Research Report

Criterion-related Validity of the Short Form of the International Physical Activity Questionnaire in Adults Who Are Blind

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The World Health Organization advocates that a greater focus should be placed on the surveillance of patterns of physical activity and the identification of specific high-risk groups and measures to respond to their needs (World Health Assembly, 2004). From a public health perspective, it is important to examine if adults meet the current general recommendation of at least 30 minutes of moderate or greater physical activity per day (World Health Assembly, 2004). Doing so requires accurate measurements of physical activity for supporting the promotion of health and physical activity.

Currently, there are various methods to assess physical activity in daily life, including objective measures, such as heart rate, accelerometry, and pedometry, and subjective recall questionnaires or physical activity diaries. Questionnaires have been the most frequent method of assessing the physical activity of populations or population groups because of their low cost and their general acceptance by participants (Lee, Macfarlane, Lam, & Stewart, 2011).

The short form of the International Physical Activity Questionnaire (IPAQ-S) has been recommended for use in studies to evaluate patterns of physical activity that are relevant to health (World Health Organization, 2007). The IPAQ-S also includes a measure of sedentary behavior, which may be useful since there is ample evidence that sedentary behavior and the lack of physical activity are independent behaviors that have specific effects on health (Garber et al., 2011). Thus, even when adults meet physical activity guidelines, sitting for prolonged periods can compromise their metabolic health (Owen, Healy, Matthews, & Dunstan, 2010).

The IPAQ-S has been shown to be a reliable and valid measure of physical activity and sedentary behavior of the general population (Craig et al., 2003; Rosenberg, Bull, Marshall, Sallis, & Bauman, 2008). Nevertheless, there is evidence that it overestimates physical activity when compared to objective methods like accelerometry (Lee et al., 2011); thus, like other questionnaires, the IPAQ-S appears to be vulnerable to recall and reporting bias.

To our knowledge, there is no evidence on the use of the IPAQ-S with adults who are blind. Therefore, the study presented here examined the criterion validity and measurement bias of the IPAQ-S in adults who are blind using accelerometry as an objective measure of physical activity.

Methods

Participants

The inclusion criteria consisted of being aged 18 to 65, being legally blind (with a central visual acuity of 20/200 or less in the better eye with the use of corrective lenses or a corrected field of vision less than 20 degrees), living independently in the community, being an associate of Associação dos Cegos e Amblíopes de Portugal (ACAPO), the Portuguese association for people with visual impairments, having a telephone number registered in the ACAPO database, and living in the Lisbon area. Of the 177 potential participants, 77 could not be contacted by telephone (because they had invalid telephone numbers or were unreachable after two attempts), 30

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declined to participate, and 3 had moved out of the Lisbon area, leaving 67 participants.

One of the researchers met each of the persons who agreed to participate in his or her home. During the first visit, the participants were instructed on the proper use of the accelerometer. After they wore the accelerometer for a week, they were administered the IPAQ-S during the second visit.

The participants were informed about the objectives of the study and gave their informed consent to participate. The study was approved by the University of Évora ethics committee and conducted in accordance with the Declaration of Helsinki.

Accelerometry

Daily physical activity was assessed by accelerometers (ActiGraph, GT1M model, Fort Walton Beach, Florida), which are small electronic devices (3.8 × 3.7 × 1.8 centimeters, or 1.5 × 1.4 × by 0.55 inches, and 27 grams, or 0.9 ounce) that measure the acceleration of normal human movements in a numeric value known as a count. An epoch refers to the amount of time over which activity counts are summed and stored. The accelerometer measures movement in electrical signals (counts), which are proportional to the muscular force producing the motion; that is, more physical activity results in more counts per unit of time. In our study, activity counts were recorded in 15-second epochs, but we chose to express activity counts in 60-second epochs because this is the time sampling interval used in most field studies that have evaluated the concurrent validity of IPAQ-S and accelerometry (such as Ekelund et al., 2006). Processing was done with the program MAHUffe v.1.9.0.3 (available at <www.mrc-epid.cam.ac.uk>).

The participants were instructed to use the accelerometer during waking hours for 7 consecutive days, except during water activities. The device was securely attached on the right hip, near the iliac crest. We included the results from participants who wore the accelerometer for at least 10 hours per day during at least 5 days, including 1 weekend day (Craig et al., 2003). Periods of at least 60 consecutive minutes of zero counts were considered nonwear time.

The minutes per day spent in sedentary behavior were indicated by fewer than 100 counts per minute. The cutoff points for calculating the minutes spent in light, moderate, and vigorous physical activity were set to 100–1,952, 1,953–5,724, and ≥ 5,725 counts per minute, respectively (Craig et al., 2003).

The IPAQ-S

The IPAQ-S was used as a self-report measure of physical activity and sitting time (sedentary behavior). It is a seven-day recall measure of physical activity that provides information on the time spent walking, the time spent in vigorous and moderate-intensity activity, and the time spent in sedentary activity. The total amount of physical activity was converted to metabolic equivalents (MET minutes per week), where one metabolic equivalent is equal to the expenditure of energy while resting.

A researcher administered the questionnaire during individual interviews with the participants. The questionnaire included any physical activity that the participants did at work; as part of housework and yard work; to get from place to place; and in their spare time for recreation, exercise, or sports. For data collection on sedentary behavior, the participants were instructed to think about the time they spent sitting at work, at home, while doing course work, and during leisure time. Sitting time has been used as a specific marker of sedentary behaviors during waking hours (Owen et al., 2010).

Statistical analysis

The Kolmogorov-Smirnov statistic showed that the IPAQ-S data were not normally distributed. The Wilcoxon signed-rank test was used to study differences in the time spent in

Table 1
Characteristics of the participants: Means (*SDs* in parentheses).

Variable	Men (N = 37)	Women (N = 21)	All (N = 58)
Age (in years)	49.6 (10.6)	44.5 (12.2)	47.7 (11.3)
Height (in centimeters)	170.2 (6.2)[a]	155.7 (6.5)	165.0 (9.4)
Weight (in kilograms)	77.6 (14.2)[a]	68.8 (14.4)	74.4 (14.8)
BMI (kg/m^2)	26.8 (4.7)	27.7 (5.4)	27.1 (4.8)

Note: BMI = body mass index.
[a]Significant differences between the genders.

moderate to vigorous physical activity and sedentary behavior as measured by the ActiGraph and IPAQ-S. The criterion-related validity of the two instruments was assessed by the Spearman rank-order correlation.

The agreement between the ActiGraph and IPAQ-S for the time spent in moderate or vigorous physical activity and in sedentary behavior was examined by a Bland–Altman analysis, in which the differences between the ActiGraph and IPAQ-S were plotted against the means of both (Bland & Altman, 1999).

The agreement between the number of participants who met or did not meet the physical activity guidelines (accumulating at least 30 minutes of moderate or vigorous physical activity per day), as determined by the two different methods, was assessed with the chi-square test. Sensitivity and specificity (the ability of the IPAQ-S to identify participants who met or did not meet the physical activity guidelines, respectively) were also calculated. The analyses were conducted with PASW for Windows v.18.0. For all the tests, statistical significance was set at $p < .05$.

Results

Nine participants were excluded from the analysis because they did not wear their devices for a sufficient amount of time. The characteristics of the participants are presented in Table 1. According to the accelerometer data, the participants completed an average of 216.9 (± 65.3) counts per minute and 5,494 (± 2,428) steps per day. The total amount of physical activity computed from the IPAQ-S was 2,278.5 (± 2,224.2) MET minutes per week. The participants reported walking 56 (± 58) minutes per day.

Table 2 shows the correlation of the physical activity measures using accelerometry and the IPAQ-S. A modest but significant

Table 2
Spearman's rank correlation coefficient between sedentary behavior and physical activity measured by the ActiGraph and the IPAQ-S.

	IPAQ-S			
ActiGraph	Sitting (hours per day)	MVPA (minutes per day)	Walking (minutes per day)	Total physical activity (MET minutes per week)
Sedentary (hours per day)	.36**	−.12	−.02	−.18
Light physical activity (minutes per day)	−.09	.11	.26*	.27*
MVPA (minutes per day)	−.08	−.04	.22	.17
Total activity (minutes per day)	−.14	.10	.30*	.30*
Average physical activity (counts per minute)	−.31*	.03	.26	.25
Steps	−.21	.15	.33*	.38*

Note: MVPA = moderate to vigorous physical activity.
* $p < .05$; ** $p < .01$.

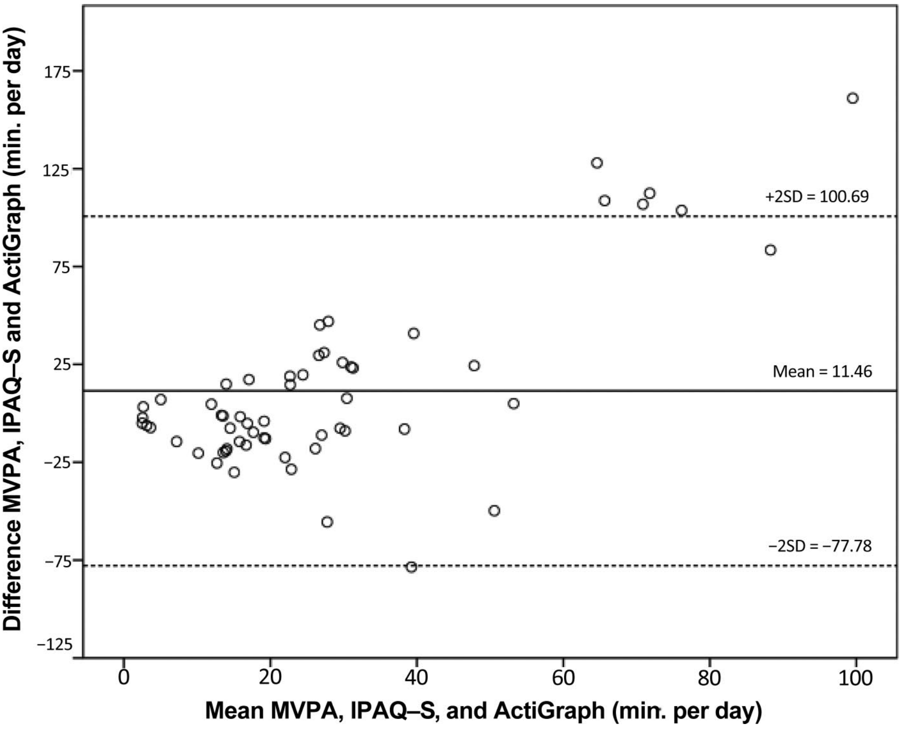

Figure 1. Bland-Altman plot of moderate to vigorous physical activity.

correlation was observed among several variables.

The Wilcoxon signed-rank test showed that there was no significant difference ($z = .82$, $p = .41$) between the average time spent in moderate or vigorous physical activity from the accelerometer (22.25 ± 16.08 minutes per day) and from the IPAQ-S (33.71 ± 41.59 minutes per day). Figure 1 shows a Bland-Altman plot of the data on moderate–vigorous activity, with a mean difference of 11.46 (± 45.53) minutes per day and 95% limits of agreement of −77.78 to 100.69 minutes per day. The 95% limits of agreement were very large, and as physical activity increased over 60 minutes per day, the agreement between the IPAQ-S and ActiGraph decreased further.

There was a significant difference ($z = 6.60$, $p < .001$) between the average amount of time spent in sedentary behavior from the accelerometer (10.63 ± 1.50 hours per day) and from the IPAQ-S (6.16 ± 2.42 hours per day). Figure 2 shows a Bland-Altman plot of the data on sedentary behavior, with a mean difference of −4.47 (± 2.31) hours per day and 95% limits of agreement of 0.06 to −8.99 hours per day. The lower the values reported in the IPAQ-S, the larger the errors between the instruments.

The specificity of the IPAQ-S was 33% and the sensitivity was 60%. A chi-square test found no differences between the methods in the proportion of participants who achieved the recommended levels of physical activity (IPAQ-S, 37.9%; accelerometer, 25.9%); these differences were not statistically significant, χ^2 (1) =.18, $p = .67$, $N = 58$.

Discussion

Our results demonstrated moderate criterion validity for some of the indicators of physical activity and sedentary behavior derived from the IPAQ-S. The statistically significant correlation coefficients that were found for the

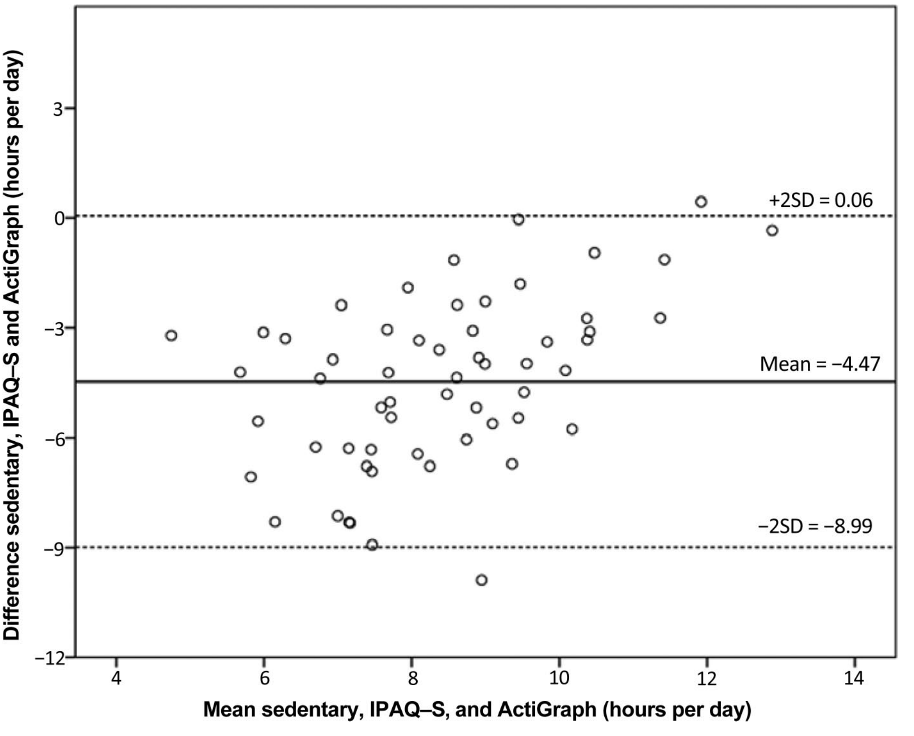

Figure 2. Bland-Altman plot of sedentary behavior.

derived self-reported measures with objectively measured physical activity were similar to those obtained in the 12-country validity study of the IPAQ (Craig et al., 2003). The correlation between the IPAQ-S overall score (MET minutes per week) and any objective index of physical activity from accelerometry was also in accordance with the values reported in a recent systematic review (Lee et al., 2011).

The time spent in moderate or vigorous physical activity calculated from the IPAQ-S was not associated with accelerometer measures. Accelerometry is precise in assessing ambulatory activities but is not suitable for use during water activities and may not yield precise information about the intensity of activities, such as carrying heavy loads, walking on stairs, stationary cycling, or resistance exercise (Hagstromer et al., 2008). On the other hand, the IPAQ-S was originally developed for the general population, and it is possible that some concepts that were used in the questionnaire may not be as easily understood by people with limited experience with exercise, as was the case of the participants in this study (only 16% of the participants reported that they were engaged in some form of exercise or sports).

Participation in structured activity is easier to assess with a questionnaire than is the engagement in spontaneous activities (Hagstromer et al., 2008). It is also important to note that the IPAQ-S is a subjective measure of physical activity, and it is possible that the participants often gave answers reflecting socially approved behaviors rather than actual practices.

Bland-Altman plots showed poor agreement between the accelerometer data and the data on moderate to vigorous physical activity and sedentary behavior accessed with the IPAQ-S. Using the IPAQ-S leads to an overestimation of physical activity levels, especially

at high values of self-reported physical activity. This finding is in accordance with previous studies of the general population, which reported that the IPAQ-S overestimated physical activity by 36% to 173% (Lee et al., 2011).

The IPAQ-S sitting time was associated with the sedentary time assessed by accelerometry (Spearman's correlation = 0.36), confirming the level of correlation (0.34–0.36) found in two recent studies in other populations (Grimm, Swartz, Hart, Miller, & Strath, 2012; Rosenberg et al., 2008). The participants reported less sitting time (~42%) than the time spent in sedentary behavior assessed by accelerometry, and the results were similar to those reported recently in older adults of the general population (Grimm et al., 2012). It is possible that self-report methods underestimate sitting time because of the inability of participants to recall the ubiquitous behavior that is sitting (Harrington, Dowd, Bourke, & Donnelly, 2011). Concurrently, accelerometry overcomes some of the limitations of subjective methods for assessments of sedentary behavior, but the detection of specific postures, such as sitting and lying or standing still, is somewhat limited (Atkin et al., 2012).

There was no difference between IPAQ-S and accelerometry in the proportion of participants who achieved the guidelines for physical activity. However, the IPAQ-S was much more successful in detecting the participants who did not achieve the recommended amount of physical activity (sensitivity of 60%) than in detecting the participants who did meet those recommendations (specificity of 33%). This result suggests that IPAQ-S is not a good method for classifying people who are blind as sufficiently active.

The strength of our study included the number of participants and the fact that it was the first time that IPAQ-S was examined as a tool for assessing physical activity and sedentary behavior in people who are blind. The main limitations included the absence of children, adolescents, and older adults, and the fact that the level of severity of blindness was not evaluated.

In conclusion, the IPAQ-S has acceptable criterion validity for use with young and middle-aged adults who are blind. However, there is limited agreement on physical activity and sedentary behavior measured with the accelerometer and IPAQ-S. The specificity of IPAQ-S to classify correctly people who achieved current physical activity guidelines was low, whereas the sensitivity was acceptable.

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