ORIGINAL ARTICLE

Development and initial validation of the Brunel lifestyle physical activity questionnaire

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Objectives: To develop a valid and reliable internet based lifestyle physical activity questionnaire suitable for use among the United Kingdom population.
Methods: After a detailed content analysis and item generation using a panel of experts, an internet based measure of lifestyle physical activity behaviour was developed. Data were collected from 1369 subjects in total. Confirmatory factor analysis was used to examine the two subscales of the Brunel lifestyle physical activity questionnaire among independent samples and by use of multisample analyses.
Results: The confirmatory factor analysis showed the psychometric integrity of two subscales: planned physical activity and unplanned physical activity.
Conclusion: The questionnaire is a valid and reliable instrument designed to provide an online behavioural assessment to be used in conjunction with a 12 week personalised fitness programme delivered through the internet.

Measurement of lifestyle physical activity (PA) by self administered behavioural assessment facilitates effective screening, monitoring, and intervention.[1] It is necessary for PA interventions to move towards mass media approaches that make more effective use of newer technologies such as the internet.[2] The Brunel lifestyle physical activity questionnaire (BLPAQ), the questionnaire developed in this study, provides one way in which to exploit the power of the internet to improve people's health.

The theoretical underpinnings of the BLPAQ reflect the necessity to distinguish between planned and unplanned PA.[1] It has been proposed that, to maintain optimal health, people should engage in at least 30 minutes of daily PA that comprises both planned and unplanned modes.[3] A number of studies have designed questionnaires to tap PA behaviours without distinguishing between planned and unplanned modes.[4–6] Further, concerns with measurement have pervaded previous attempts to assess PA behaviour, typically aspects of the validity and reliability of instruments.[7 8] The purpose of the present study was to develop a valid and reliable lifestyle PA questionnaire, designed for use on the internet, suitable for the United Kingdom population.

METHODS

Design

Our research strategy was to develop a questionnaire and examine its validity in 10 stages. On the basis of conceptual discussions of lifestyle PA,[1 9] items were developed to tap the two PA domains of planned PA (PPA) and unplanned PA (UPA). A latent variables analysis approach was used to facilitate inference of overall levels of PPA and UPA from a number of observable ''manifest'' variables or indicators.[10]

Stage 1: generation of item pool (expert panel 1)

The generation of the initial item pool was based on a number of considerations including (*a*) existing questionnaires,[4 11 12] (*b*) our understanding of the nature of lifestyle PA, and (*c*) input from a panel of experts (expert panel 1). The panel of experts assisted in the generation of items and established the extent to which the initial item pool tapped the intended constructs. Expert panel 1 comprised 12 people (six men and six women; mean (SD) age 36 (5) years) who worked in the health and fitness industry, were academics with an interest in health and fitness, and/or possessed knowledge of questionnaire development. Demographic details are an important consideration for diagnostic purposes.[13] Thus a series of demographic items were developed (available on request), which were also scrutinised by expert panel 1.

Stage 2: item comprehensibility and applicability (pilot sample 1)

To establish the comprehensibility and applicability of the items, and to make fine adjustments, the initial item pool of 10 items was piloted among a panel of 16 members of the lay public (six men, seven women, three did not report their sex; mean (SD) age 35 (15) years). This panel comprised a purposive stratified sample intended to reflect a range of socioeconomic groups, different age groups, both sexes, and diverse ethnic minorities.

Stage 3: further test of content validity of the BLPAQ (expert panel 2)

To establish the importance of each item to the measurement of the intended construct, a panel of 36 experts (mean (SD) age 34 (8) years) rated the refined item pool and reworded/deleted/added items as necessary. There were 22 men (mean (SD) age 34 (7) years) and 14 women (mean (SD) age 32 (8) years) in expert panel 2. This group extended the work completed by expert panel 1 and pilot sample 1. Fifteen members of expert panel 2 had a doctoral qualification in a related area and five were full professors. The remainder were educated to at least master's level and drawn form both industry and academia. Figure 1 shows the final version of the BLPAQ derived from this procedure.

Structure of the BLPAQ

Respondents were asked to provide honest answers about their activity behaviour. The section on lifestyle PA

Abbreviations: BLPAQ, Brunel lifestyle physical activity questionnaire; CFA, confirmatory factor analysis; CFI, comparative fit index; EFA, exploratory factor analysis; PA, physical activity; PPA, planned physical activity; SRMR, standardised root mean residual; UPA, unplanned physical activity

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.

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 min	10–20 min	21–30 min	More than 30 min
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 h	1–2 h	3–5 h	More than 5 h
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)

Figure 1(A) Brunel lifestyle physical activity questionnaire: pre-planned lifestyle physical activity. The demographics section has not been included in the interests of brevity. It can be requested from the first author.

behaviours was preceded by the definition: ''planned PA is any activity that is scheduled into your daily routine, which may enhance your health, fitness, or wellbeing.''[1] Examples include brisk walking, gardening, cycling, team games, etc. Responses to each item in the PA subscale were provided on a five point continuous closed numerical scale consisting of the following anchors relating to a ''normal'' week: never, 1–2 times, 3–4 times, 5–6 times, 7 or more times. Participants responded by either ticking or clicking with their mouse. The six items measuring PPA were intended to tap the intensity, frequency, and duration of such activity. Frequency of unplanned behaviour was not assessed given the difficulty in obtaining valid measurements because of its highly transitory nature.[14]

Stage 4: administration of the BLPAQ in pen and paper format (pilot sample 2a and 2b)

In stage 4, a pen and paper based version of the BLPAQ was administered to 563 volunteers representing a broad cross section of the United Kingdom population in terms of socioeconomic and ethnic background (checked against 2001 UK Census results). The mean (SD) age was 32 (13) years, with 260 men (mean (SD) age 32 (13) years) and 303 women (mean (SD) age 31 (12) years).

Using item scores from the pilot sample 2 data, a univariate outlier test ($z > \pm 3.29$)[10] revealed 12 outliers, which were deleted. Twenty one multivariate outliers were also identified and deleted using Mahalanobis' distance test ($p<0.001$).[10] The remaining 530 cases were split randomly into two equal groups—pilot samples 2a and 2b—with the first half used to explore the factor structure of the BLPAQ.

Stage 5: confirmation of the BLPAQ factor structure

Pilot sample 2b was used to confirm the factor structure of the BLPAQ using results of an exploratory factor analysis (EFA), and to test competing models using structural equation modelling techniques (EQS version 5.7).

Stage 6: piloting the BLPAQ on the internet (pilot sample 3)

An internet based version of the BLPAQ was used to collect data from pilot sample 3: 742 volunteers representing a broad cross section of the United Kingdom population in terms of socioeconomic and ethnic background. The mean age of

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 h	2–4 h	5–7 h	8–9 h	10 h or more

(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)

Scoring the Brunel lifestyle physical activity questionnaire

- 1. Sum the scores from items 1–6 and divide by 6 for a planned physical activity factor score.
- 2. Sum the scores from items 7–9 and divide by 3 for an unplanned physical activity factor score.

Figure 1(B) Brunel lifestyle physical activity questionnaire: unplanned lifestyle physical activity. The demographics section has not been included in the interests of brevity. It can be requested from the first author.

respondents in pilot sample 3 was 37 (10) years, with 450 men (mean (SD) age 36 (9) years) and 292 women (mean (SD) age 37 (10) years). After initial analyses, eight univariate outliers and 15 multivariate outliers were deleted. Pilot sample 3 was used to reconfirm the factor structure of the BLPAQ and to test its invariance with the data derived from pen and paper administration in stage 5. An additional item was introduced to identify types of physical activities that respondents most enjoyed, which could be fed back within the internet based intervention programme.

Statistical methods for stages 4–10

EFA and confirmatory factor analysis (CFA) were used to examine the validity of the factor structure of the BLPAQ. In stage 4, EFA was used on data from pilot sample 2a (n = 265) to test for the hypothesised PPA and UPA factors. In stage 5, pilot sample 2b (n = 265) was used to confirm the hypothesised factors and to test the tenability of competing models that were theoretically meaningful. In stage 6, data from pilot sample 3 (n = 719) were used to confirm the factor structure using internet based completion. Owing to the change in data collection medium, competing models were re-examined.

The model was estimated using the maximum likelihood estimation method, as Mardia's normalised estimate (pilot sample 2a = 2.09) indicated that the data were not multivariate normally distributed. The comparative fit index (CFI) and standardised root mean residual (SRMR) were used to assess model fit. These are purported to out-perform other goodness of fit statistics.[15]

According to Hu and Bentler,[16] the cut-off value relating to a relatively good fit between the hypothesised model and the observed should be close to 0.95 for the CFI, and close to 0.08 for the SRMR. These indices were used to evaluate model fit. In addition, Akaike's information criterion was used to test the tenability of competing models. The model with the lowest Akaike's information criterion 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 with multisample CFA. Before this procedure, the fit of the model was tested independently with the hypothesised two factor model. In stage 8, the standardised solutions for each sample were examined.

In stage 9, having tested for the relevant parametric assumptions,[10] a three way independent samples multivariate analysis of variance was used to examine subgroup differences with the Statistical Package for Social Sciences (SPSS) version 10.0: 2 (groups: pilot sample 2 and pilot sample 3) × 2 (sex) × 4 (age groups). The data were split into four equal age groups: 18–27 years (n = 253); 28–34 years (n = 266); 35–42 years (n = 232); 43–73 years (n = 233).

Table 1 Factor loadings for responses to the Brunel lifestyle physical activity questionnaire after Varimax rotation on pilot sample 2a (n = 265)

Variable	Factor loading	
	PPA	UPA
Times per week on PPA	0.77	–
Duration of PPA at this weekly rate	0.82	–
Duration per session of PPA	0.88	–
Total time engaged in PPA	0.91	–
Duration of persistence in PPA	0.69	–
Intensity of PPA	0.76	–
Duration of UPA	–	0.84
Intensity of UPA	–	0.74
Physical demand of job/daily activities	–	0.76
Eigenvalue	4.03	1.79
% of variance explained	44.75	19.86
Cumulative % of variance explained	44.75	64.60

Factor loadings below 0.40 are excluded.
PPA, Planned physical activity; UPA, unplanned physical activity.

Recommendations for BLPAQ norms were made on the basis of the multivariate analysis of variance results.

In stage 10, the internal consistency of the two factors was assessed using Cronbach α coefficients.

RESULTS

The results are presented sequentially in accordance with the methodological stages described above. Given that stages 1–3 involved the generation of items and the establishment of content validity, the presentation begins with stage 4.

Stage 4: EFA

Table 1 contains the results of the EFA. Principal components analysis extracted two factors accounting for 64.6% of the variance. A clear factor solution emerged with strong loadings (>0.60) on each of the two expected factors of PPA and UPA. This factor structure was consistent with theoretical predictions.[1]

Stage 5: CFA

Based on the EFA results (table 1), two factors were hypothesised to emerge from the lifestyle PA items: PPA and UPA. Consequently, a nine item, two factor model was tested using CFA on the data obtained from pilot sample 2b. Overall, the data from pilot sample 2b showed an acceptable fit (table 2), with the robust CFI (0.94) very close to the criterion value.[16]

Stage 6: test and re-test of competing models

The validity of a competing one factor congeneric model, based on the hypothesis that participants did not distinguish between PPA and UPA, was tested using CFA (table 2). The goodness of fit indices for the congeneric model showed a poor fit to the data (all indices <0.90). The results showed better fit indices for the two factor model, providing evidence of discriminant validity for PPA and UPA. In addition, we tested a Tau equivalent model, which has equal true score variances and equal error variances, and results indicated a poor fit. Alternative models were re-tested using pilot sample 3 (table 3).

Table 2 Fit indices for confirmatory factor analysis of the Brunel lifestyle physical activity questionnaire on pilot sample 2b (n = 265)

	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

*p<0.001.
CFI, Comparative fit index; SRMR, standardised root mean squared residual; AIC, Akaike's information criterion.

Table 3 Fit indices for confirmatory factor analysis of the Brunel lifestyle physical activity questionnaire on pilot sample 3 (n = 719)

	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

*p<0.001.
CFI, Comparative fit index; SRMR, standardised root mean squared residual; AIC, Akaike's information criterion.

Stage 7: multisample CFA

Given that there was a strong fit in pilot sample 2b and pilot sample 3 independently for the two factor model, it was hypothesised that factor loadings would be equal across these samples. Thus the Lagrange multiplier test was used to assess whether equality constraints were imposed correctly. Multisample CFA, with factor loadings constrained to be equal across both samples, indicated a CFI of 0.91 (table 4), which is slightly below the criterion value.[16]

The Lagrange multiplier test results indicated that three items had significantly different factor loadings across samples. Specifically, releasing the equality constraint for: (*a*) the intensity of the UPA item would reduce χ^2 by 51.1 (v = 5, p<0.01); (*b*) the duration per session of the PPA item would reduce χ^2 by 42.6 (v = 4, p<0.01); (*c*) the intensity of the PPA item would reduce χ^2 by 23.9 (v = 2, p<0.001). Subsequently, the CFI increased to 0.92 (SRMR = 0.07).

The Lagrange multiplier test supported the notion that constituents of PPA and UPA should be allowed to correlate. The correlation between the two factors was significant (r = 0.10, p<0.01); however, given that significant findings are boosted by large sample sizes[10] and the percentage of variance explained is only 1.1%, the factors are largely orthogonal in nature.

Stage 8: standardised solutions

When acceptable fit indices have been evidenced, it is appropriate to examine the standardised solutions of a sample to assess the amount of unique variance accounted for each item by the factor (table 5). Table 5 indicates that all of the items tap unique variance other than the item concerning total time engaged in PPA, which exceeded the cut-off point for error variance of 0.90.

Table 4 Fit indices for multisample confirmatory factor analysis of the Brunel lifestyle physical activity questionnaire (n = 984)

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

*p<0.001.
CFI, Comparative fit index; SRMR, standardised root mean squared residual; AIC, Akaike's information criterion.

Table 5 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)

	Factor loading		Measurement error	
Item	2b	3	2b	3
Times per week engaged in PPA	0.77	0.80	0.64	0.60
How long engaged in PPA at this rate	0.79	0.71	0.61	0.70
Duration of each session on PPA	0.90	0.90	0.44	0.44
Total time engaged in PPA at this rate	0.93	0.94	0.37	0.34
Past persistence at PPA programme	0.57	0.51	0.83	0.86
How vigorously engaged in PPA	0.75	0.64	0.66	0.77
Time spent on UPA per week	0.68	0.76	0.73	0.65
How vigorously engaged in UPA	0.73	0.57	0.69	0.82
How physically demanding is job/daily activities	0.53	0.65	0.85	0.76

PPA, Planned physical activity; UPA, unplanned physical activity.

Stage 9: subgroup differences

Subgroup differences were examined using combined data from pilot sample 2b and pilot sample 3 to determine whether the BLPAQ would require separate sets of norms. A three way multivariate analysis of variance of BLPAQ factor scores by sample, age, and sex (table 6) indicated a significant multivariate interaction effect for sample by age group (Wilks' $\lambda = 0.99$; $F_{6,1934} = 2.13$; $p<0.05$; $\eta^2 = 0.007$). Follow up univariate analyses showed that the interaction effect held only for PPA ($F_{3,968} = 3.05$; $p<0.05$; $\eta^2 = 0.009$); however, Tukey's post hoc test with Bonferroni adjustment did not indicate any significant differences. The multivariate analysis of variance also revealed main effects for sample (Hotelling's T = 0.009; $F_{2,967} = 19.60$; $p<0.05$; $\eta^2 = 0.039$) and sex (Hotelling's T = 0.009; $F_{2,967} = 4.46$; $p<0.05$; $\eta^2 = 0.009$). Follow up univariate analyses for sample (PPA: $F_{1,968} = 19.77$, $p<0.001$, $\eta^2 = 0.020$; UPA: $F_{1,968} = 23.14$, $p<0.001$, $\eta^2 = 0.023$) revealed that the pen and paper sample (pilot sample 2b) reported significantly higher levels of both PPA and UPA when compared with the internet sample (pilot sample 3). Across both samples, women reported that they engaged in more UPA than men.

In all cases, the significant differences were associated with very small effect sizes as indicated by the η^2 statistic.[18] Therefore, separate tables of norms for each subgroup of the population are not required.

Stage 10: internal consistency

Internal consistency estimates for the BLPAQ subscales using Cronbach's α were as follows for PPA and UPA respectively: pilot sample 2b, $\alpha = 0.91$ and 0.65; pilot sample 3, $\alpha = 0.88$ and 0.68; and both samples combined, $\alpha = 0.90$ and 0.68. UPA has a marginal α coefficient, which did not exceed the cut-off criterion of 0.70.[10]

DISCUSSION

Two subscales of the BLPAQ were identified using EFA and supported by a series of CFAs. Tests of alternative models

Table 6 Descriptive statistics and three way multivariate analysis of variance of Brunel lifestyle physical activity questionnaire factor scores by sample, sex, and age group on pilot sample 2b (n = 265) and pilot sample 3 (n = 719)

Variable	Mean	SD	*F* ratio	Source of difference
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
Sex				
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
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	

Three way interaction (sample × sex × age group): Wilks' $\lambda = 0.99$; $F_{6,1934} = 1.83$; $p>0.05$; $\eta^2 = 0.006$.
Two way interaction (sample × sex): Wilks' $\lambda = 1.00$; $F_{2,967} = 0.73$; $p>0.05$; $\eta^2 = 0.002$.
Two way interaction (sample × age group): Wilks' $\lambda = 0.99$; $F_{6,1934} = 2.13$; $p<0.05$; $\eta^2 = 0.007$.
Two way interaction (sex × age group): Wilks' $\lambda = 0.99$; $F_{6,1934} = 1.72$; $p>0.05$; $\eta^2 = 0.005$.
Sample main effect: Hotteling's T = 0.041; $F_{2,967} = 19.60$; $p<0.001$; $\eta^2 = 0.039$.
Sex main effect: Hotteling's T = 0.01; $F_{2,967} = 4.46$; $p<0.05$; $\eta^2 = 0.009$.
Age group main effect: Wilks' $\lambda = 0.99$; $F_{6,1934} = 2.01$; $p>0.05$; $\eta^2 = 0.006$.
*$p<0.01$; **$p<0.001$.
PPA, Planned physical activity; UPA, unplanned physical activity.

What is already known on this topic

For optimal health, people should engage in at least 30 minutes of daily physical activity comprising both planned and unplanned modes. A number of questionnaires have been designed to draw on PA behaviours without distinguishing between planned and unplanned modes.

What this study adds

A valid and reliable internet based questionnaire has been designed which allows researchers to test theories underlying planned and unplanned physical activity behaviour.

revealed that the two factor solution comprising PPA and UPA was the most stable. The multisample analysis (pilot sample 2b *v* pilot sample 3) showed that three items required equality constraints to be released, which resulted in a marginal fit (CFI = 0.92, SRMR = 0.07). Detailed analysis indicated that there was slight instability between samples in how respondents perceived the intensity of their UPA, the duration of their PPA per session, and the intensity of their PPA. This instability may reflect difficulties in summating the information requested by the items as it may vary from day to day. It is not possible to identify the precise source of this variation; however, secondary analyses showed that, for all three items, significantly ($p<0.01$) higher scores were reported by pilot sample 2b. One plausible explanation is that, if this sample were on the whole more physically active, they would be able to recall their PA habits with greater accuracy.[17]

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 PPA and UPA in the former. One plausible interpretation is the occurrence of social desirability given that respondents were actively recruited. In addition, internet based respondents were seeking to increase their PA and wanted to use the questionnaire as a vehicle towards this end.

Regardless of the mode of data collection, women reported more UPA than men (table 6). This may indicate that, in the United Kingdom, women are more likely to engage in activities such as housework, walking the dog, shopping, and playing with children.[18] Further, it is interesting to note that the UPA reported by women is significantly greater ($t_{982} = -4.55$; 97.5% confidence interval = −0.34 to −0.12; $p<0.001$) than the proportion of UPA engaged in by men (female mean UPA = 43.2%; male mean UPA = 39.8%).

Strengths and limitations

The use of health behaviour change programmes employing internet based technologies is cost effective and allows participants to work at their own pace and convenience.[19] Home based programmes enhance accessibility for people limited by finances or transportation.[20]

Potential disadvantages of internet based methods of communication are that a high financial outlay is required to develop systems such as the one described herein. Also, access to internet based programmes is not yet universal. In December 2003, 49% of United Kingdom households had internet access (http://www.statistics.gov.uk/releases). Further, instruments such as the BLPAQ should not be administered as a substitute for professional medical support, but as a complement to it.

A limitation with the structure of the BLPAQ concerns the marginal α of the three item UPA subscale. In cases where the number of items in a subscale is less than 10, an α coefficient of 0.60 is acceptable as long as there is evidence for validity and there are good theoretical and/or practical reasons for the subscale.[21] Further, the homogeneity of this subscale was demonstrated by CFA, which is a more rigorous test than Cronbach's α, and there is sound theoretical premise for the content of the PPA subscale.

Conclusions and recommendations

The BLPAQ is a valid and reliable internet based questionnaire that allows researchers to test theories underlying PPA and UPA behaviour.[22] A major recommendation is for extension of the validation process to test concurrent and predictive validity. Further, if unplanned daily activities at a moderate intensity can be promoted, it is more likely that PA requirements can be met. The notion of integrating unplanned lifestyle PA behaviours to enhance health status is concordant with current thinking among exercise professionals, government agencies, and epidemiologists.[1 9 23]

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Ethics: The study received ethical approval from the institutional review board and written informed consent was sought from subjects.

REFERENCES

1 **Dunn AL**, Andersen RE, Jakicic JM. Lifestyle physical activity interventions: history, short- and long-term effects, and recommendations. *Am J Prev Med* 1998;**15**:398–412.
2 **Marcus BH**, Owen N, Forsyth LH, *et al*. Physical activity interventions using mass media, print media, and information technology. *Am J Prev Med* 1998;**15**:362–78.
3 **Pescatello LS**. Exercising for health: the merits of lifestyle physical activity. *West J Med* 2001;**174**:115–18.
4 **Ainsworth BE**, Jacobs DR, Leon AS. Validity and reliability of self-reported physical activity status: the Lipid Research Clinics questionnaire. *Med Sci Sports Exerc* 1993;**25**:92–8.
5 **Godin G**, Shephard RJ. A simple method to assess exercise behaviour in the community. *Can J Appl Sport Sci* 1985;**10**:141–3.
6 **Washburn RA**, Adams LL, Haile GT. Physical activity assessment for epidemiologic research: the utility of two simplified approaches. *Prev Med* 1987;**16**:636–46.
7 **Kriska AM**, Caspersen CJ. Introduction to a collection of physical activity questionnaires. *Med Sci Sports Exerc* 1997;**29**:S5–9.
8 **Sallis JF**, Saelens BE. Assessment of physical activity by self-report: status, limitations, and future directions. *Res Q Exerc Sport* 2000;**71**:1–14.
9 **US Department of Health and Human Services**. *Physical activity and health: a report of the Surgeon General*. Atlanta, GA: US Department of Health and Human services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, 1996.
10 **Tabachnick BG**, Fidell LS. *Using multivariate statistics*. 4th ed. Needham Heights, MA: Allyn and Bacon, 2001.
11 **Baeke JA**, Burema J, Frijters JE. A short questionnaire for the measurement of habitual physical activity in epidemiological studies. *Am J Clin Nutr* 1982;**36**:936–42.

12 **Sallis JF**, Haskell WL, Wood PD, *et al*. Physical activity assessment methodology in the Five-City Project. *Am J Epidemiol* 1985;**121**:91–106.
13 **Balarajan R**, Soni-Raleigh V. The ethnic population of England and Wales in the 1991 Census. *Health Trends* 1992;**24**:113–16.
14 **Ajzen I**. Residual effects of past on later behavior: habituation and reasoned action perspectives. *Pers Soc Psychol Rev* 2002;**6**:107–22.
15 **Fan X**, Thompson B, Wang L. Effects of sample size, estimation methods and model specification on structural equation modelling. *Structural Equation Modeling* 1999;**1**:56–83.
16 **Hu L-T**, Bentler PM. Cut-off criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Structural Equation Modelling* 1999;**6**:1–55.
17 **Chaiken SC**. Hueristic versus Systematic information processing and use of sources versus message cues in persuasion. *J Pers Soc Psychol* 1980;**39**:752–66.
18 **Biddle SJH**, Mutrie N. *Psychology of physical activity: determinants, well-being and interventions*. London: Routledge, 2001.
19 **Fotheringham MJ**, Owies D, Leslie E, *et al*. Interactive health communication in preventive medicine: internet-based strategies in teaching and research. *Am J Prev Med* 2000;**19**:113–20.
20 **Buckworth J**. Exercise determinants and interventions. *Int J Sport Psychol* 2000;**31**:305–20.
21 **Loewenthal KM**. *An introduction to psychological tests and scales*. 2nd ed. London: UCL Press Limited, 2001.
22 **Bargh JA**. The four horsemen of automaticity: awareness, intention, efficiency, and control in social cognition. In: Wyer RS, Srull TK, eds. *Handbook of social cognition*. 2nd ed, vol 1. Hillsdale, NJ: Erlbaum, 1994.
23 **Pate RR**, Pratt M, Blair SN, *et al*. Physical activity and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA* 1995;**273**:402–7.