Can the IPAQ-Long be Used to Assess Occupational Physical Activity?

Lydia Kwak, Maria Hagströmer, and Michael Sjostrom

Background: To be able to draw any conclusions regarding the health effects of occupational physical activity (OPA), more information is needed regarding valid measures to assess OPA. Aims were to compare OPA as assessed with the International Physical Activity Questionnaire long version (IPAQ-L) with OPA assessed with an accelerometer and to assess the contribution of OPA to total PA. Methods: Working adults (n = 441; mean age = 49.4 yrs; 44% males) wore an accelerometer for 7 days in free-living situations and completed the IPAQ-L. Comparisons were made between IPAQ-L-work and accelerometer data limited to working time (Moderate and Vigorous PA (accelerometer-MVPA-work) and average intensity). Subgroup analyses were performed. Results: Spearman correlation was \( r = 0.46 \) \((P < .01)\) between IPAQ-L-work and accelerometer-MVPA-work. Correlations ranged from \( r = 0.27 \) to \( r = 0.55 \) in respectively obese and overweight subjects. The contribution of IPAQ-L-work to IPAQ-total was 24.7%. Conclusions: The IPAQ-L work domain is a moderately good measure of time spent on MVPA at work and can be used to assess the contribution of OPA to total PA. This study provides valuable information regarding the use of the IPAQ-L in assessing work domain specific PA, and underscores the importance of assessing OPA, as it can contribute for a substantial part to total PA.

Keywords: accelerometry, self-report, validity, work-related

The scientific evidence regarding the inverse relationship between regular physical activity (PA) and several disease outcomes continues to accumulate.\(^1,2\) Results of recent studies suggest that the health benefits of PA might differ between the different domains of PA (ie, leisure time and sports, work, transport, or home).\(^3,5\) Of these domains adults most likely spent most time in the work domain.\(^6\) The PA performed in this domain is referred to as occupational or work-related PA and includes all PA done as part of a job.\(^7\) Conflicting results exist regarding the protective effect of occupational physical activity (OPA) with regard to disease outcomes.\(^8,9\) While some studies observe protective effects of OPA against for example cardiovascular disease\(^4,10,11\) others show no or negative associations.\(^5,12,13\) Moreover, recent studies have shown that the PA performed in different domains, such as leisure time and work, might have contrasting cardiovascular effects.\(^4,10,13,14\)

These contradictory findings could be due to the use of unreliable and invalid questionnaires. In a recent systematic review on the repeatability and validity of questionnaires measuring OPA, we showed that despite the abundance in questionnaires only few were tested adequately.\(^15\) One of the questionnaires which did receive good ratings for assessing OPA was the long version of the International Physical Activity Questionnaire (IPAQ-L).\(^15\) The IPAQ assesses health-enhancing PA by measuring time spent in walking and other moderate- to-vigorous intensity activities. The short form of the IPAQ (IPAQ-S) assesses all domains of activity within generic intensity-specific questionnaire items, while the IPAQ-L assesses more detailed domain-specific activity within separate questionnaire items.\(^14\) The IPAQ is one of the most widely used questionnaires globally, it has been evaluated in many countries and translated into many languages.\(^16\)

Despite the fact that the IPAQ-L as a whole has been validated extensively, the specific item assessing OPA has only been validated against an activity logbook in a very small sample (n = 46) of adults.\(^17\) To be able to draw any valid conclusions regarding the potential separate health benefits of OPA it is essential that valid measures exist to accurately assess OPA. For this more additional comparisons with more objective measures of OPA in a larger sample are needed. The main aim of this study was to compare OPA as assessed with the IPAQ-L with OPA assessed with an accelerometer in a large sample of the Swedish population. As the contribution of OPA to the chances of meeting physical activity guidelines has seldom been examined and findings are inconclusive,\(^18-21\) the second aim was to assess the contribution of OPA to total PA.
Methods

Study Population and Design

In 2007 a telemarketing company approached 2000 randomly selected adults (18–69 years) from the Swedish population register. The adults were informed about the study and invited to participate, 1152 adults agreed to participate. For the current study only data from those individuals who were ≥ 80% employed, who worked regular day-shifts during the week, and who had complete accelerometer data for at least 4 working days (weekdays) were included (n = 440).

A detailed study protocol has been described elsewhere. Briefly, participants received an accelerometer and a questionnaire. They were instructed to wear the accelerometer for 7 consecutive days during waking hours starting on the Monday morning after receiving the materials. The accelerometer should be worn directly to the skin as close as possible to the center of gravity (ie, at the lower back). On the eighth day, participants completed the questionnaire, which contained several parts, including the IPAQ-L. Subsequently, all materials were sent back to the research center in a prepaid envelope. The study was approved by the Huddinge University Hospital ethical board (# 378/02) and all subjects gave consent to participate in the study.

Assessment of Total and Work-Related Physical Activity

International Physical Activity Questionnaire-Long Version. The self-administered IPAQ-L was used to assess both OPA (IPAQ-L-work) and total PA (IPAQ-L-total). It consists of 27 items that identify the frequency (times per week) and duration (minutes and/or hours per day) of vigorous and moderate intensities of PA and of walking performed in several activity domains, during the last 7 days. The domains are work (7 items); transportation (6 items); housework, house maintenance, and family care (6 items); recreation, sport and leisure (6 items); and time spent sitting (minutes or hours per day) in a weekday and in a weekend day (2 items). All domains contain examples of items related to vigorous and moderate PA.

The following outcome measures were calculated: 1) IPAQ-L-work expressed as minutes per day, 2) IPAQ-L-work expressed as MET-minutes per week, and 3) IPAQ-L-total expressed as MET-minutes per week. The IPAQ-L scoring protocol was used for the calculations. Briefly, total minutes of (occupational) PA were computed by transforming reported hours to minutes and adding them to the reported minutes. For MET-minutes per week, the minutes were multiplied by the number of days and then multiplied by the appropriate Metabolic Equivalent of Task (MET), where 1 MET equals the energy expenditure of sitting down quietly.iltrated cross-validation and provided the most accurate group level estimate of time spent in moderate intensity activity. In addition, average intensity was calculated taking the total counts divided by the recorded time (counts per minute) both during work (accelerometer-work) and the total day (accelerometer-total).

Other Variables Measured

The demographic data collected with the questionnaire included questions regarding age, gender, height (cm), weight (kg), educational attainment, and employment status. Body Mass Index (BMI) was calculated as weight in kilograms divided by height in meters squared and categorized into 3 levels (normal weight: BMI < 25kg/m², overweight: BMI 25–30kg/m², obese BMI > 30kg/m²).

Educational attainment (1 item) was assessed on a 5-point scale and categorized into 3 levels (compulsory school, at least 2 years of high school, and college/university). Three items were used to assess subject’s current employment status, subjects indicated if they were employed and if so for what percentage. Moreover, they were asked how many hours they worked the previous week and if they could indicate on a 4-point scale what kind of shift this
was [day-shift (weekdays); day and evening (incl. weekend); day and evening; night].

**Analysis**

All statistical analyses were performed using SPSS (Statistical Package for the Social for Windows, 17.0, 2009, SPSS Inc., Chicago, IL). The characteristics of participants were described as mean (SD) and percentages. The outcomes of the IPAQ-L were described as 25th, 50th, and 75th percentiles scores, as they were not normally distributed. To assess the contribution of IPAQ-L-work to IPAQ-L-total, the percentage of IPAQ-L-work to IPAQ-L-total (MET-minutes per week) was calculated. The Bland-Altman method was used to provide an indication of the systematic and random error and heteroscedasticity of the data. Variables used for the Bland-Altman plot were minutes per day spent in IPAQ-L-work versus MVPA-work according to the accelerometer (accelerometer-MVPA-work). The difference between the two was tested with a paired nonparametric Wilcoxon test. To compare the IPAQ-L with the accelerometer output nonparametric Spearman correlation coefficients were calculated.

**Results**

Table 1 shows the descriptive characteristics of the 227 men and 213 women included in the study. Most subjects were between 35 and 54 years of age, had a normal weight and higher education. The 25th, 50th, and 75th percentile scores for IPAQ-L-work and IPAQ-L-total are presented in Table 2 for the total sample and for gender and BMI categories separately.

Table 3 shows the mean minutes per day of accelerometer-MVPA-work and IPAQ-L-work. A mean (SD) difference was observed of 19.4 (121.8) minutes per day, $P < .05$. The 95% limits of agreement ranged from 7.97–30.8 minutes per day. Differences between the IPAQ and accelerometer increased as the minutes per day reported in the work domain increased ($R^2 = .784$; Figure 1).

The Spearman correlation coefficients between the IPAQ-L-work and the accelerometer are presented in Table 4. Overall, correlations between the IPAQ-L-work and accelerometer-MVPA-work ranged from $r = .27$ ($P < .05$) in obese subjects to $r = .55$ ($P < .01$) in overweight subjects. In the total sample the correlation was $r = .46$ ($P < .01$). Correlations between average intensity and IPAQ-L-work was highest in women ($r = .48$, $P < .01$), when limited to occupational time, but for the total day in normal weight subjects ($r = .36$, $P < .01$).

The contribution of IPAQ-L-work to IPAQ-L-total was higher in men than women (26.7% versus 22.3%) and higher in obese subjects compared with normal weight and overweight subjects, respectively 30.1, 20.6 and 28.9% (Table 2).

**Discussion**

The current study investigated the potential of the IPAQ-L to provide comprehensive data on OPA. The results suggest that the IPAQ-L work domain is a moderately good measure of time spent on MVPA at work when compared with the accelerometer, both among the general sample as well as among gender and most BMI-subgroups.

The few studies that have compared OPA data assessed with a questionnaire, with accelerometer output limited to occupational time, report results that are in line with our findings. Philippaerts and colleagues compared occupational activities from 2 questionnaires with...
Table 2  Percentile Scores for IPAQ-L-work and IPAQ-L-total and IPAQ-L-work in Relation to IPAQ-L-total

<table>
<thead>
<tr>
<th></th>
<th>IPAQ-L (MET minutes/week)</th>
<th>IPAQ-L-work</th>
<th>IPAQ-L-total</th>
<th>IPAQ-L-work to IPAQ-L-total</th>
</tr>
</thead>
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<tr>
<td></td>
<td>N</td>
<td>25th</td>
<td>50th</td>
<td>75th</td>
</tr>
<tr>
<td>Total</td>
<td>441</td>
<td>0</td>
<td>297</td>
<td>2400</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>227</td>
<td>0</td>
<td>330</td>
<td>2970</td>
</tr>
<tr>
<td>Women</td>
<td>213</td>
<td>0</td>
<td>264</td>
<td>1463</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal &lt;25</td>
<td>224</td>
<td>0</td>
<td>99</td>
<td>1014</td>
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<tr>
<td>Overweight 25–30</td>
<td>152</td>
<td>0</td>
<td>454</td>
<td>3536</td>
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<tr>
<td>Obese ≥30</td>
<td>52</td>
<td>25</td>
<td>549</td>
<td>2679</td>
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</tbody>
</table>

Note. The contribution of IPAQ-L-work to IPAQ-L-total was calculated as (IPAQ-L-work / IPAQ-L-total) × 100.

Table 3  Mean (SD) of Minutes per Day in IPAQ-L-work and Accelerometer-MVPA-work

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>IPAQ-L-work (min/day)</th>
<th>Accelerometer-MVPA-work (min/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>441</td>
<td>86.5 (137.1)</td>
<td>67.1 (38.6)*</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>227</td>
<td>94.2 (141.3)</td>
<td>67.4 (39.1)</td>
</tr>
<tr>
<td>Women</td>
<td>213</td>
<td>78.3 (132.7)</td>
<td>66.9 (38.2)**</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Normal &lt;25</td>
<td>224</td>
<td>68.7 (121.1)</td>
<td>69.5 (43.5)*****</td>
</tr>
<tr>
<td>Overweight 25–30</td>
<td>152</td>
<td>108.6 (154.9)</td>
<td>66.5 (32.5)</td>
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<tr>
<td>Obese ≥30</td>
<td>52</td>
<td>94.4 (137.5)</td>
<td>58.5 (30.8)</td>
</tr>
</tbody>
</table>

Note. IPAQ-L-work measures MVPA for occupational PA. Cut-off for accelerometer-MVPA-work > 760 counts/min. Differences based on nonparametric paired Wilcoxon-test with significance at * P < .05; ** P < .01; *** P < .001.

Figure 1 — Bland-Altman plot for minutes per day spent in IPAQ-L-work and MVPA-work (>760 counts/min); Mean (SD) 19.4 (121.8) minutes per day, P < .05.
Accelerometer output limited to work time among 166 men and observed correlations ranging from 0.26–0.50 for the Tecumseh Community questionnaire and correlations of 0.33–0.42 for the Baecke questionnaire. A comparison of similar dimensions assessed with the Occupational Physical Activity Questionnaire and with an accelerometer among a convenience sample of 41 adults showed correlations ranging from –0.20 to 0.21. A strength of the current study however, is the large sample size; the comparison with the accelerometer was made among 441 subjects, which is substantially more than the above-mentioned studies. The large sample size made it possible to explore the data by gender and BMI. To our knowledge this is the first study comparing IPAQ-L-work with accelerometer output and more specifically with output limited to occupational time. Comparisons of IPAQ-L-work with other self-report measures, showed low correlations (around $r = .23$) with a PA diary, but a moderate association ($r = .64$) with OPA assessed with a log book. Combining the findings of the current study with those observed with the above mentioned self-report measures further strengthen our observations that the IPAQ-L work domain is a moderately good measure of OPA.

Our finding that lower correlations were observed in the obese subjects could be a result of differential bias. However, it could also be a result of the discrepancy between the IPAQ-L, which assesses activities related to effort, and the accelerometer which assesses body movement. It might take more effort for an obese individual to perform a given ambulatory activity than for a normal weight individual. For the same body movement as assessed with the accelerometer, an obese individual might therefore report more effort on the IPAQ-L than a normal weight individual. Another possibility is that obese individuals might move more slowly, as a result of which MVPA is not being detected by accelerometry but is reported on the IPAQ (see Table 3). Our findings correspond with those of a previous validation study, which compared aerobic capacity with the IPAQ, they found that subjects with low aerobic capacity were more likely to over report their physical activities. It could also be a result of the smaller sample size of this group.

Our findings show that the differences in OPA between the IPAQ and the accelerometer increased with higher IPAQ values. This may reflect failure to recall time well, or it may be a result of individuals rounding up time in the IPAQ, leading to larger differences at higher values.

The second aim of the study was to assess the contribution of OPA to total PA, as assessed with the IPAQ-L. The contribution of OPA to overall PA was nearly 25% and approximately 30% in the obese subjects. These findings are comparable with those observed in an Australian study, which showed that OPA contributed from 21% to 24% to total PA among workers from a relatively high socioeconomic status and from 32% to 39% among those from a lower socioeconomic status. These finding imply that OPA may provide a substantial contribution to meeting the PA guidelines. Allender and colleagues illustrated this in their study, which showed that the percentages of individuals meeting the UK government recommended level of PA decreased from 36% of men and 25% of women to 23% and 19% respectively, when excluding OPA.

Even though the accelerometer is an objective measure of PA, it is not without limitations as it only provides information about acceleration in the vertical plane. However, a three-axial accelerometer might not have yielded more accurate data. It is very difficult to capture the mostly nonambulatory activities reported in

<table>
<thead>
<tr>
<th>Gender</th>
<th>N</th>
<th>Accelerometer-MVPA-work</th>
<th>Accelerometer-work</th>
<th>Accelerometer-total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>441</td>
<td>0.46**</td>
<td>0.39**</td>
<td>0.26**</td>
</tr>
<tr>
<td>Men</td>
<td>227</td>
<td>0.44**</td>
<td>0.33**</td>
<td>0.21**</td>
</tr>
<tr>
<td>Women</td>
<td>213</td>
<td>0.49**</td>
<td>0.48**</td>
<td>0.32**</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal &lt;25</td>
<td>224</td>
<td>0.44**</td>
<td>0.41**</td>
<td>0.36**</td>
</tr>
<tr>
<td>Overweight 25–30</td>
<td>152</td>
<td>0.55**</td>
<td>0.43**</td>
<td>0.28**</td>
</tr>
<tr>
<td>Obese ≥30</td>
<td>52</td>
<td>0.27*</td>
<td>0.26</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Note. Accelerometer-MVPA-work, moderate and vigorous physical activity limited to occupational time. Cut-off for accelerometer-MVPA-work > 760 counts/min. Significance at * $P < 0.05$, ** $P < .01$. 

Table 4  Spearman Correlations Between IPAQ-L-work and Accelerometer Data (Accelerometer-MVPA-work and Average Intensity) Registered During Work (8 AM to 4 PM) and Total Day
IPAQ-L work domain, such as heavy manual work (ie, heavy lifting), with an accelerometer (whether one, two or three-axial), as it cannot capture certain categories of activities that are highly nonambulatory, nor those that are derived from movement patterns that contain both nonambulatory and ambulatory activities. A strength of the current study is that by using the cut-point as suggested by Matthew we were able to capture a more full range of activities encountered in daily living (ie, activities performed at work). The limitation of the accelerometer to capture nonambulatory activities could explain the mean difference between IPAQ-L-work and accelerometer-MVPA-work. This could however also reflect an over-reporting of OPA in the IPAQ-L. This is in line with previous studies which have observed that the IPAQ-L yields higher values of PA than the accelerometer. Additional analyses to deal with potential statistical noise generated by the correlation between OPA and PA reported in other domains (data not shown) among those reporting low or null levels of physical activity in other domains yielded similar findings to those reported.

This study is subject to several limitations. Firstly, the results should be interpreted in relation to the sample from which they were obtained. The mean age of the subjects approached 50 years of age, around 40% was college educated and nearly all worked regular day-shifts. This would suggest that there was not a lot of variability in occupations, with a high representation of white-collar workers. It is unknown whether the same findings would have been found among younger adults with lower education levels, with mostly blue-collar occupations. Moreover, the study findings may be only applicable to populations of developed countries that not just have higher education levels, but also have more stable work conditions than low or middle income countries. Hallal and colleagues for example showed that the IPAQ-L work domain was difficult to administer in Latin America, where an important proportion of the population has low education levels and volatile working conditions. A second limitation concerns the conceptualization of a working day between 8 AM to 4 PM, as this information was not collected from the subjects, but based on a Swedish standard working day. In relation to this matter no information was gathered regarding when subjects had lunch, as a result of which no subtraction of time could be made from the accelerometer for lunch-breaks. This could be a source of bias if the study sample was very physically active during lunch and correctly reported these activities in the leisure-time domain of the IPAQ-L. A third limitation pertains to the small sample size of obese subjects. Approximately 12% of our entire sample was classified as being obese, which is representative of the Swedish population. However, conducting the correlation analyses in a sample with 52 subjects might explain the lower correlation observed among those subjects in comparison with the rest of the sample. A fourth limitation relates to identifying periods of more than 20 minutes with no counts as an accelerometer malfunction or non wear, however it could also reflect an actual situation in which subjects are being still in their sitting and not creating any vertical deflections. Finally, in the current study comparisons were limited to an accelerometer, a combination of an accelerometer and a diary or logbook would have provided more information regarding specific behavior.

Conclusions

In conclusion, the IPAQ-L work domain is a moderately good measure of time spent on MVPA at work and can be used to assess the contribution of OPA to total PA. This study provides valuable information regarding the use of the IPAQ-L in assessing work domain specific PA, in addition to total PA and different intensities of PA, in populations of developed countries. Moreover, it underscores the importance of assessing OPA, as our findings show that OPA can contribute for a substantial part to total PA. Valid information on OPA will further strengthen our knowledge regarding 1) the relationship between OPA and any potential health benefits, 2) the contribution of OPA to meeting the PA guidelines, and 3) possible compensation behavior between the different PA domains (ie, between leisure time and work).

Acknowledgments

MS and MH were responsible for the design of the original study. MH collected the data. LK analyzed the data and conceived and drafted the original manuscript. MH assisted with the statistical analyses. MH and MS provided critical feedback on drafts. All authors read and approved the final manuscript. This manuscript arises from the project (Instruments for Assessing Levels of Physical Activity and related Health Determinants-ALPHA), which has received funding from the European Union, in the framework of the Public Health Programme. Additional personal funding was received from the Swedish Council for Working Life and Social Research (FAS). None of the authors have any professional relationships with companies or manufacturers who will benefit from the results of the current study. The study sponsors had no involvement in the study design or the collection, analysis, and interpretation of data. The authors declare no potential conflicts of interest, real or perceived.

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