DEVELOPMENT AND VALIDATION OF THE BRUNEL LIFESTYLE PHYSICAL ACTIVITY QUESTIONNAIRE

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by

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ABSTRACT

The purpose of the present programme was to develop and validate a theoretically-grounded instrument to measure the planned and unplanned dimensions of lifestyle PA (PPA and UPA; Dunn, Andersen, & Jakicic, 1998). In Study 1, two samples of British adults (Internet: *N* = 742; paper: *N* = 563) were used to establish the content validity of the Brunel Lifestyle Physical Activity Questionnaire (BLPAQ). Exploratory factor analysis yielded a two-factor model (UPA and PPA) that produced acceptable fit indices using confirmatory factors analyses with both samples. The purpose of Study 2 was to examine the test-retest reliability of the BLPAQ over 5 weeks using a sample of leisure centre users, university staff members, and university students (*N* = 337). High correlations were observed between the two administrations (range = .93-.98; $p < .01$). Thereafter, the data were subjected to proportion of agreement (PoA) analysis as advocated by Nevill, Lane, Kilgor, Bowes, and Whyte (2001). Both PPA and UPA demonstrated satisfactorily high internal agreement (PoA > 95%). In Study 3, the BLPAQ was cross-validated using two criterion measures: the Baecke Questionnaire of Habitual Physical Activity (Baecke, Burema, & Frijters, 1982) and the Godin's Leisure-Time Exercise Questionnaire (Godin & Shephard, 1985). Multiple linear regressions were performed to predict PPA and UPA from the subscales of the two reference measures. The predictive models differed markedly in terms of gender. Subsequently, the sample of 338 British adults was divided into two subsamples, and these were subjected to a cross-validation using the Limits of Agreement (LoA) methodology advocated by Bland and Altman (1986). The agreement plots revealed that both BLPAQ subscales demonstrated acceptable inter-sample agreement when compared to the criterion measures. In Study 4, a series of structural equation models were tested with the aim of predicting PPA and UPA using the variables that constitute the Theory of Planned Behaviour (TPB). The TPB was able to predict PPA but not UPA. The addition of a direct path between past behaviour to UPA did not result in a significant prediction. Further work is required to examine the factorial structure of the PPA subscale and to increase the number of items in the UPA subscale. In sum, the programme has contributed a valid and reliable theory-based measure of PA as well as evidence to support the utility of the TPB in PA research. However, the TPB framework may require the addition of predictors such as past behaviour and actual behavioural control.

ACKNOWLEDGEMENTS

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I would like to give special thanks my parents, Antonio and Egle, for their unconditional love, and for the encouragement that they gave me to pursue excellence in everything that I do. Finally, I acknowledge my girlfriend Christine, whose endless love, faith, and conviction have helped me to achieve the seemingly impossible.

The man who moved a mountain was the one who began carrying away small stones

Chinese Proverb

DEDICATION

This thesis is dedicated to the memory of my late father, Gelindo Antonio Vencato, who taught me the value of persistence in striving to achieve my dreams.

He used to say:

“Chi la dura, lá vince.”

He who persists, wins.

Thank you Dad.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: GENERAL INTRODUCTION

1.1 Introduction to the Research Programme

A wise man should consider that health is the greatest of human blessings

Hippocrates

Health is the real wealth, not pieces of gold and silver

Mahatma Ghandi

Every human being is the author of his own health or disease

Buddha

The quotations that appear above bear witness to the centrality of health within human experience; it is one of the few facets of life which remains constant down the ages. During the last three decades, the issue of physical activity (PA) has risen to prominence, both as a research theme and a matter of public interest (US Department of Health and Human Services [USDHHS], 2000). This focal shift may be attributed to two factors. The first of these is the increasing prevalence of physical inactivity (PI) in developed countries and the detrimental consequences thereof (Department of Health [DoH, 2004); the second is the growing scientific work which has shone a light onto the health benefits that PA can provide (Haskell et al., 2007; Hardman, 2001; Kesaniemi et al., 2001). There is a considerable body of evidence suggesting that PA not only contributes to well-being but is also essential for good health. Physically active individuals experience a substantial reduction in their risk of developing major chronic diseases (50%) and premature death (30%; Hu et al., 1999, 2000; Kesaniemi et al., 2001; Manson et al., 1999).

During the last three decades, it has become apparent that the amount of exercise intensity needed to produce health benefits is considerably less than the intensity needed to improve physical fitness (ACSM, 1998, 2005; Dunn et al., 1998; Lee & Skerrett, 2001; Haskell et al., 2007; Pescatello, 2000). Additionally, a growing number of scientific studies (e.g., Kesaniemi et al., 2001; Lee, Rexrode, Cook, Manson, & Buring, 2001; Pescatello, Costanzo, & Murthy, 2000) have demonstrated favourable effects on cardio-metabolic health resulting from low-to-moderate-intensity PA typical of everyday life, such as brisk walking, performed for at least 150 min/week (Kesaniemi et al., 2001). Eaton, Shostak, and Konner (1988, p. 168) suggested that:

> The exercise boom in not just a fad; it is a return to “natural” activity – the kind for which our bodies are engineered and which facilitates the proper function of our biochemistry and physiology. Viewed through the perspective of evolutionary time, sedentary existence, possible for great numbers of people only during the last century, represents a transient and unnatural aberration.

Several recent reports have found an ever-increasing worldwide epidemic in terms of inactive lifestyle and obesity (e.g., Bauman & Craig, 2005; Booth, Gordon, Carlson & Hamilton, 2000; Haskell et al., 2007; Stubbs & Lee, 2004), and both of these conditions are risk factors for multiple non-communicable diseases (Penedo & Dahn, 2005; Waxman, 2004). Inactive lifestyle also represents a waste of human potential (Hardman, 2001) as well as a vast economic burden (USDHHS, 1996, 2000). For instance, the annual direct cost of PI in the United States is more than $150 billion (Pratt, Macera, & Wang, 2000) whereas in the UK, the budgetary deficit caused by sedentary behaviour is estimated to be in excess of £10 billion (DoH, 2004); a figure which is equivalent to more than 15% of National Health Service expenditure (Phillips, 2002).

The Department of Health of England (DoH, 2004) reported that only 31% of the adult population in this country meet the Chief Medical Officer's recommended levels of MPA to accrue general health benefits. Specifically, it has been noted that there is a decline in PA with age and particularly after the age of 35. In particular, participation in walking has been found to decline from 45.0% among men aged 16-24 to 8.0% among men aged 75 and over. Among women, walking remained relatively stable among those aged 16-54 (28.0–32.0%, but declined to 5.0% for those aged 75 and over (DoH, 2000).

Two national health surveys in UK (Activity and Health Research, 1992; Health Survey for England, 1998) found that approximately 70% of English adults do not engage in sufficient PA for there to be health benefits. The Chief Medical Officer (DoH, 2004) noted that approximately 30% of the 200,000 death/year from coronary artery diseases (CHD) could be avoided. Additionally, the most comprehensive survey of PA patterns of English adults (*N* = 4,316), the Allied Dunbar National Fitness Survey (Activity and Health Research, 1992) found that activity levels vary greatly between genders, age groups, and socio-economic and/or ethnic groups. Similar findings were also reported by the UK Health Education Authority's National Survey of Activity (*N* = 2,837; Walker & Hoinville, 1995).

Countering the ever-increasing tendency towards PI can be achieved through the promotion of a more active lifestyle (Biddle & Mutrie, 2007, p. 165; Woods, Mutrie, & Scott, 2002) which may consist of both planned and unplanned activities (Dunn, Andersen, & Jakicic, 1998). The Chief Medical Officer for England suggests that the public as well as the National Health Service (NHS) and other governmental and health institutions require a cultural shift, because behavioural change is difficult to achieve (DoH, 2004). Bandura (1995) captured the essence of the problem when he stated that health-related behavioural change would be relatively easy if there were not so many obstacles to overcome.

As PA is an intentional behaviour, the current levels may reflect personal attitudes about time availability, cultural and societal values, and beliefs about the conduciveness of our homes, neighbourhoods, and environments to active living (Montoye, Kemper, Saris, & Washburn, 1996, p. 3). A mental shift in the personal perception PA levels is required because many mistakenly believe that they are already active enough (Shephard, 2003). Activity level might only increase when people come to desire its associated physical and psychological benefits, and when lifestyle opportunities have been be created through changing people's physical and cultural landscape (DoH, 2004). Therefore, the assessment of behavioural trends in moderate-intensity habitual PA may provide the knowledge necessary to prescribe effective lifestyle interventions (Dunn et al., 1998; Salmon, Owen, Bauman, Schmitz, & Booth, 2000).

The assessment of habitual PA relies either on questionnaires, interviews, and diaries, or more objective measures such as accelerometry, motion sensors, and heart rate monitors (Montoye et al., 1996, p. 4). However, owing to their relatively low cost, questionnaires are the most widely-used instruments in large-scale epidemiological studies (DoH, 2004; Shephard, 2003). Questionnaires vary greatly in terms of their content, the length of time required for their completion, the period surveyed, and the extent of respondent supervision required (Kriska & Caspersen, 1997; Lamb & Brodie, 1990; Montoye et al., 1996, p. 42).

There is a great variety in the depth of measurement ranging from binary classifications (e.g., active vs. inactive) and simplistic questions (e.g., Godin & Shephard, 1985) to highly extensive instruments which require over an hour to complete with the assistance of a trained administrator (e.g., Stephens & Craig, 1990; Vuillemin, 1998). Measurement periods vary from one week (e.g., Caspersen, Bloemberg, Saris, Merritt, & Kromhout, 1991) to an entire lifetime (e.g., Friedenreich, Courneya, & Bryant, 1998; Vuillemin, Guillemin, Denis, Huot, & Jeandel, 2000). However, questionnaire responses may be affected by recall, age, cultural bias (Shephard, 2003), social desirability (e.g., Klesges et al., 1990), and the context of questioning (e.g., Baranowski, 1988; Durante & Ainsworth, 1996).

Questionnaires also have limited validity and reliability when compared to objective measures of PA (Shephard, 2003). In particular, difficulties are encountered in the assessment of low- and moderate-intensity effort (Shephard); the most prevalent form of activity among the general British and North American populations (DoH, 2004; USDHHS, 1996). Hence, attention must be focused on developing better methods for the assessment of lower-intensity PA behaviour (Washburn, Heath, & Jackson, 2000).

Lifestyle interventions require valid and reliable measures of their efficacy. The accurate measurement of PA in the field represents a daunting task owing to the absence of an adequate criterion against which existing instruments may be compared (Montoye et al., 1996, p. 43). The practice of inter-correlating various field methods may have some value. However, due to the fact that each technique has intrinsic errors, it is impossible to determine the true validity and reliability of any one of them (Shephard, 2003).

There is an identified need for a measure to assess the efficacy of interventions which are aimed at increasing planned and unplanned PA on a large scale (Dunn et al., 1998; Pescatello, 2001; Pratt, 1999). There are many questionnaires which are capable of appraising PA (see Pereira et al., 1997 for a comprehensive inventory). However, they were not developed with the express purpose of assessing the planned and unplanned dimensions of lifestyle physical activity (LPA). Further, none of these questionnaires have been constructed using a well-established theoretical framework, which is a pre-requisite for the testing of any intervention (Brawley, 1993).

Various theoretical approaches have been advanced in an effort to predict health-related behavioural change such as the health belief model (Becker, 1974; Janz & Becker, 1984), the protection motivation theory (Maddux & Rogers, 1983; Van der Velde & Van der Pligt, 1991), the social cognitive theory (Bandura, 1986; 2000) and the theories of reasoned action (Ajzen & Fishbein, 1980), planned behaviour (Ajzen, 1991), and past behaviour (Bagozzi & Kimmel, 1995).

The theory of planned behaviour (TPB; Ajzen, 1991), which predicts both intention and behaviour, is probably the most extensively used theoretical framework in PA research (Hardeman et al., 2002). The predictors include attitudes towards the behaviour, normative socialised values, and perceptions of behavioural control. Several reviewers (e.g., Conner & Armitage, 1998; Hagger, Chatzisarantis, & Biddle, 2002a) have asserted that variations in these beliefs may promote behavioural change. Consequently, the TPB (Ajzen, 1991) could be more widely used to develop and evaluate interventions (see e.g., Blue, 1995; Armitage & Conner, 2001; Hagger et al., 2002a, b).

It has been posited that many behaviours are determined primarily by previous behaviour (see Conner & Sparks, 2005) rather than the cognitive factors described in the theory of planned behaviour (Sutton, 1994). For example, Conner and Armitage (1998) reported large positive correlations between past behaviour and intention, attitudes, and future behaviour. Because unplanned PA may admit a habitual element (Dunn et al., 1998; Pescatello & VanHeest, 2000), the variable of past behaviour may have utility in predicting it.

1.2 Research Outline

Throughout this doctoral thesis, the author will review the scientific evidence underpinning current LPA interventions. This evidence will be used in the development of a new psychometric instrument that will measure both the planned and unplanned subcomponents of LPA. To achieve this aim the author will:

1. Examine the genesis and proliferation of diverse PA guidelines and recommendations.
2. Evaluate the efficacy of the LPA interventions which have being employed to reduce levels of sedentary behaviour in UK and other industrialised countries.
3. Gauge the validity and reliability of measures used to assess PA in epidemiological research.
4. Develop and initially validate a new measure that will ascertain the planned and unplanned subcomponents of LPA: The Brunel Lifestyle Physical Activity Questionnaire (BLPAQ).
5. Evaluate the new measure’s ability to differentiate between the subcomponents of LPA using two psychological perspectives, which are widely used to predict PA behaviour: the TPB (Ajzen, 1991) and past behaviour (Bagozzi & Kimmel, 1995).

1.3 Purposes and Rationale of Research Programme

There are no valid and reliable measures to distinguish between the planned and unplanned subcomponents of LPA; a dearth which may hamper both researchers and practitioners. The primary purpose of this research programme will be the development and validation of a questionnaire capable to ascertain planned and unplanned PA, which might have the potential to guide researchers in their prescription of LPA interventions and inform health-care policy makers on the efficacy of those interventions. The results of the current research programme might also be used by environmental planners to enhance the programmes that are designed to increase PA levels in the general population.

Many researchers have expressed the need for valid and reliable instruments that can support PA research in the field of health psychology (e.g., Dunn et al., 1998; Haskell & Kiernan, 2000; Shephard, 2003). The TPB is thought to have a large role to play in developing and evaluating PA interventions (e.g., Conner & Armitage, 1998; Hardeman et al., 2002). Nevertheless, research that underpins the promotion of LPA interventions using the TPB is sparse. This paucity might stem from the lack of a valid measure to assess the planned and unplanned subcomponents of LPA. Hence, a secondary aim for this research programme will be the initial validation of the new measure using two psychological constructs that have been extensively used in exercise and health research for predicting health-related behaviours.

1.4 The Research Programme

Background to the programme of research: At the start of the programme, the first supervisor signed a contract with Bio-Medical Research Ltd., to co-develop a PA instrument designed to provide feedback for customers purchasing Slendertone™ abdominal muscular-toning belts. The author was employed as a research assistant for one year, during which time he collected pen-and-paper data, designed the questionnaire (under supervision), and then validated it. Bio-Medical Research Ltd. provided the author with a sample of 742 online responses as an initial phase of the measure's development. However, the management responsible for the Slendertone product changed rapidly, and the company withdrew their support after the first year. Due to positive customer feedback, Bio-Medical Research Ltd. began to sell personalised feedback derived from questionnaire responses as a standalone service. From that point, the author undertook all data collection duties and further developed the instrument himself.

The course of the present research programme is illustrated in Figure 1.1 and described below:

Study 1: After establishing the face and content validity of the BLPAQ, the instrument will be subjected to exploratory and confirmatory factor analyses to establish and verify its factorial structure; the reliability of the subscales will also be estimated.

Study 2: Following the demonstration of test-retest reliability, the BLPAQ items will undergo proportion of agreement analysis to examine item-related stability (Nevill et al., 2001). The samples used will be drawn from three different populations (students vs. general population vs. leisure centre users); thus providing evidence for the generalisability of the instrument.

Study 3: Two widely-used PA questionnaires (Godin Leisure-Time Exercise Questionnaire: Godin & Shephard, 1985; Questionnaire of Habitual Physical Activity: Baecke, Burema, & Frijters, 1982) will be used as reference measures to ascertain the criterion-related validity of the BLPAQ. Additionally, the BLPAQ data will cross-validated using the limits of agreement methodology advocated by Bland and Altman (1991).

Study 4: The theory of planned behaviour will be used to predict planned PA, whereas past-behaviour will be used as a predictor of unplanned PA, thus evaluating the theoretical relevance of these constructs (see Figure 1.1). Notably, all the participants for each study, within the research programme, were recruited separately.

1.4.1 Delimitations

The following delimitations applied to the doctoral programme:

1. The vast majority of participants in this research programme resided in the South-East of England at the time of data collection.
2. The participants did not fully reflect the socio-economic strata of the UK population.
3. At least 30% of the students involved in this research programme were not born in UK.
4. Participants in this research programme were of 18 years of age or older.
5. For the first study only, a large subsample of the participants was recruited via the Internet administration of the BLPAQ. Subsequent studies were delimited to pen-and-paper measurement format.
6. Measures of PA were delimited to self-reported participation in habitual PA. Other available instruments, such as accelerometers or doubly labelled water, were not used owing to funding restrictions.

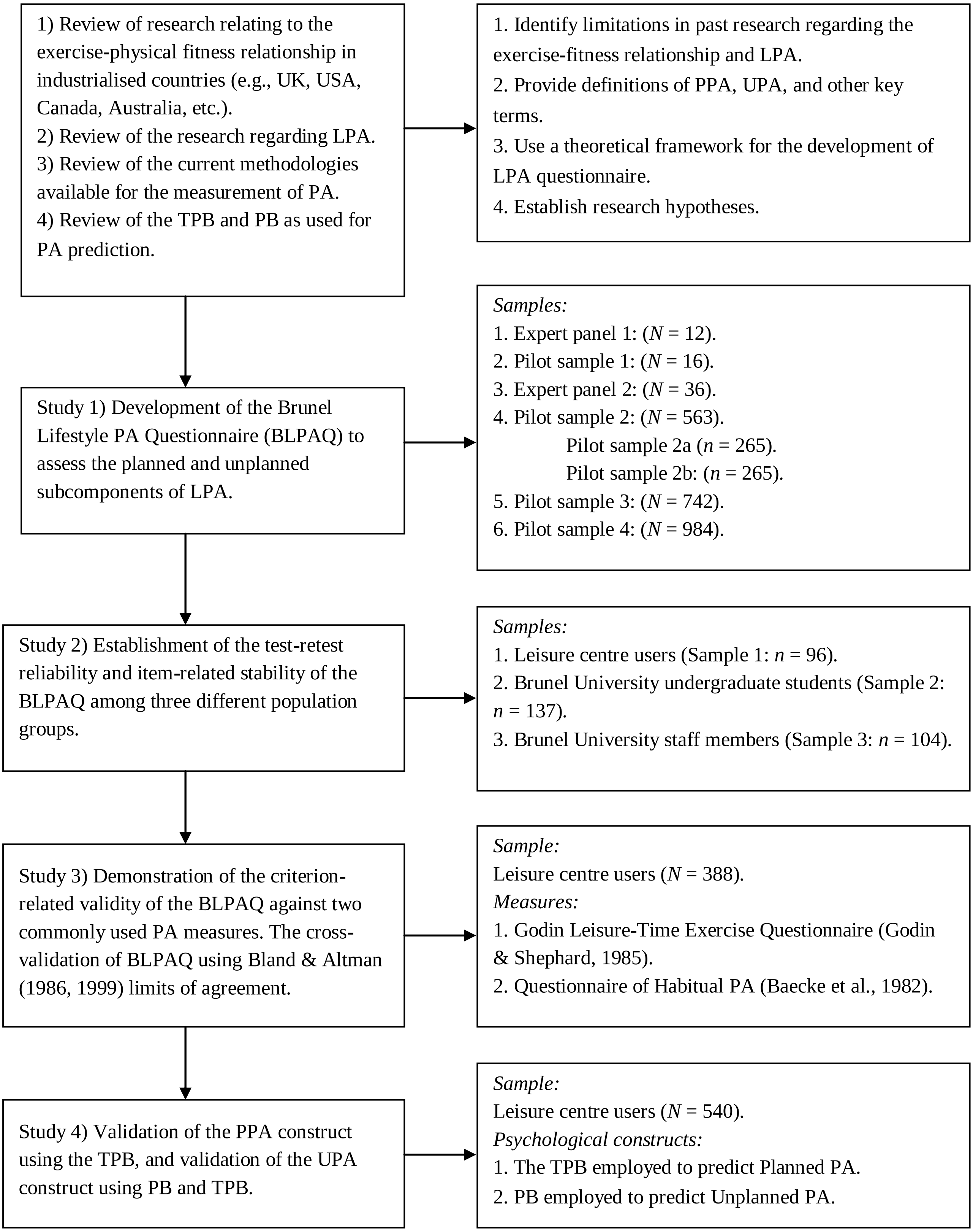


Figure 1.1 Diagrammatic representation of the present research programme.

7. In establishing the cross-validation and criterion-related validity of the BLPAQ, only self-report PA questionnaires were used (Godin Leisure-Time Exercise Questionnaire: Godin & Shephard, 1985; Baecke Questionnaire of Habitual Physical Activity: Baecke, et al., 1982). All data were collected from a number of samples drawn from adult volunteers using cross-sectional psychometric methodology. The cross-sectional sampling approach was used to identify, explore, analyse, and predict the relationships between selected variables (Thomas, Nelson, & Silverman, 2005, p. 288).

1.5 Definition of Key Terms

1.5.1 Physical Activity

Caspersen et al. (1985, p. 127) defined PA, as "a voluntary movement produced by skeletal muscles that results in energy expenditure." Knowledge of the benefits of a physically active lifestyle has prompted many governmental agencies and health institutions (e.g., Pate et al., 1995; USDHHS, 1996) to produce guidelines which prescribe the minimum amount of PA necessary (intensity, frequency, and duration) to reduce all-cause mortality rates (Lee & Skerrett, 2001).

1.5.2 Exercise

Caspersen et al. (1985, p. 127) defined exercise, as "a planned, structured, and repetitive bodily movement that is positively correlated with physical fitness, and its main objective is to maintain or improve it." Exercise may lead to health benefits and improvements in fitness and physical performance (Bouchard & Shephard, 1994). There is an acknowledged overlap between the constructs of exercise and PA (Biddle & Mutrie, 2001). In the present programme of study, the term *exercise* will be used to denote planned PA including instructor-led classes (e.g., aerobics, step, body pump, etc.), jogging, swimming, and recreational sport (e.g., basketball, volleyball, ice skating, etc.).

1.5.3 Physical Fitness

Caspersen et al. (1985) defined physical fitness (PF) as “a set of attributes that people have achieved that relate to the ability to perform PA” (p. 129). This definition suggests that PF is related partly to current PA levels and partly to heredity (Biddle & Mutrie, 2001, p. 8). Pate (1988), instead, suggested that PF is: “the functional capacity required for comfortable and productive involvement in day-to-day activities … and should encompass manifestation of the health-related outcomes of high level of habitual activity” (p. 177).

1.5.4 Metabolic Energy Expenditure Unit

All forms of PA can be assessed in energy expenditure terms using the MET unit. The intensity of each activity is classified in multiples of one MET; for instance, a 2-MET task requires twice the energy expenditure of a 1-MET activity. One MET is defined as the energy expenditure required to sit quietly, which, for the average adult is approximately 3.5 ml of oxygen $\cdot$ kg body weight^{-1}$\cdot$ min^{-1} or 1kcal $\cdot$ kg^{-1} body weight $\cdot$ h^{-1} (see Ainsworth, Jacobs, & Leon, 1993 for an extensive classification of physical activities and their energy costs).

1.5.5 Moderate-intensity Physical Activity

The term moderate-intensity PA (MPA) denotes any activity that requires energy expenditure ranging from 3–5.9 METs (Leenders, Sherman, & Nagaraja, 2000; Masse et al., 1999; Pate et al., 1995).

1.5.6 Vigorous-intensity Physical Activity

Vigorous-intensity PA (VPA) is any activity that requires energy expenditure equal to or greater than 6 METs (Leenders et al., 2000; Masse et al., 1999; Pate et al., 1995).

1.5.7 Lifestyle Physical Activity

Dunn et al. (1998) defined lifestyle physical activity (LPA), as "self-selected activities, which includes all leisure, occupational, or household activities that are at least moderate to vigorous in their intensity and could be planned or unplanned activities that are part of everyday life" (p. 399). Hence, such activity is self-selected rather than being prescribed. The individual may consciously plan LPA or it may take an unplanned form, for example, having to walk to one's workplace because there is no adjacent car park. LPA can be promoted through the use of various behavioural strategies or environmental cues and manipulations which serve to decrease sedentary behaviour and, in so doing, surpass the minimum public health guidelines for PA (Dunn et al.).

1.5.7.1 Planned Physical Activity

Planned PA (PPA) is defined as "any activity (be it structured or unstructured in nature) that is scheduled into one's daily routine, which may enhance one's health, fitness or well-being" (Karageorghis, Vencato, Chatzisarantis, & Carron, 2005, p. 2).

1.5.7.2 Unplanned Physical Activity

Unplanned PA (UPA) is defined as "any other form of PA that is not scheduled into one's daily routine or that is already part of one's routines, which may be considered to be beneficial to one's health, fitness or well-being" (Karageorghis et al., 2005, p. 3).

1.5.8 Physical Inactivity

The Surgeon General (USDHHS, 1996) defined physical inactivity (PI) as:

> Performing no vigorous-intensity PA (exercise or sports participation that can make the respondent "sweat or breathe hard" for at least 20 minutes) and performing no light to moderate-intensity PA (walking or cycling for at least for at least 30 minutes) during the last week. (pp**.** 188-189).

1.5.9 Habitual Physical Activity

The Center for Disease Control (CDC; 2000) proposed that habitual PA (HPA) is any activity that can be included into one's daily routine such as climbing the stairs, domestic activities, and walking to work, resulting in energy expenditure. Although, the CDC (2000) classification closely resembles the definition of LPA that was introduced previously, it does not distinguish between planned and unplanned physical activities. Nonetheless, due to their conceptual similarity, some of the published evidence associated with HPA will be used to support the development of the BLPAQ.

1.5.10 Factor Analysis

Researchers involved in the development and evaluation of tests and scales use factor analytic techniques extensively to explore and confirm statistical "factors" or groupings among items (Pallant, 2007, p. 179). Factor analysis (FA) is a way of mapping the relationships between all variables rather than just pairs of variables (Loewenthal, 2001, p. 13). There are two main approaches to factor analysis: exploratory and confirmatory.

1.5.10.1 Exploratory Factor Analysis

Exploratory FA (EFA) is often used in the early stages of research to gather information about existing interrelationships among a set of variables thereby assigning them into a factorial structure (Pallant, 2007, p. 179).

1.5.10.2 Confirmatory Factor Analysis

Confirmatory factor analysis (CFA) is a sophisticated set of techniques used to test (or confirm) specific hypotheses or theories concerning the structure underlying a set of variables previously established through EFA or theory (Pallant, 2007, p. 180).

1.5.11 Randomised Controlled Trials

Randomised controlled trials (RCT) are used to determine whether or not the associations uncovered in epidemiological studies or small-scale laboratory experiments represent true cause-and-effect relationships that are likely to apply to large numbers of people. The validity of the trial depends on the representativeness of the sample and on the similarity between the treatment and control groups with respect to characteristics thought to affect outcome. The random assignment of subjects to either treatment or control groups is essential as it equally distributes known and unknown confounding variables between these groups (Buckworth & Dishman, 2002, p. 37).

1.5.11.1 Control Groups

The experience of the control group should equate to that of the treatment group in every respect other than the critical treatment factor. In a clinical population, the effects of exercise on physical and/or mental health should be compared to traditional treatment rather than to a no-treatment control (Buckworth & Dishman, 2002, p. 37).

CHAPTER 2: REVIEW OF LITERATURE

Since the dawn of the human race, a natural cycle of intermittent physical activity (PA) has typified our existence, and our species evolved to be well suited to habitual, moderately intense PA (Eaton et al., 1988). This trait is still imprinted into our genetic make-up (Ästrand, 1994). However, it appears that our lifestyles are no longer compatible with our genetic heritage.

Many researchers (Bauman, Ford, & Armstrong, 2001; Caspersen et al., 1994; Crespo, Keteyian, Heath, & Sempos, 1996; Phillips et al., 1996; Pratt et al., 1999; Sallis & Owen, 1999) and governmental bodies (e.g., CDC, 2005; DoH, 2004; USDHHS, 1996; WHO, 2003), suggested that only 15.0–25.0% of the world's adult population exercise vigorously, about 35.0–50.0% engage in some moderate-intensity PA, and about 25.0–45.0% is insufficiently active. Additionally, the WHO (2003) estimated that approximately two million deaths every year are attributable to a sedentary lifestyle and that physical inactivity (PI) is one of the top 10 causes of death, disease, and disability in the world. In developed countries more than half of adults are insufficiently active (Bauman et al., 2001; DoH, 2004; USDHHS, 1996). In Europe the direct and indirect contribution of PI to disease burden is 32.8% (Powles, Zatonski, Hoorn, & Ezzati, 2005).

In the rapidly growing cities of the developing world (e.g., Mexico City, Cairo, Sâo Paulo, etc.) PI is an even greater problem. Crowding, poverty, crime, traffic, low air quality, lack of parks, sports and recreation facilities make PA prohibitively difficult (WHO, 2003). For instance, in Sâo Paulo, approximately 70.0% of the population is inactive, and similarly in Buenos Aires where only 20.0% of the population do engage in vigorous PA three times a week (Pan-American Health Organisation [PAHO], 2002).

This data, together with important reviews on determinants and barriers to exercise (e.g., Dishman, & Sallis, 1994; Grieser et al., 2006; Spence, Poon, & Mummery, 1997), indicated that a majority disliked activities of vigorous intensity. The main reasons cited were: (a) People felt that they were "not the sporty type" (Killoran, 1994), (b) did not have enough time to exercise (Killoran; Spence et al.,; Stephens, & Craig, 1990), (c) they were unconcerned about their health (Spence et al.), (d) they resisted to disruptions of their daily routine (Dishman & Sallis, 1994), (e) they lacked in motivation (Spence et al.,), (f) they did not have social support and/or access to facilities (Dishman & Sallis), (g) their dislike for the imposed conformity of gymnasium-based exercise (King et al., 1992), and (h) the inclemency of the weather (Dishman & Sallis).

From this evidence, public health researchers surmised that most people were not exercising at the amounts prescribed by the ACSM's (1990) exercise guidelines because of a misperception that vigorous exercise was their only alternative (Pate et al., 1995). Thus, the Expert Panels of the CDC and the ACSM (Pate et al., p. 403) recommended that:

> Every adult should accumulate 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week … adults who engage in moderate-intensity physical activity – i.e., enough to spend 200 calories per day – can expect many of the health benefits described herein … one way to meet this standard is to walk 2 miles briskly … most adults do not currently meet the standard described herein.

2.1 Making Sense of Current Physical Activity Recommendations

A simplified method proposed by Corbin, LeMasurier, and Don Franks (2002) can be used to classify activities by type and associated benefits, thereby presenting a basis for multiple recommendations (see Figure 2.1). Four levels of PA are included in the *Physical Activity Pyramid* and can be used to simplify exercise prescription. Once an individual's goals are known, it is possible to determine how much PA is sufficient by using the appropriate frequency (F), intensity (I), and duration/time (T) for the type of activity (FIT: Corbin et al., p. 4).

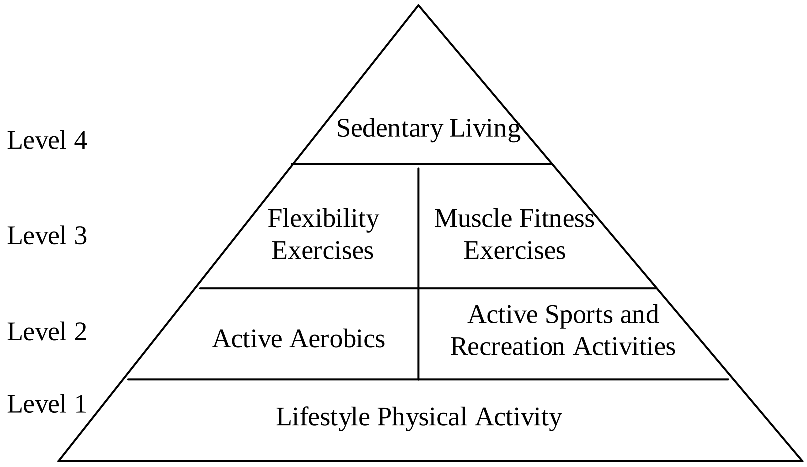


Figure 2.1 The Physical Activity Pyramid.

Note. Adapted from Corbin and Lindsey (2007, p. 64).

2.1.1 Level 1 - Lifestyle Physical Activity

The lifestyle physical activity (LPA) occupies the first level of the pyramid, and comprises activities such as brisk walking, mowing the lawn, heavy backyard work, climbing stairs, occupational and household activities. Frequency of activity is typically on all or most days of the week, and is equivalent to moderate-intensity PA. There is an accumulating body of evidence showing that programmes which promote unplanned and habitual activities can increase levels of PA in inactive populations

(Sherwood & Jeffery, 2000). Benefits include general health promotion, chronic disease risk reduction, and contribution to weight maintenance.

2.1.2 Level 2 - Active Aerobic, Active Sports and Recreational Activities

All these activities included in Level 2 are more vigorous in nature. Active aerobics are activities such as aerobic dance, jogging, and biking. Active sports are typically of a moderate- to vigorous-intensity. Many sports such as basketball, squash, and tennis require short bursts of vigorous-to-maximal intensity interspersed with short rest periods. However, some sports such as golf, bowling, fishing, and softball can be considered as LPA. Recreational activities such as hiking or canoeing, if performed vigorously, can also contribute to meet the three weekly sessions of moderate-to-vigorous recommendations for active sports (Corbin et al., 2002).

2.1.3 Level 3 - Muscle Fitness and Flexibility Exercises

Muscle fitness exercises can improve one's ability to perform daily activities, increase bone density (reduced risk of osteoporosis), and increase lean tissue (ACSM, 1998). It is suggested that muscle fitness be performed two to three times per week, involving 8–10 exercises targeting the major muscle groups (Rhea, Alvar, Ball, & Burkett, 2002). The ACSM position statements (guidelines) on muscle fitness for adults and older adults are examples of recommendations for this level of the pyramid. Flexibility exercises can improve the ability to use joints through the full range of motion. Every type of PA from levels 1, 2, and 3 (muscle fitness) of the pyramid can positively contribute to flexibility development (ACSM, 2000, 2005).

2.1.4 Level 4 - Physical Inactivity

Prolonged inactivity (sedentary living) has been identified as a risk factor for coronary artery disease (CHD: American Heart Association [AHA], 1992; Manson et al., 2002; USDHHS, 1996). Other than normal sleep (6-8 hr/day), excessive PI caused by watching television, playing video games, working at a computer, and driving should be counteracted by engaging in LPA or activities from the other levels of the pyramid (see Table 2.1).

Table 2.1

Selected Benefits Associated with Physical Activity

Fitness	Illness prevention	Wellness promotion	Weight control
Cardiovascular	Heart disease	Optimal functioning	Weight loss
Strength	Diabetes	General well-being	Weight gain
Muscular endurance	Osteoporosis	Enjoyable leisure	Weight maintenance
Flexibility	Back problems	Mental health	
Body composition	Some forms of cancer		

Note. Adapted from Corbin et al. (2002, p. 2).

2.1.5 The Emergence of New Physical Activity Recommendations

Physical activity is a complex behaviour (Haskell et al., 2007), which is determined by a multitude of factors that have become more intricate over the past century as advances in science and technology continually change the world (Dzewaltowski, 2008; Humpel, Owen, & Leslie, 2002). To attain a firm knowledge base of LPA behaviours, researchers must first understand the great complexity and versatility of PA as a psychological, behavioural, and social phenomenon (Marttila, Laitakari, Nupponen, Miilunpalo, & Paronen, 1998; Miilunpalo, Nupponen, Laitakari, Marttila & Paronen, 2000).

Considerable research on the relationship between exercise or PA and health began only in the second half of the 20th Century, and since then several scientifically-based guidelines have been developed (Blair & Connelly, 1996; Blair, LaMonte & Nichaman, 2004; Corbin et al., 2002; Saris et al., 2003), and recently updated (Haskell et al., 2007; Nelson et al., 2007). However, PA should be prescribed for an individual based on his/her personal needs and interests. Guidelines provided by experts are designed to help in individual prescriptions, but are typically general in nature. Indeed, experts drafting these guidelines cannot be aware of the needs of all individuals who may be using them.

2.1.5.1 Interpreting Existing Physical Activity Guidelines

Initially the guidelines issued by the ACSM (1978, 1990) focused on fitness promotion in healthy adults, perhaps because more knowledge had been accumulated about fitness rather than general health benefits. During the last three decades, the ACSM has constantly updated previous recommendations to include the latest exercise prescription guidelines for healthy and clinical populations, as well as for children, the elderly, and pregnant women (ACSM, 2000, 2005). Although these guidelines were not meant to be international recommendations, many scientists and health organizations (e.g., British Heart Foundation [BHF], 2005; Bucksch, 2005; DoH, 2004; WHO, 2003) view them as such because of the comprehensive knowledge that has been gathered to develop them.

Ever since their first publication, the ACSM's guidelines have served as the health and fitness industry's standard template for PA and exercise prescription for normally healthy people, cardiac rehabilitation patients and various special populations (Corbin et al., 2002). Recently, the ACSM and the American Heart Association (AHA; Haskell et al., 2007) have reconfirmed and partially updated the original recommendations of PA proposed by ACSM (Pate et al., 1995). These new guidelines highlight the importance of performing at least 30 min of MPA on five days or more per week to promote and maintain health in adults aged 18–65 yrs (Haskell et al.,) and older adults (Nelson et al., 2007).

2.1.5.2 Origins of Moderate-intensity Physical Activity Recommendations

Initially, many health and fitness professionals, who had been using the previous ACSM (1978, 1990) guidelines for improving cardiovascular fitness, disagreed with the new PA recommendations. To remedy this dissatisfaction, Corbin and Pangrazi (1996) published an article to help health and fitness professionals elucidate the role and application of concomitant fitness and PA recommendations. The fundamental point of these new guidelines was to encourage the greatest number of sedentary younger and older adults to achieve the greatest benefits for their health by increasing regular MPA (Corbin et al., 2002; Haskell et al., 2007). Further, Ekkekakis & Petruzzello (1999, p. 337) stated that “one of the assumptions underlying the new PA recommendations is that lower doses of activity (i.e., intensity and duration) are more enjoyable for the average person, thus leading to higher involvement and adherence rates.”

Some evidence supporting the benefits of these new guidelines for MPA was provided by Hakim and colleagues (1998, 1999): men who walked <0.25 mile/day had a 2-fold greater risk of CHD than those who walked >1.5 mile/day. Further, they noted that men who walked 0.25 to 1.5 mile/day had a greater risk than men who walked longer distances did. Moreover, when distance walked was modelled as a continuous variable, the risk of CHD was reduced by 15.0% for every 0.5-mile/day increase in walking distance. These findings did not change when they were adjusted for age and other risk factors, including smoking, total and high-density lipoprotein (HDL) plasma cholesterol, hypertension, and diabetes (see Table 2.1).

2.1.5.3 Origins of Lifestyle Physical Activity Guidelines

During the last decade, the need to promote more "physically active living" or an "active lifestyle" (Killoran, Cavill, & Walker, 1994; Quinney, Gauvin, & Wall, 1994) has finally been recognised in an effort to produce a more palatable message for the general population (Biddle & Mutrie, 2007, p. 10; Morris, 1996). The majority of health and fitness professionals believe that the physical and mental health benefits might be accomplished through MPA. The primary reason for this belief resides in the assumption that LPA guidelines will motivate the majority of adults in developed countries to become regularly active (Biddle & Mutrie, p. 31; Morris). Dunn et al. (1998), after an extensive review of LPA interventions, proposed that recommendations should place the emphasis on an active lifestyle achieved by performing MPA of a planned and unplanned nature that may have beneficial effects on health (e.g., walking to work, climbing stairs, household chores, etc.) for a total of 150 or more min per week.

Presently, technology has greatly reduced the intensity of physical labour in most occupations, and the workplace has become a progressively less important component of VPA for many people (Dzewaltowski, 2008). For those with sedentary occupations, leisure-time activity or commuting to and from the workplace is the main source of exercise (Nordstrom, Dwyer, Bairey Merz, Shircore, & Dwyer., 2003). While, household and other chores are significant they are largely overlooked as components of the total weekly energy expenditure in full time caregivers (Blair, Kohl, & Barlow, 1993; Masse et al., 1997). Although this research has not directly influenced the public health recommendations for PA, they have played a meaningful role in the conception of specific LPA interventions. The paucity of randomised MPA studies and the absence of a gold standard measure capable of detecting variations in the adoption of LPA recommendations has prevented exercise and health scientists from formulating suitable LPA interventions and promoting them to the general population.

2.2 Lifestyle Physical Activity Interventions

Until the mid-1980s, epidemiological studies used self-reported occupational or leisure-time PA as the exposure variable. Many authors (e.g., Blair et al., 2004; Shephard, 2003) found that the extant body of evidence was of limited use because many of the self-reports used were found to be inaccurate and not fully validated. Therefore, it would be difficult to prescribe with confidence the precise dosage of exercise that is associated with observed health benefits (Blair & Connelly, 1996; Blair et al., 2004).

Research employing more objective measures of exposure, such as aerobic or cardiorespiratory fitness (e.g., Ainsworth et al., 1993; Godin & Shephard, 1985), fitness/work indexes (e.g., Baecke et al., 1982; Kriska & Bennett, 1992) or the relation of PA and/or exercise to health outcomes (e.g., Blair et al., 1989, 1995; Erikssen et al., 1998; Kampert, Blair, Barlow, & Kohl, 1996) generally provided stronger associations with health outcomes than studies with self-reported PA. However, they failed to provide a description of the amount and types of regular PA required for protection against many chronic diseases, weight management, and mental health conditions (Bauman, 2004; Blair et al., 2004).

Dunn and colleagues (Dunn et al., 1998), after an extensive review of existing literature of LPA interventions, proposed that recommendations should place the emphasis on:

> Active lifestyles; by performing self-selected moderate intensity physical activities, of *planned* and *unplanned* nature that may have beneficial effects on

> health (e.g., walking to work, climbing stairs, household chores, etc.) for a total of 150 or more minutes per week ... These activities are selected by the individual and are not prescribed. Also, these self-selected activities can be planned by the individual or they can be unplanned by manipulation of the environment… (p. 399)

To date, very few studies have examined the adoption and maintenance of LPA recommendations to enhance the mental health and health-related quality of life in the elderly (e.g., Lamb, Bartlett, Ashley, & Bird, 2002; Munro, Nicholl, Brazier, Davey, & Cochrane, 2004; Reijneveld, Westhoff, & Hopman-Rock, 2003); while others aimed at increasing leisure time activities (e.g., Brawley, Rejeski, & Lutes, 2000; Harland et al., 1999), or reducing inactivity (e.g., Pinto et al., 2002; Swinburn, Walter, Arroll, Tilyard, & Russell, 1998).

2.2.1 Evidence-based Studies Adopting Lifestyle Physical Activity Interventions

Databases searched for this review include Medline, Medscape, PsycInfo, Sciencedirect, and SPORTDiscus, using the keywords leisure-time physical activity, lifestyle physical activity, structured physical activity, unstructured physical activity, incidental physical activity, habitual physical activity, occupational physical activity, locomotion physical activity, gardening, walking, stairs climbing, and sedentary lifestyle. Citation lists were cross-referenced to include eligible papers not identified during the computerised literature search. Finally, abstracts from recent scientific conferences including the ACSM, Society of Behavioural Medicine, and AHA were also searched.

The selected LPA interventions met the following criteria: (a) All papers and abstracts reported on interventions that satisfied the definition of LPA; (b) all studies incorporated at least a measure of PA (e.g., cardiorespiratory fitness, exercise adherence and/or attrition, etc.) as an outcome measure; (c) studies used randomised controlled trials (RCT) methodology that assigned participants to one or more LPA interventions, to a standard exercise treatment group, and/or to a control group; and (d) all participants were adult. The decision to restrict the minimum age to 18 was determined by the initial research proposal of developing an instrument that would be used commercially (see Karageorghis et al., 2005).

The majority of these research articles used LPA as a specific intervention. Among these investigations, six studies also used diet as an intervention and independent variable (e.g., Andersen et al., 1999; Jakicic, Wing, Butler, & Robertson, 1995; Pinto et al., 2002). The interventions included walking groups (e.g., Woolf-May et al., 1998; 1999), lifestyle versus structured PA programmes (e.g., Dunn et al., 1997; Heesch, Mâsse, Dunn, Frankowski, & Dolan Mullen, 2003), weight control programmes incorporating MPA (e.g., Jakicic, Marcus, Gallagher, Napolitano, & Lang, 2003), stair climbing programmes (e.g., Boreham et al., 2005), intensive training programmes (e.g., Andersen et al.,; Jakicic et al.,). Additionally, the selected studies investigated the effects of LPA home-based versus gymnasium-based interventions (e.g., Dunn et al., 1997; Jakicic, Winters, Lang, & Wing, 1999), tailored versus standard self-help intervention programmes (e.g., Bull, Kreuter, & Scharff, 1999; Marcus, Bock, et al., 1998), outdoor walking programmes (e.g., Murphy & Hardman, 1998), and group-based versus media-delivered programmes (e.g., Andersen et al.,; Marshall, Leslie, Bauman, Marcus, & Owen, 2003; Mutrie et al., 2002).

Samples included university students, sedentary but healthy middle-aged and older adults, postmenopausal women and adults with chronic disease (e.g., colon cancer). Among the 30 studies, 21 used less than 200 participants, of which 16 studies had less than 100 participants. Nine studies employed more than 200 participants; of which one had more than 650 participants (Marshall et al., 2003), whereas another recruited more than 1,500 employees at participating worksites (Marcus, Bock, et al., 1998).

The evidence from the studies included in this review (e.g., Asikainen et al., 2002; Boreham et al., 2005; Ebisu, 1985; Murphy & Hardman, 1998; Osei-Tutu & Campagna, 2005) and additional meta-analyses (e.g., Dunn et al., 1998; Hardman, 2001) has shown that adopting exercise regimens comprising of several short daily sessions can improve the cardiovascular fitness of inactive and sedentary individuals. Further, many researchers (e.g., Murphy, Nevill, Neville, Biddle, & Hardman, 2002; Tully, Cupples, Chan, McGlade, & Young, 2005) and national institutions (e.g., DoH, 2004; USDHHS, 1996) also suggest that performing multiple short-bouts of PA over the course of a day might enhance exercise adherence. However, in a recent report, the Chief Medical Officer for England (DoH, 2004) recognised the difficulty many have in translating the latest PA recommendations (ACSM, 2005; Haskell et al., 2007) into a meaningful behaviour pattern that can be incorporated into their lifestyles (Hillsdon, Thorogood, Anstiss, & Morris, 1995).

The findings of the selected studies have been organised into two main sub-sections. Firstly, a review of the effects of short-bout MPA interventions on two outcome measures (i.e., aerobic fitness and exercise adherence) which has been subdivided into: a) Short and intermediate-term interventions (7–32 weeks); and b) long-term interventions (9–18 months). Secondly, a review of the objective evidence of LPA promotion, which was derived from diverse media channels (i.e., computer-based, internet, etc.), will provide additional support for the development and implementation of LPA interventions.

2.2.1.1 Effects of Short- and Intermediate-term Moderate-intensity Physical Activity Interventions on Aerobic Fitness

Ebisu (1985) examined the effects of jogging the same distance in one, two, or three daily sessions at 80.0% of HRmax for 10 weeks on 53 untrained young university Japanese male students (age: M = 21.0 years, SD = 1.2 years), and found that $\dot{V}O_{2max}$ improved by 6.9%, 9.8% and 8.3% respectively ($p < .05$). He concluded that two and three short bouts are more effective than one daily bout in improving aerobic fitness in young adult males. Although Ebisu supervised the exercise sessions, the actual duration of these bouts is unknown because only distances were reported; hence, these results may not be directly applicable to a wider population.

Jakicic et al. (1995), in a 20-week study, found that multiple 10 min bouts of MPA provided similar significant improvements ($p < .05$) of aerobic fitness when compared to a single continuous bout of exercise (5.0% and 5.6% respectively) in 56 overweight adult women (age: M = 40.6, SD = 6.6 years). Similarly, Murphy, and Hardman (1998) compared the effects of short-bouts (SB) and long-bouts (LB) of brisk walking among 34 sedentary women (age: M = 46.7, SD = 6.1 years) during a 10-week trial. They reported that the SB and LB groups improved their $\dot{V}O_{2max}$ to a similar degree (8.0% or 2.5 ml/kg/min; $p < .05$) when compared to a control group. Although there was no difference between the SB and LB groups, they speculated that the SB intervention was as effective as LB in improving aerobic fitness in previously sedentary middle-aged women. A common limitation in these two studies can be attributed to the measure of self-reported exercise time. It has been shown that self-reported PA is often an imperfect estimate of the actual amount of PA performed (Jakicic, Polley, & Wing, 1998). Further, the small samples size could have reduced the statistical power of these investigations (Haskell & Kiernan, 2000). These limiting factors could have contributed to the small improvements in $\dot{V}O_{2max}$ reported in both studies.

To compensate for the lack of precision in self-reported exercise duration, Schmidt, Biwer, and Kalscheuer (2001) supervised 48 overweight female college students (age: *M* = 19.7, *SD* = 1.4 years) during aerobic fitness training. They found that, after a 12-week intervention, $\dot{V}O_{2max}$ increased significantly ($F_{3,34} = 7.2$, $p < .001$) from baseline in all intervention groups, with the exception of the control group. Schmidt and colleagues also noted that there was no significant interaction among intervention groups and speculated that multiple bouts of aerobic exercise were as effective as a single bout of exercise. Despite these positive results, it appears that the participants were not randomly assigned due to logistical problems experienced because of the rigorous exercise protocol. Hence, the applicability of these results to unsupervised, older populations is doubtful.

Asikainen et al. (2002) investigated the effects of multiple brisk walking bouts in 134 healthy but sedentary postmenopausal women (age: *M* = 57.3, *SD* = 4.3 years) during a partially-supervised 15-week intervention programme. The participants exercised 5 days/week at 65.0% of their maximal aerobic power, and expended about 300 kcal during one (S1) or two (S2) daily exercise sessions. They reported that there were significant improvements of $\dot{V}O_{2max}$ for S1 (8.7% or 2.5 ml/kg/min, $p < .001$, $\Delta = 0.97$) and S2 (8.8%; 2.5 ml/kg/min, $p < .001$, $\Delta = 0.97$). Asikainen et al. concluded that brisk walking performed in either a single or in multiple bouts, is a feasible exercise modality for sedentary postmenopausal women. Although, this is the first piece of research that has provided some evidence for the benefits of short-bouts of MPA in postmenopausal women of normal weight, the duration of the study could be extended to insure the detection of all potential benefits (e.g., BMI, body fat %, blood pressure, etc.). Additionally, all the exercise sessions should have been supervised (cf. Schmidt et al., 2001), thus providing additional evidence for the promotion of these types of MPA interventions to a larger audience.

Murphy et al. (2002) studied 32 sedentary adults (age: *M* = 44.5, *SD* = 6.1 years) during a 14-week programme of self-governed outdoor brisk walking. They used a cross-over design (2 x 6-week programmes plus a 2-week wash-out between programmes), which consisted of two different patterns (long- vs. short-bouts, and short- vs. long-bouts). The single long-bout lasted 30 min/day, whereas the multiple short-bouts consisted of 3 x 10 min/day stints. Overall, participants' predicted aerobic fitness increased significantly with both programmes, but the increase was greater following the short-bouts pattern (14.2% or 3.95 ± 3.21 ml/kg/min, $p < .05$, $\Delta = 0.72$) than the long-bout pattern (3.8% or 1.1 ± 3.21 ml/kg/min, $p < .05$, $\Delta = 0.18$). These findings are in direct contrast to those provided by Jakicic et al., (1999), who reported that the improvement in aerobic fitness was greater in the long- versus short-bouts of exercise pattern.

A possible explanation for these results could be that the participants assigned to the short- versus long-bouts group completed more of the prescribed walking in both programmes, hence increasing the magnitude of their improvement (Murphy et al., 2002). Additionally, the authors reported that the $\dot{V}O_{2max}$ of both groups was significantly higher before the second intervention period than at baseline, possibly because the wash-out interval was too short. It is well-known that the greatest increases in $\dot{V}O_{2max}$ occur earlier in a training period, so the potential for improvement might have been reduced during the second period. Thus, the cross-over design, which worked well for other outcomes (e.g., waist circumference, systolic blood pressure, diastolic blood pressure, etc.), is a limitation in the interpretation of these findings pertaining to $\dot{V}O_{2max}$.

Boreham et al. (2005) replicated previous research (e.g., Boreham, Wallace, & Nevill, 2000) and examined the effects of an 8-week stair-climbing programme on aerobic fitness among a group of 15 sedentary (age: M = 18.8, SD = 0.7 years) but otherwise healthy young women. The task was progressively increased from one ascent a day in week 1 to five ascents a day in weeks 7 and 8. The stair climbing group displayed a significant increase in $\dot{V}O_{2max}$ (17.1%, $p < .05$, $\Delta = 0.88$), thus providing some evidence that climbing stairs for at least 11 min/day is sufficient to elicit some cardiovascular adaptations. Furthermore, Boreham et al. (2005) suggested that the 11 min/day of stair climbing performed in the final weeks of this programme resulted in similar improvements to $\dot{V}O_{2max}$ as walking for 36 min/day over 24 weeks.

In summary, there is some evidence of the effectiveness of short-bouts of strenuous exercise on aerobic fitness in young women; however, research should be carried out in other populations. For instance, it is well-established that sedentary individuals, older adults, and obese people may find this intensity of exercise too strenuous, and may therefore need a longer time-frame to reach similar improvements in $\dot{V}O_{2max}$. Further, the number of participants should be raised to increase the statistical power (Haskell & Kiernan, 2000). Also, the integration of an additional intervention group performing a task of similar intensity magnitude (e.g., walking up-hill on a treadmill) would have provided additional evidence for the efficacy of short-bouts of vigorous exercise over a short period of time.

Although there is compelling evidence of the health benefits associated with short-bouts of MPA (2–10 min; e.g., Boreham et al., 2005; Woolf-May et al., 1999), some research has found this practice to be less effective in promoting health benefits than the *traditional* single daily bout of 20 min or more (e.g., Andersen et al., 1999; DeBusk, Stenestrand, Sheehan, & Haskell, 1990; Snyder, Donnelly, & Jacobsen, 1996). For example, DeBusk et al., after an 8-week study of sedentary but healthy middle-aged men (N = 36; age: M = 51.5, SD = 6.0 years), established that a single long bout of running (1 x 30-min) was more effective in increasing $\dot{V}O_{2max}$ (7.6% or 2.4 ml/kg/min, $p < .05$) than multiple short-bouts (3 x 10-min). Nevertheless, the researchers concluded that multiple short-bouts of MPA to be a more adequate form of exercise for insufficiently active individuals.

Woolf-May et al. (1999) reported no improvement in aerobic fitness after an 18-week programme of brisk walking engaged in by 56 middle-aged healthy, but sedentary, individuals. The participants were subdivided into three intervention groups (long-bout – LB: n = 19, age: M = 50.1, SD = 6.3 years; intermediate-bouts – IB: n = 10, age: M = 57.7, SD = 6.1 years; short-bouts – SB: n = 14, age: M = 54.3, SD = 7.4 years) and a control group (CG: n = 13, age: M = 54.7, SD = 7 years). It is possible that these results were also influenced by the low statistical power (Haskell & Kiernan, 2000). Similarly, after a 32-week programme engaged in by 13 middle-aged, sedentary participants (age: M = 43, SD = 11 years), Snyder, Donnelly, Jacobsen, Hertner, and Jakicic (1997) found that short-bouts of brisk walking for a total of 30 min (i.e., 3 x 10 min) performed at the workplace did not improve aerobic capacity. However, seven of the 13 participants increased their aerobic capacity, lost fat, and improved insulin levels. The positive results obtained by these participants may be attributed to their older age, lower maximal aerobic fitness, and higher fat percentage at baseline; suggesting that MPA is more beneficial for sedentary older adults with poor aerobic fitness and a higher body fat percentage.

Many aspects of cardiac function, such as early diastolic ventricular filling (the relaxation phase of the cardiac cycle in the left ventricle [LV]), appear to decline with increasing age (e.g., Brenner, Apstein, & Saupe, 2001; Woolf-May, Ferret, Owen, & Bird, 2003). However, some researchers (e.g., Forman et al., 1992; Owen, 1999) found that older people who engage regularly in habitual aerobic exercise displayed the cardiac characteristics of younger individuals. Until recently, it was thought that only habitual VPA resulted in changes to LF function. However, a study conducted by Woolf-May et al. (1999) found that an intervention of brisk walking (i.e., 20-40 min/day for a total of 150 min/week) that lasted for 18 weeks resulted in increased LV function in a group of sedentary, but healthy individuals (n = 19; age range: 41–65, M = 50.1, SD = 6.3 years).

Woolf-May et al. (2003) replicated their earlier study (Woolf-May et al., 1999) using shorter bouts of brisk walking on a group of 64 sedentary, but healthy participants. The participants were randomly assigned to two samples: a multiple short-bouts walking group (SW: n = 27; age: M = 53.6, SD = 7.6 years; 10 min x 3/day for a total of 150 min/week) and to a control group (CG: n = 37; age: M = 55.5, SD = 6.3 years). Notably, LV function did not improve in either group. This result suggested that, despite the intensity and overall weekly duration of the exercise, the accumulated 10-min bouts of brisk walking were not as effective in producing a change in LF function.

2.2.1.2 Effects of Long-term Moderate-intensity Physical Activity Interventions on Aerobic Fitness

Andersen et al. (1999) tested the effects of MPA on aerobic fitness among sedentary, obese women, using two different regimens: a diet plus 30 min (3 x 10 min/day short-bouts) of MPA per week (DMPA: n = 20; age: M = 42.9 years, SD =

7.9 years), versus a diet plus three aerobics classes (45 min step aerobics) per week (DSA: *n* = 20; age: *M* = 43.2, *SD* = 9.1 years). After the 68-week long weight management programme, a significant improvement in maximum oxygen uptake ($p < .001$) was seen in both DMPA and DSA groups, with no significant difference between them at any point during the course of the study. Donnelly, Jacobsen, Heelan, Seip, and Smith (2000) compared the long-term effects of an 18-month programme of continuous bouts of brisk walking (CB: 3 days/week; 1 x 30 min/session) versus intermittent bouts (InB: 5 days/week; 2 x 15 min/session) on aerobic fitness in previously sedentary moderately obese women (*N* = 22). They found significant changes for aerobic capacity of 8.0% and 6.0% for the CB and InB groups of brisk walking, respectively, concluding that continuous and intermittent bouts of MPA may be effective in improving some measures of aerobic capacity in moderately obese women over a long period.

Donnelly et al. (2000) further suggested that a programme of diet and increased MPA may be a suitable alternative to diet plus aerobic exercise for overweight women. However, in this study, it is impossible to ascertain whether the improvements in $\dot{V}O_{2max}$ were due to the greater reduction of body weight reported by the InB group, or due to the higher adherence to this intervention compared to the aerobic exercise. After one year, there were twice as many participants (*n* = 8) of the InB group in the most active tertile indicating the effectiveness of this type of intervention over a long term. However, additional studies, with larger numbers of both men and women are needed to replicate this finding and to identify which individuals are best suited for either MPA or VPA.

Jakicic et al. (2003) conducted a study examining the effects of exercise duration and intensity among 201 middle-aged sedentary women (age: *M* = 37, *SD* =

5.7 years) in a university-based weight control programme. These participants were randomly subdivided into one of four exercise groups (G1: Vigorous intensity/high duration; G2: Moderate intensity/high duration; G3: Moderate intensity/moderate duration; or G4: Vigorous intensity/moderate duration) based on estimated energy expenditure (1,000 kcal/week vs. 2,000 kcal/week) and exercise intensity (moderate vs. vigorous). After 12 months, 184 participants completed the study and $\dot{V}O_{2max}$ was increased in all groups (G1: 22.0% ± 19.9%; G2: 14.9% ± 18.6%; G3: 13.5% ± 16.9%; G4: 18.9% ± 16.9%; $p < .04$). Post hoc analysis found no difference between the groups according to exercise intensity ($p = .11$) or exercise duration ($p = .35$).

Jakicic et al. (2003) also demonstrated that varying levels of exercise resulted in significant improvements to aerobic fitness. The authors concluded that improvements in aerobic fitness were more likely to be associated with exercise duration (≥ 150 min/week) than to exercise intensity (MPA vs. VPA), and that improvements in $\dot{V}O_{2max}$ may enhance overall health independently of body weight as suggested by previous research (e.g., Farrell, Braun, Barlow, Cheng, & Blair, 2002; Lee, Blair, & Jackson, 1999; Wei et al., 1999). Nevertheless, Jakicic et al.'s study suffered from some limitations. For instance, the absence of a diet-only comparison group prevented the independent evaluation of this variable. This study also used an intensive behavioural intervention to maximise exercise participation; an approach that may not be realistic in clinical settings. In addition, because the majority of exercise performed in this study consisted of brisk walking, the effect of other forms of exercise (e.g., resistance exercise for muscle strength and/or endurance) on long-term changes in $\dot{V}O_{2max}$ and body weight could not be ascertained.

2.2.2 Effects of Short-bouts of Moderate-intensity Physical Activity on Exercise Adherence and Attrition

To accrue health benefits from exercise, it is not only important for participants to initiate a PA programme, but to adhere to the programme; hence creating a lifestyle change (Jacobsen, Donnelly, Snyder-Heelan, & Livingstone, 2003). Research has established that attrition rates approach 25.0% during the first 24 weeks of an exercise programme (Dishman, Sallis, & Orenstein, 1985). Further, it has been found that programmes lasting over 12 months may have attrition rates greater than 50.0% (Martin, Morrow, Jackson, & Dunn, 2000). Therefore, during the first six months of a PA intervention, it is critical for participants to create a lifestyle change that may be maintained for a lifetime (Jacobsen et al., 2003). Consequently, the formation of habits is an essential aspect of exercise adherence (Aarts, Paulussen, & Schaalma, 1997; Buckworth & Dishman, 2002, p. 226).

In LPA interventions that utilise cognitive and behavioural modification, participants are usually asked to adhere to multiple behaviour patterns such as: (a) attendance at group or individual sessions, (b) completion of homework, (c) compliance with the protocol, and (d) self-monitoring of PA. Adherence in clinical trials has become an issue because attrition and inconsistent adherence can negatively affect power (Cook & Campbell, 1979). Additionally, adherence to structured exercise programmes based on regular bouts of 30 min or more is poor (DoH, 2004; Haskell, 1994; USDHHS, 1996).

It has been suggested that people may be more likely to maintain an active lifestyle if they undertake several short-bouts of exercise at intervals throughout the day (Blair, Kohl, Gordon, & Paffenbarger, 1992; Woolf-May et al., 1998). Therefore, health promoters ought to convey to the general population that an active lifestyle is comprised of exercises that can be habitually included within the daily routine without placing additional demands upon their time (Hillsdon et al., 1995). Walking is a very popular form of exercise for a broad segment of the population (Siegel, Brackbill, & Heath, 1995). Moreover, Woolf-May et al. (1998) proposed that completing short walks, such as from the home to the station, would appear to be a suitable form of MPA that elicits health-related benefits.

2.2.2.1 Effects of Short- and Intermediate-term Moderate-intensity Physical Activity Interventions on Exercise Adherence and Attrition

Jakicic and colleagues (Jakicic & Wing, 1997; Jakicic et al., 1995) demonstrated that greater improvements in exercise adherence were achieved with three to four short 10-min bouts (SB) of moderate-intensity exercise when compared with one 30–40 min long-bout (LB) of continuous exercise. Jakicic et al. found that obese women assigned to intermittent exercise reported a greater number exercising days (M = 87.3, SD = 29.5 days) than the LB group (M = 69.1, SD = 28.9 days, $p < .05$). Similarly, Jakicic and Wing (1997) reported that short-term adherence in previously sedentary, obese women was significantly higher in the SB group (M = 4.9, SD = 1.5 day/week) than the LB group (M = 3.8, SD = 1.2 day/week, $p < .02$). They concluded that multiple exercise bouts improve adherence, produce similar improvements in fitness and slightly greater weight loss when compared to a continuous exercise condition, and that SB may be more suitable when prescribing exercise to sedentary obese people (Jakicic et al., 1995; Jakicic & Wing, 1997).

Despite these encouraging findings, neither of the studies in question (Jakicic et al., 1995; Jakicic & Wing, 1997) examined the compliance with the protocol. Additionally, the absence of control groups (e.g., diet only or MPA only) prevented the researchers from evaluating the true effects of those interventions. It is well known that rapid improvements in weight loss can motivate obese participants to adhere to the protocol and, therefore, increase their attendance to exercise sessions (Thurston & Green, 2004). Further, the use of self-monitoring diaries for PA and diet is of limited accuracy (Shephard, 2003) due to social desirability; especially in obese people (Fogelholm & Kukkonen-Harjula, 2000; Klesges et al., 1990), thus limiting the validity and reliability of these findings.

Other studies (e.g., Murphy & Hardman, 1998; Murphy et al., 2002) measured adherence as the number of minutes spent exercising compared to the number of minutes suggested in the protocols. For instance, Murphy et al. found that, when enrolled in the short-bouts programme, participants were able to complete a significantly greater percentage of the recommended walking time (92.6% ± 2.2% and 85.1% ± 5.7%, $p < .05$, respectively) than during a single-bout programme. Similarly, after the completion of a 12-week home-based intervention of brisk walking, Tully et al. (2005) reported that the overall adherence to the prescribed protocol was equivalent to 90.3%. The aforementioned studies found much higher exercise adherence levels than those related to leisure centre-based exercise interventions. For instance, King, Haskell, Young, Oka, and Stefanick (1995) found that adherence to intervention protocols ranged from 50.0–75.0%. These initial findings suggested that participants more readily accept unsupervised home-based MPA programmes than short- or intermediate-term leisure-based interventions.

Recent meta-analytical research found that adherence to an exercise programme was higher when barriers to participation were removed (Wendel-Vos, Droomers, Kremers, Brug, & van Lenthe, 2007). Thus, home-based rather than facility-based programmes may improve adherence and lower attrition rates (King et al., 1992). It is plausible that the overweight participants in Wendel-Vos et al.'s study were more motivated to maintain an exercise regimen in the privacy of their homes away from potential body-image judgments made by other leisure centre users (Annesi, 2006; Castellani, Ianni, Ricca, Mannucci, & Rotella, 2003). Further, the availability of equipment at home might have made the exercise more convenient (Jakicic, Wing, Butler, & Jeffrey, 1997; Raynor, Coleman, & Epstein, 1998), thus facilitating adherence to the programme (Castellani et al.).

2.2.2.2 Effect of Long-term Moderate-intensity Physical Activity Interventions on Exercise Adherence and Attrition

Little data is available regarding adherence and attrition for MPA interventions of an intermittent nature over the long term. However, enhancing ongoing participation in exercise may translate into weight loss, and improve cardiovascular fitness in sedentary, overweight populations. For example, Jakicic et al. (1999), using home-based exercise equipment, compared the effects of intermittent with continuous PA on adherence. After 18 months of a behavioural weight control programme with 3 exercise groups (LB: long-bout exercise; SB: multiple short-bout exercise; SBEQ: multiple short-bout exercise with home exercise equipment using a treadmill), they reported that only 33 (22.0%) of the original 148 participants did not complete the programme.

Jakicic et al. (1999) found no significant difference ($p = .77$) in exercise adherence between groups at months 1–6. However, during months 7–12 exercise adherence was 47.2%, 62.5% and 72.2% for the LB, SB and SBEQ groups respectively (all $p < .05$), and during months 13–18 adherence was similar for the SB and SBEQ groups, but higher for those in the long-bout group (LB = 70.6%, SB = 64.0%, and SBEQ = 73.1%, all $p < .05$). The researchers concluded that access to home exercise equipment might have facilitated the maintenance of short-bouts of

PA, as has been found in previous research (e.g., Jakicic et al., 1997; Raynor et al., 1998). However, because the long-bout exercise group did not have access to home-based exercise equipment, the effectiveness of this exercise intervention in overweight women remains unclear. Moreover, this finding may not be generalised because of the absence of male participants, failure to control for dietary intake, and absence of a control group.

Jacobsen et al. (2003) compared the effects of long-term (72 weeks) continuous (CON) and intermittent (INT) exercise on attrition and adherence in previously sedentary, moderately obese women. These authors calculated exercise adherence as the number of sessions completed compared to the number of sessions prescribed. Attrition was calculated as the number of participants in the study compared to the total number of participants originally enrolled, at intervals of 12 weeks. Attrition was appreciatively 58.0% for both groups from baseline until week 72. However, attrition was greater in the CON group (38.0%) when compared to the INT group (16.0%) in the first 24 weeks. Adherence, which was calculated as the number of sessions completed divided by the number of sessions prescribed per week, was reported to be high for both groups (> 80.0%) throughout the entire study. The authors concluded that a long-term intervention might suffer from a higher attrition rate, and surmised that intermittent exercise is less likely to suffer from drop-out than a continuous exercise programme during a short- to intermediate-term intervention.

The main limitation in this study was the absence of both a control group and of male participants. Additionally, participants in both groups were discouraged from adjusting their exercise behaviour to their time availability, hence creating a potential barrier to exercise (Donahue, Mielenz, Sloane, Callahan, & Devellis, 2006). Hence, these limitations prevent the findings from being generalised to a wider population.

Jakicic et al. (2003) used an intervention that tested the effects of exercise duration (moderate vs. high) and intensity (moderate vs. vigorous) on a 12-month weight loss programme in 201 previously sedentary and overweight women (age: *M* = 37, *SD* = 5.7 years). From the original sample, 17 participants withdrew from the study before its completion; this is equivalent to a dropout rate of 8.0%. Overall, participants attended 79.2% of group sessions for Months 1–6, with an attendance rate of 71.4% over the entire 12-month period. The researchers did not find any difference between the exercise groups suggesting that all groups complied similarly with the exercise and dietary programmes. Notably, this study was based on an intensive behavioural intervention designed to maximise exercise participation; an approach that might prove impractical in most non-clinical settings. Additionally, because the majority of the exercise in this study was brisk walking, the effects of other form of exercise (e.g., resistance training) on long-term adherence could not be ascertained.

2.2.2.3 Equivocal Findings Concerning Short-bouts of Lifestyle Physical Activity on Exercise Adherence and Attrition

Some researchers (e.g., Schachter, Busch, Peloso, & Sheppard, 2003; Schmidt et al., 2001) found no significant differences in exercise adherence between the short- and long-bout exercising groups. For instance, Schmidt et al. used the average number of days/week as a measure of adherence to a lifestyle PA programme. All participants exercised in a similar fashion throughout the intervention (LB = 1 x 30 min: adherence *M* = 3.9, *SD* = 0.5 day/week; IB = 2 x 15 min: adherence *M* = 3.7, *SD* = 0.5 day/week; SB = 3 x 10 min: adherence *M* = 3.7, *SD* = 0.6 day/week). However, a chi-square test of the percentage of participants who dropped out between exercising groups showed a statistical significance ($\chi^2 = 28.7$, $p < .001$). The LB group reported 0.0% dropout compared to 17.0% and 33.0% for the IB and the SB groups respectively. These results suggested that one supervised long-bout of aerobics, in a structured environment, was more acceptable and sustainable than multiple shorter sessions, possibly due to the logistical and temporal constraints to female college students.

Schachter et al. (2003) examined the effects of two home-based regimens of aerobic exercise in sedentary women suffering from Fibromyalgia over a period of 16 weeks. The 143 women undertook either a long bout of exercise (LBE: 1 x 30 min/day; n = 51, age: M = 41.3, SD = 8.7 years), two short bouts of exercise (SBE: 2 x 15 min/day; n = 56, age: M = 41.9, SD = 8.6 years), or no exercise (NE: n = 36; age: M = 42.5, SD = 6.7 years). The intervention groups exercised progressively from 10–30 min, 3–5 times/week. The dropout rates for the NE, LBE, and SBE groups were 14.0%, 29.0%, and 38.0% respectively. The researchers concluded that the higher drop out rate for the SBE group was due to higher cumulative physical pain experienced by these participants on a daily basis, compared to the LBE and control groups. They also concluded that, for people suffering from Fibromyalgia, exercise programmes that incorporate multiple bouts of low impact aerobics are not as effective as a single bout of exercise in maintaining adherence and improving physical function.

2.2.3 Efficacy of Personalised Lifestyle Physical Activity Interventions: A Direct Approach

Face-to face interventions are considered to be the optimal means for changing health-related behaviour and constitute the standard approach in many settings. They are effective in promoting PA to the individual as well as to participants in group-based conditions resulting insignificant increases in fitness variables and exercise duration (King, Haskell, Taylor, Kraemer, & DeBusk, 1991). Participant-intervention matching can be implemented using a "targeted" and/or "tailored" approach (Marcus & Lewis, 2003).

A "targeted" message provides information directed to an identified group, which is typically based on one or more variables, such as Stage of Motivational Readiness (SMR; Marcus & Owen, 1992). A shortcoming of targeted interventions is the inappropriateness of the information provided, which might not be suitable for every individual of an identified group, and that might not address their unique needs, interests, and concerns (Kreuter, Strecher, & Glassman, 1999). Tailored messages, on the other hand, are customised information reflecting the needs and interests of each individual. Therefore, the messages are usually based on several variables believed to be important in changing or promoting the target behaviour. Moreover, a tailored approach would also provide feedback based on the individual's reported level of self-efficacy (e.g., Marcus, Bock, et al., 1998).

For instance, Dunn et al. (1997) reported that 78.0% of participants assigned to a tailored LPA intervention were meeting or exceeding the ACSM guidelines (Pate et al., 1995) at 6 months as measured by SMR (Marcus & Owen, 1992). When examining whether participants were meeting this criterion by using estimated energy expenditure as measured by the Stanford 7-Day PAR interview (Blair et al., 1985), 32.0% of the LPA group and 27.0% of the structured-exercise group were meeting or exceeding this goal. At 24 months, a similar pattern of results was evident. Instead, when using the Stages of Change to assess compliance to the ACSM's guidelines (Pate et al., 1995), Dunn and colleagues found that 61.0% of participants in the LPA group and 50.0% of participants in the structured-exercise group were meeting this criterion, whereas the PAR reference measure estimated that only 20.0% of both groups were meeting this goal. Although SCR and 7-Day PAR estimates are significantly related (Marcus & Simkin, 1993), a better understanding of the sensitivity and specificity of each of these two scales is needed.

Combining a tailored with a targeted approach has been found to be an efficacious strategy for increasing PA behaviour. For example, Marcus, Bock, et al. (1998) conducted a study comparing the efficacy of two low-cost interventions, in which sedentary participants (*N* = 194) were randomly assigned to a tailored intervention group or a comparison group consisting of standard treatment (materials were not targeted or tailored). The intervention group was provided with stage-matched instruction booklets (i.e., targeted intervention materials) and individualised advice and feedback based on participants' responses to constructs believed to be important in behaviour of change (i.e., self-efficacy). Participants in the intervention group increased their minutes of PA per week and were more likely to achieve the ACSM recommended level than the comparison group. Additionally, the increase in PA participation was maintained at the 12-month follow-up point (Bock, Marcus, Pinto, & Forsyth, 2001).

Theory-based, face-to-face interventions are efficacious; however, they are usually very time-consuming and expensive to administer, require specialist staff (Hillsdon et al., 1995; Shephard, 1992), are impractical, and reach only a small part of the general population (Annesi, 1998). To minimise these barriers and increase the dissemination of targeted and/or tailored interventions, new and more effective channels of communication, such as telephone- and computer-based interventions should be more extensively employed (Kreuter, Farrell, Olevitch, & Brennam, 2000; Marcus et al., 2002). Such channels may prove to be critical when cost and time constraints do not allow for frequent or lengthy face-to-face contacts, or for reaching individuals who have typically avoided health promotion programmes because of real or perceived barriers of access, cost, or transportation (Marcus, Lewis, et al., 2007; Marcus, Napolitano, et al., 2007; Sevick et al., 2007).

2.2.4 Efficacy of Media-Based Lifestyle Physical Activity Interventions: An Indirect Approach

A variety of health, fitness, and PA messages have been in the media (particularly television) for many years, and more recently on the internet (e.g., Kahn et al., 2002; Vandelanotte, Spathonis, Eakin, & Owen, 2007). The interventions adopted were mainly based on social-marketing models and other theories of behaviour change (e.g., Transtheoretical Model, Social Cognitive Theory, Theory of Planned Behaviour, Health Belief Model, etc.). These perspectives have been particularly influential in shaping and promoting media-based PA interventions (Donovan & Owen, 1994; King et al., 2002; Marcus, Owen, Forsyth, Cavill, & Fridinger, 1998). However, little is known about the efficacy of media-based methods in promoting more active lifestyles among individuals, groups, communities, or nations, especially for women (Marcus & Forsyth, 1998).

Few healthcare professionals, who routinely offer behavioural counselling, are trained to deliver LPA interventions, or view it as central aspect of the services they provide (Frank & Kunovich-Frieze, 1995; Livaudais et al., 2005; Wee, McCarthy, Davis, & Phillips, 1999). Further, cost containment in healthcare limits the frequency and length of contact with patients. In additions, it is difficult for many people to attend a health-care centre (Glasgow, Bull, Piette, & Steiner, 2004; Noell & Glasgow, 1999). Thus, there is an appeal in reaching a greater number of individuals, with lower costs and more flexible interventions, which are less labour-intensive (Ball, Salmon, Leslie, Owen, & King, 2005; Yancey et al., 2004).

Several reviews (e.g., Dishman & Buckworth, 1996; Jolly, Taylor, Lip, & Stevens, 2006) indicate that interventions designed to increase PA can be effective, particularly when they are delivered using remote approaches and emphasize home-based, lifestyle activities. For instance, Dishman and Buckworth, in a review of 127 published studies on PA interventions from the years 1965-1995, found larger effect sizes for indirect interventions (e.g., print mailings, telecommunication) than for those that were strictly one-to-one. Further, telephone and other mediated approaches (e.g., text messaging, internet, mail, etc.) allow both the health professional and the patient a level of convenience and flexibility that is often diminished or lacking in group-based PA regimens (Castro & King, 2002; Napolitano & Marcus, 2002).

Marshall, Owen, and Bauman, (2004) reviewed research published since 1997 on the effectiveness of mass media, print, telephone, and website-delivered PA interventions. They found that the print-based delivery of programmes can have a modest impact on PA behaviour. Further, they suggested that there is a strong case for the potential of telephone- and internet-delivered interventions, although, as they noted, there is some evidence that these media channels are effective. Marshall et al. concluded that all of these *mediated* approaches to PA programme delivery will be important elements of future public health interventions. They also suggested that mutually supportive combinations of different media are likely to be more effective and need to be further developed and researched. Consequently, for the purpose of the current research programme, a greater emphasis will be placed on those LPA interventions delivered using the internet.

2.2.4.1 Effects of Internet-delivered Lifestyle Physical Activity Interventions

The internet has a considerable, but largely untested, potential as a medium for delivering theory-based health-behaviour-change programmes (Spittaels & De

Bourdeaudhuij, 2006). One advantage of the internet is the ability to reach a wide variety of people at once, at any time and location (Fotheringham, Owies, Leslie, & Owen, 2000). In the last five years, internet use has expanded tremendously and is still increasing due to drops in cost and improved high-speed access (Spittaels & De Bourdeaudhuij). Miniwatts International (2006) reported that there are more than one billion internet users worldwide, with the largest connection rate in North America (68.6%), followed by Oceania (52.6%), and Europe (36.1%). Currently, many adults use the internet to receive information or advice about changing health-related behaviour. The reported number of adults in the United States, who have searched the internet for health-related information, varies from between 35.0% to 80.0% (Baker, Wagner, Singer, & Bundorf, 2003; Fox, 2005).

The internet has many advantages over print, telephone, broadcast, and face-to-face media. These include novelty, flexibility, convenience of use, instantaneous interactivity, the provision of information that is individually tailored, and the facilitation of interpersonal interaction and social support (Dirkin, 1994; Fotheringham et al., 2000). People have reported a higher preference for PA advice delivered via e-mail or the internet than via telephone or print media (Marshall, Eakin, Leslie, & Owen, 2005). For example, Marshall et al. reported that 35.0% of those surveyed expressed a preference for receiving PA advice via the internet, in the form of a series of e-mails, as opposed to other indirect strategies such as books (14.0%), videos (12.0%), postal mail (8.0%), or the telephone (5.0%). Consequently, researchers started to develop and evaluate online health advice on various topics such as smoking (e.g., Feil, Noell, Lichtenstein, Boles, & McKay, 2003; Lenert et al., 2003), diet (e.g., Irvine, Ary, Grove, & Gilfillan-Morton, 2004; Oenema, Brug, & Lechner, 2001) and PA (e.g., Marshall et al., 2003; Napolitano et al., 2003).

The literature relating to feedback on cognitive or job performance outcomes has also yielded some intriguing findings (Spittaels & De Bourdeaudhuij, 2006). Marcus, Bock, et al. (1998) conducted a study based on computer-based individually tailored intervention materials, which were delivered by either printed mail or via internet. The participants were 194 sedentary adults, who were recruited through newspaper advertisements. They received either a motivationally-matched individually-tailored intervention (IT), or a standard self-help intervention (ST), which were delivered by repeated mailings at baseline, week 4, and at 3 and 6 months. Participants were assessed regarding current PA behaviour, motivational readiness to adopt regular PA, and psychological constructs associated with PA participation (e.g., self-efficacy).

Participation increased between baseline and at 6 months for both groups with a greater increase among IT participants. The IT group outperformed the ST group on all primary outcome measures: (a) Minutes of PA per week, (b) reaching CDC/ACSM recommended minimum PA criteria, and (c) achieving the action stage of motivational readiness for PA adoption. Both treatment groups showed an improvement in the psychological construct associated with PA adoption between baseline and 6 months, with no significant differences between the two groups. The authors concluded that utilizing computerised expert-systems and self-help manuals to provide individually-tailored, motivationally-matched interventions to be an effective, low-cost solution for enhancing PA participation in the community. However, these results may be unrepresentative of the sedentary population, as the participants were highly motivated volunteers with access to computer technology.

Napolitano et al. (2003) examined the efficacy of an internet-based intervention on 65 sedentary employees of several large hospitals (*n* = 30 intervention group [IC]; *n* = 35 control group). The intervention was based on the stage of motivational readiness (SMR: Marcus & Owen, 1992), and consisted of the access to a website plus 12 weekly e-mails containing several suggestions for maintaining an active lifestyle. At the 1 and 3-month follow-up stages, those in the IG group were more likely to have progressed in the SMR (Marcus & Owen) for PA than participants in the control group. At the 1-month assessment point, the IG exhibited an increase in minutes of MPA, relative to control group. However, at the 3-month assessment this difference was no longer significant.

At the 1 and 3-month assessment points the IG not only increased their walking time from baseline, but they also spent more time in walking activity than the control group. Napolitano et al. (2003) concluded that a theory-based PA website and weekly e-mail tip sheets can have a short-term impact on PA motivation and behaviour. These results concur with previous research reporting that many individuals are more likely to seek feedback about performance from a computer as opposed to a human source (Kluger & Adler, 1993; Karabenick & Knapp, 1988).

Conversely, Marshall et al. (2003) tested the efficiency of mediated PA interventions to reach large numbers of people at their workplace. Intervention programmes, based on the SMR (Marcus & Owen, 1992), were delivered through the mail and electronically. Australian university staff (*N* = 655; age: *M* = 43.0, *SD* = 10.0 years) were randomly assigned to either an 8-week, stage-targeted print programme (Print), or an 8-week, stage-targeted internet programme (Web) group. The main outcome measure was a change in self-reported PA, which was assessed with the short version of the International Physical Activity Questionnaire (IPAQ; Craig et al., 2003). The authors only found that there was an increase in total PA reported by the Print participants, who were inactive at baseline, and a significant decrease in the average time spent sitting on a weekday in the Web group. The researchers concluded that there were no differences between the Print and Web programme in terms of their effects on reported PA. However, the Print group demonstrated slightly larger effects and a higher level of recognition of programme materials.

Overall, these studies suggest that internet-delivered advice and feedback may be more readily accepted, than that delivered by a person due to a lack of perceived social threat. However, there are two undesirable outcomes of computer-based interventions that researchers should consider before using this approach: (a) They diminishes human interaction, hence promoting a level of social isolation that prevents individuals from receiving supportive affirmations and sympathetic understanding, and (b) individuals lose the opportunity of personal sharing and modelling, which have been shown to be helpful in facilitating initial behaviour change (Kipnis, 1991). Additionally, Hillsdon et al. (1995) suggested that adherence to MPA programmes is further enhanced when participants have direct access to personalised instructions, and continuous support from the intervention administrators and other group members.

2.2.5 Summary of Lifestyle Physical Activity Interventions

In summary, LPA interventions have been shown to be efficacious in both younger and older adults. Most studies have been conducted over a relatively short period of time (e.g., 8 weeks to 6 months) and demonstrated that participants were able to maintain their levels of PA, and consequently maintained and/or improved their fitness levels. The adoption of LPA interventions lead to positive effects on CVD risk factors such as reduced excess body fat and lowered blood pressure when compared to other more structured exercise programmes (e.g., Andersen, Bartlett, Moser, Evangelisti, & Verde, 1997; Dunn et al., 1997).

At the present time, interventions aimed at increasing LPA do not appear to have had a significant public health effect largely because these have been delivered mostly to small groups of individuals in clinical settings (e.g., Andersen et al., 1997; Dunn, Blair, et al., 1997; Dunn, Garcia, et al., 1998; Dunn, Marcus, et al., 1997; Brawley et al., 2000). However, LPA interventions delivered by mail, telephone and electronically have demonstrated that there may be opportunities to reach larger numbers of individuals (e.g., Cardinal, 1995; Cardinal, & Sachs, 1995; Chen et al., 1998; Marcus, Bock, et al., 1998; Marcus, Emmons, et al., 1998). Overall, LPA interventions demonstrate long-term effects, both in terms of increasing MPA and in reducing sedentary activity. For example, at the end of two-year long *Project Active*, over one fifth of the participants were meeting or exceeding public health guidelines for MPA.

Recently, a number of MPA interventions have been conducted using the internet produced strong evidence of their effectiveness in reducing physical inactivity in sedentary and unfit younger and older adults. It has been proposed that websites promoting PA behavioural change should be theory-based (Doshi, Patrick, Sallis, & Calfas, 2003), and that their efficacy could be enhanced by adding tailored advice, such as personal feedback on participants' risk behaviour and the ways to change it (Kirsch & Lewis, 2004). Investigations into the influence of environmental determinants on active and/or sedentary behavioural choices represent a new research avenue for the health, exercise, and sport sciences (Owen, Leslie, Salmon, & Fotheringham, 2000). Further, Dishman, Oldenburg, O'Neal, and Shephard (1998) recommended that future research into worksite MPA programmes should use multiple modes of intervention delivery and analysis.

New approaches to measurement that emphasise direct observation of environmental attributes and behaviours will be particularly instructive for health and exercise promoters (Owen et al., 2000). However, the majority of LPA studies listed in this review have used self-reported measures of PA that are known to have limited validity (Sallis, Owen, & Frank, 2000). A critical step towards effectively promoting greater PA among adults of different ages is to identify the determinants of PA for each of these populations (Sherwood & Jeffery, 2000). Identification of these determinants might enhance the design, relevance, and effectiveness of programmes aimed at increasing PA among adults (Sallis & Hovell, 1990; Sherwood & Jeffery) and help define and fulfil the public health potential of PA (Dishman, et al., 1985).

It has been suggested that PA is a complex behaviour with multiple determinants, and that these determinants should be examined within a valid theoretical framework (Dzewaltowski, 1994; Sallis & Hovell, 1990; Sherwood & Jeffery, 2000). Thus, there is a need for further scientific investigation into the effectiveness of MPA interventions; which should (a) Be designed taking into account criteria such as randomisation, blinding, and compliance; (b) utilise valid and reliable measures; and (c) be grounded in theory (Dishman et al., 1998; Eves, Webb, & Mutrie, 2006).

2.3 Measures of Physical Activity

During the past four decades the measurement of PA in epidemiological studies has evolved considerably (Ainslie, Reilly, & Westerterp, 2003; Bauman, Phonsavan, Scoeppe, & Owen, 2006; Valanou, Bamia, & Trichopoulou, 2006). The importance of quantifying PA levels and estimating the resulting energy expenditure (EE) has been widely recognised by epidemiology researchers, health care providers, exercise professionals, and policy makers (DoH, 2004; Dubbert, 2002; USDHHS, 1996; Wareham & Rennie, 1998). McArdle, Katch, and Katch, (1999) defined EE as "the energy produced by the body during rest and/or physical activity" (p. 171). However, accurate assessment of PA in field-based research remains challenging due to its complexity and multidimensionality (Lamonte & Ainsworth, 2001; Sparling, Owen, Lambert, & Haskell, 2000). Consequently, the development and refinement of methodologies to measure PA warrant research priority (Valanou et al).

In absolute terms, PA is defined as any bodily movement produced by the contraction of skeletal muscles resulting in EE (Caspersen et al., 1985). However, it is important to understand that PA and EE are not synonymous terms (Lamonte & Ainsworth, 2001). PA is a behaviour that produces EE and it is typically quantified in terms of its frequency (e.g., bouts or counts), duration (e.g., min or hr per bout) and type (e.g., aerobic or anaerobic; structured or unstructured; transport-related or occupational; gardening or housework; walking or stair climbing, etc.). Instead, EE reflects the energy cost or intensity associated with a given activity (Lamonte & Ainsworth; Valanou et al., 2006).

Developments over the last two decades suggest that the study of exercise and PA has reached new levels of scientific sophistication and importance in the sphere of public health (Dubbert, 2002). However, the absence of a gold standard measurement has encouraged the development of various methods for gauging activity levels and the resulting EE (Valanou et al., 2006). Many authors and governmental agencies suggested that, to understand the dose-response relationships of diverse activities and their effects on health, researchers should employ valid and reliable measures designed to assess specific aspects of PA in certain populations and environments (ACSM, 1998; DoH, 2004; Lee, 2007; Williams, 2001).

2.3.1 Contemporary Physical Activity Assessment Techniques

The selection of an adequate PA measure rests upon a number of factors, including the dimension of PA that is under investigation, the sample size, and the study's frame of reference (e.g., current activity vs. past activity; Rennie & Warehem, 1998). For instance, in order to study the associations between an active lifestyle and health outcomes only simple measurement techniques are required (e.g., self-reported exercise frequency over one week; Gruner, Alig, & Muntwyler, 2002; Washburn, Goldfield, Smith, & McKinlay, 1990). Notably, there is a stronger link between health and physical fitness than with PA; a probable consequence of the greater accuracy with which physical fitness can be measured (Kesaniemi et al., 2001).

Methods of measuring PA, both objectively (e.g., doubly labelled water, accelerometers, heart rate monitors, etc.) and subjectively (e.g., diaries and questionnaires, etc.); consequently, these measures exist along a continuum of accuracy (LaPorte, Montoye, & Caspersen, 1985; Melby, Ho, & Hill, 2000; Shephard, 2003; USDHHS, 1996). Livingstone, Robson, Wallace, and McKinley (2003) suggest that the choice of a measure for ascertaining PA levels in field-based research should be based on certain criteria: (a) Minimal interference with habitual activity patterns; (b) social acceptability; (c) continuous and detailed recording of usual activity patterns; and (d) applicability to large population groups. Most of the measures available quantify PA behaviours within a certain time period (Valanou et al., 2006). Very few measures report behavioural patterns such as the number of blocks walked, or weekly sweating episodes (Shephard).

When measuring PA, there are well documented limitations associated with each principal assessment technique (see Montoye et al., 1996; Sallis & Saelens, 2000; Valanou et al., 2006; Vanhees et al., 2005). At population level, self-report PA questionnaires are the most commonly used (Shephard, 2003). However, only a few of the existing questionnaires capture PA in a variety of daily situations, such as transportation, occupation, household and family care, as well as leisure time (Kriska & Casperson, 1997). In a review of self-report PA questionnaires, Sallis and Saelens evaluated the validity of various instruments against objective measures of activity, primarily accelerometers, and DLW. They noted that the coefficients for global measures of PA were relatively low (r = .14–.36). Generally, PA is grossly overestimated by self-report questionnaires, especially MPA (Valanou et al.). Validity is higher for VPA than for MPA and appears to be stronger for interview measures compared to self-administered questionnaires, whereas reliability values are in the range of .70–.95 (Pereira et al., 1997; Sallis & Saelens).

Objective measures, such as doubly labelled water (DLW), offer little practicality for large-scale studies owing to their high costs and labour intensiveness. However, DLW serves as a criterion to validate other methods over prolonged period of time (Montoye et al., 1996, p. 43). Methods such as direct observation, heart-rate monitoring, and motion sensors ascertain PA with a reasonable level of accuracy; however, they cannot describe behaviour patterns and are only applicable to small- to medium-scale studies. Self-report instruments such as diaries and logs aim to record the type and duration of PA over a specified time period; thus, they are the only methods appropriate for large-scale studies.

All of the aforementioned measurement techniques are subject to a variety of limitations, such as high costs, unreliability, and lack of acceptability to the respondent, specificity to the targeted population and applicability to the research question (Buckworth, & Dishman, 2002, p. 31). Further, despite their ability in recording diverse dimensions of activity behaviour, these tools do not simultaneously assess all five components of PA (i.e., mode, time engaged, duration, frequency, and intensity; Kohl, 2001; Lee, 2007). Self-report measures, instead, represent the best compromise between social acceptability, accuracy, minimal cost, and simplicity of administration (Blair, 1995).

The timeframe for the recall of activities generally ranges from 24-hr to 14 days, but it can be as long as 12 months (Shephard, 2003). The best criteria for assessing the criterion validity of self-report measures are accelerometers and log books (Ainsworth, 2000). Accelerometers are small computer motion sensors, which should be used in conjunction with log books to enable concurrent information regarding the type of PA and its purpose. However, accelerometers cannot differentiate between walking and other moderate-intensity activities. This limitation means that data from accelerometers can only be used to assess participation in walking and moderate-intensity activities combined.

Maximal oxygen uptake is sometimes used as a surrogate measure of PA. However, for people who participate only in lower-intensity activities, the correlation between activity and fitness levels, as assessed by oxygen uptake, may not be strong (Blair et al., 2004). Additionally, this measure of fitness require complex and expensive equipment and are neither practical nor appropriate for monitoring population levels of activity (cf. Ainslie et al., 2003; Valanou et al., 2006).

2.3.1.1 Diary and Log-based Self-report Measures

Diary records require participants to continuously detail their daily activities for a short period of time (e.g., 24-hr; Haskell & Kiernan, 2000). Diary records provide estimates of daily EE by using estimated energy costs of diverse activities from previously published research (Ainsworth, Bassett, et al., 2000; LaPorte et al., 1985). Activity logs report the duration of most activities performed during the day, which have been grouped into broad categories (e.g., sitting, standing, walking, etc.; Haskell & Kiernan). The recording period for diaries and logs is relatively short, usually 1–7 days with sampling intervals as often as every minute and as infrequent as every 4 hr. Data collected in a diary or log can either be expressed as minutes engaged in certain intensity categories of PA or as daily EE.

Generally, diaries and logs provide a description of individuals' daily PA patterns. Additionally, it is possible a quantification of bouts of activities performed during the day. Also, difficulties in recalling past activities are eliminated, providing that the participants report their activities as instructed (Matthews, 2002, p. 110). These instruments, however, have many disadvantages: (a) The intensive effort, co-operation and motivation that are required by participants; (b) the short time frame of data collection makes the recorded PA patterns less representative of an individual's habitual activity behaviour (Matthews, p. 113); (c) the continuous logging of activities might be considered to be tedious, hence, the longer the period of data collection the less accurate the recall might be (Montoye et al., 1996, p. 43); (d) diaries require more effort than logs on the part of individuals and a higher level of resources from the research team regarding data entry and reduction; (e) the utility of diaries is particularly problematic in children and the elderly because of cognitive limitations (Pate, 1993). Finally, concerning the scoring of data collected by the aforementioned methods, it has been argued that using published values of activity intensity (Ainsworth, Haskell, et al., 2000) may not provide accurate estimates of EE, but they seem to be adequate for rank-ordering individuals according to overall PA levels (LaPorte et al., 1985).

2.3.2 Physical Activity Questionnaires

Currently there are more than 30 questionnaires that have been developed to assess PA, and the decision to select a specific measure is based on its appropriateness to the research questions (Buckworth & Dishman, 2002, p. 31). Generally, PA questionnaires are retrospective and require the recall of specific activities over a stated time period (see Appendix B). Data regarding PA behaviour are normally transformed into an estimate of EE. Typically, only gross classification of individuals' activity levels (i.e., sufficiently active or inactive, etc.) is possible (Domínguez-Berjón, Borrell, Nebot, & Plasència, 1999; USDHHS, 1996). Indeed, this is a distinctive weakness of such measures. However, Shephard (2003) suggested that, "for many purposes an accurate but simple classification of activity levels may be more appropriate than an attempt at estimating overall energy expenditure" (p. 203).

Some of the most frequently-used PA questionnaires for epidemiological research have been designed to ascertain leisure-time PA (e.g., Lamb, & Brodie, 1990; Taylor et al., 1978), occupational PA (e.g., Ainsworth, Jacobs, Leon, Richardson, & Montoye, 1993), or both (e.g., Baecke et al., 1982; Sallis et al., 1985). Activities may be grouped into light (intensity less than 50.0% of $\dot{V}O_2max$), moderate (intensity levels between 51.0–69.0% of $\dot{V}O_2max$), and vigorous (intensity level greater than 70.0% of $\dot{V}O_2max$), which usually correspond to specific levels of EE or MET values (see Ainsworth 2003).

2.3.3 Physical Activity Questionnaire Development

Physical activity is a complex set of behaviour which is not easily measured (Haskell & Kiernan, 2000). Almost every aspect of the assessment of PA presents challenges to the questionnaire development: (a) Assigning meanings to the words "exercise" and "physical activity"; (b) demarcating the different domains of PA (e.g., leisure-time, gardening/yard work, household chores, etc.); (c) specifying timeframes (e.g., last week versus a typical week); (d) differentiating the seasonality of participation (e.g., summer vs. winter participation, etc); (e) the use of symptoms of activity (sweating, breathlessness) vs. examples of those activities to exemplify questionnaire items; and (f) the impact of different modes of questionnaire administration (e.g., telephone, interview, or self-completed questionnaire).

At this juncture, it is important to outline that a large number of PA measures can readily confuse investigators and practitioners. To illustrate this, anecdotal evidence indicates that the terms *exercise* and *physical activity* may be understood differently (DoH, 2004; USDHHS, 1996). For some individuals exercise may signify sports participation, VPA or structured activity. For others exercise may only be thought of as something one does as a leisure-time activity. Thus, effective questionnaires must ensure that the respondents have a clear understanding of the types of activity being assessed by each item.

2.3.3.1 Validation of Questionnaires

Many researchers (e.g., Caspersen 1989; Montoye, et al., 1996, p. 42; Sallis & Salenes, 2000) suggested that only in a few instances have the validity and/or reliability of questionnaire measures been thoroughly tested. Shutz (1994) proposed that the validation stage of a questionnaire should be theory-driven, and stated that, "premature publication of measurement tools has led to the proliferation of psychological tests and a considerable amount of research of questionable validity" (p. 38). Further, both Schutz and Anastasi and Urbina (1997, p. 8) have proposed that developers of a self-report psychometric inventory should adhere to rigorous standards in constructing the instrument's items and their validation.

2.3.3.2 Reliability of Physical Activity Measures

The establishment of reliability is an essential aspect of the validation process for psychometric instruments (Anastasi & Urbina, 1997, p. 85; Morrow, 2002, p. 39). A high degree of stability implies that the results are repeatable (i.e., consistent) and that the measure can be used to accurately assess intervention programmes (Golafshani, 2003; Vanhees et al., 2005).

Several comprehensive reviews have been published in the last three decades reporting on the reliability of various PA assessment methodologies, including self-report measures (e.g., Lagerros & Lagiou, 2007; Sallis & Saelens, 2000; Schutz, Weinsier, & Hunter, 2001; Valanou et al., 2006). Kirk and Miller (1986) identified three types of reliability referred to in quantitative research: a) The degree to which a measurement remains constant over repeated administrations; b) the stability of a measurement over time; and c) the similarity of measurements within a given time period.

In a comprehensive review of the most-frequently-used PA questionnaires, Pereira et al. (1997) reported that nearly all the measures demonstrated high test-retest coefficients in respect of total activity and vigorous activity (r = .5–.8). Nevertheless, they noted that the corresponding coefficients were relatively low in the case of light-to-moderate intensity PA (typically $r < .5$). A possible explanation for this state of affairs might reside with the type of PA being measured. Most of the instruments in question focus on recreational PA of a moderate-to-vigorous intensity because such behaviour is easier to recall than occupational, transportation, parenting, garden tasks, and household activities (e.g., Gunn, et al., 2002; Wendel-Vos, Schuit, Saris, & Kromhout, 2003). Consequently, recall bias is reduced (Hu, 2008, p. 135). However, in the general population, recreational PA accounts for only a small part of the total

PA and EE (DoH, 2004; Morrow, Jackson, Bazzarre, Milne, & Blair, 1999; USDHHS, 1996).

2.3.3.3 Limitations of Reliability Measurement

The consistency of questionnaire item response is generally determined through the test-retest method (Charles, 1995). However, Joppe (2000) asserted that this process might sequentially sensitise the respondent to the subject matter, and hence influence their responses. Such an effect might ultimately inflate the estimated reliability of the measure. Further, Crocker and Algina (1986) noted that when participants respond to a set of test items, the scores obtained represent only a limited sample of behaviour. As a result, the scores could change due to some characteristic of the respondent, which might lead to measurement error.

Sallis and Saelens (2000), in their review of PA measures, found that total PA (TPA) and VPA scores tended to exhibit higher validity and reliability than those pertaining to moderate intensity PA (MPA). Accordingly, Durante and Ainsworth (1996) suggested that the relatively low reliability associated with measures of MPA, might be explained by a reduced recall of moderate-intensity activities. According to this explanation, recall of VPA is likely to be inflated due to the potent physiological cues involved (e.g., increased heart rate, sweating, and breathing). Additionally, the various dimensions of PA (e.g., energy expenditure vs. physical fitness) are liable to become confused during assessment, which leads to problems in formulating intervention strategies (Rennie & Wareham, 1998).

The reliability of PA measures is also compromised by imprecise cognitive processing on the part of respondents (i.e., understanding the difference between PA, exercise, and sport; Baranowski, 1988), and recall errors (Shephard, 2003), especially when measures of PA are administered to children (e.g., Argiropoulou, Michalopoulou, Aggeloussis, & Avgerinos, 2004), or the elderly (e.g., Lissner, Potischman, Troiano, & Bengtsson, 2004). Additionally, reliability may be influenced by variability in the level of PA over time occasioned by such circumstances as changing jobs or an illness (Washburn & Montoye, 1986). Individual differences that predict recall biases (e.g., education level, are, etc.) may also heighten the variability of PA reports (Buchowski, Townsend, Chen, Acra, & Sun, 1999; Jakicic, Polley, et al., 1998) as might seasonal variability (e.g., Levin, Jacobs, Ainsworth, Richardson, & Leon, 1999; Pivarnik, Reeves, & Rafferty, 2003).

2.3.4 Statistical Techniques Used to Measure Reliability

Many authors have emphasised the necessity for researchers to use appropriate statistical analyses to test the reliability and stability of their instruments (e.g., Biddle, Markland, Gilbourne, Chatzisarantis, & Sparkes, 2001; Crocker & Algina, 1986; Schutz, 1994). Anastasi and Urbina (1997, p. 91) proposed that the most straightforward method for ascertaining the reliability of test scores is by repeating the identical test on two or more occasions. Tests of correlation, such as Pearson's Product-Moment, have been used extensively to assess test-retest reliability (Hopkins, 2000; Lane, Nevill, Bowes, & Fox, 2005). The criterion value for demonstrating acceptable test-retest reliability is an $r \geq .80$ (Anastasi & Urbina, 1997, p. 91).

Interclass reliability is considered the simplest method for establishing test stability. A test is administered to the same participants twice (e.g., on the same day), and then the scores are correlated together using the PP-MC (r_{xx}) to assess the extent of stability (Morrow et al., 2005, p. 86). When the test is re-administered after a longer period (e.g., days or weeks hence) the resulting correlation coefficient represents the measure's *reliability*. Thus, a measure can be considered to be stable and consistent across time (Morrow et al., p. 86).

Several authors (e.g., Booth, Owen, Bauman, & Gore, 1996; Lane et al., 2005; Matthews, 2002; Safrit, 1976) have identified a number of limitations to the use of PP-MC in the establishment test-retest reliability. For example, Safrit proposed that the principle of the PP-MC is to determine the relationship between two variables. In theory, it is not appropriate to use PP-MC coefficients derived from multiple measurements of the same variable. Further, if PA behaviour is measured four times repeatedly, for example, then six correlation coefficients (one for each test-restest pair) will be calculated. However, the correlation coefficient of all four scores cannot be generated at the same time. Safrit also suggested the PP-MC coefficients cannot indicate the existence of a systematic error, especially in the presence of a large correlation. Nevill, Lane, Kilgor, Bowes, and Whyte (2001) supported Wilson and Batterham's (1999) assertion that, whereas the PP-MC may be useful in identifying strong relationships between test and retest, it would be ineffective in identifying the direction of this relationship and/or systematic bias (Nevill et al.).

Booth et al. (1996) highlighted the risk of inflated reliability estimates when a large proportion of the sample reports no participation in any form of PA at both test and retest measurements. As these participants would have null values on both occasions, this would mask the variability of the remaining scores. An implicit assumption underlying reliability studies is that the object of measurement is relatively stable over a short period of time. However, in the case of PA, a low reliability coefficient could be attributable to a true variation in the activities reported, the poor measurement characteristics of the instrument, or to both.

Further criticisms of the PP-MC in a reliability context were made by Lane et al. (2005), who suggested that, when assessing factor-level stability, it might be possible to identify items that elicit inconsistent responses when compared to the others within the scale (Nevill et al., 2001; Oppenheim, 1966), even when correlation is perfect (r = 1.00). In addition, Morrow (2002, p. 45) asserted that the PP-MC merely measures the variance of two measures from a shared linear relationship, but not the *agreement* between them.

A growing body of research and criticism supports the viewpoint that there are alternatives to PP-MC in reliability assessment (e.g., Bland & Altman, 1986, 1999, 2003; Lane et al., 2005; Wilson & Batterham, 1999). For instance, Nevill et al. (2001) and Wilson and Batterham suggested that stability should be calculated separately for each item of a questionnaire, especially when the response set of the self-report measure in question consists of a categorical Likert-type scale as does the BQHPA [e.g., “never (1)” or “7 or more times (5)”].

2.3.4.1 Proportion of Agreement

Shutz (1998, p. 393) stated that “traditionally … the PP-MC has been used to quantify both the reliability and stability of constructs, which are usually considered as synonyms, and the single statistic calculated represents the longitudinal consistency of a set of observed scores.” However, it may also be necessary to assess the stability of responses to individual items (e.g., Nevill et al., 2001; Wilson & Batterham, 1999). Establishing the stability of a measure is of paramount importance, thus Shutz proposed the Proportion of agreement (PoA) analysis; an item-related stability test that can be calculated simply by computing the difference between the responses recorded on two separate occasions taken from the same participant (Guijt, Sluiter, Frings-Dresen, 2007; Nevill et al.).

The principal reason for establishing item-level stability is that “poor reliability and stability of individual items may be overlooked in the ‘averaging or cancelling out’ process when assessing the reliability or stability of [scale scores]”

(Nevill et al., 2001, p. 273). Further, Conroy and Metzler (2003) suggested that heightened awareness of item-related stability tests resulted in methods, (e.g., proportion of exact response agreement, 95% limits of agreement) that overcame the limitations which apply to the more popular indices of relative agreement (i.e., PP-MC, intraclass correlation). Additionally, the PoA analysis can be computed using abnormally-distributed data (Wilson & Batterham, 1999), a situation which many MLPA researchers have encountered (e.g., Orsini et al., 2008; Villanueva, Giles-Cortia, & McCormack, 2008).

To date, no PA questionnaire has incorporated PoA analysis as part of the validation process. However, several psychometric-instrument development studies (e.g., Lane et al., 2005; Nevill et al., 2001) utilised PoA analysis in the establishment of item-related stability (e.g., Task and Ego Orientation in Sport Questionnaire - TEOSQ: Duda & Nicholls, 1992; the Social Physique Anxiety Scale - SPAS: Hart, Leary, & Rejeski, 1989).

Nevill and colleagues suggested that, when using a 5-point Likert-type scale to assess relatively-stable ‘trait’ constructs, the PoA statistics should show that most participants’ scores (90%) fall within 1 *referent value* ± 1 of the median score (*Mdn* = 0). For example, the PoA results in respect of the SPAS’s 12 items ranged from 76.3–93.8%. However, only seven of those items demonstrated sufficient agreement to confer stability (i.e., 90% ± 1 *Mdn*). Therefore, Nevill and colleagues concluded that assessing item-related stability by using the composite sum of all the items within a factor has the potential to mask the instability of rogue items.

Lane et al. (2005) found that correlational methods (i.e., PP-MC, intraclass, and kappa) are influenced by the range of scores and the interval over which data are measured. Indeed, items which demonstrate the lowest PoA may produce the highest inter-correlations. They proposed that the computation of PoA for test-retest differences with a referent value of ± 1 could provide additional insight into the stability of questionnaire instruments. Lane et al. also suggested that this method should be employed to supplement other statistical approaches (e.g., PP-MC) because it may prove helpful in identifying rogue items during the initial stages of validation.

Although the aforementioned researchers have provided strong support for the use of the PoA analysis, statistical limitations do apply. For instance, Lane et al. (2005) highlighted that the acceptability criterion (i.e., 90% ± 1 *Mdn*) is arbitrary, even though the percentage of scores within the reference range of ± 1 could be considered the most practical value (Nevill et al., 2001). Lane et al. also suggested that the basis for selecting a range of ± 1 is that variation is inevitable when measuring target constructs using self-report measures. Due to the absence of objective and observable scores, self-report psychometric measures can only provide *estimates* of psychological constructs, which are themselves transient in nature (see Blascovich, 2000, p. 118; Nisbett & Wilson, 1977). Additionally, Nevill et al. detailed that, when analysing self-report test-retest data, PoA analysis is unable to detect systematic bias or differentiate between "near misses" and "wide disagreements".

2.3.5 The Validation of Physical Activity Questionnaires

The process of validation can be viewed as the continuous accumulation of evidence for the meaningfulness and usefulness of a measure (Mahar & Rowe, 2002, p. 52). In clinical as well as epidemiological research, the comparison of a new measurement technique with an established one or *criterion* is often needed to ascertain whether they agree sufficiently for the new to replace the old (Bland & Altman, 1986, 1999, 2003). There are three forms of validity associated with self-report questionnaires (i.e., *content, construct,* and *criterion validity)*; in actuality, there are two types of criterion-RV: *concurrent validity* and *predictive validity*. The main difference between them is the point in time at which the criterion is measured (Morrow, 2002, p. 43).

2.3.5.1 Factors Affecting Criterion-Related Validity

In criterion-RV it is essential that the criterion is as accurate as possible. The degree of variability in the criterion and the surrogate measure may also impact on the criterion-RV coefficients. Morrow (2002, p. 43) proposed that, the greater the variability in the surrogate and criterion measures, the higher the potential validity.

Owing to the transient characteristics of PA behaviour, every valid PA measure will report some degree of error (Morrow, p. 44). The amount of error associated with validity is referred to as the *standard error of estimate* (*SEE*). The *SEE* reflects the measurement error associated with each participant's obtained or observed score (Baumgartner & Jackson, 1999; Morrow, Jackson, Disch, & Mood, 2000; Safrit & Wood, 1995). Theoretically, errors of measurements are generally distributed around a mean of zero ($M = 0.0$). Therefore, some errors are positive and add to the obtained score, while others are negative and result in a reduction of the score. For instance, a score of ± 1.96 *SEE* can be interpreted as 95% accurate. Thus, *SEE*s help to determine one's confidence in interpreting the predicted score, as well as the strength of relationship with the criterion measurement.

The generalisability of the obtained criterion-RV coefficient is another major issue in PA research. Morrow (2002, p. 44) suggested that the instrument's validity should be evaluated in diverse settings which include: a) Participants (who vary in age, cognitive ability, gender, reading ability, etc.); b) time (of day, season, etc.); c) location (office and/or working place, school, college, university, leisure club, etc.); d) environmental barriers (neighbourhood, footpaths, cycling lanes, parks, etc.); and

e) other variables that may change from one administration to another (e.g., ambient temperature, participants' illnesses, etc.).

Finally, a major problem associated with validation is the inadequate and/or doubtful validity of the criterion measure. Scores from a reference measure should reflect a highly valid assessment of the PA behaviour which is being investigated (Ebel, 1983). This implies that, in the event of an inadequate criterion measure being employed, the validity coefficient will be of little importance and use in the validation process. Additionally, Hagströmer, Oja, and Sjöström (2006, p. 755) suggested that, "the inability of activity monitors to detect certain types of activities might introduce a source of error in criterion-RV studies."

Ebel (1983) argued that a criterion measure is rarely, if ever, unquestionably valid or accurate in its reflection of what it was intended to quantify. Thus, the lack of generally-accepted reference criteria measure has led researchers to place additional emphasis on construct validity (Shephard, 2003). In essence, validity coefficients demonstrate only poor-to-fair agreement (r = .2–.4; de Courten, 2002), although researchers have reported that r values between .3 and .5 as "reasonably valid" (Shephard, 2003, p. 202). However, Rennie and Wareham (1998) suggested that an ideal criterion instrument should reveal a correlation of at least r = .6 with the reference measure.

Any inference related to the validity of a PA questionnaire is also restricted to the specific population in which the study was conducted. Hence, its use should be restricted to the purpose and population for which it was designed (Wareham & Rennie, 1998; Wareham et al., 2002). For example, Wendel-Vos et al. (2003) developed a questionnaire (the Short QUestionnaire to ASsess Health-enhancing physical activity: SQUASH) which assesses the behavioural and movement dimensions of PA as proposed by Dunn et al. (1998) and Pescatello (2001). Craig et al. (2003) developed a PA questionnaire (the International Physical Activity Questionnaire: IPAQ) in an attempt to ascertain PA behaviour in terms of the ACSM guideline (2005) which were underlined by Haskell et al. (2007). However, neither of these measures has been fully validated, which prevents them from being used as criterion measures.

2.3.5.2 Criticisms of Correlation Coefficients in Establishing Validity

The correlation between PA questionnaire scores and criterion measures is regarded as the best type of evidence for the validity and reliability of a test (Ebel, 1983). If two measures correlate well (e.g., $r = \geq .80$), then the instrument is said to possess good criterion-RV. However, correlational methods such as the PP-MC have a number of inherent weaknesses.

High reliability coefficients do not necessarily guarantee that PA questionnaires can provide a precise and complete measure of participants' activity patterns (Shephard, 2003). For instance, Baranowski (1988) suggested that individuals might provide consistent but inaccurate responses at two points in time. Additionally, Sallis and Saelens (2000) and Mathews (2002, p. 113) suggested that self-report measures of PA could potentially assess a stable self-perception of a respondent's own habitual PA behaviour.

Bland and Altman (1986, 1999) have criticised the use of correlational analyses on the basis that these techniques measure only the relationships between constructs rather than their agreement. Further, they (1999) noted that correlational analyses are highly influenced by the range of participants' measurements (e.g., when comparing the results of a new instrument that measures $\dot{V}O_{2\,max}$ with an existing test). Additionally, Nevill and Atkinson (1997) suggested that when two tests are administered to a homogeneous sample – which is composed of participants who are similar in terms of age, body mass, and physical fitness – the correlation between the results of the two tests will be relatively small, but not necessarily less valid.

2.3.5.3 Limits of Agreement

Atkinson and Nevill (2001) encouraged the use of *limits of agreement* (LoA: Bland & Altman, 1986, 1999, 2003) to provide information which supplements the other correlational analyses (Atkinson & Nevill, 1997). A measure of agreement refers to the absolute measurement error that is associated with one measurement taken from a participant (Guijt, et al., 2007); whether an instrument is capable of eliciting comparable scores in the same participant over time (de Vet, 1998).

Originally, the LoA method (Bland & Altman, 1986, 1999) was developed for testing two sets of independent data obtained on one occasion, and not repeated measures (Myles & Cui, 2007). However, due to its simplicity of interpretation, it has been widely used to explore data in many diverse situations including test-retest reliability (e.g., Booth, et al., 1996; Macfarlane, Lee, Ho, Chan, & Chan, 2007; Pols, Peeters, Ocké et al., 1997).

The LoA method has received great attention from the medical research community since the first Bland and Altman (1986) publication, and, at the time of writing, it has been cited on more than 11,500 occasions (Myles & Cui, 2007). In the field of sports sciences, Atkinson and Nevill (1997) have presented strong supporting arguments for using Bland and Altman's method to assess the validity of psychometric instruments which use interval and/or ratio scales.

Bland and Altman (1999) proposed that 95% of participants' scores should be included in the analysis which excludes extreme or unusual measurements; the level of agreement found amongst the remaining scores represents predictive accuracy. The

LoA analysis results in three statistics: the *bias,* which describes the mean difference between two measurements, and the *upper* and *lower limits of agreement* which represent a range of 1.96 SD units above and below this mean (Lamb, 1998). The bias and both limits can be expressed graphically as horizontal lines on a plot of participants' differences (*y*-axis) against the mean of their repeated measures (*x*-axis). In the improbable eventuality of perfect agreement for test-retest data, the LoA analysis would yield a bias of 0.0 and 95% limits of ± 0.0 with all lines overlapping (Lamb).

Thus far, there is only a small number of studies that has ascertained the criterion-RV of a PA questionnaire through the use of LoA statistics in adult populations (e.g., Conway, Irwin, & Aisnworth, 2002; Ekelund et al., 2006; Kayes et al., 2007; Macfarlane, Lee, Ho, Chan, & Chan, 2007). Notably, very few of the most widely used PA measures can demonstrate a good criterion-RV (e.g., BQHPA - Baecke et al., 1982; GLTEQ - Godin & Shephard, 1985). Yet, none of the existing PA measures have been cross-validated using the LoA method. Therefore, it is possible to infer that many PA questionnaires possess limited validity as measures of PA behaviour and consequently they might be considered unsatisfactory as criterion measures.

2.3.5.4 Shortcomings of Limits of Agreement

Lamb (1998) suggested that LoA analysis offers a more complete evaluation of correlation than other statistical techniques providing that data fulfil three important conditions: a) The test-retest differences among the participants are normally distributed; b) the means of the two datasets are not significantly different; and c) there is no significant relationship between the test-retest differences and the respective means.

In the eventuality of the test-retests differences being abnormally distributed, the computation of the upper and lower limits (± 1.96 *SD*) does not provide a value that accounts for 95% of the sample. Therefore, Bland and Altman (1986) suggested that a log-transformation might be required to normalise the data. With regard to condition (b), Bland and Altman proposed that a significant ($p < .05$) difference between the means is indicative of either systematic measurement error or a learning process. This implies a situation in which the first and the second administrations have not been performed under identical conditions. They suggested that a correlation analysis would therefore be inappropriate with this data, and a paired-samples *t* test would clarify whether condition (b) was satisfied. Regarding condition (c), a PP-MC should be computed to assess whether the test-retest differences and their means have the tendency to either increase or decrease in magnitude as the variable of interest increases in value (Lamb, 1998).

In considering the advantages of the LoA method and its related assumptions, a note of caution is warranted; it has been found to suffer from the same limitations as the PoA analysis previously described in Subsection 2.3.3.1). The criterion for acceptability (i.e., 95%; *bias* ± 1.96 *SD*) is somewhat arbitrary (Lane et al., 2005; Nevill et al., 2001), even though the percentage of scores within the reference range of ± 1.96 *SD* should be the value that has the most practical utility (Altman & Bland, 1986).

Notably, all self-report measures are susceptible to systematic and/or random bias, and therefore, the LoA analysis would be incapable of distinguishing between “near misses” and “wide disagreements” (Nevill et al., 2001, p. 274); this susceptibility maybe due, in part, to the transient nature of PA behaviour (see Blascovich, 2000, p. 118; Nisbett & Wilson, 1977). Additionally, O’Connor, Mahar, Laughlin, Wier, and Jackson (2007) found that LoA might not be suitable for evaluating the accuracy of measures developed with diverse regression models, especially for physiological data (e.g., $\dot{V}O_{2\,max}$) because they might exhibit the tendency to be correlated with measurement error.

2.3.6 Self-report Instrument Types

Self-report instruments may be clustered into five general categories: PA records (diaries and logs; see Section 2.3.1.1), PA recall questionnaires, quantitative history questionnaires, general measures of PA behaviour and global self-report questionnaires (Haskell & Kiernan, 2000; Keim, Blanton, & Kretch, 2004; Lamonte & Ainsworth, 2001; LaPorte et al., 1985; Valanou et al., 2006).

2.3.6.1 Recall Questionnaires of Physical Activity Behaviour

Typically, recall questionnaires consist of 5–15 items, which tap specific details about respondents' PA levels, or provide a more general quantification of their usual PA patterns. The scoring systems could range from simple ordinal scales (e.g., 1–5, low to high PA) to summary indices (e.g., exercise units) or a summed score of continuous data (e.g., MET-min day-1; Lamonte & Ainsworth, 2001). These measures generally succeed in classifying the study population into general categories of PA as well as quantifying PA patterns (Ainsworth, Bassett, et al., 2000).

2.3.6.1.1 The Stanford 7-day Physical Activity Recall. The Stanford 7-day PA recall (7-day PAR: Blair et al., 1985; Sallis et al., 1985) demonstrated reliability correlations of r = .65, .08, .31 and .61 for light, moderate, hard and very hard activity groups respectively (Sallis et al.). Arroll, Jackson, and Beaglehole (1991) assessed the validity of the 7-day PAR over a period of 3 months. They obtained Spearman *rho* = .60, *rho* = .48, and *rho* = .91 from the PA recall for moderate, vigorous, and total activity. The authors concluded that the 7-day PAR reasonably reflects activity in a community-based sample, and that this measure may be sensitive to MPA that are performed intermittently throughout the day.

2.3.6.1.2 International Physical Activity Questionnaire. The International Physical Activity Questionnaire (IPAQ: Craig & Russell, 1999; Craig et al., 2003), in its four short and four long versions (administered by telephone or self-administration), was developed originally to satisfy the need for a self-reported measure that can be used cross-nationally to measure physical activity and inactivity. The IPAQ is based on current recommendations for MPA (ACSM, 2005; Pate et al., 1995) and VPA (ACSM, 1990). In their work, Craig et al. concluded that the diverse forms of the IPAQ have acceptable measurement properties for monitoring population levels of PA among young and older adults. However, Tehard et al. (2005), and Rzewnicki, Vanden Auweele, & De Bourdeaudhuij, (2003) found that the IPAQ overestimated the PA reported by participants. Additionally, Rzewnicki et al. suggest that many people from the general population do not understand the IPAQ consistently, and recommend that the IPAQ could be improved by implementing procedure changes without changing the IPAQ items themselves.

2.3.6.1.3 Physical Activity Scale for the Elderly. The Physical activity Scale for the Elderly (PASE: Washburn, Smith, Jette, & Janney, 1993) was designed specifically for the elderly and has shown moderate reliability (r = .75). The PASE includes information on leisure time, household, and occupational activities during the past 7 days. Participants also report the time they spend sitting, walking outside their home, any sport activity and its intensity levels (i.e., light, moderate, and strenuous), muscle strengthening and/or endurance training.

Recall questionnaires share the same advantages and constraints as self-report instruments (Macera, Johnes, Kimsey, Ham, & Pratt, 2000). Additionally, many review articles (e.g., Ken-Dror, Lerman, Segev, & Dankner, 2005; Schutz, Weinsier, & Hunter, 2001) have also highlighted two main issues regarding the validity and reliability of the aforementioned measures: (a) The lack of detail on the reliability of the components that constitute the measures (e.g., frequency and time performing PA; Everson & McGinn, 2005); and (b) the interpretation of the term "physical activity" by the participants, despite the attempts of researchers and interviewers to provide a clear definition (cf. Kriska & Caspersen, 1997; Shephard, 2003).

2.3.6.2 Quantitative History Questionnaires

These instruments are the most comprehensive PA self-report measures, and consist of 15–60 items requiring up to an hour to complete. Due to their length, they are usually interviewer-administered. They are highly detailed and typically reflect the volume (frequency, intensity, and duration) of PA performed under various conditions, including work, household, transportation, and recreational activities. In this fashion, detailed information about the EE, as well as patterns of PA observed during the course of the previous day, week, month, year, or even a lifetime can be acquired (Ainsworth, Richardson, Jacobs, Leon, & Sternfeld, 1999). These measures have been found to discriminate accurately between very active and sedentary groups (Conway et al., 2002).

2.3.6.2.1 The Tecumseh Community Questionnaire. The Tecumseh Community Questionnaire (TCQ: Reiff et al., 1967) has been used for epidemiological investigations as a measure of habitual PA performed during the previous year (Montoye, 1975). Jacobs, Ainsworth, Hartman, and Leon (1993) reported test-retest coefficients of $r = .92$ and $r = .69$ with 1 week and 12 weeks between administrations respectively. However, this questionnaire, in its original format, measures only PA at work and transportation to and from work. Due to this limitation, a revised and improved procedure of the TCQ was performed by Taylor and colleagues (Taylor et al., 1978). This revised form, called the Minnesota Leisure Time Physical Activity questionnaire (MLTPA: Taylor et al.), reports only non-occupational PA over one year and includes a list of 63 activities.

2.3.6.2.2 The Minnesota Leisure Time Physical Activity Questionnaire. The MLTPA (Taylor et al., 1978) has been used in several large studies including the Multiple Risk Factor Intervention Trial (Leon & Connett, 1991; Leon, Myers, & Connett, 1997). The MLTPA questionnaire has demonstrated good reliability (r = 0.69) in epidemiological research (Jacobs et al., 1993). Nevertheless, Richardson, Leon, Jacobs, Ainsworth, and Serfass (1994) also reported that the MLTPA questionnaire underestimated low- to moderate-intensity PA; more specifically it inaccurately assessed walking activities and omitted certain activities such as commuting to and from work or voluntary use of stairs. These findings were subsequently reconfirmed by Starling, Matthews, Ades, and Poehlman (1999), who subjected the MLTPA to criterion-related validity against DLW, and found that this measure underestimated the EE by approximately 55.0–60.0% in a group of elderly adults (35 women and 32 men). A likely explanation for these underestimations may be attributable to the fact that the MLTPA only measures leisure-time activities, such as team sports and other higher intensity activities.

2.3.6.2.3 CARDIA Physical Activity History Questionnaire. The CARDIA Physical Activity History Questionnaire (CARDIA PAHQ: Jacobs, Hahn, Haskell, Pirie, & Sidney, 1989) includes items about activities participation over the past 3 months and past year. This questionnaire assesses 13 different types of activities, of which eight include vigorous intensity activities such as jogging, racket sports, bicycling, swimming, exercise, dancing, weight lifting, and vigorous job activity.

Validity of this method is supported by comparison of body composition, energy intake, physical fitness, and blood lipids across physical activity groups. Test-retest reliability was found to range from r = .77–.84 (Jacobs, et al.).

An advantage of the aforementioned measures is their ability to adequately ascertain seasonal variation in PA when the timeframe is long enough (Haskell & Kiernan, 2000). Further, quantitative history questionnaires are also considered appropriate for surveys aiming to detect the dose-response relationship between PA and health in population-based surveillance. However, these measures have two major drawbacks: (a) the high costs required for implementation, guaranteeing quality control, and processing the data; and (b) these questionnaires might create a large cognitive burden on responders in order to remember, in detail, activities performed in the past (Shephard 2003).

2.3.6.3 General Measures of Physical Activity Behaviour

These survey-based instruments provide less detail than the aforementioned tools, but for this reason they are usually easier to administer and score. They assess occupational and leisure-time PA, and the timeframe may vary from a day to a week. Participants' habitual activity patterns are measured and scored and individuals are ranked or classified accordingly. Numerous questionnaires of this type have been used in large and often-cited population studies (e.g., Baecke, et al., 1982; Haskell, Taylor, Wood, Schrott, & Heiss, 1980; Kannel & Sorlie, 1979; Salonen, Puska, & Tuomilehto, 1982; Yasin, Alderson, Marr, Pattison, & Morris, 1967).

2.3.6.3.1 Framingham Physical Activity Index. The Framingham Physical Activity Index (FPAI; Kannel & Sorlie, 1979) includes questions about participants' usual PA over a period of 24 hr, and is administered via an interview that last approximately 15 min. The PA index correlated significantly (r = .33–.75) with other questionnaires (Albanes, Conway, Taylor, Moe, & Judd, 1990). Garcia-Palmieri, Costas, Cruz-Vidal, Sorlie, and Havlik, (1982) established the FPAI test-retest reliability, and found significant correlation coefficients between the two administrations (time-gap: 30–36 months) ranging from r = .30–.59. However, this measure is limited in its ability to ascertain low- to moderate-intensity activities of intermittent nature (e.g., housework, parenting, gardening, etc.); more specifically it does not assess walking activities, and excludes certain activities such as commuting to and from work or intentional use of stairs.

2.3.6.3.2 Baecke Questionnaire of Habitual Physical Activity. The Baecke Questionnaire of Habitual Physical Activity (BQHPA; Baecke et al., 1982) is a short, self-administered questionnaire developed for the assessment of the habitual levels of PA in the Dutch population. The BQHPA ascertains the usual activity performed during a typical week, and it consists of three open questions, 15 items rated on a 5-point Likert-type scale anchored by 1 (“never” or “much less”) and 5 (“always”, “very often” or “much more”), and a dichotomous item (cf. Pereira et al., 1997). The BQHPA can be categorised into three PA dimensions: work/occupational activity (work index: WI), leisure-time sport and exercise (sport index: SI), and leisure-time activities excluding exercise (leisure index: LI). Additionally, a fourth index is obtained by computing the scores of the aforementioned indices: total PA index (TPAI).

The BQHPA was originally validated using a group of 306 young Dutch men and women (age range: 20–32 years) (Baecke et al., 1982). Test-retest correlation coefficients for the three activity indices over three months ranged from r = .74 for the LI, to r = .81 for the SI, and r = .88 for WI. Further, Jacobs and colleagues reported the following test-retest correlations (one week): $r = .86$ for the LI, $r = 0.90$ for the SI, $r = 0.78$ for the WI, and $r = 0.93$ for TPAI.

The BQHPA has demonstrated a high level of criterion validity in several studies (e.g., Jacobs et al., 1993; Richardson, Ainsworth, Wu, Jacobs, & Leon, 1995; Tehard et al., 2005; see Appendix C). For instance, using the workload from a maximum treadmill test as a criterion, Jacobs et al. (1993) found a significant correlation with the BQHPA's Sport Index ($r = .52$), total PA index (TPAI: $r = .54$), and Leisure Index ($r = .26$) in a group of 78 adults. Jacobs et al., and Mahoney and Freedson (1990) both found that the TPAI (sum of individual indices) was significantly correlated with Caltrac accelerometer results ($r = .19$ and .53 respectively; $p < .05$). However, in a similar study, Miller, Freedson, and Kilne (1994) reported a nonsignificant correlation of *rho* = .32 ($p > .05$) between the two measures; a result which may be explain with reference to the lack of statistical power associated with the small number of participants ($n < 50$; see Altman, 1991, p. 456).

Richardson et al. (1995) investigated the extent to which the BQHPA predicted lifestyle PA (LPA) levels in 78 men and women (age range: 21–59 years). Scores on the BQHPA were compared with six 48-hour PA records, three peak oxygen consumption ($\dot{V}O_{2peak}$) assessments, and a measure of body fat percentage (BF%). Moderate positive correlations were found between Sport Index scores and the record of heavy / high-intensity PA in both men and women ($r = .73$ and .63 respectively; $p < .01$). There was also a moderate correlation between Leisure Index scores and records of light-intensity PA ($r = .73$, $p < .05$) for men, but not for women ($r = .23$, $p > .05$).

The BQHPA was associated with the indirect criterion measures ($\dot{V}O_{2peak}$ and BF%). For instance, the SI subscale score was directly associated with $\dot{V}O_{2peak}$

(women: $r = .67$; men: .45; $p < .01$), and inversely correlated with BF% (women: $r = -.44$, $p < .01$; men: $r = -.37$, $p = .08$). Potential gender differences were also detected in the relationships between the Leisure Index and both objective measures: The correlation between $\dot{V}O_{2peak}$ and the Leisure Index was nonsignificant in men ($r = .13$, $p > .05$), but not in women ($r = .38$, $p < .01$). An inverse trend was reported for the associations between the Leisure Index and BF% (women: $r = -.51$, $p < .01$; men: $r = -.09$, $p > .05$).

The associations between the BQHPA and the two criterion measures (self-reported PA and $\dot{V}O_{2peak}$) were equally significant for high-intensity PA. However, the correlations were not equivalent across gender in the case of low-intensity PA. An explanation for this disparity may lie in the review of Shephard (2003) who proposed that high-intensity PA is more easily recalled than low-intensity PA, which is not as well defined (Richardson, et al., 1994).

The higher correlations between the leisure index and both $\dot{V}O_{2peak}$ and BF% among women may be explained in terms of daily miscellaneous activity involving walking (e.g., household-related behaviours, stair climbing, etc.); the performance of household chores and occupational activities is an important component of the daily PA spectrum for women (Ainsworth, et al., 1993; Hooftman, van der Beek, Bongers, & van Mechelen, 2005) as is their perceptions of the location in which they live (Foster, Hillsdon, & Thorogood, 2004).

Pols et al. (1995) tested the replicability of the BQHPA using a sample of 134 Dutch women and men aged 20–70 years. Construct validity was determined by comparing the BQHPA results to a quadruply-repeated 3-day activity dairy (3-DAD: Bouchard et al., 1983). TPAI and Mean EE (per 24 hours) were strongly correlated (men: $r = .56$; women: $r = .44$; both $p < .05$).

The authors suggested that the weaker correlation in respect of women indicated that, to classify a population of (elderly) women by their level of PA, a questionnaire should emphasise household tasks, parenting and child care, and other low-intensity activities. In contrast, the findings of Pols and colleagues (1995) showed that, in men, the level of association between the TPAI and the 3-DAD warranted the use of the BQHPA in epidemiological studies.

Philippaerts, Westerterp, and Lefevre (1999) provided strong support for the BQHPA as a reference measure. They administered the BQHPA alongside two other PA questionnaires (the Five City Project Questionnaire and the TCQ) to a group of 19 Flemish male participants; DLW was used as the criterion. Philippaerts et al. found that, when compared with the Five City Project Questionnaire and the TCQ, TPAI demonstrated the highest correlation with the level of PA (PAL: $r = .69$, $p < .001$). Further, they used multiple stepwise regression analyses to predict PAL and found that the largest individual contribution was that of the TPAI (45%). However, some caution is required when considering the validity of the TPAI because both of the aforementioned studies were conducted using groups of healthy Dutch adults. Therefore, it is conceivable that the BQHPA would perform differently in populations from other cultures, races, or age groups because the respective activity patterns may vary (Shephard, 2003; Washburn, Kline, Lackland, & Wheeler, 1992).

More recently, Tehard et al. (2005) compared IPAQ and BQHPA scores in a population of 757 obese adults. They found that PA assessments from the two questionnaires correlated significantly ($rho = .51$, $p < .001$) for the whole sample. Further, general obesity demonstrated a similarly negative relationship with both questionnaires. However, they found that the IPAQ was a less-sensitive measure of the relationship between PA and abdominal obesity than the BQHPA, especially in men. Miller et al. (1994) found that the BQHPA was significantly correlated with the GLTEQ ($r = .61$, $p < .01$) but not with the 7-Day PAR ($r = .07$, $p > .05$). This negative result may have been due to the small number of participants in Miller et al.'s study and the specialised population that he used (i.e., physiotherapists).

Albanes et al. (1990) concurrently tested eight PA questionnaires and found that the BHPAQ correlated significantly with the FPAI ($r = .57$), with the MLTPA ($r = .36$) and the HIP of the New York Questionnaire ($r = .78$), but it did not correlate with the 7-Day PAR ($r = .16$). Additionally, Miller, et al. (1994) replicated Albanes et al.'s research among a group of 33 physical therapists. They found that the BQHPA was uncorrelated with the 7-Day PAR, but it was significantly correlated ($r = .61$) with the Godin Leisure-Time Exercise Questionnaire (GLTEQ: Godin & Shephard, 1985). These results suggest that the BQHPA might be more closely related to PA questionnaires that measure the same domains of activity, rather than those that ascertain the overall level of PA accumulated throughout the previous seven days.

In summary, the BQHPA has proved to be a sound measure for use in epidemiological research in both male and female populations for several reasons: a) it can be easily administered; b) it is high reliable; c) it demonstrates high levels of validity, and d) it provides an accurate assessment of both high-and low-intensity activities. However, Siconolfi, Lasater, Snow, and Carleton (1985) reported that some of its items may prove difficult to answer and hence may require further comparison and evaluation. For instance, the two items (2 and 8) that refer to work-related activities may be difficult for retired people or those without an occupation to respond to. For this reason, additional occupational activities such as housework and family care should be considered (Pols, Peeters, Kemper, & Collette, 1996). The BQHPA is also limited in its utility to estimate EE based on attributions related to certain occupational activities (Ainsworth, Haskell, et al. 2000). Such attributions may no longer be accurate due to changes in automation and technological advancement in the workplace (Florindo, Latorre, Jaime, Tanaka, Zerbini, 2004).

Initial research conducted by Godin and Shephard (1985) investigated the concurrent validity of the GLTEQ with a sample of 306 healthy adult volunteers between the ages of 18 and 65 years (men n = 163; women n = 143). Body fat percentage (BF%) and maximum oxygen intake ($\dot{V}O_{2max}$) were used as validity criteria. $\dot{V}O_{2max}$ was positively correlated with both the Vigorous (r = .35) and Sweat subscales (r = .26) and the TPAS (r = .24; all $p < .05$). Conversely, BF% was negatively correlated with both the vigorous (r = -.21) and sweat subscales (r = -.21) as well as the TPAS (r = -.13; all $p < .05$).

Jacobs et al. (1993) investigated the inter-relationships of 10 self-report PA measures using a Caltrac accelerometer (CA), $\dot{V}O_{2max}$, and BF% with a sample of 78 university faculty staff and students who were aged between 20 and 59 years. The Leisure subscale of the GLTEQ correlated positively with the CA (r = .32; $p < .05$), the 4-week PA history measure (FWH; r = .36; $p < .05$), and $\dot{V}O_{2max}$ (r = .56; $p < .05$), and inversely with BF% (r = -.43; $p < .05$). Similarly, the Sweat subscale of the GLTEQ demonstrated a positive relationship with the CA (r = .29; $p < .05$), FWH (r = .31; $p < .05$), and $\dot{V}O_{2max}$ (r = .57; $p < .05$), whereas it was negatively correlated with BF% (r = -.40; $p < .05$). Jacobs and colleagues concluded that the GLTEQ is a measure of habitual PA which demonstrates fair to moderate levels of validity. They also suggested that the absence of occupational and household activities might have reduced the validity of the GLTEQ measure when compared to other self-report questionnaires.

Miller et al. (1994) sampled 33 physical therapists to compare GLTEQ responses with those of four other PA questionnaires by using a Catrac Accelerometer (CA) over a 7-day period. They reported that GLTEQ-TPAS was correlated with CA readings (*rho* = .45; $p < .01$), and with the responses to the NASA and BQHPA instruments (*rho* = .54 and .61 respectively; $p < .01$). Additional support for the GLTEQ is provided by Sallis and Saelens (2000), who reported that the instrument demonstrated criterion-RV ($r = .36$; $p < .05$) with accelerometers. Gosney, Scott, Snook, and Motl (2007) and Motl, McAuley, Snook, and Scott (2006) tested the validity of the GLTEQ as a measure of habitual PA in individuals suffering with MS. Both studies reported moderate correlations between the GLTEQ total leisure activity score and the movement counts from an ActiGraph accelerometer ($r = .52$, $r = .53$, $p < .05$ respectively).

2.3.6.4 Global Self-report Questionnaires

Global self-report questionnaires require participants to provide a generic classification of their typical PA patterns over a specific time period, and usually for specific domains (e.g., leisure, occupation, etc.). Using this approach, participants report their PA relative to colleagues or those of a similar age and sex (Haskell & Kiernan 2000). Global self-report questionnaires are brief (i.e., 1–4 items), and, as a consequence, provide fewer details than the other self-report measures. Due to their brevity, such questionnaires only attempt to assess global PA patterns (e.g., active vs. non-active or low, moderate, and high activity levels; Lamonte & Ainsworth 2001). Global measures have been used in numerous investigations: from National Health Surveys (e.g., Bloom 1982) to validation studies for the diverse measures used in epidemiological research (e.g., Caspersen & Pollard 1988; Jacobs et al. 1993;

Washburn, Adams, & Haile, 1987). The results suggested that global measures are particularly accurate in ascertaining vigorous activities.

A major limitation of global self-report questionnaires is that they do not capture information about the type, intensity, and pattern of PA. Washburn et al. (1987) observed that when age and sex groups were compared, different PA profiles were found among participants reporting the same rating. Although these measures provide valid and reliable methods for classifying elderly people (e.g., Dipietro, Caspersen, Ostfeld, & Nadel, 1993; Voorrips, Ravelli, Dongelmans, Deurenberg, & Van Staveren, 1991) and adolescents (e.g., Sallis, Condon, Goggin, Kolody, & Alearaz, 1993) into PA groups, they have not been found to accurately or reliably gauge changes in PA (especially low to moderate-intensity activity) because of poor cognitive recall (Sallis et al.).

2.3.6.4.1 Health Insurance Plan of New York Questionnaire. Early global questionnaire included the Health Insurance Plan (HIP) of the New York Questionnaire (Shapiro, Weinblatt, Frank, & Sager, 1965), which inquired about PA patterns connected with one's job and leisure time. Those who responded to the mail-administered questionnaire were subsequently classified by an interviewer into three PA categories (i.e., light, intermediate, and heavy) using a points system. Jacobs et al. (1993) found a test-retest correlation coefficient of $r = .86$ with a 1 month time gap. However, they also found that HIP was uncorrelated with the MLTPA ($r = .00$) and with the Caltrac accelerometer ($r = .07$). Albanes et al. (1990), conversely, reported correlation coefficients that ranged from $r = .40$ (7-day PAR) to $r = .78$ (BQHPA).

2.3.6.4.2 Godin Leisure-Time Exercise Questionnaire. The GLTEQ (Godin & Shephard, 1985) assesses typical leisure-time exercise habits through two questions. The first question assesses the frequency of strenuous (e.g., jogging), moderate (e.g., fast walking), and mild (e.g., easy walking) exercise during one's free time in a typical week (> 20 min/session). These weekly frequencies of strenuous are then multiplied by nine, five, and three metabolic equivalents (i.e., 3, 5, and 9), respectively, and summed to form a measure of total leisure activity (TAI). The second question measures the weekly frequency of any regular activity undertaken long enough to cause perspiration. Two-week test-retest reliability coefficients of r = .48 for light, r = .46 for moderate, and r = .94 for strenuous exercise were reported. Additionally, Godin and Shephard also found that maximal aerobic capacity ($\dot{V}O_{2max}$) and body fat percentage were both strongly correlated with strenuous exercise (r = .38 and r = .21), the TAI (r = .24 and r = .13), and the frequency of sweating (r = .26 and r = .21).

2.3.7 Comparing the GLTEQ with the BQHPA

As these two instruments were selected as the criterion measures in the present programme, a comparison between them is warranted. The GLTEQ has two major advantages over the BQHPA (Baecke et al., 1982). It focuses on a typical week without specifying an exact period, whereas the BQHPA references the last seven days, which may be atypical. A second advantage is that the GLTEQ assesses only leisure-time exercise, which is consistent with the way in which PPA is defined, whereas the BQHPA includes occupational and leisure activity (e.g., walking and cycling). Additionally, the GLTEQ has also been used in research investigating light-intensity PA such as walking (Blacklock, Rhodes, & Brown, 2007; Brown & Rhodes, 2006; Jacobs et al., 1993; Rhodes, Brown, & McIntyre, 2006; Rhodes, Courneya, Blanchard, & Plotnikoff, 2007).

2.3.7.1 Selecting the Most Appropriate Physical Activity Questionnaire

Generally, in PA investigation great attention is place on the selection of measures that are suitable to answer the research questions (Pols, Peeters, Kemper, & Grobbee, 1998). Thus, the choice of a questionnaire depends on several factors:

1) *The research question of the study*. If the study focuses on cardiovascular disease, then the emphasis should be on aerobic exercise (e.g., Jennings, 1995; Tanaka et al., 1997) as this improves cardiovascular fitness. Conversely, in a study investigating the relationship between PA and osteoporosis, bone loading activities like jumping and sprinting will be more important (e.g., Greendale, Barrett-Connor, Edelstein, Ingles, & Haile, 1995; Tanaka et al., 2001; Wolman, Faulmann, Clark, Hesp, Harries, 1991).

2) *The study population*. Age and gender of the population under investigation are important when choosing a questionnaire. Questionnaires that refer to playing sports or heavy yard work during leisure-time, instead of gardening, walking, or house chores, might be more suitable for male rather than female populations (Armstrong, Bauman, & Davies, 2000). Additionally, education level and cultural aspects should also be considered because most questionnaires have been designed for use with Western populations (Pols et al., 1998).

3) *Outcomes of the questionnaire*. The results of the questionnaire can be described in (kilo-) joules or calories, in hours (duration of activity), in METs, or as an activity score. In cases where researchers plan to use multiple questionnaires in the same study, it is important that they assess whether the results of the different instruments can easily be compared or combined (Pols et al., 1998).

Pols et al. (1998) suggested that, in the eventuality that none of the available questionnaires completely meet their requirements, researchers should develop a new questionnaire that does. Regardless of this situation, they encourage researchers to also consider testing extant questionnaires to ascertain whether they can assess the components of PA under investigation and whether they are reproducible and valid among the populations in question.

2.3.8 Challenges in Measuring Planned and Unplanned Physical Activity

Translating the responses to existing PA questionnaire into estimates of the prevalence of "adequate planned or unplanned activity for health benefits" as proposed by Dunn et al. (1998, p. 399) presents challenges to both researchers and practitioners. For instance, there is some consensus that the recommendation to exercise at least 30 min at a moderate intensity on most days of the week (ACSM, 1998, 2005; Pate et al., 1995) implies a minimum of five days in order to accumulate the minimum requirement of 150 min of MPA each week. However, there has been some debate about whether these 150 min must be taken on five separate days, or whether the total weekly EE is critical for health benefit. In Australia, this issue is being investigated by assigning a measure of intensity or relative PAEE, which is usually expressed as METS, to each activity category (Armstrong et al., 2000).

There is some evidence to suggest that the use of METs carries some limitations (Ainsworth, 2002; Stone & Shiffman, 1992). When using the Compendium of Activities (Ainsworth, Haskell, et al., 2000) to estimate energy cost, investigators ought to remind participants to recall only the time spent in movement. The Compendium was not developed to establish the precise energy cost of PA, but rather to provide a classification system that standardises the MET intensities of activities used in survey research (Ainsworth).

Ainsworth (2002) also suggested that the values in the Compendium do not account for differences in body mass, adiposity, age, sex, efficiency of movement, and the geographic and environmental conditions in which the activities are performed. Thus, participants' variability in EE scores for the same activity can be large and the true energy cost may not be close to the stated MET level as presented in the Compendium. Another limitation of recalling daily PA to calculate EE was highlighted by Stone and Shiffman (1992) who suggested that "even a short recall interval does not automatically guarantee easy and accurate recall if the events to be recalled are small or frequent" (p. 124).

Early epidemiological work on the relationships between PA and health were based on occupational PA. The work of Morris and colleagues (e.g., Morris & Heady 1953; Morris, Kagan, Pattison, Gardner, & Raffle, 1966) with London bus drivers and that of Paffenbarger and Hale (1975) with the San Francisco longshoremen was highly influential in this field. However, during the 1970s and 1980s occupations became increasingly more sedentary, and the contribution of work-related PA to daily EE has declined ever since. This decline, and the fact that people are more likely to have control over their leisure than their work time PA, partly explains why many of the current questionnaires are focused on leisure-time activity. Nevertheless, there are some occupations such as parking enforcement, brick laying, logging, waiting, and nursing, which still involve considerable daily PAEE. A challenge for future research in PA assessment will be to ascertain more carefully the relative impact of occupational and leisure-time activity on health, perhaps from a new perspective as proposed by Dunn et al. (1998).

2.4 Theories of Health-related Behaviour

Theories of health-related behaviour are categorised by their *range of application* (general, health-, domain-, or behaviour-specific), and *formal structure* (stage vs. continual theories; see Armitage & Conner, 2000; Sutton, 2003). The theory of reasoned action (TRA: Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) and its successor the theory of planned behaviour (TPB: Ajzen, 1985, 1988, 1991) are general in scope and can thus be applied to a wide range of behaviours outside the health sphere. Conversely, theories such as the health belief model (Strecher & Rosenstock, 1997) refer explicitly to health-related behaviours. Behaviour- and domain-specific models have a range of application which is narrower still. For example, the AIDS risk reduction model (Catania, Kegeles, & Coates, 1990) was developed to predict preventative behaviour such as condom use.

Stroebe (2000) proposed that general models be preferred for their parsimony and stated, "it is not very economical to continue to entertain specific theories of health behaviour unless the predictive success of these models is greater than that of general models of behaviour" (p. 27). Hence, if a general theory can be used to explain complex behaviours such as engagement in regular exercise then such an approach has greater utility and economy than a number of specific theories that apply to subtypes of that behaviour. The implication of Stroebe's proposition is an approach of initial reliance on a general theory which can they be modified so as to apply to a specific behaviour or domain (Sutton, 2004, p. 106).

The formal structure of health-related behavioural theories is either staged or continual (Sutton, 2005, p. 225). Each type of theory bears different implications for interventionists. For instance, stage theories carry the assumption that: a) behavioural change involves movement through a sequence of discrete stages; b) different factors are important at different stages; and finally c) interventions should be *stage-matched* to some extent.

The most widely-used stage theory is the Transtheoretical model (TTM: Prochaska & DiClemente, 1982, 1983; Prochaska, Redding, & Evers, 2002; Prochaska & Velicer, 1997), which has been applied to a wide range of health-related behaviours (e.g., Dunn et al., 1997; Prochaska, Velicer, Prochaska, & Johnson, 2004; Woods, Mutrie, & Scott, 1999). The TTM model incorporates five distinct stages: pre-contemplation, contemplation, preparation, action, and maintenance. However, the TTM – like other stage-based theories (e.g., the Precaution Adoption Process Model: Weinstein & Sandman, 1992) – suffers from serious conceptual and measurement issues. Further, Sutton (2004, p. 107) and Weinstein, Rothman, and Sutton (1998) warned researchers who are considering the TTM to be aware that it is a complex and challenging theory to test, especially in the exercise arena (e.g., Adams & White, 2003, 2005; Hutchison, Breckon, & Johnston, 2009), which cannot be wholly recommended in its present form (Spencer, Adams, Malone, Roy, & Yost, 2006, Sutton, 2005, p. 247).

The main focus in the present programme of study, therefore, is the application of a continual (i.e., multi-stage) theory of behaviour, namely the TPB (Ajzen, 1985, 1988, 1991). The causal relationships specified by this theory can be represented in the form of a path diagram, the output of which is behaviour. Various cognitive determinants are assumed to influence directly or indirectly through the effects of a *mediator* or *intervening variable* (Baron & Kenny, 1986, p. 1170). Instead, when two variables simultaneously influence behaviour, each can be said to *moderate* the effects of the other one (Baron & Kenny).

2.4.1 A Brief Introduction to the Theory of Planned Behaviour

The TPB (Ajzen, 1985, 1988, 1991) is a prominent continual model of health-related PA for the following reasons: (a) It is general in scope; (b) the relevant constructs are clearly defined and their causal inter-relationships are specified (Ajzen, 2006a); (c) unambiguous recommendations are provided in respect of how the constructs should be operationalised (Ajzen, 2006a, b); (d) it has been widely used to study behaviours both within (e.g., Peters, Kok, & Abraham, 2008; Ogden, 2003) and outside the health domain (e.g., Conner et al., 2007; Stead, Tagg, MacKintosh, & Eadie, 2005); and finally (e) meta-analyses in the exercise domain show that TPB accounts for a significant proportion of variance intentions and behaviour (e.g., Godin & Kok, 1996; Hagger et al., 2002a). To better understand the causal relationships between the constructs within the TPB, a brief description of its predecessor (i.e., the Theory of Reasoned Action: TRA; Ajzen & Fishbein, 1970) is necessary.

2.4.1.1 The Theory of Reasoned Action

The TRA was developed to explain causal, volitional behaviour, based on the premise that individuals act in a rational manner by taking into account information that is available to them, and by considering the possible implications of their actions (Ajzen & Fishbein, 1980). The TRA also suggests that an individual's intention to perform a given behaviour is the immediate determinant of that behaviour (Ajzen, 1988). Further, the TRA proposes that people create rational decisions about their behaviour based on: (a) the information and beliefs about the behaviour and its consequences; (b) their personal expectations; and, (c) the value they place on the outcome.

According to the TRA, the most important predictor of behaviour is the intention to perform the behaviour (Ajzen & Fishbein, 1970, 1980). Intentions are the product of two cognitive processes: Attitude towards the behaviour (the individual's positive or negative perception of performing the given behaviour) and subjective norms (the individual's perception of pressure from important others to perform or not perform the given behaviour; see Figure 2.1).

The adoption of a specific behaviour, according to Ajzen and Fishbein (1980; Fishbein & Ajzen, 1975), is not directly related to personality, education or cultural background; however, they exert their indirect influence on attitudes towards the behaviour and subjective norms. Additionally, Ajzen and Fishbein, after reviewing studies of the relationship between attitudes and behaviour, formulated the *principle of correspondence* (see also Ajzen & Fishbein, 1977; Ajzen & Fishbein, 2005, pp. 173-222; Ajzen, 1988).

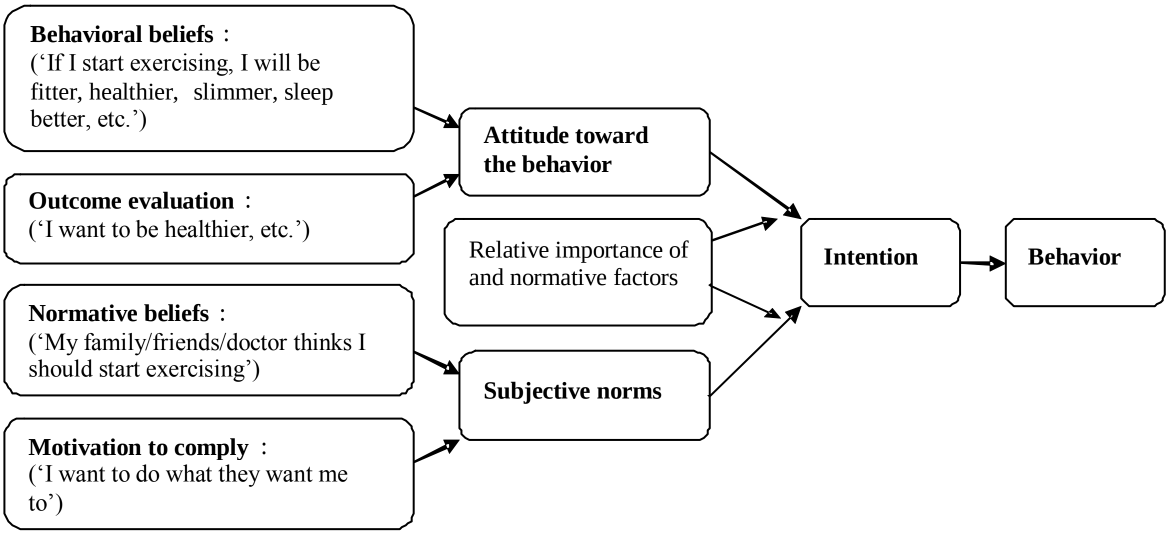


Figure 2.2. Main components of the TRA.

Note. Adapted from Fishbein and Ajzen (1975).

The principle of correspondence states that each attitude and behaviour has four elements of *action*, *target*, *context* and *time*, and that correspondence between attitudes and behaviour will be greatest when both are measured at the same degree of specificity. For example, an individual's attitude towards exercising (action) to get fit (target) in the gym (context) in the following week (time) should exhibit a stronger relationship with a behavioural measure designed to assess gym-based exercise in the previous week, than to an index of fitness (Armitage & Christian, 2004, p. 3; Conner & Spark, 2005, p. 170).

2.4.1.2 Moderator and Mediator Variables within the Theory of Reasoned Action Framework

During the last decade many facets of *attitude strength* have been found to *moderate* the attitude-behaviour relationship (e.g., Conner & Sparks, 2002; Kookinaki & Lunt, 1998; Thomsen, Borgida, & Lavine, 1995). However, Krosnick, Bonniger, Chuang, Berent, and Carnot, (1993, p. 1143) suggested that there might not be a reliable relational framework for measuring attitude strength. This affirmation implies that there is the need for additional investigation to understand the effects of attitude strength on attitude-behaviour relationship (Armitage & Christian, 2004, p. 4). Additionally, only one potential *mediator* has been investigated, namely, *behavioural intention* (Fishbein & Ajzen, 1975). Ajzen and Fishbein, (1980) suggested that behavioural intentions should be considered to be the product of the motivation required to perform a particular behaviour, which is the reflection of an individual's decision to follow a course of action, as well as an index of how hard people are willing to try to perform a behaviour.

Many quantitative and narrative reviews provide support for the utility of the TRA in predicting intentions and behaviour (e.g., Hausenblas, Carron, & Mack, 1997; Randal & Wolff, 1994; Sheppard, Hartwick, & Warshaw, 1988). For instance, Sheppard et al., found an average multiple correlations of R = .66, and an average intention-behaviour correlation of r = .53, which account for a "large" proportion of the variance in behaviour (Cohen, 1988, p. 80). These results suggest that the TRA (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) possesses satisfactory predictive validity.

2.4.2 The Theory of Planned Behaviour

Ajzen (1988) conceded that, "The TRA was developed explicitly to deal with purely volitional behaviours" (p.127); in other words, in situations in which the individual has complete free choice over their behaviour (Armitage & Christian, 2004, p. 6; Blue, 1995). However, human behaviours, such as exercise, may be influenced by barriers impeding its execution. Inevitably these barriers will limit the individual's control over the behaviour (Buckworth & Dishman, 2002, p. 201). To address this shortcoming, Ajzen (1988) proposed"…a conceptual framework that addresses the problem of incomplete volitional control" (p. 132), and added a new construct to the original TRA model, namely, *Perceived Behavioural Control* (PBC; i.e., the perception that one possesses about the resources and the opportunity to execute the behaviour).

With the addition of PBC, the revised model was named the theory of planned behaviour (TPB). Within this theory, PBC reflects past experience as well as external factors such as anticipated impediments, obstacles, resources, and opportunities that may influence the performance of the behaviour (Ajzen, 1991). Findings suggest PBC affects behaviour both directly and indirectly through its influence on intentions (e.g., Ajzen, 2006a; Armitage, 2005; Dean, Farrell, Kelley, Taylor, & Rhodes, 2007; Everson, Daley, & Ussher, 2007; Lucidi, Grano, Barbaranelli, & Violani, 2006).

The TPB (Ajzen, 1985, 1988, 1991) reflects the influence of Bandura's (1986, 1997) concept of self-efficacy (i.e., the belief that we can act effectively and exercise some control over events that influence our lives). Ajzen (1985) added the concept of self-efficacy to the TRA because control beliefs are important determinants of PBC (Gross, 2001). PBC may exert a direct effect on behaviour bypassing behavioural intentions (Gross, 2001; see dotted line in Figure 2.2).

2.4.2.1 Determinants of Intention and Behaviour

As in the TRA, intention is cast as the key element of the TPB (Ajzen, 1985). Ajzen (2006a) suggested that intention is the cognitive representation of a person's readiness to perform behaviour. Given an adequate amount of Actual Behavioural Control (ABC) over the behaviour in question, an individual would be expected to follow through on their intentions and engage in the behaviour whenever the opportunity arises. Ajzen (1985) suggested that behavioural intention is the cumulative result of three *salient beliefs*, which are weighted in terms of their importance and relevance to the behaviour in question and the individual(s) performing that behaviour: *behavioural beliefs*, *normative beliefs*, and *control beliefs*. These beliefs affect attitude towards the behaviour, subjective norms, and PBC (see Figure 2.2).

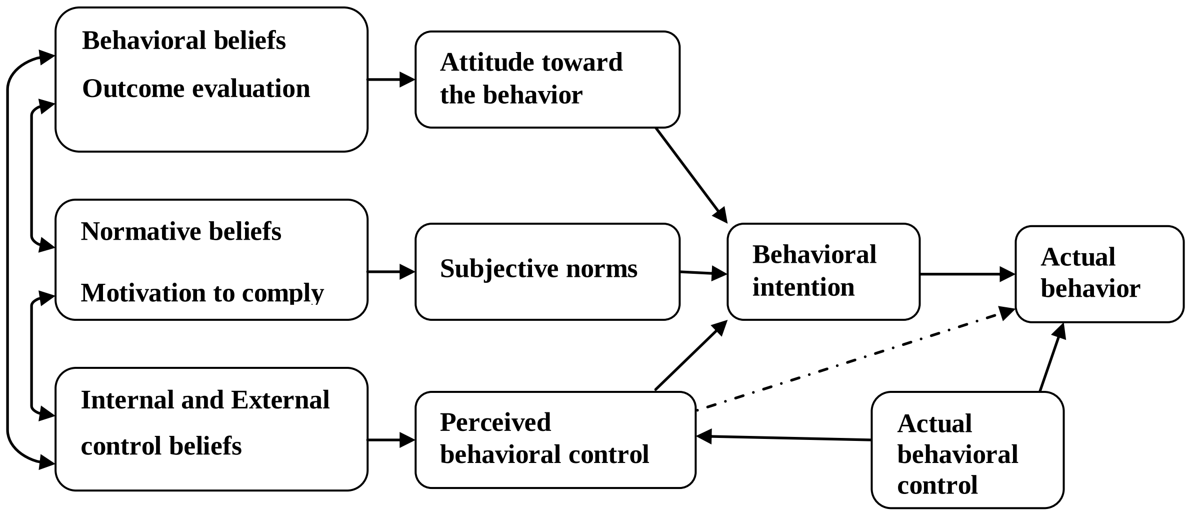


Figure 2.2. Schematic representation of the TPB.

Note. Adapted from Ajzen (2006a).

Ajzen (1991) proposed that the three salient beliefs are ultimately responsible for intentions and actions through their influence on the predictor variable. Thus, behavioural intention (BI) is computed through a linear regression analysis on attitudes towards the behaviour, subjective norms, and PBC. The link between PBC and intention, symbolizes the fact that, in general, people are more inclined (i.e., intend) to perform positively-valued behaviours that are perceived to be achievable (cf. Bandura, 1986).

The weights in the BI regression equation are thought to change as a function of the behaviour and the population examined (Ajzen, 1991, p.188). There is evidence to indicate that there may be individual differences in the weights placed on different components, for example, some individuals could base their intentions on attitudes (i.e., attitude strength: Patch, Tapsell, & Williams, 2005; Sparks et al., 1992), and others on norms across behaviours (Dean, et al., 2007; Trafimow & Findlay, 1996).

Although it is conceptually plausible that intention is moderated by PBC, this interaction has been found to be insignificant in practice (Ajzen, 2002); perhaps because the link between PBC and behaviour is more complex (Conner & Sparks, 2005, p. 172). Perceived behavioural control can exert its influence directly and interactively, through behavioural intention, on behaviour. This condition is based on the assumption that, no matter how strong a person's intentions are, the implementation of an intention is at least partially determined by personal and environmental barriers.

Ajzen (1991) stated that "the addition of perceived behavioural control should become increasingly useful as volitional control over behaviour decreases" (p. 185). The theory states that, as volitional control decreases, the importance of PBC increases thus becoming a stronger predictor of intention (Ajzen, 2002). The more resources and opportunities an individual's believe they posses, and the fewer impediments and obstacles they anticipate, internal and external, the greater their PBC should be (Hagger, Chatzisarantis, Culverhouse, & Biddle, 2003) (see Figure 2.2).

Typically, the TPB is represented graphically without *actual behavioural control* (ABC). To date, little research has been carried out on ABC due to the difficulty in defining and measuring it (Ajzen & Fishbein, 2005, p. 192; Sutton, 2004, p. 111); therefore, the direct path from ABC to behaviour is still causally ambiguous (Sutton 2002, p. 200). To overcome this issue, Ajzen and Fishbein (2005, p. 192) suggested that PBC can be used as a proxy for ABC to the degree that people's perceptions of control are precise. The direct link between PBC and behaviour is not a causal path (see Figure 2.2), and attempts to change PBC would probably not lead directly to behavioural change (Sutton, 2004, p. 111).

2.4.2.2 Determinants of Attitudes

Attitudes represent the positive or negative value which an individual attaches towards a given behaviour (Ajzen, 1991). This value stems from the individual's beliefs about the projected outcome of the behaviour and the evaluation of this outcome. In turn, the individual forms positive attitudes towards the behaviour that may produce desirable outcomes and negative attitudes that are linked to undesirable outcomes. Additionally, Fishbein (1993) asserted that attitudes towards the behaviour are the product both of beliefs about the consequences of engaging in the behaviour, and the positive or negative evaluation of these consequences. Accordingly, if an individual believes that climbing stairs will produce health-related benefits, and perceives that to be a desirable outcome, then he or she will be more likely to form a favourable attitude toward climbing stairs. Therefore, the link between attitude and behavioural beliefs is generally strong (Armitage & Conner, 2001).

2.4.2.3 Determinants of Subjective Norms

Subjective norms are considered to be the individual's perceptions of the social pressure emanating from important others (referents) to engage or abstain from a given behaviour (Ajzen, 2006a). Like attitudes, subjective norms result from a set of normative beliefs, which are the perceived behavioural expectations of important others (i.e., family, friends, spouse, doctor, or teacher). They are quantified in the model as the subjective likelihood that specific salient groups or individuals think the individual should or should not perform the behaviour, multiplied by the motivation to comply with that referents' expectation (Conner & Sparks, 2005).

2.4.2.4 Determinants of Perceived Behavioural Control

Perceived control refers to an individual's perception of the degree of personal control over a given behaviour (Ajzen, 2006a), and conceptually it shares some similarities with self-efficacy (Bandura, 1986, 1997). The individual's perception is formed by a set of *control beliefs* concerned with the presence or absence of resources and opportunities to perform the behaviour successfully, weighted by the perceived power of each factor (Ajzen, 1991). However, Terry (1993) criticised the PBC construct as being overly simplistic. Accordingly, Terry and O'Leary (1995) proposed that the items habitually used to measure PBC should be classified into the *internal* and *external* aspects of control.

Terry and O'Leary (1995) identified these internal aspects of control as *perceived ability* and *personal agency* over the behaviour (e.g., information, personal deficiencies, emotions, etc.), whereas the external aspects of control were defined in term of the *influences of external barriers* to behaviour (e.g., opportunities, dependence on others, etc.). For example, if a person perceives that he or she has access to the necessary resources and perceives that there are opportunities (or a lack of obstacles) to perform the behaviour, then he or she is likely to experience a high degree of PBC (Ajzen, 1991). Armitage and Conner (1999) provided some initial evidence of the distinction between internal and external aspects of perceived control; however, this division may also be responsible for the poor internal consistency values that typify PBC measurements (Hagger et al., 2002a).

2.4.2.5 The Moderating Effects of Past Behaviour within the Theory of Planned Behaviour

In predicting behaviour, past behaviour (PB) explains unique variance over and above that accounted for by the TPB variables (cf. Ajzen, 1991; Conner & Armitage, 1998; Hagger et al., 2002a; Ouellette & Wood, 1998). For example, successful behavioural predictions have been made on cycle helmet use (Quine, Rutter, & Arnold, 1998), breast self-examination (Hodgkins & Orbell, 1998), and exercise (DuCharme & Brawley, 1995; Norman & Smith, 1995). Conner and Armitage (1998) in their narrative review of TPB research reported that adding PB to the TPB variables explained, on average, an additional 7.0% of the variance in intention and 13.0% of the variance in behaviour. A major limitation of the TPB is its inability to fully account for the influence of PB on intention and future behaviour. Norman and Conner, (2006) suggested that, to overcome this drawback, behaviour might be also measured in terms of both PB and/or habit.

2.4.2.5.1 Habitual processes. Regular exercise is a function of both deliberative (planned) and automatic (habitual/unplanned) processes; however, the latter are not assessed by the TPB. For example, Bozionelos and Bennet (1999) found PB to be a stronger predictor of exercise than attitude towards the behaviour, subjective norms, and PBC. Further, Hagger et al. (2002a) reported that PB predicted intentions to perform PA directly and indirectly through self-efficacy and positive attitudes. Hence, controlling for PB is of particular importance in the context of PA research because people must exercise regularly for health benefits to accrue (Rivis & Sheeran, 2003).

Ouellette and Wood (1998) suggested two ways in which PB may influence future behaviour. First, past performance may provide individuals with information that directs their beliefs about the behaviour (i.e. a conscious response). Second, the repetition of the same behaviour may lead to the formation of a habitual response. Hence, the behaviour is triggered by stimulus cues and is performed automatically with little effort or conscious awareness. Under such circumstances, intentions (and other social cognitive variables) may lose their predictive validity. Thus, whenever PB is found to have a direct effect on future behaviour over and above the influence of social cognitive variables, this might be taken as evidence that the behaviour is under habitual control.

One common limitation of both the TRA and TPB is that these models focus exclusively on deliberative processes and ignore the effects of automatic mental processes (habits) on behaviour (Fazio, 1990). In general, deliberative processes are characterised by considerable cognitive work and effort. They involve a consideration of the available information and an analysis of costs and benefits (Barg, 1994). Conversely, habitual processes, which individuals have developed through past experience and observation, facilitate fast decisions (Barg; Chaiken, 1980). In recognising the probable affects of automatic mental processes on volitional behaviour, many researchers have attempted controlling for these influences within the deliberative paradigm of the TPB (e.g., Albarracín & Wyer, 2000; Chatzisarantis, Hagger, Biddle, & Karageorghis, 2002; Godin, Valois, Jobin, & Ross, 1991; Hagger et al., 2002b).

Bargh (1994) proposed that habits form when a situational cue is sufficient to trigger a behavioural response automatically without any deliberation or information processing. Verplanken and Aarts (1999) further developed this concept when they defined habits as "learned sequences of acts that have become automatic responses to specific cues, and are functional in obtaining certain goals or end-states" (p. 104). Hence, the *frequency* as well as the *consistency* of behaviour are the main components that influence the development of habits (Hagger & Chatzisarantis, 2005).

Few models of health behaviour have attempted to officially incorporate the role of habitual processes. One exception is Triandis' (1977) model, which considers behaviour to be a function of intention, facilitating conditions, and habit. In essence, Triandis argued that new behaviours are primarily determined by intention whereas repeated behaviours are primarily determined by habit (as measured by the frequency of PB). Thus, as behaviours are repeated and become habitual, their performance should depend less on a rational statement of the individual's intentions and more on their previous behaviour. Hence, as the frequency of habitual actions increases, the strength of the intention-behaviour relationship should weaken.

Verplanken, Aarts, and van Knippenberg (1997) have demonstrated that habit reduces the acquisition of information and the elaborateness of choice strategies in decision-making. Thus, to the extent that repeatedly performing behaviour reduces deliberation (e.g., Chatzisarantis et al., 2002; Ouellette & Wood, 1998) the TPB should be less predictive of both intention and behaviour. For instance, Ouellette and Wood, in their meta-analysis, reported that intention was a stronger predictor than PB of occasionally performed behaviours, whereas PB was a stronger predictor than intention of frequently performed behaviours.

Trafimow (2001) reported that habit moderated the attitude-intention and subjective norms-intention correlations for condom use. In line with predictions, the correlations for those reporting high levels of habit were non-significant, whereas the correlations for those reporting low levels of habit were significant. Finally, Norman and Conner (2006) examined the moderating effects of PB on intention-behaviour among binge drinkers. Past behaviour explained an additional 66.0% of the variance in intention and 78.0% of the variance in behaviour. Additionally, PB was found to moderate the attitude-intention and intention-behaviour relationships, such that weaker relationships were observed with increasing frequency of PB.

2.4.2.5.2 Discrepancy of past behaviour as a measure of automatic behaviour. Several researchers have questioned the use of PB as a measure of automatic effects, as it is very limited as an index of habit (Aarts & Dijksterhuis, 2000; Ajzen, 2002; Bargh, 1994). Indeed, PB may reflect the influences of other unmeasured variables on intention (see Ajzen; Hagger et al., 2002b). Additionally, the effects of PB on behavioural intention may predominantly reflect recent performance of the behaviour (Hagger & Chatzisarantis, 2005) as recent events are more easily recalled than earlier occurrences (Ajzen). Moreover, Verplanken and Orbell (2003) proposed that PB may also be a poor measure of habit because the *consistency* with which behaviour is performed across situations contributes to the development of habit, a factor which is not taken into account by measures of PB.

Hagger and Chatzisarantis (2005) suggested that the development of habit measures should incorporate both frequency and consistency of performance. They also stressed the importance of including the measurement of PB in the TPB to test its *sufficiency* (see Sutton, 2004), since the consistent effect of PB on exercise intentions and behaviour does not offer a complete explanation of volitional behaviour

(Chatzisarantis & Biddle, 1998). In response to this call and Bryan and Rocheleau's (2002) suggestions, it is apparent that more research is needed to test the TPB and PB variable in their application to the prediction of intention and behaviour within a health context. One such avenue of research may lie in the validation of an instrument that can measure the sub-components of LPA behaviours (i.e., planned and unplanned PA), as suggested by Dunn et al. (1998) and Pescatello (2001).

2.4.3 Summary of Research Using the Theory of Planned Behaviour

Several recent meta-analyses (e.g., Albarracín, Fishbein, Johnson, & Muellerleile, 2001; Armitage & Conner, 2001; Glasman & Albarracín, 2006), and narrative reviews (e.g., Bozionelos & Bennet, 1999; Hardeman, Griffin, Johnston, Kinmonth, & Wareham, 2000; Hardeman et al., 2002; Symons, Downs, & Hausenblas, 2005) have demonstrated the efficacy of the TPB in the prediction of BI and behaviours across a variety of contexts (e.g., smoking: Conner, Sandberg, McMillan, & Higgins, 2006; condom use: Conner & Flesch, 2001; and binge drinking: Cooke, Sniehotta, & Schuz, 2006). The TPB has been applied to research investigating sports and leisure time activities in a wide variety of samples including young adults (Motl et al., 2002), competitive athletes (Mummery & Wankel, 1999), patients with heart disease (Godin, et al., 1991; Prapavessis et al., 2005), pregnant women (Godin, Valois, & Lepage, 1993), and healthy adults (Bryan & Rocheleau, 2002).

2.4.3.1 Meta-analytic Reviews of the Theory of Planned Behaviour in Exercise and Physical Activity Settings

Godin and Kok (1996) conducted a meta-analysis of 18 studies, published from 1985-1996, that applied the TPB to a wide range of health-related behaviours (see Appendix D). The results suggested that the theory is a useful predictor of several health-related behaviours. Indeed, the mean correlation (R^2) between the TPB predictor variables and intention was .41, whereas for behaviour the value dropped slightly to .34. Overall, the researchers found that attitudes and PBC significantly contributed to the prediction of intention, whereas the contribution of subjective norms to the prediction of intention was less important. Godin and Kok's findings suggested that subjective norms are not as relevant as attitudes and PBC in the prediction of health-related behaviours. Intention was the main predictor of behaviour; nevertheless, PBC contributed significantly in almost half of the studies.

Hagger et al. (2002a) extended Hausenblas et al.'s (1997) research, and in so doing reviewed 72 independent studies. They strengthened their analysis by including the amount of variance in intention and behaviour explained by the TPB in the exercise setting. The effects of PB as predictor of all TPB variables were also analysed. The TPB was able to explain 44.5% of the variance in intention and 27.4% of the variance in exercise behaviour. The inclusion of PB in the analysis accounted for the greatest amount of variance in intention (60.2%) and exercise behaviour (46.7%) compared with the other models tested. Furthermore, Hagger et al. reported effect sizes for the other relationships in the theory which corresponded to those reported by Hausenblas et al. in their meta-analysis.

As indicated above, the relationships predicted by the TPB have been supported both in the exercise setting and when using general-population samples. Further, the TPB has a greater predictive value than either the health belief model or the protection motivation theory (Quine, et al., 1998) and of TRA (Conner & Armitage, 1998). Although there is empirical support for the TPB, there is a lack of conceptual clarity regarding the notion of PBC (Sutton, 2002, p. 200; Terry 1993; Terry & O'Leary, 1995).

Ajzen (1985) conceptualised PBC as an estimate of the extent to which an individual has control over the successful execution of a specific behaviour, and also as the individual's appraisal of their ability to perform that behaviour. However, Ajzen (1988) proposed two processes of control that were theoretically distinguishable from one another (see Furnham, 2005, p. 237). The first related to perceived controllability over behaviour (cf. Rotters, 1966, *locus of control*), which refers to judgments of the existing personal control over potential external barriers. The second, related to Bandura's (1982) self-efficacy beliefs, referred to perceived levels of internal control. Nevertheless, Bandura stated that "locus of control and self-efficacy bear little or not relation to each other" (p. 124).

2.4.3.2 Theory of Planned Behaviour and Exercise Research in Young Adults

A number of studies have found the TPB to be predictive of both intentions to exercise and exercise behaviour itself in young adults. Using the TPB, Bryan and Rocheleau (2002) were able to account for 67.0% of the variance in intention to engage in resistance training and 40.0% of the variance in actual resistance training behaviour in male and female college students. In another study, Okun, Karoly, and Lutz (2002) found smaller but significant results in studying leisure-time exercise behaviour in 530 college students. The TPB was able to account for 35.0% of the variance in intention and 20.0% of the variance in leisure-time exercise behaviour.

2.4.3.3 Studies not supporting the Theory of Planned Behaviour in Exercise Domains

It is worth noting that studies examining the TPB in exercise settings have not always resulted in findings that support the predictions of the theory. For example, Yordy and Lent (1993) examined undergraduates to compare the utility of various social cognitive models, including the TRA and TPB. The authors found that the TPB did not make any significant improvement to the predictions of the TRA, possibly suggesting that PBC was not an important predictor in the exercise domain.

Dzewaltowski, Noble, and Shaw (1990) reported similar results. They found that while PBC made a significant contribution in predicting intention to participate in physical activity, PBC had no direct effect on actual participation.

By looking at both exercise intention and behaviour, Bozionelos and Bennett (1999) found that PBC was only predictive of intention. Furthermore, neither attitudes towards the behaviour nor subjective norms were predictive of intention. While subjective norms have consistently been regarded as the weakest of the TPB constructs (e.g., Blue, 1995; Hagger et al., 2002b), the finding of attitudes towards the behaviour not being a significant predictor was unexpected (Hausenblas et al., 1997).

2.4.3.4 Theory of Planned Behaviour and the Influence of Exercise Moderators in Diverse Samples

In addressing the aforementioned inconsistencies, the effect of moderators is one avenue which may be worthy of examination. Moderation refers to a situation wherein the strength and/or valence of the relationship between an independent and a dependent variable is regulated by a second independent variable (i.e., the moderator; Baron & Kenny, 1986). In a review, which examined how researchers could best understand those factors that might influence PA; it was found that moderators should always be included in the assessment of any theory-based PA intervention (Baumann, Sallis, Dzewaltowski, & Owen, 2002).

Baron and Kenny (1986) suggested that moderator variables are very important in theory development and practical application as they can uncover or clarify relationships among constructs and subsequently direct interventions. In a review of PA intervention studies, (Baranowski, Anderson, & Carmack, 1998) also recommended the use of moderators to increase the efficacy of predictive models as well as interventions. In their meta-analyses, both Hausenblas et al. (1997) and

Hagger et al. (2002a) recommended the examination of moderators in an effort to further the use of TPB. Years earlier, Ajzen (1985) implied at this sentiment when he added the PBC construct to the theory of reasoned action suggesting that level of control may moderate the relationship between intention and behaviour. If a moderator is able to produce stronger relationships among theoretical constructs by segregating a population into more specific sub-groups, interventions could be made more specific and perhaps be more successful. The exercise setting may prove to be a moderator within the TPB owing to the fact that the tenets of the theory are subject to change as the behaviour or setting changes (Ajzen, 1991). For example, attitudes may be more important than subjective norms in Situation A, while the reverse may be true in Situation B.

Recent literature has shown that factors such as different exercise types may influence the magnitude of the relationship between TPB constructs and exercise behaviour. For example, Bryan and Rocheleau (2002) looked at the type of exercise (i.e., aerobic versus resistance exercise setting) in young adults. They found that, while the TPB was able to account for significant amounts of variance in both types of exercise, more than double the variance (40.0% vs. 19.0%) in exercise behaviour was explained in resistance, as compared to aerobic, exercise. In addition, it was found that PBC was a stronger predictor of both intentions and behaviour for resistance trainers. Bryan and Rocheleau suggested that less volitional control was available in resistance exercisers because of the need for special equipment and facilities, whereas with aerobic exercisers, PA could be performed virtually anywhere with minimal equipment (e.g., jogging, cycling, etc.).

CHAPTER 3: DEVELOPMENT AND INITIAL VALIDATION OF THE BRUNEL LIFESTYLE PHYSICAL ACTIVITY QUESTIONNAIRE

3.1 Introduction

The measurement of lifestyle PA habits has been an important topic for researchers in both medicine and health (Dunn et al., 1998). This is hardly surprising given that PA is known to reduce the risk of cardiovascular disease (DoH, 2004; Physical Activity Guidelines Advisory Committee [PAGAC] 2008; USDHHS, 2000), to control body weight (Thune, Njolstad, Lochen, & Forde, 1998) and to confer mental health benefits (Byrne & Byrne, 1993; Plate & Rodin, 1990). Measurement of such habits via self-administered behavioural assessment facilitates screening, monitoring and intervention (Murgatroyd, Shetty, & Prentice, 1993); hence, the health practitioner is provided with a wide array of relevant information without a need for expensive and labour-intensive measures such as doubly-labelled water (e.g., Hise, Sullivan, Jacobsen, Johnson, & Donnelly, 2002; Schoeller, 1999; Schoeller & Jefford, 2002), motion sensors (i.e., accelerometers; Leenders, Sherman, & Nagaraja, 2006; Westerterp, 1999), and respiratory analysis (e.g., Snellen, 1980; Snitker, Tataranni, & Ravussin, 2001).

Much research has demonstrated the necessity to provide interventions to reverse the trend in sedentary lifestyle. Without such interventions, the majority of the population in developed regions such as the North America and Europe would remain at their current relatively inactive levels (Sallis, Hovell, & Hofstetter, 1992; Biddle, & Mutrie, 2007, p. 29). It is, therefore, imperative that such interventions be made available to the large majority of the population who are sedentary or insufficiently active (DoH, 2004; Haskell et al., 2007; Nelson et al., 2007; PAGAC, 2008). Owing to the nature of this challenge for health practitioners, PA interventions must move beyond reliance of face-to-face and other *downstream* approaches (i.e., workshops, aerobics classes, meetings, etc.) towards mass media approaches that can make more effective use of newer technologies such as the Internet (Marcus, et al., 1998; Vandelanotte, et al., 2007).

Newer forms of communication technology such as interactive computer-mediated programmes, Internet- and e-mail-based interventions have the potential to support personalised PA interventions on a large scale (Buckworth & Dishman, 2002, p. 251). More specifically, home-based programmes enhance accessibility and convenience for individuals limited by finances or transportation (Buckworth, 2000). Past research that has compared home-based intervention programmes to programmes in traditional exercise facilities have generally reported more positive outcomes for home-based interventions **(**Buckworth; Chen, 1998; Cyarto, Brown, Marshall, & Trost, 2008; Kahn et al., 2002; Wilbur et al., 2008). Therefore, the purpose of the present study was to develop a web-based LPA questionnaire that was both valid and reliable, and that would be suitable for use among the general population in the UK.

It has repeatedly been pointed out that interactive health communication using the Internet will impact on the range and flexibility of the intervention options available in preventive medicine (Dunn et al., 1998; Patrick, Robinson, Alemi, & Eng, 1999; Pealer, Weiler, Pigg, Miller, & Dorman, 2001; Robinson, Patrick, Eng, & Gustalfson, 1998). However, such methodologies should not compromise scientific integrity for technological convenience and commercial viability. Therefore, the design of the LPA questionnaire outlined in the present report was based on a number of principles associated with “computer-mediated communication” (Jacko & Sears, 2003).

3.1.1 Significance of the Present Study

The rationale for the present study centred upon a need to develop an Internet-based LPA questionnaire that was both valid and reliable, and that would also be suitable for use among the general population in the UK. Further, it was deemed important to develop a measure that did not take in excess of 5 min to complete given that this is a critical issue for respondent completion of self-report measures (Bogen, 1996; Loewenthal, 2001, p. 71; Shephard, 2003). The approach was *macro-analytical* rather than *micro-analytical*. That is, there was no intention to assess units of PA (expressed in terms of energy expenditure); rather, the new questionnaire was intended to assess general patterns of behaviour that characterised the lifestyle and habits of respondents. Based on conceptual discussions of LPA (Dunn et al., 1998; Pescatello, 2001), items were developed to tap the two domains of planned PA and unplanned PA (see Appendix E).

3.2 Method

3.2.1 General Overview of the Research Strategy

The general research strategy was to develop a questionnaire and then examine its validity in nine progressive stages. In each stage, a different aspect of validity was the focus as per the recommendations of Anastasi and Urbina (1997, pp. 30–31). In the initial stage, an item pool was developed and its content validity examined using a group of experts (Expert Panel 1). In Stage 2, the comprehensibility of the items was reviewed using a sample of participants; a group of white-collar workers (Pilot Sample 1). In Stage 3, a second panel of experts (Expert Panel 2) was recruited to evaluate the items in terms of their relevance to the two main constructs – planned PA and unplanned PA.

In Stage 4, a sample of 563 participants was recruited from the general UK population that was split in two to form Pilot Sample 2a and Pilot Sample 2b. The data was then explored the factor structure of the questionnaire using Pilot Sample 2a. Stage 5 involved testing factorial validity through use of confirmatory factor analysis (CFA) on Pilot Sample 2b. In this stage, competing models representing different theoretical positions were also tested. Stage 6 involved an examination of the invariance of the model using multi-sample CFA between a pen and paper sample (Pilot Sample 2b) and an Internet-based sample (Pilot Sample 3). Stage 7 examined the standardised solutions of each sample to assess the amount of unique variance accounted for each item by the factor. In Stage 8, subgroup differences were analysed and norms were developed based on data collected from Pilot Samples 2a, 2b and 3. The final stage, Stage 9, examined the internal consistency of the factors independently for Pilot Sample 2b and Pilot Sample 3 as well as for both of these samples combined.

3.2.1.1 Ethical Considerations

The following procedures were applied to the participants who assisted in each stage of the initial development of the BLPAQ. Informed consent was obtained from all participants (see Appendix E). Subsequently, information was given regarding the purpose of the study and the respondents were provided with the assurance both that their data would be kept confidentially and that they were free to withdraw without penalty. Further, the participants were given ample opportunity to ask any questions to clarify their understanding of the data collection procedure and the nature of the research. Subsequent to responses being given, the participants were thanked for their assistance and offered a point of contact to facilitate any further enquiry regarding the research.

3.2.1.2 Stage 1: Generation of Item Pool - Expert Panel 1. The generation of the initial item pool was based on a number of considerations including the author's knowledge of LPA, the feedback from a panel of experts (Panel 1), and existing questionnaires such as the Baecke Questionnaire of Habitual Physical Activity (Baecke et al., 1982), Health Insurance Plan of New York Questionnaire (HIP; Shapiro, Weinblatt, Frank, & Sager, 1965), Lipid Research Clinics Questionnaire (Ainsworth et al., 1993), and the Stanford Usual Activity Questionnaire (Sallis et al., 1985). The selected items were intended to represent the pre-set factor headings of planned PA and unplanned PA.

The primary tasks of the panel of experts were to assist in the generation of items and to establish the extent to which the initial item pool tapped the intended constructs. Thus, they assisted in establishing both face and content validity for the items. Expert Panel 1 comprised 12 individuals (six men and six women: $M = 35.7$, $SD = 5.2$ years) who worked in the domain of the health and fitness industry, were academics with a specific interest in health and fitness, and/or possessed knowledge of questionnaire development. Of those who reported their ethnicity, eight were White UK/Irish and two were White European.

Demographic details are an important consideration for diagnostic purposes (Balarajan & Soni-Raleigh, 1992, pp. 113–116). Therefore, a series of demographic items were also developed for inclusion in the questionnaire including name, title, contact details, occupation, marital status, number of children and their ages, ethnic origin, weight, height, clothes sizes, and medical conditions or health problems. Expert Panel 1 was also requested to scrutinize the wording of the demographics-related questions.

3.2.1.3 Stage 2: Item Comprehensibility and Applicability - Pilot Sample 1

To establish the comprehensibility and applicability of the items, the initial item pool generated by the author was also piloted among a panel of 16 members of the lay public: six men, seven women, and three who did not report their gender (age: *M* = 35.1, *SD* = 14.9 years). This panel comprised a stratified random sample intended to reflect a range of socio-economic groups, different age groups, both genders and ethnic minorities. In terms of ethnic background, 11 were White UK/Irish and three were White European, one was Indian and one was Black Afro-Caribbean. Feedback from Pilot Sample 1 enabled the author to make fine adjustments in the working of the BLPAQ items.

3.2.1.4 Stage 3: Test of Content Validity of the BLPAQ - Expert Panel 2

To establish the importance of each item to the measurement of the intended construct in quantitative terms, a panel of 36 experts (age: *M* = 34.1, *SD* = 8.1 years) was used to rate the refined item pool and to re-word/delete/add items as necessary. There were 22 men (age: *M* = 34.1, *SD* = 7.3 years) and 14 women (age: *M* = 31.9, *SD* = 7.8 years). This group was recruited to build upon the work completed by the Expert Panel 1 and Pilot Sample 1. These experts assisted in the refinement of a pool of items that would be suitable for a large-scale pilot and statistical, rather than qualitative analysis. Fifteen of these experts had a doctoral qualification in a related area and five were full university professors. The remainder of Expert Panel 2 were educated to at least master’s level and were drawn form both industry and academic world. In terms of their ethnic background, 23 were White UK/Irish, nine were White European, two fell into the category of White Others and two were Black Afro-Caribbean. This expert panel also scrutinised the wording of the demographics-related questions. The final version of the BLPAQ that was derived from this procedure is presented in Appendix E.

3.2.1.5 Structure of the Brunel Lifestyle Physical Activity Questionnaire

Respondents were asked to provide an honest answer to each item and to give the response that most represented them (see Appendix E). The section on LPA behaviours is preceded by a definition indicating that: “planned physical activity is any activity that is scheduled into your daily routine, which may enhance your health, fitness or well-being. Examples include brisk walking, gardening, cycling, team games, etc.” (Blair, Dunn, Marcus, Carpenter, & Jaret, 2001). Each item in the PA subscale is responded to on a 5-point continuous-closed numerical scale (see Courneya, 1994: e.g., *how many times a week do you engage in planned physical activity?* → Never, 1–2 times, 3–4 times, 5–6 times, 7 or more times). Subjects indicate a response by ticking or clicking with their mouse in the circle associated with the point on the scale that best represents their behaviour. The six items measuring planned PA were intended to tap the intensity, frequency and duration of the activity. The items tap both current and past planned PA. Frequency of unplanned behaviour was not assessed given that this would be extremely difficult to take valid measurements of given its highly transitory nature (Ajzen, 2002a).

3.2.1.6 Stage 4: Administration of the Brunel Lifestyle Physical Activity Questionnaire in a Pen-and-paper Form Pilot Sample 2a and 2b

Following scrutiny from the second expert panel and its comprehensibility and applicability tested with Pilot Sample 1, a pen and paper-based version of the BLPAQ was administered to members of the public (Pilot Sample 2). Data collection process for Pilot Samples 2 and 3 took place during the late spring and summer months of 2004. More specifically, recruitment for Pilot Sample 2 took place from April 4, to

August 30, 2006; recruitment for Pilot Sample 3 took place from May 1, to June 30, 2004 (see Appendix E). These were 563 volunteers who represented a broad cross-section of the British population in terms of socio-economic and ethnic background (see Table 3.1). They were recruited on the street, where they were approached by the investigator and asked to participate in the study. The age range spanned from 18 to 73 (age: $M = 31.7$, $SD = 12.7$ years) while the gender breakdown comprised 260 men (age: $M = 32.1$, $SD = 13.4$ years) and 303 women (age: $M = 31.4$, $SD = 12.2$ years). The mean BMI for male subsample was 25.3 (SD = 3.2 units) while the mean for female subsample was 23.7 ($SD = 2.7$ units). The mean height for men were 1.78 m ($SD = 0.1$ m) and their weight was 80.3 kg ($SD = 11.6$kg); while for women, the respective means were 1.65 m ($SD = 0.1$ m) and 64.4 kg ($SD = 11.8$ kg).

A test for univariate outliers using standard scores ($z > \pm 3.29$; Tabachnick & Fidell, 2007, p. 77) revealed 12 outliers that were subsequently deleted. Additionally, 21 multivariate outliers were identified and deleted using Mahalanobis' distance test ($p < .001$; Tabachnick & Fidell, 2007, p. 77) from Pilot Sample 2 data. The remaining 530 cases were split randomly into two equal groups (Pilot Samples 2a, 2b; see Table 3.2) with the first half of the sample used to explore the factor structure of the BLPAQ items.

Table 3.1

Ethnic Background and Gender Details of Participants for Pilot Sample 2

	Pilot Sample 2 % (*N* = 563)	Males % (*n* = 260)	Females % (*n* = 303)
Ethnicity			
White UK/Irish	66.6	65.9	66.5
Black-Caribbean	1.8	1.2	2.8
Black-African	2.8	4.0	2.1
Indian	8.7	6.8	11.7
Pakistani	2.8	2.4	1.8
Bangladeshi	0.4	0.8	0.0
Chinese	1.4	0.4	2.1
Mixed race	1.4	2.0	0.7
White European	6.9	9.2	5.3
White-Other	3.7	4.0	2.8
Asian-Other	1.1	0.4	1.8
Non-specified	2.3	2.5	2.1
Gender			
Men	46.7		
Women	53.3		

3.2.1.7 Stage 4: Piloting the Brunel Lifestyle Physical Activity Questionnaire on the Internet - Pilot Sample 3

Following collection of data from Pilot Samples 2a and 2b, an Internet-based version of the BLPAQ was used to collect data from 742 volunteers representing a broad cross-section of the British population in terms of socio-economic and ethnic background (Pilot Sample 3). The sample was automatically recruited by providing contact information when they purchased a health product (Slendertone abdominal-muscle stimulator) online. This sample was used to re-confirm the factor structure of the BLPAQ and to test its invariance with the data derived from pen and paper administration in Stage 4 (see Table 3.3). The mean age of participants was 36.5 years (*SD* = 9.6 years), while the gender breakdown comprised 450 men ranging in age from 18-68 years (age: *M* = 36.2, *SD* = 9.3 years) and 292 women ranging in age from 19-66 years (age: *M* = 37.1, *SD* = 10.2 years). The mean BMI for the men in the sample was 26.9 (*SD* = 3.6 units), while the mean for the women was 24.9 (*SD* = 3.8 units). The mean height for men were 1.79 m (*SD* = 0.1 m) and the weight was 86.4 kg (*SD* = 13.2 kg), while for women, the respective means were 1.66 m (*SD* = 0.1 m) and 68.5 kg (*SD* = 11.1 kg). Fifteen multivariate outliers and eight univariate outliers were identified and deleted.

Table 3.2

Ethnic Background and Gender Details of Participants for Pilot Samples 2a and 2b

	Pilot Sample 2a (N = 265)		Pilot Sample 2b (N = 265)	
	Men % (n = 136)	Women % (n = 129)	Men % (n = 113)	Women % (n = 152)
Ethnicity				
White UK/Irish	64.0	67.4	68.1	65.8
Black-Caribbean	0.7	2.3	1.8	3.3
Black-African	6.6	3.9	0.9	0.7
Indian	5.9	10.1	8.0	13.2
Pakistani	3.7	2.3	0.9	1.3
Bangladeshi	0.7	0.0	0.9	0.0
Chinese	0.0	2.3	0.9	2.0
Mixed race	1.5	0.8	2.7	0.7
White European	12.5	3.9	5.3	6.6
White-Other	3.7	3.1	4.4	2.6
Asian-Other	0.0	1.6	0.9	2.0
Non-specified	0.7	2.3	5.3	2.0
Gender	51.3	48.7	42.6	57.4

With regard to piloting the programme on the Internet, instructions were provided to the Webmaster not to allow respondents to proceed if they reported any medical or health problems that related to their ability to exercise. Further, the Webmaster was instructed not to allow respondents with a BMI < 18.0 and ≥ 35.0

units to proceed as the package was not deemed appropriate for this particular sector of the population. Furthermore, an additional item (Item 10) requests the types of activities that respondents most enjoy engaging in so that these activities could be fed back during the internet-based intervention programme.

Table 3.3

Ethnic Background and Gender Details of Participants for Pilot Sample 3

	Pilot Sample 3 % (*N* = 742)	Men % (*n* = 450)	Women % (*n* = 292)
Ethnicity			
White UK/Irish	62.5	63.6	61.0
Black-Caribbean	2.6	2.4	2.7
Black-African	4.2	4.9	3.1
Indian	9.6	8.4	11.3
Pakistani	2.7	3.1	2.1
Bangladeshi	0.3	0.4	0.0
Chinese	1.8	0.9	3.1
Mixed race	1.3	1.3	1.4
White European	6.5	6.4	6.5
White-Other	3.6	3.6	3.8
Asian-Other	2.2	2.0	2.4
Non-specified	2.8	2.9	2.7
Gender		60.6	39.4

3.2.2 Statistical Methods for Stages 5–9

Statistical analysis was used to explore and confirm the factorial validity of the proposed subscales. Both EFA and CFA were used to examine the validity of the factor structure of the BPAQ. In Stage 5, EFA was used on data collated from Pilot Sample 2a (N = 265) to test for the existence of the hypothesized factors of planned physical activity and unplanned physical activity. Pilot Sample 2b (N = 265) was used to confirm the two hypothesised factors and to test for the tenability of competing models that were theoretically meaningful. In Stage 6, data from Pilot Sample 3 (N = 719) was used to confirm the factor structure using Internet-based completion and, given the change in the medium used to collect data, competing models were examined once again.

In contrast to exploratory EFA, when using CFA, the factors and their parameters are specified *a priori* by the researchers (see Long, 1983). Specification of factors involves allowing some parameters to be estimated, fixing others at a constant value. Free parameters were estimated on the basis of a measured variance-covariance matrix, while fixed parameters represented particular hypotheses that the researcher wished to test. The model was estimated using the Maximum Likelihood estimation method, as Mardia's (1970) normalised estimate (Pilot Sample 2a = 2.09) indicated that the data were not multivariate normally distributed (see Hoyle & Panter, 1995, pp. 158–176). The statistics used to assess model fit were the robust comparative fit index (CFI) and the standardised root mean residual (SRMR). These goodness-of-fit statistics are proposed to out-perform other statistics given that they displayed restricted random variation under various conditions of model misspecification, sample size, and estimation methods (Fan, Thompson, & Wang, 1999). Although it was reported the χ^2 statistic and the associated degrees of freedom, χ^2 was not used to assess model fit given that its power to detect miniscule differences increases as sample size increases (Barrett, 2007).

According to Hu and Bentler (1999), the cutoff value required before one can assert a relatively good fit between the hypothesised models and the observed should be close to 0.95 for the CFI, and close to 0.08 for the SRMR. These indexes were used to evaluate the adequacy of model fit. In addition, it was used Akaike's Information Criterion (AIC; Akaike, 1987) to test the tenability of competing models. The AIC indicates the extent to which a model would cross-validate in an independent sample, without requiring a second sample. In comparing models, the model that obtains the lowest AIC is considered to have the best fit.

In Stage 7, the invariance of the factor structure was tested using Pilot Sample 2b and Pilot Sample 3. Invariance was tested using multi-sample CFA. Before this procedure was initiated, the fit of the model was tested independently with the hypothesised two-factor model. In Stage 7, the standardised solutions for each sample were examined.

In Stage 8, having tested for the relevant parametric assumptions (see Tabachnick and Fidell, 2007, pp.250–253), a three-way independent samples MANOVA was used to examine subgroup differences (2 [groups: Pilot Sample 2 and Pilot Sample 3] x 2 [gender] x 3 [age groups]). Thereafter, norms were developed for the BPAQ based on the MANOVA results.

In Stage 9, the internal consistency of the two factors was assessed using Cronbach's (1951) alpha coefficients. This was computed for each pilot sample independently and for the merged results of Pilot Sample 2b and Pilot Sample 3.

3.3 Results

Results will be presented sequentially starting with the research stages involving statistical analyses (Stages 5–9), given that Stages 1- 3 were used to generate the items and to establish content/face validity.

3.3.1 Stage 5: Exploratory Factor Analysis

The EFA results are presented in Table 3.4. Principal components analysis extracted two factors accounting for a total of 64.60% of the variance. These factors were freely selected by the analysis and not imposed *a priori*. There were no cross-loadings and thus, a clear factor solution emerged with strong loadings (>.60) on each of the two expected factors of planned PA and unplanned PA. This factor structure was entirely consistent with the theoretical predictions outlined earlier.

Table 3.4

Factor Loadings for Responses to the Brunel Lifestyle Physical Activity Questionnaire after Varimax Rotation on Pilot Sample 2a (N = 265)

Variables	Factors	
	Planned PA	Unplanned PA
Times per week on planned PA (1)	.77	
Duration of planned PA at this weekly rate (2)	.82	
Duration per session of planned PA (3)	.88	
Total time engaged in planned PA (4)	.91	
Duration of persistence in planned PA (5)	.69	
Intensity of planned PA (6)	.76	
Duration of unplanned PA		.84
Intensity of unplanned PA		.74
Physical demand of job/daily activities		.76
Eigenvalue	4.03	1.79
% of variance explained	44.75	19.86
Cumulative % of variance explained	44.75	64.60

Note. Factor loadings below 0.40 are excluded.

3.3.1.1 Confirmatory Factor Analysis

Based on the results of the EFA (see Table 3.4), two factors were hypothesized to emerge from the lifestyle physical activity items, planned and unplanned physical activity. Consequently, a 9-item, two-factor model was tested using CFA on the Pilot Sample 2b. The model specified that items related to their hypothesized factor with the variance of the factor fixed at 1. Overall, the Pilot Sample 2b showed an acceptable fit (see Table 3.5), with the robust comparative fit index (CFI) (0.94) very close to the criterion value specified by Hu and Bentler (1999).

Table 3.5

Fit Indices for Confirmatory Factor Analyses of the Brunel Lifestyle Physical Activity Questionnaire on Pilot Sample 2b (N = 265)

Fit indices	Two-factor model	One-factor model	Tau Equivalent
χ^2	106.74*	231.72*	255.80*
df	26	26	34
CFI	0.94	0.83	0.82
SRMR	0.05	0.11	0.20
AIC	54.74	179.72	187.80

Note. † CFI = Comparative fit index; SRMR = Standardised root mean squared residual; AIC = Akaike's information criterion.

*$p < .001$.

3.3.2 Stage 6: Test of Competing Models

Having established a good fit for the two-factor model, the validity of a competing one-factor congeneric model, based on the hypothesis that participants did not distinguish between planned and unplanned physical activity, was also tested using CFA (see Table 3.5). The goodness-of-fit indexes for the one-factor congeneric model showed a poor fit to the data (all indexes <.90). When two models are compared, the more parsimonious model (most degrees of freedom) is preferred unless it is demonstrated that a less parsimonious model displays a significantly better fit (Gerbin & Anderson, 1993). The present results showed much better fit indexes for the two-factor model, providing evidence of discriminant validity for planned and unplanned physical activity. A Tau-equivalent model (Lord & Novick, 1968) was also computed, which has equal true score variances and equal error variances, but similar to the congeneric model, this showed a poor fit to the data.

3.3.3 Stage 7: Multisample Confirmatory Factor Analysis

Based on the results of the CFA in Stage 6, an additional CFA was performed to reconfirm the two-factor model that emerged from the PA items representing planned and unplanned forms of PA. Consequently, a 9-item, two-factor model was tested using CFA on Pilot Sample 3 (*N* = 719). Data from this sample were collated using an Internet-based version of the BLPAQ. The model, previously specified in Stage 4, was re-tested with a second CFA using Pilot Sample 3. In addition, competing models were explored using the same procedure as in Stage 5. Overall, Pilot Sample 3 showed an acceptable fit to the data (see Table 3.6).

Table 3.6

Fit Indices for Confirmatory Factor Analyses of Brunel Lifestyle Physical Activity Questionnaire on Pilot Sample 3 (N = 719)

Fit indices	Two-factor model	One-factor model	Tau Equivalent
χ^2	282.72*	649.38*	992.42*
df	26	27	34
CFI	0.92	0.80	0.70
SRMR	0.06	0.12	0.23
AIC	230.72	595.38	924.42

Note. † CFI = Comparative fit index; SRMR = Standardised root mean squared residual; AIC = Akaike’s information criterion.

*$p < .001$.

As there was a strong fit in both samples independently for the two-factor model, we hypothesized that factor loadings would be equal across samples. The Lagrange multiplier (LM) test was used to assess whether the equality constraints were imposed correctly. Multisample CFA, with factor loading constrained to be equal across both groups indicated a CFI of 0.91 (see Table 3.7), which is slightly below the criterion value set by Hu and Bentler (1999).

Table 3.7

Fit Indices for Multisample Confirmatory Factor Analysis of Brunel Lifestyle Physical Activity Questionnaire on Pilot Sample 2b and Pilot Sample 3 (N = 984)

Fit indices	Two-factor model
χ^2	449.71*
df	70
CFI	0.91
SRMR	0.07
AIC	309.71

Note. † CFI = Comparative fit index; SRMR = Standardised root mean squared residual; AIC = Akaike's information criterion.

**p* < .001.

The LM test was used to assess if the equality constraints were imposed correctly. Multisample CFA, with factor loadings constrained to be equal across both groups, indicated a CFI of 0.91 (see Table 3.7), which is slightly lower then the criterion value (Hu & Bentler, 1999). The LM test results indicated that three items had significantly different factor loadings across samples. Specifically, tests results showed that: (a) releasing the equality constraint (EC) for the intensity of unplanned

PA item would reduce χ^2 by 51.10 ($df = 5$, $p < .01$); (b) releasing the EC for the duration per session of planned PA item would reduce χ^2 by 42.60 ($df = 4$, $p < .01$); and (c) releasing the EC for the intensity of planned PA item would reduce χ^2 by 23.95 ($df = 2$, $p < .001$). With these constraints removed, the CFI increased to 0.92.

The LM test supported the notion that constituents of the planned and unplanned physical activity should be allowed to correlate. The correlation between the two factors was significant ($r = .10$, $p < .01$); however, given that significant findings are boosted by use of large sample sizes (Berg & Latin, 2007, p. 152) and that the percentage of variance explained is only 1.1%, it is apparent that the factors are orthogonal in nature.

3.3.3.1 Standardised Solutions

When acceptable fit indices have been evidenced, it is appropriate to examine the standardized solutions of a sample to assess the amount of unique variance accounted for each item by the factor (see Table 3.8). Table 3.8 indicates that all of the items tap unique variance other than the item concerning total time engaged in planned PA. This was the only item that exceeded the cutoff point for error variance of .90.

Table 3.8

Standardised Factor Loadings and Items for the Confirmatory Factor Analysis of the Brunel Lifestyle Physical Activity Questionnaire Factors for Pilot Sample 2b (N = 265) and Pilot Sample 3 (N = 719)

Item	Factor loading Samples		Measurement error Samples	
	2b	3	2b	3
Times per week engaged in planned PA	.77	.80	.64	.60
How long engaged in planned PA at this rate	.79	.71	.61	.70
Duration of each session on planned PA	.90	.90	.44	.44
Total time engaged in planned PA at this rate	.93	.94	.37	.34
Past persistence at planned PA program	.57	.51	.83	.86
How vigorously engaged in planned PA	.75	.64	.66	.77
Time spent doing unplanned PA per week	.68	.76	.73	.65
How vigorously engaged in unplanned PA	.73	.57	.69	.82
How physically demanding is job/daily activities	.53	.65	.85	.76

Note. PA = Physical activity.

3.3.4 Stage 8: Subgroup Differences

Subgroup differences were examined using both samples to establish whether separate sets of norms would need to be developed for the BLPAQ. A three-way multivariate analysis of variance (MANOVA) of BLPAQ factor scores by sample, age and gender (Table 3.9) indicated a significant multivariate interaction effect for sample by age group (Wilks' λ = .987, $F_{6,1934}$ = 2.132, $p < .05$, η_p^2 = .007). The data were split into four equal age groups in accordance with the following breakdown: 18–27 years (*N* = 253), 28–34 years (*N* = 266), 35–42 years (*N* = 232), 43–73 years (*N* = 233). Follow-up univariate analyses showed that the interaction effect held only for planned PA ($F_{3,968}$ = 3.054, $p < .05$, η_p^2 = .009); however, Tukey's *post hoc* test with Bonferroni adjustment did not indicate any significant differences.

The MANOVA also revealed main multivariate effects for sample Hotelling's (*T* = .009, $F_{2,967}$ = 19.596, $p < .05$, η_p^2 = .039) and gender (Hotelling's *T* = .009, $F_{2,967}$ = 4.463, $p < .05$, η_p^2 = .009). Follow-up univariate analyses for sample (Planned PA: $F_{1,968}$ = 19.769, $p < .001$, η_p^2 = .020; Unplanned PA: $F_{1,968}$ = 23.145, $p < .001$, η_p^2 = .023) revealed that the pen and paper sample (Pilot Sample 2b) reported significantly higher levels of both planned and unplanned PA when compared to the Internet sample (Pilot Sample 3). Across both samples, females reported that they engaged in more unplanned physical activity than males.

Table 3.9

Descriptive Statistics and Three-way MANOVA of Brunel Lifestyle Physical Activity Questionnaire Factor Scores by Sample, Age Group and Gender

Variables	*M*	*SD*	*F* ratio	Source of dif.
Sample				
Pilot Sample 2b PPA (A)	3.62	1.07		
Pilot Sample 3 PPA (B)	3.24	1.04	19.77***	A > B
Pilot Sample 2b UPA (C)	2.50	0.81		
Pilot Sample 3 UPA (D)	2.21	0.78	23.15***	C > D
Age group				
18-27 years PPA	3.46	0.98		
28-34 years PPA	3.33	1.06		
35-42 years PPA	3.29	1.09		
43-73 years PPA	3.26	1.10	1.86	____________
18-27 years UPA	2.31	0.74		
28-34 years UPA	2.22	0.81		
35-42 years UPA	2.34	0.82		
43-73 years UPA	2.30	0.82	2.01	____________
Gender				
Male PPA (A)	3.39	1.04		
Female PPA (B)	3.28	1.08	1.31	____________
Male UPA (C)	2.19	0.78		
Female UPA (D)	2.42	0.80	6.98**	D > C

Table 3.9 *(continued).*

	M	*SD*	*F*-ratio	Source of dif.
Three-way interaction (Sample x Age group x Gender):				
Wilks' $\lambda = 0.99$, $F_{6,1934} = 1.83$, $p > .05$, $\eta_p^2 = .006$				
Two-way interaction (Sample x Age group):				
Wilks' $\lambda = 0.99$, $F_{6,1934} = 2.13$, $p < .05$, $\eta_p^2 = .007$				
Two-way interaction (Age x Gender):				
Wilks' $\lambda = 0.99$, $F_{6,1934} = 1.72$, $p > .05$, $\eta_p^2 = .005$				
Sample main effect: Hotteling's $T = 0.041$, $F_{2,967} = 19.60$, $p < .001$, $\eta_p^2 = .039$				
Age group main effect: Wilks' $\lambda = 0.99$, $F_{6,1934} = 2.01$, $p > .05$, $\eta_p^2 = .006$				
Gender main effect: Hotteling's $T = 0.01$, $F_{2,967} = 4.46$, $p < .05$, $\eta_p^2 = .009$				

Note. † PPA = Planned physical activity, UPA = Unplanned physical activity.

* $p < .05$. ** $p < .01$. *** $p < .001$.

In all cases, the significant differences were associated with very small effect sizes as evidenced by the η_p^2 statistic (Cohen, 1988, pp. 29-31), therefore it was deemed inappropriate to generate separate tables of norms for each subgroup of the population at this juncture. Nonetheless, a single table of norms has been provided (see Table 3.10); but once further data is gathered, subsequent analyses may well reveal the need for separate tables of norms for different subgroups of the population.

Table 3.10

Normative Data for the Brunel Lifestyle Physical Activity Questionnaire Based Upon Pilot Samples 2b and 3 (N = 984)

T score	Planned PA	Unplanned PA	*T* score	Planned PA	Unplanned PA
84		15	55	23	8
83			54		
82			53	22	
81			52	21	
80		14	51		7
79			50	20	
78			49		
77			48	19	
76		13	47	18	
75			46		6
74			45	17	
73			44	16	
72			43		
71		12	42	15	5
70			41		
69			40	14	
68			39	13	
67		11	38		4
66	30		37	12	
65			36	11	
64	29		35		
63	28	10	34	10	3
62			33	9	
61	27		32		
60			31	8	
59	26	9	30		
58	25		29	7	
57			28	6	
56	24				

Note. PA = Physical activity

3.3.5 Stage 9: Internal Consistency

Internal consistency (Cronbach's alpha) estimates for the BLPAQ subscales were as follows: Pilot Sample 2b - Planned PA α = .91, Unplanned PA α = .65; Pilot Sample 3 - Planned PA α = .88, Unplanned PA α = .68; both samples combined - Planned PA α = .90, Unplanned PA α = .68. Unplanned PA has a marginal alpha coefficient, which did not exceed the cutoff criterion of .70 (Nunnally, 1978, p. 245). This may be a result of only having three items in the subscale (Schutz & Gessaroli, 1993). However, the homogeneity of the scale was demonstrated by CFA, which is a more rigorous test than Cronbach's alpha.

3.4 Discussion

The purpose of the present study was to develop an Internet-based LPA questionnaire that is both valid and reliable and is suitable for use among the UK general population. The result was a 10-item inventory that assesses an individual's degree of involvement in planned and unplanned LPA. Two subscales of the BLPAQ were identified using exploratory factor analysis and supported by a series of confirmatory factor analyses. Tests of alternative models revealed that the two-factor solution comprising planned PA and unplanned LPA was the most stable.

Exploration of the items yielded the solution that was predicted with all loadings higher than .60. This shows that the first 9 items of the BLPAQ loaded strongly onto their hypothesised factors. The cumulative variance explained was 64.60%. The CFA that followed on Pilot Sample 2b indicated that the two-factor solution showed a very good fit to the data (CFI = 0.94, SRMR = 0.05). Tests of viable alternative models demonstrated relatively poor fit to the data (one-factor model: CFI = 0.83, SRMR = 0.11; Tau-equivalent model: CFI = 0.82, SRMR = 0.20). The strength of the initial two-factor solution was demonstrated further using CFA with on-line data derived from Pilot Sample 3 (CFI = 0.92, SRMR = 0.06). The multi-sample analysis (Pilot Sample 2b vs. Pilot Sample 3) showed that three of the items did not have equal loadings across samples and required equality constraints to be released. Once the equality restraints had been released, a marginal fit resulted (CFI = 0.92, SRMR = 0.07).

Looking at these equality constraints in more detail, it was apparent that there was slight instability between samples in how respondents perceived the intensity of their unplanned PA, the duration of their planned PA per session, and the intensity of their planned PA. This instability may reflect difficulties in summating the information requested by the items as it could vary from day-to-day. At this juncture, it is not possible to identify the exact source of this variation; however, secondary analyses demonstrated that in the case of all three items, there were significantly ($p < .01$) higher scores reported by Pilot Sample 2b. One plausible explanation is that if this sample was, on the whole, more physically active, the available evidence would suggest that they would be better able to recall their PA activity habits with greater precision (Chaiken, 1980).

In addition to slight instability in the factor loadings between pen and paper and Internet-based versions of the BLPAQ, there were clear differences in the nature of the data collected. Most notably, it appeared that respondents reported engaging in significantly more planned and unplanned LPA in pen and paper format. One interpretation for this finding is the occurrence of social desirability given that the research team actively recruited the respondents. Another interpretation is that the Internet-based respondents were seeking to increase their PA and thus wanted to use the questionnaire as a vehicle toward this end. Hence, although pen and paper respondents in Pilot Sample 2b were approached by the research team, Internet-based

Pilot Sample 3 were self-selected and might be described as being in the *contemplation* or *preparation phase* in terms of the Transtheoretical model of stages of change (Prochaska & Marcus, 1994). Further, Pilot Sample 3 was provided with the inducement of a progressive PA programme that was administered to them via weekly e-mail for a period of three months.

Examining the sample differences in more detail, it is apparent that regardless of the mode of data collection, females reported more unplanned PA than males (Table 3.9). This finding may reflect the fact that women in the UK population are more likely than men to engage in activities such as stair-climbing, housework, walking the dog, shopping and playing with children (Coupland et al., 1999; DoH, 2004). Further, it is interesting to note that, according to the present findings, the unplanned PA reported by women is significantly greater ($t_{982} = -4.43$, $p < .001$) than the proportion of unplanned PA engaged in by men (women mean UPA = 43.18%; men mean UPA = 39.81%). Therefore, women appear to get most of their PA from unplanned activities.

3.4.1 Strengths and Limitations

3.4.1.1 Cost-effectiveness of the BLPAQ

One of the major strengths of the BLPAQ is its cost-effectiveness when compared to other commonly used PA field assessment methods such as doubly-labelled water (e.g., Hise et al., 2002; Schoeller, 1999; Schoeller & Jefford, 2002), motion sensors (i.e., accelerometers: Westerterp, 1999), and respiratory analysis (e.g., Snellen, 1980; Snitker et al., 2001). This cost-effectiveness serves to eliminate one potential barrier that may inhibit people from adopting a healthy lifestyle (Giles-Corti & Donovan, 2002; Ford et al., 1991).

Home-based programmes, such as that associated with the BLPAQ, enhance accessibility and convenience for individuals limited by finances or transportation (Buckworth, 2000). Past research that has compared home-based interventions to programmes in traditional exercise facilities have generally reported more positive outcomes for home-based interventions (Buckworth, 2000; Chen, 1998; Kahn et al., 2002). Further, the design of the BLPAQ was based on a number of principles associated with computer-mediated communication (Rheingold, 2000), and interactive health communication (Fotheringham et al., 2000; USDHHS, 1996).

3.4.1.2 Accessibility and Efficiency of Internet-based Information

Vandelanotte et al. (2007) suggested that Internet-delivered PA interventions have the potential to overcome many barriers associated with traditional face-to-face exercise counselling or group-based PA programmes. Primarily, Internet users can look for advice at any time, any place, and often at a lower cost compared with other delivery modalities (Ritterband et al., 2003). Furthermore, there are additional practical advantages likely to be conferred by such methods of communication which include: (a) Novelty and wide appeal; (b) flexibility and interactivity; (c) automated data collection and processing; (d) individual tailoring; (e) credible simulation (role playing through "what if" scenarios); (f) openness of communication; and (g) multi-media interfaces (Fotheringham et al., 2000; Vandelanotte et al.).

The use of health-behaviour change programmes (Fotheringham et al., 2000) employing Internet-based technologies allows participants to work at their own pace and at times which are convenient to them. This optimizes conditions for learning through increasing the flexibility of the learning experience (Kumar, Bostow, Schapira, & Kritch, 1993); thus, giving participants a greater sense of autonomy (Ryan & Deci, 2000). Further, the duration and frequency of advice-giving sessions has been found to have an effect on compliance to a PA programme (e.g., Harvey-Berino, Pintauro, & Gold, 2002; Harvey-Berino, Pintauro, Buzzell, & Gold, 2004; Rovinak, Hovell, Wojcik, Winett, & Martinez-Donate, 2005). It is expected that the results from the BLPAQ will be used to provide health and exercise-related advice to respondents via weekly e-mails. It has been suggested that multiple follow-up sessions are more effective than a single, one-off consultation or group counselling session (Gemson, Sloan, Messeri, & Goldberg, 1990; Iso et al., 1991; McGowan, Joffe, Duggan, & McKay, 1994).

3.4.1.3 Disadvantages of Internet-based Communication Methods

It is also necessary to mention the potential disadvantages of Internet-based methods of communication. First, a high initial financial outlay is required to develop systems such as the one described in the present study. Second, access to Internet-based programs is not yet universal. The latest available figures for the UK (ONS - 26 August, 2008) reveal that in 2007, 61% of households had access to the Internet. Third, the technology required is being constantly upgraded and redeveloped which has a financial implication for users of such systems. Finally, it is proposed that instruments such as the BLPAQ should not be administered as a substitute for professional medical support but as a complement to it.

3.4.1.4 Commercial Context

The data-collection for Sample 3 (internet respondents) took place within a commercial context as the participants had previously purchased a Slendertone abdominal muscular-stimulation belt. For this reason, the participants may not have been truly representative of the general population in that they sought out and invested in a health-related product thereby demonstrating a heightened level of motivation with regards to their PA levels, which may have translated into a greater compliance with the process of data collection. Conversely, those who are not orientated towards improving their health may prove less likely to disclose personal information regarding PA and engage with investigators. A further consideration that applies to data collection within a commercial context is the possibility that respondents viewed the purpose of the investigation with greater diffidence as they may have associated with the commercial interests of the Slendertone as opposed to the apparent educational purpose of University administered questionnaires.

3.4.1.5 Data Ownership

A major drawback which afflicted this study was the dependence on the co-operation of the commercial partner. In the present study, a change in management personnel precipitated a breach of the initial agreement between the research group and Slendertone. When the commercial value of the BLPAQ became apparent to the new management team, they terminated the relationship with the principal researcher (doctoral supervisor) with the effect that several planned phases of web-based data collection were unfulfilled. Hence, the internet-based questionnaire was only partially validated.

3.4.1.6 Internal Consistency of UPA Subscale

A minor limitation identified in the structure of the BLPAQ is the marginal alpha of the unplanned PA subscale. It has been suggested that in cases where the number of items in a subscale is less than 10, an alpha coefficient of .60 is acceptable as long as there is good evidence for validity and there are good theoretical and/or practical reasons for the subscale (Loewenthal, 2001, p. 60). Further, the homogeneity of this subscale was demonstrated by CFA, which is a more rigorous test than Cronbach’s alpha (1951). There is sound theoretical premise for the content of the unplanned PA subscale, which overrides the weakness identified in its internal consistency.

3.4.2 Conclusions and Recommendations

The present study reports the development and initial validation of the BLPAQ – a valid and internally consistent measure of both planned and unplanned PA. The BLPAQ, as an Internet-based questionnaire, allows respondents to receive weekly exercise-related advice. This advice is based upon their current PA behaviours. Further, the instrument allows researchers to test theories underlying planned and unplanned behaviour (Ajzen, 1991; Bargh, 1994).

A recommendation is for researchers to continue to test the concurrent and predictive validity of the BLPAQ. Further, it is imperative that researchers begin to realise the benefits of unplanned activities. Walking briskly to work, doing the housework, walking the dog, playing with children, and so on are all activities that may constitute part of the PA requirements for a healthy lifestyle. If such activities can be encouraged on a day-to-day basis at a moderate intensity, it is likely that requirements for PA can be met. Herein also lays the challenge for practitioners – to promote planned and unplanned activities as an advantageous way to achieve healthful benefits. The notion of integrating unplanned lifestyle PA behaviours to enhance health status is certainly concordant with current thinking among exercise professionals, government agencies and epidemiologists (e.g., ACSM, 2005; DoH, 2004; Dunn et al., 1998; Haskell et al., 2007; Nelson, et al., 2007; Pescatello, 2001; USDHHS, 1996).

CHAPTER 4: TEST-RETEST RELIABILITY OF THE BRUNEL LIFESTYLE PHYSICAL ACTIVITY QUESTIONNAIRE

4.1 Introduction

Owing to their wide availability, low cost, and limited imposition on the respondent, PA questionnaires are advantageous in researching PA behaviour when compared to other direct and / or objective measurement tools (see Conway, Irwin, et al., 2002; Mahabir et al., 2006; Walsh, Hunter, Sirikul, & Gower, 2004). However, PA is a complex and multifaceted concept, hence there is an inherent challenge in obtaining accurate measurements (Conway, Seale et al., 2002; Lamonte & Ainsworth, 2001; Rennie & Warehem, 1998; Shephard, 2003), particularly for activities that are of low-to-moderate intensity, or those that are not routine (Friedenreich et al., 2006).

The need for valid and reliable moderate intensity LPA (MLPA) measures has been widely recognised as a priority for the continuous advancement of this field of research endeavour (Friedenreich et al., 2006; Lamonte & Ainsworth, 2001; Wareham & Rennie, 1998). Further, relatively few questionnaires measuring MLPA have undergone a thorough examination of their psychometric properties, thereby bringing into question their predictive validity (Friedenreich et al., 2006; Shephard, 2003). However, Morrow (2002, p. 39) suggested that the establishment of reliability is pre-requisite to the validation process. Accordingly, the reliability of a PA measure must first be assessed before being utilised for epidemiological research (Caspersen, 1989; Moy, 2005; Rennie & Wareham, 1998).

Despite the problems previously detailed (see Subsection 2.3.1), the majority of self-report PA questionnaires have been validated using correlational methods such as the PP-MC. Conversely, the application of PoA statistics has been scant, albeit many researchers have encouraged their use (e.g., Atkinson & Nevill, 2001; Lane et al., 2005; Nevill et al., 2001). Therefore, the principal aim of the present research study is to ascertain the reliability and stability of the BLPAQ using the aforementioned statistical methods (i.e., both PP-MC and PoA). A secondary aim of this study is to provide additional supporting evidence for the stability of the BLPAQ as a measure of MLPA using PoA as a statistical methodology. The results of these statistical analyses will increase the knowledge base regarding the use of PoA as a significant technique for ascertaining the stability of current and future PA measures as suggested by Nevill et al. (2001).

4.1.1 Hypotheses

The following research hypotheses were tested in the present study:

H_1) Considering the range of correlation coefficients reported in Appendix C and Appendix D and elsewhere (e.g., Pereira et al., 1997; Sallis & Saelens, 2000), it was hypothesised that both the planned PA and unplanned PA BLPAQ factors would show similar or higher reliability scores than the PA measures reported in aforementioned Tables.

H_2) Regarding the PoA results presented in Subsection 4.2.2.2 relating to the parameters proposed by Nevill et al. (2001), it was hypothesised that both the planned PA and unplanned PA BLPAQ factors would demonstrate similar or higher agreements of those of the abovementioned studies.

4.2 Methods

4.2.1 Participants

Participants (*N* = 337) were recruited from the counties of Berkshire and Middlesex in southeast England over a 5-month period. The participants in Sample 1 (*n* = 96; *M* age = 38.8, *SD* = 17.7 years) were regular gym users at a Council-run leisure centre (Langley Leisure Centre, Berkshire). The participants in Sample 2 (*n* =

137; *M* age = 24.4, *SD* = 4.9 years) were undergraduate students, and those in Sample 3 (*n* = 104; *M* age = 41.1, *SD* = 11.9 years) were staff members of Brunel University (Middlesex). Recruitment for each sample took place during the late spring and summer months of 2006. More specifically, recruitment for Sample 1 took place from April 24, to June 30, 2006; recruitment for Sample 2 took place from May 1, to June 30, 2006; and recruitment for Sample 3 took place from July 3, to August 25, 2006 (see Appendix F). The BLPAQ was re-administrated to all participants after a period of approximately 5 weeks (see Appendix G).

The age range of the participants was 18-87 years (*M* age = 33.6, *SD* = 14.1 years). Overall, the three samples included 146 males (*M* age = 47.1, *SD* = 19.9 years) and 191 females (*M* age = 30.9, *SD* = 9.9 years). The mean BMI score for men was 24.02 units (*SD* = 3.12), mean height was 1.77 m (*SD* = .07 m), and mean weight was 75.36 kg (*SD* = 11.99 kg). For women, the mean BMI score was 22.53 units (*SD* = 2.5), while the respective means for their height and weight were 1.65 m (*SD* = .06 m), and 61.73 kg (*SD* = 8.14 kg). Table 4.1 contains a summary of the demographic detail for each sample.

4.2.1.1 Demographics of Sample 1

Ninety-six participants were recruited from a local leisure centre. They ranged in age from 18-87 years, while the mean age was 38.8 years (*SD* = 17.7 years). This sample included 43 males (*M* age = 47.1, *SD* = 19.9 years) and 53 females (*M* age = 30.9, *SD* = 9.9 years). The mean BMI score was 24.77 units (*SD* = 3.42) for men and 22.87 units (*SD* = 2.67) for women. The mean height and weight scores were 1.75 m (*SD* = .08 m) and 75.98 kg (*SD* = 13.44 kg) for men and 1.64 m (*SD* = .06 m) and 61.34 kg (*SD* = 8.81 kg) for women. From the original sample, a total of 81 participants (84.4%) completed the questionnaire at the second administration.

Table 4.1

Ethnic Background and Gender Details of Participants for each Sample Used in the Brunel Lifestyle Physical Activity Questionnaire Reliability Analyses

	All Samples % (N = 337)	Sample 1 % (n = 96)	Sample 2 % (n = 104)	Sample 3 % (n = 137)
Ethnicity				
White UK/Irish	62.0	55.2	63.5	66.3
Black-Caribbean	3.0	5.2	1.5	1.9
Black-African	3.9	4.1	5.8	1.9
Indian	11.6	13.5	10.9	10.6
Pakistani	4.7	7.3	3.6	3.8
Bangladeshi	0.9	1.0	0.0	1.9
Chinese	1.5	2.1	2.2	0.0
Mixed race	3.0	1.0	2.9	4.8
White European	7.1	7.3	9.4	5.8
White-Other	1.5	2.1	0.0	1.9
Asian-Other	0.9	1.0	0.0	1.0
Gender				
Male	43.3	44.8	39.4	47.1
Female	56.7	55.2	60.6	52.9

4.2.1.2 Demographics of Sample 2

One hundred thirty-seven participants were recruited from the population of undergraduate students at Brunel University (School of Sport and Education, Business School, and the School of Health Sciences and Social Care). Their age range was 18-34 years, while their mean age was 24.4 years (*SD* = 4.9 years). The sample included 54 males (*M* age = 23.52, *SD* = 4.8 years) and 83 females (*M* age = 25.0, *SD* = 4.8 years). The mean BMI score was 22.68 units (*SD* = 2.50) for men and 22.53 units (*SD* = 2.37) for women. The mean height and weight scores were 1.78 m (*SD* = .06 m) and 72.03 kg (*SD* = 9.63 kg) for men and 1.66 m (*SD* = .05 m) and 61.68 kg (*SD* = 6.89 kg) for women. From the original sample of 137, a total of 127 participants (92.7%) completed the questionnaire at the second administration.

4.2.1.3 Demographics of Sample 3

One hundred-four participants were recruited from the staff working at the School of Sport and Education and other schools located at Brunel University. They ranged in age from 22-72 years, while their mean age was 41.1 years (*SD* = 11.9 years). The sample included 49 men (*M* age = 42.6, *SD* = 12.3 years), and 55 women (*M* age = 39.8, *SD* = 11.4 years). The mean BMI score was 24.78 units (*SD* = 3.14) for men and 22.88 units (*SD* = 2.37) for women. The mean height and weight scores were 1.77 m (*SD* = .06 m) and 78.31 kg (*SD* = 12.56 kg) for men and 1.64 m (*SD* = .06 m) and 61.51 kg (*SD* = 8.29 kg) for women. From the original sample, a total of 90 participants (86.5%) completed the questionnaire at the second administration.

4.2.2 Procedure

Informed consent was obtained from all participants (see Appendix F). Subsequently, information was given regarding the purpose of the study and the respondents were provided with the assurance both that their data would be kept confidentially and that they were free to withdraw without penalty. Further, the participants were given ample opportunity to ask any questions to clarify their understanding of the data collection procedure and the nature of the research. Subsequent to responses being given, the participants were thanked for their assistance and offered a point of contact to facilitate any further enquiry regarding the research.

Following the initial administration of the BLPAQ, participants were invited to complete the retest measure after a 5-week period, which was considered of sufficient length to ensure that participants could not recall their BLPAQ responses (Wendel-Vos, Schuit, Saris, & Kromhout, 2003), and of sufficient brevity to prevent seasonal changes in PA from influencing the results (Matthews et al., 2001; Pivarnik et al., 2003). A similar approach was used to validate the recently-developed Short Questionnaire to Assess Health-enhancing Physical Activity (SQUASH: Wendel-Vos et al.) which measures MLPA as defined by Pate et al. (1995) in accordance with the ACSM (1998, 2005).

The rationale for choosing three different participant groups was based on the need to develop a measure that is validated for used with diverse age- and socio-economic groups. Notably, both socio-economic status and ethnicity have been found to influence the amount of PA undertaken during leisure time (e.g., Ahmed et al., 2005; Crespo, Smit, Andersen, Carter-Pokras, & Ainsworth, 2000; Marshall et al., 2007; Sundquist, Winkleby, & Pudaric, 2001). Certain PA measures have only been validated for a specific age group (e.g., Modified Baecke Physical Activity Questionnaire for Older Adults: Voorrips, Ravelli, Dongelmans, Deurenberg, & Van Staveren, 1991), special populations (e.g., Modified Baecke Physical Activity Questionnaire: Florindo et al., 2006), or diverse nationalities (e.g., Baecke Physical

Activity Questionnaire: Florindo, Latorre, Jaime, Tanaka, & Zerbini, 2004). The rationale for choosing a testing period spanning late spring to summer (April to August) was to reduce the possible influence of seasonality on MLPA levels (Matthews et al., 2001; Pivarnik et al., 2003).

4.2.2.1 Measures

The BLPAQ has been presented in Study 1 (see Subsection 3.2.1.5) and appears in Appendix E. The only modification made to the BLPAQ applied to the introduction of the version used for the retest. The revised wording asked the participants to report the average planned and unplanned PA that they had accomplished *over the last 5-week period* (see Appendix G).

4.2.3 Data Analysis

Analyses were conducted using the Statistical Package for Social Sciences (SPSS: v 15.0). Correlation coefficients between test-retest administrations of the BLPAQ were calculated to assess reliability based on PP-MCs (one-tailed). The resulting coefficients (for each gender and sample group) were also subjected to a difference test ($p < .05$; $z_{obs} \geq 1.96$). Subsequently a PoA analysis was performed for each item of the BLPAQ as indicated by Nevill et al. (2001).

The findings from the PoA analyses were entered into a single-sample Wilcoxon Signed-Ranks test (WS-RT; Wilcoxon, 1945) to determine whether or not there was a departure from the hypothesised median ($Mdn = 0$) for each participant's score. When interpreting the statistical output from WS-RTs, the effect-size resulting from the *z*-score is represented by the r_{ES} symbol; a statistic which represents the *direction* of the difference (i.e., positive/negative) in the ranking position of the two scores for each item of the PPA and UPA factors. To calculate r_{ES}, the *z*-score is divided by the squared root of the number of observations for each sample (Rosenthal, 1991, p. 19). The r_{ES} effect-sizes were appraised according to the criteria proposed by Cohen (1988, p. 22 small effect: $r = .10$; medium effect: $r = .30$; large effect: $r = .50$).

An a priori decision was made that any participants who did not complete the retest measure would be removed from the sample (Sample 1: $n = 39$, Sample 2: $n = 15$; Sample 3: $n = 10$). Subsequently, the data from the three samples were scrutinised for normality and possible outliers as recommended by Tabachnick and Fidell (2007, p. 77). A visual inspection of distributional normality was made. Where necessary, a square-root transformation was computed for each sample to ensure that the data would be suitable for parametric analysis.

4.3 Results

Five univariate (Sample 2: $n = 3$ [one male and two females]; Sample 3: $n = 2$ [two males]) and 16 multivariate outliers (Sample 1: $n = 1$ [one female]; Sample 2: $n = 13$ [four males and nine females]; Sample 3: $n = 2$ [two females]) were deleted prior to further analysis. Tests for distributional normality revealed that the PPA and UPA factors deviated significantly from normality in respect of each sample (Sample 1: D [81] = .116 – .177, $p < .01$; Sample 2: D [127] = .114 – .176, $p < .001$; Sample 3: D [90] = .169 – .201, $p < .001$), thus requiring transformation to normalise them (i.e., standard skewness and kurtosis ≤ 1.96). Square-root transformation was used, which entails the addition of 1 unit to the highest possible value for each item, thus creating a constant, before the subtraction of each participant's item-score from the constant value (Tabachnick & Fidell, 2007, p. 88). The data were retested and visually checked for standard skewness and kurtosis, and were found to exhibit a more acceptable range.

4.3.1 Pearson Product-moment Correlations

Across all samples, PPA and UPA scores showed significant test-retest correlations (*r* = .96, *p* < .01, variance explained = 92.2% respectively). Furthermore, there were large and positive correlations between the test and retest scores in respect of each individual sample; the co-efficients ranged from *r* = .93 to *r* = .98 (*p* < .01; range of variance explained = 86.5–96.0%; see Table 4.2).

Table 4.2

Pearson's Product-Moment Correlation (One-tailed) Test Results for Planned Physical Activity and Unplanned Physical Activity across Three Samples

	All Samples (*N* = 277)	Sample 1 (*n* = 80)	Sample 2 (*n* = 111)	Sample 3 (*n* = 86)
Planned Physical Activity	.96*	.95*	.96*	.95*
Unplanned Physical Activity	.96*	.98*	.93*	.96*

* *p* < .01.

4.3.1.1 Planned Physical Activity and Correlation Coefficients

Table 4.2 presents the PP-MC results relative to PPA for each sample, which ranged from *r* = .95 to *r* = .96 (*p* < .01; variance explained range = 90.3–92.2%). More specifically, Table 4.3 reports the correlation results for the male groups, which ranged from *r* = .91 to *r* = .97 (*p* < .01; variance explained range = 82.8–94.1%). Whereas, the PPA correlation results for the female groups ranged from *r* = .95 to *r* = .99 (*p* < .01; variance explained range = 90.3–98.0%). Analyses of significant difference in the correlation coefficients between male and female groups found that three scores were significantly greater for the female groups (all samples: *r* = .94 vs.

.97; Sample 2: $r = .91$ vs. .99; Sample 3: $r = .92$ vs. .98; all at $p < .05$). The explained variance ranged from 82.5-99.2% (see Table 4.3).

4.3.1.2 Unplanned Physical Activity and Correlation Coefficients

Table 4.2 reports the PP-MC results relative to UPA for each sample, which ranged from $r = .93$ to $r = .98$ ($p < .01$; variance explained range = 86.5–96.0%). Table 4.3 presents the correlation results for the UPA relative to the male groups ranged from $r = .88$ to $r = .98$ ($p < .01$; variance explained range = 77.4–96.0%). The correlation coefficients for the female groups ranged from $r = .97$ to $r = .99$ ($p < .01$; variance explained range = 94.1–98.0%). Analyses of significant difference in the correlation coefficients between male and female groups found that three scores were significantly greater for the female groups (all samples: $r = .93$ vs. .98; Sample 2: $r = .88$ vs. .99; Sample 3: $r = .94$ vs. .99; all at $p < .05$). The explained variance ranged from 77.4–98.0% (see Table 4.3).

Table 4.3

Pearson's Product-Moment Correlation (One-tailed) Test Results for Men and Women, and the Significance of Difference between Correlation Coefficients for Planned Physical Activity and Unplanned Physical Activity in each of the Three Samples

	All Samples (N = 277)		Sample 1 (n = 80)		Sample 2 (n = 111)		Sample 3 (n = 86)	
	M (n = 125)	W (n = 152)	M (n = 38)	W (n = 42)	M (n = 45)	W (n = 66)	M (n = 42)	W (n = 44)
Planned Physical Activity	.94*	.97*†	.97*	.95*	.91*	.99*†	.92*	.98*†
Unplanned Physical Activity	.93*	.98*†	.98*	.97*	.88*	.99*†	.94*	.99*†

Note. M = men; W = women; † = significant correlation coefficients difference between genders.

†p < .05. *p < .01.

4.3.2 Proportion of Agreement

The PoA method was used to ascertain the proportion of test-retest agreement for all items of the BLPAQ. This statistical analysis has been recommended by Nevill et al. (2001) for establishing the stability of a questionnaire that uses a 5-point Likert-type scale. Further, this "item-by-item" PoA may also be used to identify rogue items in the initial stages of psychometric measure validation (Lane et al., 2005). The test-retest variations from the median (*Mdn* = 0) for each item-score were transformed into the percentage (%) of agreement for each item composing the two variables of the BLPAQ.

Results for the PPA are displayed in Tables 4.4–4.9, while the results for the UPA are presented in tables 4.10–4.15. Specifically, Tables 4.4 and 4.10 present the findings for the participants (*N* = 277) used for this study. Tables 4.5 and 4.6 display the results for the PPA from the male subgroup (*n* = 125), whereas Tables 4.11 and 4.12 present the findings for the UPA from the female subgroup (*n* = 152). The remaining tables show the results from each of the three samples. No additional PoA analysis was performed for the male and female subgroups within each sample due to an insufficient number of participants (*n* < 50; Altman, 1991, p. 456).

4.3.2.1 Planned Physical Activity and Proportion of Agreement

All PPA factor items, for each sample, were above the minimum threshold recommended by Nevill et al. (2001). Therefore, they were considered to display strong PoA levels between the test-retest administrations. Regarding the results from all samples' participants (*N* = 277; see Table 4.6), the PoA ranged from 97.1–99.6%. All PPA factor items where also tested for significance of deviation from the *Mdn* between test-retest administrations of the questionnaire using the single sample WS-R test. These analyses produced only small negative effect sizes (r_{ES} range = .00 to -.14).

Item 3, however, was found to have significant deviation (T = 188.50, p < .01, r_{ES} = -.14) from the median at the re-administration of the BLPAQ.

Results from the male subgroup (n = 125) can be viewed in Table 4.5. The PoA for all the items composing the PPA ranged from 95.2–99.2%, and the single-sample WS-R test produced only small negative effect sizes (r_{ES} range = -.02 to -.14), with two items showing a significant deviation (Item 1: T = 78.50, p < .05, r_{ES} = -.14: Item 6: T = 37.50, p < .05, r_{ES} = -.13) from the *Mdn*. Findings from the female subgroup (n = 152) are presented in Table 4.6. The PoA for all the PPA items ranged from 98.0–100%, and the single-sample WS-R test produced only small negative effect sizes (r range = -.01 to -.20). Only two items showed a significant deviation (item 1: T = -3.00, p < .05, r_{ES} = -.11: item 3: T = 0.00, p < .01, r_{ES} = -.20) from the *Mdn*.

Results for Sample 1 (n = 80) can be examined in Table 4.7. The PoA for all the items composing the PPA ranged from 96.3–100%, and the single-sample WS-R test produced only small negative effect sizes (r_{ES} range = -.02 to -.21). Only item 3 showed a significant deviation (T = 12.00, p < .01, r_{ES} = -.21) from the *Mdn*. Findings for Sample 2 (n = 111) are presented in Table 4.10. The PoA for all the PPA factor items ranged from 95.5–100%, and the single-sample WS-R test produced only small negative effect sizes (r_{ES} range = -.01 to -.11). None of the items showed any significant deviation (p > .05) from the median. Findings for Sample 3 are presented in Table 4.9. The resulting PoA for all the PPA factor items ranged from 96.5–98.9%. Tests for the deviation from the median produced small effect sizes (r_{ES} range = .00 to -.15). Only item 3 scored significantly lower (T = 38.50, p < .05, r_{ES} = -.15) at the second administration of the questionnaire.

Table 4.4

Proportion of Agreement Analysis Results for Planned Physical Activity Items for All Samples (N = 277)

	Score range		Test 1 - Test 2		T	r_{ES}	% (± 1)	≤ 1	0 diff	≥ 1
	Min	Max	*M*	*SD*						
Planned Physical Activity Item 1	-2	2	0.025	0.446	202.50	-.04	97.1	13	246	18
Planned Physical Activity Item 2	-3	2	-0.022	0.488	-230.00	-.03	97.1	16	245	16
Planned Physical Activity Item 3	-2	2	0.094	0.472	188.50	-.14*	97.1	9	237	31
Planned Physical Activity Item 4	-2	3	0.011	0.413	217.00	-.01	98.6	15	247	15
Planned Physical Activity Item 5	-2	1	-0.007	0.351	-232.50	-.01	99.6	16	246	15
Planned Physical Activity Item 6	-1	3	0.036	0.361	121.00	-.06	98.2	11	251	15

Note. Min = minimum; Max = maximum; T = single sample Wilcoxon signed-ranks test; r_{ES} = direction of effect size; diff = difference

* $p < .01$.

Table 4.5

Proportion of Agreement Analysis Results for Planned Physical Activity Items for Men (n = 125)

	Score range		Test 1 - Test 2		T	r_{ES}	% (± 1)	≤ 1	0 diff	≥ 1
	Min	Max	*M*	*SD*						
Planned Physical Activity Item 1	-2	2	0.112	0.571	78.50	-0.14*	95.2	7	101	17
Planned Physical Activity Item 2	-3	2	-0.056	0.558	-69.00	-0.07	96.0	11	106	8
Planned Physical Activity Item 3	-2	2	0.088	0.596	126.00	-0.10	95.2	9	98	18
Planned Physical Activity Item 4	-1	3	0.024	0.499	126.50	-0.02	99.2	11	102	12
Planned Physical Activity Item 5	-2	1	-0.032	0.439	-94.50	-0.05	99.2	12	104	9
Planned Physical Activity Item 6	-1	2	0.080	0.451	37.50	-0.13*	97.6	5	108	12

Note. Min = minimum; Max = maximum; T = single sample Wilcoxon signed-ranks test; r_{ES} = direction of effect size; diff = difference

* $p < .05$.

Table 4.6

Proportion of Agreement Analysis Results for Planned Physical Activity Items for Women (n = 152)

	Score range		Test 1 - Test 2		T	r_{ES}	% (± 1)	≤ 1	0 diff	≥ 1
	Min	Max	M	SD						
Planned Physical Activity Item 1	-2	1	-0.046	0.290	-3.00	-0.11*	98.7	6	145	1
Planned Physical Activity Item 2	-3	2	0.007	0.423	41.00	-0.02	98.0	5	139	8
Planned Physical Activity Item 3	0	2	0.098	0.341	0.00	-0.20**	98.6	0	139	13
Planned Physical Activity Item 4	-2	2	0.000	0.325	13.50	-0.01	98.1	4	145	3
Planned Physical Activity Item 5	-1	1	0.013	0.257	22.00	-0.04	100	4	142	6
Planned Physical Activity Item 6	-1	3	0.000	0.364	-21.00	-0.01	98.7	6	143	3

Note. Min = minimum; Max = maximum; T = single sample Wilcoxon signed-ranks test; r_{ES} = direction of effect size; diff = difference

* $p < .05$. ** $p < .01$.

Table 4.7

Proportion of Agreement Analysis Results for Planned Physical Activity Items for Sample 1 (n = 80)

	Score range		Test 1 - Test 2		*T*	r_{ES}	% (± 1)	≤ 1	0 diff	≥ 1
	Min	Max	*M*	*SD*						
Planned Physical Activity Item 1	-1	2	0.087	0.532	48.00	-0.12	97.6	6	63	11
Planned Physical Activity Item 2	-3	1	-0.037	0.561	-45.50	-0.04	97.6	7	66	7
Planned Physical Activity Item 3	-2	1	0.163	0.514	12.00	-0.21*	96.3	2	66	12
Planned Physical Activity Item 4	-2	1	0.025	0.389	18.00	-0.05	98.8	3	71	6
Planned Physical Activity Item 5	-1	1	0.038	0.335	15.00	-0.08	100	3	71	6
Planned Physical Activity Item 6	-1	2	-0.013	0.405	-25.00	-0.02	98.8	6	70	4

Note. Min = minimum; Max = maximum; *T* = single sample Wilcoxon signed-ranks test; r_{ES} = direction of effect size; diff = difference

* $p < .01$.

Table 4.8

Proportion of Agreement Analysis Results for Planned Physical Activity Items for Sample 2 (n = 111)

	Score range		Test 1 - Test 2		T	r_{ES}	% (± 1)	≤ 1	0 diff	≥ 1
	Min	Max	*M*	*SD*						
Planned Physical Activity Item 1	-2	2	0.009	0.415	13.00	-0.01	96.4	3	104	4
Planned Physical Activity Item 2	-2	2	-0.009	0.457	11.00	-0.07	95.5	4	103	4
Planned Physical Activity Item 3	-2	2	0.027	0.368	16.00	-0.05	98.2	3	102	6
Planned Physical Activity Item 4	-1	2	-0.027	0.343	-20.00	-0.06	99.1	7	101	3
Planned Physical Activity Item 5	-1	1	-0.045	0.313	-18.00	-0.10	100	8	100	3
Planned Physical Activity Item 6	-1	2	0.054	0.353	7.00	-0.11	98.2	2	103	6

Note. Min = minimum; Max = maximum; T = single sample Wilcoxon signed-ranks test; r_{ES} = direction of effect size; diff = difference

Table 4.9

Proportion of Agreement Analysis Results for Planned Physical Activity Items for Sample 3 (n = 86)

	Score range		Test 1 - Test 2		T	r_{ES}	% (± 1)	≤ 1	0 diff	≥ 1
	Min	Max	*M*	*SD*						
Planned Physical Activity Item 1	-2	2	-0.012	0.391	-12.50	-0.02	97.3	4	79	3
Planned Physical Activity Item 2	-3	1	-0.023	0.460	25.00	-0.02	98.9	5	76	5
Planned Physical Activity Item 3	-2	2	0.116	0.541	38.50	-0.15*	96.5	4	69	13
Planned Physical Activity Item 4	-1	3	0.047	0.507	25.00	-0.06	97.7	5	75	6
Planned Physical Activity Item 5	-2	1	0.000	0.406	33.00	0.00	98.9	5	75	6
Planned Physical Activity Item 6	-1	3	0.058	0.470	10.50	-0.08	97.7	3	78	5

Note. Min = minimum; Max = maximum; T = single sample Wilcoxon signed-ranks test; r_{ES} = direction of effect size; diff = difference

* $p < .05$.

4.3.2.2 Unplanned Physical Activity and Proportion of Agreement

All of the UPA factor items were above the minimum threshold recommended by Nevill et al. (2001); therefore, they were considered to display strong PoA levels between the test-retest administrations. Specifically, results for the analyses from all participants' data (N = 277) produced PoA that ranged from 98.2–99.6% (see Table 4.10). All UPA factor items were also tested for significance of deviation from the median (Mdn = 0) between test-retest administrations using the single-sample WS-R test. These analyses produced only small negative effect sizes (r_{ES} range = -.03 to -.05). None of these items were found to have significantly deviated ($p > .05$) from the *Mdn* at the re-administration of the BLPAQ.

The resulting PoA for the male and female subgroups can be viewed in Tables 4.11 and 4.12. Overall, all of the UPA factor items, for both groups, were above the minimum threshold recommended by Nevill et al. (2001). The PoA for the male subgroup (n = 125) ranged from 96.0–99.2%, while the agreement for the female subgroup (n = 152) was 100%. Additionally, all items were tested for significance of deviation from the *Mdn*. These analyses produced only small effect sizes (r_{ES} range = .00 to -.08), and none of the items significantly deviated ($p > .05$) from the median at the re-administration of the BLPAQ.

Specifically, for Sample 1 (n = 80; see Table 4.13), the PoA for each item was 100%. All items, where tested for the significance of deviation from the *Mdn* between the two administrations using the single-sample WS-R test. These analyses produced only small effect sizes (r_{ES} range = .00 to -.08), and none of the items significantly deviated ($p > .05$) from the *Mdn* between test-retest administrations of the questionnaire.

Findings for Sample 2 (*n* = 111) can be viewed in Table 4.14. PoA for all the PPA factor items ranged from 97.3-99.1%, and the single-sample WS-R test produced only small effect sizes (r_{ES} range = .00 to -.06). None of the items significantly deviated ($p > .05$) from the *Mdn*. Results for Sample 3 (*n* = 86) are presented in Table 4.15. The resulting PoA for all the PPA factor items ranged from 97.7-100%. Tests for the deviation from the *Mdn* produced small effect sizes (r_{ES} range = .00 to -.20), with only item 2 having scored significantly less ($T = 0.00$, $r_{ES} = -.20$, $p < .01$) at the second administration of the BLPAQ, and exhibiting a 100% agreement between the two administrations.

Table 4.10

Proportion of Agreement Analysis Results for Unplanned Physical Activity Items for All Samples (N = 277)

	Score range		Test 1 - Test 2		T	r_{ES}	% (± 1)	≤ 1	0 diff	≥ 1
	Min	Max	*M*	*SD*						
Unplanned Physical Activity Item 1	-2	2	-0.014	0.361	-129.00	-0.03	98.5	14	253	10
Unplanned Physical Activity Item 2	-1	2	0.022	0.329	148.00	-0.05	99.6	11	250	16
Unplanned Physical Activity Item 3	-2	2	-0.014	0.371	-118.00	-0.03	98.2	13	254	10

Note. Min = minimum; Max = maximum; T = single sample Wilcoxon signed-ranks test; r_{ES} = direction of effect size; diff = difference.

Table 4.11

Proportion of Agreement Analysis Results for Unplanned Physical Activity Items for Men (n = 125)

	Score range		Test 1 - Test 2		T	r_{ES}	% (± 1)	≤ 1	0 diff	≥ 1
	Min	Max	*M*	*SD*						
Unplanned Physical Activity Item 1	-2	2	-0.016	0.492	-78.00	-0.02	96.8	10	107	8
Unplanned Physical Activity Item 2	-1	2	0.048	0.418	66.50	-0.08	99.2	7	106	12
Unplanned Physical Activity Item 3	-2	2	-0.032	0.491	-48.00	-0.04	96.0	9	110	6

Note. Min = minimum; Max = maximum; T = single sample Wilcoxon signed-ranks test; r_{ES} = direction of effect size; diff = difference.

Table 4.12

Proportion of Agreement Analysis Results for Unplanned Physical Activity Items for Women (n = 152)

	Score range		Test 1 - Test 2		T	r_{ES}	% (± 1)	≤ 1	0 diff	≥ 1
	Min	Max	*M*	*SD*						
Unplanned Physical Activity Item 1	-1	1	-0.013	0.199	-7.00	-0.05	100	4	146	2
Unplanned Physical Activity Item 2	-1	1	0.000	0.230	18.00	0.00	100	4	144	4
Unplanned Physical Activity Item 3	-1	1	0.000	0.230	18.00	0.00	100	4	144	4

Note. Min = minimum; Max = maximum; T = single sample Wilcoxon signed-ranks test; r_{ES} = direction of effect size; diff = difference.

Table 4.13

Proportion of Agreement Analysis Results for Unplanned Physical Activity Items for Sample 1 (n = 80)

	Score range		Test 1 - Test 2		T	r_{ES}	% (± 1)	≤ 1	0 diff	≥ 1
	Min	Max	*M*	*SD*						
Unplanned Physical Activity Item 1	-1	1	0.000	0.276	10.50	0.00	100	3	74	3
Unplanned Physical Activity Item 2	-1	1	-0.037	0.335	-15.00	-0.08	100	6	71	3
Unplanned Physical Activity Item 3	-1	1	-0.025	0.317	-13.50	-0.06	100	5	72	3

Note. Min = minimum; Max = maximum; T = single sample Wilcoxon signed-ranks test; r_{ES} = direction of effect-size; diff = difference.

Table 4.14

Proportion of Agreement Analysis Results for Unplanned Physical Activity Items for Sample 2 (n = 111)

	Score range		Test 1 - Test 2		T	r_{ES}	% (± 1)	≤ 1	0 diff	≥ 1
	Min	Max	M	SD						
Unplanned Physical Activity Item 1	-2	2	-0.036	0.380	-18.50	-0.06	98.2	7	101	3
Unplanned Physical Activity Item 2	-1	2	0.018	0.356	27.50	-0.04	99.1	5	100	6
Unplanned Physical Activity Item 3	-2	2	0.000	0.405	22.00	0.00	97.3	4	102	5

Note. Min = minimum; Max = maximum; T = single sample Wilcoxon signed-ranks test; r_{ES} = direction of effect-size; diff = difference.

Table 4.15

Proportion of Agreement Analysis Results for Unplanned Physical Activity Items for Sample 3 (n = 86)

	Score range		Test 1 - Test 2		*T*	r_{ES}	% (± 1)	≤ 1	0 diff	≥ 1
	Min	Max	*M*	*SD*						
Unplanned Physical Activity Item 1	-2	2	0.000	0.406	18.00	0.00	97.7	4	78	4
Unplanned Physical Activity Item 2	0	1	0.081	0.275	0.00	-0.20*	100	0	79	7
Unplanned Physical Activity Item 3	-2	2	-0.023	0.375	-8.00	-0.04	97.7	4	80	2

Note. Min = minimum; Max = maximum; *T* = single sample Wilcoxon signed-ranks test; r_{ES} = direction of effect size; diff = difference.

* $p < .01$.

4.4 Discussion

The principal aim of the present study was to ascertain the reliability of the BLPAQ over a 5-week period among three diverse samples. It was expected that the BLPAQ's reliability scores should have matched and/or been greater than those of the questionnaires used for comparative purposes (i.e., BQHPA and GLTEQ; see Appendices C and D). Judgements about the adequacy of reliability of a new measure are frequently based on the size of the correlation coefficient, which can range from 0 to 1 (or -1 in the case of an inverse association).

McDowell and Newell (1996) and Ware, Brook, Davies, and Lohr (1981) offered convenient "rules of thumb" suggesting that a very high reliability coefficient (e.g., $r = .85$ to $r = .90$) would be required when scores of a single person are being considered, but more modest values (e.g., $r = .50$ to $r = .70$) would be acceptable when measuring two groups of participants. Nunnally (1978, p. 245) recommended that instruments used in basic research should have reliability of $r \geq .70$. He suggests that increasing reliabilities much beyond $r = .80$ is unnecessary for basic research. On the other hand, Nunnally also suggests that instruments used in applied settings (e.g., health assessment) a reliability of $r = .80$ may not be high enough. Where important decisions regarding the fate of participants are made on the basis of test scores, then reliability should be at least $r = .90$, preferably $r = .95$ or better.

Results from all the analyses showed very high correlation coefficients between test-retest administrations of the BLPAQ (range $r = .88$ to $r = .99$, all at $p < .01$, range of variance explained = 77.4–98.0%; see Tables 4.2 and 4.3). Specifically, it was found that both the PPA and UPA test-retest correlation coefficients were $r = .96$ ($p < .01$; see Table 4.2). These results suggest that both subscales of the BLPAQ can explain 92.2% of the variance, thus underlying the significance of these factors in ascertaining MLPA behaviour in the general population. These findings indicate that the BLPAQ can explain a greater percentage of the variance than the BQHPA (Baecke et al., 1982) and the GLTEQ (Godin & Shephard, 1985) when re-administered within a 5-week period. A comparison with the BQHPA and GLTEQ reliabilities scores can provide additional evidence for the adequate reliability of the BLPAQ (see Appendices C and D).

The reliability scores for the PPA and UPA factors exceed those reported in Appendix C and Appendix D, and elsewhere (see: Pereira et al., 1997; Philippaerts & Lefevre, 1998; Sallis & Saelens, 2000). In light of the strong reliability scores found in this study ($r > .85$), the first research hypothesis (H_1) is accepted. Indeed, the correlations scores of the BLPAQ are higher than those of the BQHPA and the GLTEQ. However, they only represent the existing correlation between two administrations of the same test, but not their direction (Nevill et al., 2001) and / or stability (Lane et al., 2005).

Lane et al. (2005) suggested that a stable construct should exhibit no systematic shift in scores. They also argued that if all participants reported a test-retest increase of 1, the increment would show a systematic shift and acceptable stability coefficients in terms of a ± 1 criterion. The current results showed that all items comprising the PPA and UPA factors have demonstrated a very high (> 95% ± 1) degree of stability. Furthermore, the present findings have exceeded most of the agreement scores presented by Conroy and Metzler (2003), Lane et al., and Nevill et al. (2001). Although the agreements for each item of the BLPAQ may not be compared to any other PA questionnaires’ item used in sport and exercise psychology, the second research hypothesis (H_2) can be accepted given that both construct of the BLPAQ have been found to have a very high stability (Nevill et al.).

4.4.1 Comparison of the Results of the Brunel Lifestyle Physical Activity Questionnaire with the Baecke Questionnaire of Habitual Physical Activity

Examination of the original work of Baecke et al. (1982) revealed that three of the four indices of the BQHPA (i.e., Leisure, Work, and Total PA) reflected similar activities to those measured by the PPA and UPA factors. Therefore, the current BLPAQ's results can be compared with those reported in Appendix C. Baecke and colleagues used a 3-month timeframe between test and retest, and found PP-MC coefficients ranging from r = .74 (Leisure index, variance explained = 54.8%) to r = .88 (Work index, variance explained = 77.4%; no p value reported). Using a shorter time period between test and retest (i.e., 1-month) Jacobs et al. (1993) reported significant (p < .05) Spearman Rank-Order Correlation (SR-OC) results that ranged from r_s = .78 (Work index, variance explained = 60.8%) to r_s = .93 (Total PA index, variance explained = 86.5%; see Table 4.1).

Jacobs et al. (1993) employed 28 university students and 50 university members of staff, and, although they did not report each group's results separately, a comparison can nevertheless be made with the findings from two of the three samples (Sample 2 and Sample 3) utilised in this study. The PP-MC coefficients for Sample 2 (University students, n = 111) indicated that both PPA and UPA had statistically significant (p < .01) correlations (r = .96, variance explained = 92.2%; r = .93, variance explained = 86.5% respectively). Also, correlation analyses on Sample 3 (university members of staff, n = 86) revealed that both PPA and UPA had statistically significant (p < .01) coefficients (r = .95, variance explained = 90.2%; r = .96, variance explained = 92.2% respectively). Overall, these results provide additional evidence that the PPA and UPA items of BLPAQ were able to capture a greater variance of MLPA behaviour than the BQHPA when testing university students and members of staff.

It can be speculated that the participants in the Jacobs' et al. (1993) work might have perceived the requirement of active lifestyle differently from the population subgroups in the current study. Although at the time of the Jacobs' study the benefits of an active lifestyle were already advertised to the general population, it could be hypothesised that those participants were not as motivated as the participants in the present samples. Perhaps the level of mass media influence towards a more active lifestyle was not as pressing as it is nowadays (Fox, 2005). Further, the BHPAQ does not measure household activities, which could provide some form of MLPA such as yard-work, gardening, and vigorous hovering, that have been found to contribute to the aerobic capacity (Talbot, Metter, & Fleg, 2000).

One additional issue with the lower reliability scores for the BHPAQ might be found in the wording of the items measuring occupational and leisure-time PA. Klungel et al. (2000) found that the question structure and the scale type (i.e., Likert-type) in self-report questionnaire might influence participants recall accuracy. Therefore, it can be deduced that the BLPAQ items are more effective in measuring the activities investigated in this study.

4.4.1.1 Comparison of the Gender Results of the Brunel Lifestyle Physical Activity Questionnaire with Those of the Baecke Questionnaire of Habitual Physical Activity

In the current study, the PPA correlation results for both genders, ranged from $r = .91$ to $r = .97$ ($p < .01$) for the male groups, instead for the female groups ranged from $r = .95$ to $r = .99$ ($p < .01$). Analyses of differences between male and female subgroups found that three scores were significantly greater ($p < .05$) for the female groups (All Samples: $r = .94$ vs. .97; Sample 2: $r = .91$ vs. .99; Sample 3: $r = .92$ vs. .98). Instead, the UPA correlation results for the male groups ranged from $r = .88$ to $r = .98$ ($p < .01$). While the UPA correlation coefficients for the female groups ranged from $r = .97$ to $r = .99$ ($p < .01$). Analyses for significant differences of the correlation coefficients from both genders found that three scores were significantly greater ($p < .05$) for the female groups (all samples: $r = .93$ vs. .98; Sample 2: $r = .88$ vs. .99; Sample 3: $r = .94$ vs. .99).

These findings indicate that the measures of PPA and UPA are more sensitive to the variation between genders in most groups. A possible explanation for these variations might be linked to how males and females perceive MLPA as part of their leisure time and/or working life (e.g., ball games, household activities, gardening, walking pets, parenting children, shopping, etc.). It is suggested that among women and men there could be different sports profiles. For instance, men more often participate in sports with high impact (e.g., ball games), whereas women more often participate in walking-related activities (Ainsworth, Richardson, Jacobs, Leon, & Sternfeld, 1999; Barnekow-Bergkvist, Hedberg, Janlert, & Jansson, 1996; Sisson, McClain, & Tudor-Locke, 2008; Speck & Harrell, 2003). These differences could possibly account for the differences recorded during this investigation.

These current results are comparable to those found by Pols et al. (1995), who utilised two long-term periods from baseline to retest (i.e., 5- and 11-month periods) the stability of a slightly modified version of the BQHPA (see Appendix C). They employed a sample comprised of 64 Dutch males (*M* age = 41.1, *SD* = 11.0 years) and 62 Dutch females (*M* age = 48.8, *SD* = 14.8 years) with ages ranging from 20 to 70 years, and reported the PP-MC coefficients for both groups. They found that the repeatability for both male and female groups at 5 months was slightly higher than at

11 months, but not statistically significant (*p* > .05). They suggested that the repeatability for men and women was similar, but did not report the corresponding effect sizes. Specifically, at 5 months from the baseline, the PP-MC coefficients for Work, Leisure and Total PA indexes (men: *r* = .89, .76, .85; women: *r* = .80, .83, .83 respectively) were statistically significant (*p* < .05). At 11 months from the baseline, they reported significant (*p* < .05) coefficient for Work, Leisure and Total PA indexes (men: *r* = .83, .71, .80; women: *r* = .84, .81, .77 respectively). It was not reported if the two groups significantly differed from each other in the correlation coefficients at both times (i.e., 5- and 11-month).

Pols et al. (1995) acknowledged that their study design demanded a lot of time and co-operation from the participants. Specifically, participants not only had to report their PA behaviour, but also they had to complete a questionnaire on diet on three occasions. Additionally, the participants had to visit the research centre several times and were visited at home twice for dietary recalls. Most likely, the relatively demanding schedule of activities may have created selection bias towards more health-oriented people, possibly leading to overestimation of the quality of the test instrument. Although, Pols et al. provided some evidence of the reliability of the BHPAQ in a Dutch population; they concluded that this PA measure might be more accurate for men than for women possibly due to the little emphasis on household tasks, especially when classifying PA behaviour in a population of elderly women.

4.4.2 Comparison of the Brunel Lifestyle Physical Activity Questionnaire Results with the Godin's Leisure Time Exercise Questionnaire

Inspection of the original work of Godin and Shephard (1985) revealed that the three components of the GLTEQ (i.e., Light PA, Moderate PA, and Total PA) reflected comparable activities to those that have been measured with the PPA and

UPA factors. Therefore, the findings from the BLPAQ (see Tables 4.2 and 4.3) can be compared with those of the GLTEQ reported in Appendix D.

The BLPAQ results also exceeded the reliability values measured by the GLTEQ (Godin & Shephard, 1985; Jacobs et al., 1993). In their questionnaire reliability study, Godin and Shephard found that the correlation coefficients and the variance explained for Light PA, Moderate PA and Total PA were $r = .48$ (variance explained = 23.0%), $r = .46$ (variance explained = 21.2%), $r = .74$ (variance explained = 54.8%) ($p < .05$) respectively. Notably, the findings from Godin and Shephard were obtained within a 2-week time span, which suggests that the stability of the BLPAQ is greater than that of the GLTEQ over a longer timeframe.

This point is further reinforced by the findings of Jacobs et al. (1993), who conducted a retest study employing a 1-month time-span, and used the GLTEQ with a group of 78 university members of staff and students. Their reported significant ($p < .05$) SR-OC results that ranged from $r_s = .24$ (Light PA, variance explained = 5.8%), $r_s = .36$ (Moderate PA, variance explained = 13.0%), and $r_s = .62$ (Total PA, variance explained = 38.4%; see Appendix D). In both studies, the 2-week and 1-month retest observations on the GLTEQ indicated strong correlation coefficients for strenuous PA $r = .94$ (variance explained = 88.4%; Godin & Shephard, 1985), and $r_s = .84$ (variance explained = 70.6%; Jacobs et al., 1993). Shephard (2003) suggested that these results were probably influenced by high intensity activities (estimated METs > 7.0), which have been found to be more easily committed to memory over a short period of time.

Overall, reliability decreases with the length of recall period, partly due to seasonal and/or temporal variations in PA patterns (Shephard, 2003). For instance, Lamb and Brodie (1990), who utilised the Minnesota Leisure Time Physical Activity (MLTPA) questionnaire, found a two week correlation coefficient of $r = .86$.

Additionally, Folsom, Jacobs, Caspersen, Gomez-Marin, and Knudsen (1986), who also employed the MLTPA, found a 5-week correlation coefficient of r = .88. Studies on the College Alumnus Questionnaire found correlation coefficients of r = .72 at 1-month, falling to r = .3 to r = .4 over 8–12 months (Ainsworth, Leon, Richardson, Jacobs, & Paffenbarger, 1993; Cauley, LaPorte, Sandler, Schramm, & Kriska, 1987; Jacobs et al., 1993).

4.4.3 Proportion of Agreement

Another primary aim of the present study was to ascertain the reliability of the BLPAQ using the PoA as a novel methodology for establishing test-retest stability of a PA measure. To the best of the author's knowledge, none of the existing PA questionnaires have been validated using the PoA method, for evaluating their item-related stability, as proposed by Nevill et al. (2001). The results from the PoA analyses for the PPA (see Tables 4.4–4.9) and for the UPA (see Tables 4.10–4.15) are discussed separately to provide a clearer understanding regarding the stability percentages (%) of these two subcomponents of MLPA. However, due to the scant research available in the psychology of physical activity regarding the application of PoA as a reliability methodology for the validation of PA measures, the author will utilise the studies presented in Subsection 2.3.3.1 (e.g., Lane et al., 2005; Nevill et al.) as a benchmark for evaluating the significance of the current results.

The PoA is a nonparametric test, which requires a sample of at least 100 participants to be meaningful (Nevill et al., 2001). Therefore, some of the results presented in the following sections should be interpreted with caution, as two of the three samples did not meet this criterion. The comparison between gender groups was only possible when all the participants' scores were tested together. Additionally, the findings of Sample 1 (gym users) and Sample 2 (university students) may have greater generalisability for comparable sub-groups in the population; whereas Sample 3 (university staff members) may be more appropriate for comparison with trends of PA in the general UK population, if equivalent studies were available.

4.4.3.1 Proportion of Agreement and Planned Physical Activity Factor Items

Each PPA item, for each sample, was above the minimum threshold recommended by Nevill et al. (2001), and their range of agreement spanned from 95.2–100.0%. The results from the participants of all samples (N = 277; see Table 4.4) showed that the agreement between test-retest ranged from 97.1–99.6% and that the significance of deviation from the *Mdn* between the two administrations of the questionnaire produced small negative effect sizes (r_{ES} range = -.01 to -.14). Results from the male participants (n = 125; see Table 4.5) showed agreement for all the items ranging from 95.2–99.2%, and produced small negative effect sizes (r_{ES} range = -.02 to -.14). Similarly, findings for the female participants (n = 152; see Table 4.6) showed agreement for all the items ranging from 98.0–100.0%, and produced only small negative effect sizes (r_{ES} range = -.01 to -.20).

Results for Sample 1 (n = 80; see Table 4.7) revealed the agreement for all the items composing the PPA that ranged from 96.3–100%, and only small negative effect sizes (r_{ES} range = -.02 to -.21). Additionally, findings for Sample 2 (n = 111; see Table 4.8) and for Sample 3 (n = 86; see Table 4.9) ranged from 95.5–100% (r_{ES} range = -.01 to -.11), and from 96.5–98.9% (r_{ES} range = .00 to -.15) of agreement respectively.

Results from participants in all samples (N = 277) showed that item 3 had significantly deviated from the median: T = 188.50, r_{ES} = -0.14, $p < .01$. Equally, item 3 in the female participants (n = 152) recorded a significant deviation from the median: T = 0.00, r_{ES} = -.20, $p < .01$. Additionally, both Sample 1 (n = 80) and

Sample 3 ($n = 86$) demonstrated a significant deviation form the median for item 3: $T = 12.00$, $r_{ES} = -.21$, $p < .01$, and $T = 38.50$, $r_{ES} = -.15$ $p < .05$, respectively. In all other samples item 3 scored higher, although not significantly ($p > .05$), at the retest.

Item 3 enquires about the duration of each session of PPA. During the first administration of the BLPAQ, the majority of the participants may have become more aware of the time they engaged in PPA, which could have motivated them to increase the average time for each session prior the retest. Alternatively, they might have over-reported their time expended in a particular activity owing to social desirability (e.g., Adams et al., 2005; Warnecke, et al., 1997). Adams et al. found that social desirability was significantly (*ß* = 0.65Kcal/kg/day, 95% CI = 0.06–1.25, $p < .05$) associated with PA among women when activity was assessed using a 7-day PAR, but not when a 24-hour PAR was used. Instead, Motl, McAuley, and DiStefano (2005) found a weak association between social desirability assessed by the Marlow-Crowne Social Desirability Scale and a self-reported PA. These findings may indicate that the association between social desirability and self-reported PA could be gender specific, and/or instrument specific.

Two other items, from the male participants ($n = 125$) showed a significant positive deviation from the median (item 1: $T = 78.50$, $r_{ES} = -0.14$, $p < .05$: item 6: $T = 37.50$, $r_{ES} = -0.13$, $p < .05$). Instead, the female participants ($n = 152$) reported a negative but significant deviation from the median for item 1: $T = -3.00$, $r_{ES} = -0.11$, $p < .05$. Item 1 enquires about how many times a week one engages in PPA, whereas, item 6 asks how vigorously one engages in PPA. Both these items have been scored higher at the retest, possibly due to more favourable weather conditions, which according to recent research (Matthews et al., 2001; Plasqui & Westerterp, 2004) may have encouraged more vigorous activities outdoors.

Changes in the environment, ambient temperature, and daylight are thought to induce seasonal changes in PA (DoH, 2004; USDHHS, 1996). Seasonal variation in leisure time PA has been described in cross-sectional surveys (e.g., Uitenbroek, 1993; USDHHS, 1996), and in small longitudinal studies among homogenous groups (e.g., Dannenberg, Keller, Wilson, & Castelli, 1989; Matthews et al., 2001; Pivarnik et al., 2003). For example, Dannenberg et al. used data from the Framingham Study, and found that vigorous leisure-time PA (LTPA) behaviour was more likely to occur during the summer months, and was positively ($p < .001$) related to reduced cardiovascular disease risk factors, such as lower cholesterol and body mass index.

Similarly, Mathews et al. (2001) and Pivarnik et al. (2003) reported a significant ($p < .01$) increase in leisure-time activity during the summer months. Specifically, Pivarnik and colleagues found that levels of PA were highest in summer, followed by spring and autumn. These studies have provided some compelling evidence that vigorous LTPA as well as MLPA behaviour (i.e., walking, cycling, etc.) are influenced by seasonal weather (Pivarnik et al.). However, the measure used by Pivarnik et al. (i.e., the Behavioural Risk Factor Surveillance System), which assesses the leisure activity over the past month, has not been validated for seasonal variability of PA behaviours, thus preventing a generalisation of their findings.

4.4.3.2 Proportion of Agreement and Unplanned Physical Activity Items

Each item composing the UPA construct was above the minimum PoA threshold recommended by Nevill et al. (2001), and their range of agreement spanned from 96.0–100%. The results from the participants of all samples (N = 277; see Table 4.10) demonstrate that the proportion of agreement ranged from 98.2–99.6%. The significance of deviation from the median, between test-retest administrations of the BLPAQ, produced small negative effect sizes (r_{ES} range = -.03 to -.05). The current results from the male participants (*n* = 125; see Table 4.11) indicated agreement for all the items ranging from 96.0–99.2%, and produced small negative effect sizes (r_{ES} range = -.02 to -.08). Findings for the female participants (*n* = 152; see Table 4.12) indicated agreement for all the items was 100%, but produced a small negative effect size (r_{ES} = -.05).

Results for Sample 1 (*n* = 80; see Table 4.13) demonstrated that the agreement for all the items was 100%, and two small negative effect sizes (r_{ES} = -.06 to -.08). The agreements for Sample 2 (*n* = 111; see Table 4.14) and for Sample 3 (*n* = 86; see Table 4.15) ranged from 97.3–99.1% and from 97.7–100% respectively. In both samples, all the items composing the UPA showed small negative effect sizes (Sample 2: r_{ES} = -.04 to -.06; Sample 3: r_{ES} = -.04 to -.20). However, Sample 3 recorded a significant ($p > .01$) deviation from the *Mdn* for item 2 ($T = 0.00$, r_{ES} = -.20, $p < .01$). Item 2 enquired about the intensity level relating to unplanned activities. It would appear that the seasonality factor, which might have influenced the responses to item 6 in the PPA construct, might also be applicable to this item.

4.4.4 Strengths and Limitations of the Present Study

To interpret these findings appropriately, the methodological limitations of the present study and the potential generalisability of the current results should be considered.

4.4.4.1 Sample Characteristics and Perception of Exercise Intensity Level

All participants were convenience samples. Participants in Sample 1 were regular gym users, who were regular exercisers. The Chief Medical Officer for England (DoH, 2004) reported that about 10% of the English population exercises at vigorous intensity three or more time per week for more than 20 min, and that overall only 30% at the minimum level for experiencing health benefits (ACSM, 2005;

Haskell et al., 2007). Consequently, the PP-MC results showed that Sample 1 tended to have higher coefficients than the other two samples. Thus, it is plausible that their perception of the intensity level for activities included in PPA and UPA constructs might differ from other members of the general population.

4.4.4.2 Representativeness of Samples

The representativeness of the participants (i.e., Samples 1, 2, and 3) selected for the present validation process might not reflect the population to whom the questionnaire will be applied. For instance, Sample 2 (Brunel University students) and Sample 3 (Brunel University staff members) although convenient for recruitment (e.g., Ainsworth, et al., 1993; Lamb & Brodie, 1991; Jacobs et al., 1993) introduced the potential for bias, as these sub-groups may not be representative of the general population. Sample 1 (regular exercisers) provided some indication of PA behaviour in the general population, these results might not reflect generalisability to rest of the English populace because of the higher PA levels (e.g., Sequeira, Rickenbach, Wietlisbach, Tullen, & Schutz, 1995; Taylor et al., 1984).

4.4.4.3 Duration of Interval between Test and Retest

In the present study the time-span for the second administration of the BLPAQ was adopted from a previous study (5 weeks; Wendel-Vos et al., 2003), where the authors validated a PA measure that was designed to investigate the PA for health benefits guidelines as proposed by ACSM (2000, 2005). However, as shown in Appendices C and D, there are variances in the length of time allowed between administrations of PA instruments in the reported studies. Thus, choosing the optimal time between administrations is problematic. When the time between administrations is short (e.g., 1 day) participants could simply be remembering what they reported in the first test, rather than undertaking the entire recall process again. Therefore, the reliability coefficients of the measure might reflect participants' memory recall (Morrow et al., 2005).

To overcome this issue, some researchers (e.g., Ridley, Dollman, & Olds, 2001; Weston et al., 1997) tried a variety of techniques to balance out the "remembering what they wrote/forgetting what they did" relationship. These strategies involved not informing participants that they will be repeating the questionnaire and exposing them to intellectually challenging or distracting situations between recalls (Ridley et al.; Weston et al.). However, none of these strategies were adopted in the present study. Consequently, any comparison of reliability coefficients with the existing literature (e.g., Jacobs et al., 1993; Pols et al., 1995) must be approached with some caution.

4.4.4.4 Cultural and Regional Differences

The BQHPA (e.g., Boreham et al., 2004) and the GLTEQ (e.g., Dugdill, Graham, & McNair, 2005) have been seldom used in UK-based research. The little evidence from these studies prevents additional comparison with the present findings. Although there are no reported differences in PA behaviour between the southeast and other English regions (Cavill & Rolfe, 2006), there are, however, some differences between England, Scotland, Wales, and Northern Ireland (e.g., DoH, 2004). Therefore, the present findings cannot be generalised to the entire UK population.

4.4.4.5 Timing of Retest

An additional limitation of this study was the selection of the test-retest period for Sample 2 (University students) and Sample 3 (University staff members). The measurement period for Sample 2 coincided with their examination time (1 May to 30 June 2006). It can be speculated that the coincidence of the retest measurement with the exam time might have prevented many of them for maintaining regular PA.

4.4.4.6 Seasonal Effects

Regarding Sample 3, the measurement period coincided with the summer vacation period (July 3 to August 25, 2006). The elevated daytime temperatures experienced during the summer (Department for Environment, Food and Rural Affairs [DEFRA] 2006), might have prevented the participants from pursuing planned activities. It is plausible that the high temperature encouraged the participants to perform activities at lower intensity. Thus, all of these conditions could have lowered the retest results.

4.4.4.7 Self-selection of Participants

Rennie and Wareham (1998) suggested that self-selected participants might produce bias, because the validation processes are relatively intrusive and time-consuming for the respondent. They suggested that although self-selection might be necessary, it is important to examine the generalisability of the validation subpopulation with caution.

4.4.4.8 Statistical Power

Finally, the PoA and the single-sample WS-RT (Wilcoxon, 1945) are both nonparametric methods. Nonparametric tests may lack power as compared with more traditional approaches (Whitley & Ball, 2002). This is a particular problem if the sample size is small ($n < 50$; Altman, 1991, p. 456), or if the assumptions for the corresponding parametric method (e.g., normality of the data) hold. Further, nonparametric methods are used predominantly for hypothesis testing rather than estimation of effects. Nevertheless, the WS-RT is a powerful nonparametric test for comparing related samples (Thomas & Nelson, 2001, p. 201). However, appropriate computer software for nonparametric methods sometime can be limited. In this study, it was necessary to create a data set where all scores were equal to zero – as the expected population median (*Mdn* = 0) – for investigating any change in each participant's scores and their direction at the retest.

4.4.4.9 Proportion of Agreement

A limitation inherent to the PoA method is that it is unable to assess either systematic bias when analysing self-report test-retest data, or differentiate between "near misses" and "wide disagreements" (Nevill et al., 2001, p. 277). Therefore, the lack of information regarding the systematic bias (e.g., over- and/or under-reporting) could possibly prevent interventions aimed at reducing it, when using the PoA methodology for the validation of future PA measures. The absence of UK-based studies, which have employed the PoA method to ascertain the stability of existing PA measures, prevents the comparison of the present findings with an appropriate criterion.

4.4.5 Conclusions

The psychometric qualities of a questionnaire are frequently used to select the best instrument for the research study at hand. It is essential to estimate these psychometric qualities in a variety of situations to acquire estimates that are suitable for different populations. Reliability is determined by the consistency with which participants report similar answers for the various items presented in the questionnaire (Morrow, 2002, p. 41). Thus, test reliability shows the degree of differences in test-retest scores that are attributable to "true" portion in the construct under investigation. The true portion corresponds to the perfectly accurate value of what has been measured (Morrow, p. 40). Whereas any condition that is irrelevant to the purpose of the test represents error variance (Anastasi & Urbina, 1997, p. 84). In this study, the reliability coefficients reveal the extent to which the present results are free from error variance (Thomas, Nelson, & Silverman, 2005, p. 198). The high correlation coefficients may suggest that not only the majority of the participants were able to differentiate between planned and unplanned activities, but also that they were able to significantly recall low-to-moderate intensity PA, which have been found to compromise the reliability of other PA measures (Shephard, 2003).

The notion of reliability has been used widely to address several aspects of psychometric stability (Anastasi & Urbina, 1997, p. 84). Stability can be understood as the consistency of a measurement over a period of time (Morrow, 2002, p. 41). A measure might report a high reliability, but it should not be assumed that it has high stability across time. Stability might be affected by unpredictability in levels of PA due to personal circumstances, and possibly seasonal variability. In this study, the results of the PoA analyses show that the PPA and UPA factors of the BLPAQ have a high stability. However, there was a small random error as a result of the exams period for the university students and summer vacation for the university staff members. Additionally, the elevated daily temperatures experienced during the summer months (M = 19.0 ^{0}C; BBC, 2008) could have affected some of the planned and unplanned activities. Overall, the present results provide the initial evidence that the BLPAQ has the ability of detecting low-to-moderate intensity LPA over a short time-period.

The novel use of the PoA method, as a complementary application, has highlighted the necessity of changing the established validation procedures of future PA questionnaires. Further, the application of the PoA has also raised the need for the re-validation of existing PA questionnaires owing to the limited or inexistent data regarding their stability. Thus, the present study could be used as a PoA criterion for evaluating the stability of existing and/or future PA questionnaires used in UK-based research.

4.4.5.1 Practical Implications of the Present Findings and Future Recommendations

The BLPAQ has some distinctive advantages compared to many other PA measures, because it is short (only one page), and quick to complete (3–5 min). The BLPAQ also represents a novel way to estimate the current PA guidelines for health (ACSM, 2005; Haskell et al., 2007) in large populations. Further, this study also provides the initial insights into the application of the PoA as proposed by Nevill et al. (2001) as a new statistical methodology that can be used for the development of new PA measures and/or the revalidation of existing questionnaires. This approach could be used in future research as complementary methodology to more traditional correlation statistics; especially when using large samples. The PoA method and the related Limits of Agreement (LoA) may become relevant statistical methodologies when identifying the efficacy of future PA interventions.

The need for further research in the field of PA for health-related benefits is becoming more pressing in the light of the new recommendations recently published by the American Heart Association (Haskell et al., 2007). The accurate measurement of PA for health-related benefits was initially identified by Jacobs et al. (1993) and subsequently restated by the ACSM (2005). They suggested that important areas of PA, such as Light and Moderate PA, household chores, and occupational activity should be further investigated when developing new PA questionnaires. In light of this necessity, the BLPAQ will be further validated in following two Chapters. The main aim of Chapter 5 is the assessment of the BLPAQ ability to measure low-to-moderate PA as proposed by Jacobs and colleagues and ACSM in an English population. Thus, the BLPAQ will be subjected to a criterion-related validity (C-RV) and a cross validation (C-V) analyses by using two extensively validated questionnaires (i.e., BQHPA, GLTEQ).

CHAPTER 5: CRITERION VALIDITY AND CROSS-VALIDATION OF THE BRUNEL LIFESTYLE PHYSICAL ACTIVITY QUESTIONNAIRE

5.1 Introduction

Effective interventions to promote PA in sedentary adult populations must have clear theoretical underpinnings. A further pre-requisite to the study of PA is the availability of valid and reliable epidemiological data. Accordingly, the development of a validated measure of PA is an essential step in this process (Booth, Okely, Chey & Bauman, 2002). Validated, reliable measures of PA form a basis for future epidemiological research and interventions that will result in improved psychological and physiological health (Biddle & Mutrie 2007).

Many of the extant measures of PA are rooted in the ACSM guidelines of the 1980s and early 1990s (Kriska & Capserson, 1997). These instruments focus mainly on energy expenditure and other related physiological outcomes (e.g., oxygen consumption, exercise units, etc.). Health psychologists have extrapolated quantitative estimates of PA behaviour from such measures (i.e., the frequency, intensity, and duration of PA). Additionally, Dunn et al. (1998) and Pescatello, (2001) proposed that, owing to its intricacy, PA should also be measured from a more qualitative perspective. Consequently, there is a need for further research in the fields of exercise and medical sciences regarding the validity of PA measures which can be used to ascertain the effectiveness of future interventions at local and national levels (DoH, 2004).

Unlike the existing measures of PA, the BLPAQ is grounded in a psychological theory (i.e., the theory of planned behaviour, Ajzen, 1985, 1991) and should therefore provide a more accurate means of assessing PA from a psychological perspective. The BLPAQ has been developed using British samples and will therefore be culturally applicable to UK exercise participants in a way that earlier measures such as the GLTEQ and BQHPA are not.

Although the initial BLPAQ results are promising (see Studies 1 and 2), the instrument requires further evaluation; especially with regard to its validity. Criterion-RV will be used to demonstrate the accuracy of the newly developed instrument by comparing it with another well-established reference measures, the BQHPA (Baecke et al., 1982), and the GLTEQ (Godin & Shephard, 1985).

Both instruments appear to be acceptable reference measures for use in the present study as they are simple, have been widely used in large epidemiological and health-related behaviour research (e.g., Ekkekakis, Thome, Petruzzello, & Hall, 2008; Reed & Phillips, 2005; Remsberg et al., 2007; Tehard et al., 2005), and demonstrated high reliability and criterion-RV (e.g., Florindo & Latorre, 2003; Jacobs et al., 1993; Philippaerts et al., 1999). Such qualities are desirable, especially if the focus is on a change in individuals' patterns of PA behaviour over time and the timeframe of reference is seven days (Mahar & Rowe, 2002; Sallis & Saelens, 2000, Shephard, 2003). Further, the use of two analogous measures of both PA and walking was deemed advantageous because each uses a similar response frame thereby easing the participants' response burden and reducing the subsequent error (see Sudman & Bradburn, 1983, as referenced by Rhodes et al., 2007, ¶ 14).

In response to the criticism of correlational statistics in the establishment of validity, Bland and Altman proposed a method to assess the agreement between two sets of scores (1986, 1999). Bland and Altman's method has been widely endorsed by researchers in the fields of exercise and medical science (e.g., Atkinson & Nevill, 2001; Bland & Altman, 1986, 1999, 2003; Lamb, 1998; Lane et al., 2005; Nevill & Atkinson, 1997; Nevill et al., 2001), because it is both simple and intuitive (Bland &

Altman, 2007). Accordingly, the LoA approach will be used to cross-validate of the BLPAQ against two criterion measures: the BQHPA and the GLTEQ.

Butler et al. (2006) proposed that cross-validation is an important aspect of scale development because the results should be replicable to another, similar population. The cross-validation of self-administered questionnaires in the social sciences is relatively commonplace (e.g., Butler et al.; Conroy & Motl, 2003; Kendall & Hollon, 1989). However, to the best of the author's knowledge, there are no studies relating to the cross-validation of PA questionnaires using the LoA approach (see Subsection 2.3.5.3).

The two main purposes of the present study are the ascertainment of the criterion-RV of the BLPAQ, and the cross-validation of the three instruments using a split-sample approach to compare the accuracy of each measure's results.

5.1.1 Hypotheses

The following research hypotheses were tested in the present study:

H_1. The BLPAQ correlation results would be similar and /or higher than those of the two criterion measures employed in this study (see Tables 5.1 and 5.2).

H_2. GLTEQ-Vigorous and GLTEQ-Moderate would be the strongest predictors of PPA.

H_3. GLTEQ-Light would be the strongest predictor of UPA.

H_4. GLTEQ-Sweat would be negatively correlated with UPA.

H_5. BQHPA-WI would be the strongest predictor of UPA.

H_6. BQHPA-SI would be the strongest predictor of PPA.

H_7. The BLPAQ items would demonstrate a similar or tighter LoA than those relating to the BQHPA subscales.

5.2 Methodology

5.2.1 Participants

The number of participants required for the criterion-RV and cross-validation phases was determined prior to data collection based on the following criteria:

1) Multiple linear regression (ML-regression) analysis requires a large sample size when the distribution is heavily skewed. Because the BLPAQ data reported in Study 2 (see Section 4.3.3) was abnormally distributed, the number of participants for the present study was determined using Tabachnick and Fidell (2007, p. 123) guidelines for ($N > 50 + 8m$; where m is the number of independent variables). In the present study there is a single independent variable (IV: Gender), therefore the minimum number of participants required was computed to be $N = 58$.

2) The multivariate analysis of variance (MANOVA) is reasonably immune to modest violations of normality; however, to ensure *robustness* it requires at least 20 cases for each cell (Tabachnick & Fidell, 2007, p. 251). In the present study there are two levels for the single IV and nine dependent variables (DVs: PPA, UPA, BQHPA-WI, BQHPA-SI, BQHPA-LI, GLTEQ-Light, GLTEQ-Moderate, GLTEQ-Vigorous, and GLTEQ-Sweat) making a total of 18 cells. Thus, the required number of participants for the MANOVA was 360 (18 x 20 = 360).

3) Concerning the sample size requirement for the LoA procedure, Altman (1991, p. 456) suggested that a sample size of at least 50 participants would be necessary providing that the agreement is tested on parametric data (i.e., normally distributed). Bland and Altman (1999) recognised that LoA methods might prove less reliable when using non-parametric data, especially with small samples. Therefore, Nevill et al. (2001) proposed that, when the data does not satisfy the assumptions of normal distribution, the LoA analyses would require at least 100 participants. Due to

the sample size requirements of the MANOVA, the number of participants in the present study was estimated to be $N \geq 360$. Table 5.1 presents the ethnic background for the entire sample of participants, and for the gender subsamples employed in the present study.

Table 5.1

Ethnic Background and Gender Details of Participants for Brunel Lifestyle Physical Activity Questionnaire Criterion Validity Analysis

	Participants % (N = 388)	Men % (n = 170)	Women % (n = 218)
Ethnicity			
White UK/Irish	63.9	68.2	60.6
Black-Caribbean	2.1	0.6	3.2
Black-African	5.7	7.6	4.1
Indian	11.9	9.4	13.8
Pakistani	3.9	2.9	4.6
Bangladeshi	0.8	0.6	0.9
Chinese	1.3	0.0	2.3
Mixed race	2.3	0.0	4.1
White European	6.7	8.2	5.5
White-Other	0.8	1.8	0.0
Asian-Other	0.8	0.6	0.9
Gender		43.8	56.2

In the present study, *N* = 388 participants were recruited from Langley Leisure Centre (Slough, Berkshire County) over a 3-month period. The participants' ages ranged from 18–69 years (*M* = 26.5, *SD* = 10.4 years). The sample comprised 170 men (age range = 18–69, *M* = 27.3, *SD* = 12.0 years) and 218 women (age range = 18–60, *M* = 25.9, *SD* = 8.9 years), which corresponded to 43.8% and 56.2% of the sample respectively. The age range for males was 18–69 years, and their mean BMI was 23.5 units (*SD* = 3.2), while the age range for females was 18–60 years, and their mean BMI was 22.3 units (*SD* = 2.4). The mean height and weight for males were 1.78 m (*SD* = 0.1) and 74.8 kg (*SD* = 12.0 kg), while for females the respective means were 1.65 m (*SD* = 0.1 m) and 60.9 kg (*SD* = 8.5 kg).

5.2.2 Procedures

Each participant was approached by the researcher upon arriving at the reception area of the leisure centre. Informed consent was obtained from all participants (see Appendix H). Subsequently, information was given regarding the purpose of the study and the respondents were provided with the assurance both that their data would be kept confidentially and that they were free to withdraw without penalty. Further, the participants were given ample opportunity to ask any questions to clarify their understanding of the data collection procedure and the nature of the research. Participants were then invited to complete the three questionnaires before taking part in a group exercise class or using any of the other leisure centre facilities (e.g., gymnasium, swimming pool, etc.).

Upon request, the researcher clarified the meaning of any item and its applicability to the participant in question. Subsequent to responses being given, the participants were thanked for their assistance and offered a point of contact to facilitate any further enquiry regarding the research. The sample included solely clients of the leisure centre who were making use of the facilities as opposed to those making casual visits to the bar etc. The data collection spanned from September 20, 2006 to November 20, 2006.

5.2.3 Measures

The criterion measures used for the criterion-RV of the BLPAQ have been described extensively in Subsections 2.3.6.3.2 (BQHPA) and 2.3.6.4.2 (GLTEQ). However, for the purposes of this study, the two reference measures were subjected to a small number of minor modifications, which are described in detail in the following two Subsections (5.2.3.1 and 5.2.3.2). Regarding the BLPAQ, all information regarding its initial validity and reliability has been reported in Study 1 and Study 2 respectively (see Subsections 3.3 and 4.3). In Study 2 it was found that both variables of the BLPAQ possess strong reliability coefficients (PPA: $r = .96$; UPA: $r = .96$) and a very high PoA ($\geq 95.0\%$, Nevill et al. 2001). In the present study, the participants were asked to respond to the six PPA items and the three UPA items while reporting any PA performed during *the past seven days*.

5.2.3.1 The Baecke Questionnaire of Habitual Physical Activity

The BQHPA was selected because it provides an assessment of habitual activities which was a requirement of the present design. Habitual PA is that which has been established over a period of planning and deliberation regarding its importance and usefulness, and which consequently requires less decisional effort to be performed (Barg, 1994; Verplanken & Aarts, 1999; Verplanken & Orbell, 2003), hence satisfying the need to compare the planned and unplanned subcomponents of PA in the BLPAQ.

The BQHPA (see Appendix H) contained an item (1) relating to the nature of the respondent’s occupation, which was not integrated in the final analyses because it was deemed to be irrelevant for the present study. Similarly, item 9 ("Do you play sport?"), and the following two sub-questions "which sport do you play most frequently?" and "if you play a second sport:" were also not utilised. Instead, the researcher utilised the intensity-level scores relating to these two sub-questions and collapsed them into a single item score. However, all the items in the BQHPA-SI (sport index) were considered to be useful for the comparison with the PPA in the BLPAQ. In accordance with the recommendations of Shephard (2003), the main focus of the present study was the frequency and duration of planned and unplanned LPA in terms of health-related benefits, rather than an investigation of vigorous activities and their effects on fitness levels and the estimation of EE.

5.2.3.2 The Godin Leisure Time Exercise Questionnaire

Originally, this instrument was designed to record bouts of exercise frequencies lasting 15 min or longer during a typical week. For the purpose of this study, the time span for each exercise bout was changed to 30 min (see Appendix H) in accordance with ACSM's (2005) guidelines for recommended PA levels. This modification was also desirable as it reduced the possibility of reporting errors by the respondents.

5.2.4 Data Analysis

The data analysis comprised of five discrete analytic phases. During the initial phase of data analysis, the participants' scores were checked for missing cases ($z > \pm$ 3.29) and multivariate normality ($p < .001$) as recommended by Tabachnick and Fidell (2007, p. 77). Following a visual check, it was found that the first question of the BQHPA-SI (i.e., "do you play sport?") demonstrated a considerable number of missing cases in each gender group. Thus, in accordance with the conservative recommendations of Tabachnick and Fidell (p. 67), the group mean values for each item were calculated from the available data and used to replace the missing values. This action prevented a possible reduction in variance that would have occurred if the new mean values had been calculated from the available data. Subsequently, the dataset was tested for skewness, kurtosis, homogeneity, and normality. Following a visual verification of skewness, kurtosis, and normal distribution, it was deemed that transformation was required (see Tabachnick & Fidell, p. 86).

In the second analytic phase, the dataset was checked for multicollinearity ($r \geq .80$ and above; Tabachnick & Fidell, 2007, p. 88). Tabachnick and Fidell (p. 253) suggested that a high correlation ($r > .90$) between two or more DVs may cause redundancy. Additionally, Fox (1991, cited by Tabachnick & Fidell, p. 90) suggested that, if $r > .90$, the estimation precision of the regression coefficients will be halved. After computing multiple PP-MC (one-tailed) correlations it was found that all the dependent variables reported an $r < .70$, which indicated that the correlations between the dependent variables were unlikely to heavily influence the MANOVA and ML-Regression.

During the third phase of data analysis, the data were subjected to a MANOVA to ascertain whether the mean differences between the groups were attributable to chance (Tabachnick & Fidell, 2007, p. 246). A 2 x 7 (Gender x BLPAQ [PPA, UPA] / GLTEQ [Light, Moderate, Vigorous, Sweat subscales] / BQHPA [Work, Sport, Leisure Indices]) MANOVA was performed to ascertain if there were significant differences between groups on the composite DVs, and to provide separate univariate results for each DV (Pallant, 2007, p. 275).

In the forth analytical phase (criterion-RV of BLPAQ) the dataset was subjected to a ML-Regression, which was conducted to identify any *functional* relationships between the dependent variables. These functional relationships are mathematical in nature and might lead to inferences of cause-and-effect (Pallant, 2007, p. 146). Although ML-Regression is based on correlations (see Subsection 2.3.4 for a brief review of the limitations relative to correlation analyses), it allows for a more specific exploration of the interrelationships among a set of variables (Pallant, p. 146). However, the major limitation of all regression techniques is that one can only ascertain relationships, but can never be sure about the underlying causal mechanism (Hemmer, 2007, p. 85). Additionally, MLR analysis assumes that the relationship between variables is linear. In reality, this assumption is rarely met (Hemmer, p. 86). The interested reader is directed to Tabachnick and Fidell (2007, pp. 121-128) for a more comprehensive explanation of the limitations relative to regression techniques. The researcher did not adjust the regression models for any confounding factors, such as BMI, body weight, occupation intensity, or age.

In the fifth and final analytical phase, the data were subjected to the LoA method (Bland & Altman, 1986, 1999), which was only employed to cross-validate the three measures. This method tested the generalisability of each instrument in two equivalent but independent samples. The original sample was randomly subdivided into two groups of equal size (n = 187). Bland and Altman stipulated certain assumptions to be followed when utilising LoA analysis for comparing the data from two instruments or from two samples (e.g., normal distribution, means of the two sample datasets not significantly different, etc.). Once these assumptions were verified, the LoA for each sample was calculated using the formula: $Md \pm 1.96SD$, where Md = mean of differences and SD = standard deviation of the differences. The LoA calculations were performed using an Excel spreadsheet, which was formulated according to Bland and Altman's mathematical prescriptions. All other analyses were executed using the Statistical Package for Social Sciences (SPSS: v 15.0).

5.3 Results

Initial checks for univariate outliers using *z* scores ($z > \pm 3.29$) revealed multiple outliers ($N = 14$). These cases, relating to eight males and six females, were deleted prior to further analyses (Tabachnick & Fidell, 2007, p. 77). Checks for multivariate outliers ($p < .001$) did not reveal any problematic cases. The resulting data from the final sample of 374 participants were subjected to a series of five discrete analytic phases. Tests for normal distribution indicated that all dependent variables deviated significantly from normality ($p < .001$). A significant deviation from normality is quite common in large samples when using the Kolmogorov-Smirnov statistic (Pallant, 2007, p. 62). Accordingly, standard skewness and kurtosis were also examined, and these were all within an acceptable range (≤ 1.96). On the basis of this latter test, the decision was taken to not transform the data.

Pearson's product-moment correlation (PP-MC) was used to assess the three datasets for any existing interactions between DVs and for potential group difference prior to additional analyses. The results from the PP-MC are presented in Table 5.4. Tests for the normal distribution of the data revealed that the PPA and UPA factors of the BLPAQ, the indices of the BQHPA, and the subscales of the GLTEQ deviated significantly from normality (BLPAQ: $D = .133–.123$, $p < .001$; BQHPA: $D = .083–.124$, $p < .001$; GLTEQ: $D = .147–.292$, $p < .001$), thus requiring transformation to normalise them (i.e., standard skewness and kurtosis ≤ 1.96). Standard skewness and kurtosis were retested and visually checked, and both exhibited a more acceptable range.

5.3.1 Pearson Product-moment Correlations

The results of the inter-correlations between the PPA and UPA factors and the reference measures are shown in Table 5.4. Twenty-six of the 36 correlations in the matrix are significant ($p < .05$). The notable exception is the moderate subscale of the GLTEQ which does not correlate significantly with UPA, the work, sport, and leisure indices of the BQHPA, or the light subscale of the GLTEQ. In addition, the work index of the BQHPA does not correlate with the sport index of the BQHPA or the light and moderate subscales of the GLTEQ.

5.3.2 Results from the MANOVA on all Three Samples

The results of the MANOVA are displayed in Table 5.3. The omnibus statistic indicated a main effect for gender (Hotelling's Trace = .17, $F_{9, 364} = 6.55$, $p = .000$, $\eta_p^2 = .15$). Planned activity did not differ by gender ($p = .24$), neither did UPA ($p = .10$), the work and sport indices of the BQHPA ($p = .10$ and .60 respectively), nor the moderate subscale of the GLTEQ ($p = .95$). However, gender significantly affected the leisure index of the BQHPA ($p = .03$), and the light, vigorous, and sweat subscales of the GLTEQ ($p < .01$). The direction of influence was as follows. Women reported higher LPA on the GLTEQ than men; a result that was also obtained for the vigorous and moderate subscales of the GLTEQ ($p < .001$) whereas men reported higher scores on the light subscale than women ($p < .001$). Notably, the gender differences in the leisure index of the BQHPA and the GLTEQ vigorous subscale were not meaningful ($\eta_p^2 < .02$). However, the differences that applied to the Light and Sweat subscales were meaningful ($\eta_p^2 = .04$–.09), especially in the case of the Vigorous subscale ($\eta_p^2 = .09$).

Table 5.2

Pearson's Product-Moment Correlations between Planned Physical Activity, Unplanned Physical Activity, Baecke Questionnaire of Habitual Physical Activity and Godin's Leisure Time Exercise Questionnaire Subscale Scores

Item / Subscale	UPA	BQHPA / Work	BQHPA / Sport	BQHPA / Leisure	GLTEQ / Light	GLTEQ / Moderate	GLTEQ / Vigorous	GLTEQ / Sweat
PPA	-.25 **	.11 *	.64 **	.30 **	-.47 **	.12 *	.13 **	.56 **
UPA		-.38 **	-.13 **	-.36 **	.24 **	.03	-.01	-.39 **
BQHPA / Work				.17 **	-.01	.06	.10 *	.22 **
BQHPA / Sport				.16 **	-.34 **	.06	.09	.37 **
BQHPA / Leisure					-.22 **	-.04	-.10 *	.30 **
GLTEQ / Light						.04	-.06	-.48 **
GLTEQ / Moderate							.30 **	.10 *
GLTEQ / Vigorous								.15 *

Note. PPA = planned physical activity; UPA = unplanned physical activity; BQHPA = Baecke Questionnaire of Habitual Physical Activity; GLTEQ = Godin Leisure-Time Exercise Questionnaire.

* $p < .05$. ** $p < .01$.

Table 5.3

Descriptive Statistics and MANOVA for Planned Physical Activity, Unplanned Physical Activity, Baecke Questionnaire of Habitual Physical Activity Indices, and Godin's Leisure Time Exercise Questionnaire Subscales

	Men		Women			
Dependent variable	*M*	*SD*	*M*	*SD*	*F* ratio (*df*)	η_p^2
PPA	1.41	.02	1.44	.01	1.38(14.48, 372)	.00
UPA	1.63	.02	1.59	.02	2.76(15.07, 372)	.01
BQHPA Work Index	1.39	.02	1.43	.01	2.86(13.31, 372)	.01
BQHPA Sport Index	1.50	.01	1.51	.01	.28(6.96, 372)	.00
BQHPA Leisure Index	1.54	.02	1.59	.01	5.02(14.89, 372) *	.01
GLTEQ Light	3.59	.11	3.00	.10	15.96(672.39 372) **	.04
GLTEQ Moderate	3.05	.11	3.06	.10	.00(649.08, 372)	.00
GLTEQ Vigorous	3.37	.15	3.94	.13	7.99(1271.32, 372) **	.02
GLTEQ Sweat	1.44	.06	1.88	.05	36.60(165.30, 372) **	.09
Omnibus statistics: Hotelling's Trace = .17, $F_{9, 364} = 6.55$, $p < .001$, $\eta_p^2 = .15$						

Note. PPA = planned physical activity; UPA = unplanned physical activity; BQHPA = Baecke Questionnaire of Habitual Physical Activity; GLTEQ = Godin Leisure-Time Exercise Questionnaire.

* $p < .05$. ** $p < .01$.

Table 5.4

Summary of Multiple Linear Regressions for Variables Predicting Unplanned Physical Activity (N = 374)

	Entire sample (N = 374)				*Women (n = 212)*				*Men (n = 162)*			
	unstandardised		stand.		unstandardised		stand.		unstandardised		stand.	
Variable	*B*	*SE B*	β	*t*	*B*	*SE B*	β	*t*	*B*	*SE B*	β	*t*
(Constant)	2.41	.15		16.31***	.06	.16		.36	1.42	.24		5.87***
BQHPA / Work	-.31	.05	-.29	-6.18***	.06	.05	.06	1.15	-.16	.11	-.12	-1.47
BQHPA / Sport	.02	.07	.02	.31	.73	.08	.51	9.54***	.33	.13	.20	2.67**
BQHPA / Leisure	-.23	.05	-.23	-4.69***	.03	.05	.03	.51	-.01	.07	-.01	-.17
GLTEQ / Light	.01	.01	.07	1.37	-.02	.01	-.11	-1.89	.03	.01	.14	2.40 *
GLTEQ / Moderate	.01	.01	.06	1.24	.02	.01	.11	2.32*	-.02	.01	-.12	-1.66
GLTEQ / Vigorous	.00	.01	.02	.30	.00	.01	.03	.62	.04	.01	.33	4.33***
GLTEQ / Sweat	-.07	.02	-.24	-4.23**	.08	.02	.29	4.95***	-.15	.03	-.40	-4.73***
	R= .55; R^2 = .30.				R= .78; R^2 = .61.				R= .60; R^2 = .35.			

Note. PPA = planned physical activity; UPA = unplanned physical activity; BQHPA = Baecke Questionnaire of Habitual Physical Activity; GLTEQ = Godin Leisure-Time Exercise Questionnaire.

* p < .05. ** p < .01. *** p < .001.

Table 5.5

Summary of Multiple Linear Regressions for Variables Predicting Planned Physical Activity (N = 374)

	Entire sample (N = 374)				*Women (n = 212)*				*Men (n = 162)*			
	unstandardised		stand.		unstandardised		stand.		unstandardised		stand.	
Variable	*B*	*SE B*	β	*t*	*B*	*SE B*	β	*t*	*B*	*SE B*	β	*t*
(Constant)	.11	.11		.95	2.83	.19		15.33***	.10	.18		.54
BQHPA / Work	.03	.04	.02	.64	-.27	.06	-.29	-4.78***	.03	.08	.02	.31
BQHPA / Sport	.67	.06	.47	11.97***	-.11	.09	-.08	-1.21	.58	.09	.39	6.40***
BQHPA / Leisure	.12	.04	.12	3.09**	-.38	.06	-.37	-6.12***	.23	.05	.26	4.26***
GLTEQ / Light	-.02	.01	-.16	-3.94***	-.01	.01	-.04	-.50	-.03	.01	-.23	3.96***
GLTEQ / Moderate	.01	.01	.07	1.82	.02	.01	.13	2.27*	.00	.01	.01	.17
GLTEQ / Vigorous	.00	.00	.04	.92	-.01	.01	-.12	-2.04*	.01	.01	.09	1.34
GLTEQ / Sweat	.07	.01	.26	5.79***	-.05	.02	-.19	-2.70**	.10	.02	.27	3.90***
	R= .75; R^2 = .57.				R= .64; R^2 = .41.				R= .75; R^2 = .56.			

Note. PPA = planned physical activity; UPA = unplanned physical activity; BQHPA = Baecke Questionnaire of Habitual Physical Activity; GLTEQ = Godin Leisure-Time Exercise Questionnaire.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 5.6

Limits of Agreement Analysis and Pearson's Product-Moment Correlations for Planned Physical Activity, Unplanned Physical Activity, Baecke Questionnaire of Habitual Physical Activity Indices, and Godin's Leisure Time Exercise Questionnaire Subscales

	LoA			Bias					Random Error							
Dependent variable	Lower	Upper	*t*	Ratio	*SE*	95% CI			Ratio	*SE*	95% CI lower LoA			95% CI upper LoA		
PPA	-.56	.51	.10	-.02	.02	-.06	to	.02	.53	.04	-.63	to	-.49	.44	to	.58
UPA	-.48	.50	.28	.01	.02	-.03	to	.04	.49	.03	-.55	to	-.42	.43	to	.56
BQHPA / Work	-.50	.49	.14	-.01	.02	-.04	to	.03	.50	.03	-.57	to	-.44	.43	to	.56
BQHPA / Sport	-.38	.39	.04	.01	.01	-.02	to	.04	.38	.03	-.43	to	-.33	.34	to	.44
BQHPA / Leisure	-.52	.52	.18	.00	.02	-.04	to	.04	.52	.03	-.59	to	-.45	.45	to	.59
GLTEQ / Light	-1.88	1.86	.07	-.01	.07	-.15	to	.14	1.87	.12	-2.13	to	-1.63	1.61	to	2.11
GLTEQ / Moderate	-1.86	1.97	.14	.05	.07	-.09	to	.20	1.91	.13	-2.11	to	-1.60	1.71	to	2.22
GLTEQ / Vigorous	-2.22	2.55	.01	.16	.09	-.02	to	.35	2.38	.16	-2.54	to	-1.90	2.23	to	2.87
GLTEQ / Sweat	-.72	.65	.17	-.04	.03	-.09	to	.01	.69	.05	-.82	to	-.63	.56	to	.74

Note. PPA = planned physical activity; UPA = unplanned physical activity; BQHPA = Baecke Questionnaire of Habitual Physical Activity; GLTEQ = Godin Leisure-Time Exercise Questionnaire.

5.3.3 Results from the Multiple Linear Regression Analysis for Variables Predicting Planned Physical Activity and Unplanned Physical Activity

The results of the ML-Regression analysis for variables predicting the UPA and PPA items are displayed in Tables 5.4 and 5.5 respectively. The Beta (β) statistic represents the *unique* contribution that each IV made to the prediction of UPA. Beta values are also presented in a standardised form that permits a comparison in terms of their order of magnitude (e.g., a standardised beta of .60 as opposed to .15 means that the former exerts four times as much influence in the predictive model than the latter).

5.3.3.1 Multiple Linear Regression Analysis for Variables Predicting Unplanned Physical Activity (Entire Sample)

The Work index of the BQHPA made the largest unique contribution to the predictive model (B = -.31, β = -.29, p < .001) followed by the Sweat subscale of the GLTEQ (B = -.07, β = -.24, p < .01), and the Leisure index of the BQHPA (B = -.23, β = -.23, p < .001). The remaining variables did not significantly contribute to the model (β < .08, p > .05).

5.3.3.2 Multiple Linear Regression Analysis for Variables Predicting Unplanned Physical Activity (Women)

The Sport index subscale of the BQHPA made the largest unique contribution to the predictive model (B = .73, β = .51, p < .001) followed by the Sweat (B = .08, β = .29, p < .001) and Moderate subscales of the GLTEQ (B = .02, β = .11, p < .05). The remaining variables did not significantly contribute to the model (β < .12, p > .05).

5.3.3.3 Multiple Linear Regression Analysis for Variables Predicting Unplanned Physical Activity (Men)

The Sweat index subscale of the GLTEQ made the largest unique contribution to the predictive model (B = -.15, β = -.40, p < .001) followed by the Vigorous subscale (*B* = .04, *β* = .33, *p* < .001), the Sport index of the BQHPA (*B* = .33, *β* = .20, *p* < .01), and finally the Light subscale of the GLTEQ (*B* = .03, *β* = .14, *p* < .05). The remaining variables did not significantly contribute to the model (*β* < .12, *p* > .05).

5.3.3.4 Multiple Linear Regression Analysis for Variables Predicting Planned Physical Activity (Entire Sample)

The Sport index subscale of the BQHPA made the largest unique contribution to the predictive model (*B* = .67 *β* = .47, *p* < .001) followed by the Sweat subscale of the GLTEQ (*B* = .07, *β* = .26, *p* < .001), the Light subscale of the GLTEQ (*B* = -.02, *β* = -.16, *p* < .001), and the BQHPA Leisure index (*B* = .12, *β* = .12, *p* < .01). The remaining variables did not significantly contribute to the model (*β* < .07, *p* > .05).

5.3.3.5 Multiple Linear Regression Analysis for Variables Predicting Planned Physical Activity (Women)

The Leisure index of the BQHPA made the largest unique contribution to the predictive model (*B* =-.38, *β* = -.37, *p* < .001) followed by the Work subscale (*B* = -.27, *β* = -.29, *p* < .001), the Sweat, (*B* = -.05, *β* = -.19, *p* < .01), Moderate (*B* = .02, *β* = .13, *p* < .05), and Vigorous (*B* = -.01, *β* = -.12, *p* < .05) subscales of the GLTEQ. The remaining variables did not significantly contribute to the model (*β* < .08, *p* > .05).

5.3.3.6 Multiple Linear Regression Analysis for Variables Predicting Planned Physical Activity (Men)

The Sport index of the BQHPA made the largest unique contribution to the predictive model (*B* = .58, *β* = .39, *p* < .001) followed by the Sweat subscale of the GLTEQ (*B* = .10, *β* = .27, *p* < .001), the Leisure index of the BQHPA (*B* = .23, *β* = .26, *p* < .001), and finally the Light subscale of the GLTEQ (*B* = -.03, *β* = -.23, *p* < .001). The remaining variables did not significantly contribute to the model (*β* = .09, *p* > .05).

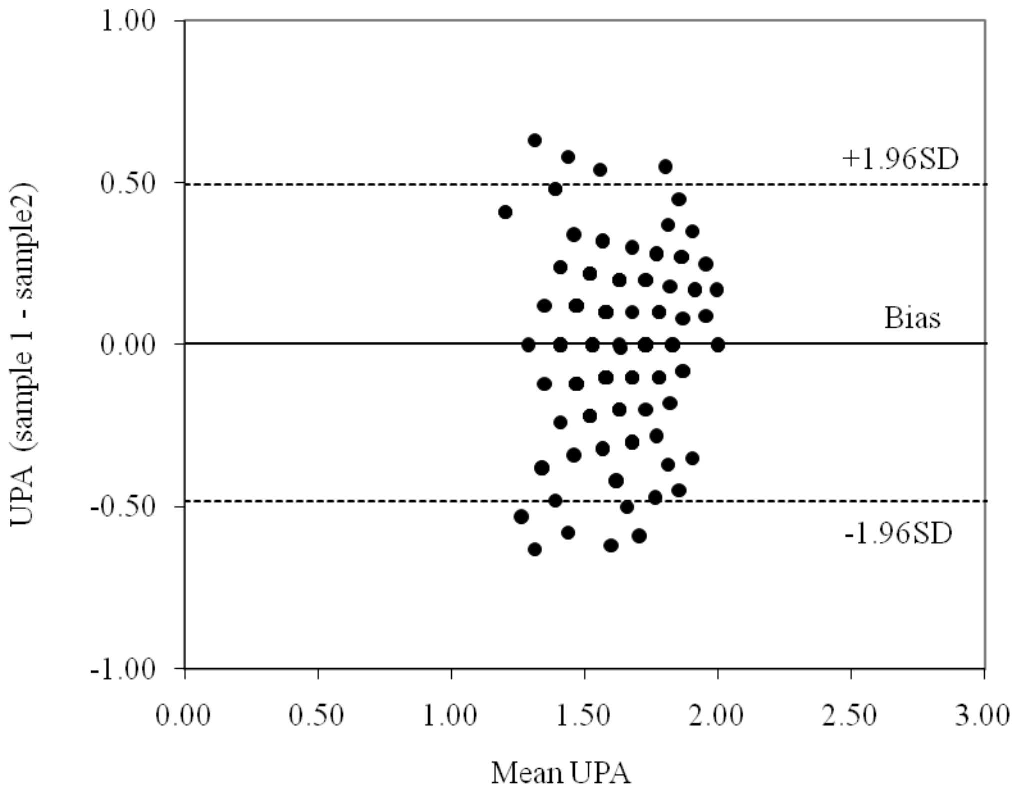


Figure 5.1. LoA analysis for UPA factor.

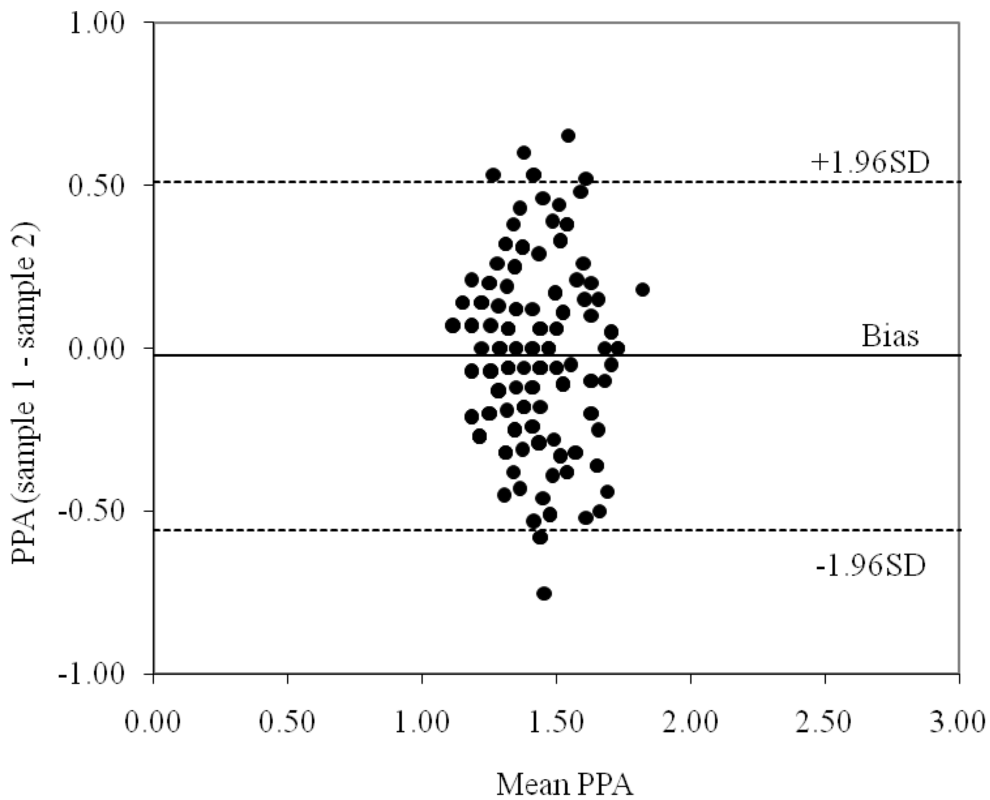


Figure 5.2. LoA analysis for PPA factor.

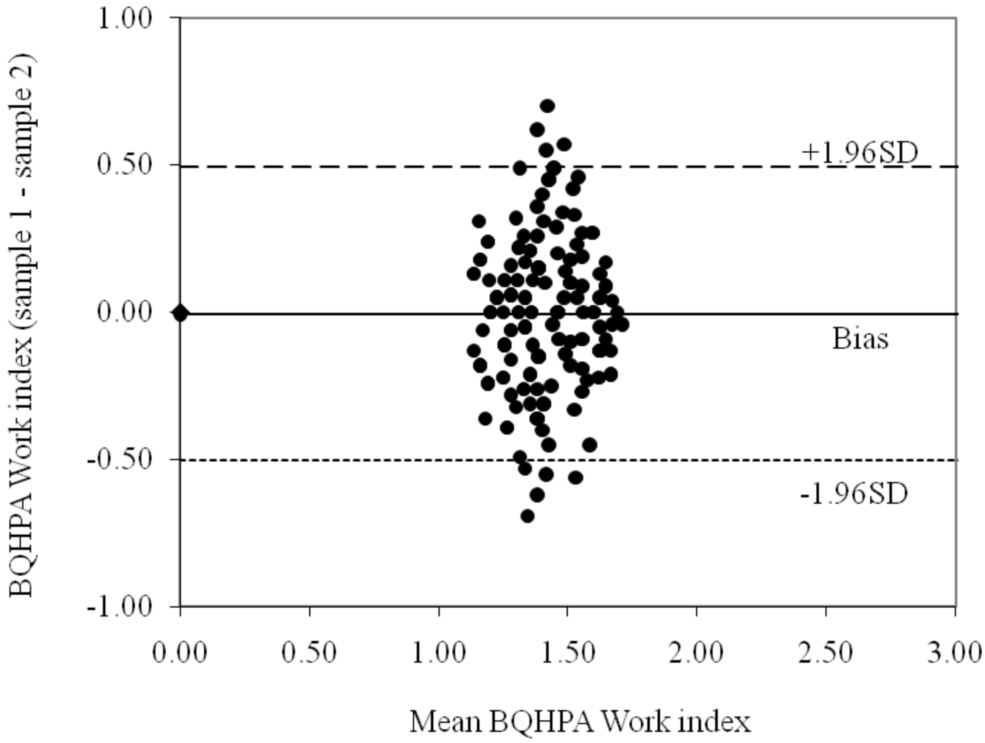


Figure 5.3. LoA analysis for BQHPA Work index.

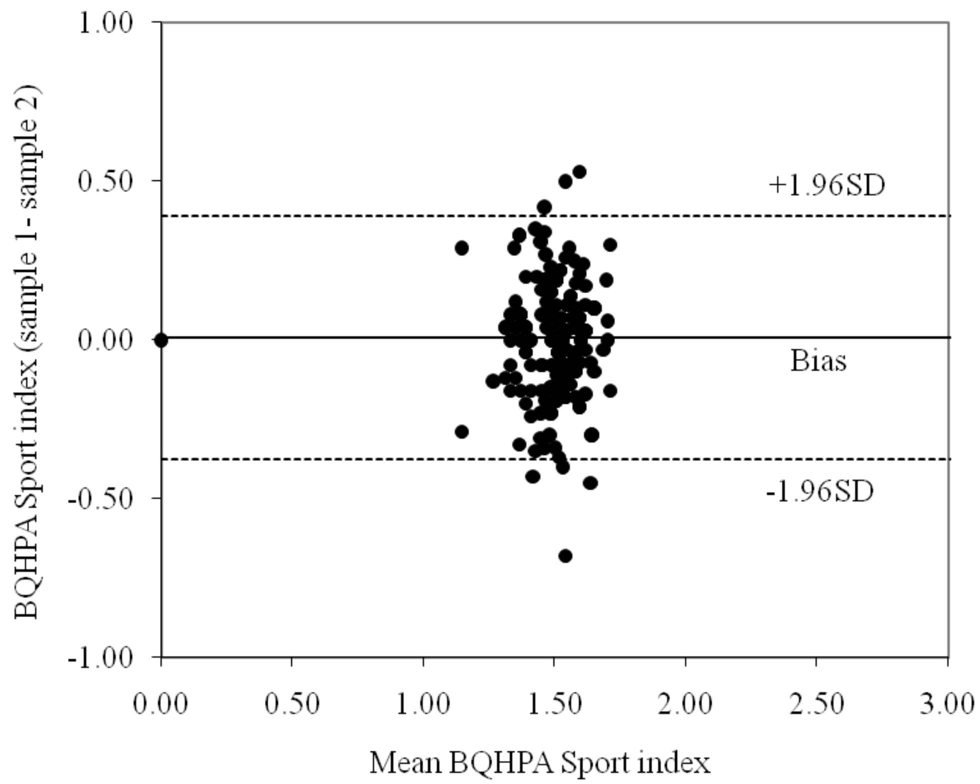


Figure 5.4. LoA analysis for BQHPA Sport index.

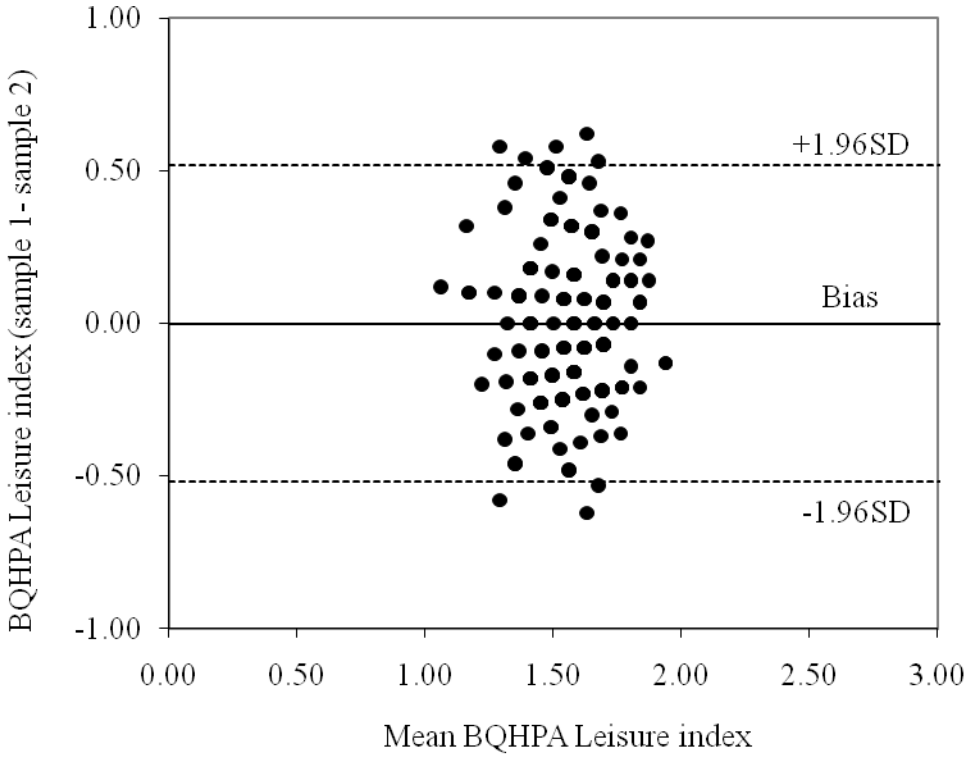


Figure 5.5. LoA analysis for BQHPA Leisure index.

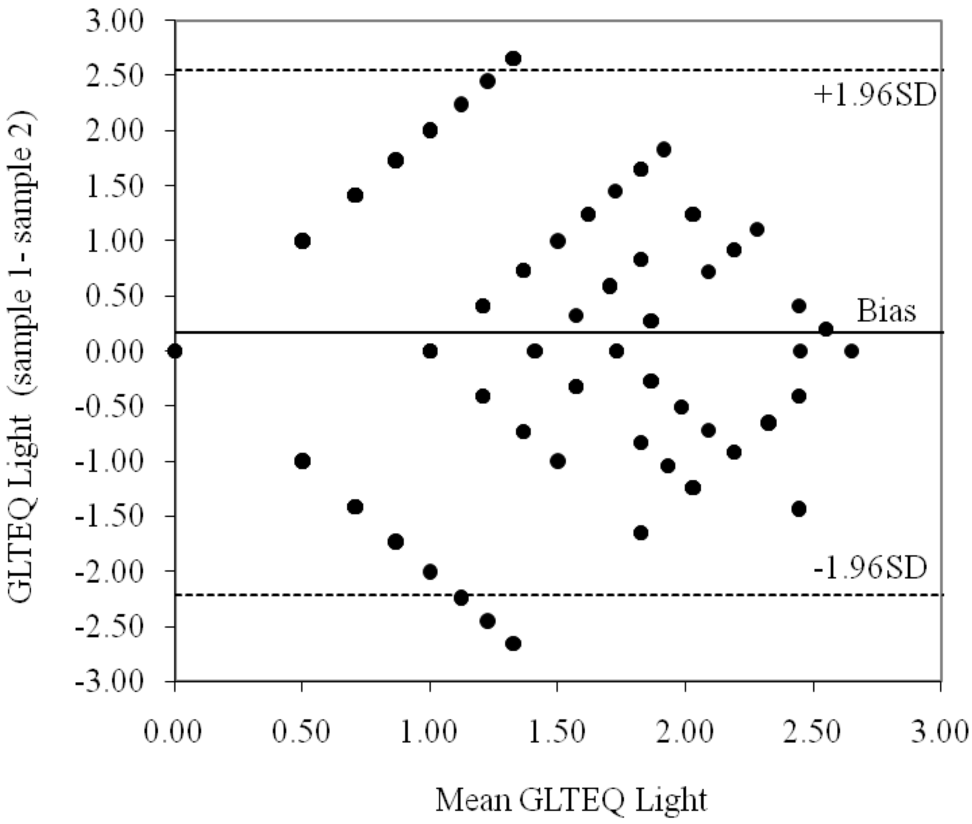


Figure 5.6. LoA analysis for GLTEQ Light subscale.

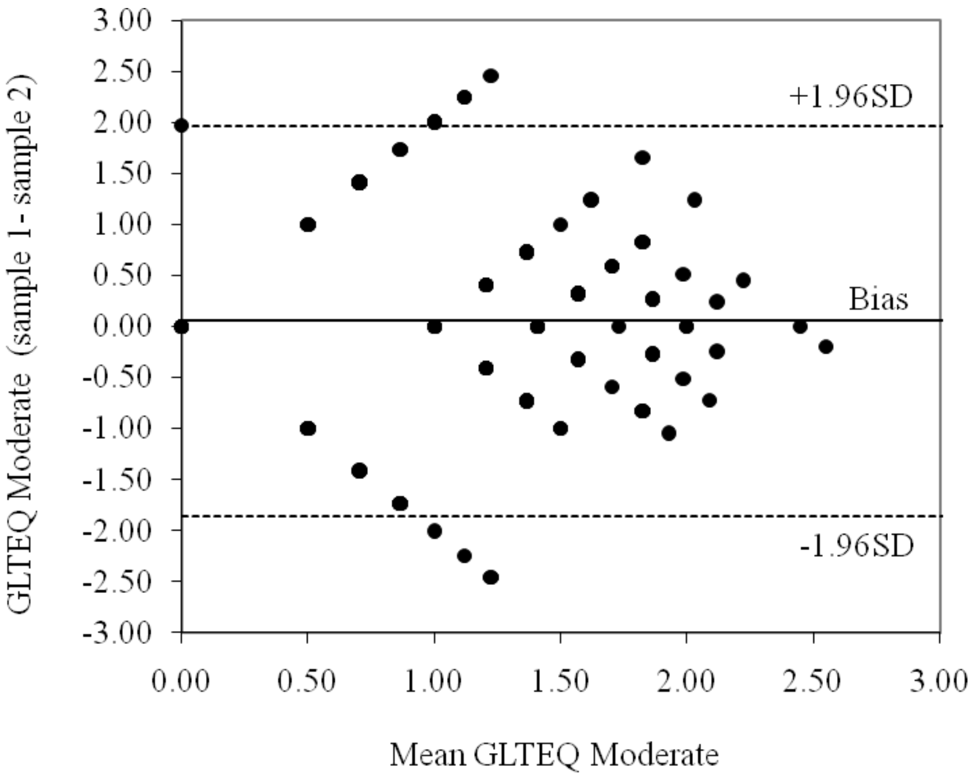


Figure 5.7. LoA analysis for GLTEQ Moderate subscale.

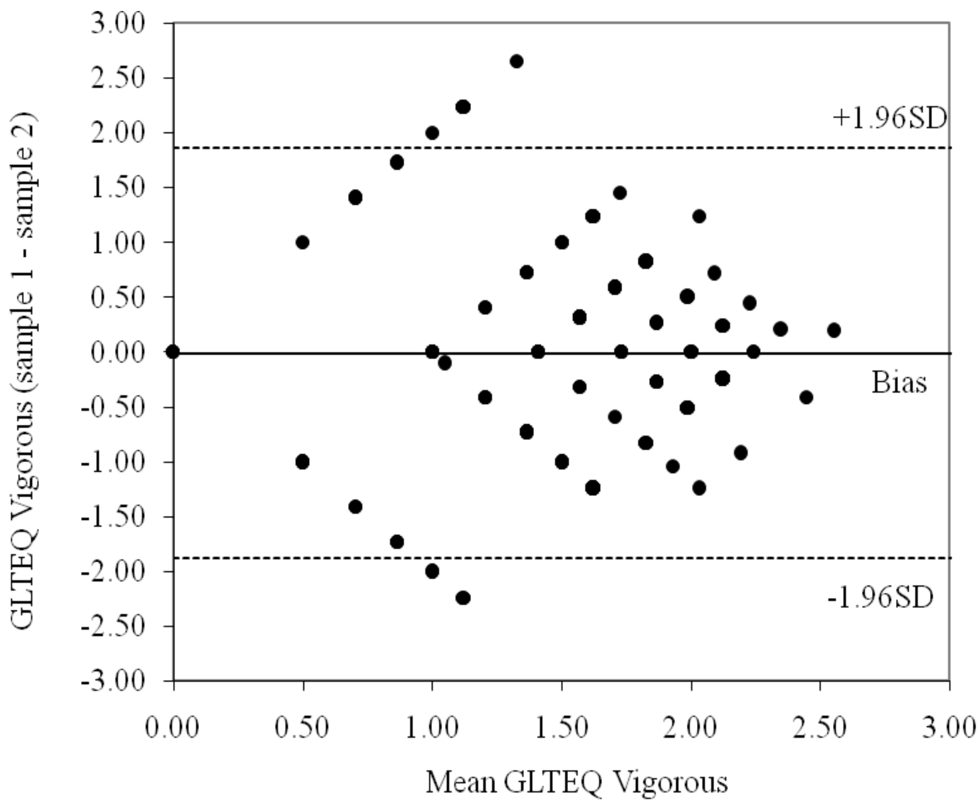


Figure 5.8. LoA analysis for GLTEQ Vigorous subscale.

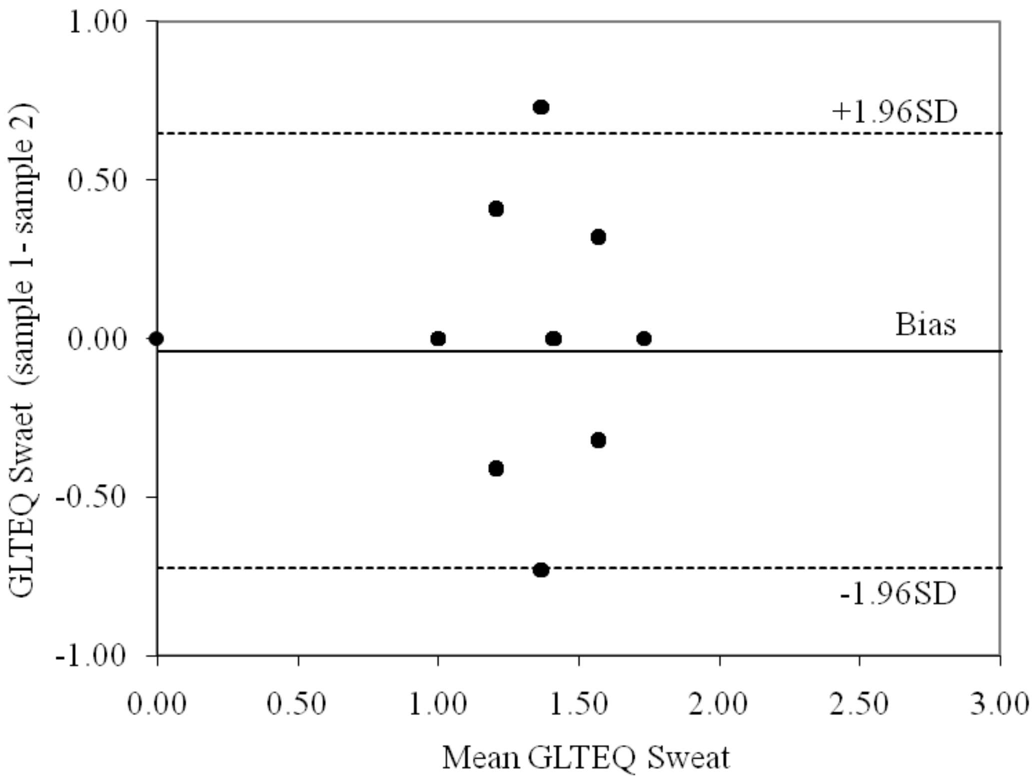


Figure 5.9. LoA analysis for GLTEQ Sweat subscale.

5.3.4 Limits of Agreement analyses

The results of the LoA analyses for the cross-validation of the BLPAQ and the criterion measures are shown in Table 5.6. Because the LoA analysis is essentially a visual one without established statistical assessment criteria (Bland & Altman, 2007), the results are primarily presented as a series of figures (5.1–5.9). In order to assess the acceptability or agreement associated with the LoA interval, a scientist should use his/her own judgement (Bland & Altman, 1986). In the case of the present study, the data were logarithmically transformed due to their distributional abnormality; a practice which is commonplace within the PA domain owing to the skewed distributions which typically present (Dishman, et al., 1998; Garcia-Aymerich et al., 2004).

The effect of the transformation is that the results of the LoA can no longer be directly related to the original scales used (e.g., a five-point Likert scale). Hence, the judgements that Bland and Altman (1986) referred to are impeded as the output of the analyses are no longer an analogue of the measures used. However, a visual analysis of the trends is still realizable as is a comparison of the LoA pertaining to each individual questionnaire subscale. A comprehensive literature search revealed very little information regarding the visual interpretation of the LoA scatter plot. However, an early conference paper by Altman and Bland (1983) provided a general guideline for researchers to follow. Essentially, vertical and horizontal symmetries are sought. In terms of horizontal symmetry, the grouping of the data points around the bias should not vary systematically across the x-axis; if it were to then one could conclude, for example, that there was less agreement as the range of the measurement variable increases. It is expected that the data points should be normally distributed about the mean (x-axis) and the bias (y-axis).

A visual check revealed that the variable demonstrating the strongest agreement was the Sport index of the BQHPA (see Figure 5.4; range = .77 [-.38–.39], lower LoA: 95% CI = -.43– -.33, upper LoA: 95% CI = .34 to .44). The Work index of the BQHPA demonstrated marginally less agreement than the Sport index (see Figure 5.3; range = .99 [-.50–.49], lower LoA: 95% CI = -.57– -.44, upper LoA: 95% CI = .43 to .56). Finally, the Leisure index demonstrated relatively less agreement, and in particular a wider distribution of scores along the x-axis (see Figure 5.5; range = 1.04 [-.52–.52], lower LoA: 95% CI = -.59– -.45, upper LoA: 95% CI = .45 to .59). Regarding the BLPAQ subscales, UPA demonstrated a stronger agreement (see Figure 5.1; range = .98 [-.48–.50], lower LoA: 95% CI = -.55– -.42, upper LoA: 95%

CI = .43 to .56) than PPA (see Figure 5.3; range = 1.07 [-.56–.51], lower LoA: 95% CI = -.63– -.49, upper LoA: 95% CI = .44 to .58).

In terms of a comparison between the BLPAQ and BQHPA factors, PPA bears a strong resemblance to the Work index of the BQHPA and a somewhat less to the Sport index whereas UPA approximates the Leisure index of the BQHPA. The Light, Moderate, and Vigorous subscales of the GLTEQ demonstrated a highly similar pattern whereby the agreement between the subsamples was markedly reduced at the lower end of the measurement range (see Figures 5.6–5.8; $M < 1.50$). The intervals between the upper and lower LoA for each of the aforementioned GLTEQ subscales were considerably larger than those pertaining to the BLPAQ and BQHPA (Light: range = 4.77; Moderate: range = 3.83; Vigorous: range = 3.74). The Sweat subscale of the GLTEQ presented a strong level of agreement (see Figure 5.9; range = 1.37 [-.72–.65], lower LoA: 95% CI = -.82– -.63, upper LoA: 95% CI = .56 to .74). The low number of data points present in Figure 5.9 relative to the other LoA analyses merely reflects the fact that each point represents the scores of multiple participants, which may be attributable to the parsimony of the 3-point scale used.

5.4 Discussion

The main purpose of the present study was twofold: First, to establish the criterion validity of the BLPAQ and second, to cross-validate the measure. The results represent convincing evidence that the BLPAQ is a valid measure of PA owing to the satisfactory correlations it has demonstrated with the two reference measures of choice. The resulting correlations between the BLPAQ factors, the BQHPA indices, and the GLTEQ subscales ranged from poor-to-reasonably valid (r = .10-.64). Shephard (2003) and de Courten (2002) proposed that PA measures generally inter-correlate within a similar range (i.e., r = .20-.50); only the correlation between UPA and the Sport index of BQHPA exceeded the ideal value of $r = .60$ (Rennie & Wareham, 1998). Overall, the PP-MC analysis identified six significant ($p < .01$) negative correlations between the PPA or UPA and the reference measures.

The results of the MANOVA analysis, which tested the response data for potential gender differences, showed that men and women reported similar levels of PPA and UPA ($p > .05$). These results indicated that the BLPAQ is valid for both men and women within a physically active population. Nevertheless, the results of the MLR analysis showed differences between genders in the prediction of the BLPAQ subscales by the two criterion measures. The LoA analysis provided an alternative means of cross-validating the BLPAQ against the criterion measures. All of the variables demonstrated satisfactory agreement (between subsamples). The BQHPA and BLPAQ subscales demonstrated broadly similar plot distributions and LoA.

5.4.1 Research Hypotheses

The findings in respect of each hypothesis will be briefly reported prior to more expansive discussion in the following Subsections 5.4.2 – 5.4.5. H_1 was accepted as the BLPAQ correlations yielded similar or higher coefficients than those of the two criterion measures (see Appendix C for BQHPA and Appendix D for GLTEQ). Table 5.2 presents 40 coefficients relating to these criterion measures (M = .37), 32 of these 40 being significant at the .05 level. In the present study (see Table 5.2) 12 of the 14 correlations between the PPA and/or UPA items and the criterion measures were significant at the .05 level (M = .32). Ten of the 14 correlation coefficients were equal or greater than 0.3, which compares with 25 of 40 in the case of the criterion measures (see Appendix C for BQHPA and Appendix D for GLTEQ).

H_2 was refuted as the Vigorous and Moderate subscales of the GLTEQ were not the strongest predictors of PPA (see Table 5.5). Rather, the Sport index of the

BQHPA and the Vigorous and Sweat subscale of the GLTEQ proved the strongest predictors of PPA (β = .47, .26, and -.16 respectively; $p < .001$). This finding will be further discussed in Subsection 5.4.4.

H_3 was refuted as the Light subscale of the GLTEQ was not the strongest predictor of UPA (see Table 5.4). Instead, the Work and Leisure indices of the BQHPA and the Sweat subscales of the GLTEQ proved the strongest predictors of UPA (β = -.29, -.24, and -.23; $p < .01$). This finding will be further discussed in Subsection 5.4.4. H_4 was accepted as the Sweat subscale of the GLTEQ was negatively correlated with UPA ($r = -.39$, $p < .01$; see Table 5.2).

H_5 was accepted given that the Work index of the BQHPA was the strongest predictor of UPA ($\beta = -.29$, $p < .001$; see Table 5.4). However, it should be noted that, in the case of men, the Work index was the fifth highest predictor of UPA and, in fact, did not make a significant contribution to the equation ($\beta = -.06$, $p > .05$). H_6 was accepted as the Sport index of the BQHPA proved to be the strongest predictor of PPA ($\beta = .47$, $p < .001$; see Table 5.5). H_7 was accepted in that the BLPAQ items (PPA and UPA) demonstrated similar limits of agreement when compared to those relating to the BQHPA indices.

5.4.2 Correlational Analysis for Ascertaining Multicollinearity

The correlational analysis was performed as a pre-requisite to the MANOVA in order to ascertain that the dependent variables did not inter-correlate too highly (i.e., $r \geq .80$) and thus violate the relevant multicollinearity assumptions (see Pallant, 2007, p. 282). However, the results will be briefly introduced here as they colour the interpretation of the following analyses. The two BLPAQ factors were inversely correlated, which is expected as they reflect *mutually exclusive* patterns of PA with divergent intensity levels ($r = -.25$, $p < .01$). UPA correlated positively with the Light subscale of the GLTEQ ($r = .24$, $p < .01$). This result is expected as unplanned PA is more likely to be of a light intensity; high intensity activities by their nature require some degree of planning (Barg, 1994; Barg & Chartrand, 2000). Accordingly, neither the Moderate nor the Vigorous subscales of the GLTEQ exhibited a relationship with the UPA factor.

UPA was negatively correlated with each BQHPA index (Work: $r = -.38$, Sport: $r = -.13$, and Leisure: $r = -.36$; all $p < .01$) and the Sweat subscale of the GLTEQ ($r = -.39$, $p < .01$). The inverse correlation between GLTEQ Sweat subscale and the BQHPA Sport index was anticipated as both these indices refer to vigorous forms of PA. The results in respect of the remaining two indices of the BQHPA (i.e., Work and Leisure indices) are less readily explicable in that the UPA descriptors incorporate activities that are reflected in both the Work and Leisure indices of the BQHPA (e.g., walking, cycling, lifting loads at work).

The inverse correlation between the Work index of the BQHPA and UPA may be attributable, in part, to the prevalence of extra-work activity (e.g., dog walking, gardening, shopping) in the descriptor list given for UPA. Similarly, the inverse correlation of the Leisure index and UPA may reflect the fact that the descriptor list of the latter is replete with activities which are ambiguous in terms of their pertinence to leisure; that is, behaviours which may be undertaken both as enjoyable past-times but also as chores, which in fact require some degree of planning (e.g., gardening, shopping, dog walking). Equally, it may be that there are fundamental inconsistencies relating to the wording and conceptualisation of the UPA items and/or the work and leisure indices of the BQHPA.

PPA correlated positively with all indices of the BQHPA (Work: $r = .11$, $p < .05$; Sport: $r = .64$, $p < .01$; Leisure: $r = 30$, $p < .01$) and the subscales of the GLTEQ

(Moderate: $r = .12$, Vigorous: $r = .13$, and Sweat: $r = .56$; all $p < .05$). These findings are in line with expectations in that PPA is likely to be moderate-to-vigorous in terms of its intensity; one does not systematically plan to engage in activities of a very light intensity as these generally assume a habitual pattern (e.g., Oulette & Wood, 1998; Verplanken & Orbell, 2003). For this reason, it is more probable that low-intensity activities are entered into on a spontaneous basis (Verplanken, 2006; Verplanken & Orbell). As expected, PPA was negatively correlated with the Light subscale of the GLTEQ ($r = -.47$, $p < .01$).

It is noteworthy that half of the cells within the matrix that did not inter-correlate pertained to the Moderate subscale of the GLTEQ; a finding which points towards the intrinsically ambiguous nature of the moderate-intensity PA concept (Shephard, 2003). It is of interest that the descriptors used for the Moderate subscale appear to consist of a mixture of leisure and sporting activities, both of which may be undertaken across a range of intensities from light to vigorous. Hence, there might be some contradiction inherent in the wording used. Also, the sample consisted of physically active participants. Hence, activities such as “easy cycling” could have been misconstrued as light activity.

5.4.3 Gender Differences

The results indicated that PA behaviour differed across gender accounting for 17% of the explained variance (see Table 5.3). In terms of the meaningfulness of the differences, the measure that was most affected by gender was the GLTEQ: Men reported higher frequencies of light PA (e.g., Buchowski, Acra, Majchrzak, Sun, & Chen, 2004; Wannamethee et al., 2002). The greater incidence of light PA reported by men in the present study may have simply been due to the descriptions used in the GLTEQ. The activities listed as exemplars for the Light subscale include many stereotypically masculine pastimes such as golf, archery, and fishing. It is therefore possible that gender-appropriate descriptors would negate the reported difference in light PA across genders.

Unexpectedly, women reported a higher incidence of vigorous and sweat-inducing PA. This finding contradicts the more traditional stereotype of men engaging in higher levels of PA than women (see e.g., Ainsworth, 2000). However, the unexpected gender disparity in the results may be explained by the fact that the participants were physically active (i.e., leisure-centre users). In particular, the female participants were highly likely to have been engaged in exercise-to-music classes or cardio-vascular training with the intention of high calorie expenditure. Both of these activities entail exercise at a relatively high percentage of maximum HR, which relates clearly to the description of strenuous exercise given in the GLTEQ ("Heart Beats Rapidly"). Conversely, the resistance training regimens that the male participants were more likely to have been engaged in may not have been as readily indentified as strenuous according to these terms.

A further issue is that of the *perception* of intensity. Gender stereotypes may have exerted a subtle influence on these results insofar as women may have more readily rated incidents of moderate activity as *vigorous* (Speck & Harrell, 2003). There is evidence to suggest that women are less likely to exert themselves in the presence of male group exercise instructors in order to conform to gender stereotyping (e.g., Brewer, Diehl, Cornelius, Joshua, & Van Raalte, 2004; Hardy, Hall, & Prestholdt, 1986; Lindwall & Ginis, 2008); potentially, these social-presentational concerns may extend beyond the laboratory to questionnaire response.

The higher frequency of light PA reported by men was reflected in the scores of the BQHPA Leisure index. This is unsurprising, as the descriptors used for the

Leisure index all reflect light-to-moderate PA (i.e., cycling, walking, and watching television). The lack of difference between men and women in the frequency of sport-related exercise as measured by the Sport index was unexpected (see e.g., Ainsworth, 2000). As with the Vigorous subscale of the GLTEQ, these findings may have been influenced by the specific population that was sampled. It is probable that women who attend leisure centres are more likely to engage in sporting activity than members of the general female population. With reference to the Work index, the lack of difference between men and women may reflect changing gender roles within the workplace; almost every participant reported a form of work-related activity.

In the present study, no differences were apparent in UPA or PPA between the genders. This result was somewhat unanticipated as patterns of PA adoption are thought to differ by gender (Barnekow-Bergkvist, et al., 1996; Joint Health Surveys Unit, 2004; Sallis, et al., 1992). However, any gender differences in the PA patterns of the participants in the present study may have been masked by their status as daytime gymnasium users and the correspondingly large proportion within the sample of students, the self-employed, and those with irregular shift patterns.

5.4.4 Prediction of Planned and Unplanned Physical Activity

Disregarding the gender subsamples, it appears that only three subscales made a significant contribution ($p < .01$) to the regression equation to predict UPA: the Work and Leisure indices of the BQHPA and the Sweat subscale of the GLTEQ. Each of these predictors correlated negatively with UPA. However, it is noteworthy that the relationship between UPA and the predictor variables differs markedly between genders. Hence, in order to interpret the regression equations in a meaningful way, a comparison will now be presented between gender groups.

In the case of women, the strongest predictor of UPA was the Sport index of the BQHPA (26% of variance explained; $p < .001$), followed by the Sweat subscale of the GLTEQ (8.4% of variance explained, $p < .001$), and finally the Moderate subscale of the GLTEQ (1.2% of variance explained, $p < .05$). Each of these unique contributions was positive in nature which means, in simple terms, that women who engage in a high frequency of UPA behaviour tend to partake in sweat-inducing physical exercises and in particular sporting activities. The implication of this finding is that sport-orientated women are highly active in other exercise settings, which is consistent with the idea of a dichotomy between active and sedentary women. A further ramification is that women's UPA does not necessarily consist of light-intensity activities. It should be borne in mind that the characteristics of the sample may have influenced this result. It is conceivable that women who do not attend gymnasia may exhibit high participation in UPA without necessarily engaging in any sport. This profile would more readily fit an intuitive notion of a distinction between high and low intensity PA.

In the case of men, a different picture unfolds in as much as four predictors of UPA emerge; two of them strong (GLTEQ-Sweat: 16% of variance explained, $p < .001$; GLTEQ-Vigorous: 11% of variance explained, $p < .001$) and the other two weak (BQHPA-Sport index: 4% of variance explained, $p < .01$; GLTEQ-Light: 2% of variance explained, $p < .05$). The unexpected aspect of this result is that whereas GLTEQ-Vigorous makes a positive contribution to UPA, the influence of GLTEQ-Sweat is negative. Logically, vigorous activity as listed in the GLTEQ (e.g., running, squash, and football) is highly likely to induce sweating. Hence, there is a possibility that the male respondents either misinterpreted the GLTEQ instrument or deliberately under-reported the incidence of sweating owing to social desirability (i.e., the desire to demonstrate a high level of fitness which would allow them to engage in high intensity activity without breaking into a sweat). As with women, the Sport index of the BQHPA loaded positively on UPA (although making a far smaller contribution; 4% vs. 26% of explained variance). However, unlike women, the Light subscale of the GLTEQ did make a positive albeit small contribution to predicting UPA; a result which is in line with expectations.

The overall contribution to the explanation of the regression models for the female subsample was almost twice that of relating to the male subsample (61% vs. 35% of variance explained). This finding demonstrates that the UPA measure may be more conducive to the assessment of unplanned activity in women than in men. Indeed, there is a small possibility that the UPA construct may have more utility in describing female as opposed to male PA. Alternatively, measurement issues may have been more prevalent in the male subsample. For example, men may have had greater difficulty in recalling UPA or interpreting the UPA items.

As with UPA, the regression equations for PPA differed markedly by gender. However, the regression model relating to men was similar to that which applied to the entire sample. In the case of men, four variables made a unique contribution to the model: The strongest was the Sport Index of the BQHPA (15% of variance explained, $p < .001$) followed by the Sweat subscale of the GLTEQ (7% of variance explained, $p < .001$), the Leisure Index of the BQHPA (7% of variance explained, $p < .001$), and finally the GLTEQ-Light subscale (5% of variance explained, $p < .001$). Each of these variables loaded positively with the exception of the GLTEQ-Light subscale. These findings meet with expectations: Men who undertake a high frequency of PPA also engage in leisure-time exercise, sweat-inducing activity, and sports but not lighter-intensity activities (Kenchaiah, Sesso, & Gaziano, 2009; Swain & Franklin, 2006).

However, less expected, was the absence of a positive contribution from the GLTEQ-Vigorous subscale to the model, especially considering the Sweat-inducing activities are, by their nature, of vigorous intensity. As with UPA, this result points towards the possibility of some misunderstanding on the part of the male subsample in the distinction between the Vigorous and Sweat subscales of the GLTEQ.

In the case of women, five variables made a unique contribution to the model, three strongly and two moderately: The strongest was the Leisure index of the BQHPA (14% of variance explained, $p < .001$) followed by the Work index of the BQHPA (8% of variance explained, $p < .001$), the Sweat (4% of variance explained, $p < .01$), Moderate (2% of variance explained, $p < .05$), and Vigorous (1% of variance explained, $p < .05$) subscales of the GLTEQ. Each of these variables loaded negatively with the exception of the GLTEQ-Light subscale.

Notably, the findings in respect of PPA differ markedly by gender, indicating that, for the present sample, the relationship between planned activity as assessed by the BLPAQ and other measures of PA was highly distinct for men and women. The negative polarity of the contributions was unexpected, especially in the case of the main contributor- the Leisure index of the BQHPA. The activities used as exemplars in the PPA section of the BLPAQ are leisure related (e.g., cycling, brisk walking, team games etc.). Hence, the result appears counter-intuitive in that participation in leisure activities should serve as a positive predictor of PPA.

A possible explanation may lie in the fact that the women in the sample not only took part in PA within the leisure but also worked (all had some form of employment), and may have been more likely than the male subsample to have had additional family commitments (e.g., childcare, household activities). In other words, the female subsample was likely to have led very busy lives. Hence, they may have had very little time to take part in conventional leisure-time activities as assessed by the BQHPA. Further, it is possible that their gymnasium-based PA needed to be planned and constituted their principal form of PA during leisure time. This explanation, although resting on several assumptions (i.e., shift-work, childcare, self-employed), does explain fully why the regression models predicting PPA differed between men and women.

With reference to the Work index of the BQHPA, a negative contribution to the equation indicated that women who partook of PPA were likely to have been relatively inactive at work. It may have been that such women were higher earners and hence had greater facility to engage in leisure-time activities or simply more energy. A possible reason that this result did not accrue in the male sample is a gender difference in job type (active vs. sedentary). Whereas 30% of the men performed active professions (e.g., farmer, personal trainer, bricklayer), only 12% of women did likewise. Of the remaining contributors to the equation model (the Moderate, Vigorous, and Sweat subscales of the GLTEQ), none explained a high percentage of variance (1-4%).

The BQHPA and GLTEQ scores explained 41% of the variance in the female subsample and 56% in respect of the men. This result demonstrates that, whereas UPA was more easily predicted by the criterion measures for women than for men, the opposite applied to PPA. Because no previous research has established criterion validity for planned and unplanned PA these results can be viewed as initial benchmarks for future scale development.

5.4.5 Cross-validation of the Brunel Lifestyle Physical Activity Questionnaire Using Limits of Agreement

Although the LoA analysis performed in the present study is novel, the lack of comparison points in the literature makes these findings difficult to interpret. A further drawback is that the results pertaining to the different measures cannot be directly compared in some cases because of the variety of scales used (e.g., the BLPAQ utilises a 5-point scale, whereas three of the GLTEQ items are assessed on an open-ended scale). However, several points of interest remain which will be presented in the following paragraphs.

First, it appears that the LoA scores pertaining to the GLTEQ-Light subscale are more widely-dispersed about the mean than those relating to the other two subscales with which it can be directly compared (i.e., Moderate and Vigorous). This result is explicable with reference to Shephard (2003), who reported in a review that light-intensity PA is difficult to recall accurately when compared to moderate and high intensity PA. Further, there will be a greater range of possible scores for light PA (as opposed to moderate- and high-intensity) because of the higher frequency of such behaviour (e.g., Le Masurier et al., 2008). However, the relative lack of agreement in scores on the Light subscale of the GLTEQ should be borne in mind by future researchers.

The PPA and UPA factors of the BLPAQ are comparable to the BQHPA subscales as they share a common five-point scale. Both the PPA and the UPA exhibit similar ranges of agreement (1.07 and .98 respectively) to those of the Work and Leisure indices of the BQHPA (.99 and 1.04 respectively). Notably, the BQHPA subscales have narrowly-defined contexts (Fletcher & Hattie, 2004; Hacking, Post, Schepers, Visser-Meily, & Lindeman, 2006) whereas the BLPAQ's factors have a broader remit which should lead to less agreement. Perhaps for this reason, the Sport index of the BQHPA, which has a highly specific context, is associated with narrower limits of agreement (range = .77; PPA: range = 1.07; UPA: range = .99). This outcome is consistent with the suggestion that, within the PA spectrum, sporting behaviour is amongst the easiest to identify and recall (Shephard, 2003).

A further explanation for the dense grouping of the data points on the LoA plot for the Sport index (see Figure 5.4) is that, in some cases, missing data were replaced by the mean score (see Subsection 5.3.4), a practice which may have increased central tendency. The visual similarity between the PPA and Work index plots (see Figures 5.2 and 5.3) may stem from the fact that both variables share some common features: by necessity work activity requires a higher degree of planning than some of the activities performed during leisure time. Further, any activity that is *planned* may, to some extent, be perceived as a type of work. There is also a degree of similitude between the PPA and Sport index plots (see Figures 5.2 and 5.4). This resemblance is readily explicable as sporting activity is, by its nature, likely to be planned. An additional comparison can be drawn between the UPA and Leisure index plots (see Figures 5.1 and 5.5). This similarity is also an expected one, as leisure activities are generally of an unplanned nature (Dunton & Schneider, 2006; Pescatello, & VanHeest, 2000).

The Sweat subscale of the GLTEQ, although it is measured according to a three-point scale, can be informally contrasted with the BLPAQ’s factors by applying a multiplication factor of 1.67 to the LoA scores. While this procedure does not render the scales identical (as they do not share the same *intervals*), they cover the same range (1 - 5). Whereas the LoA in respect of PPA and UPA range over approximately 1 point (1.07 and .98 respectively), the corresponding spread for the Sweat subscale is far larger (2.29) indicating a potential measurement issue appertaining to the present sample or an underlying lack of validity for the subscale itself. Notably, while the accompanying *t*-tests indicated that all the variables agreed across subsamples (1 and 2), the Sweat subscale was borderline significant ($t = .17$, $p = .06$) and hence on the verge of disagreement.

Collectively, the results of the LoA agreement are encouraging insofar as they add support to the validity claims of the BLPAQ measure. In addition, future researchers will be able to use the LoA scores as benchmarks against which to compare the agreement of other instruments and sample populations.

5.4.6 Strengths and Limitations of the Present Study

The present study represents a significant improvement on previously published research in its use of a more rigorous psychometric methodology to validate a PA questionnaire (Kriska & Caspersen, 1997; Schmidt & Steindorf, 2006; Shephard, 2003). The use of LoA analyses in the present study can be considered a strength, in that the correlational methods that are generally employed for cross-validation purposes merely measure association as opposed to agreement (Bland & Altman, 1986). With regards to the use of correlational statistics, a questionnaire presenting known systematic bias can correlate strongly with an unbiased reference measure (Bellach, 1993; Schmidt & Steindorf), thereby disguising a lack of agreement between the two measures.

The validity of PA questionnaires should not be judged solely on the basis of correlations, but rather on multiple statistical methodologies that compensate for each other's unique shortcomings (Hebert & Miller, 1991; Neilson, Robson, Friedenreich, & Csizmadi 2008; Schmidt & Steindorf, 2006). The current study has several limitations, of which the most notable is the reliance on self-report PA instruments as criterion measures. Nevertheless, self-report measures remain the most frequently employed method used to assess PA. There are a number of additional limitations that relate to the specific sample chosen.

5.4.6.1 Criterion Measures

A closer examination of the results points towards a fundamental incongruity between the BLPAQ factors and the criterion measures (GLTEQ and BQHPA). There was a theoretical distinction between the two sets of variables: whereas the GLTEQ and BQHPA are rooted in a physiological approach to energy expenditure the BLPAQ factors stem from a psychological theory- unplanned and planned behaviour. The focus of the BLPAQ is conscious awareness of PA in the form of planning. In particular, there appeared to be a lack of fit in relation to the GLTEQ in that its factors incorporated UPA and PPA to some extent; a dilemma that was heightened by the wording used for the GLTEQ's response set. Plotnikoff, Courneya, Trinh, Karunamuni, and Sigal (2008) found that the absence of occupational and household activities might have reduced the ability of the GLTEQ in ascertaining participants' PA behaviour. A further issue pertaining to the GLTEQ was the arbitrary nature of the scale used; its open-ended nature did not facilitate clear comparison with the other measures employed. With hindsight, it is possible that other instruments would have served as more apt criteria- the IPAQ (Craig et al., 2003) or the SQUASH (Wendel-Vos et al., 2003) for example.

5.4.6.2 Sample and Environment

The sample was constituted primarily of the physically active (i.e., leisure centre users). It is probable that these participants differed from the general population in terms of their PA behaviour. With particular reference to gender, the female subsample may have been less typical of the general population than the male subsample. Women reported a higher frequency of intense PA; a finding which highlights the distinctness of the present sample from the general population (DoH, 2004; Dornelas, Stepnowski, Fischer, & Thompson, 2007; USDHHS, 1996). For this reason, caution must be taken when applying the results of this study to less-active populations.

Burton, Oldenburg, Sallis, and Turrell (2007) emphasised the importance of the *environment* in which measures of PA are recorded. The leisure-centre setting in which the data were collected may have influenced the results to some extent by activating knowledge structures relating to moderate and vigorous PA for example (Murtagh, Boreham, & Murphy, 2002; Spelman, Pate, Macera, & Ward, 1993). The gymnasium context is associated with a certain type of motivation which relates less to social factors and pleasure and more towards body image and fitness, particularly among women (Bakken Ulseth, 2008). Hence, there is a possibility that the results of the present study may have differed were the data collected outside of the leisure-centre environment.

5.4.6.3 Perception of Fitness and Social Desirability

Because indirect measures of PA were used there was a possibility that *perceptions* of fitness and/or appearance mediated the results to some extent (Ninot, Fortes, & Delignières, 2006; Silberstein, Striegel-Moore, Timko, & Rodin, 1988). A protraction of this limitation is the possibility that social desirability may have influenced the results; a known contaminant of the responses to self-report instruments in general (Thomas, Nelson & Silverman, 2005, p. 206) and specifically in the PA domain (Motl, McAuley, & DeStefano, 2005). It is also possible that some of the women altered their responses, to some extent, because they were being questioned by a university investigator, as it was reported by Acker, Barry, and

Esseveld (1983). Again, the context (gymnasium environment) and the specific population (leisure centre users) must be brought into focus: gender stereotypes may not operate in the same manner in a population where a culture of PA exists.

5.4.6.4 Individual Differences: Age and Socio-economic Status

Older people tend to perform more light-to-moderate PA than younger participants (Meijer, Goris, Wouters, & Westerterp, 2001; Westerterp, 2003). In the present study, there was an unequal subdivision of participants by age: the 18-21-year-old age group was over-represented. Hence, age may have been an uncensored independent variable which influenced the causal relationships between the variables under examination. Further, the independent variable of socio-economic class was excluded from the analysis. Research has shown that people with higher incomes tend to participate more in leisure-time activities, and students tend to perform more higher-intensity PA; the present sample contained a relatively high proportion of students.

5.4.7 Conclusions and Recommendations for Future Research

Collectively, the evidence is consistent with the conclusion that the BLPAQ represents a criterion- and cross-validated measure of unplanned and planned PA. The LoA analysis demonstrated that the internal agreement of the BLPAQ was commensurate with the criterion measures. Of the two factors, UPA demonstrated a more consistent relationship with the criterion measures because it confirmed expectations. The results demonstrated that gender plays a strong role in determining PA patterns. Phongsavan, McLean, and Bauman (2007) emphasised the importance of taking into account gender differences when designing interventions aimed at increasing PA. Although UPA and PPA scores did not differ by gender for this sample, there were clear and present differences in the relationships between these factors and the criterion measures. Whereas the GLTEQ and BQHPA better predicted UPA than PPA in women, men displayed the opposite trend whereby the criterion measures regressed more successfully on PPA than UPA. Nevertheless, the physically-active sample used must be taken into account when considering the effects of gender.

The present study also highlighted potential weaknesses in the GLTEQ instrument, particularly in the Sweat subscale which demonstrated low levels of internal agreement and an unexpectedly poor correspondence with the Vigorous subscale of the same instrument. Indeed, the results pertaining to the Sweat subscale were problematic across the entire sample. In future, researchers may wish to focus on the following directions in order to further develop the BLPAQ as well as the GLTEQ.

Work is required to further the validation of the BLPAQ. Specifically, it is necessary that additional C-RV to be undertaken with different subsamples including sedentary individuals and older adults. Work with diverse populations will establish the BLPAQ as a tool that might aid UK community-based interventions (e.g., the work conducted by Wormald, Waters, Sleap, & Ingle, 2006).

Further C-RV work with the BLPAQ should be carried out using physiological measures such as waist circumference and BMI in order to assess the correspondence between the UPA and PPA factors and physiological indicators. In addition, data from the BLPAQ might be referenced against an objective measure of PA such as an accelerometer (e.g., MTI Actigraph, Manufacturing Technology Inc., Fort Walton Beach, FL, USA). Additionally, BLPAQ validation studies can incorporate more appropriate criterion measures reflecting the latest PA recommendations (Haskell et al., 2007) such as the IPAQ (Craig et al., 2003) or the

SQUASH (Wendel-Vos et al., 2003). Owing to the conceptual limitations in the present study, the GLTEQ should be remedied by additional validation work. The author recommends a *protocol analysis* in which participants are interviewed as they complete the instrument and provide detailed information about the interpretation of the items and their descriptors (e.g., Iqbal, Rafique, Badruddin, Qureshi, & Gray-Donald, 2006). This type of procedure has been successfully employed by the developers of other psychometric instruments within the health domain (e.g., Karageorghis, Priest, Terry, Lane, & Chatzisarantis, 2006). The scale used for the Light, Moderate, and Vigorous factors might be better analysed if the data were divided into frequency categories as opposed to the open-ended scale.

Finally, the BLPAQ factors should be tested against the theoretical framework from which they emanate, namely the theory of planned behaviour (TPB: Ajzen, 1985, 1991). This might be accomplished through path analysis whereby the TPB variables will be used to predict PA behaviour as measured by the BLPAQ.

The BLPAQ might be used for future research ascertaining the effectiveness of intervention to promote PA in adult populations. It is hoped that these interventions will now have a stronger theoretical underpinning which will in turn allow practitioners to make more precise and effective recommendations regarding increasing the frequency of PA. As a consequence of this, the BLPAQ may play a small role in improving public health through increased awareness of the determinants of PA behaviour.

CHAPTER 6: PREDICTING PLANNED AND UNPLANNED PHYSICAL ACTIVITY USING THE THEORY OF PLANNED BEHAVIOUR

6.1 Introduction

Considerable evidence exists to support the belief that LPA of moderate intensity contributes positively to both physical and psychological wellbeing in healthy adults as well as those suffering with CHD, type 2 diabetes, obesity, breast or colorectal cancer, osteoporosis, and depression (DoH, 2004; USDHHS, 2000). These benefits, however, are only experienced by a small percentage of the population - those who are regularly physically active (CDC, 2001). For this reason, a better understanding of the antecedents and determinants of PA behaviour may exert beneficial consequences on general health.

Brawley (1993) argued that "anyone interested in understanding and promoting interventions in health and exercise-related contexts must adopt the scientist-practitioner model… [where] theory guides practice" (p. 99). As detailed in Subsection 2.3, research involving the measurement of PA as a psychological construct has arisen from a largely atheoretical base: the most widely used PA instruments have yet to be validated using an appropriate theoretical structure pertaining to health behaviour such as the TPB, which has been extensively described in Subsection 2.4.2.

Behavioural interventions based upon a suitable theoretical framework – as opposed to those based directly on empirical findings – are significant for a number of reasons. First, the intrinsic order of theoretical frameworks provides structure and guidance. Second, because they are grounded in a wide body of work, a well-constructed theory may provide an explanation when an intervention does not prove successful; and finally, because if an intervention is based purely on the results of an isolated study or anecdotal evidence, there is no prescribed method of interpreting any unexpected findings (Brawley, 1993).

Mahar and Rowe (2002, p. 54) proposed that one of the final stages of the validation process should comprise testing of the theories relating to the PA construct of interest. Further, Messick (1989) introduced the notion that theory-testing should be at the heart of a strong construct-validation process. The underlying tenets of the various theories of health behaviour are as follows: a) any behaviour is based on cognitive activity; b) any behaviour is purposeful; and c) any behaviour is under the control of the individual (Bandura, 1986).

At present, none of the most widely-used PA measures (see Section 2.3) have been validated using the TPB and the past behaviour (PB) item. To offer guidance for the design of effective interventions, behavioural science models must be predictive of behaviour and indicate procedures that promote change in behaviour (Baranowski, et al., 1998). Additionally, as suggested by Oulette and Wood (1998), behaviour may be performed without conscious reference to attitudes, subjective norms, and PBC when the conditions associated with the behaviour remain the same (Bagozzi & Kimmel, 1995; Sutton, 1994). Therefore, the primary rationale of this study centred upon demonstrating the predictive validity of the BLPAQ with reference to a psychological theory, namely the TPB, and PB.

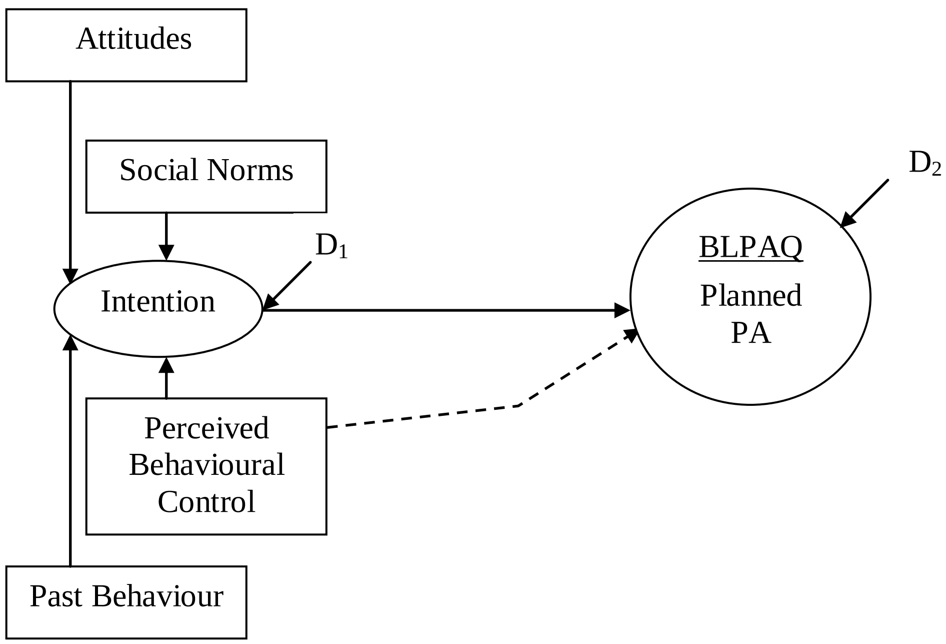
The purpose of the present study was to test the four models of PA which are represented in Figure 6.1. Figure 6.1a depicts two models which predict PPA from the TPB factors and Past Behaviour. Specifically, Intention is cast as a *mediator* or *intervening variable* (Baron & Kenny, 1986) in that it mediates the effects of the other TPB factors on PPA behaviour. The dotted line indicates that in one of the two models, a direct path is specified between PBC and PPA. Thus, PBC has both a *direct* and *indirect* effect on behaviour whereas in the second PPA model no such path is specified; hence, PBC has only an *indirect* effect on behaviour. Figure 6.1b depicts the two models that apply to the prediction of UPA. In this case, the distinction between them lies in the specification of a direct path between PB and UPA behaviour. When the direct path was specified in the model, the indirect path (via Intention) was omitted.

6.1.1 Significance of the Present Study

While responses from instruments such as the BQHPA, IPAQ, and GLTEQ have been interpreted in the light of relevant behavioural theories (e.g., Conn, Tripp-Reimer, & Maas, 2003; Nigg, Lippke, & Maddock, 2009; Rhodes, Courneya, & Jones, 2004), the resulting inferences are questionable owing to the fact that the measures in question were not specifically developed and validated using appropriate psychological framework such as the TPB.

The behavioural dimension of PA (as opposed to movement performed, and energy expenditure) is conceptualised as having planned and unplanned sub-dimensions of LPA (Dunn, et al., 1998; Pescatello, 2001). Thus, the measurement of PB in the present study will contribute to the validation of the unplanned and planned sub-components of LPA (i.e., PPA and UPA; Dunn et al.; Pescatello).

6.1a) Two models to predict planned PA from TPB and Past Behaviour



6.1b) Two models to predict unplanned PA from TPB and Past Behaviour

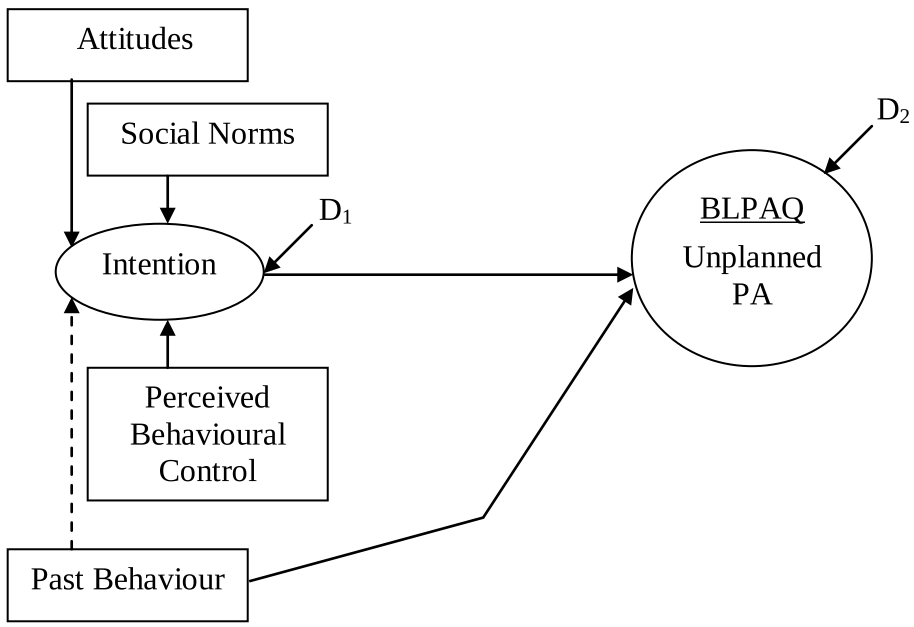


Figure 6.1. Hypothesised path models representing the relationships between the Theory of Planned Behaviour factors, past behaviour, and the planned and unplanned physical activity factors.

6.1.2. Hypotheses

The following research hypotheses were tested in the present study:

H_1) In accordance with the predictions of the TPB, it was hypothesised that attitude, social norms, PBC, and PB would predict PPA when mediated by Intention as proposed by (see Ajzen, 2006a; Hagger et al., 2002a).

H_2) PBC was expected to directly predict PPA behaviour in accordance with the findings of Armitage (2005) and Dean et al. (2007).

H_3) Attitude, social norms, PBC, and PB were not hypothesised to predict UPA behaviour when mediated by Intention. Due to the incipient nature of the UPA construct, there are no research findings available which can support the third hypothesis. However, it may be theorised that the TPB will not predict *unplanned* behaviour as it was specifically developed to predict *planned* behaviour only (see Aarts, et al., 1997). Further, in the third study of the present programme, UPA was inversely correlated with PPA (see Table 5.4).

H_4) Finally, past unplanned behaviour was expected to directly predict UPA behaviour. In a PA context, PB has been shown to predict future behaviour (see Norman & Conner, 2006).

6.2 Method

6.2.1 Participants

As structural equation models (SEM) are based on covariances, they are less stable when computed from small samples (Tabachnick & Fidell, 2007, p. 682). Additionally, the estimation of parameters and chi-square statistics is very susceptible to sample size. Hence, Tabachnick and Fidell (p. 682) suggested that SEM, like factor analysis, requires a large sample ($N > 300$). Velicer and Fava (1998) reported that, in obtaining a robust model through EFA, the size of the sample was as important as the size of the factor loadings and the number of variables. Further, Comrey and Lee (1992) provided the following guideline for factor analysis: a sample size of 100 can be considered as “poor”, 200 as “fair”, 300 as “good”, 500 as “very good”, and 1,000 as “excellent”. Tabachnick and Fidell (p. 613) suggested that a simple size of at least 300 participants is acceptable for factor analysis.

In accordance with the aforementioned sample size recommendations, 540 participants were recruited from two leisure centres in the southeast of England: Langley Leisure Centre (Berkshire County) and Uxbridge Virgin Active Health Club (Middlesex County) over a 12-week period (see Table 6.1). The participants ranged in age from 18-76 years (*M* age = 28.7, *SD* = 12.4 years). 240 of the participants were men (44.4% of the sample; age: *M* = 29.0 years; *SD* = 13.5; range = 18-76) and 300 were women (55.6% of the sample; age: *M* = 28.4 years; *SD* = 11.5; range = 18-73). The mean BMI for males was 23.9 (*SD* = 3.1 units) and 22.5 for females (*SD* = 2.9 units). The mean height for men was 1.8 m (*SD* = 0.1 m) and their weight was 75.9 kg (*SD* = 11.7 kg), while for women the respective means were 1.7 m (*SD* = 0.1 m) and 61.6 kg (*SD* = 9.4 kg).

Table 6.1

Ethnic Background and Gender Details for the Sample Used in the Brunel Lifestyle Physical Activity Questionnaire Validation Analysis

	Entire Sample % (N = 540)	Male Participants % (n = 240)	Female Participants % (n = 300)
Ethnicity			
White UK/Irish	73.1	76.3	70.7
Black-Caribbean	2.6	1.3	3.7
Black-African	3.1	3.8	2.7
Indian	7.4	5.8	8.7
Pakistani	3.0	1.7	4.0
Bangladeshi	0.6	0.8	0.3
Chinese	1.5	1.7	1.3
Mixed race	1.9	0.4	3.0
White European	5.0	5.4	4.7
White-Other	0.9	2.1	0.0
Asian-Other	0.9	0.8	1.0
Gender		44.4	55.6

6.2.2 Procedures

Each participant was approached by the researcher upon arriving at the reception area of the leisure centre. A brief explanation of the main purpose of the research was provided, and informed consent was obtained from all participants (see Appendix I). Participants were provided with two questionnaires (TPB and BLPAQ) and a stamped self-addressed envelope; the TPB was completed in situ whereas the BLPAQ was retained for subsequent response and return to the researcher (see Appendix I). Participants were invited to complete the TPB questionnaire before using any of the facilities within the leisure centre (e.g., gymnasium, swimming pool, etc.). To prevent response bias, the importance of giving honest and accurate responses was stressed before completion of the TPB questionnaire. Informed consent was obtained from participants, and they were assured that their responses would be kept in strict confidence.

Participants were provided with a pen, and they completed the TPB questionnaire in approximately 5 min. After the researcher made checks for any missing data, they were verbally invited to complete and return the BLPAQ after a 5-week period. The period of 5 weeks was considered long enough to ensure that participants could not replicate their initial responses from memory, and short enough to prevent large changes in PA levels due to seasonal variability (see Pivarnik et al., 2003). A similar approach was used to validate the recently-developed MLPA questionnaire (i.e., SQUASH: Wendel-Vos et al., 2003) and in establishing the reliability of the BLPAQ (see Subsection 4.3.2).

The researcher answered any questions regarding the meaning of items that were perceived to be unclear (e.g., clarifying the meaning of planned and unplanned PA), and items that were potentially irrelevant to the respondent (e.g., occupation for the retired, non-working parents, and/or students, etc.). The sample participants included only leisure centre clients who used the indoor facilities. Before the completion of the 5-week interval between responses, the researcher contacted each participant by telephone to prompt them to complete and return the BLPAQ (see Appendix J). Their phone numbers were collected at the initial point of contact. The data collection spanned a 10-week period from January 14, 2007 to of March 30, 2007. These precautions were taken to minimise the effects of seasonal change on PA behaviour patterns (Mathews et al., 2001; Pivarnik et al., 2003).

6.2.3 Measures

The first stage of the present study used a questionnaire that assessed planned and unplanned PA based on the TPB as recommended by Ajzen (2006a, 2006b) and assessed the following variables:

6.2.3.1 Behavioural Intention

Behavioural Intention (BI) was measured using four items: BI_1) "I intend to do planned physical activities for at least 30 minutes, 5 times per week during my leisure time, over the next 5 weeks", BI_2) "I intend to do planned physical activities for at least 30 minutes, five times per week during my leisure time, over the next 5 weeks with the following regularity," BI_3) "I intend to do planned physical activity for at least 30 minutes, five times per week during my leisure time, over the next 5 weeks," and BI_4) "I intend to do planned physical activity for at least 30 minutes, ______ days per week, during my leisure time over the next 5 weeks."

Items BI_1-BI_3 were scored on 7-point Likert-type scales anchored by "Unlikely" (1) and "Very likely" (7) for BI_1, "Not at all" (1) and "Every day" (7) for BI_2, and finally "Definitely not" (1) and "Definitely" (7) for BI_3. Conversely, item BI_4 asked the respondents to state the number of days per week they intended to exercise for at least 30 min. The mean of the 4 items constituted the BI measure. In the present study, the Cronbach alpha coefficient for the behavioural Intention items was $\alpha = .93$.

6.2.3.2 Attitude

The respondents were presented with the statement: “My participation in planned physical activity, for at least 30 minutes, 5 days per week over the next 5 weeks during my leisure time is:” Responses were assessed using five bipolar adjectives. One adjective reflected moral evaluation (bad/good); two adjectives reflected instrumental evaluations (useless/useful, harmful/beneficial), and a further two adjectives reflected affective evaluation (unenjoyable/enjoyable, boring/interesting). All adjectives were rated on 7-point semantic differential scales. The mean value for each of the five items was taken as the measure of attitude, with higher scores indicating a positive attitude towards the participation of planned PA for at least 30 min during their leisure time. The attitude items achieved a satisfactory internal reliability score ($\alpha = .91$).

6.2.3.3 Subjective Norms

Participants were asked if they perceived that their friends, family members or other influential people influenced their decision to participate in planned PA. Subjective norms (SN) were measured using three items: SN_1) “Most people who are important to me think that I should do planned physical activities for at least 30 minutes, 5 days per week during my leisure time over the next 5 weeks,” SN_2) “Most people who are important to me pressure me to do planned physical activities for at least 30 minutes, 5 days per week during my leisure time over the next 5 weeks,” and SN3) “Most people who are important to me expect me to do planned physical activities for at least 30 minutes, 5 days per week during my leisure time over the next 5 weeks.” These items were scored on a 7-point Likert-type scale, anchored by “Strongly agreed” (1) and “Strongly disagree” (7).

The mean of the three items was taken as the measure of subjective norms with higher scores indicating greater influence of social referents on participation in PPA during leisure time. In the present study, the alpha coefficient for subjective norms was less satisfactory ($\alpha = .55$) and did not exceed the established cutoff criterion of .70 (Nunnally, 1978, p. 245). Notably, in a meta-analytic review, Conner and Armitage (1998) criticised SN measures for their poor reliability and lack of prediction. Therefore, their use must be recognised as a limitation in the present study.

6.2.3.4 Perceived Behavioural Control

The Perceived Behavioural Control (PBC) construct was tapped by three items: PBC_1) “How much control do you have over participating in planned physical activities for at least 30 minutes, 5 days per week during your leisure time over the next 5 weeks?”, PBC2) “If I wanted to, I could do planned physical activities for at least 30 minutes, 5 days per week during your leisure time over the next 5 weeks,” and PBC3) “I feel in complete control over whether I will do planned physical activities for at least 30 minutes, 5 days per week during my leisure time over the next 5 weeks.”

These items were scored on 7-point Likert-type scales anchored by “Very little control” (1) and “Complete control” (7) for $PBC_{1,}$ “Strongly disagree” (1) and “Strongly agree” (7) for PBC_2, and finally “Completely false” and “Completely true” for PBC_3. The mean of the 3 items was taken as the measure of BPC, with the higher scores indicating a greater degree of control. The Cronbach alpha coefficient score for this scale was satisfactory ($\alpha = .83$).

6.2.3.5 Behavioural Measures

Planned and unplanned PA were assessed after a 5-week time-gap using the BLPAQ (Karageorghis et al., 2005), which has been extensively presented throughout this research programme. Participants were asked to base their responses on the frequency, duration, and intensity of planned and unplanned PA during the past 5 weeks. In the present study, it was found that the internal reliability (Cronbach alpha) of the PPA factor was $\alpha = .82$, whereas the alpha coefficient for the UPA factor was less satisfactory ($\alpha = .53$). A low alpha coefficient was also reported in Study 1 ($\alpha = .68$); however, this may have been a consequence of item paucity ($n = 3$; Schutz & Gessaroli, 1993), or participants who may not have been wholly representative of the general population.

Loewenthal (2001, p. 10) suggested that factors composed of few items are more susceptible to variation in terms of their internal reliability. Further, Briggs and Cheek (1986, p. 115) proposed that the homogeneity of a scale composed of fewer than 10 items could be demonstrated by using inter-item correlations in the .2 to .4 range. In this study, the UPA items reported inter-item correlations spanning from .22 to .39, thus satisfying the initial requirements of homogeneity (Loewenthal, p. 12; Pallant, 2007, p. 95).

6.2.3.6 Past Behaviour

Past Behaviour (PB) was measured through one item expressed on a 6-point scale (Bagozzi & Kimmel, 1995) and preceded by the statement: “during the last six months, I have been doing physical activity”. Responses to this item were anchored by “Not at all” (1) and “Most of the days per week” (6).

6.2.4 Data Analysis

Analyses were conducted using the Statistical Package for Social Sciences (SPSS: V 15.1) and Structural Equation for Windows (EQS: v 6.1; Bentler, 2006). In the present study, the data analysis comprised of nine distinct stages: three preparatory stages (outlier identification and removal, inter-correlation, and MANOVA) and six stages of model evaluation. The data were scrutinised for possible outliers as recommended by Anastasi and Urbina (1997, p. 63) and Tabachnick and Fidell (2007, p. 77). In order to meet the assumptions of the subsequent MANOVA, variables were intercorrelated as described in Section 5.2.4. The correlation matrix was also used as a point of reference during the following SEM analyses. The third stage comprised of a MANOVA that was performed to ascertain whether the TPB factors, PB item, UPA, or PPA factors differed by gender. This analysis was undertaken to ascertain whether the subsequent SEM analyses were to be carried out separately for both gender groups (i.e., once for women and once for men).

The SEM and factor analysis itself consisted of six discrete stages. Initially, a path analysis was computed to predict PPA from the TBP factors and PB, which served as a moderator; the intention factor of the TPB was configured as a mediator (see Figure 6.1a). Following the initial path analysis, the output from the Lagrange Multiplier test (LM) was consulted in order to determine which cells in the covariance matrix made the greatest addition to the magnitude of the chi-square statistic. The path analysis was then recomputed with additional covariances specified within the model: The absolute and incremental fit indices consisted of chi-square (χ^2), Comparative Fit Index (CFI), Standardised Root Mean Squared Residual (SRMR), Root Mean Square of Approximation (RMSEA), and the Akaike Information Criterion (AIC). The recommended cut-off values for the first three indices are as follows: .95 for CFI, .08 for SRMR, .06 for RMSEA. The chi-square and AIC indices were used to assess model complexity wherein the lowest values represented the best-fitting model (Hu & Bentler, 1999).

Owing to the variations in the performance of fit indices relative to sample size and the distribution of misspecification, it has been suggested that a multiple index strategy including both absolute and incremental indices should be used to identify well-fitting models, including those with misspecified factor covariance(s), factor loading(s), or both (Hu & Bentler, 1999). In the interests of brevity, standardised solutions were only presented for the final models in each sequence of development (i.e., those with the highest fit indices).

The second stage of the analysis comprised a path analysis, which was used to predict PPA from the TBP factors and PB (see Figure 6.1a). However, in contrast with the previous stage, a direct path was specified between PBC and PPA. Subsequently, additional covariances were specified according to the results of the LMT and the model was recomputed.

The third stage comprised exploratory and confirmatory factor analyses of the PPA. Initially, an EFA was performed to assess the underlying factor structure of the PPA (see Pallant, 2007, p. 179-199). Subsequently, a CFA was computed to ascertain the strength of the overall PPA factor following the removal of the problematic items. Following the factor analyses, the modified PPA factor was then re-analysed following the same procedures that were used in Stages 1 and 2.

The sixth and final stage consisted of two path analyses to predict UPA from the TPB factors and the PB item. The first of these models included an indirect path between PB and UPA (mediated by *intention*). Conversely, in the second model, there was only a direct path between PB and UPA. Contrary to the method followed for the PPA factor, no factor analyses were carried out on the UPA factor owing to the small number of items therein.

6.3 Results

The data were subjected to a series of five discrete analytic phases. Initial checks for univariate outliers using *z* scores ($z > \pm 3.29$) revealed multiple outliers (*N*

= 20). These cases, relating to 12 men and eight women, were deleted prior to further analyses (Tabachnick & Fidell, 2007, p. 77). Checks for multivariate outliers ($p <$ .001) revealed four cases, relating to three women and one man, which were also deleted.

6.3.1 *Correlation matrix*

The results of the inter-correlations between the TBP factors, the PB item, and the PPA and UPA factors are presented in Table 6.2. None of the 21 correlation coefficients exceeded the .80 cut-off as suggested by Pallant (2007, p. 282). Hence, the data were deemed to satisfy the multicollinearity assumption underlying MANOVA.

6.3.2 Multivariate Analysis of Variance

The results of the MANOVA are presented in Table 6.3. The test variables were unaffected by gender (Hotelling's Trace = .01, $F_{7, 508} = .89$, $p = .52$, $\eta_p^2 = .01$). Accordingly, the SEM procedures which follow were conducted using the entire sample rather than male and female subsamples.

6.3.3 Path Analysis to Predict Planned Physical Activity Factor (Indirect Path between Perceived Behavioural Control and Planned Physical Activity)

The results of the path analysis used to predict the PPA factor are presented in Table 6.4. PPA Model 1 demonstrated unacceptable fit ($\chi^2 = 4494.28$, $df = 190$, $p =$ .001, RMSEA = .119, SRMR = .12, CFI = .73, AIC = 999.43) according to Hu and Bentler's (1999) recommendations. Following the specification of one covariance (PPA item 1 – PPA item 4) the revised model (Model 2) demonstrated fit indices which were more acceptable ($\chi^2 = 5137.57$, $df = 190$, $p = .001$, RMSEA = .064, SRMR = .06, CFI = .94, AIC = 177.53).

Table 6.2

Pearson's Product-Moment Correlations between Theory of Planned Behaviour, Past Behaviour, Unplanned Physical Activity, and Planned Physical Activity Factors

Item / Factor	TPB-SN	TPB-PBC	TPB-Intention	Past Behaviour	UPA	PPA
TPB-Attiude	.09*	.28**	.44**	.42**	-.00	-.07
TPB-SN		.01	-.22**	-.05	.04	.04
TPB-PBC			.36**	.39**	-.07	-.01
TPB-Intention				.67**	-.01	.08*
Past Behaviour					.01	.07*
UPA						.25**

* $p < .05$. ** $p < .01$.

Table 6.3

Descriptive Statistics and MANOVA for Theory of Planned Behaviour, Past Behaviour, Unplanned Physical Activity, and Planned Physical Activity Factors

	Men		Women			
Dependent variable	*M*	*SD*	*M*	*SD*	*F* ratio (*df*)	η_p^2
TPB-Attitude	5.73	1.00	5.71	1.11	.04 (1, 514)	.00
TPB-SN	4.82	1.43	4.81	1.57	.01 (1, 514)	.00
TPB-PBC	4.40	.96	4.38	1.01	.02 (1, 514)	.00
TPB-Intention	4.36	1.69	4.21	1.56	1.07 (1, 514)	.00
Past Behaviour	4.04	1.35	3.87	1.30	2.24 (1, 514)	.00
UPA	2.74	.70	2.62	.65	3.67 (1, 514)	.01
PPA	3.95	.65	3.91	.64	.51 (1, 514)	.00
Omnibus statistics: Hotelling's Trace = .01, $F_{7, 508}$ = .89, p = .52, η_p^2 = .01						

* $p < .05$. ** $p < .01$.

Table 6.4

Stage 6: Factor Loading for Responses to the Planned Physical Activity Factor of the Brunel Lifestyle Physical Activity Questionnaire after Varimax Rotation

	Two-factor model		Single factor after items removal	
Variables	PPA Factor 1	PPA Factor 2	PPA without item 1	PPA without item 4
Duration of PPA at this weekly rate (PPA2)	.88		.68	.68
Duration per session of PPA (PPA3)	.76		.73	.71
Duration of persistence in PPA (PPA5)	.68		.79	.82
Intensity of PPA (PPA6)	.51	.41	.75	.77
Times per week of PPA (PPA1)		.94		.48
Total time engaged in PPA (PPA4)		.76	.69	
Eigenvalue	2.92	1.12	2.46	2.67
% of variance explained	48.62	18.64	49.25	53.47
Cumulative % of variance explained	48.62	67.26	49.25	53.47

Note. Factor loadings below .40 are excluded; PPA = Planned physical activity.

6.3.4 Path Analysis to Predict Original Planned Physical Activity Factor (Direct and Indirect Paths between Perceived Behavioural Control and Planned Physical Activity)

The results of the path analysis used to predict the PPA factor are presented in Table 6.5. PPA Model 3 returned unacceptable fit (χ^2 = 5407.55, *df* = 190, *p* = .001, RMSEA = .104, SRMR = .09, CFI = .83, AIC = 721.96) according to Hu and Bentler's (1999) recommendations. Following the specification of one covariance (PPA item 1 and PPA item 4) the revised model (Model 4) demonstrated more acceptable fit indices (χ^2 = 5407.55, *df* = 190, *p* = .001, RMSEA = .101, SRMR = .09, CFI = .84, AIC = 674.95).

6.3.5 Exploratory and Confirmatory Factor Analyses of Planned Physical Activity Factor

The results of the EFA of the modified PPA factor(s) are presented in Table 6.4. Principal components analysis extracted a two-factor solution which accounted for 67.26% of the variance. Items 2, 3, 5, and 6 loaded onto PPA Factor 1 whereas items 6, 1, and 4 loaded onto PPA Factor 2. Notably, item 6 cross-loaded albeit the loading was higher for Factor 1 (.51) than for factor 2 (.41). A decision was taken to compute two additional EFAs to ascertain whether subsequent removal of items 1 and 4 would provide a better solution. These two items were selected for possible removal based on a series of CFAs which were conducted to test the fit of a single-factor model without each item in turn. The strongest solutions were provided by the models which lacked items 1 and 4 respectively.

Table 6.5

Stages 4 - 9: Fit Indices for the Measurement and Structural Models in Stages 4–9

Model	χ^2 (*df*)	CFI	RMSEA	90% CI for RMSEA	SRMR	AIC
Stage 4						
PPA Model 1: Indirect path only between PBC - PPA	4494.28 (190)*	.73	.119	.113–.124	.12	999.43
PPA Model 2: Revision of model 1 (covariance specified: PPA items 1 and 4)	5137.57 (190)*	.94	.064	.052–.065	.06	177.53
Stage 5						
PPA Model 3: Direct and indirect paths between PBC - PPA	5407.55 (190)*	.83	.104	.098–.110	.09	721.96
PPA Model 4: Revision of model 3 (covariance specified: PPA items 1 and 4)	5407.55 (190)*	.84	.101	.095–.107	.09	674.95
Stage 6						
CFA of single-factor PPA model without item 1	705.83 (10)*	.90	.165	.133–.198	.05	65.43
CFA of single-factor PPA model without item 4	613.08 (10)*	.89	.160	.128–.193	.05	61.14
Stage 7						
PPA Model 5: Without item 4; Indirect path only between PBC – PPA	5047.21 (171)*	.94	.064	.057–.070	.05	155.53
PPA Model 6: Revision of model 5 (covariance specified: PPA items 2 and 3)	5047.21 (171)*	.95	.059	.052–.066	.05	109.58

Table 6.5 (*continued*).

Model	χ^2 (*df*)	CFI	RMSEA	90% CI for RMSEA	SRMR	AIC
Stage 8						
PPA Model 7: Without item 4; Direct and indirect paths between PBC – PPA	5047.21 (171)*	.86	.096	.089–.102	.08	523.63
PPA Model 8: Revision of model 7 (covariance specified: PBC items 1 and 3)	5047.21 (171)*	.92	.072	.065–.079	.07	233.73
Stage 9						
UPA Model 1: Indirect path only between PB - UPA	4522.16 (136)*	.95	.064	.057–.072	.05	121.93
UPA Model 2: Direct path only between PB - UPA	4522.16 (136)*	.92	.081	.074–.089	.07	260.97

Note. CFI = Comparative fit index; RMSEA = Root mean square of approximation; SRMR = Standardised root mean squared residual; AIC = Akaike's information criterion; PPA = Planned physical activity; UPA = Unplanned physical activity; CFA = Confirmatory factor analysis; PB = Past behaviour; PBC = Perceived behavioural control. The Satorra–Bentler chi-square and the fit indices from the robust ML solution are reported, except for SRMR indices, which are from the ML solution. Measurement models were constrained for factor loadings and covariances. Structural models were constrained for structural paths.

* $p < .001$.

6.3.6 Path Analysis to Predict Modified Planned Physical Activity Factor (Item 4 Removed; Indirect Path between Perceived Behavioural Control and Planned Physical Activity)

The results of the path analysis used to predict the PPA factor from the TPB Intention factor and the PB item are presented in Table 6.5. Model 5 demonstrated unacceptable fit indices (χ^2 = 5047.21, *df* = 171, *p* = .001, RMSEA = .064, SRMR = .05, CFI = .94, AIC = 155.53) according to Hu and Bentler's (1999) recommendations.

The ML test indicated that one covariance pair (PPA item 2 and PPA item 3) needed to be specified. Accordingly, the revised model (6) demonstrated acceptable fit indices (χ^2 = 5047.21, *df* = 171, *p* = .001, RMSEA = .059, SRMR = .05, CFI = .95, AIC = 109.58). Furthermore, the standardised solution revealed that the specified path between intention and PPA was predictive (2.02, $p < .05$).

6.3.7 Path Analysis to Predict Modified Planned Physical Activity Factor (Item 4 Removed; Direct and Indirect Paths between Perceived Behavioural Control and Planned Physical Activity)

The results of the path analysis used to predict the PPA factor from the TPB Intention factor and the PB item are presented in Table 6.5. Model 7 demonstrated unacceptable fit indices (χ^2 = 5047.21, *df* = 171, *p* = .001, RMSEA = .096, SRMR = .08, CFI = .86, AIC = 523.63) according to the recommendations of Hu and Bentler (1999). The ML test indicated that one covariance pair (PBC item 1 and PBC item 3) needed specification. Consequently, the revised model (Model 8) yielded fit indices which were somewhat more acceptable (χ^2 = 5047.21, *df* = 171, *p* = .001, RMSEA = .072, SRMR = .07, CFI = .92, AIC = 233.73). However, the standardised solution revealed that intention did not predict PPA (1.43, $p > .05$). The direct path between PBC and PPA was nonsignificant (.05, $p > .05$).

6.2a) PPA Models 6 and (8)

6.2b) UPA Models 1 and (2)

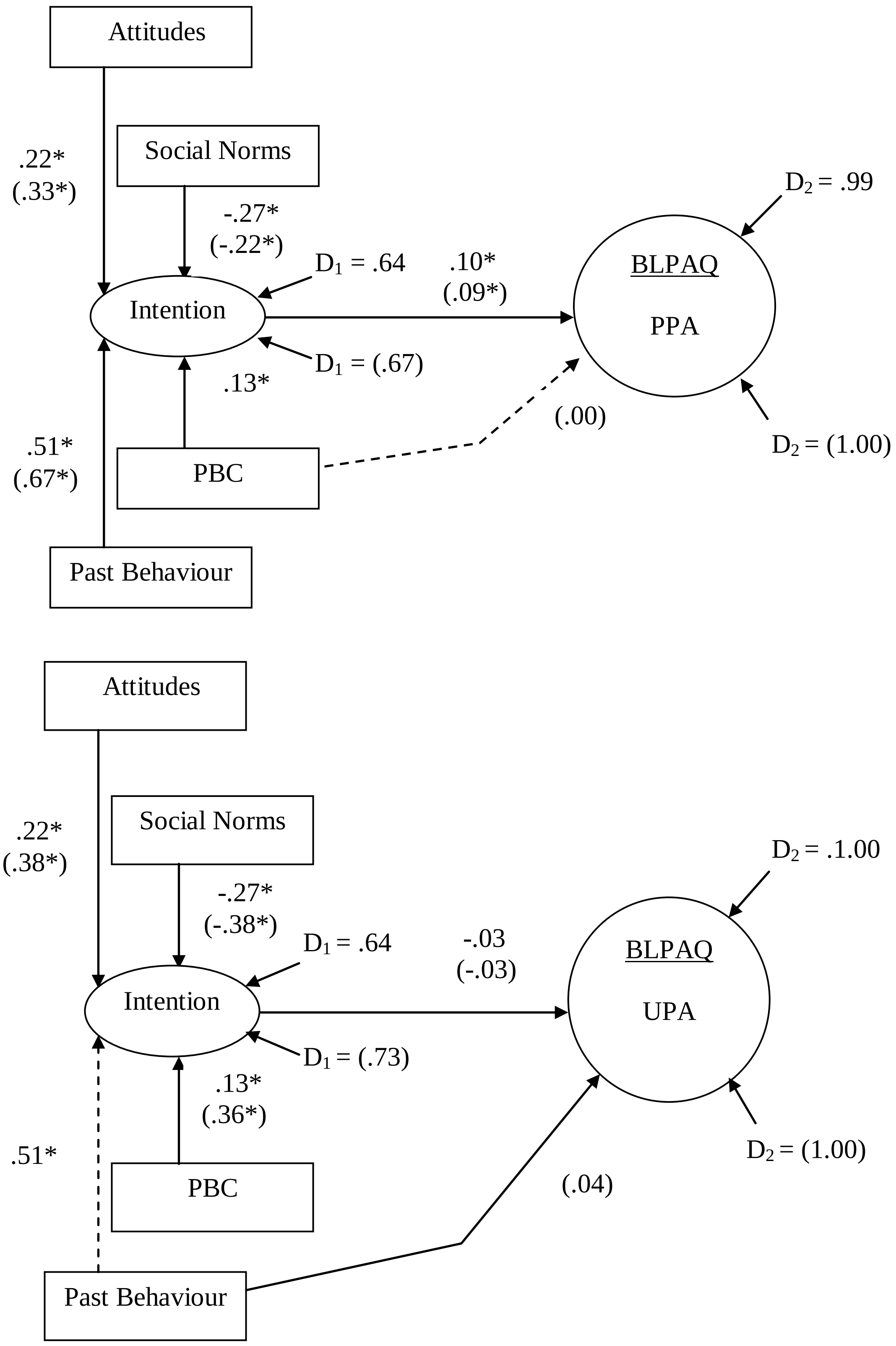


Figure 6.2. Path analyses of the relationships between the TPB, past behaviour and the planned and unplanned physical activity factors.

Note. All inter-correlation statistics relate to PPA Model 6 and UPA Model 1 except the figures in brackets which relate to PPA Model 8 and UPA Model 2.

6.3.8 Path Analysis to predict Unplanned Physical Activity Factor.

Table 6.5 contains the results of the path analysis used to predict the UPA factor from the TPB Intention factor and the PB item. UPA Model 1, which specified only an indirect path between PB and UPA, showed acceptable fit indices (χ^2 = 4522.16, *df* = 136, *p* = .001, RMSEA = .064, SRMR = .05, CFI = .95, AIC = 121.93). However, the standardised solution revealed that the specified path between BI and UPA was weak (-.03, *p* > .05).

UPA Model 2, which specified only a direct path between PB and behaviour, demonstrated unacceptable fit indices (χ^2 = 4522.16, *df* = 136, *p* = .001, RMSEA = .081, SRMR = .07, CFI = .92, AIC = 260.97) according to the recommendations of Hu and Bentler (1999). In addition, the standardised solution showed that the specified path between BI and UPA was weak (-.03, *p* > .05) as was the direct path between PB and UPA (.04, *p* > .05).

6.4 Discussion

The main purpose of this study was to test the predictive validity of the BLPAQ. Specifically, a series of structural models were subjected to path analyses (see Figure 6.2). The TPB factors and PB item were used to predict PPA via Intention, both with and without a direct path between PBC and behaviour. Following model revisions, which included covariance specification and item removal, acceptable fit indices were returned and, consequently, H_1 was accepted. H_2 was refuted as PBC did not directly predict PPA behaviour. The TPB factors did not predict UPA behaviour; hence, H_3 was accepted. However, H_4 was refuted as PB did not directly predict UPA.

The results indicated a clear structural association between the TPB, past behaviour, and PPA. Hence, the PPA factor of the BLPAQ has demonstrated predictive validity and, by extension, a psychologically-based theoretical underpinning. However, the positive nature of the result should be weighed against the fact that a series of modifications were necessary to establish an acceptable fit and, although the path coefficient between Intention and PPA behaviour was significant it was small in magnitude (.10, $p < .05$; cf. Hagger, Chatzisarantis, Biddle, & Orbell, 2001; Nigg, et al., 2009; Rhodes, Macdonald, & McKay, 2006). The results pertaining to UPA were not as congruent with expectations. Although, UPA behaviour was not predicted by the TPB (-.03, $p > .05$), past behaviour did not predict present behaviour.

The two-factor structure which emerged from the EFA that was computed in Stage 6 was attributable to the emphasis on “duration” of activity which characterised PPA items 2, 3, and 5 (Factor 1). Only items 1 and 4 loaded strongly onto Factor 2 and their complementarity can be explained by the fact that item 4 represented a summation of all the activity sessions reported in item 1; hence, these items are co-dependent to some extent.

The fact that item 6 did not load strongly onto either factor may be explained in part by the fact that all of the other items refer to time whereas item 6 assesses intensity. Ajzen and Fishbein (1977) emphasised the importance of standardizing items in terms of their reference to time, amongst other structural elements (TACT: Target, Action, Context, & Time). Essentially, item 4 was excluded because it was a compound of items 3 and 1(item 4 = item 3 x item 1). For the same reason, it is also likely to be subject to higher variability on a weekly basis than the other items (cf. Shephard, 2003).

The specification of a covariance between PPA items 2 and 3 in the sixth model is also indicative of a potential overlap in the interpretation of the item which may relate to the TACT principle. Both items relate to durations of time but whereas the former relates to the weekly frequency of PPA, the latter refers the length of each session. The acceptability of the sixth model's fit indices underscores the utility of the TPB as a predictor or PA behaviour (Blue, 1995; Bryan & Rocheleau, 2002; Godin & Kok, 1996; Hagger et al., 2002a, 2002b; Nigg et al., 2009; Okun, et al., 2002). Specifically, *Intention* (planning) is thought to be the most salient predictor of the performance or non-performance of a specific behaviour (Buckworth & Dishman, 2002, p. 223). In the present study, the prediction co-efficient relating to the path between Intention and behaviour was significant.

When compared to model 6, the specification of a direct path between PBC and behaviour, led to a sizeable decrement in the fit of Models 7 and 8, thus weakening the Intention-behaviour prediction to the point that it was nonsignificant. This result was somewhat unexpected as PBC has been shown to be a direct determinant of behaviour (Ajzen, 2006a; Armitage, 2005; Dean, et al., 2007; Everson, Daley, & Ussher, 2007; Lucidi, et al., 2006). In particular, Godin and Kok (1996) noted that although Intention was the main predictor of behaviour in the studies they meta-analysed, PBC made a significant contribution in almost half of the cases.

The lower fit indices of Models 7 and 8 may be attributable to the influence of barriers impeding the execution of planned behaviour (cf. Buckworth & Dishman, 2002, p. 201). Nevertheless, Ajzen and Fishbein (2005) asserted that the direct link between perceived behavioural control and behaviour is not a causal path (p. 192). Indeed, Sutton (2004, p. 111) suggested that attempts to change perceived control would probably not lead to behavioural change directly.

Hagger et al. (2003) highlighted the disparity between perceptions of behavioural control and the *actual* degree of control. The leisure centre users who participated in the present study may have had to balance a high number of competing lifestyle, occupational, and domestic commitments thus impairing their actual behavioural control. Indeed, Ajzen (1991) stated that "the addition of perceived behavioural control should become increasingly useful as volitional control over behaviour decreases" (p. 185). Notably, there is a lack of conceptual clarity regarding the notion of perceived control (Sutton, 2002, p. 200; Terry 1993; Terry & O'Leary, 1995). Indeed, Bozionelos and Bennett (1999) found that perceived behavioural control was only predictive of Intention.

With reference to UPA Model 1, the failure of the Intention and the PB items to predict UPA (.04, $p > .05$) was anticipated because the TPB assumes, by its nature, a degree of planning and cannot therefore serve as an indicator of UPA. Nonetheless, the high acceptability of the fit indices, which satisfied Hu and Bentler's (1999) recommendations, requires further explanation as it would appear to contradict the nonsignificant path coefficient linking Intention and behaviour. However, due to the nonsignificance of the prediction coefficient, the good fit of the model serves to underline the dissimilarity of the two constructs. The strong contribution of PB to Intention (.51, $p < .05$) was anticipated because PB has been shown to account for a high degree of the variance explained in Intention (Hagger et al., 2002a).

The second UPA model, PB is cast as an independent predictor of behaviour rather than a moderator of the Intention-behaviour path. The specification of the direct link between PB and UPA weakens the fit of the model. Further, PB failed to predict behaviour (.04, $p > .05$). This result was unanticipated as PB has been shown to be the strongest predictor of Intention and behaviour; explaining variance over and above of that accounted for by the other TPB variables (cf. Ajzen, 1991; Conner & Armitage, 1998; Hagger et al., 2002a; Norman & Conner, 2006). The answer to this discrepancy may lie in the fact that Intention has been shown to be a stronger predictor of behaviour than PB in the case of *infrequently performed* activity (Oullette & Wood, 1998). Because of its spontaneous nature, there is a possibility that UPA, as measured in the present study, may have been somewhat infrequently performed (e. g., vigorous household chores, or brisk walking to work: Slattery, Edwards, Ma, Friedman, & Potter, 1997).

Eves, Scott, Hoppé, and French (2007) found that walking is inadequately represented in memory, as there are several ways in which walking can be regulated, and many may not involve conscious awareness. For example, walkers have been found to regulate their velocity in response to changes in the visual environment (Prokop, Shubert, & Berger, 1997), adjust stride length based on changes in the consequences of walking (e. g., punctuality: Reiser, Pick, Ashmead, & Garing, 1995), choose the less challenging or a more direct path across open ground (Helbing, Keitsch, & Molnar, 1997) and minimise energy expenditure while walking (Holt, Fonseca, & Obusek, 2000; Holt, Jeng, Radcliffe, & Hamill, 1995; Warren, 1984). Eves, et al. (2007) suggested that the cognitive processes involved in this regulation are automatic and thus inaccessible to consciousness, making difficult to assess walking with self-reports and even harder to predict.

A further explanation may reside in the reported failure of PB measures to control for habitual PA which has become automatic (e.g., Aarts & Dijksterhuis, 2000; Ajzen, 2002). The *consistency* with which a behaviour is performed across situations contributes to the development of habit; a factor which is not accounted for in measures of PB (Verplanken & Orbell, 2003). In addition, the measure of PB used in the present study referred to the past 6 months, whereas Hagger and Chatzisarantis (2005) noted that the effects of PB on Intention may predominantly reflect recent performance.

Finally, in the present study, the TBP factors, PB, PPA and UPA did not differ according to gender. These findings are congruent with previous research, as TBP and PB have been shown to predict Intention and activity behaviour similarly across gender groups (e. g., Dean, et al., 2007; Downs, Graham, Yang, Bargainner, & Vasil, 2006). Nevertheless, there are few studies that found gender differences in PB and PA (e.g., Godin & Shephard 1985, Mummery, Spence, & Hudec, 2000).

6.4.1. Strengths and Limitations

The present study represents an important stage in the development process of the BLPAQ. The validation of the BLPAQ using a theoretical framework can be considered a strength of this study, in that the TPB significantly predicted PPA and not UPA, thus providing additional evidence of their exclusivity. Much research in the field of PA is based on findings which spring from measures that have not been validated using a pertinent theoretical framework (e.g., Baecke et al., 1982; Craig et al., 2003; Godin & Shephard, 1985). Therefore, most of the conclusions stemming from this body of research should be interpreted with caution before being accepted as evidence to support the effectiveness of their respective interventions. Nonetheless, the current study has several limitations which follow:

6.4.1.1 Response Priming

In order to facilitate the participants' responses under time constraints, the researcher prompted them by verbally listing examples of PPA and UPA behaviour. A possible drawback associated with this practice was that the participants may have been primed in their responses (Eves, et al., 2007). For example, McColl (2005, p. 15) and Krosnick (2000) suggested that the precise choice of wording used by experimenters unconsciously influenced participants' responses in a rowing task.

Future researchers are encouraged to offer a set list of activities from which participants can select them and report their intensity and duration on a weekly basis.

6.4.1.2 Measurement Issues

With reference to UPA, there may be an inherent difficulty in accurately recalling and estimating the duration and frequency of spontaneous activities (Shephard, 2003). It is conceivable that PPA is represented as part of a network or structure within long-term memory and is therefore more readily recalled. Additionally, the reliability of the data which is obtained via self-report measures of PA hinges entirely on the ability of respondents to provide relevant information about their own behaviour (Matthews, 2002, p. 108). Indeed, testing the TPB itself is both complex and challenging, especially in the exercise domain (Adams & White, 2003, 2005; Hutchison, et al., 2008; Spencer, et al., 2006),

With reference to PB, a lack of congruity may have existed between the PB measure used in the present study and the structure of the items which constituted the BLPAQ factors. Specifically, the PB measure referred to PA without reference to planning thus disregarding the distinction between planned and unplanned activity. In order for the PB measure to have been appropriate to the BLPAQ factors, it would have been necessary to divide it into two distinct items: unplanned PB and planned PB. The failure of PB to predict unplanned activity may have been caused by a lack of congruity between the UPA and PB items. It is essential that items are congruent in terms of their content (Darker, French, Longdon, Morris, & Eves, 2007) and structure (see e.g., Ajzen & Fishbein, 1977).

6.4.1.3 Measurement of Planned Physical Activity Intensity

The PPA item relating to intensity does not discriminate for differing intensity levels across exercise bouts (“how vigorously do you engage in pre-planned physical activity?”). Hence, participants are required to extrapolate an average estimation of intensity that may not necessarily reflect *any* of their actual activity. However, over-simplification of the current approach should weighed against time-efficiency gains; in fact, there is an intrinsic trade-off between the intrusivity of the measure and the meaningfulness of the information gathered: In order to obtain data that were more accurate and comprehensive, it may have been necessary to violate the time constraints placed on the present data collection procedure (< 5 min; Loewenthal, 2001, p. 71; Shephard, 2003).

6.4.1.4 Habitual Physical Activity

One criticism of the TPB is that it focuses exclusively on deliberative processes and consequently ignores the effects of automatic mental processes (habits) on behaviour (Fazio, 1990). It is conceivable that the repeated performance of a specific behaviour would lead to a reduction in the control processes implied by the TPB in favour of the automatic responses which typify habitual reactions (Eagly & Chaiken, 1993). Nevertheless, it is important to emphasise that Intention may act as a bridge between habitual processes and the TPB as it is integral to both conceptual frameworks (Aarts, et al., 1997; Verplanken, 2006).

6.4.1.5 Sample Characteristics

The sample comprised physically active participants (i.e., gymnasium users). Even among these users, there was an element of selection in favour of those making use of the facilities as opposed to attending for social reasons. Therefore, these respondents may have exhibited higher levels of PA than the general population. For this reason, caution must be taken when applying the results of this study to less-active populations.

6.4.1.6 Experimenter Effect

Because the experimenter was well known as a group exercise leader in the leisure centre where the data were collected, it is plausible that those who participated in the data collection allowed their prior acquaintance with the researcher to influence their decision to partake in the study and the responses they gave. In particular, because the role of a exercise leader requires amicable relations with clientele, there was a possibility that the responses were subject to the influence of social desirability.

6.4.2. Conclusions and Recommendations for Future Research

The TPB significantly predicted a modified version of the PPA subscale; a result which underlines the explanatory capacity of the TBP in the field of exercise and health psychology. The relationship between PBC, Intention, and PPA was unexpectedly problematic. However, the PBC construct is affected by a number of acknowledged issues (see e.g., Ajzen & Fishbein, 2005; Hagger et al., 2003). The failure of Intention to predict UPA underscored the theoretical distinction between planned and unplanned PA. However, the absence of a direct link between PB and UPA has raised questions concerning the measurement of both constructs. Evidently, the UPA factor of the BLPAQ requires more refinement than its PPA counterpart.

In the future, researchers may wish to focus their efforts on refining the PPA and UPA items. These items require further modification on several grounds: a) one option would be to specify intensity in respect of each session of PPA; b) when collecting PB data in conjunction with measures of planned and unplanned PA, it is important to ensure congruity between the items, that is if UPA is the criterion variable then the PB item used must refer specifically to unplanned PB; and c) the conceptual distinction between planned and unplanned PA may require further investigation as the two constructs share common features. One prospective avenue for future researchers would be a qualitative investigation of respondents' perceptions of the PPA and UPA constructs and the respective item pools utilised in the BLPAQ measure. This procedure would strengthen the face validity of the instrument by including the perspectives of non-expert respondents.

The role of individual factors in determining the relationship between Intention and PA behaviour requires further investigation. Although gender did not influence the inter-relationships of the variables selected for the present study, there is a possibility that a sample from the general population (i.e., not consisting exclusively of leisure-centre users) may respond differently. Notably, Ajzen (1991) stated that "the relative importance of attitude, subjective norm, and PBC in the prediction of Intention is expected to vary across behaviours and situations" (p. 188). Other personal factors which were not investigated in the present study include age, socio-economic status, and ethnicity (and the interactions between these). Finally, future investigations of PB, the TPB, and PA should incorporate estimations of the contribution of habitual processes. Hagger and Chatzisarantis (2005) proposed that such measures of habit should take into consideration both the frequency and consistency of PB.

In combination with the TPB, the BLPAQ provides researchers with a valid means to investigate and model PA patterns in adult populations. There is also the possibility that exercise and health practitioners will be able to develop more effective interventions which benefit from stronger theoretical underpinnings. Consequently, a better understanding of the antecedents and determinants of PA behaviour may ultimately exert a positive influence on public health.

CHAPTER 7: GENERAL DISCUSSION

7.1 Introduction

An insight into the determinants of PA behaviour is required to successfully promote both planned and unplanned LPA (Baranowski & Jago, 2005; Brug, Oenema, & Ferreira, 2005). There is also a requirement for further understanding of the behavioural factors that facilitate or obstruct an active lifestyle (Estabrooks & Glasgow, 2006; Wendel-Vos, et al., 2007). As such, there is a clear need for a valid and reliable instrument; one that also takes advantage of the internet as a data-collection medium (Tsai, Chee, & Im, 2006). Accordingly, the original contribution to knowledge made by the present research programme centres on the development of a theoretically-grounded instrument that can be used to measure the planned and unplanned subdimensions of LPA from a behavioural perspective.

The basic assumptions underlying the design of the BLPAQ were that the instrument should: (a) Be reproducible and valid; (b) be short (taking less than 5 min to complete); (c) contain questions on planned and unplanned PA with reference to occupation, leisure time, household, transportation means, and other daily activities as recommended by Dunn et al. (1998) and Pescatello (2001); (d) assess compliance with the ACSM's (2005) PA guidelines for accruing health benefits; and (e) be validated using a theoretical framework explaining planned and unplanned behaviour (e.g., Ajzen, 1991, 2006a).

7.2 Summation of the Findings of the Present Research Programme

Study 1was focussed on the development and initial validation of the BLPAQ. The design of the BLPAQ was based on a number of principles associated with computer-mediated communication (Fotheringham et al., 2000; Rheingold, 2000) and interactive health communication (USDHHS, 1996; Vandelanotte et al., 2007).

Internet-delivered PA interventions have the potential to overcome many barriers associated with traditional face-to-face exercise counselling or group-based PA programmes (Vandelanotte et al.), especially for women (Tsai et al., 2006). Indeed, web-based communication carries several advantages over pen-and-paper alternatives including automation, flexibility, and the stimulation of open communication (Fotheringham et al.; Tsai et al.).

The findings of Study 1 confirmed the ability of the BLPAQ to assess the various activities performed at home, at work, and during leisure time, which can be integrated into self-directed PA programmes in the absence of an exercise facility. The PPA subscale demonstrated high internal consistency ($\alpha = .90$), whereas the UPA showed only marginal consistency ($\alpha = .68$) according to widely-accepted recommendations (Nunnally, 1978, p. 245). A possible explanation for the lower internal consistency of the UPA subscale may reside in the low number of items of which it is comprised (Loewenthal, 2001, p. 60). Notably, the pen-and-paper-based sample reported significantly higher UPA and PPA scores than internet-users. It is unclear whether these differences were attributable to response bias in that the internet-based sample may have been less susceptible to social desirability constraints (Motl et al., 2005; Tsai et al., 2006; see Subsection 7.3). With reference to gender, it was found that women generally performed a higher level of UPA than men (Barnekow-Bergkvist et al., 1996; Joint Health Surveys Unit, 2004).

Study 1 made the following original contributions to knowledge: (a) The psychometric development of an instrument designed to assess the planned and unplanned subdimensions of LPA- the BLPAQ; (b) the multisample validation of the BLPAQ using both conventionally collected (i.e., pen-and-paper) and internet-derived data; and (c) the establishment of an internet-delivered PA intervention strategy (i.e., “e-health”) based on the utilisation of the BLPAQ.

Study 2 was an examination of the reliability and item-related stability of the two subscales of the BLPAQ. The initial set of analyses showed that both PPA and UPA demonstrated significant test-retest reliability coefficients (see Table 4.3). In combination, the two subscales of the BLPAQ explained 92.2% of the variance in PA behaviour. Notably, the BLPAQ explained a greater percentage of the variance in behaviour than the BQHPA (Baecke et al., 1982), the GLTEQ (Godin & Shephard, 1985), and a variety of other PA measures (see Pereira et al., 1997; Philippaerts & Lefevre, 1998; Sallis & Saelens, 2000). Hence, the BLPAQ demonstrated a high degree of predictive efficacy.

Findings from the correlational analyses revealed that levels of reported PPA and UPA may vary by gender. A possible explanation for this invariance may reside in the way that the male and female respondents perceived LPA as a part of their leisure time and/or working lives. Also, the genders may have different perceptions of both the intensity of LPA activities (Lawlor, Taylor, Bedford, & Ebrahim, 2002; Merom, Phongsavan, Chey, & Bauman, 2006) and the wording used in the items (see Catellier & Muller, 2002, p. 98; Warnecke et al., 1997). Subsequently, the agreement between the two administrations of the BLPAQ was tested using the PoA methodology (Bland & Altman, 1986, 1999). Every item comprising the PPA and UPA factors reported very high item-related stability scores which exceeded the values reported by Conroy and Metzler (2003) and Lane et al. (2005).

The unique contributions to knowledge stemming from Study 2 were as follows: (a) Initial evidence of high test-retest reliability coefficients for both subscales of the BLPAQ; (b) indication of the divergence in PPA and UPA scores by gender; and (c) a demonstration of the applicability and utility of the PoA methodology in determining item-related stability of a PA measure.

Study 3 comprised an examination of the criterion-related validity of the BLPAQ, which was followed by a split-half, cross-validation of the instrument. Both procedures utilised the BQHPA and GLTEQ as reference measures. As expected, PPA was inversely correlated with UPA (see Table 5.2). Unexpectedly, UPA demonstrated an inverse correlation with the Work and Leisure indices of the BQHPA which may indicate that the participants considered some of the UPA activities presented to be of a planned nature (e.g., cycling to work, lifting heavy loads, etc.).

In terms of gender difference, while there were no reported differences in UPA and PPA scores between men and women, the ML-Regression analysis revealed gender discrepancies in the predictive relationships of the criterion measures to the BLPAQ subscales; whereas UPA was more readily predicted by the criterion measures for women than for men, the opposite applied to PPA. The lack of any direct gender differences in UPA and PPA scores may be explained with reference to the physically active sample chosen. In contrast with the general population, the female respondents in the sample used for Study 2 were more likely to undertake vigorous exercise than men (Bakken Ulseth, 2008).

The LoA analysis used in the Study 3 demonstrated that the agreement between the split samples for the BLPAQ subscales was comparable to that shown by the criterion measures. Visually, the plot distributions revealed similarities between the two BLPAQ factors and the subscales of the BQHPA. Specifically, the UPA factor corresponded to the Leisure index while the PPA factor was linked to the Work and Sport indices. In summary, the outcomes of the LoA analyses lend support to the validity claims of the BLPAQ measure.

The results from the Study 3 provided the following original contributions to knowledge: (a) Strong evidence of criterion-related validity of both BLPAQ subscales; (b) the demonstration of comparable split-sample LoA for the BLPAQ and BQHPA; (c) an initial application of the LoA methodology in cross-validating multiple PA self-reports; and (d) tentative evidence of gender differences in PA patterns across three measures (i.e., BLPAQ, BQHPA, and GLTEQ).

In Study 4, the BLPAQ subscales were further validated using an established theoretical framework which has been employed to account for planned behaviour from a psychological perspective; the TPB. In addition to the TPB factors, a PB item was utilised as a predictor of UPA. The results indicated that the TPB factors were able to predict PPA following a series of model modifications. However, contrary to expectations (Hagger et al., 2002a), there was no direct prediction term between PBC and PPA. As expected, neither TPB nor the PB item predicted UPA behaviour.

Exploratory and confirmatory factor analyses of the PPA subscale lent support to a single-factor model. Nevertheless, a competing two-factor model emerged which explained a greater percentage of the variance in PPA. This model was problematic owing to the cross-loading of item 6 (“how vigorously do you engage in pre-planned physical activity”) onto both factors. This factorial ambiguity may have been partly attributable to the lack of structural correspondence in the content of the various items (see Ajzen, 2006a).

Although PBC is thought to predict behaviour independently of intention (Godin & Kok, 1996), the specification of a direct link between PBC and PPA resulted in a decrement in model fit. This result was explained in terms of the conceptual limitations of PBC (see Sutton, 2002), which serves as a *proxy* of Actual Behavioural Control (Ajzen & Fishbein, 2005; Hagger et al., 2003). The unexpected failure of PB to predict UPA behaviour was discussed in terms of the role of habitual processes which may bypass conscious deliberation (see Oullette & Wood, 1998). Further, light-intensity PA- which constitutes the mainstay of UPA- may be difficult to recall accurately as it is regulated subconsciously with little recourse to formal representational structure (Eves et al., 2007; Shephard, 2003).

In terms an original contribution to knowledge, Study 4 provided: (a) Partial evidence of the construct validity of both BLPAQ subscales in the context of psychological theory; (b) a basis for the redesign of the PPA items; (c) some indication that the UPA factor may require expansion beyond its current three items; and (d) additional evidence to support the utility of the TBP within the PA domain.

7.3 Limitations and Related Conceptual Issues

In addition to the specific limitations associated with each individual study, several methodological and conceptual issues pervaded the entire research programme; these will be identified and briefly elaborated upon. An inherent challenge in the measurement of PA when using self-report measures is that of recall accuracy; light-intensity activities are especially difficult to recall owing to their spontaneous nature (Shephard, 2003).

It could be posited that high-intensity PA is more likely to adhere to a formal structure as it may require initial planning and arrangement (see also Ainsworth, Richardson, Jacobs, & Leon, 1992; Richardson et al.). For example, a woman playing in a weekly football tournament would need to earmark time, make travel plans, and prepare kit, etc. This example touches on an important point; the act of planning may facilitate subsequent recall. Therefore, unplanned PA may be somewhat harder to recollect than its planned counterpart as the organisation of information enhances its memorability (Hersen, Rosner, Jesse, Drolette, & Speizer, 2003, p.228). There is a possibility that, all other factors being equal, vigorous PA would be more readily recalled than its lighter equivalent owing to the greater psychophysiological intensity of the experience (see Hall, Ekkekakis, & Petruzello, 2002). Accordingly, the internal consistency of the UPA items was relatively low in both Studies 1 and 4.

Concerns exist that the UPA construct may be somewhat susceptible to misinterpretation (Dunn et al., 1998). Specifically, every effort must be made by researchers to clarify the distinction between UPA and PPA during the response process. Indeed, there may be an overlap between two constructs as measured despite their apparent mutually exclusivity. Some individuals may interpret the two forms of activity as equivalent, especially as both UPA and PPA can share the same modality (e.g., walking, cycling, etc.). For example, the inter-correlations between UPA and PPA, which were evident in the results of Study 3 and Study 4, may have been due, in part, to the lack of exemplification provided for participants (i.e., the answer to the question: what are the practical differences between UPA and PPA). A possible solution would be to introduce the concept of planned and unplanned PA through a list of exemplars that highlights the distinction between the two. Comprehension of the concepts could be briefly verified by the researcher to ensure they have been adequately explained.

As discussed in Subsections 5.4.6.3 and 6.4.1.6, there is a possibility of social-presentational concerns influencing the responses to PA items. It is socially desirable to present oneself as being healthy and physically fit, particularly for women (Wright, O’Flynn, & Macdonald, 2006). Further, experimental work has shown that such social desirability effects are strongly influenced by gender; specifically, gender roles such as the association between intense exercise and masculinity (Hardy et al., 1986; Lindwall & Ginis, 2008). On these counts, it may be necessary to provide an indemnity against social desirability effects by emphasising to BLPAQ respondents that their responses will be kept confidentially.

The wording of the questionnaire might be changed so as to highlight the importance of refraining from altering one's responses out of self-presentational concerns (see Molt, McAuley, & DiStefano, 2005; Warnecke, et al. 1997). Notably, Risko, Quilty and Oakman (2006) suggested that internet users responding to self-reports on the web were as likely to experience social desirability as the pen and paper-based respondents.

The professional relationship between the researcher and many of the participants might have influenced participants' responses. For example, respondents might have been eager to present themselves in a positive light as their interaction with the researcher would often revolve around being encouraged to practice a more healthy and active lifestyle. Possible remedies for this potential bias, other than a change of researcher, would include online data collection and recruitment of participants from outside the gymnasium environment. In particular, the internet may provide a more confidential environment in which participants can comment on their physical activity patterns.

The raison d'être of PA research is to promote healthy behaviour in those who are inactive. Hence, a drawback of the present research programme is that the majority of its participants were drawn from highly active communities (i.e., leisure centre users). For this reason, the results generated herein should be applied with caution to the general population. It is plausible then that the relatively high activity levels of the present samples acted to create a *ceiling effect* (Cohen & Lotan, 1995) wherein there was a degree of homogeneity in responses.

In subsection 4.4.4.1, the possibility was raised that highly active participants may perceive the intensity of PA differently when compared to the less-active population. For example, elite runners may not regard a jog as a strenuous form of activity whereas an untrained person may regard brisk walking as highly strenuous; the perception of PA is somewhat subjective in nature. A further limitation that relates to the participants recruited for the present research programme relates to cultural differences. The South West of England is a multi-cultural area and, as such, potential differences in the way that PA is viewed across cultures should have been considered. Along similar lines, the influence of age on PA patterns was not accounted for in the chosen analytical methods (Studies 2, 3, and 4). A further issue that might impact upon the generelisability of the findings concerns whether internet users are reflective of the general population in terms of activity levels.

7.4 Recommendations for Future Research

The present programme of research has pronounced implications, both for practitioners and researchers alike, these will be elaborated upon in the section that follows.

7.4.1 Issues of Population and Sample Selection

Following the successful validation of the BLPAQ using samples comprised primarily of leisure centre users, there is now a need to establish validity using inactive populations. For example, cardiac rehabilitation patients, GP referrals, and others from specialised groups who suffer from chronic diseases (e.g., type-II diabetes, morbid obesity, hypertension). In particular, the BLPAQ would be useful as a tool to promote planned and unplanned activity through the multiple GP referral schemes (Taylor, Doust, & Webborn, 1998). A worthwhile line of investigation would be the extent to which primary medical supervision facilitates engagement in PA (Morgan, 2005).

Because the present programme utilised a participant pool comprised almost entirely of younger adults (< 30 years), there is considerable scope for future research with older participants; the question of whether planning, intention, and PA behaviour change as people age is particularly pertinent. Arguably, there is insufficient provision in the UK for this growing population; in 2009 over a third of the UK populous was over 50 years of age (ONS, 2005).

It has been established that the genders ascribe different motives and meanings to PA (Wright et al., 2006). In addition, the results of the present programme indicate some discrepancy between the PA behaviour of men and women. Further, there may be differences in planning strategy and organisational skills across the genders (Simons & Galotti, 1992). Hence, there is a clear mandate for additional research into the influence of gender on the performance of planned and unplanned behaviour in a PA setting. Due to the complex psychological determinants of gender-role and PA behaviour, qualitative methodologies may prove efficacious (Sharma, 2007, p.246). From a gender perspective, the samples used in the present study may not be typical of the general population as PA is generally higher in men (see e.g., Ainsworth, 2000).

7.4.2 Measurement Issues

In order to better frame the responses to the BLPAQ and aid recall, a repertory of exemplar activities should be provided for both the PPA and UPA factors. Further, the instrument needs additional specification to capture the frequency and intensity of each bout of activity; especially light-intensity PA (Shephard, 2003). In addition, a diary-based or categorical approach may facilitate the reporting of habitual PA (cf. *Self-report Habit Index*: Verplanken & Melkevik, 2008; Verplanken & Orbell, 2003).

The emotion valence associated with an event has been shown to play an important part in its recall (see Walker, Skowronski, & Thompson, 2003). Indeed, affective information may become bound to cognitive processes in memory (Grafman, Spector, & Rattermann, 2001, p. 194). For this reason, researchers should aim to harness the emotions associated with PA in attempting to facilitate a higher level of recall. For example, respondents should be prompted, both in self-report measures and in structured interviews, to actively recollect the affective dimension of their PB.

Due to its relatively low internal consistency, the UPA factor may require additional items as three is the minimum acceptable (Loewenthal, 2001, p. 32). The unidimensionality of PPA may require further investigation as the results of the final study in the present programme pointed towards the possibility of a two-factor structure in which items 2, 3, and 5 represented the *duration* of activity whereas items 1 and 4 assessed *frequency*; item 6, which cross-loaded, related to *intensity* of activity.

7.4.3 Theory of Planned Behaviour

Although there is strong support for the TPB as a predictor of exercise-related intentions and behaviour, a large proportion of the variance remains unexplained. Thus, leading researchers have proposed additional variables which may improve the predictive efficacy of the TPB (e.g., Ajzen, 2006a). The TPB may admit additional predictors providing that there is a strong theoretical justification for their inclusion and they capture a significant portion of unique variance in intentions or behaviour (Ajzen, 1991). Such predictors may include actual behavioural control (Azjen, 2006a), self-efficacy (Godin & Kok, 1996), social influence (Hamilton & White, 2008), and implementation intentions (Gollwitzer, 1999). Further, habitual and automatic processes constitute a variable that may mediate between intention and behaviour within the TPB (Aarts, et al., 1997).

With reference to the PB item, it is noteworthy to remember that PPA items 2 and 5 assess PB. Hence, future research might examine the theoretical link between PB and PPA. For this reason, it may be possible to use past PPA as a direct or indirect (moderated by intention) predictor within the TPB framework. Further, any use of the PB variable in research incorporating the BLPAQ should discriminate between planned and unplanned PB.

Individual differences may be applicable to the weights placed on different components within TPB models (see Sparks et al., 1992; Trafimow & Findlay, 1996). For example, some individuals base their intentions on affective attitudes (i.e., attitude strength: Patch, Tapsell, & Williams, 2005; Sparks et al., 1992), others on social norms (Dean, et al., 2007; Trafimow & Findlay), and others on personality traits such as extraversion (Rhodes, et al., 2005). Therefore, prospective studies may include such individual variables as moderators.

7.4.4 Research Methodology

The present programme relied heavily on quantitative and positivistic methodologies. Hence, future work in the planned and unplanned PA field might be carried out using qualitative and naturalistic methods of enquiry such as interviews, and protocol analysis (see Green, 1995). Such work would inform any redevelopment of the BLPAQ as researchers would garner more exacting information regarding respondents' interpretation of the instrument's items and instructions. Protocol analysis would therefore effectively combat the measurement issues which currently prevail in the PA sphere. As a continuation of the process which began in Study 1, the BLPAQ instrument should be subjected to further validation using *online* samples which would provide test-retest reliability, cross-validation, and evidence of predictive validity on a broader scale than has yet been achieved. A precedent for such e-health research utilising PA measures can be found in the work of Fridlund-Dunton and Robertson (2008) and Spittaels, DeBourdeaudhuij, and Vandelanotte (2007).

7.4.5 Criterion-based Validation

Criterion-based validity studies should be performed using objective criteria. For example, one research question of interest would be the correspondence of UPA and PPA with waist circumference and BMI. Alternatively, physiological markers (e.g., $\dot{V}O_{2max}$) may be used to discriminate between participants who report high or low levels of PPA and UPA. It is proposed that, with all other factors being equal, higher levels of PPA and UPA are associated with lower waist circumference and BMI.

BLPAQ scores should be compared with objective behavioural measures such as pedometry and accelerometry (see e.g., Benedetti, Antunes, Rodriguez-Añez, Mazo, & Petroski, 2007). The aim would be to determine whether the PPA and UPA can be used as a proxy measures for actual PA, which is not always practical to ascertain (Florindo & LaTorre, 2003).

There is scope for further criterion-related validation work incorporating other PA self-report measures which demonstrate more affinity with the BLPAQ than the two instruments selected in the present programme (i.e., BQHPA and GLTEQ). Two candidate reference measures would be the IPAQ (Craig et al., 2003) - a measure of energy expenditure - and the SQUASH (Wendel-Vos et al., 2003) which was developed from a behavioural perspective.

7.4.6 Theory Development

As part of the continuous development of the BLPAQ, to enable its use within the field of health and exercise psychology, the UPA and PPA factors should be validated using a variety of theoretical frameworks that include intentional behaviour. Examples of suitable theories include, the Health Action Process Approach (Schwarzer, 1992), the Transtheoretical Model (Prochaska & DiClemente, 1983), and Self-efficacy (Bandura, 1986, 1994). As UPA is likely to assume a spontaneous form and is therefore susceptible to environmental influence, there should be a theoretical emphasis on social and physical environments as these predispose, enable, and reinforce behaviour change and maintenance (Green & Kreuter, 1991; Williams et al., 2005).

Following the present programme of study, there is now a pressing need for the development of a broad conceptual framework which incorporates the BLPAQ, the TPB, PB, and various environmental and individual variables. The proposed model would aid researchers by clarifying and consolidating theoretical progress in the field. Further, a visual representation of the model would serve to communicate the *status quo* of the research to health practitioners, policymakers, and the media, thus facilitating knowledge transfer.

7.4.7 Theory-to-Practice Study

An effective practical test of the present findings could be achieved in the following manner: A longitudinal, quasi-experimental design is proposed wherein the researcher would prescribe LPA interventions for a group of relatively inactive adult participants using strategies based on the promotion of planned and unplanned PA, the TBP, and implementation intention. The outcome measures would include pre- and post-test physiological markers such as blood pressure, serum cholesterol, BMI, body fat percentage, serum glucose level, and measures of PA adherence, life-satisfaction (see Diener, 1994), self-determination (Deci & Ryan, 2000), and self-efficacy (Bandura, 1986, 1994).

7.5 General Summary and Conclusions

The principal aim of the present research programme was to develop and validate a measure of LPA with reference to the TPB. This goal has been achieved in that the BLPAQ has demonstrated internal consistency in addition to face-, construct-, criterion-related-, concurrent-, and predictive- validity. However, additional developmental procedures remain; the instrument needs to be comprehensively validated using both internet-based and pen-and-paper samples. Further, the item structure of both factors may require revision. Notably, the BLPAQ demonstrates high cost-effectiveness when compared with other PA measurement technologies such as DLW and respiratory analysis. Inexpensive PA measurement methodologies may serve to eliminate one potential barrier to the promotion of active lifestyles (Giles-Corti & Donovan, 2002; Handley, Shumway, & Schillinger, 2008).

The unique and original contribution to knowledge made by this research programme centres on the development of the BLPAQ; it is the first measure of PA to be validated in accordance with the TPB. Indeed, the TPB has demonstrated great utility in the PA domain. However, there is a clear need for its expansion.

The use of a behavioural theory to validate the BLPAQ underscores the importance of assessing PA in qualitative (i.e., planned and unplanned behaviour) as opposed to purely quantitative terms (i.e., energy expenditure). In particular, the present programme of study has revealed the importance of unplanned forms of PA, which may take a spontaneous form. It is hoped that the present research programme may ultimately lead to a broadening of the PA lexicon in such a way that members of the general population might better understand and manage their own behaviour.

Research regarding PA promotion has proceeded with insufficient attention to the role of personal factors such as gender, age, socio-economic status, and socio-cultural background. Hence, a further contribution of the present programme is the providence of a tool with which investigators can examine the antecedents of PA across different groups within society; although PI is a global concern, it may only be comprehensible on personal terms. An additional consequence of research into the planned and unplanned dimensions of PA is the possibility that policymakers will be able to modify the environment with the aim of facilitating unplanned activity (see Foster & Hillsdon, 2004; Sallis, Bauman, & Pratt, 1998).

The rise of living standards has brought with it a reduction in mandatory physical activity and an explosion of unhealthy dietary practices; factors that may prove to be the seeds of a health epidemic in the developed world. For this reason, the need to develop stratagems with which to combat PI has never been more pressing. The ultimate objective of this line of research would be to support practitioners in the development of effective interventions to promote LPA in the UK, thus making a positive contribution to public health and well being.

He who has health has hope; and he who has hope has everything

Arabian Proverb

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Acronym Repertory

Due to the necessary repetition of specialised terms in this programme of reasearch, a glossary of their acronyms has been provided to facilitate comprehension:

AAHPERD: American Alliance for Health, Physical Education for Recreation and Dance.

ABC: Actual Behavioural Control (Ajzen, 1991).

ACSM: American College of Sports Medicine.

ADNFS: Allied Dunbar National Fitness Survey.

AIC: Akaike's Information Criterion (Akaike, 1987).

AHA: American Heart Association.

AHR: Activity and Health Research.

BF: Body Fat.

BHF: British Heart Foundation.

BI: Behavioural Intention (see TPB; Ajzen, 2006a).

BLPAQ: The Brunel Lifestyle Physical Activity Questionnaire.

BQHPA: The Baecke Questionnaire of Habitual Physical Activity (Baecke et al., 1982).

BW: Body Weight

CFLRI: Canadian Fitness and Lifestyle Research Institute.

CDC: Center for Disease Control.

CI: Confidence Interval.

CFI: Comparative Fit Index.

CHD: Coronary Heart Disease.

CVD: Cardiovascular Disease.

DETR: Department of the Environment, Transport and the Regions.

DLW: Doubly-Labelled Water.

DoH: Department of Health.

DoT: Department of Transport.

DV: Dependent Variable.

EDGEC: Environment DG, European Commission.

EE: Energy Expenditure.

FITT: Frequency, Intensity, Time and Type (Corbin et al., 2002).

GLTEQ: Godin's Leisure-Time Exercise Questionnaire (Godin & Shephard, 1985).

HBM: Health Belief Model (Becker et al., 1977).

HCCSEP: Health Canada and Canadian Society for Exercise Physiology.

HDL: High-density Lipoproteins Cholesterol.

HSE: Health Survey for England.

ICC: Intraclass Correlation.

IoM: Institute of Medicine.

IPAQ: International Physical Activity Questionnaire (Craig et al., 2003).

IV: Independent Variable.

KC: Kappa Coefficient.

LB: Long-bouts.

LM: Lagrange Multiplier.

LoA: Limits of Agreement (Bland & Altman, 1986).

LPA: Lifestyle Physical Activity (Dunn et al., 1998).

LV: Left Ventricle.

MET: METabolic energy expenditure unit.

MLPA: Moderate-intensity Lifestyle Physical Activity (ACSM, 2000).

NASPE: National Association for Sport and Physical Activity.

NHS: National Health Service.

NIH: National Institute of Health.

ONS: Office for National Statistics.

OR: Odds Ratio.

PA: Physical Activity.

PAEE: PA Energy Expenditure.

PAHO: Pan-American Health Organisation.

PB: Past Behaviour (see Bagozzi & Kimmel, 1995).

PBC: Perceived Behavioural Control (see TPB).

PI: Physical Inactivity.

PMT: Protection Motivation Theory (Rogers, 1983).

PoA: Proportion of Agreement (Nevill et al., 2001).

PPA: Planned Physical Activity.

PP-MC: Pearson's Product-Moment Correlation.

PCPFS: President's Council on Physical Fitness and Sports.

RMSEA: Root Mean Square of Approximation.

SB: Short-bouts.

SCT: Social-Cognitive Theory (Bandura, 1977).

SEM: Structural Equation Model.

SLR: Stepwise Logistic Regression.

SN: Subjective Norms (see TPB).

SPC: SPearman rank-order Correlation.

SRMR: Standardised Root Mean Residual.

TPAI: Total Physical Activity Index (Baecke et al., 1982)

TPB: Theory of Planned Behaviour (Ajzen, 1991).

TTM: Transtheoretical Model (Prachaska & DiClemente, 1982, 1983).

SQUASH: Short QUestionnaire to ASsess Health-enhancing Physical Activity (Wendel-Vos et al., 2003).

TRA: Theory of Reasoned Action (Fishbein & Ajzen, 1975).

UPA: Unplanned Physical Activity (Dunn et al., 1998).

USDHHS: US Department of Health and Human Services.

WC: Waist Circumference.

WHO: World Health Organisation.

WS-RT: Wilcoxon Signed-Ranks Test (Wilcoxon, 1945).

WWW: World Wide Web.

APPENDIX B

Table 1

Most Commonly used Physical Activity Questionnaires

	Type of administration	Type of activity	Time frame	Measurement scale
Diary				
Bouchard 3-day PA record (Bouchard et al., 1983)	SAQ	Leisure and occupational	3-day	Kcal/day
Recall				
Stanford 7-Day PA Recall (Blair et al., 1985)	Interview	Habitual	7 days	METs
Harvard Alumni (Melby et al., 1992)	SAQ	Leisure	7 days	Kcal/week
Five Cities Project (Sallis et al., 1985)	Interview	Leisure and occupational	7 days	METs
Godin Leisure-Time Exercise Questionnaire (Godin & Shephard, 1985)	SAQ	Leisure (usual activity)	No specified time	Score
IPAQ (Craig & Russell, 1999)	SAQ or interview			

APPENDIX B

Table 1 (*continued)*.

	Type of administration	Type of activity	Time frame	Measurement scale
Quantitative history				
Tecumseh (Reiff et al., 1967)	Interview	Leisure	Past 12 months	METs
Stanford Usual Activity Questionnaire (Sallis et al., 1985)	Interview	Habitual	3 months	Score
CARDIA PAHQ (Jacobs et al., 1989)	Interview	Leisure, occupational and home/household	Past 12 months	Weighted score
Minnesota LTPA (Taylor et al., 1978)	Interview	Leisure	Past 12 months	METs
General				
HIP (Shapiro, et al., 1965)	SAQ or interview	Habitual	1 week	28-point scale
Lipid Research Clinics (Haskell et al., 1980)	Interview	Habitual	1 week	Classification
Framingham PA Index (Kannel & Sorlie, 1979)	Interview	Leisure and occupational	1 day	Daily index
Baecke Questionnaire of Habitual PA (Baecke et al., 1982)	SAQ or Interview	Leisure and occupational	No specified time	METs or score

Note. PA = Physical activity; IPAQ = International physical activity questionnaire; PAHQ = Physical activity history questionnaire; SAQ = Self-Administered Questionnaire; LTPA: Leisure-time physical activity. Adapted from: Melby et al. (2000, p. 112)

APPENDIX C

Table 1

Summary of Reliability Studies of Baecke Questionnaire of Habitual Physical Activity used in Adult Studies

Author(s) / year	Study design	Sample characteristics with age range and/or mean and standard deviation	Type of analysis	Summary of results	
Baecke et al. (1982)	Relationship between first test and 3-month retest	306 healthy Dutch volunteers between the ages of 20 and 32 years (males *n* = 139; females *n* = 167)	PP-MC†	Work index Sport index Leisure index	.88 .81 .74
Jacobs et al. (1993)	Relationship between first test and 1-month retest	28 men and 50 women, university faculty staff and students between the ages of 20 and 59 years (Male: *M* = 37.2; *SD* = 10.0 years; Female: *M* = 37.4; *SD* = 9.7 years)	SPC (adjusted for age)	Work index Sport index Leisure index TPAI	.78* .90* .86* .93*

APPENDIX C

Table 1 *(continued)*.

Author(s) / year	Study design	Sample characteristics with age range and/or mean and standard deviation	Type of analysis	Summary of results		
Pols et al. (1995)	Relationships between first test and 5 and 11-month retest, and agreement of tertile classification for the total PA index between baseline and retest	126 healthy Dutch volunteers between the ages of 20 and 70 years (males *n* = 64: age *M* = 41.1, *SD* = 11.1 years; *n* = 62 females: age *M* = 48.8, *SD* = 14.8 years)	PP-MC and KC	Men	5 month	11 month
				WI	.89*	.83*
				SI	.88*	.81*
				LI	.76*	.71*
				TPAI	.85*	.80*
				KC	57.1%	55.7%
				Women		
				WI	.80*	.84*
				SI	.71*	.65*
				LI	.83*	.81*
				TPAI	.83*	.77*
				KC	41.0%	45.5%

Note. PP-MC = Pearson product-moment correlation; SPC = Spearman rank-order correlation; KC = Kappa coefficient; PA = physical activity; WI = Work index; SI = Sport index; LI = Leisure index; TPAI = Total PA index

† No *p* value reported. * $p < .05$.

APPENDIX C

Table 2

Summary of Validation Studies of the Baecke Questionnaire of Habitual Physical Activity with Adults

Study authors/year	Study design	Sample characteristics with age range and/or mean and standard deviation	Type of analysis	Results summary	
Jacobs et al. (1993)	Relationship between maximum treadmill test, 3 PA indices, and CA with TPAI	78 university faculty staff and students between the ages of 20 and 59 years (men n = 28: age M = 37.2, SD = 10.0 years; women n = 50: M = 37.4, SD = 9.7 years)	PP-MC (adjusted for age)	BQHPA-SI BQHPA-LI TPAI CA-METs/TPAI	0.52* 0.26* 0.54* 0.19*
Miller et al. (1994)	Comparison between TPAI, CA, GLTEQ, and 7-day PAR	33 physical therapists (men n = 7: age M = 29.7, SD = 5.4 years; women n = 26: M = 27.5, SD = 5.7 years)	SPC	TPAI GLTEQ 7-day PAR	0.32 0.61** 0.07

APPENDIX C

Table 2 *(continued)*.

Study authors/year	Study design	Sample characteristics with age range and/or mean and standard deviation	Type of analysis	Summary of results		
Richardson et al. (1995)	Comparison of BQHPA with 48-hr PAR and $\dot{V}O_{2peak}$	78 participants (men n = 28: age M = 37, SD = 10.0 years; age range = 23-57; women n = 50: age M = 37, SD = 10 years; age range 21-59)	SPC		Men	Women
				48-hr PAR		
				H-IPA	0.73**	0.63**
				L-IPA	0.39*	0.23
				$\dot{V}O_{2peak}$		
				H-IPA	0.67**	0.45**
				L-IPA	0.13	0.38**
Pols et al. (1995)	Comparison of BQHPA with 3-DAD	134 participants (men n = 64: age M = 41.1, SD = 11.0 years; age range = 20-60; women n = 62: age M = 48.8, SD = 14.8 years; age range 20-70)	PP-MC		Men	Women
				TPAI-EE 24-hr	0.56*	0.44*

APPENDIX C

Table 2 (*continued*).

Study authors/year	Study design	Sample characteristics with age range and/or mean and standard deviation	Type of analysis	Summary of results	
Philippaerts et al. (1999)	Comparison of TPAI with DLW	19 Flemish men (age M and/or age range were unreported in the abstract)	PP-MC	TPAI-EE	0.69***
Tehard et al. (2005)	Comparison of BQHPA with IPAQ	757 obese participants (BMI ≥ 30) between the ages of 20 and 50 years (men n = 191: age M = 38.5, SD = 7.6 years; women n = 566: age M = 36.6, SD = 8.0 years)	SPC	BQHPA-IPAQ	0.51***

Note. PA = physical activity; CA = Caltrac accelerometer; MET = metabolic equivalent; PAR = physical activity record; H-IPA = high-intensity PA; L-IPA = low-intensity PA; $\dot{V}O_{2peak}$ = peak oxygen consumption; 3-DAD = 3-day activity diary; IPAQ = international physical activity questionnaire; DLW = doubly-labelled water; PP-MC = Pearson product-moment correlation; SPC = Spearman rank-order correlation; BQHPA = Baecke questionnaire of habitual physical activity; WI = work index; SI = sport index; LI = leisure index; TPAI = total physical activity index.

* $p < .05$. ** $p < .01$. *** $p < .001$.

APPENDIX D

Table 1

Summary of Reliability Studies of Godin Leisure-Time Exercise Questionnaire used in Adult Studies

Author(s) / year	Study design	Sample characteristics with age range and/or mean and standard deviation	Type of analysis	Summary of resu
Godin & Shephard (1985)	Relationships between first test and 2-week retest for activity categories, total PA score, and sweat question	306 healthy adults between the ages of 18 and 65 years (males *n* = 163: age *M* = 31.1, *SD* = 9.6 years; *n* = 143 females: age *M* = 30.3, *SD* = 10.0 years)	PP-MC	Light PA Moderate PA Strenuous PA Total PA Sweat
Jacobs et al. (1993)	Relationships between first test and 1-month retest for activity categories, total score, and sweat question	28 men and 50 women, university faculty staff and students between the ages of 20 and 59 years (male: *M* = 37.2, *SD* = 10.0 years; female: *M* = 37.4, *SD* = 9.7 years)	SPC (adjusted for age)	Light PA Moderate PA Strenuous PA Total PA Sweat

Note. PP-MC = Pearson product-moment correlation; SPC = Spearman rank-order correlation; PA = physical activity

* $p < .05$

APPENDIX D

Table 2

Summary of Validation Studies of the Godin Leisure Time Exercise Questionnaire with Adults

Study authors / year	Study design	Sample characteristics with age range and/or mean and standard deviation	Type of analysis	Summary of results		
Godin & Shephard (1985)	Relationships GLTEQ-Vigorous, -Moderate, -Light, -Sweat, TPAS and $\dot{V}O_{2max}$ and BF%	306 healthy adult volunteers between the ages of 18 and 65 years (men *n* = 163; women *n* = 143)	PP-MC	Exercise levels	$\dot{V}O_{2max}$	BF%
				Vigorous	.35*	-.21*
				Moderate	.03	.08
				Mild	.04	.06
				TPAS	.24*	-.13*
				Sweat	.26*	-.21*
Jacobs et al. (1993)	Relationships between FWH Leisure-score, GLTEQ-Sweat, and CA[†], FWH, $\dot{V}O_{2max}$ and BF%	78 university faculty staff and students between the ages of 20 and 59 years (men *n* = 28: age *M* = 37.2, *SD* = 10.0 years; women *n* = 50: *M* = 37.4, *SD* = 9.7 years)	SPC (adjusted for age)		Leisure	Sweat
				CA[†]	.32*	.29*
				FWH	.36*	.31*
				$\dot{V}O_{2max}$	.56*	.57*
				BF%	-.43*	-.40*

APPENDIX D

Table 2 (*continued*).

Study authors/year	Study design	Sample characteristics with age range and/or mean and standard deviation	Type of analysis	Summary of results	
Miller et al. (1994)	Relationship between GLTEQ-TPAS and CA†, and four other PA questionnaires.	33 physical therapists (men n = 7: age M = 29.7, SD = 5.4 years; women n = 26: M = 27.5, SD = 5.7 years)	SPC	CA†	.45**
				Questionnaires	
				NASA	.54**
				BQHPA	.61**

Note. GLTEQ = Godin leisure-time exercise questionnaire; PA = physical activity; CA = Caltrac accelerometer; MET = metabolic equivalent; NASA = self-report questionnaire (Ross & Jackson, 1990); FWH = four weeks physical activity history derived from the Minnesota leisure-time physical activity questionnaire; $\dot{V}O_{2max}$ = maximal oxygen utilisation; BF% = body fat percentage; TPAS = total physical activity score; PP-MC = Pearson product-moment correlation; SPC = Spearman rank-order correlation

† MET-min/day; * $p < .05$. ** $p < .01$.

APPENDIX E

Mr. Massimo Vencato
School of Sport & Education
Brunel University West London
Uxbridge Campus, Kingston Lane
Uxbridge, Middlesex, UB8 3PH.

June, 2004

Dear Sir/Madam,

Re: The Brunel Lifestyle Physical Activity Questionnaire

The attached questionnaire is about planned and unplanned physical activities during your leisure time and work time. We are currently conducting research into lifestyle physical activity. With this in mind, we would be grateful if you could complete the attached questionnaire.

We would like you to provide an honest answer to each question. Give the response that MOST represents how you feel and avoid dwelling for too long on any single question. Please answer ALL questions in Sections **A-C**.

These questionnaires only take a few minutes to complete. Your responses will be kept in confidence, and for the purpose of our research, a number will identify your questionnaire. Your completion of these questionnaires indicates your informed consent to participate in this study.

Thank you for your assistance in our research.

Sincerely,

Mr. Massimo Vencato

Research Student, School of Sport & Education

APPENDIX E

Brunel Lifestyle Physical Activity Questionnaire

Section A: Getting to Know You

Full name	
Gender	Male / Female
Title (please circle)	Mr Mrs Miss Ms Other (please specify) ___________
Date of birth	DD / MM / YY ________ / _________ / 19_____
Occupation (e.g., teacher, housewife, unemployed, etc.)	
Ethnic origin (please circle)	White-UK/Irish, Black-Caribbean, Black-African Indian, Pakistani, Bangladeshi Chinese, Mixed race, White European White-Other, Asian-Other, Other ethnic group (If **Other**, please specify) ______________________
Weight (stones or kilograms)	_____ stones _____ pounds or _____ kg
Height (feet or metres)	_______ feet _____ inches or ___ m ____ cm

Brunel Lifestyle Physical Activity Questionnaire

We would like you to give an honest answer to each of the questions that follow. Give the response that BEST represents you and avoid dwelling for too long on any single question. Be sure to answer ALL of the questions otherwise you will not be permitted to proceed. The questionnaire **takes less then 5 minutes to complete**. We are sure that you will find the personal profile to be most illuminating.

Section B: Planned Lifestyle Physical Activity

Please tick to indicate your response:

Note. Planned lifestyle physical activity is any activity that is scheduled into your daily routine, which may enhance your health, fitness or well-being. Examples include *brisk walking, gardening, cycling, team games,* etc.

1. How many times a week do you engage in pre-planned physical activity?	Never	1-2 times	3-4 times	5-6 times	7 or more times

2. How long have you been engaging in pre-planned physical activity at this weekly rate?	Not relevant to me	Less than 1 month	1-3 months	4-6 months	More than 7 months

3. In general, what is the duration of each session of pre-planned physical activity that you engage in?	Not relevant to me	Less than 10 mins	10 - 20 mins	21 - 30 mins	More than 30 mins

4. If you add together each session of pre-planned physical activity that you engage in during a normal week, how much time would you estimate that you spend in total?	Not relevant to me	Less than 1 hour	1-2 hours	3-5 hours	More than 5 hours

5. In the past, how long have you generally persisted with a pre-planned physical activity program before giving up?	Not relevant to me, as I have never persisted	Up to 1 month	Up to 3 months	Up to 6 months	More than 6 months, or, I have never given up

6. How vigorously do you engage in pre-planned physical activity?	Not relevant to me	Very light	Moderately hard	Hard	Very hard

("Very light" means that you hardly get out of breath.
"Very hard" means that you exercise to the extent that you are breathing deeply)

Section C: Unplanned Lifestyle Physical Activity

7. Excluding your pre-planned physical activity sessions, how many hours do you estimate that you spend doing other forms of physical activity each week?

Fewer than 2 hours	2-4 hours	5-7 hours	8-9 hours	10 or more hours

(These may include light-to-moderate housework, climbing stairs, cycling or walking to work, walking the dog, gardening, shopping, playing with children, etc.)

8. How vigorously do you engage in these other forms of physical activity?

Not relevant to me	Very light	Moderately hard	Hard	Very hard

("Very light" means that you hardly get out of breath.
"Very hard" means that you perform the activities to the extent that you are breathing deeply)

9. In general, how physically demanding are your job or your day-to-day activities?

Not at all	A little	Moderately	Quite	Highly

("Not at all" means that your activities are sedentary without requiring much movement.
"Highly" means that you are engaged in heavy labour or constantly moving around)

10. Which of these types of physical activity do you enjoy participating in?

(Tick as many as appropriate)

Walking / Hiking	Swimming	Weight-training	Aerobics / Steps
Jogging / Running	Rowing	Cycling	Step Machine
Dancing	Yoga	None	Other (please specify below)

APPENDIX F

Mr. Massimo Vencato
School of Sport & Education
Brunel University West London
Uxbridge Campus, Kingston Lane
Uxbridge, Middlesex UB8 3PH

May/July, 2006

Dear Sir/Madam,

Re: The Brunel Lifestyle Physical Activity Questionnaire

The attached questionnaire is about planned and unplanned physical activities during your leisure time and work time. We are currently conducting research into lifestyle physical activity. With this in mind, we would be grateful if you could complete the attached questionnaires.

We would like you to provide an honest answer to each question. Give the response that MOST represents how you feel and avoid dwelling for too long on any single question. Please answer ALL questions in Sections **A-B**.

These questionnaires only take a few minutes to complete. Your responses will be kept in confidence, and for the purpose of our research, your questionnaires will be identified by number only. Your completion of these questionnaires indicates your informed consent to participate in this study.

Thank you for your assistance in our research.

Sincerely,

Mr. Massimo Vencato

Research Student, School of Sport & Education

APPENDIX F

Section A: Getting to Know You

Full name	
Gender	Male / Female
Title (please circle)	Mr Mrs Miss Ms Other (please specify) ___________
Date of birth	DD / MM / YY ________ / ________ / 19_____
Occupation (e.g., teacher, housewife, unemployed, etc.)	

Ethnic origin (please circle)

White-UK/Irish	Black-Caribbean	Black-African
Indian	Pakistani	Bangladeshi
Chinese	Mixed race	White European
White-Other	Asian-Other	Other ethnic group
(If **Other**, please specify)	_________________________________	

Weight (stones <u>or</u> kilograms)	_____ stones _____ pounds	or	_____ kg
Height (feet <u>or</u> metres)	______ feet _____ inches	or	___ m ____ cm

APPENDIX F

Section B: the Brunel Lifestyle Physical Activity Questionnaire

Note. **Planned physical activity** is any activity that is scheduled into your daily routine, which may enhance your health, fitness or wellbeing. Examples include *brisk walking, gardening, cycling, team games,* etc. Please, relate your answers to your activities **over the last 7-Day period**.

1. How many times a week do you engage in pre-planned physical activity?

Never	1-2 times	3-4 times	5-6 times	7 or more times

2. How long have you been engaging in pre-planned physical activity at this weekly rate?

Not relevant to me	Less than 1 month	1-3 months	4-6 months	More than 7 months

3. In general, what is the duration of each session of pre-planned physical activity that you engage in?

Not relevant to me	Less than 10 mins	10 - 20 mins	21 - 30 mins	More than 30 mins

4. If you add together each session of pre-planned physical activity that you engage in during a normal week, how much time would you estimate that you spend in total?

Not relevant to me	Less than 1 hour	1-2 hours	3-5 hours	More than 5 hours

5. In the past, how long have you generally persisted with a pre-planned physical activity programme before giving up?

Not relevant to me, as I have never persisted	Up to 1 month	Up to 3 months	Up to 6 months	More than 6 months, or I have never given up

6. How vigorously do you engage in pre-planned physical activity?

Not relevant to me	Very light	Moderately hard	Hard	Very hard

("Very light" means that you hardly get out of breath.
"Very hard" means that you exercise to the extent that you are breathing deeply)

7. ***Excluding* your planned physical activity** sessions, how many hours do you estimate that you spend doing other forms of physical activity each week?

Fewer than 2 hours	2-4 hours	5-7 hours	8-9 hours	10 or more hours

(These may include light, moderate and heavy housework, climbing stairs, cycling or walking to work, walking the dog, gardening, shopping, playing with children, etc.)

8. How vigorously do you engage in these other forms of physical activity?

Not relevant to me	Very light	Moderately hard	Hard	Very hard

("Very light" means that you hardly get out of breath.
"Very hard" means that you perform the activities to the extent that you are breathing deeply)

9. In general, how physically demanding are your job or your day-to-day activities?

Not at all	A little	Moderately	Quite	Highly

("Not at all" means that your activities are sedentary without requiring much movement.
"Highly" means that you are engaged in heavy labour or constantly moving around)

Thank you for your co-operation

APPENDIX G

Mr. Massimo Vencato
School of Sport & Education
Brunel University West London
Uxbridge Campus, Kingston Lane
Uxbridge, Middlesex, UB8 3PH.

June/September, 2006

Dear Sir/Madam,

Re: The Brunel Lifestyle Physical Activity Questionnaires

The attached questionnaire is about planned and unplanned physical activities during your leisure time and work time. We are currently conducting research into lifestyle physical activity. With this in mind, we would be grateful if you could complete the attached questionnaires.

We would like you to provide an honest answer to each question. Give the response that MOST represents how you feel and avoid dwelling for too long on any single question. Please answer ALL questions in Sections **A-B**.

These questionnaires only take a few minutes to complete. Your responses will be kept in confidence, and for the purpose of our research, your questionnaires will be identified by number only. Your completion of these questionnaires indicates your informed consent to participate in this study.

Thank you for your assistance in our research.

Sincerely,

Mr. Massimo Vencato

Research Student, School of Sport & Education

Questionnaire completed on: _________ June/July/August/September, 2006

APPENDIX G

Section A: Background Information

Full name ______________________

Gender (please circle) | Male | Female

Title (please circle)

Mr	Mrs	Miss	Ms
Other	(please specify) ___________		

Date of birth

DD / MM / YY

________ / _________ / 19______

Ethnic origin (please circle)

White-UK/Irish	Black-Caribbean	Black-African
Indian	Pakistani	Bangladeshi
Chinese	Mixed race	White European
White-Other	Asian-Other	Other ethnic group

(If **Other**, please specify) _________________________

Occupation
(e.g., teacher, housewife, unemployed, etc.)

Weight (stones or kilograms) _____ stones _____ pounds or ________ kgs

Height (feet or metres) ______ feet _____ inches or ___ m ____ cm

APPENDIX G

Section B: Brunel Physical Activity Questionnaire

Note. **Planned physical activity** is any activity that is scheduled into your daily routine, which may enhance your health, fitness or wellbeing. Examples include *brisk walking, gardening, cycling, team games,* etc. Please, relate your answers to your activities **over the last 5-week period**.

1. How many times a week do you engage in pre-planned physical activity?

Never	1-2 times	3-4 times	5-6 times	7 or more times

2. How long have you been engaging in pre-planned physical activity at this weekly rate?

Not relevant to me	Less than 1 month	1-3 months	4-6 months	More than 7 months

3. In general, what is the duration of each session of pre-planned physical activity that you engage in?

Not relevant to me	Less than 10 mins	10 - 20 mins	21 - 30 mins	More than 30 mins

4. If you add together each session of pre-planned physical activity that you engage in during a normal week, how much time would you estimate that you spend in total?

Not relevant to me	Less than 1 hour	1-2 hours	3-5 hours	More than 5 hours

5. In the past, how long have you generally persisted with a pre-planned physical activity programme before giving up?

Not relevant to me, as I have never persisted	Up to 1 month	Up to 3 months	Up to 6 months	More than 6 months, or I have never given up

6. How vigorously do you engage in pre-planned physical activity?

Not relevant to me	Very light	Moderately hard	Hard	Very hard

("Very light" means that you hardly get out of breath.
"Very hard" means that you exercise to the extent that you are breathing deeply)

7. ***Excluding* your planned physical activity** sessions, how many hours do you estimate that you spend doing other forms of physical activity each week?

Fewer than 2 hours	2-4 hours	5-7 hours	8-9 hours	10 or more hours

(These may include light, moderate and heavy housework, climbing stairs, cycling or walking to work, walking the dog, gardening, shopping, playing with children, etc.)

8. How vigorously do you engage in these other forms of physical activity?

Not relevant to me	Very light	Moderately hard	Hard	Very hard

("Very light" means that you hardly get out of breath.
"Very hard" means that you perform the activities to the extent that you are breathing deeply)

9. In general, how physically demanding are your job or your day-to-day activities?

Not at all	A little	Moderately	Quite	Highly

("Not at all" means that your activities are sedentary without requiring much movement.
"Highly" means that you are engaged in heavy labour or constantly moving around)

Thank you for your co-operation

APPENDIX H

Mr. Massimo Vencato
School of Sport & Education
Brunel University West London
Uxbridge Campus, Kingston Lane
Uxbridge, Middlesex, UB8 3PH.

September 2006

Dear Sir/Madam,

Re: The Habitual Physical Activity Questionnaires

The attached questionnaires are about habitual physical activity during your leisure time and work time. We are currently conducting research into habitual physical activity. With this in mind, we would be grateful if you could complete the attached questionnaires.

We would like you to provide an honest answer to each question. Give the response that MOST represents how you feel and avoid dwelling for too long on any single question. Please answer ALL questions in Sections **A-D**.

These questionnaires only take a few minutes to complete. Your responses will be kept in confidence, and for the purpose of our research, a number will identify your questionnaires. Your completion of these questionnaires indicates your informed consent to participate in this study.

Thank you for your assistance in our research.

Sincerely,
Mr. Massimo Vencato
Research Student, School of Sport & Education

APPENDIX H

Section A: Background Information

Full name	
Gender (please circle)	Male Female
Title (please circle)	Mr Mrs Miss Ms Other (please specify) ___________
Date of birth	DD / MM / YY ________ / _________ / 19_____
Ethnic origin (please circle)	White-UK/Irish Black-Caribbean Black-African Indian Pakistani Bangladeshi Chinese Mixed race White European White-Other Asian-Other Other ethnic group (If **Other**, please specify) _________________________
Weight (stones or kilograms)	_____ stones _____ pounds or ________ kgs
Height (feet or metres)	______ feet _____ inches or ___ m ____ cm

Section B: Brunel Physical Activity Questionnaire

Note. Pre-planned physical activity is any activity that is scheduled into your daily routine, which may enhance your health, fitness or wellbeing. Examples include brisk walking, gardening, cycling, team games, etc. Please, relate your answers to your activities over the last **7-Day period**.

1. How many times a week do you engage in pre-planned physical activity?

Never	1-2 times	3-4 times	5-6 times	7 or more times

2. How long have you been engaging in pre-planned physical activity at this weekly rate?

Not relevant to me	Less than 1 month	1-3 months	4-6 months	More than 7 months

3. In general, what is the duration of each session of pre-planned physical activity that you engage in?

Not relevant to me	Less than 10 mins	10 - 20 mins	21 - 30 mins	More than 30 mins

4. If you add together each session of pre-planned physical activity that you engage in during a normal week, how much time would you estimate that you spend in total?

Not relevant to me	Less than 1 hour	1-2 hours	3-5 hours	More than 5 hours

5. In the past, how long have you generally persisted with a pre-planned physical activity programme before giving up?

Not relevant to me, as I have never persisted	Up to 1 month	Up to 3 months	Up to 6 months	More than 6 months, or I have never given up

6. How vigorously do you engage in pre-planned physical activity?

Not relevant to me	Very light	Moderately hard	Hard	Very hard

("Very light" means that you hardly get out of breath.
"Very hard" means that you exercise to the extent that you are breathing deeply)

7. Excluding your pre-planned physical activity sessions, how many hours do you estimate that you spend doing other forms of physical activity each week?

Fewer than 2 hours	2-4 hours	5-7 hours	8-9 hours	10 or more hours

(These may include heavy housework, climbing stairs, cycling or walking to work, walking the dog, gardening, shopping, playing with children, etc.)

8. How vigorously do you engage in these other forms of physical activity?

Not relevant to me	Very light	Moderately hard	Hard	Very hard

("Very light" means that you hardly get out of breath.
"Very hard" means that you perform the activities to the extent that you are breathing deeply)

9. In general, how physically demanding are your job or your day-to-day activities?

Not at all	A little	Moderately	Quite	Highly

("Not at all" means that your activities are sedentary without requiring much movement.
"Highly" means that you are engaged in heavy labour or constantly moving around)

Section C: Baecke Questionnaire of Habitual Physical Activity

Please, relate your answers to your activities over the last **7-Day period**.

10. What is your occupation?

____

10a. How physically demanding is your main occupation? (Please score its intensity)

Not at all	Moderately	Highly

	Never	Seldom	Sometimes	Often	Always
11. At work I sit					
	Never	Seldom	Sometimes	Often	Always
12. At work I stand					
	Never	Seldom	Sometimes	Often	Always
13. At work I walk					
	Never	Seldom	Sometimes	Often	Very often
14. At work I lift heavy loads					
	Very often	Often	Sometimes	Seldom	Never
15. After work I am tired					
	Very often	Often	Sometimes	Seldom	Never
16. At work I sweat					
	Much heavier	Heavier	As heavy	Lighter	Much lighter
17. In comparison with others my own age, I think my work is physically:					

18. Do you play sport?

YES	**NO**

If YES: Which physical activity do you engage in most frequently? _______________________________________

	Light	Moderate	High
18a. At which intensity?			

	Less than 1 hour	Between 1-2 hours	Between 2-3 hours	Between 3-4 hours	More than 4 hours
18b. How many hours per week?					
	Less than 1 month	Between 1-3 months	Between 4-6 months	Between 7-9 months	More than 9 months
18c. How many months a year?					

If you engage in a second physical activity:

Which physical activity do you engage in most frequently? ___________________________________

	Light	Moderate	High
18d. At which intensity?			

	Less than 1 hour	Between 1-2 hours	Between 2-3 hours	Between 3-4 hours	More than 4 hours
18e. How many hours per week?					

18f. How many months a year?	Less than 1 month	Between 1-3 months	Between 4-6 months	Between 7-9 months	More than 9 months
19. In comparison with others my own age, I think my physical activity during leisure time is:	Much more	More	The same	Less	Much less
20. During leisure time I sweat	Very often	Often	Sometimes	Seldom	Never
21. During leisure time I play sport	Never	Seldom	Sometimes	Often	Very often
22. During leisure time I watch television	Never	Seldom	Sometimes	Often	Very often
23. During leisure time I walk	Never	Seldom	Sometimes	Often	Very often
24. During leisure time I cycle	Never	Seldom	Sometimes	Often	Very often
25. How many minutes do you walk and/or cycle per day from work, school, and shopping?	Less than 5 min.	Between 5-15 min.	Between 15-30 min.	Between 30-45 min.	More than 45 min.

Section D: Godin Leisure-Time Exercise Questionnaire

Considering a **7-Day period** (a week), how many times on the average do you do the following kinds of exercise for **at least 30 minutes** during your **free time** (write the appropriate number on each line)

26. **STRENOUS EXERSISE**
(HEART BEATS RAPIDLY)
(i.e., running, jogging, hockey, football, squash, basketball, cross-country skiing, martial arts, roller skating, vigorous swimming, vigorous long distance cycling)

TIMES PER WEEK

____

27. **MODERATE EXERCISE**
(NOT EXHAUSTING)
(i.e., fast walking, tennis, baseball, easy cycling, badminton, easy swimming, volleyball)

____

28. **MILD EXERCISE**
(MINIMAL EFFORT)
(i.e., yoga, easy walking, golf, archery, bowling, fishing from river bank)

____

29. Considering a 7-Day period (a week), during your leisure-time, how often do you engage in any regular activity long enough to work up a sweat (heart beats rapidly)?

OFTEN	SOMETIMES	NEVER/RARELY

Thank you for your co-operation

APPENDIX I

Mr. Massimo Vencato
Department of Sport and Education
Brunel University West London,
Uxbridge Campus, Kingston Lane,
Uxbridge, Middlesex, UB8 3PH.

January/March, 2007

Dear Sir/Madam,

Re: The Planned and Unplanned Physical Activity Questionnaire

This questionnaire is about two types of physical activity that you may perform during your daily routine and your leisure time. We are interested in those *planned physical activities* that you do during your leisure time such as ***heavy housework, swimming, jogging, cycling, weight training, sports training, participating in aerobic classes, etc.*** We are also interested in those *unplanned physical activities* that are scheduled into your daily routine such as ***light and moderate housework, climbing stairs, cycling or walking to work, walking the dog, gardening, shopping, playing with children, etc.*** With this in mind, we would be grateful if you could complete the attached questionnaire.

We would like you to provide an honest answer to each question. Give the response that MOST represents how you feel and avoid dwelling for too long on any single question. Please answer ALL questions in Sections **A-I**.

The questionnaire only takes a few minutes to complete. Your responses will be kept in confidence, and for the purpose of our research, a number will identify your questionnaire. Your completion of this questionnaire indicates your informed consent to participate in this study.

Thank you for your assistance in our research.

Sincerely,

Mr. Massimo Vencato

Research Student, Department of Sport and Education

APPENDIX I

1. Section A: Getting to Know You

Full name	
Gender	Male / Female
Title (please circle)	Mr Mrs Miss Ms Other (please specify) __________
Date of birth	DD / MM / YY ________ / _________ / 19_____
Occupation (e.g., teacher, housewife, unemployed, etc.)	

Ethnic origin (please circle)

White-UK/Irish	Black-Caribbean	Black-African
Indian	Pakistani	Bangladeshi
Chinese	Mixed race	White European
White-Other	Asian-Other	Other ethnic group
(If **Other**, please specify)	________________________________	

Weight (stones or kilograms)	_____ stones _____ pounds	or	_____ kg
Height (feet or metres)	_______ feet _____ inches	or	___ m ____ cm

Telephone number (please include area code)

Home:
Work:
Mobile:

APPENDIX I

Section B

In this section, we are interested in the types of *planned physical activities* you are engaging in during your leisure time. Please note that planned physical activity includes forms of activity that are scheduled into your leisure time with the <u>intention to enhance your health, fitness or well-being</u>. For example: *going to the gym, brisk walking, gardening, cycling, and team games* may constitute forms of planned physical activity. Bearing this in mind, please list the planned physical activities that you might engage in do during the next 5 weeks.

1)	**6)**
2)	**7)**
3)	**8)**
4)	**9)**
5)	**10)**

Section C

In this section, we are interested in your **intentions** to do **planned physical activity** over the next 5 weeks. Please note that planned physical activity is any activity that is scheduled into your daily routine with the intention to enhance your health, fitness or well-being. Please answer the following questions, by referring back to types of planned physical activity you have just reported in **Section B**.

*I **intend to do planned physical activities** for at least 30 minutes, 5 times per week during my leisure time, over the next 5 weeks.*

Unlikely						Very Likely
1	2	3	4	5	6	7

*I **intend to do planned physical activities** for at least 30 minutes, 5 times per week during my leisure time, over the next 5 weeks with the following regularity:*

Not at all						Every day
1	2	3	4	5	6	7

*I **intend to do planned physical activity** for at least 30 minutes, 5 times per week during my leisure time, over the next 5 weeks.*

Definitely not						Definitely
1	2	3	4	5	6	7

I** intend to do planned physical activity **for at least 30 minutes, ______ days per week, during my leisure time over the next 5 weeks.

APPENDIX I

Section D

In this section, we are interested in your **feelings** about your **planned physical activity** that you do during your leisure time. Please note that planned physical activity is any activity that is scheduled into your daily routine with the intention to enhance your health, fitness or well-being. Please answer the following questions, by referring back to types of planned physical activity you reported in **Section B**.

*My participation in **planned physical activity**, for at least 30 minutes, 5 days per week over the next 5 weeks during my leisure time is:*

Unenjoyable	1	2	3	4	5	6	7	**Enjoyable**
Bad	1	2	3	4	5	6	7	**Good**
Useless	1	2	3	4	5	6	7	**Useful**
Boring	1	2	3	4	5	6	7	**Interesting**
Harmful	1	2	3	4	5	6	7	**Beneficial**

Section E

In this section, we are interested in **how much control** you have over your **planned physical activity** during your leisure time in the next 5 weeks. Please note that planned physical activity is any activity that is scheduled into your daily routine with the intention to enhance your health, fitness or well-being. Please answer the following questions, by referring back to types of planned physical activity you have reported in **Section B**.

*How much **control** do you have over participating in **planned physical activities** for at least 30 minutes, 5 days per week during your leisure time over the next 5 weeks?*

Very little control						**Complete control**
1	2	3	4	5	6	7

*If I **wanted to**, I could do **planned physical activities** for at least 30 minutes, 5 days per week during your leisure time over the next 5 weeks.*

Strongly agree						**Strongly disagree**
1	2	3	4	5	6	7

*I feel in **complete control** over whether I will do **planned physical activities** for at least 30 minutes, 5 days per week during my leisure time over the next 5 weeks.*

Completely false						**Completely true**
1	2	3	4	5	6	7

APPENDIX I

Section F

In this section, we would like to know about **other people's thoughts** and **beliefs** about the planned physical activity that you do during your leisure time. These people may include your parents, members of your family or other people who are important to you like your friends, employer, doctor, etc. Please note that planned physical activity is any activity that is scheduled into your daily routine with the intention to enhance your health, fitness or well-being. Please answer the following questions, by referring back to the types of planned physical activity you reported in **Section B**.

*Most people who are important to me **think** that I should do **planned physical activities** for at least 30 minutes, 5 days per week during my leisure time over the next 5 weeks.*

Strongly agree						**Strongly disagree**
1	2	3	4	5	6	7

*Most people who are important to me **pressure me** to do **planned physical activities** for at least 30 minutes, 5 days per week during my leisure time over the next 5 weeks.*

Strongly agree						**Strongly disagree**
1	2	3	4	5	6	7

*Most people who are important to me **expect me** to do **planned physical activities** for at least 30 minutes, 5 days per week during my leisure time over the next 5 weeks.*

Strongly agree						**Strongly disagree**
1	2	3	4	5	6	7

Section G

In this section, we are interested in **how much planned physical activity** you did in the **past six months** during your leisure time. Please note that planned physical activity is any activity that is scheduled into your daily routine with the intention to enhance your health, fitness or well-being. Bearing this in mind, please answer the following questions, by referring back to types of planned physical activity you have reported in **Section B**.

*During the **last six months**, I have been doing **planned physical activity**:*

Not at all	**Once per week**	**A couple of days per week**	**Several days per week**	**Many days per week**	**Most of the days per week**
1	2	3	4	5	6

APPENDIX I

Section H

In this section, we are interested in the types of ***unplanned physical activities*** you are performing in during your daily routine. Please note that unplanned physical activities are any activity that is scheduled into your daily routine. These may include *light-to-moderate housework, climbing stairs, cycling or walking to work, walking the dog, gardening, shopping, playing with children, etc.* Please, list below those unplanned physical activities that **you may do during the next 5 weeks**.

1)	**11)**
2)	**12)**
3)	**13)**
4)	**14)**
5)	**15)**
6)	**16)**
7)	**17)**
8)	**18)**
9)	**19)**
10)	**20)**

Section I

In this section, we are interested in **how much unplanned physical activity** you did in the past six months during your leisure time. Please note that unplanned physical activities are any activity that is scheduled into your daily routine. Bearing this in mind, please answer the following question, by referring back to types of unplanned physical activity you have reported in **Section H**.

*During the **last six months**, I have been doing any of these **unplanned physical activities**:*

Not at all	Once per week	A couple of days per week	Several days per week	Many days per week	Most of the days per week
1	2	3	4	5	6

Thank you for your co-operation

APPENDIX J

Mr. Massimo Vencato
School of Sport & Education
Brunel University West London
Uxbridge Campus, Kingston Lane
Uxbridge, Middlesex, UB8 3PH.

January/March, 2007

Dear Sir/Madam,

Re: The Brunel Lifestyle Physical Activity Questionnaires

The attached questionnaire is about lifestyle physical activity during your leisure time and work time. We are currently conducting research into planned and unplanned physical activity. With this in mind, we would be grateful if you could complete the attached questionnaires.

We would like you to provide an honest answer to each question. Give the response that MOST represents how you feel and avoid dwelling for too long on any single question. Please answer ALL questions in Sections **A-B**.

These questionnaires only take a few minutes to complete. Your responses will be kept in confidence, and for the purpose of our research, your questionnaires will be identified by number only. Your completion of these questionnaires indicates your informed consent to participate in this study.

Thank you for your assistance in our research.

Sincerely,

Mr. Massimo Vencato
Research Student, School of Sport & Education

Return completed questionnaire in the attached stamped self-addressed envelope
on: __________ January/February/March, 2007

APPENDIX J

Section A: Background Information

Full name	
Gender (please circle)	Male Female
Title (please circle)	Mr Mrs Miss Ms Other (please specify) __________
Date of birth	DD / MM / YY ________ / _________ / 19_____

Ethnic origin (please circle)

White-UK/Irish	Black-Caribbean	Black-African
Indian	Pakistani	Bangladeshi
Chinese	Mixed race	White European
White-Other	Asian-Other	Other ethnic group

(If **Other**, please specify) ________________________

Occupation
(e.g., teacher, housewife, unemployed, etc.)

Weight (stones <u>or</u> kilograms)   _____ stones _____ pounds   <u>or</u>   ________ kgs

Height (feet <u>or</u> metres)   _______ feet _____ inches   or   ___ m ____ cm

Section B: Brunel Physical Activity Questionnaire

Note. Pre-planned physical activity is any activity that is scheduled into your daily routine, which may enhance your health, fitness or wellbeing. Examples include brisk walking, gardening, cycling, team games, etc. Please, relate your answers to your activities over the last **5-week period**.

1. How many times a week do you engage in pre-planned physical activity?

Never	1-2 times	3-4 times	5-6 times	7 or more times

2. How long have you been engaging in pre-planned physical activity at this weekly rate?

Not relevant to me	Less than 1 month	1-3 months	4-6 months	More than 7 months

3. In general, what is the duration of each session of pre-planned physical activity that you engage in?

Not relevant to me	Less than 10 mins	10 - 20 mins	21 - 30 mins	More than 30 mins

4. If you add together each session of pre-planned physical activity that you engage in during a normal week, how much time would you estimate that you spend in total?

Not relevant to me	Less than 1 hour	1-2 hours	3-5 hours	More than 5 hours

5. In the past, how long have you generally persisted with a pre-planned physical activity programme before giving up?

Not relevant to me, as I have never persisted	Up to 1 month	Up to 3 months	Up to 6 months	More than 6 months, or I have never given up

6. How vigorously do you engage in pre-planned physical activity?

Not relevant to me	Very light	Moderately hard	Hard	Very hard

("Very light" means that you hardly get out of breath.
"Very hard" means that you exercise to the extent that you are breathing deeply)

7. Excluding your pre-planned physical activity sessions, how many hours do you estimate that you spend doing other forms of physical activity each week?

Fewer than 2 hours	2-4 hours	5-7 hours	8-9 hours	10 or more hours

(These may include heavy housework, climbing stairs, cycling or walking to work, walking the dog, gardening, shopping, playing with children, etc.)

8. How vigorously do you engage in these other forms of physical activity?

Not relevant to me	Very light	Moderately hard	Hard	Very hard

("Very light" means that you hardly get out of breath.
"Very hard" means that you perform the activities to the extent that you are breathing deeply)

9. In general, how physically demanding are your job or your day-to-day activities?

Not at all	A little	Moderately	Quite	Highly

("Not at all" means that your activities are sedentary without requiring much movement.
"Highly" means that you are engaged in heavy labour or constantly moving around)

Thank you for your co-operation