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Concurrent validity and cross-validation of the Brunel Lifestyle Physical Activity Questionnaire

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ABSTRACT

Objectives: Owing to the profoundly negative impact of inactivity on public health, it is important to have valid and reliable measures of lifestyle physical activity (LPA). The Brunel Lifestyle Physical Activity Questionnaire (BLPAQ) was designed as a measure of planned physical activity (PPA) and unplanned physical activity (UPA). The objective of the present study was to assess the criterion-related validity of the BLPAQ.

Design: A correlational design was employed.

Methods: A sample of British leisure centre users (N = 356; age range 18 – 69 y: mean age 26.5 ± 10.4 y) completed the BLPAQ and two reference measures: the Baecke Questionnaire of Habitual Physical Activity (BQHPA) and the Godin's Leisure-Time Exercise Questionnaire (GLTEQ). MANOVA was used to test for potential gender differences in LPA patterns. Each measure was also cross-validated using a split-sample approach and the limits of agreement (LoA) method.

Results: With the exception of the Moderate and Vigorous dimensions of the GLTEQ, the remaining scores of the reference instruments were correlated with both PPA and UPA factors (p < 0.05). A significant difference in levels of UPA was found between women and men (p = 0.039). Furthermore, multiple linear regression analyses demonstrated that the BLPAQ subscales could be predicted by the criterion measures. The LoA analyses demonstrated satisfactory agreement between BLPAQ subscales and those of the BQHPA and GLTEQ.

Conclusions: The BLPAQ is a criterion- and cross-validated measure of PPA and UPA that can be used to assess the efficacy of LPA interventions by researchers and practitioners. Further research should address the predictive validity of the BLPAQ – another facet of criterion validity.

Keywords: concurrent validity, gender, limits of agreement, planned physical activity, unplanned physical activity.

1. Introduction

Valid and reliable measures of physical activity (PA) provide a basis for future epidemiological research, with the resulting interventions contributing to improvements in psychological and physiological health.[1] The Brunel Lifestyle Physical Activity Questionnaire (BLPAQ)[2] was designed to tap the planned physical activity (PPA) and unplanned physical activity (UPA) components of lifestyle physical activity (LPA; see Appendix 1). The initial development of the BLPAQ indicated that the instrument was reliable (Cronbach α estimates of 0.90 for the PPA subscale and 0.68 for the UPA subscale, which had only three items) and that the two-factor structure demonstrated factorial validity (Comparative Fit Index = 0.94, Standardised Root Mean Residual = 0.05, Akaike Information Criterion = 54.74).[2] In contrast to pre-existing North American instruments, the BLPAQ was developed to be culturally appropriate to the British population. This was achieved by using British participants for the initial validation process[2] and through employing a lexicon in the development of items that would be suitable for the British population. To assess the concurrent validity of the BLPAQ, a facet of criterion validity, responses were compared with those of the Baecke Questionnaire of Habitual Physical Activity (BQHPA)[3] and Godin's Leisure Time Exercise Questionnaire (GLTEQ).[4] Both of these measures have been widely used in large-scale epidemiological and health-related behavioural research,[5, 6] and have demonstrated satisfactory reliability and criterion-related validity (C-RV).[7-9] The purpose of this study was to test the concurrent validity of the BLPAQ using the BQHPA and the GLTEQ as reference measures. Subsumed under this central purpose, gender invariance was examined for the BLPAQ scores and reference measures. The limits of agreement (LoA) method was used to assess the agreement between the sets of scores.[10]

2. Methods

The present study was approved by the Brunel University London Ethics Committee and all procedures followed were in accord with the Declaration of Helsinki. The sample was composed of 356 participants (age range 18 – 69 y; mean age 26.6 ± 10.4 y) recruited from a leisure centre in Berkshire, UK over a 3-month period. The sample comprised 201 women (56.5% of entire sample: age range = 18 – 60 y; mean age 26.5 ± 9.1 y), and 155 men (43.5% of entire

sample: age range = 18 – 69 y; mean age 26.7 ± 11.9 y; see Table 1). Each participant was approached in the reception area of the centre and written informed consent was obtained. The participant was then invited to complete the three PA questionnaires before engaging in a group exercise class or using any other leisure centre facility (e.g., gymnasium, swimming pool, etc.). Data were gathered during the day (10:00 – 16:00 h) to avoid disrupting the flow of users during peak periods.

The BQHPA taps habitual PA, which refers to activity that has been established over a period of deliberation regarding its usefulness, and consequently requires less decisional effort.[11, 12] Its three conceptually meaningful factors are classified as (1) PA at work; (2) sport during leisure time; and (3) PA during leisure time excluding sport. The factors are scored using 5-point Likert-type scales with 1 indicating very low levels of activity and 5 representing very high levels. Test-retest reliability over a 3-month period was acceptable ranging from $r = 0.74$ (Leisure index) to $r = 0.88$ (Work index). Validation studies with specific patient groups have found moderate levels of C-RV for the BQHPA.[13]

The GLTEQ assesses the frequency of exercise sessions completed during free time for at least 15 min over a typical week. Four factors comprise Light, Moderate, Vigorous, and Sweat-inducing activity. Two-week, test-retest reliability was demonstrated ($r = 0.74$) in addition to significant ($p < 0.05$) correlations with both $\dot{V}O_2$ max ($r = 0.38$), and body fat ($r = 0.21$).[4] For the purpose of this study, the timespan for each exercise bout was changed to 30 min in accordance with ACSM PA guidelines.[14]

Subsequent to data screening (see Appendix 2) and logarithmic transformations due to distributional non-normality, data analysis comprised of four phases: in the first, Pearson's product-moment correlations (PPC) were used to assess relationships among dependent variables. The second phase consisted of a 2 x 9 (Gender x BLPAQ [PPA, UPA factors]/GLTEQ [Light, Moderate, Vigorous, and Sweat subscales]/BQHPA [Work, Sport, and Leisure indices]) multivariate analysis of variance (MANOVA). In the third phase, the dataset was subjected to a multiple linear regression to assess functional relationships among the dependent variables (C-RV). In the final phase, data were subjected to a LoA analysis and, to facilitate this, the original

sample was randomly subdivided into two groups of equal size (n = 178). The LoA for each subsample was then calculated using the formula: Md ± 1.96 SD, where Md = mean of differences and SD = standard deviation of the differences.

3. Results

Twenty-five of the 36 PPCs were significant ($p < 0.05$; see Table 2). The notable exception was the Moderate subscale of the GLTEQ, which did not correlate ($p = 0.533$) 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 did not correlate ($p = 0.976$) with the Sport index of the BQHPA or the Light, Moderate, and Vigorous subscales of the GLTEQ.

In the MANOVA (see Table 3), the omnibus statistics indicated a main effect of gender (Hotelling's Trace = 0.21, F[9,346] = 7.97, $p < 0.001$, $\eta_p^2 = 0.17$). However, only the Leisure index of the BQHPA ($p = 0.011$), and all of the GLTEQ subscales differed by gender ($p < 0.001$). Women reported higher scores on the Vigorous and Sweat subscales of the GLTEQ than men (both $p < 0.001$), whereas men reported higher scores on the Light and Moderate subscales (both $p < 0.001$). All of these differences were meaningful in terms of associated effect sizes ($\eta_p^2 = 0.04 – 0.09$).

The linear regression analysis for PPA showed that the Sport index of the BQHPA made the largest unique contribution to the predictive model ($B = 0.67$, $\beta = 0.47$, $p < 0.001$), followed by the Sweat subscale of the GLTEQ ($B = 0.20$, $\beta = 0.25$, $p < 0.001$), the Leisure index of the BQHPA ($B = 0.12$, $\beta = 0.14$, $p = 0.001$), the Light subscale of the GLTEQ ($B = 0.07$, $\beta = 0.16$, $p < 0.001$), and the Moderate subscale of the GLTEQ ($B = -0.03$, $\beta = -0.08$, $p = 0.041$; see Table 4). The remaining variables did not significantly contribute to the model ($\beta \leq 0.03$, $p > 0.05$). In regard to the female subsample, the Sport index of the BQHPA made the largest unique contribution to the predictive model ($B = 0.72$, $\beta = 0.51$, $p < 0.001$) followed by the Sweat ($B = 0.22$, $\beta = 0.27$, $p < 0.001$), the Light subscale of the GLTEQ ($B = 0.05$, $\beta = 0.11$, $p = 0.047$), and Moderate subscale of the GLTEQ ($B = -0.05$, $\beta = 0.11$, $p = 0.020$). The remaining variables did not significantly contribute to the model ($\beta \leq 0.06$, $p > 0.05$).

With reference to males, the Sport index of the BQHPA made the largest unique contribution to the predictive model ($B = 0.59$, $\beta = 0.41$, $p < 0.001$) followed by the Sweat subscale of the GLTEQ ($B = 0.27$, $\beta = 0.27$, $p < 0.001$), the Leisure index of the BQHPA ($B = 0.24$, $\beta = 0.28$, $p < 0.001$), and finally, the Light subscale of the GLTEQ ($B = 0.08$, $\beta = 0.21$, $p < 0.001$). The remaining variables did not significantly contribute to the model ($\beta \leq 0.01$, $p > 0.05$).

Results of the linear regression analysis for UPA (see Table 5) revealed that the Work index of the BQHPA made the largest unique contribution to the predictive model ($B = 0.36$, $\beta = -0.30$, $p < 0.001$), followed by the Leisure index of the BQHPA ($B = 0.23$, $\beta = 0.22$, $p < 0.001$), and the Sweat subscale of the GLTEQ ($B = 0.20$, $\beta = 0.22$, $p < 0.001$). The remaining variables did not significantly contribute to the model ($\beta \leq 0.07$, $p > 0.05$). For the female subsample, the Leisure index of the BQHPA made the largest unique contribution to the model ($B = 0.37$, $\beta = 0.37$, $p < 0.001$), followed by the Work subscale ($B = 0.30$, $\beta = 0.29$, $p < 0.001$), the Sweat ($B = 0.14$, $\beta = -0.17$, $p = 0.017$), Moderate ($B = 0.07$, $\beta = 0.14$, $p = 0.016$), and Vigorous ($B = -0.04$, $\beta = -0.14$, $p = 0.027$) subscales of the GLTEQ. The remaining variables did not significantly contribute to the model ($\beta \leq 0.09$, $p > 0.05$).

For the male subsample, the Sweat index of the GLTEQ made the largest unique contribution to the model ($B = 0.48$, $\beta = 0.38$, $p < 0.001$), followed by the Sport subscale of the BQHPA ($B = -0.32$, $\beta = -0.17$, $p = 0.020$), the Vigorous subscale of the GLTEQ ($B = 0.14$, $\beta = 0.33$, $p < 0.001$), and the Light subscale of the GLTEQ ($B = 0.08$, $\beta = 0.17$, $p = 0.021$). The remaining variables did not significantly contribute to the model ($\beta \leq 0.14$, $p > 0.05$; see Table 5).

The LoA analysis is essentially a visual scrutiny without established statistical assessment criteria[10] (see Appendix 3 and Figures 1A and B, 2A–C, and 3A–D). The results of the LoA analyses for the cross-validation of the BLPAQ and the criterion measures appear in Table 6. The agreements demonstrated by the subscales of each questionnaire were compared across instruments. The BLPAQ and BQHPA subscales were scored using a 5-point scale, and were thus expected to exhibit comparable LoA results.[15] Unsurprisingly, the subscales of these instruments demonstrated similar LoAs (PPA: 0.511 to -0.511, and UPA: 0.495 to -0.495 vs BQHPA-Work: 0.492 to -0.492, and BQHPA-Leisure: 0.518 to -0.518) with the exception of the Sport index of the

BQHPA, which returned superior agreement (0.389 to -0.389; see Table 6). The interval between the upper and lower LoA for each of the GLTEQ subscales were considerably larger than those of the BLPAQ and BQHPA (GLTEQ-Light: 1.861 to -1,861; GLTEQ-Moderate: 1.966 to -1.966; GLTEQ-Vigorous: 2.549 to -2.549), whereas the Sweat subscale of the GLTEQ presented a tighter agreement (0.648 to -0.648; see Table 6). The low number of data points present in Figures 3A–D relative to the other LoA analyses, reflect the fact that each point represents the scores of multiple participants and the narrower 3-point scale attached to the GLTEQ.

5. Discussion

The correlations between the BLPAQ factors, the BQHPA indices, and the GLTEQ subscales indicated reasonable concurrent validity of the BLPAQ (r = 0.11 – 0.64). PA measures generally inter-correlate within a similar range (i.e., r = 0.20 – 0.50);[9, 11, 13, 16] only the correlation between PPA and the Sport index of BQHPA exceeded the ideal value of r = 0.60.[16] Overall, the PPC analysis identified six significant negative correlations between the BLPAQ and reference measures (see Table 2). The MANOVA results indicated that women and men reported similar levels of PPA (p = 0.128) but men reported slightly higher levels of UPA than women (p = 0.039; see Table 3), albeit that the associated effect size was not meaningful (η_p^2 = 0.01). Hence, in terms of the UPA component, it can be argued that the BLPAQ is equally valid for women and men drawn from a physically active population. The results of the linear regression analyses also showed gender differences in the prediction of the BLPAQ subscales by the two criterion measures. In the LoA analysis, every subscale demonstrated satisfactory agreement (across split samples). The BQHPA and BLPAQ subscales demonstrated broadly similar plot distributions and LoAs (see Figures 1A and B, 2A–C, and 3A–D).

The BLPAQ factors were inversely correlated, which was expected, given that they reflect *mutually exclusive* patterns of PA with divergent intensity levels (r = -0.25, p < 0.001). UPA correlated positively with the Light subscale of the GLTEQ (r = 0.24, p < 0.001). This result was also expected, as UPA is more likely to be of a light intensity; high-intensity activities, by their very nature, require some degree of planning.[17, 18]

UPA was negatively correlated with each BQHPA index (Work: r = -0.38, $p < 0.001$; Sport: r = -0.13, p = 0.016; and Leisure: r = -0.36, $p < 0.001$) and the Sweat subscale of the GLTEQ (r = -0.39, $p < 0.001$). The inverse correlation between UPA and the Work and Leisure indices of the BQHPA is problematic, as the UPA descriptors used in the BLPAQ incorporate activities that are reflected in both indices (e.g., walking, lifting loads at work). Nonetheless, the descriptor list also includes activities that are typically undertaken outside of work (e.g., playing with children, shopping, etc.), and those that are ambiguous in terms of their pertinence to leisure; that is, activities that may be enjoyable pastimes but also routine in nature (e.g., dog walking, gardening, etc.). The PPA correlated positively with all indices of the BQHPA and all subscales of the GLTEQ, with the exception of the Light subscale, with which it was negatively associated. These findings are in line with expectations inasmuch as PPA is likely to be moderate-to-vigorous in intensity; one does not systematically plan to engage in activities of a very light intensity.[19, 20]

Physical activity behaviour differed by gender, which accounted for 17% of the explained variance (see Table 3). The most meaningful of these differences was in respect of the GLTEQ subscales. Women reported a higher incidence of vigorous and sweat-inducing PA. The activities listed as exemplars for the Light subscale include many stereotypically masculine pastimes such as golf, archery, and fishing.[21] With reference to the Sport index, it appears that, similar to the general population,[22] the female subsample was as likely to engage in sport as the male subsample. The lack of gender invariance in respect of the Work index may reflect changing gender roles within the workplace; almost every participant reported a form of work-related activity. Although patterns of PA adoption are thought to differ by gender,[23] no differences in the BLPAQ factor scores were found.

It appears that only three subscales made a significant contribution ($p < 0.001$) 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 were positively correlated with UPA ($p < 0.001$). It is noteworthy that the relationship between UPA and the predictor variables differed markedly between genders. Women who engaged in a high frequency of UPA behaviour tended to partake in sweat-inducing physical exercises and in sporting activities. The implication is that sport-

orientated women are also highly active in other exercise settings, which is consistent with the notion of a dichotomy between active and sedentary women.[24, 25]

The regression equations for PPA differed markedly by gender (see Table 4) and among women, four variables made a unique contribution to the model. The strongest predictor was the Sport index of the BQHPA followed by the Sweat, Light, and Moderate subscales of the GLTEQ. With the exception of the Moderate subscale of the GLTEQ (β = -0.11, p = 0.020), each of these variables loaded positively, indicating that women intentionally planned their participation in more vigorous forms of PA.[17-20] Among men, four variables made a unique contribution to the model: Sport index of the BQHPA was clearly the strongest followed by the Leisure index of the BQHPA and the Sweat and Light subscales of the GLTEQ. The overall variance explained for women and men for both PPA and UPA was similar, albeit that the cluster of significant predictors in each regression equation was different (see Table 4 and Table 5). It is notable that the BQHPA indices are stronger predictors of PPA among the male subsample when compared to the female subsample, but that the converse was observed for the GLTEQ subscales.

Because no previous research has established facets of the criterion validity for PPA and UPA, the present results can be viewed as useful benchmarks for future scale development. Both BLPAQ factors demonstrated similar LoAs to those of the Work and Leisure indices of the BQHPA, with which they were directly comparable. In contrast, the Sport index demonstrated a narrower range, indicative of greater agreement between the split samples. Within the PA spectrum, sporting behaviour is among the easiest to identify and recall owing to its specific nature, whereas light activity proves more nebulous.[11, 15]

A probable limitation of the present study was that a physically active sample was chosen (i.e., leisure centre users). Such participants likely differed from the general population in terms of their PA behaviour. In particular, women reported a higher frequency of intense PA; a finding that highlights the distinctness of the present sample from the general population.[27] For this reason, one must apply caution when generalising the present results to less active populations. A further limitation is that participants' PA behaviours were not subsequently observed (i.e., the predictive validity facet of criterion validity) and this might be a focus for future research efforts.

6. Conclusions

The BLPAQ demonstrated acceptable concurrent validity, which strengthens the evidence base surrounding it as a valid measure of planned and unplanned PA. The LoA analyses showed that the internal agreement of the BLPAQ factors was commensurate with those of the criterion measures. The results also indicated that gender bears influence on PA patterns and should, therefore, be taken into account in the design of PA interventions.[24, 28] Further C-RV development with the BLPAQ should be conducted using anthropometric measures such as percentage of body fat,[8] ecological momentary assessment[29] with an activity diary,[30] and objective assessments of PA such as an accelerometer,[12, 31] or doubly labelled water.[7] To complete an initial construct validation process, the theoretical basis for the BLPAQ – the Theory of Planned Behaviour[32] – should be used to predict planned and unplanned PA.

Practical implications

- The BLPAQ is a measure of Lifestyle Physical Activity (LPA) with an emerging evidence base regarding its validity and reliability.
- The BLPAQ is a tool that might be considered for assessment of LPA within the British population, as well as other English-speaking populations, with further validation work.
- This questionnaire can be easily administered, and is thus particularly useful for researchers and health professionals concerned with promotion of LPA.

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Ethics approval: The study was approved by the Brunel University London Ethics Committee and all participants provided written informed consent. Participants consented to publication of the data so long as their identity was not revealed.

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Table 1

Details and ethnic background of participants (N = 356) employed in the BLPAQ Criterion-related validity analyses after the deletion of univariate and multivariate outliers.

	Participants	Women	Men
	(N = 356)	(n = 201)	(n = 155)
Age range (yr)	18-69	18-60	18-69
Mean age (yr)	26.68	26.49	26.70
Standard deviation (yr)	10.37	9.06	11.88
Ethnicity			
White UK/Irish	62.4	58.2	67.7
Black-Caribbean	2.5	4.0	0.6
Black-African	6.2	4.5	8.4
Indian	11.8	13.9	9.0
Pakistani	4.2	5.0	3.2
Bangladeshi	0.6	1.0	0.0
Chinese	1.4	2.5	0.0
Mixed race	2.2	4.0	0.0
White European	7.3	6.0	9.0
White-Other	0.6	0.0	1.3
Asian-Other	0.8	1.0	0.6
Gender percentage (%)		56.5	43.5

Note: BLPAQ = Brunel Lifestyle Physical Activity Questionnaire.

Table 2

Pearson's product-moment correlations (2-tailed) between BLPAQ, BQHPA, and GLTEQ subscales (N = 356).

Subscales	**BLPAQ / UPA**	**BQHPA / Work**	**BQHPA / Sport**	**BQHPA / Leisure**	**GLTEQ / Light**	**GLTEQ / Moderate**	**GLTEQ / Vigorous**	**GLTEQ / Sweat**
BLPAQ / PPA	-0.25	0.11	0.64	0.30	-0.47	0.12	0.13	0.56
p	<0.001	0.040	<0.001	<0.001	<0.001	0.021	0.011	<0.001
BLPAQ / UPA		-0.38	-0.13	-0.36	0.24	0.03	-0.01	-0.39
p		<0.001	0.016	<0.001	<0.001	0.533	0.808	<0.001
BQHPA / Work			0.00	0.17	-0.01	0.06	0.10	0.22
p			0.976	0.001	0.827	0.251	0.061	<0.001
BQHPA / Sport				0.16	-0.34	0.06	0.09	0.37
p				0.003	<0.001	0.258	0.106	<0.001
BQHPA / Leisure					-0.22	-0.04	-0.10	0.30
p					<0.001	0.485	0.051	<0.001
GLTEQ / Light						0.04	-0.06	-0.48
p						0.414	0.251	<0.001
GLTEQ / Moderate							0.30	0.10
p							<0.001	0.051
GLTEQ / Vigorous								0.15
p								0.004

Notes: BLPAQ = Brunel Lifestyle Physical Activity Questionnaire; PPA = planned physical activity; UPA = unplanned physical activity; BQHPA = Baecke Questionnaire of Habitual Physical Activity; GLTEQ = Godin Leisure-Time Exercise Questionnaire.

Table 3

Descriptive statistics and MANOVA for BLPAQ, BQHPA, and GLTEQ subscales (N = 356).

	Men		Women				
Dependent variable	*M*	*SD*	*M*	*SD*	***F* (df)**	***p***	η_p^2
BLPAQ PPA factor	1.40	0.19	1.44	0.21	2.33 (14.45, 354)	0.128	0.01
BLPAQ UPA factor	1.63	0.21	1.59	0.20	4.27 (15.01, 354)	0.039	0.01
BQHPA Work Index	1.39	0.16	1.43	0.22	3.35 (13.29, 354)	0.068	0.01
BQHPA Sport Index	1.50	0.12	1.51	0.15	0.54 (6.95, 354)	0.464	0.00
BQHPA Leisure Index	1.53	0.21	1.59	0.20	6.47 (14.83, 354)	0.011	0.02
GLTEQ Light subscale	1.69	0.59	1.33	0.74	25.00 (161.16, 354)	<0.001	0.07
GLTEQ Moderate subscale	1.34	0.63	1.03	0.79	15.56 (187.16, 354)	<0.001	0.04
GLTEQ Vigorous subscale	1.09	0.84	1.58	0.83	29.85 (247.11, 354)	<0.001	0.08
GLTEQ Sweat subscale	1.18	0.22	1.34	0.29	34.49 (24.19, 354)	<0.001	0.09
Omnibus statistics: Hotelling's Trace = 0.21, F (9, 346) = 7.97, $p < 0.001$, $\eta_p^2 = 0.17$							

Notes: BLPAQ = Brunel Lifestyle Physical Activity Questionnaire; PPA = planned physical activity; UPA = unplanned physical activity; BQHPA = Baecke Questionnaire of Habitual Physical Activity; GLTEQ = Godin Leisure-Time Exercise Questionnaire.

Table 4

Summary of multiple linear regressions for variables predicting PPA factor of the BLPAQ (N = 356).

Physical activity questionnaires subscales	**Entire sample (*N* = 356)**					**Women (*n* = 201)**					**Men (*n* = 155)**				
	Unstandardised		Standardised			Unstandardised		Standardised			Unstandardised		Standardised		
	B	SE *B*	β	*t*	*p*	*B*	SE *B*	β	*t*	*p*	*B*	SE *B*	β	*t*	*p*
(Constant)	0.94	0.21		4.53	<0.001	1.00	0.30		3.39	0.001	0.63	0.31		2.07	0.040
BQHPA/Work	0.03	0.04	0.02	0.64	0.521	0.06	0.05	0.06	1.24	0.215	0.01	0.08	0.01	0.13	0.898
BQHPA/Sport	0.67	0.06	0.47	11.97	<0.001	0.72	0.08	0.51	9.54	<0.001	0.59	0.09	0.41	6.89	<0.001
BQHPA/Leisure	0.12	0.04	0.14	3.43	0.001	0.04	0.05	0.04	0.86	0.390	0.24	0.05	0.28	4.65	<0.001
GLTEQ/Light	0.07	0.02	0.16	3.77	<0.001	0.05	0.03	0.11	2.00	0.047	0.08	0.02	0.21	3.68	<0.001
GLTEQ/Moderate	-0.03	0.02	-0.08	-2.05	0.041	-0.05	0.02	-0.11	-2.36	0.020	-0.01	0.02	-0.03	-0.51	0.613
GLTEQ/Vigorous	-0.01	0.01	-0.04	-1.09	0.274	-0.01	0.02	-0.03	-0.61	0.546	-0.03	0.02	-0.10	-1.59	0.113
GLTEQ/Sweat	0.20	0.04	0.25	5.54	<0.001	0.22	0.05	0.27	4.54	<0.001	0.27	0.07	0.27	4.00	<0.001
	$R = 0.75$, $R^2 = 0.57$.					$R = 0.77$, $R^2 = 0.60$.					$R = 0.76$, $R^2 = 0.57$.				

Notes: BLPAQ = Brunel Lifestyle Physical Activity Questionnaire; PPA = planned physical activity; BQHPA = Baecke Questionnaire of Habitual Physical Activity; GLTEQ = Godin Leisure-Time Exercise Questionnaire.

Table 5

Summary of multiple linear regressions for variables predicting UPA factor of the BLPAQ (N = 356).

Physical activity questionnaires subscales	**Entire sample (N = 356)**					**Women (*n* = 201)**					**Men (*n* = 155)**				
	Unstandardised		Standardised			Unstandardised		Standardised			Unstandardised		Standardised		
	B	SE *B*	β	*t*	*p*	*B*	SE *B*	β	*t*	*p*	*B*	SE *B*	β	*t*	*p*
(Constant)	0.27	0.30		0.91	0.361	0.06	0.37		0.17	0.862	1.21	0.48		2.53	0.013
BQHPA/Work	0.36	0.06	0.30	6.28	<0.001	0.30	0.06	0.29	4.75	<0.001	-0.22	0.13	0.14	1.72	0.087
BQHPA/Sport	0.01	0.08	0.00	0.08	0.934	0.12	0.09	0.09	1.31	0.192	-0.32	0.13	-0.17	-2.35	0.020
BQHPA/Leisure	0.23	0.05	0.22	4.57	<0.001	0.37	0.06	0.37	6.02	<0.001	0.01	0.08	0.01	0.10	0.922
GLTEQ/Light	0.03	0.03	0.07	1.38	0.168	-0.01	0.03	-0.02	-0.34	0.737	0.08	0.04	0.17	2.33	0.021
GLTEQ/Moderate	0.03	0.02	0.07	1.38	0.169	0.07	0.03	0.14	2.43	0.016	-0.06	0.04	-0.11	-1.51	0.132
GLTEQ/Vigorous	0.01	0.02	0.01	0.30	0.770	-0.04	0.02	-0.14	-2.23	0.027	0.14	0.03	0.33	4.33	<0.001
GLTEQ/Sweat	0.20	0.05	0.22	3.89	<0.001	0.14	0.06	0.17	2.40	0.017	0.48	0.11	0.38	4.53	<0.001
	$R = 0.55$, $R^2 = 0.30$.					$R = 0.63$, $R^2 = 0.40$.					$R = 0.59$, $R^2 = 0.35$.				

BLPAQ = Brunel Lifestyle Physical Activity Questionnaire; UPA = unplanned physical activity; BQHPA = Baecke Questionnaire of Habitual Physical Activity; GLTEQ = Godin Leisure-Time Exercise Questionnaire.

Table 6

Limits of agreement analysis for BLPAQ, BQHPA, and GLTEQ subscales (N = 356).

Physical activity questionnaires subscales	Difference between A-B		95% LoA		One-sample *t*-test		95% CI of the Difference	
	Md	*SD*	Upper	Lower	*t*	*p* (2-tailed)	Lower	Upper
BLPAQ/PPA	-0.023	0.272	0.511	-0.511	-1.11	0.270	-0.063	0.018
BLPAQ/UPA	0.006	0.250	0.495	-0.495	0.30	0.765	-0.031	0.043
BQHPA/Work	-0.005	0.254	0.492	-0.492	-0.29	0.775	-0.043	0.032
BQHPA/Sport	0.006	0.196	0.389	-0.389	0.43	0.671	-0.023	0.035
BQHPA/Leisure	-0.001	0.265	0.518	-0.518	-0.07	0.948	-0.041	0.038
GLTEQ/Light	-0.009	0.954	1.861	-1.861	-0.13	0.896	-0.151	0.132
GLTEQ/Moderate	0.054	0.975	1.966	-1.966	0.75	0.457	-0.090	0.199
GLTEQ/Vigorous	0.165	1.217	2.549	-2.549	1.81	0.072	-0.015	0.345
GLTEQ/Sweat	-0.038	0.350	0.648	-0.648	-1.46	0.147	-0.090	0.014

Notes: Md = Mean of difference between subsample 1 and subsample 2; LoA = limits of agreement; CI = confidence interval; BLPAQ = Brunel Lifestyle Physical Activity Questionnaire; PPA = planned physical activity; UPA = unplanned physical activity; BQHPA = Baecke Questionnaire of Habitual Physical Activity; GLTEQ = Godin Leisure-Time Exercise Questionnaire.

Figures: 1A, and 1B

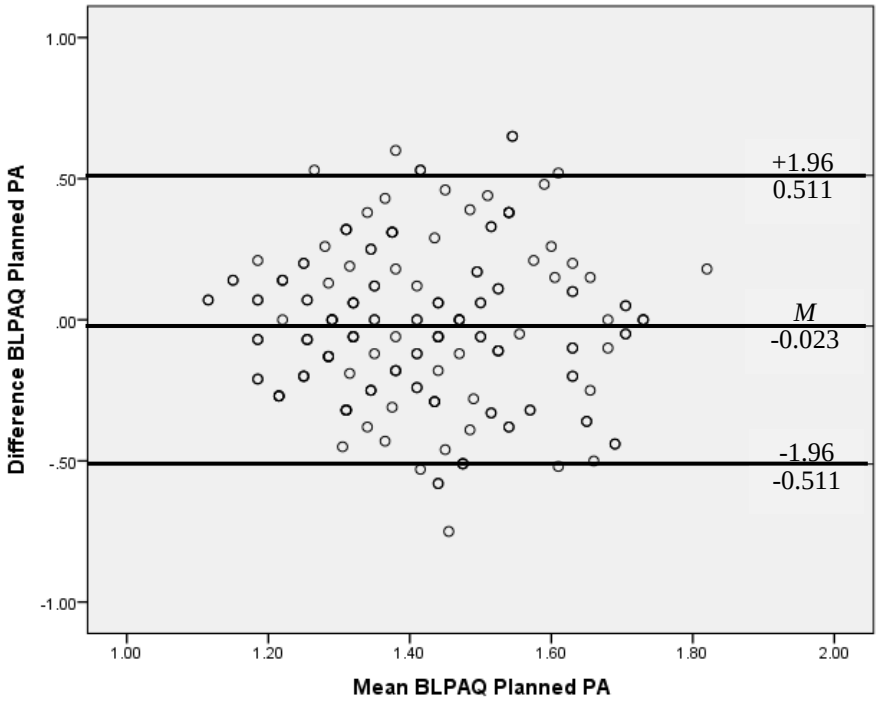

Figure 1A: Limits of Agreement for the BLPAQ - Planned Physical Activity subsample 1 and subsample 2.

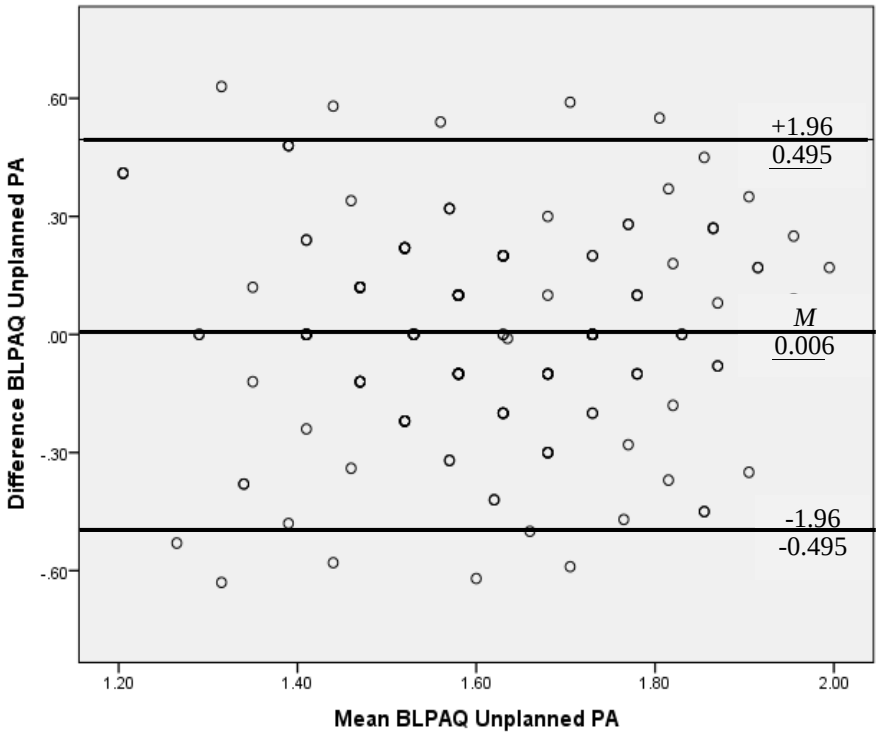

Figure 1B: Limits of Agreement for the BLPAQ - Unplanned Physical Activity subsample 1 and subsample 2.

Figures: 2A, 2B, and 2C

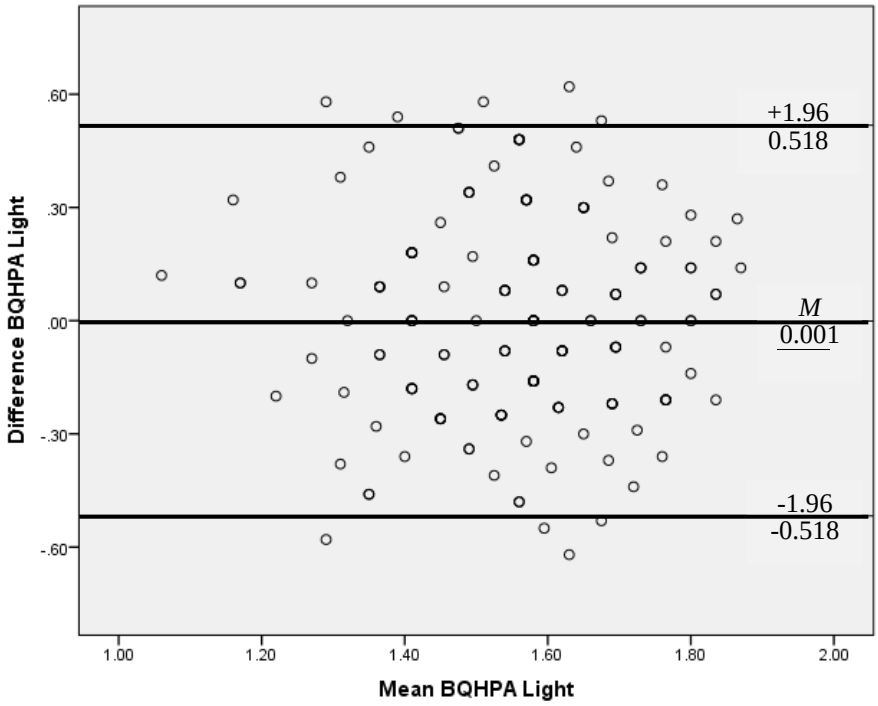

Figure 2A: Limits of Agreement for the BQHPA - Light Index subsample 1 and subsample 2.

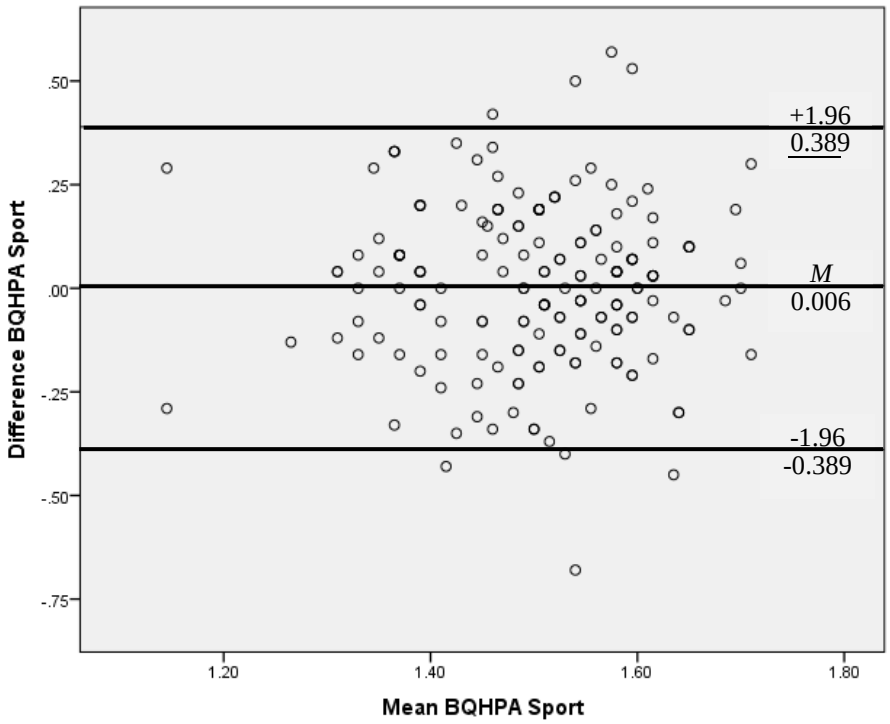

Figure 2B: Limits of Agreement for the BQHPA - Sport Index subsample 1 and subsample 2.

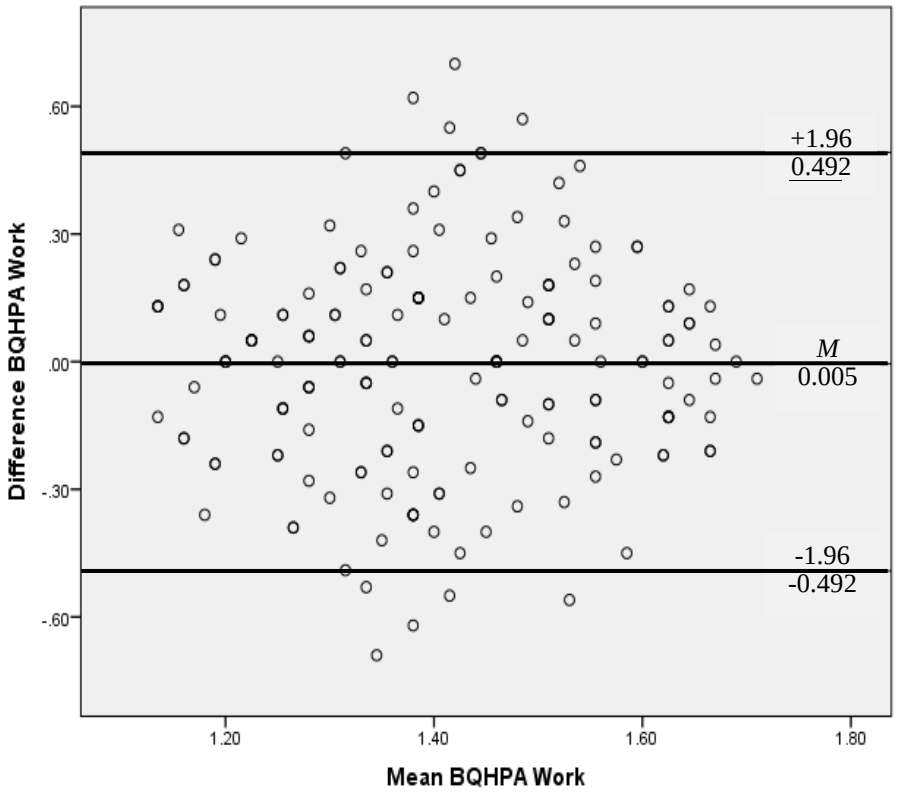

Figure 2C: Limits of Agreement for the BQHPA - Work Index subsample 1 and subsample 2.

Figures: 3A, 3B, 3C, and 3D

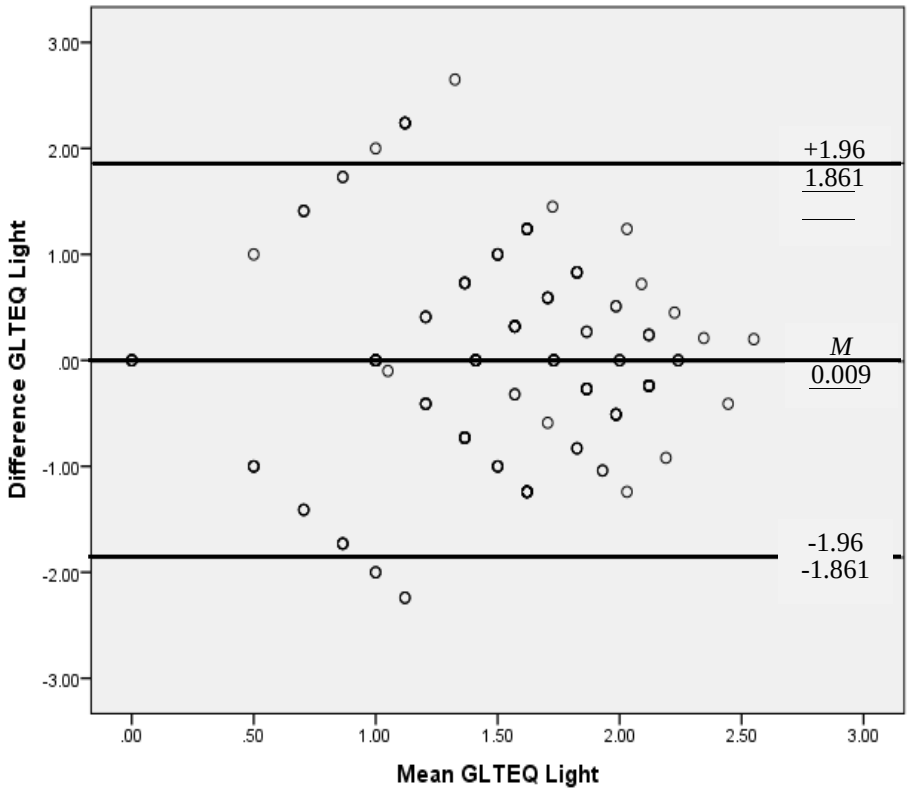

Figure 3A: Limits of Agreement for the GLTEQ - Light factor subsample 1 and subsample 2.

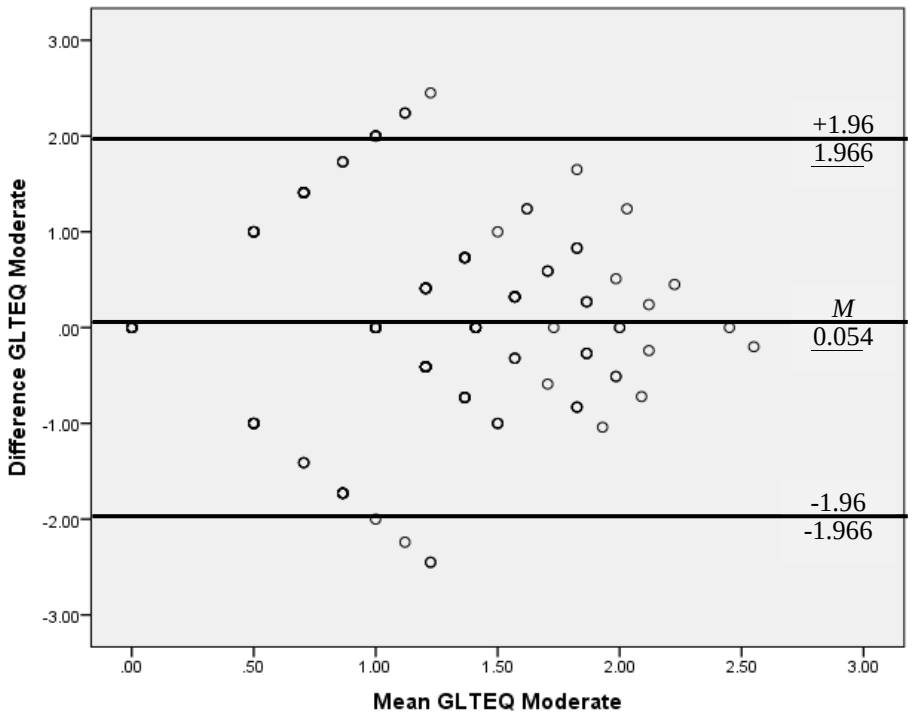

Figure 3B: Limits of Agreement for the GLTEQ - Moderate factor subsample 1 and subsample 2.

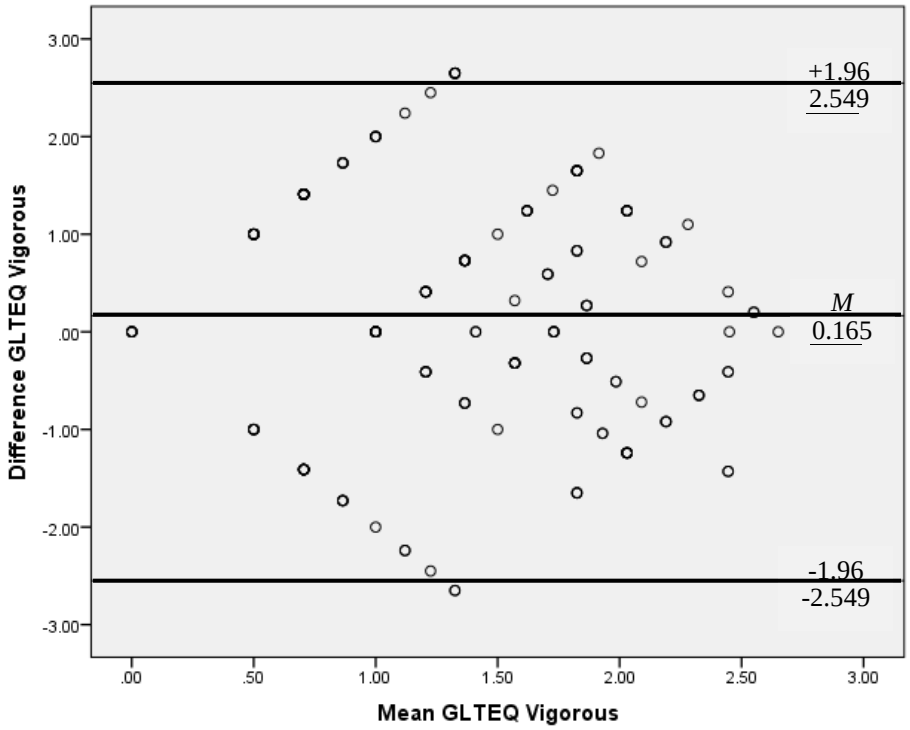

Figure 3C: Limits of Agreement for the GLTEQ - Vigorous factor subsample 1 and subsample 2.

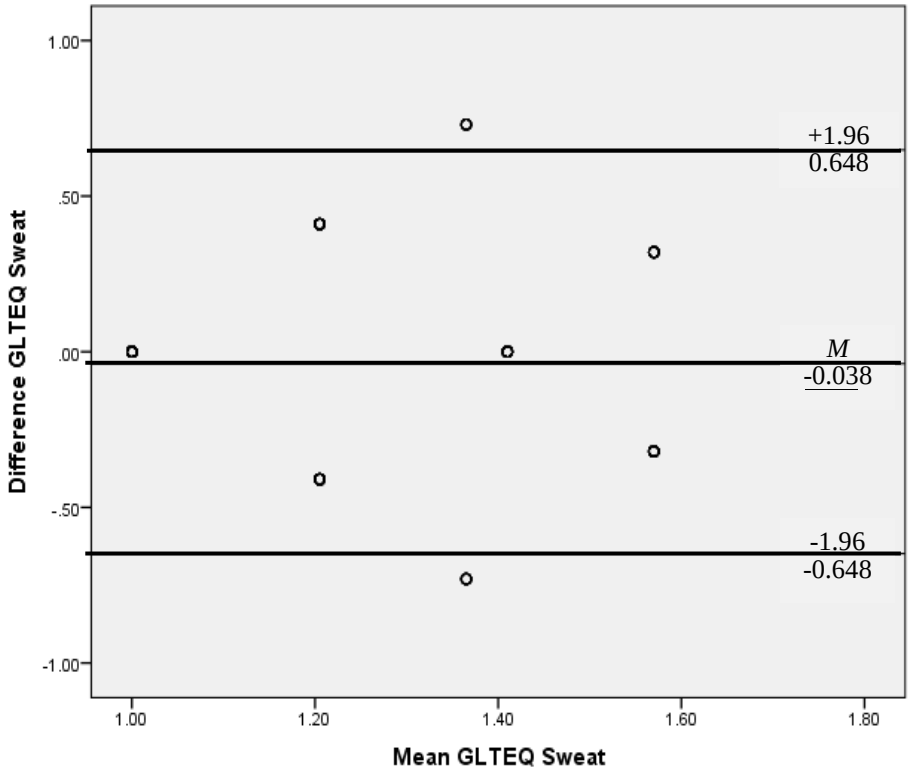

Figure 3D: Limits of Agreement for the GLTEQ - Sweat factor subsample 1 and subsample 2.

APPENDIX 1

Brunel Lifestyle Physical Activity Questionnaire[1]

Note: The demographics section has not been included in the interests of brevity and can be requested from the corresponding author.

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 than 5 minutes to complete. We are sure that you will find the personal profile to be most illuminating.

Part A: Pre-planned Lifestyle Physical Activity

Please click to indicate your response:

Note. Pre-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 in a normal 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)

Part B: 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 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)

10. Which of these types of physical activity do you enjoy participating in?

(Click as many as appropriate)

Walking / Hiking	Swimming	Weight-training	Aerobics / Steps
Jogging / Running	Rowing	Cycling	Step Machine
Dancing	Yoga	None	Other (please specify below)

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APPENDIX 2

Preparing the Data for Statistical Analysis

The number of participants required for the criterion-related validity and cross-validation phases ($N \geq 360$) was estimated in accordance with recommendations that pertain to multiple linear regression,[1] multivariate analysis of variance (MANOVA),[2] and the LoA procedure.[3, 4] Checks for univariate outliers using z scores ($z > \pm 3.29$) revealed multiple outliers ($n = 25$), and through a subsequent investigation for multivariate outliers revealed an additional seven cases ($p < 0.001$). These cases, relating to 17 females and 15 males, were removed.[2] The data were also logarithmically transformed due to distributional abnormality. This is a practice that is commonplace within the physical activity domain owing to the skewed distributions that typically present.[5, 6] The dataset was also checked for multicollinearity ($r = .80$ and above).[2] All dependent variables returned inter-correlations of $r < .70$, which were unlikely to heavily influence the MANOVA and multilinear regression.

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APPENDIX 3

Limits of Agreement

Background

The use of Limits of Agreement (LoA) was developed in response to the criticisms surrounding the use of correlational statistics in the establishment of validity. Since then, the LoA approach has been widely endorsed by researchers in the fields of exercise and medical science.[1-4]

Interpretation of results

The effect of the logarithmic transformation carried out on the data is that the results of the LoA analysis can no longer be directly related to the original scales used (e.g., a 5-point Likert scale). Hence, the judgements that Bland and Altman referred to are impeded as the output of the analyses is no longer an analogue of the measures used. In visually assessing the data, vertical and horizontal symmetries are sought.[5] In terms of vertical symmetry, the grouping of the data points around the bias should not vary along the *x*-axis, which would indicate 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).

Godin Leisure-Time Exercise Questionnaire (GLTEQ) results

The GLTEQ items are scored in terms of frequency of activity (number of incidences per week). Hence, a direct comparison with the subscale scores of the Brunel Lifestyle Physical Activity Questionnaire (BLPAQ) and Baecke Questionnaire of Habitual PhysicalActivity (BQHPA) was not possible. The intervals between the upper and lower LoA for each of the Light, Moderate, and Vigorous subscales of the GLTEQ were considerably larger than those pertaining to the BLPAQ and BQHPA (Light: range = 4.77; Moderate: range = 3.83; Vigorous: range = 3.74). Of these, the Light subscale demonstrated considerably less agreement.

Visual analysis

In terms of the visual comparison between the BLPAQ and BQHPA factors, planned physical activity (PPA) bears a strong resemblance to the Work index of the BQHPA and a moderate resemblance to the Sport index; whereas unplanned physical activity (UPA) approximates the Leisure index of the BQHPA (see Figure 2A). 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 ranges.

Discussion points

The low number of data points present in Figure 3D (GLTEQ - Sweat subscale) 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 low weekly frequency of sweat-inducing activity. The visual similarity between the PPA and Work index plots (see Figure 2C) 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. There is also a degree of similitude between the PPA and Sport index plots (see Figure 2B). This resemblance is readily explicable as sporting activity is, by its nature, likely to be planned. Notably, the Leisure index demonstrated a wider distribution of scores along the *x*-axis than the other BQHPA indices (see Figure 2A).

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