during the study, I was really conscious that I just sat and think, wow my legs hurt. Why? Because you're just sat down. That never used to happen, I used to kind of go for long walks, even working in [redacted] when I used to, used to kind of [redacted] and do all that. I think there's a lot to do with the environment that you're in, it's not necessarily the most beautiful environment just to walk out onto [redacted] but, erm, yeh I, I'm really conscious for about two months I was just sitting there, kind of silent in a corner typing away. So happy, such a happy experience I've had here.[7] *laughs*

[00:04:42.04] Interviewer: *laughs* And do you think that, erm, it sounds as though the answer might be no, but do you think as though [redacted], erm, provide you with any opportunities to be active during the day?

[00:04:55.10] Interviewee: Erm, I think there's, it's strange. I think that there's things tagged around work in terms of, you know, what the [redacted] but it seems like a handful people try to get some other people to change how they operate rather than as an organisation. You get emails about, actually in all fairness saying get out, leave the building, go for lunch, don't work late, use the stairs and all of that but it just doesn't match with that culture of maybe hundreds of people just so used to doing it. And it might be the type of people in the departments that I've been in but, but yeh there's things like 'hey there's [redacted]'. It just feels kind of like a little add on as opposed to part of the real day to day culture. I don't know if that makes sense but there are things and you look at them and you go that would be nice but then you just get caught up in the rest of it and you can't do things at lunchtime because you have meetings over lunch and you can't leave at 5.30 to go and do Pilates [redacted] because actually some buggar has put a meeting in 5 till 6 and stuff like that so, yeh if everybody's culture changed and the working practices change, those things would mean more. But then you watch people, and you'll see people get lifts two floors up and things like that so again it's just this strange… dynamic and you kind of get caught up in it.[8]

[00:06:25.03] Interviewer: Yeh it just becomes the norm.

[00:06:27.09] Interviewee: Yeh. You stand out the lift and you go right shall we just walk and say no, no, no, so you end up, so you can talk to people getting a lift for two or three flights of stairs, so you think oh my god this is crazy.[9]

[00:06:36.29] Interviewer: Do you think that people are influenced by their sort of managers within their team in terms of what they...?

[00:06:42.20] Interviewee: Yeh. I've seen two sides of that so, I've seen in [redacted], really strangely… people criticised for leaving, just an example of that culture of kind of top down influence. So you'll have managers who work really late, junior people who really fell pressurised to stay at their desk and be seen staying at their desk and I've witnessed comments being made about such and such left at 5.30, what's that all about when there's people there until 6.30 and people saying right, let's go for, I've had people say let's go for a walk and have a meeting walking around the thing, and others say we can't do that. It's this, you want to be, there's some sort of culture of wanting to be seen to act in a particular way which leads right down to really practical things that if you're not sitting at your desk… you're probably not doing something productive. Which is again another strange thing and I'm not sure where it comes from but it's a definite kind of push from people.[10,11]

[00:07:47.27] Interviewer: Yeh. Do you feel as though you've been influenced by that?

[00:07:48.24] Interviewee: Yeh. It's quite strange. And [redacted] but still thinking, oh even with a standing desk it's, that was really strange

because you pop your desk up and then people are kind of complaining 'oh I can't see you're blocking the sunlight' or 'I don't like you looking down at me' and all of that. But then you end up going ok I'll just sit down at my desk and you think bloody hell as well you can't do anything to change it because you're the odd one out.[12] You're the person whose saying let's walk, you're the one saying let's go and sit in the park or let's have a standing meeting and things. Nine times out of ten you've got nine people out of ten will go no let's sit or let's do this that and the other so it's quite difficult to change that and you do get pulled into it just to kind of fit in with the culture.[13]

[00:08:32.02] Interviewer: Yeh, yeh. So, by you, erm, I mean I know you've said it's difficult to change it, but do you think that you have influenced the people maybe that you manage, by suggesting other ideas that maybe they're not used to?

[00:08:44.06] Interviewee: No, I think I probably came across at times as, erm, oh that's a weird thing. Genuinely people are that's, that's, why would you want to stand and have a meeting and things like that so…influence people in the sense that people just think it's a bit strange. And you then you just kind of give up and say 'buggar it'. You know what I'll [redacted] when I get home that'll be fine, or I'll do all that, let you all get on with it.[14]

[00:09:09.25] Interviewer: Yeh. When they've made comments about your desk, was it completely serious or?

[00:09:15.08] Interviewee: Yeh. They would, in most instances there's been, not in the sense of don't use that desk because people can't really say that. But comments about really practical things like 'Oh, you're overlooking me' and… or 'I feel like there's a shadow over me'. You know these little things? And you can understand it because you are standing over them and that makes me really conscious about doing that side of it so probably 90% of the time I don't use it other than to stretch my legs maybe for five or ten minutes. And that's really disappointing but you can kind of appreciate if that people are sitting there and you're standing literally at their shoulder and that's a bit maybe to do with the physical working space that we've got but that's, that's a bit of a disappointment that I find.[15] That yeh it was, it was difficult over time to use it. Flip side of it, people see it and want to test out the desks themselves so there's a little bit of er, kind of people being inquisitive about it but then, 'Oh I don't want you to do that, that's different or special' or whatever or 'Why hasn't everybody got it?' you know all the usual sort of things that, so.[16]

[00:10:22.11] Interviewer: Has that been in [redacted]?

[00:10:26.09] Interviewee: Yeh.

[00:10:26.09] Interviewer: Because there's a couple of other desk [redacted] has that been a bit different?

[00:10:33.06] Interviewee: [redacted] that

was kind of tricky because, yeh, for whatever reason… people surrounding the desk and it was this kind of thing and it's like oh, you're, you're looking down. And it didn't particularly help that [redacted] erm, it was quite a strange thing [redacted]. It became quite a psychological thing that oh right, he's kind of looking up at you to talk to you. That was quite strange. Whereas, fortunately or unfortunately [redacted].[17] Not for the study but because somebody had an injury and that meant that people had to accept it. It was, it was the reason for it as opposed to just somebody wants a desk or it's a test as somebody is actually injured and that's the reason.[18]

[00:11:50.07] Interviewer: So, do you think that's more acceptable to people, the fact that this person's injured?

[00:11:55.07] Interviewee: Yeh. It was, it was really noticeable and then subsequently when people have a bad back or somebody's done something it's always 'can we use the standing desk' and people could understand the value of it and why it would be a special thing for special people to use. More difficult for people to appreciate that one or two or ten or twenty people should have this, almost a privilege. People seemed to see it as a privilege, which it is, erm, and when it's more of a communal thing, where people can pop and use it and share it that became much more acceptable. It was being, I think there were two or three desks in the area [redacted]. Everybody loved that. But when it was just one or two people standing there… not so great.[19]

[00:12:45.01] Interviewer: Yeh that's interesting. When you say it's seen as a privilege, what do you mean?

[00:12:52.02] Interviewee: I, I, yeh, just sensed that… everybody wants everything, [redacted], cause when I was in the study I was thinking [redacted] everybody wants what everybody else has to a certain degree. And, people were aware that the standing desks aren't standard, and people were aware that they cost money and people were aware of x, y and z. And it was kind of, well they are a new toy to play with type thing, so there's that sort of people want to try it and do it and then when they can't do it because actually… people are assigned, there was that sort of 'Oh I want one, how do I get one'. And the flip side of that a well…what makes you so special type thing. And yeh, a desk that when people are sitting there going 'oh I've got a bad back I wish I could stand up at work' is in that sense a bit of a privilege. And also, the kind of awareness that there's probably not that much chance for widespread, everybody's going to have one so there was that 'oh there isn't really a chance for billy or bob to get one in two weeks' time' so I think that... It didn't mean huge problems it just meant that yeh there was that strange thing over a desk. It happens when you move offices, and everybody fights to get next to the window. It was that sort of I want that, which was an unusual thing to do. So, I kind of didn't expect it.

[00:14:18.18] Interviewer: Yeh. Do you think, erm, when people, [redacted] when people say, 'oh I've got an injury I wish I had one' and if you're at it because it's yours but you're sat. Does that make you feel...?

[00:14:34.05] Interviewee: Yeh, I've had people, I've had people, so I go through strange periods where I use it a lot and then I wouldn't use it at all and a lot of the time when I'm not using it it's because I've got a lot of papers out and I want to simultaneously do three things and probably just because of habit it feels easier to be sitting and doing all that, and you will get people going, "well, what's the point of you having that?" And there is this expectation that if you have got it, you'll use it seven and half hours non-stop... and then if you're not using it seven and a half hours non-stop people say, "Well, what's the point of you having it? Give *me* it", type thing, as opposed to this... and then you have to explain to people it's not necessarily about using it 24 hours a day. It's more a... breaking things up, at times. So, yeah, that was... that was why I, they were saying, I should have that instead.[20]

Did you find that you got a lot of interest then? A lot of people coming and asking you about it?

Umm... at the - yeah, in the first instance, when it was first installed, yes... less curiosity in terms of "could I try it out" and more curiosity of "why? why? What's that? That's weird! What you doing all the way up there?" so that sort of *negative* thing of somethings different, why? And then, by the time [redacted] it was a little more accepted, and then it was just a case of people saying "do you mind if I use your desk for a couple of hours".[21,22] But the problem was that we were operating, hot desking, and that had its own issues that it's difficult to hot desk with that type of arrangement, so... so yeah, it got a different type of interest [redacted]

Do you think - why is it difficult to hot desk?

Umm... in the, well... certainly in that study period when you've got those week blocks, you of course need to not do that, and... and real practicalities like... well, that's not real practicalities, it's more the formation of the department and the way people are that, again, this hot desking's a great thing where you can dash around, but... we hot desk because there's one extra person to the number of desks so actually what you had is everybody's got their crap all over the place, and... It was just, you know, people felt a little bit... instead of just saying "I'm gonna take that desk" it was a 'special' desk and there was a "*can* I take it, do I have to book it specially and can you explain how to work it". So, it actually wasn't that people to just rock up and do... It should be, there's nothing special, it's just a desk, you can stand there but people felt like it was different, special... and it never got used but it used to have a little hot desk thing on... I think it got used maybe once in [redacted] so that's quite strange.[23]

Just to go back to before you got the desk, so I think you chose at that type, didn't you, the whole version? Was there any reason why you chose that one over the other desk?

I thought I assumed, maybe, that... ahh... that the idea of having this, a complete desk, so all of your stuff can be on it and it just goes up and down, as opposed to almost having a base desk and then things come out of that. I don't it just felt like, on practical level you can have everything there, you've got a working surface that moves as well as a keyboard and a computer, so it's not just your computer, and a small section that's moving, umm... that was the theory behind it.

You didn't like the other one did you? Cos I'm trying to remember and I'm sure I saw an email that you'd [redacted] saying something like "I want to take part as long as..."

There was a problem, yeah, because we have a test one and it was the test one where it was umm... I can't remember which one, there was 3 wasn't there. there was one, there was the big one that I've got, there was the one where it's kind of a, a mini desk comes out, and there was one where it was kind of satellite bits... there was something about testing and we all tested in [redacted] and nobody used it because everything was... it was all extendable arms, and everything was bouncing around and all that. And it just felt like you were going mad and actually that test one got used for about a day and then just sat there and nobody would use it for a while. So that was the idea, that, yeah... cos I want to be able to stand and write or not have things wobble, umm...[24]

So, had you seen the one that you got before it was installed?

No, only the pictures, so I kind of had visualised what it would be like. Umm... so yeah it was *kind of* what I expected. So that was good, it wasn't too different, umm... but yeah, there were probably test ones that I could have seen but I didn't. I didn't see one.

So, when you - you just said you thought it was quite similar, was there anything that you didn't or don't particularly like about it?

The... the things that leads to me sitting quite a bit, strangely and as I say this, I'm very conscious that there's no reason that it should lead for me to be sitting, but it's as if the extendable keyboard bit was built by a 5-year-old in Taiwan. It is the wobbliest piece of cheap plastic, hanging there, that you've ever seen, so... what you find is that actually, one of those good bits that is you can pull out and move your keyboard, the practicality of it is that your keyboard is more or less... kind of the same size as the extendable bit and you have a very small area for the mouse, so when you're used to working on a big desk, you can have your keyboard there and you can have... anything like that. And it's just this... strange thing in terms of practicalities, normal desks that we have - or that I had - was a bit bigger anyway, so I'm used to having bigger work surface, with a keyboard, and a thing that you can move around inch by inch. so then to change it to... to use it properly with the extendable keyboard bit that... quite... confined, and then if you want to put your keyboard on the actual top big desk bit, then... you've got a lot less space because the desk is smaller, so actually it was quite difficult to use in that sense, that the practicalities of it moving a long like that are absolutely fine, but the dimensions of it and... You get so used to having 20 bits of papers and 2 books and the keyboard there and you throw your keyboard out the way. So, it kind of means you've got to be a bit more organised, which is probably, why I'd love to be organised, not the greatest.[25]

So, is that a bigger issue when you're standing than sitting, or...?

Umm, standing, yes. Actually, standing and typing has... I can stand and type, if it was... If I use the keyboard on the firm, flat thing, that's fine, I can stand and type but when you stand, and type and you've got the extendable, adjustable bit coming out, for whatever reason, ahh... it's just not quite as comfortable. it's really strange describing... you don't have... you know, if you're sitting at a desk – I know this isn't too much use cos your recording it - but when you're standing at a desk you can rest your wrists and type but when you have this low extendable you can't rest your wrists, and actually I find - I did generally find that when I was doing that, umm... I would end up twisting my hands in different ways cos I wasn't doing my standard thing of supporting myself on those silly gang part mats. and the easiest way to do that, rather than kind of rerouting cables and doing it, was when you need to type lots, just sit, and then you can... and then I found myself kind of, my legs underneath the keyboard support, my wrists... and then it was actually much more uncomfortable, therefore, to do long periods of typing.[26] it came into its own when you were just reading emails or reading documents, where you wanted to scribble things, then its fine, you can... or for me at least it worked absolutely fine, I'm sure other people are much more adept at using wrists and fingers and stuff...

Do you still use it now, standing?

Yeah, I was... I... Last Wednesday, I find myself... it's quite strange, it's now become a case of "oh I fancy just standing for half an hour" and doing it as opposed to... "I must". Now it's been there so long it becomes an asset to use. You get used to it, and... Yeah, so, I pop it up for half an hour and I'll sit down for an hour and a half and I'll do it that way. And it's a bit of a disappointment cos I thoughts I'd use it a lot more, but... it... does get used.[27] Where I was... not... kind of [redacted]. I came at the flip side of that cos I brilliantly was [redacted] but yeah, I find that when the last portion of that study period came around it was brilliant so yeah... I was fit and healthy, didn't have any aches and pains, could stand for hours on end, loved doing that, and then as a consequence of that finally using it properly, now... going "yeah, I'll use it for now", umm... and it's actually standing up there now for when I go back down, so that's quite good.[28]

So, you feel as though there's definitely up and downs in how much...

Yeah, umm... outside of the... so, in that study period, as I say...

The last one?

Yeah, the last one, so I used it a lot, cos I was really conscious that I hadn't used it a lot cos at various times... when I was looking back at diaries and things, you go back to the very beginning of the culture that we've got, you know, it was 5 days a week that you might predominantly just be sitting and you know so 6 hours a day so I didn't really get to use it. And then so the first period where actually there were no study-long meetings and I wasn't doing x, y, and z, I actually just had desk space time, and found that I used it a hell of a lot.[29]

And then after that... having finally been able to use it in a monitored situation... properly... finally I had that thing switch in my mind going "yeah you can use this all the time, its fine". So it didn't take that... the thing that changed my behaviour was having the monitor on, which made me consciously think about what I was doing which is part of the purpose, but being in a situation where not only did I have the monitor on, but I was able finally to do what I was trying to do, and then over the course of the week or whatever it was, finally, the switch had flicked in my head, is that "oh yeah, that's easy, I can do this" so... but then with the realisation having had the desk for quite a long period of time, that it wasn't going to be 24 hours a day or 7 and a half hours a day, I knew that it was OK to kind of use it for a couple of hours here and there, as opposed to forcing myself to stand and hop from foot to foot... don't know what that counts for... Fixes my posture anyway![30]

So, do you think it was putting you off that you weren't able to use it as much as you thought you would, so it put you off using it?

The first I think it was the first 2 or 3 periods, it was just horrific timing, I... really bad timing. I was... I remember when I first got [redacted], so I was really exhausted, and it was really strange, I [redacted]. So, I almost purposely... didn't use it because I just needed to sit, each sugar and fat and... and get healthy again. So that was really bad timing in the sense that 2 or 3 months it began I was kind of consciously not doing exercise and all of that. And then gradually, you see... you almost see the thing - a graph of what your general health outside of it - and then as soon as I start feeling healthy and fit again, then start to do that, and it's exactly the same as starting to [redacted] and all those different things.[31]

Do you think that when you first got - we might have talked about this already, tell me if we have - but when you first got it and you know, you just said you wanted to sit all [redacted], do you think that that has an effect on the people on your team? Sort of thinking why has he got this desk and he's not...?

No, I think the other thing is that people knew from... keep coming up to me all the time and saying "are you ok? are you ok?" so they knew I wasn't doing particularly well, umm... but I... the good thing is that the people here I work with are all kind of research minded people, so they appreciate that even if I wasn't using it, it was still part of that study, that in different scenarios when you feel like x, y, and z or you've got these things to do, it's just as valid in the context of the study to not do it... and then I think, there's a couple of people said "well, actually it's probably best that you're realistic and you're not using it, because otherwise it would just be an artificial thing that you're kind of..." just doing it because you've got a band on your waist, versus doing it because it's part of your life.[32]

Do you think that now you've got the desk and now that you're using it a little bit more, do you think that that's had an influence on like anything... any other exercise or activity?

It's part of that, it's part of... I think, yeah, so... unsurprisingly, it's like eating a big plate of vegetables, you feel better for eating the big plate of vegetables, so... when you've been standing up for 2 or 3 hours you genuinely feel like that's a lot - well, you know it's a lot better

for you, but you actually feel that "yes, I feel a lot better for doing that". And, there is a big difference, I'm [redacted] when I sit for hours I do just get really lethargic and tired, so having that opportunity - sometimes I'll go for lunch, ahh... I'll come back into the office and I'll be a bit sleepy tired so I'll stand up, and it means that when the day ends, I'm not completely exhausted, which means that when I get back home [redacted] sus I've been sat for 7 or 8 hours, your legs are knackered and you're so tired, and you go back and you just sit, and that's it, so... definitely been part of that change back to a more healthy lifestyle.[33]

How did you find doing the monitoring?

Umm, I'm... I'm shocking. Honestly, you know what, and... I think... again, it was another thing that made me realise that how many times I've done studies and been really alarmed at people for doing it. So that first bit [redacted], and lots of weird things, it was surprisingly easy just to forget, and... I think the... so once I stopped myself forgetting and there were days when I'd forget the waist band but of course you've got the thing stuck on you, that was a really good thing, I think that was fine, you can't really forget to stick something on you, but even throughout it, even the last period when I was really conscientious cos I thought right "there's no excuses now, I need to do this properly" umm... still found myself forgetting what the hell I'd done during the day, so by the end of the day - honestly, by the end of the day at 10 o clock at night when everybody's home and writing up the day I would find myself going "what did I do for those 2 hours?" and it's not so difficult during the work period, but outside work accounting, and a written account for what I was doing from 5.30 till 10, probably just cos I'm stupid, I would find myself going "was I... walking? Did I get... right I got the bus and..." that was the trickiest bit. umm, and sometimes if you don't... if you don't do it that day and you have to look back at the day before, then you're just thinking "ohhh, I did some stuff...!" that's it. So, yeah, the monitoring was a strange one... but bizarrely it did all feel that when I was using it more and... everything had clicked into place in the final monitoring period, it was easier to do it then previous times, so I'm kind of in, probably gonna trash the case study in terms of what happens when you are really a mess versus when you're quite healthy and fit and mental capacity working...[34]

And do you - I think I've pretty much asked everything and I'm conscious that I think it's after 10 - did you have anything else that you wanted to say about the project?

No, I... I, I just think that there was... just really interesting that it bought up for me those things that we covered which was people's attitudes towards somebody - anybody - having something different that's seen as better and therefore this strange dynamic that it leads to, not all the time but sometimes.[35] ah, and the monitoring bit of, you know, personal thing, I'm sorry I didn't do it particularly well for the first 2 but then, just the awareness that... yeah, like that written part of the monitoring, for some minds like mine which is kind of stupid... and I remember suddenly thinking, actually, had there been the opportunity or the time available for me to have some online app-y thing, cos everything's apps now... and that was a strange one, that... thinking back [redacted] it would, yeah, some... a more interactive way of doing it, but not because it's

bad to have written things or whatever, but... there's just this... even in my mind, this expectation, that everything I do in the world, should just be able to click a button, and so yeah, I get so used to doing that, that going back to writing and using a pen and paper... was surprisingly challenging, really weird, and I just didn't expect that at all, but it was, and, ah... so that was my thing, I think we've all got really lazy, or at least I have. If I can't tap with touch screens, probably not worth it, that's... just my laziness. But apart from that,[36] no, is that it was just umm... yeah, it was - it was a good study, and it was a good study in the sense that there's a lesson to it, and there is actually a definite change in behaviour as a consequence of it, because the monitoring makes you actively think about it, eventually... and I'm sure for a lot of people it was the first day, it was the click in the mind, for me it took a lot longer, but there was definitely a change where you go "ooh, and now I don't like sitting" and I actually feel guilty, it's like exercise, if you don't do the exercise you feel guilty? And I feel guilty if I find myself sitting there all day, which wouldn't have happened before, because there wasn't any option. So, it's really good to have that positive option to do something else.[37]

Can I just ask a couple more questions?

Of course you can, there's no problem.

Did you have a period [redacted]

I found what happened was that... as soon as I did get the desk... so it was less that negative and more the reverse positive bit that as soon as I did get the desk, I think it was about a month and a half... the first day I used it non-stop, so it was... I didn't really... at first I wasn't too bothered, and as that period went on when I didn't have the option of using the desk, I began to think... "oh, this isn't good" it's like... it's that strange psychological thing with exercise, as long as you've got the option of doing it you're ok not doing it, the moment that you don't have the option, starts to prey on your mind, and by the time they'd put the desk it was like "yayyy! I can do it again, I can do it again". So that probably helped with the whole... in this final month or two of the study, it changed dramatically for me.[38] and it's probably a combination of also... being fit and healthy, standing there and not having the option, which made me realise how good it was, and then... really wanting to make the most of the study period, all combined, did change it quite a lot.

[redacted]

[redacted] kind of work backwards, as in... was there space for me physically in the department, which then led to another period of - [redacted] eventually it worked out OK, and then... but that in itself highlighted issues of this that... when you've got limited space, I mean maybe hot-desking arrangements, there's that... how do you incorporate this in the working environment if it's only one desk versus everybody's get-up, and all those little things...

[redacted]

[redacted] I was just sitting there thinking "how does it take 2 weeks to work out...? I'll just get a tape measure, no?" So, all those little things are actually... you can't really use them in certain environments, umm, cos of the way that we're configured, so that probably meant another delay, which in the end was, as I say, was really good, cos it made me realise what is it? 'You don't know what you've got till it's gone' and that was the truth. I think if you took the desks away, people who were using them would be really quite upset, even if when you walk around, they're not using them all the time.[39]

Annotations

[1] sed nature of office

[2] sed nature of office and limited opps to break up

[3] diff occupations/roles - differs in terms of how sedentary

[4] culture/norms - work through lunch, stay late, email culture

[5] sed nature + technologisation

[6] norms / culture - eating @ desk

[7] sed nature of work

[8] challenges to workplace health promotion - initiatives not fitting with wider culture and working practices

[9] norm - culture of not being active at work

[10] influence of leaders/ top down

[11] professional id - at desk = productive (sit-stand desk: you can reduce sitting but still be productive)

[12] comments from others

[13] social norms at work

[14] standing as abnormal

[15] comments from others

[16] curiosity / privilege

[17] hierarchy + power/authority

[18] more acceptable to others when have a "reason" for standing rather than just doing it

[19] desk envy - seen as a privilege

[20] privilege / guilt as don't have "need" and others think they deserve it more as "injured"

[21] standing as abnormal

[22] becoming more accepted

[23] "special" product

[24] displeasing aesthetically

[25] issues - size, quality etc - links to working style and organisation

[26] issues - interacts with how you use it

[27] use over time - now an "asset" - sustainable?

[28] limitations - injury/illness and using more in monitoring period

[29] use and general work schedule

[30] monitoring = behavioural TOOL

[31] use over time - linked to illness

[32] validity of monitoring and context

[33] increased PA + increased mood

[34] issues with monitoring

[35] jealousy/privilege at new "toy"

[36] limitations of diary

[37] experiencing guilt - moral behaviour

[38] patterns of use - clicked over time - linked to not having access to desk for a while (notice when something gets taken away from you!)

[39] use over time - would be upset if taken away!

2. Formal observation field notes extract

Phase [redacted] Date: [redacted]

Most employees will walk from the station (either train or tube) which takes around 5 minutes – and then an extra five minutes or more to actually get to your desk! Some people cycle in but almost nobody drives due to it [redacted], busy traffic, limited parking spaces and congestion charges.[1] As I approached [redacted], I could see a long queue from the reception area all the way outside the offices and past the cafe (at least 20 meters) – I wondered what was going on, a fire alarm already on my first day back!? But no – it was the queue for the lift!![2] Something I then remembered from my time interning last year. It was something that I had heard much about but never actually witnessed due to my start time being 10am, an hour after the 'usual' start time of 9am. I always used to take the stairs anyway, I hate waiting around so I would have almost always chosen to do this regardless, but the main reason I did this was because, as a member of the physical activity team, we were asked to advocate and demonstrate being physically active at work.[3] However, today I was stuck in the lift queue, as with it being my first day volunteering I had not yet received my pass that would allow me access through the door at the top of the stairwell. Thus, anyone who forgets their pass, or whose 'main' place of work isn't this building, will not be able to access the stairs and will have to get the lift to the reception. I noticed at least 2 helmets whilst I was stood in the lift queue, and a fair few people wearing trainers, but these were combined with relatively smart clothes (the dress code here is officially smart-casual).[4] The queue did move relatively quickly, but I must have been stood in it for at least 5 minutes. And then it took another 2-3 minutes getting to [redacted] (i.e. [redacted] reception) from the ground floor reception. This is because we stopped at most of the floors along the way, albeit the first floor we stopped at being the fifth. As I was stood in the queue I did see at least 10 people taking the stairs this morning.

Reception: After my morning coffee, I arrived at the [redacted] reception on [redacted] only just before nine (the lift episode took longer than expected!). I told one of the two female receptionists that I was here to [redacted], signed the sign in book (without being asked), and then went and took a seat (without being asked!). I realised this after I was already seated on the sofa-style seating that lines the window-wall of the reception, and figured that it was most likely because I have followed this procedure numerous times before (when visiting [redacted] other Macmillan colleagues) as the receptionist has asked me to fill in the sign in book and take a seat (perhaps offered, rather than asked). Thus, it was probably part habit (both in this specific situation and in general) and part doing what I thought I was expected to do. Upon realising that I had automatically sat down, I considered standing, but decided to stay seated, even though I knew I had a whole day of sitting ahead of me, as I was still drinking the remnants of my coffee whilst simultaneously trying to make research notes in my phone. I think there's probably enough seating here for about 8 people, but I was the only one that was waiting in the reception area this morning[5] Whilst I was waiting for [redacted] a lady came to reception to tell the receptionist that she was conducting interviews this morning and that the first interviewee was meant to show up at 9am but hadn't arrived yet, and could she let him know that they're in meeting room 13 when he arrives. After the receptionist said yes and the lady left, she promptly came back to say 'the meeting rooms don't have phones, do they? Do

you want to take my mobile number so that you can call me when he's here?' The receptionist replied saying, 'it's ok, I'll just come to you', the lady replied saying 'oh yeah, it's not that far...' This was the first instance of witnessing a pre-occupation with methods of communication that mean you do not have to move from where you are seated (or stood?) – Such as phone (by the interviewing employee) but a move towards incorporating movement by the receptionist. I overheard someone else, later in the day whilst I was working, come up to his male colleague from a different floor and say 'I thought I'd come and speak to you rather than emailing'.[6]

I spent the first few minutes deleting the 175 emails that I had already acquired on my new [redacted] email (Jo set up the account towards [redacted]), before heading off to the weekly team catch up in the break-out area. Of these emails, at least 4 were from someone in the team saying that chocolates/biscuits etc were on the shelf, brought back from their holidays.[7] Around half of the emails were from reception, saying that 'the sandwich man is on the [redacted] 'the sandwich man is on the [redacted] etc – I think we receive about 4 emails a day, close to lunch time, saying which floor the sandwich man is on. I remember this very well from interning, and immediately set these messages to go straight to the 'delete' bin.[8] Although the 'sandwich man' means that people can buy from him and so don't even need to leave the office (or their floor, mostly) at lunch time, most people seem to bring their own lunch or go and buy from outside the office anyway. I brought my own today, and worked through lunch to reply to (urgent) PhD emails, so my physical activity levels today will have been very limited.

Weekly team catch-up: [redacted] have 'break-out areas' on all of the floors, which are meeting spaces that do not require booking, and so you can use if and when they are available. Even at 9.30 in the morning the break-out area was relatively busy, but no one was using the standing/sit-stand tables. There is an Ergotron full sit-stand desk (a demo that we installed) that has a PC and a phone on it so that people can use it to work if they wish, and a small, square standing table that is more conducive to holding standing meetings (non-Ergotron – [redacted] have supplied this themselves).[10] T[9]he break out area on [redacted] (where the [redacted] is located) is a separate room from the rest of the office space, unlike some of the break out areas on other floors are right in the middle of the open-plan office, with only one glass/transparent plastic wall separating.

My work tasks: I knew prior to starting today that [redacted] had organised for [redacted] to set me some work to do during these two weeks, and had scheduled a meeting for us for early afternoon. We met in the break out area and this time stood at the standing table (suggested by [redacted]), who confirmed that this table was new but that they'd had a circular one that moves up and down (so it is sitting and standing) since he'd been here, which is at least a couple of months.

Other observations: Probably only around ½ - 2/3 of the desks were taken on the [redacted] floor today. It seemed fairly quiet in the office today (based on what I remember from last year) but the teams have moved around since, which may be why. For example, it always seemed to be [redacted]! However, at one point

one team behind me broke out singing 'happy birthday'. There were occasions that I heard people laughing and chatting friendlily behind me, but the little team that I was sat within (3 ladies) talked infrequently, and then only about work tasks. They seemed friendly enough when I was introduced to them in the morning, but were very engaged in their work the whole day that I was at my desk. However, I could feel [redacted] phone vibrate on the desk probably at least every five minutes. Probably the only non-work-related conversation (that I heard at least) was a lady asking, 'are you being good and going to the gym'? She said, 'yeah, I have to go straight from work 'cos then I have no excuse'. She left at about 4pm.

The desks are arranged in banks of 6, 3 on either side. Each floor must contain about 10-15 of these banks. Only the odd one is arranged slightly differently. There are two printers on each floor, in the middle and one end of the office, meaning most people don't have to walk very far to get printing. Form one end to the other it probably takes under 30s to walk, must try it! Middle of each floor is the lift lobby and stairs are located at each of the ends.[11]

[redacted] stood, has a note pad clipped onto her monitor and was at her desk most of the day. [redacted] was barely at her desk but when she was she was stood too. Whilst [redacted] was stood in what looked like a 'good' posture, I noticed [redacted] quite a few times with her elbows on her keyboard/the paper propping up the keyboard, her back hunched in a rather awkward looking position.[12] There is no 'sitting' option when they are working on the computer, but they both did sit to eat their lunch. It was a little bit out of my line of vision, but every time I peered or wandered over, no –one was using the demo desk in the [redacted] team.

A lady that I know from my interning time – [redacted] – now has her own sit-stand device. It is a [redacted]. She said she loves the opportunity to sit and stand. She said it's 'not as cool as the superman desk over there' – I didn't know that she was referring to the Ergotron one at first![13] She said this one is annoying in some ways as when it is down there is a platform meaning that it takes away her desk space quite dramatically and she prefers the Ergotron one much more as it doesn't do this so much. Also, when standing it brings the monitor forward and it is too close! She can't stand further back as the arm support doesn't come out far enough.

Annotations

[1] active travel to work - not feasible to drive

[2] get lift (norm)

[3] occupational identity - pressure to make healthy choices at work

[4] artefacts - clothing (easier to cycle in etc if not smart/city wear)

[5] sitting as normal + env supports sitting

[6] email/phone/lack of movement culture

[7] cake culture

[8] counteracts health initiatives - availability of unhealthy food (offers... buy a sandwich and fizzy drink and get free crisps or biscuits), and directly communicating option where have to do least amount of walking

[9] standing becoming more normal

[10] some opportunity to reduce sitting

[11] layout - limited opps for pa....

[12] poor posture if desk not right height

[13] aesthetic / personality

3. Informal observation field notes extract

Date: [redacted]

The site survey with [redacted] went very well. I felt as though I was just there to oversee a conversation between [redacted] and Ergotron representatives, reminding of the details of the study at times. They were able to discuss desk options and logistics/technical details. [redacted] has known about the sit-stand project for a number of months now.[1]

Following the [redacted] site survey, we headed to PHE. The project is meant to take place at [redacted] which is where the majority of the [redacted] are relocating to [redacted]. I met with [redacted] is a health and safety representative who couldn't make the inception meeting and so I invited her along to the site survey instead. I had asked [redacted] to arrange for someone from facilities to attend the site survey as this really is crucial for the technical aspects of the project, but she had forgotten and when we asked [redacted] at the last minute she was unable to make it. But this definitely meant that the meeting was less productive than the [redacted]. We looked around the layout of [redacted] which was obviously useful for visualising the space etc but the [redacted] staff who currently occupy the building were there with their current desks that they will be taking with them when they move. This meant that we couldn't really do anything there as the desks were not the ones that would be there when [redacted] move in. We went across to [redacted] to have a look at those desks as they are pretty much the same ones that will be installed in [redacted], but just a little bit bigger. This was certainly useful for Ergotron but both parties didn't benefit as much without having a facilities person there.[2] It also transpired from this meeting that the move to [redacted] may not be as soon as we were at first told [redacted]. The move was meant to take place during the summer, but it is now going to be in 2 phases – the second being [redacted]. This will push

back data collection until at [redacted]t and thus desk installation [redacted]. I definitely got the impression from [redacted] that this was a little up in the air and they were themselves frustrated with what was happening with the move. In fact, in the inception meeting [redacted] conversations between [redacted] definitely eluded to that.[3] At the meeting we discussed all elements of the proposal including desk options and [redacted]. Discussion points included taking a paper to leadership and what would happen if the project was unsuccessful – we agreed to hold review meetings discuss how the project was going. [redacted] The email has gone out [redacted]. I wanted to send this email personally, but I was not given access to an email list. Alternatively, [redacted] emailed all the accommodation reps of each team and asked them to forward onto their respective teams. Unfortunately, with this method I do not know exactly what went out to each team member (i.e. the content of the email) and actually if the email went out at all or not. So far we have had 8 interested [redacted] so we may have to send a reminder email as we want 15 participants from PHE and this 8 may not translate into actual participants after the workshops.[4]

Trying to book rooms is a bit of a nightmare [redacted] in fact no one at PHE has taken ownership of the [redacted] I am being an inconvenience when I contact them. It is completely different [redacted] both project managing the sit-stand study from their end and they have taken much more of a hands-on [redacted].[5]

[redacted]

[redacted] has emailed to say she can't attend the first 2 workshops now. We had agreed she would attend to support [redacted] as it will show employees that they are on board and also to answer any issues etc.[6]

[redacted]

We installed a demo workstation at [redacted]. I asked for, ideally, a hot desk or a meeting room space for the workstation to be located but [redacted] said she has been told they do not have the capacity to put it there. It would have been nice to speak to facilities / IT about this and explain that the workstation would not take away any space as it can be used in the seated position if preferred, but we were tight for time and really needed the workstation to be installed that day. Thus, we ended up installing the workstation [redacted]. This was not ideal as people may be less likely to want to go and look at it if [redacted] working there, and although we sent an email to all staff saying they were welcome to have a look and trial it in [redacted] absence, they may be less inclined to do so when it is [redacted] specific desk, as it would mean being with their team which may put some people off. I will get feedback from [redacted] though and the people around her as to whether many people were interested etc. The install was useful as it highlighted some issues to do with cables needed etc and so will be meeting with facilities to discuss these issues shortly.[7]

Annotations

[1] engagement / collaboration between parties

[2] not having right people there - not being able to get hold of the right people -- linked to newness / people leaving / intensity of work priority

[3] delays in office relocations - beyond control

[4] recruiting issues - not being given access to lists of staff / not having them / not getting "permission" to recruit via intranet etc.

[5] lack of ownership

[6] lack of commitment

[7] issues installing demo desk - not having access to right people to ask things, not being given permission to do things

Appendix S

Iterations of thematic frameworks – theme development

Thematic framework v1.0

A. Introductory themes (employee and employer_

1. **EMPLOYEE (INDIVIDUAL) CONTEXT: UNDERSTANDING SITTING, PA AND HEALTH:** This theme relates to the meaning of sitting, standing and physical activity in employee's lives

SSPA1 – Physical activity profile: sitting and standing seen as components of PA profile or separate issues, lifestyle behaviour vs. structured exercise, sedentary nature of life, PA as moral/ethical behaviour (intrinsically "bad")

SSPA2 – Motivations and challenges for reducing sedentary behaviour and increasing physical activity: health (preventative and maintenance), weight/appearance, enjoyment/mood, Physical activity and life stage/life events, physical activity-work-family-leisure balance

2. **(UN)HEALTHY ORGANISATIONAL CULTURE: PROMOTING WORKPLACE HEALTH:** This theme relates to the health promotion efforts of the organisation and their 'fit' with the values and assumptions inherent within the organisation that influence the health/lifestyle behaviours of employees

PWH1 - Sedentary nature of the office, dislike/not being natural, limited breaks in sitting, change over time: technologisation, seniority, role

PWH2 – OH issues re. workplace sitting, level of awareness of health risks of SB (limited, mostly just know its "bad" not why) and opps to reduce sitting in the workplace (WP strategies) (media/policy/word of mouth/ previous experience)

PWH3 - Work (health) culture: nature of org (health focused, charity/public), level and intensity of work, fundraising/campaigning, team culture, influence of societal norms

PWH4 – Health promotion –initiatives, policies and processes (including occupational health), and the work environment – benefits and challenges (e.g. not leading by example, lack of 'fit' with work culture, norms, communication, geography of different sites, whether own the sites, diverse nature of workforce), and the perceived role of organisation in promoting health and wellbeing of employees – practice what preach, CSR, effectiveness benefits

B. Employee

1. **SIT-STAND EXPERIENCE AND THE PERSON-PRODUCT INTERACTION:** This theme considers the use and acceptability of the sit-stand workstation as influenced by the person-product interaction.

PPI1 – Patterns of use – generally + across time – linked to comfort, enjoyment, novelty, adaptation, surprise (different to expectation) and day-to-day (e.g. work-based, comfort, time)
PPI2 – Issues and benefits – aesthetic, design; linked to person-product interaction: nature of work and work style (e.g. autonomy), psych value/motivation/personality
PPI3 – Desk envy – new product/curiosity, jealousy/privileged, want other desk ("grass always greener")

2. **SIT-STAND AND SOCIAL RELATIONSHIPS:** This theme considers the influence on interpersonal relationships and power-relations on the patterns of use and experience of having a sit-stand workstation

SR1 – Social and symbolic meaning of sitting and standing **–** sitting as normal and standing as abnormal, hierarchy, sitting and standing "roles" (e.g. DJ, teacher)
SR2 – The influence of interpersonal relationships on extent of use and experience of using sit-stand workstation – perceived impact on others, comments from others, power/position, experiencing guilt (privilege, feeling "should" stand, others having "need" and moral behaviour)
SR3 – Knowledge exchange (positive and negative) re. sit-stand –cultural shift towards standing in the workplace

3. **SIT-STAND: PHYSICAL ACTIVITY, HEALTH, PRODUCTIVITY AND PROFESSIONAL IDENTITY -** This theme considers the impact of the sit-stand intervention on behaviour "away from the desk", physical and psychological health, and productivity at work

PHP1 – Increased awareness of how sedentary you are, change in behaviour inside (increased PA at work, reduced sitting and increased PA at work in different contexts (e.g. working from home, meetings)) and outside workplace
PHP2 – Physical and psychological benefits and problems using desk – e.g. posture, MSD, discomfort, wellbeing, alertness
PHP3 - Efficiency/productivity issues and benefits of using sit-stand
PHP4 – Professional identity – health + professional identity (lazy/alert + perception of "healthier" = perceived professional identity), at desk = work so does not reduce perceived productivity, occupational id – NEED to be PA (feel should, part of job and better at job due to working in health?), intrinsically value work (career not job) = if sit-stand desk increases productivity then do it, if not then do not.

C. Employer

1. ORGANISATIONAL ATTITUDES REGARDING ADOPTING SIT-STAND AS A HEALTH PROMOTION TECHNIQUE IN THE WORKPLACE

OA1 –fit with organisational health and wellbeing approach and nature of org: role of org in promoting health (exemplar) and healthy workplace model, commitment to reducing SB and increasing PA (nationally PHE, and for cancer patients at Macmillan), one of many strategies and is a choice (health and wellbeing as an option not enforced

OA2 – perceived benefits of SS - able to continue working whilst standing (unlike other PA strategies), reduce SB more using SS than other strategies, increase in understanding of SB, sit-stand fits with incr. in flexible nature of work and next logical step in furniture design (ss for all), innovative/forward thinking, gives company competitive edge
OA3 – Sedentary behaviour and sit-stand scepticism – design issues with SS desks, unsure of benefit of SS over other initiatives, sceptical of need to reduce sitting in workplace, sit-stand desks a nice to have rather than a priority/essential part of work, generally still seen as OH for those who "need" it rather than a solution for all (lack of sympathy towards preventative rationale), viewed as a fad/gimmick (grouped with treadmill desk but perception by most that they should not be)
OA4 – Cost: spending money on SS – view that there would be a cost benefit (but not always.. and why spend money on SS over other initiatives (limited budget), view that there *needs* to be a cost benefit, perception that cost is only an issue when there isn't an OH "need" for SS, perception of employee reaction (esp. in context of strategic review for PHE), perception of stakeholder/public perception, size of org, perception that cost will reduce over time and make it a more feasible solution

2. COMPLEXITIES AND CHALLENGES OF IMPLEMENTING THE SIT-STAND TRIAL

CCI1 – Organisational commitment and wider organisational factors – priority of project, written into job role, organisational contextual factors (e.g. changing staff, restructure, time-pressures) limiting commitment, lack of authority/ hierarchical nature, and issues of postponement and people moving roles/changing jobs (linked to internal change programme), training, other sites feeling left out, amazement that participants did not go to view desks
CC12 – Installing the sit-stand desks – communication issues between different parties/collaborative approach, perception of disruption on install day (e.g. noise issues, perception that wasn't too complex compared to past experiences), access issues, adjustment (which resulted in multiple trips back), hidden costs (employee time + amendments to desks and cables), fit with the organisation / environment (perception that desk company should adapt to the org rather than vice versa, fit with usual standard (e.g. uniform desks, phone raised, reasonable adjustment such as fan), linked to org processes (e.g. hierarchy and sign-off)

3. THE POTENTIAL FOR A WIDER SIT-STAND APPROACH

SSC1 – culture change within the organisations throughout trial – linked to national appetite for SS (behind some other countries), visibility, helped make diff stakeholders in the org aware of the possibilities (and got a few SS desks in during the trial), increased demand for SS across the organisation, SS being integrated into DSE policies and training, a factor in health and wellbeing increasing in priority for org (and specifics on SB in workplace, e.g. lunch and learn), BUT not enough informal talk about SS, recognition that hard to capture culture change
SSC2 - Evidence and support required to adopt sit-stand approach: first priority is ROI/cost-benefit (and recognition that this is complex and hard to establish), health, feasibility evidence, high-level advocates, passionate senior leaders, support from the bottom line/powerful stories from participants, legislation/culture of office design, economic climate and context of org (whether having to make cuts),

SSC3 – Wider considerations for adopting SS approach – ownership of project and role of different teams, who gets them (OH vs for all, hot desks vs personal desks), equality and diversity issues (e.g. unfair to offer to some not others if there are proven benefits, cultural impacts, wheelchair users), facilities and estates (more feasible when re-locating/buying new furniture), procurement (e.g. how it would be funded – central budget vs teams), diverse nature of workforce and who would benefit from SS, communication, H+S (e.g. add to DSE training, policy) social workplace issues, how to convince / communicate with employees that are adverse to sit-stand desks and technological change in general, demo desks

Thematic framework v2.0

(condensing v1.0 by merging themes/subthemes, focusing on findings that specifically relate to research questions, and merging employee and employer perspectives)

Key E = employees, O = organisational/stakeholders/managers, B = both

1. **The healthy workplace: a rationale for sit-stand desks in office-based workplaces**

- Role of the organisation in promoting health and how SS fits into this (B)
- Workplace as a sedentary environment and how SS fits into this (B)
- Workplace health culture
  (a) programme/initiatives
  (b) challenges of promoting workplace health + how these also apply to sit-stand (B)

2. **Feasibility of implementing and using sit-stand workstations in the office-based workplace**

- Logistics of implementing sit-stand desks (O)
- Choosing and using the sit-stand desk
  - **A)** patterns of use (E)
  - **B)** Complex interplay of factors that restrict use of sit-stand desk: desk design, individual attitudes towards PA and health, organisational and work-related factors, interpersonal relationships, influence on work (efficiency)(E)

3. **Acceptability of implementing and using sit-stand workstations in the office-based workplace**

- Organisational attitudes regarding the adoption of sit-stand (benefits and scepticism, cost, evidence needed) (O)
- Experience of using sit-stand
  - A) The normalisation of sitting and interpersonal relationships (E)
  - B) physical and psychological comfort / discomfort (E)

4. **Reducing sitting and increasing standing and physical activity: sit-stand potential**

- The impact of sit-stand on sitting, standing and physical activity (E)
- Organisational culture change – towards the sit-stand workplace (B)

Thematic framework v3.0

(revised during the writing process)

1. **ORGANISATIONAL DISCOURSES –** This theme relates to organisational factors that facilitate and restrict the feasibility and acceptability of implementing sit-stand desks within the workplace

    a. Organisational effectiveness
    b. Ethical implications
    c. Implementation issues

2. **EMPLOYEES' EXPERIENCES –** This theme relates to aspects of employees' experiences of using a sit-stand desk that facilitate and restrict the perceived feasibility and acceptability of using sit-stand desks within the workplace

    a. Relationship with the sit-stand desk
    b. Health and productivity
    c. Culture and social change

3. **INFLUENCE OF THE INTERVENTION (RESEARCH) ON BEHAVIOUR –** This theme relates to the influence of the sit-stand desk intervention and wider research activities on sitting, standing and activity in work and non-work contexts

    a. Sitting and standing at the desk
    b. Employee work schedules and preferences
    c. Physical activity at work
    d. Behaviour in non-work contexts

Appendix T

Copy of ethical approval letter

Head of School of Sport & Education
Professor Ian Rivers

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Jennifer Hall
PhD Researcher
School of Sport and Education
Brunel University

29th April 2014

Dear Jennifer

RE45-13 Mixed method evaluation of an office based sit-stand workstation intervention

I am writing to confirm the Research Ethics Committee of the School of Sport and Education received your application connected to the above mentioned research study. Your application has been independently reviewed to ensure it complies with the University/School Research Ethics requirements and guidelines.

The Chair, acting under delegated authority, is satisfied with the decision reached by the independent reviewers and is pleased to confirm there is no objection on ethical grounds to grant ethics approval to the proposed study.

Any changes to the protocol contained within your application and any unforeseen ethical issues which arise during the conduct of your study must be notified to the Research Ethics Committee for review.

On behalf of the Research Ethics Committee for the School of Sport and Education, I wish you every success with your study.

Yours sincerely

pp Dr Richard J Godfrey
Chair of Research Ethics Committee
School Of Sport and Education

The Queen's Anniversary Prizes
2011

Appendix U

Copy of consent forms

Consent form for intervention participants

BC•SHaW | Brunel Centre *for* Sport, Health and Wellbeing

Take a Stand for Workplace Health: A sit-stand workstation evaluation project

CONSENT FORM

STUDY ID No

If you would like to take part in this project, you will need to give your 'informed consent' by answering the questions below. This means that you understand what the project is about, and that you agree to take part. Even when you have signed this statement you can still decide not to take part in the research.

	YES	NO
1. Has somebody explained this project to you?		
2. Do you understand what this project is about?		
3. Have you asked all the questions you want at this stage?		
4. Have you had your questions answered in a way you understand?		
5. Do you understand it's OK to stop taking part at any time?		
6. Are you willing to take part in the project?		
7. Do you agree to any focus group/interviews you participate in being audio recorded with note taking?		
8. Do you agree to being sent text messages as a reminder to fill in the activity diary?		
9. Do you understand that you will not be referred to by name in any report concerning the study?		

If any answers are NO or you DO NOT want to take part please do not sign your name
If you DO want to take part, you can write your name below

Name
Address

Postcode email
Contact number (work) contact number (mobile)

Signature Date

Name of Researcher Jennifer Hall

Signature of Researcher Date

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Consent form for stakeholder participants

BC•SHaW Brunel Centre *for* Sport, Health and Wellbeing

Take a Stand for Workplace Health: A sit-stand workstation evaluation project

CONSENT FORM: interviewees

STUDY ID No

If you would like to take part in this project, you will need to give your 'informed consent' by answering the questions below. This means that you understand what the project is about, and that you agree to take part. Even when you have signed this statement you can still decide not to take part in the research.

	YES	NO
1. Has somebody explained this project to you?		
2. Do you understand what this project is about?		
3. Have you asked all the questions you want at this stage?		
4. Have you had your questions answered in a way you understand?		
5. Do you understand it's OK to stop taking part at any time?		
6. Are you willing to take part in the project?		
7. Do you agree to the interviews being audio recorded with note taking?		
8. Do you understand that you will not be referred to by name in any report concerning the study?		
If any answers are NO or you DO NOT want to take part please do not sign your name If you DO want to take part, you can write your name below		
Name Address Postcode email Contact number (work) contact number (mobile)		
Signature Date		
Name of Researcher Jennifer Hall		
Signature of Researcher Date		

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Appendix V

Correlation tables – Correlations between outcome variables

A. Pearson correlation coefficients between ActivPAL variables during the work hours ToD at the 3-month timepoint across pooled IG participants, * p < .05, ** p < .01

	Sitting min.	Standing min.	Stepping min.	No. of steps	No. of sitting bouts	No. of sitting bouts 0-30 min.	No. of sitting bouts 30+ min.	Min. in sitting bouts 0-30 min.	Min. in sitting bouts 30+ min.	No. of SS trans	No. of SS trans. per sitting hours
Sitting min.	-	-.687**	-.559*	-.447	.124	.011	.788**	.067	.705**	.114	-.470
Standing min.	-.687**	-	.473	.404	-.079	-.001	-.551*	.043	-.547*	-.080	.417
Stepping min.	-.559*	.473	-	.971**	-.028	.030	-.427	-.072	-.70	-.021	.391
No. of steps	-.447	.404	.971**	-	-.061	-.017	-.302	-.116	-.254	-.053	.305
No. of sitting bouts	.124	-.079	-.028	-.061	-	.993**	-.468	.911**	-.554*	.999**	.779**
No. of sitting bouts 0-30 min.	.011	-.001	.030	-.017	.993**	-	-.568*	.917**	-.643**	.994*	.840**
No. of sitting bouts 30+ min.	.788**	-.551*	-.427	-.302	-.468	-.568*	-	-.520*	.962**	-.476	-.863**
Min. in sitting bouts 0-30 min.	.067	.043	-.072	-.116	.911**	.917**	-.520*	-	-.660**	.905**	.752**
Min. in sitting bouts 30+ min.	.705**	-.547*	-.370	-.254	-.554*	-.643**	.962**	-.660**	-	-.558*	-.889**
No. of SS trans.	.114	-.080	-.021	-.053	.999**	.994**	-.476	.905**	-.558*	-	.783**
No. of SS trans. per sitting hours	-.470	.417	.391	.305	.779**	.840**	-.863**	.752**	-.889**	.783**	-

B. Pearson correlation coefficients between GT3X+ variables during the work hours ToD at the 3-month timepoint across IG participants, * p < .05, ** p < .0

	Light PA min	Moderate PA min	Vigorous PA min	MVPA min	Axis1 CPM	Vector Magnitude CPM	No. of MVPA bouts ≥ 10 min	Min. in MVPA bouts ≥ 10 min
Light PA min	-	.265	-.423	.228	.373	.653**	.243	.161
Moderate PA min	.265	-	.160	.945**	.854**	.779**	.783**	.726**
Vigorous PA min	-.423	.160	-	.238	.342	.113	.379	.562*
MVPA min	.228	.945**	.328	-	.950**	.841**	.782**	.809**
Axis1 CPM	.373	.854**	.342	.950**	-	.928**	.802**	.841**
Vector Magnitude CPM	.653**	.779**	.113	.841**	.928**	-	.718**	.734**
No. of MVPA bouts ≥ 10 min	.243	.783**	.379	.782**	.802**	.718**	-	.944**
Min. in MVPA bouts ≥ 10 min	.161	.726**	.562*	.809**	.841**	.734**	.944**	-

C. Pearson correlation coefficients between ActivPAL and GT3X+ variables during the work hours ToD at the 3-month timepoint across IG participants, * p < .05, ** p < .01

ActivPAL	Light PA min.	Moderate PA min.	Vigorous PA min.	MVPA min.	Axis1 CPM	Vector Magnitude CPM	No. of MVPA bouts ≥ 10 min.	Min. in MVPA bouts ≥ 10 min.
GT3X+								
Sitting min.	-.318	-.405	-.035	-.569*	-.550*	-.505	-.289	-.411
Standing min.	.192	.296	-.271	.381	.313	.355	.143	.185
Stepping min.	.699**	.636**	.015	.778**	.866**	.906**	.531*	.658**
No. of steps	.599*	.686**	.101	.810**	.876**	.872**	.568*	.690**
No. of sitting bouts	.277	.013	-.512*	-.068	-.130	-.045	-.195	-.330
No. of sitting bouts 0-30 min.	.318	.053	-.529*	-.010	-.073	.009	-.161	-.288
No. of sitting bouts 30+ min.	-.451	-.312	.363	-.399	-.364	-.380	-.151	-.151
Min. in sitting bouts 0-30 min.	.308	.053	-.704**	-.070	-.112	-.025	0.121	-.342
Min. in sitting bouts 30+ min.	-.458	-.342	.542*	-.379	-.334	-.362	-.131	-.006
No. of SS trans.	.285	.027	-.511*	-.054	-.119	-.035	-.182	-.317
No. of SS trans per sitting hrs	.480	.305	-.520*	.306	.234	.293	.056	-.007

Appendix W

A table displaying all outcome variables for both ActivPAL and GT3X+ during work hours, reported as mean (SE), across time and between IG

	baseline			2-weeks			3-months			6-months			12 months		
	SS-MC	**SS-O**	**CG**	**SS-MC**	**SS-O**	**CG**	**SS-MC**	**SS-O**	**CG**	**SS-MC**	**SS-O**	**CG**	**SS-MC**	**SS-O**	**CG**
ActivPAL															
Sitting minutes	313.67 (21.24)	328.48 (22.71)	307.22 (19.00)	287.78 (24.13)	262.36 (25.80)	322.49 (21.59)	294.19 (18.74)	303.06 (20.03)	334.03 (16.76)	291.24 (22.99)	296.40 (24.57)	319.89 (20.56)	244.05 (36.77)	286.31 (24.51)	308.04 (27.79)
Standing minutes	117.39 (18.27)	113.67 (19.53)	128.51 (16.34)	152.42 (22.38)	168.97 (23.93)	112.24 (20.02)	137.74 (16.54)	147.79 (17.68)	97.55 (14.80)	141.92 (21.84)	152.13 (23.35)	111.66 (19.54)	168.90 (32.35)	155.12 (21.56)	123.04 (24.45)
Stepping minutes	40.24 (4.96)	36.19 (5.30)	41.92 (4.43)	37.59 (3.57)	43.29 (3.82)	40.97 (3.20)	39.64 (3.75)	29.36 (4.00)	40.97 (3.35)	46.02 (4.97)	31.67 (5.32)	48.19 (4.45)	47.96 (6.19)	36.80 (4.13)	49.16 (4.68)
No. of steps	1899.81 (254.13)	1828.09 (271.67)	1924.36 (239.59)	1858.70 (180.94)	2115.73 (193.43)	1859.44 (170.59)	1842.76 (145.80)	1471.06 (155.87)	1783.76 (137.46)	2206.04 (167.79)	1570.49 (179.37)	2129.04 (158.19)	2130.35 (293.64)	1834.19 (195.76)	2199.58 (239.76)
No. of sedentary bouts	29.25 (3.51)	27.41 (3.75)	25.53 (3.14)	21.05 (2.40)	23.67 (2.56)	27.37 (2.15)	24.71 (2.33)	24.40 (2.49)	26.72 (2.08)	29.51 (2.62)	23.60 (2.80)	28.61 (2.34)	18.25 (4.41)	24.82 (2.94)	29.94 (3.33)
No. of sedentary bouts 0-30 minutes	26.40 (3.82)	23.82 (4.08)	23.13 (3.41)	18.20 (2.62)	21.15 (2.80)	24.50 (2.34)	21.73 (2.58)	21.31 (2.76)	23.32 (2.31)	26.43 (2.86)	20.49 (3.06)	25.76 (2.56)	15.75 (4.83)	21.96 (3.20)	27.56 (3.65)
No. of sedentary bouts 30+ minutes	2.85 (0.46)	3.59 (0.50)	2.41 (0.42)	2.85 (0.49)	2.52 (0.52)	2.88 (0.44)	2.99 (0.38)	3.09 (0.40)	3.40 (0.34)	3.08 (0.47)	3.11 (0.50)	2.85 (0.42)	2.50 (0.67)	2.86 (0.44)	2.38 (0.50)
Minutes in sedentary bouts 0-30 minutes	162.31 (17.81)	149.04 (19.04)	170.58 (15.93)	127.11 (16.35)	135.79 (17.48)	173.07 (14.63)	138.68 (14.76)	141.97 (15.78)	157.68 (13.20)	148.91 (13.59)	136.86 (14.53)	182.45 (12.16)	103.00 (27.17)	136.44 (18.12)	187.41 (20.54)
Minutes in sedentary bouts 30+ minutes	149.35 (28.08)	179.44 (30.02)	136.64 (25.12)	160.67 (26.40)	126.57 (28.22)	149.42 (23.61)	155.52 (21.49)	161.08 (22.97)	176.35 (19.22)	142.34 (23.77)	159.54 (25.41)	137.44 (21.26)	141.06 (40.59)	149.87 (27.06)	120.62 (30.68)
No. of sit-stand transitions	28.47 (3.51)	26.81 (3.75)	24.96 (3.14)	20.55 (2.42)	23.12 (2.58)	26.77 (2.16)	24.01 (2.35)	23.80 (2.51)	26.16 (2.10)	28.88 (2.62)	22.94 (2.80)	27.89 (2.34)	19.90 (4.43)	24.30 (2.95)	29.22 (3.35)
No. of sit-stand transitions per sedentary hours	4.91 (0.69)	4.96 (0.69)	5.09 (0.58)	4.39 (0.77)	5.76 (0.77)	5.06 (0.64)	4.78 (0.71)	4.81 (0.71)	4.80 (0.59)	5.62 (0.79)	5.00 (0.79)	5.32 (0.66)	5.24 (1.31)	5.58 (0.87)	5.72 (0.99)
ActiGraph															
Sedentary minutes	401.38 (8.27)	392.93 (8.27)	378.96 (8.27)	405.56 (8.61)	379.20 (8.61)	380.07 (8.61)	390.09 (11.09)	397.58 (11.09)	382.87 (11.09)	388.63 (8.47)	396.48 (8.47)	384.92 (8.47)	373.42 (10.81)	385.97 (8.37)	376.99 (10.00)
Light PA minutes	52.15 (4.74)	59.65 (4.74)	57.24 (4.74)	45.94 (4.82)	58.13 (4.82)	61.26 (4.82)	51.26 (4.06)	49.79 (4.06)	52.06 (4.06)	58.95 (6.06)	55.87 (6.08)	62.93 (6.08)	58.82 (6.33)	58.58 (4.90)	56.10 (5.86)
Moderate PA minutes	20.29 (3.29)	19.40 (3.29)	26.13 (3.29)	19.24 (2.55)	22.01 (2.55)	19.78 (2.55)	22.36 (2.80)	18.92 (2.80)	21.57 (2.80)	23.69 (2.72)	17.03 (2.72)	28.10 (2.72)	21.22 (3.92)	19.42 (3.04)	29.74 (3.63)
Vigorous PA minutes	1.87 (0.69)	1.10 (0.65)	0.28 (0.65)	2.81 (0.87)	1.70 (0.82)	0.12 (0.82)	1.88 (0.56)	0.83 (0.53)	0.45 (0.53)	1.49 (0.96)	0.95 (0.90)	2.15 (0.90)	2.14 (0.80)	0.91 (0.62)	1.31 (0.74)
MVPA minutes	23.35 (3.56)	20.50 (3.56)	26.42 (3.56)	23.23 (3.10)	23.70 (3.10)	19.90 (3.10)	24.43 (3.04)	19.75 (3.04)	22.02 (3.04)	25.07 (3.11)	17.98 (3.11)	30.25 (3.11)	23.36 (4.13)	20.33 (3.20)	31.04 (3.82)
No. of MVPA bouts ≥ 10+ minutes	0.36 (0.17)	0.26 (0.17)	0.71 (0.17)	0.44 (0.14)	0.56 (0.14)	0.42 (0.14)	0.54 (0.13)	0.28 (0.13)	0.52 (0.13)	0.59 (0.16)	0.16 (0.16)	0.90 (0.16)	0.43 (0.21)	0.25 (0.16)	0.91 (0.20)
Minutes in MVPA bouts ≥ 10+ minutes	5.71 (2.33)	3.78 (2.33)	7.61 (2.47)	7.87 (2.21)	7.23 (2.21)	5.71 (2.35)	7.64 (2.04)	3.63 (2.04)	7.55 (2.16)	8.44 (2.16)	2.37 (2.16)	12.05 (2.30)	5.97 (2.95)	3.55 (2.28)	14.04 (2.95)
Axis 1 counts per minute	273.62 (33.74)	237.39 (33.74)	279.33 (33.74)	277.66 (32.26)	268.62 (32.36)	232.18 (32.26)	276.43 (30.23)	225.56 (30.23)	244.93 (30.23)	294.89 (35.07)	208.34 (35.07)	332.10 (35.07)	285.40 (37.67)	238.23 (29.18)	326.43 (34.87)
Vector Magnitude counts per minute	420.67 (38.09)	381.60 (38.09)	414.29 (38.09)	414.36 (35.79)	414.08 (35.79)	380.08 (35.79)	434.82 (31.33)	359.01 (31.33)	388.99 (31.33)	464.23 (40.24)	337.04 (40.24)	478.54 (40.24)	444.93 (43.52)	388.01 (33.71)	472.93 (40.30)

Appendix X

A table displaying all outcome variables for both ActivPAL and GT3X+ across the whole day, reported as mean (SE), across time and between IG

	baseline			2-weeks			3-months			6-months			12-months		
	SS-MC	**SS-O**	**CG**	**SS-MC**	**SS-O**	**CG**	**SS-MC**	**SS-O**	**CG**	**SS-MC**	**SS-O**	**CG**	**SS-MC**	**SS-O**	**CG**
ActivPAL															
Sitting minutes	559.59 (32.55)	551.83 (34.79)	553.69 (29.11)	541.47 (34.60)	480.09 (36.99)	566.53 (30.95)	537.88 (26.22)	541.49 (28.03)	558.02 (23.45)	509.46 (33.84)	527.01 (36.17)	583.60 (30.27)	505.59 (40.67)	540.96 (27.11)	546.24 (30.74)
Standing minutes	275.05 (20.39)	307.28 (21.80)	281.89 (18.24)	299.62 (21.82)	340.27 (23.33)	260.36 (19.52)	277.15 (21.88)	300.63 (23.39)	247.06 (19.57)	310.42 (30.30)	312.58 (32.40)	248.14 (27.12)	331.43 (35.54)	294.14 (23.69)	276.65 (26.86)
Stepping minutes	106.71 (11.15)	103.68 (11.92)	117.99 (9.97)	106.90 (9.32)	106.12 (9.97)	113.61 (8.34)	110.37 (10.56)	95.04 (11.29)	122.26 (9.45)	125.43 (10.28)	99.46 (10.99)	121.27 (9.20)	105.24 (13.80)	97.94 (9.20)	137.07 (10.43)
No. of steps	4645.19 (557.26)	4712.96 (595.73)	5459.86 (498.43)	4779.38 (479.43)	4763.25 (512.54)	5045.31 (428.82)	4934.05 (576.07)	4506.88 (615.85)	5728.75 (515.26)	5655.88 (523.36)	4650.56 (559.50)	5472.59 (458.11)	4315.68 (734.45)	4540.14 (489.63)	6270.85 (555.19)
No. of sedentary bouts	52.00 (4.57)	51.91 (4.89)	49.30 (4.09)	44.04 (3.49)	47.79 (3.74)	53.09 (3.13)	49.10 (3.99)	48.39 (4.27)	49.84 (3.57)	57.19 (3.77)	50.32 (4.03)	56.16 (3.37)	37.50 (7.46)	48.48 (4.98)	55.75 (5.64)
No. of sedentary bouts 0-30 minutes	46.53 (4.87)	46.81 (5.21)	44.58 (4.36)	38.57 (3.60)	43.75 (3.85)	47.92 (3.22)	44.15 (4.09)	43.02 (4.38)	44.49 (4.40)	52.18 (4.12)	45.57 (4.40)	51.27 (3.68)	32.39 (7.82)	44.35 (43.50)	51.15 (5.91)
No. of sedentary bouts 30+ minutes	5.47 (0.57)	5.10 (0.61)	4.72 (0.51)	5.46 (0.54)	4.04 (0.57)	5.17 (0.48)	4.96 (0.46)	5.37 (0.49)	5.35 (0.41)	5.01 (0.59)	4.75 (0.63)	4.89 (0.53)	5.11 (0.66)	4.98 (0.44)	4.60 (0.50)
Minutes in sedentary bouts 0-30 minutes	264.21 (26.25)	268.40 (28.06)	279.51 (23.48)	233.96 (21.26)	251.87 (22.73)	288.93 (19.01)	260.05 (22.10)	239.98 (23.62)	269.94 (19.76)	255.96 (21.89)	252.98 (23.40)	309.82 (19.58)	202.42 (39.43)	250.55 (26.29)	301.34 (29.81)
Minutes in sedentary bouts 30+ minutes	295.39 (36.71)	283.43 (39.24)	274.19 (32.83)	307.51 (33.90)	228.22 (36.24)	277.61 (30.32)	277.83 (26.33)	301.69 (28.15)	288.08 (23.55)	253.50 (37.17)	274.03 (39.74)	273.78 (33.25)	303.17 (43.26)	290.40 (28.84)	244.90 (32.70)
No. of sit-stand transitions	51.74 (4.55)	51.70 (4.87)	49.01 (4.07)	43.77 (3.50)	47.62 (3.74)	52.88 (3.13)	48.81 (3.98)	48.22 (4.25)	49.64 (3.56)	56.93 (3.75)	50.13 (4.01)	55.83 (3.36)	36.96 (7.43)	48.24 (4.95)	55.41 (5.62)
No. of sit-stand transitions per sedentary hours	5.72 (0.57)	5.66 (0.61)	5.44 (0.51)	5.02 (0.50)	6.14 (0.53)	5.69 (0.44)	5.49 (0.41)	5.40 (0.44)	5.31 (0.37)	7.26 (0.84)	6.16 (0.89)	5.76 (0.75)	4.52 (0.82)	5.49 (0.55)	6.03 (0.62)
ActiGraph															
Sedentary minutes	686.93 (19.51)	652.06 (19.51)	674.72 (19.51)	686.48 (18.86)	625.85 (18.86)	641.08 (18.86)	641.78 (17.62)	643.15 (17.62)	656.41 (17.62)	658.71 (17.57)	644.64 (17.57)	661.51 (17.57)	669.20 (20.59)	644.44 (15.95)	655.80 (19.06)
Light PA minutes	143.84 (10.02)	145.02 (10.02)	153.23 (10.02)	140.14 (12.23)	140.37 (12.23)	160.38 (12.23)	131.61 (9.53)	129.45 (9.53)	148.49 (9.53)	157.25 (12.81)	147.96 (12.81)	161.48 (12.81)	146.01 (11.32)	132.56 (8.76)	160.72 (10.48)
Moderate PA minutes	39.58 (5.08)	45.52 (4.79)	61.75 (4.79)	43.92 (5.41)	45.34 (5.10)	52.20 (5.10)	49.81 (7.73)	50.29 (7.28)	61.20 (7.28)	53.15 (6.48)	46.62 (6.11)	62.61 (6.11)	46.12 (7.79)	48.88 (6.03)	68.19 (7.21)
Vigorous PA minutes	6.68 (2.48)	5.00 (2.47)	2.13 (2.63)	6.88 (2.20)	5.50 (2.20)	4.10 (2.34)	4.55 (1.76)	6.69 (1.76)	2.40 (1.87)	4.15 (1.61)	5.49 (1.61)	1.78 (1.71)	9.22 (3.93)	3.44 (3.05)	6.72 (3.64)
MVPA minutes	55.51 (8.01)	50.52 (8.01)	66.53 (8.01)	57.31 (7.07)	50.83 (7.07)	56.89 (7.07)	59.06 (8.31)	56.98 (8.31)	67.25 (8.31)	62.10 (7.06)	52.11 (7.06)	65.78 (7.06)	55.34 (9.46)	52.32 (7.33)	74.91 (8.76)
No. of MVPA bouts ≥ 10+ minutes	1.37 (0.37)	1.14 (0.37)	1.01 (0.37)	1.57 (0.32)	1.23 (0.32)	1.59 (0.32)	1.79 (0.44)	1.61 (0.44)	1.88 (0.44)	1.78 (0.35)	1.21 (0.35)	1.94 (0.35)	1.25 (0.52)	1.29 (0.41)	2.25 (0.49)
Minutes in MVPA bouts ≥ 10+ minutes	22.05 (5.98)	18.58 (5.98)	33.09 (5.98)	25.70 (5.65)	18.66 (5.65)	25.82 (5.65)	27.95 (8.14)	25.61 (8.14)	37.11 (8.14)	27.82 (7.01)	19.49 (7.01)	35.80 (7.01)	23.01 (10.03)	21.10 (7.77)	42.62 (9.29)
Axis 1 counts per minute	364.58 (44.61)	341.99 (44.61)	383.44 (33.61)	382.81 (42.34)	355.67 (42.34)	380.24 (42.34)	387.23 (47.99)	387.60 (47.99)	407.09 (47.99)	400.79 (37.42)	355.22 (37.42)	388.04 (37.42)	397.93 (61.05)	351.83 (47.29)	440.50 (56.52)
Vector Magnitude counts per minute	584.74 (49.03)	549.54 (49.03)	575.26 (49.03)	604.07 (48.58)	554.32 (48.58)	606.70 (48.58)	602.02 (51.82)	578.12 (51.82)	626.08 (51.82)	633.17 (39.80)	555.01 (39.80)	609.97 (39.80)	534.94 (49.10)	548.00 (34.72)	658.81 (41.50)

Appendix Y

A table displaying comparisons between work hours and non-work hours for all outcome variables (change from baseline) on average, and across the post-intervention timepoints for both intervention group (SS-O and SS-MC) participants

	Average			2-weeks			3-months			6-months			12-months		
	Work hours	**Nonwork hours**	**Total hours**	**Work hours**	**Nonwork hours**	**Total hours**	**Work hours**	**Nonwork hours**	**Total hours**	**Work hours**	**Nonwork hours**	**Total hours**	**Work hours**	**Nonwork hours**	**Total hours**
ActivPAL (change from baseline															
Sedentary minutes	-39.83	7.55	-32.28	-44.66 (19.42)	1.52 (14.55)	-43.15 (21.24)	-22.25 (16.43)	5.85 (14.32)	-16.40 (13.00)	-26.93 (19.07)	-11.40 (14.97)	-38.32 (21.56)	-65.47 (16.07)	34.24 (16.96)	-31.24 (14.99)
Standing minutes	39.89	-21.51	18.38	44.48 (16.05)	-15.98 (9.25)	28.50 (12.21)	26.77 (13.45)	-28.76 (9.21)	-1.98 (10.19)	31.03 (16.77)	-9.69 (15.03)	21.34 (23.32)	57.28 (14.12)	-31.61 (12.45)	25.67 (17.04)
Stepping minutes	0.64	-1.49	-0.85	1.90 (3.25)	-0.66 (6.03)	1.24 (6.63)	-3.51 (4.15)	1.43 (6.48)	-2.09 (7.70)	0.97 (3.32)	7.04 (6.87)	8.01 (7.33)	3.20 (3.27)	-13.75 (8.96)	-10.55 (9.77)
No. of steps	19.42	22.62	42.04	112.31 (154.18)	-17.28 (258.61)	95.03 (295.04)	-197.04 (184.09)	254.92 (321.98)	57.89 (373.32)	43.11 (158.09)	466.80 (309.40)	509.91 (343.37)	119.28 (164.13)	-613.95 (409.08)	-494.67 (446.18)
No. of sedentary bouts	-4.53	1.41	-3.12	-6.12 (2.97)	-0.05 (1.42)	-6.17 (2.91)	-3.83 (3.01)	0.64 (1.88)	-3.19 (2.75)	-1.64 (2.34)	3.67 (2.38)	2.03 (2.62)	-6.52 (3.53)	1.37 (1.22)	-5.15 (3.32)
No. of sedentary bouts 0-30 minutes	-4.14	1.39	-2.76	-5.62 (3.02)	-0.05 (1.42)	-5.67 (3.04)	-3.66 (3.21)	0.63 (1.92)	-3.04 (2.95)	-1.54 (2.29)	3.98 (2.50)	2.44 (2.69)	-5.75 (3.63)	0.98 (1.25)	-4.77 (3.52)
No. of sedentary bouts 30+ minutes	-0.43	0.70	-0.28	-0.68 (0.27)	3.12 (1.50)	-0.64 (0.33)	0.03 (0.36)	7.12 (2.65)	0.36 (0.35)	-0.28 (0.38)	0.62 (1.39)	-0.47 (0.44)	-0.78 (0.32)	0.39 (0.22)	-0.38 (0.43)
Minutes in sedentary bouts 0-30 minutes	-23.98	1.76	-22.22	-26.03 (17.73)	2.18 (8.07)	-23.85 (16.24)	-16.97 (18.48)	1.41 (10.67)	-15.56 (15.94)	-13.90 (13.26)	2.31 (8.75)	-11.59 (12.86)	-39.01 (14.60)	1.13 (8.78)	-37.88 (13.78)
Minutes in sedentary bouts 30+ minutes	-15.85	5.80	-10.06	-18.64 (18.64)	-0.66 (11.83)	-19.30 (25.78)	-5.28 (23.25)	4.44 (14.45)	-0.84 (22.82)	-13.03 (17.52)	-13.70 (12.13)	-26.73 (18.39)	-26.46 (15.94)	33.11 (14.47)	6.65 (20.65)
No. of sit-stand transitions	-4.37	1.82	-2.56	-5.94 (2.90)	2.12 (2.69)	-3.82 (2.05)	-3.78 (2.99)	0.60 (1.82)	-3.19 (2.76)	-1.58 (2.30)	3.62 (2.42)	2.03 (2.66)	-6.19 (3.51)	0.94 (1.21)	-5.25 (3.34)
No. of sit-stand transitions per sedentary hours	0.05	0.03	0.08	-0.17 (0.51)	0.03 (0.21)	-0.15 (0.39)	-0.31 (0.60)	0.07 (0.39)	-0.24 (0.36)	0.55 (0.40)	0.50 (0.61)	1.05 (0.54)	0.12 (0.66)	-0.48 (0.42)	-0.36 (0.45)
ActiGraph (change from baseline															
Light PA minutes	-1.89	-2.66	-4.55	-5.37 (2.68)	1.19 (4.79)	-4.18 (5.36)	-5.88 (3.75)	-8.02 (4.02)	-13.90 (5.24)	1.01 (3.72)	7.16 (7.66)	8.17 (7.24)	2.67 (5.47)	-10.95 (4.65)	-8.28 (8.27)
Moderate PA minutes	0.57	1.95	2.52	0.78 (1.65)	-0.07 (2.31)	0.71 (2.72)	0.79 (1.53)	4.44 (3.38)	5.23 (4.11)	0.52 (1.23)	4.60 (3.26)	5.12 (3.57)	0.17 (1.79)	-1.17 (4.78)	-1.00 (4.94)
Vigorous PA minutes	0.11	-0.02	0.09	0.72 (0.29)	-0.37 (1.27)	0.35 (1.40)	0.07 (0.35)	-0.30 (2.02)	-0.22 (1.82)	-0.21 (0.41)	-0.81 (2.04)	-1.02 (2.08)	-0.16 (0.26)	1.40 (2.04)	1.23 (2.03)
MVPA minutes	0.67	0.93	2.60	1.50 (1.78)	-0.44 (2.65)	1.06 (3.01)	0.87 (1.59)	4.14 (3.88)	5.01 (4.43)	0.30 (1.32)	3.80 (3.36)	4.10 (3.77)	0.00 (1.77)	0.23 (5.66)	0.23 (5.77)
No. of MVPA bouts ≥ 10+minutes	0.10	0.14	0.24	0.19 (0.11)	-0.04 (0.18)	0.15 (0.21)	0.10 (0.09)	0.34 (0.24)	0.44 (0.29)	0.06 (0.10)	0.18 (0.17)	0.24 (0.17)	0.03 (0.10)	0.08 (0.24)	0.12 (0.28)
Minutes in MVPA bouts ≥ 10+minutes	1.17	2.47	3.64	2.81 (1.30)	-0.94 (2.68)	1.87 (3.11)	0.89 (1.32)	5.57 (3.58)	6.46 (4.07)	0.66 (1.31)	2.67 (3.00)	3.34 (2.88)	0.31 (1.38)	2.59 (4.26)	2.89 (4.70)
Axis 1 counts per minute	4.60	19.14	23.74	17.63 (17.61)	-1.68 (17.16)	15.96 (17.19)	-4.51 (19.26)	38.64 (22.61)	34.13 (24.72)	-3.89 (15.41)	28.61 (21.45)	24.72 (23.10)	9.16 (16.67)	11.00 (41.22)	20.16 (37.99)
Vector Magnitude counts per minute	6.88	14.99	21.88	13.08 (23.66)	-0.63 (19.47)	12.45 (20.70)	-4.22 (26.49)	27.14 (26.75)	22.93 (29.74)	-0.49 (19.97)	27.44 (28.37)	26.94 (29.47)	19.16 (26.94)	6.01 (58.96)	25.18 (58.11)