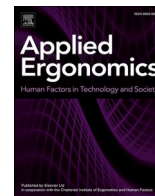




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# Validity of the occupational sitting and physical activity questionnaire (OSPAQ) for home-based office workers during the COVID-19 global pandemic: A secondary analysis

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## ABSTRACT

High levels of occupational sitting is an emerging health concern. As working from home has become a common practice as a result of COVID-19, it is imperative to validate an appropriate self-report measure to assess sitting in this setting. This secondary analysis study aimed to validate the occupational sitting and physical activity questionnaire (OSPAQ) against an activPAL4™ in full-time home-based 'office' workers ( $n = 148$ ; mean age = 44.90). Participants completed a modified version of the OSPAQ and wore an activPAL4™ for a full work week. The findings suggest that the modified OSPAQ has fair levels of validity in terms of correlation for sitting and standing ( $\rho = 0.35-0.43$ , all  $p < 0.05$ ) and agreement (bias = 2–12%) at the group level; however, estimates were poor at an individual level, as suggested by wide limits of agreement ( $\pm 22-30\%$ ). Overall, the OSPAQ showed to be an easily administered and valid questionnaire to measure group level sitting and standing in this sample of adults.

## 1. Introduction

Sedentary behaviour is defined as any waking behaviour in a seated, lying or reclining posture while expending less than or equal to 1.5 metabolic equivalents (Tremblay et al., 2017). Increased time spent sedentary has been associated with a higher risk of type 2 diabetes, cardiovascular disease and all-cause mortality (Katzmarzyk et al., 2019), independent from physical activity levels (Owen et al., 2010). Office-working adults have been shown to spend up to 77% of their workday sitting (Thorp et al., 2012), and therefore represent an at-risk population for high levels of sedentary time. The health concerns associated with high amounts of sedentary behaviour are increasingly being recognized with, for example, the recent launch of the Canadian 24-Hour Movement Guidelines for Adults, which provide time-specific recommendations for limiting daily sedentary time (Ross et al., 2020). Accordingly, it is not surprising that numerous interventions have targeted sedentary behaviour reduction in the workplace (Blackburn et al.,

2020).

In response to the SARS-CoV-2 (COVID-19) global pandemic, many desk-based workers have pivoted from working at the office to working from home. For instance, findings from a survey targeting American full- or part-time office-workers ( $n = 5858$ ), found that only 20% reported working from home almost all the time or full-time pre-COVID; however, since the onset of COVID-19, these proportions have risen to 71% working from home most of the time or full-time (Pew Research Center, 2020). This rapid, unplanned and unequipped transition from office-to home-based settings for many office workers, in addition to social distancing and lockdown measures, has been linked to significant decreases in overall physical activity as well as significant increases in total daily sitting time (Ammar et al., 2020; Fitbit, 2020; Tison et al., 2020). Evidence suggests that these decreases in physical activity may also be having a negative impact on mental health outcomes, including increased depression, loneliness, stress and decreased positive overall mental health (Meyer et al., 2020).

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This work-from-home trend seems likely to outlive the global COVID-19 pandemic, as this pivotal transition seems to have already changed the environment of future office work. For instance, many workers have reported both preference and employer granted options for in-office/work-from-home flexibility indefinitely (Anderson et al., 2021; Pew Research Center, 2020). Hence, it is important that interventions begin to target this new growing population's sedentary behaviour patterns. Currently, evidence is sparse regarding interventions aimed at reducing sedentary behaviours in office workers who work from home. In addition to effective interventions, accurate measures to capture sedentary behaviour in this new "office environment" need to be tested and validated. Ideally, a measure that is less expensive and can be easily and quickly distributed, such as a self-report questionnaire, is urgently needed to advance sedentary research in this new segment of the working population.

While the preferred method of sedentary behaviour measurement is with a device that can differentiate sitting from standing (i.e., activPAL™), this type of device-based measurement is usually expensive (e.g., costs associated with purchasing each device, delivery to participants, dressings needed) and relatively invasive to ask participants to wear. Due to this cost barrier and added participant burden, there are a number of self-report questionnaires that have been developed and used in the literature. Questionnaires that have been previously used to assess sedentary behaviours in office working adults include, but are not limited to, the International Physical Activity Questionnaire (IPAQ; Ekelund et al., 2006), the Workforce Sitting Questionnaire (Aittasalo et al., 2017), the Sedentary Behaviour Questionnaire (SBQ; Rosenberg et al., 2010) and the Occupational Sitting and Physical Activity Questionnaire (OSPAQ; Chau et al., 2012). Amongst these, the OSPAQ has been used in an array of populations such as university students (Dillon et al., 2021), university employees (Headley et al., 2018), sedentary obese individuals (Lohana and Yadav, 2020), health professionals (Zafiroopoulos et al., 2019) and of relevance, office workers (Nelson-Wong et al., 2020; Rollo and Prapavessis, 2020; Urda et al., 2017), to measure time spent sitting, standing, walking and performing heavy labour tasks during work hours. The OSPAQ measures sitting and standing as separate behaviours, thus, making it an ideal self-report tool to properly classify sedentary behaviour separate from physical inactivity. It is also very easy to implement as it only consists of three questions, minimizing participant burden. Validation studies using the OSPAQ have previously been conducted in various populations and demonstrated mixed levels of agreement and reliability depending on the occupation (i.e., sedentary versus non-sedentary) and device-based measure used (i.e., Actigraph versus activPAL™) (Chau et al., 2012; Jancey et al., 2014; Maes et al., 2020; van Nassau et al., 2015). Whether these findings can be replicated among traditional office-workers now working from home warrants investigation. It is imperative to establish the 'construct validity' of this questionnaire in an at-home 'office' worker population to allow future research to confidently assess sedentary behaviour within this setting, without the need for costly device-based measures. It is also important to note that these previous validation studies carry several limitations and pose risk of bias due to inadequate sample size (van Nassau et al., 2015) or use a device that cannot accurately differentiate sedentary behaviour (i.e., sitting) from physical inactivity (i.e., standing) (Chau et al., 2012; Jancey et al., 2014).

Validity evidence is lacking towards a questionnaire that can be administered to home-based office workers. Hence, a secondary analysis of data from an unpublished randomized controlled trial (NCT04488796) was undertaken to examine the measurement of agreement between the OSPAQ and the activPAL4™ inclinometer for estimating percentage of time spent sitting, standing and moving (i.e., walking) during work hours in office-working adults who had transitioned to working from home due to the COVID-19 pandemic.

## 2. Material and methods

### 2.1. Study design & population

We performed a secondary analysis on data from an unpublished pre-registered randomized controlled trial (NCT04488796) that aimed to decrease and break up time spent sedentary among home-based office workers. Data were collected from September to December 2020. Participants were full-time, home-based office workers living in London, Ontario or the surrounding area. Individuals were eligible to participate if they were 18 years or older, self-declared working full-time (i.e., employed 30+ hours/week) 5 days per week (i.e., Monday to Friday), self-declared working at least 3 days per week from their home, were able to read and write in English and had access to a computer with Internet and email. Participants were ineligible if they were planning on leaving their current employer or taking a leave of absence/vacation for more than three consecutive workdays for the duration of the study. They were also ineligible if they self-declared having a medical condition or physical limitation that prevented them from being physically active.

Participants were recruited using a number of strategies. First, contact was made via email with relevant liaisons and/or senior executives of potential businesses of interest (i.e., offices/businesses that were known to be working from home due to COVID-19). If interested, they were asked to email all full-time employees within their respective office/business inviting them to participate. Second, recruitment emails were sent directly to home-based office-working employees whose contact information was publicly available on company or institution websites (e.g., employee directories). Third, home-based office workers were recruited via recruitment posters distributed on various social media platforms (i.e., Facebook, Instagram, Twitter, LinkedIn). The recruitment emails included relevant study details (i.e., objective, eligibility criteria, brief procedures) and instructed interested individuals to contact the researcher via email if they wished to participate or wanted to receive additional details prior to making a decision. The study was approved by the institutional research ethics board.

### 2.2. Procedure & measures

After receiving a study invitation email, interested participants were sent a link with a unique authorization code and asked to complete an online questionnaire through a survey website called SoSci ([www.sosci-survey.de](http://www.sosci-survey.de)). The online questionnaire consisted of a Letter of Information, informed consent and a baseline questionnaire assessing relevant demographic characteristics and outcomes of interest (i.e., primary and secondary measures including the OSPAQ). Upon completion of the first questionnaire, participants were emailed a PDF version of the Letter of Information/Informed Consent and were asked to sign the form (digitally) and send it back to research personnel, along with their address for activity monitor delivery. Participants received the activPAL4™ device via courier and were instructed to apply the device on Sunday evening and to wear the device all day for a period of 5 working days (Monday through Friday). Upon receiving the activPAL4™, participants also received a link (via email) to a detailed video outlining the proper procedures on how to apply the device. If there was any confusion, they were asked to either email or call one of the researchers. Upon finishing, they were instructed to place the device into the return envelope that was provided, and it was picked up via courier the following Saturday. Participants then underwent a 4-week intervention period, filling out the OSPAQ at the end of each workweek (i.e., Friday). During the fourth week, they again wore the activPAL™ device and this was the period used for this secondary analysis validation study.

### 2.3. OSPAQ-revised

The percentage of time spent sitting, standing and moving (i.e.,

walking) during work hours was measured using a modified version of the OSPAQ (Chau et al., 2012). Due to the sedentary ‘office’ setting, ‘heavy labour or physically demanding tasks’ was removed from the questionnaire. This decision was made based off previous work done in the field that have reported low or zero prevalence of this behaviour in the workplace (Chau et al., 2012; Jancey et al., 2014; van Nassau et al., 2015). Participants were asked to record both the total number of days and hours they worked in the last 7 days. Participants were then asked to record the percentage of time spent sitting, standing, and moving (i.e., walking) on a typical workday in the last 7 days (i.e., ‘How would you describe your typical workday for the last 7 days? This involves only time spent in work-related activities and does not include what you did in your leisure time.’). The sum of all percentages were to equal a total of 100% (e.g., 80% occupational sitting, 10% occupational standing and 10% walking). Time spent in each behaviour (minutes) was calculated as follows: [Minutes worked in the last 7 days/Days at work in the last 7 days] × [Percentage of the behaviour reported (i.e., sitting/standing/moving)/100].

#### 2.4. activPAL™

The activPAL™ is currently considered the most accurate field-based measure of sitting time and sit-to-stand transitions (Kozey-Keadle et al., 2011). The activPAL4™ was the model used in the present study and is a small device worn on the midline anterior aspect of the thigh (right or left) that can differentiate between sedentary, standing and free moving activity using proprietary algorithms (Intelligent Activity Classification, PAL Technologies). Participants were instructed to wear the device for a full work week (i.e., Monday-Friday) at baseline as well as during the last intervention week. The activPAL™ monitor has been shown to be highly accurate as direct observation has shown a perfect correlation for time spent sitting/lying, standing and walking in primary school aged children (Aminian and Hinckson, 2012) and has been used in many previous validation studies involving adults (Clark et al., 2013; Júdice et al., 2015). The activPAL™ default settings were used, the validation wear time protocol was set to the ‘24-hour protocol’ (allowing 4 hours of non-wear per day), and data were downloaded in custom duration epochs (15 seconds) via activPAL™ Professional Software (version 8.11.4.61) and transferred to Microsoft Excel (version 16.44). Participants were required to have at least three valid workdays from Monday-Friday to be used in data analysis, which is consistent with previous studies (Edwardson et al., 2017). In the baseline questionnaire, participants were asked to report the start and end time of their workday (i.e., What are the hours you work in-between?). The data analyzed for each participant’s workday included the data between the self-declared start time (i.e., 9:30am) up to (and including) the last 15 seconds (5:29:45pm) before the official end time (i.e., 5:30pm). Average daily sedentary time (minutes per day) was calculated [total amount of time/average number of days] using two different equations. First, as the sum of ‘sedentary’, ‘primary lying’ and ‘secondary lying’ time. Second, all the behaviours included in the first approach plus time spent in ‘seated transportation’. Time spent standing was calculated from the ‘upright time’. Time spent moving was done as two separate calculations, the first consisting solely of ‘stepping time’ and the second combining ‘stepping time’ with ‘cycling time’. Each valid day of data was totaled and then averaged for the number of valid days to calculate average daily time (minutes) for the week. The percentage of time spent sitting, standing and walking from the activPAL4™ was calculated as follows [average minutes spent in the behaviour (i.e., sitting, standing or moving): per workday/total minutes of work time (i.e., 9:30 a.m. to 5:30 p.m. = 8 hours\*60)] × [100].

#### 2.5. Statistical analysis

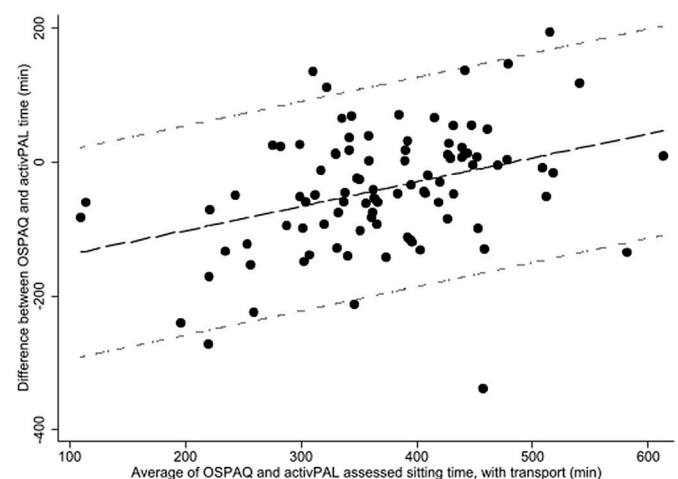
Statistical procedures were conducted in SPSS Statistics, Version 27 (SPSS Inc., Chicago, Illinois), GraphPad Prism version 9.0.2 (GraphPad

Software Inc., San Diego, CA) and Stata Statistical Software Release 11.0 (StataCorp LP, College Station, TX) software programs. The level of significance was set at  $p < 0.05$ . Descriptive statistics were calculated for all demographic variables collected at baseline and are shown as mean (standard deviation (SD)) or number (percentage) of the sample. Univariate ANOVAs (continuous variables) and chi-square tests (categorical variables) were conducted to ensure that there were no systematic differences between participants with valid and invalid data (all  $p$ -values  $> 0.05$ ). Bland and Altman (1999) do not recommend excluding outliers; however, they do suggest assessing the influence of outliers on the results. Therefore, we ran the analysis both before and after removing extreme outliers with a winsorization technique (Guttman and Smith, 1969). A total of 11 data points were imputed this way. The removal of extreme outliers did not impact the results and were therefore left in the analysis.

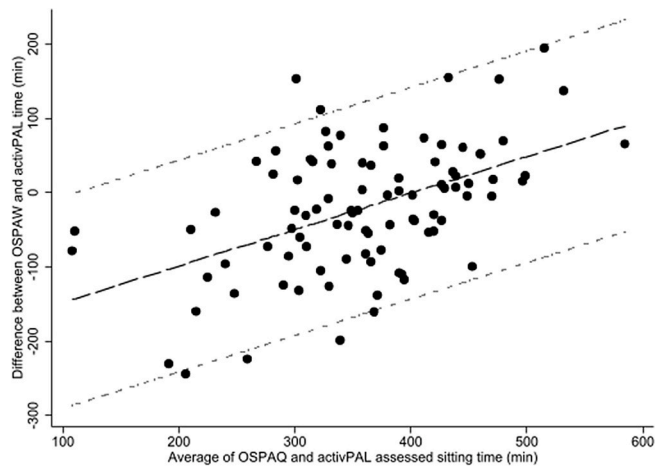
Spearman correlation coefficients were calculated to assess the degree of association between the activPAL4™ and modified OSPAQ. The strength of the correlation was interpreted as poor ( $<0.30$ ), fair ( $0.30$ – $0.50$ ), moderately strong ( $0.60$ – $0.80$ ), or very strong ( $>0.80$ ) (Chan 2003). Limits of agreement between the activPAL4™ and the modified OSPAQ were determined according to the recommendations by Bland and Altman (Bland and Altman, 1986). The difference [OSPAQ – activPAL4™] of the two paired measurements (as a percentage) was plotted against the average [(OSPAQ + activPAL4™)/2] of the two measurements (as a percentage). Percentage was deemed the most appropriate way to express the data because the OSPAQ is asked and interpreted as a percentage. The Bland-Altman plots expressed in minutes can be found in supplementary data Figs. 1–5. The mean difference, or bias, between the methods and the 95% limits of agreement intervals were calculated. Linear regression was used to determine linear bias. Significant linear bias indicates that the variability remained constant across average values while the mean difference increased significantly as average values increased. Therefore, where linear regression showed to be significant, the Bland-Altman plot presents the trend line for mean difference obtained from the regression and limits of agreement ( $\pm 1.96$  SD).

#### 2.6. Missing data

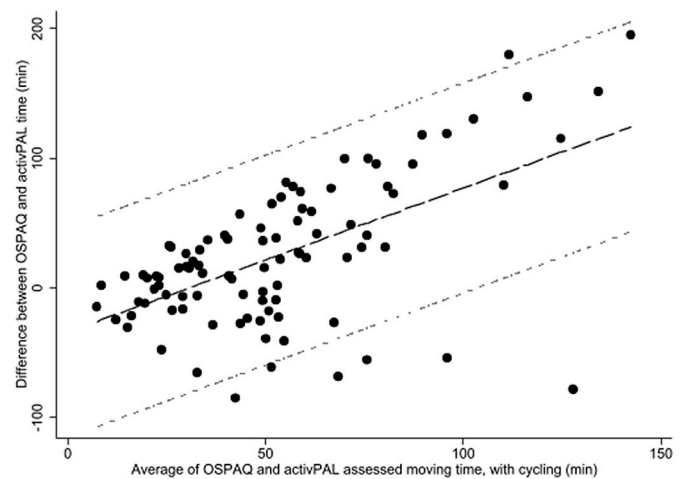
On any given variable at a single assessment point, the maximum percentage of missing data was 28% ( $n = 41$ ). Of the 148 participants



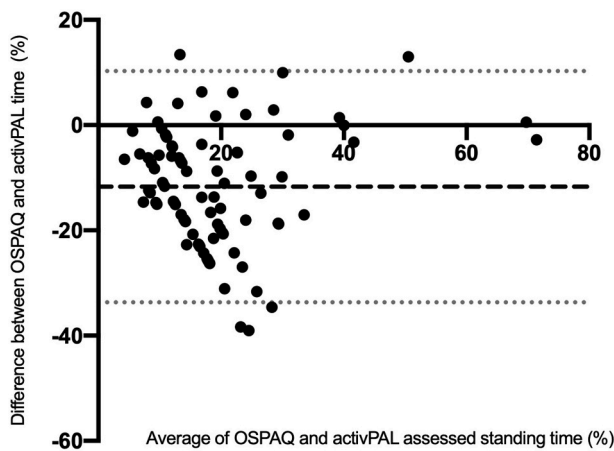
**Fig. 1.** Bland-Altman plot of agreement of total self-report (OSPAQ) sitting time (including transportation time) with device-derived (activPAL4™) sitting time ( $n = 95$ ). The y axis is the difference between the two measures and the x axis is the average of the two, both expressed as a percentage. The bolded dashed line shows the mean difference between the two measures ( $-5.63$ ), with the dashed lines representing the limits of agreement ( $\pm 29.87$ ).



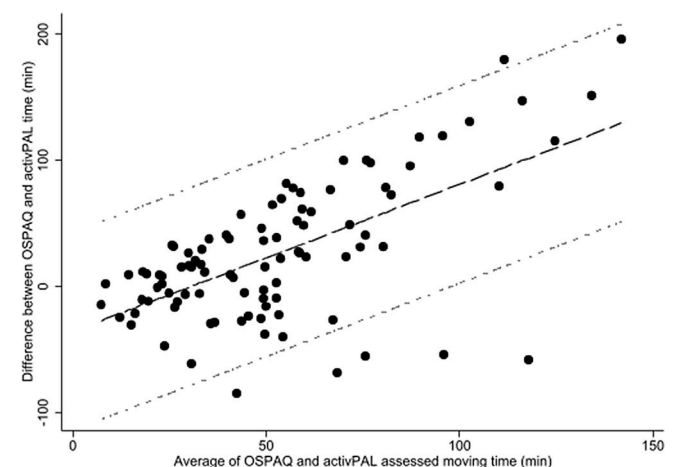
**Fig. 2.** Bland–Altman plot of agreement of self-report (OSPAQ) sitting time (excluding transport time) with device-derived (activPAL4™) sitting time ( $n = 95$ ). The y axis is the difference between the two measures and the x axis is the average of the two, both expressed as a percentage. The bolded dashed line shows the mean difference between the two measures ( $-1.58$ ), with the dashed lines representing the limits of agreement ( $\pm 28.31$ ).



**Fig. 4.** Bland–Altman plot of agreement of self-report (OSPAQ) moving time (including cycling time) with device-derived (activPAL4™) moving time ( $n = 95$ ). The y axis is the difference between the two measures and the x axis is the average of the two, both expressed as a percentage. The bolded dashed line shows the mean difference between the two measures ( $+6.44$ ), with the dashed lines representing the limits of agreement ( $\pm 15.36$ ).



**Fig. 3.** Bland–Altman plot of agreement of self-report (OSPAQ) standing time with device-derived (activPAL4™) sitting time ( $n = 95$ ). The y axis is the difference between the two measures and the x axis is the average of the two, both expressed as a percentage. The bolded dashed line shows the mean difference between the two measures ( $-11.71$ ), with the dotted lines representing the limits of agreement ( $\pm 22.34$ ).



**Fig. 5.** Bland–Altman plot of agreement of self-report (OSPAQ) moving time (excluding cycling time) with device-derived (activPAL4™) moving time ( $n = 95$ ). The y axis is the difference between the two measures and the x axis is the average of the two, both expressed as a percentage. The bolded dashed line shows the mean difference between the two measures ( $+6.60$ ), with the dashed lines representing the limits of agreement ( $\pm 14.93$ ).

that filled out the baseline questionnaire, 108 of them had valid activPAL4™ data and of those, 95 had valid self-report data. Independent samples *t*-tests revealed that those who had valid activPAL4™ data were not different from those who did not have valid data on all demographic variables ( $p$ -values  $> 0.05$ ). Taken together, all missing data were considered random. Hence, we decided to exclude missing data from the analysis.

### 3. Results

Descriptive statistics for the demographic variables, days worked from home and minutes worked per week are shown in Table 1. Percentages and minutes of device based (activPAL4™) and self-reported (OSPAQ) behaviour characteristics during work hours are illustrated in Table 2. The spearman rank correlation coefficient data between the activPAL4™ device and modified OSPAQ are displayed in Table 3. All the spearman correlations were found to be significant ( $p < 0.05$ ). The

correlation of the activPAL4™ device with sitting and standing were fair ( $\rho = 0.35$ – $0.43$ ) and the correlation with moving was poor ( $\rho = 0.21$ – $0.22$ ).

The Bland–Altman plots for percentage of time spent sitting, standing and moving is displayed in Figs. 1–5.

For total time spent sitting (Fig. 1), linear regression showed a significant positive association between the difference in the two measures (self-reported minus activPAL4™ derived sitting time) and the average of these two measures ( $B = 0.42$ ,  $SE = 0.12$ ,  $p = 0.001$ ). Thus, the mean difference is estimated at  $-37.97\% + 0.42 \times$  average of the two measures. At mean levels of average self-reported/activPAL4™-derived sitting time (76.29%), the mean difference indicated self-reported sitting time was  $-5.63\%$  lower than activPAL4™-derived sitting time with wide limits of agreement ( $\pm 29.87\%$ ). When excluding transportation time from the device based sitting time (Fig. 2), the linear regression again showed a significant positive association between the difference in

**Table 1**  
Participant characteristics presented as mean (SD) or count (%) of group.

Variable	Total sample (n = 148)	Valid data (n = 108)	Statistic (valid vs invalid)	p-level
Age (years)	44.90 (SD = 11.41)	45.52 (SD = 11.38)	F(1,147) = 1.181	0.279
Gender			X <sup>2</sup> (2) = 2.784	0.249
Male	40 (27.0%)	30 (27.8%)		
Female	107 (72.3%)	78 (72.2%)		
Non-Binary	1 (0.7%)	0 (0.0%)		
Ethnicity			X <sup>2</sup> (4) = 0.688	0.953
White	126 (85.1%)	91 (84.3%)		
Asian	7 (4.7%)	6 (5.6%)		
Black or African American	3 (2.0%)	2 (1.9%)		
Hispanic or Latino	4 (2.7%)	3 (2.8%)		
Other	4 (2.7%)	3 (2.8%)		
BMI (kg/m <sup>2</sup> )	27.33 (SD = 5.74)	27.42 (SD = 5.94)	F(1,147) = 0.105	0.747
Level of Education			X <sup>2</sup> (4) = 1.741	0.783
Highschool Diploma	13 (8.8%)	9 (8.3%)		
College Degree	26 (17.6%)	17 (15.7%)		
University Degree	57 (38.5%)	42 (38.9%)		
Masters	30 (20.3%)	22 (20.4%)		
Doctorate (i.e., MD, PhD)	22 (14.9%)	18 (16.7%)		
Marital Status			X <sup>2</sup> (4) = 4.533	0.339
Single	26 (17.6%)	22 (20.4%)		
Married or equivalent	107 (72.3%)	73 (67.6%)		
Separated or equivalent	7 (4.7%)	6 (5.6%)		
Divorced	7 (4.7%)	6 (5.6%)		
Widowed	1 (0.7%)	1 (0.9%)		
Work Sector			X <sup>2</sup> (3) = 2.546	0.467
Private	61 (41.2%)	41 (38.0%)		
Public	77 (52.0%)	58 (53.7%)		
Charity	2 (1.4%)	2 (1.9%)		
Other	7 (4.7%)	6 (5.6%)		
Days worked from home				
Five	118 (79.7%)	83 (76.9%)	X <sup>2</sup> (1) = 2.048	0.175
Four	19 (12.8%)	15 (13.9%)	X <sup>2</sup> (1) = 0.395	0.782
Three	11 (7.4%)	10 (9.3%)	X <sup>2</sup> (1) = 1.938	0.289
Physical Activity <sup>a</sup>			X <sup>2</sup> (1) = 0.107	0.852
Yes	85 (57.4%)	61 (56.5%)		
No	62 (42.6%)	46 (42.6%)		
Minutes Worked	494.56 (SD = 62.55)	493.71 (SD = 65.82)	F(1,147) = 0.074	0.785

<sup>a</sup> In the past 3 months, have you been active for a minimum of 30 min/day on at least 3 days of the week? (i.e., jogging, biking, swimming).

the two measures and the average of these two measures ( $B = 0.55$ ,  $SE = 0.11$ ,  $p = < 0.001$ ). Thus, the mean difference is estimated at  $-42.63$  percent  $+0.55$  x average of the two measures. At mean levels of average self-reported/activPAL4™-derived sitting time (74.26%), the mean difference indicated self-reported sitting time was  $-1.58\%$  lower than activPAL4™-derived sitting time with wide limits of agreement ( $\pm 28.31\%$ ).

For percentage of time spent standing during the workday (Fig. 3), linear regression was not significant and log transformation did not appear to limit the spreading of the data points. Thus, the original Bland-Altman methods were used (Bland and Altman, 1999). Examination of the Bland-Altman plot showed a systematic underestimation of time spent standing with a mean difference of  $-11.71$  (SD = 11.21) and wide 95% limits of agreement ( $\pm 22.34\%$ ).

For percentage of time spent moving including device measured cycling time (Fig. 4), linear regression showed a significant positive association between the difference in the two measures (self-reported minus activPAL4™ derived moving time) and the average of these two measures ( $B = 1.18$ ,  $SE = 0.14$ ,  $p < 0.001$ ). Thus, the mean difference is

**Table 2**  
Percentages and minutes of device-based (activPAL4™) and self-reported (OSPAQ) behaviours during work hours.

Variable	(activPAL4™: n = 108, OSPAQ: n = 95) Mean (SD), Median (Range)	(n = 108) Mean (SD), Median (Range)
% Sitting		
activPAL4™	<sup>a</sup> 75.00 (12.48), 74.96 (27.22–94.32)	<sup>b</sup> 78.82 (13.34), 79.57 (27.96–130.41)
OSPAQ	71.82 (18.82), 75.00 (20.00–97.00)	
Minutes Sitting		
activPAL4™	<sup>a</sup> 365.85 (72.57), 369.61 (136.09–502.51)	<sup>b</sup> 384.50 (77.61), 386.72 (144.12–625.95)
OSPAQ	339.51 (108.28), 336.00 (68.57–612.00)	
% Standing		
activPAL4™	25.09 (12.46), 25.04 (5.68–72.78)	
OSPAQ	13.46 (13.48), 10.00 (0.00–70.00)	
Minutes Standing		
activPAL4™	122.60 (64.26), 113.81 (27.24–393.01)	
OSPAQ	61.36 (56.88), 45.00 (0.00–294.00)	
% Moving (i.e., walking)		
activPAL4™	8.06 <sup>c</sup> (4.75), 6.96 (1.54–24.09)	<sup>d</sup> 8.23 (4.93), 7.17 (1.54–26.45)
OSPAQ	14.72 (10.86), 10.00 (0.00–50.00)	
Minutes Moving (i.e., walking)		
activPAL4™	<sup>c</sup> 39.64 (25.13), 33.40 (7.40–146.82)	<sup>d</sup> 40.51 (26.52), 34.89 (7.40–166.61)
OSPAQ	68.58 (51.04), 54.00 (0.00–240.00)	

<sup>a</sup> Without transportation time included.

<sup>b</sup> With transportation time included.

<sup>c</sup> Without cycling time included.

<sup>d</sup> With cycling time included.

**Table 3**  
Concurrent validity of the OSPAQ with the activPAL4™.

Variable	(n = 95) ρ
% Sitting <sup>a</sup>	0.406***
% Sitting <sup>b</sup>	0.425***
% Standing	0.349**
% Moving <sup>c</sup>	0.224*
% Moving <sup>d</sup>	0.211*

\*Significant at the 0.05 level.

\*\* Significant at the 0.001 level.

\*\*\* Significant at the 0.0001 level.

<sup>a</sup> Without transportation time included.

<sup>b</sup> With transportation time included.

<sup>c</sup> Without cycling time included.

<sup>d</sup> With cycling time included.

estimated at  $-7.04\% + 1.18$  x average of the two measures. At mean levels of average self-reported/activPAL4™-derived moving time (11.44%), the mean difference indicated self-reported moving time was 6.44% higher than activPAL4™-derived moving time with wide limits of agreement ( $\pm 15.36\%$ ). After excluding device measured cycling time for percentage of time spent moving (Fig. 5), linear regression was still significant ( $B = 1.21$ ,  $SE = 0.14$ ,  $p < 0.001$ ). Thus, the mean difference is estimated at  $-7.10\% + 1.21$  x average of the two measures. At mean levels of average self-reported/activPAL4™-derived moving time (11.36%), the mean difference indicated self-reported moving time was 6.60% higher than activPAL4™-derived moving time with wide limits of agreement ( $\pm 14.93\%$ ).

The Bland-Altman plot for minutes of time spent sitting, standing and moving can be found in the supplementary data Figs. 1–5.

## 4. Discussion

### 4.1. Main finding

The aim of the current study was to assess the criterion validity and absolute measurement of agreement of the OSPAQ against the activPAL4™ device for measuring occupational sitting, standing and moving in a sample of home-based office workers. Findings indicated fair levels of validity ( $\rho = 0.35$ – $0.43$ , all  $p < 0.05$ ) and acceptable agreement (mean difference = 2–12%) when comparing self-reported sedentary and standing with the device at the group level; however, estimates were poor at an individual level, as suggested by wide limits of agreement ( $\pm 22$ – $30\%$ ). For moving time, we observed poor levels of validity ( $\rho = 0.21$ – $0.22$ , all  $p < 0.05$ ) and acceptable agreement (bias = 6–7%). Although the observed biases for moving time were reasonable the 95% limits of agreement were too large ( $\pm 15\%$ ) to have confidence in recommending the self-report measure for use at the individual level. Thus, the modified OSPAQ may be appropriate for use in large-scale studies examining group-level data rather than for studies requiring estimates of an individual's sedentary behaviour profile. Beyond these general conclusions, there are some other observations that warrant commentary.

When looking at the Bland-Altman plots for sitting time (Figs. 1–2), it seems the more people sit, the more accurate they are at recalling their sitting time, which was confirmed after performing linear regression ( $p < 0.001$ ). For example, at around the 80% mark, the individual data points cluster more around the midline compared to the 50% mark, indicating better agreement at a higher sitting percentage. For standing, it is suggested through the data that participants consistently underestimate the time in this behaviour (Fig. 3). This is illustrated by the fact that most of the data points are below the midline. When looking at the moving time plots (Figs. 4–5), we see patterns of inconsistent over-estimation. That is, the less people move, the more accurate they were at recalling the behaviour, which again was confirmed by a linear regression ( $p < 0.001$ ). Specifically, the individual data points of these plots are more clustered around the midline when people moved for 10% or less of their workday.

### 4.2. Relevant literature

With respect to previous work in this field, the first validation study conducted by Chau et al. (2012) used a convenience sample of office-workers ( $n = 99$ ) and reported a moderate level of agreement between the OSPAQ and device (Actigraph) for estimating time sitting and standing. The authors reported the difference between the two measures as 'small', with the 95% limits of agreement for sitting ranging from  $-141.63$  to  $185.18$  min (326.81-min range). Although these large ranges could be attributed to the fact that the Actigraph accelerometer cannot differentiate between sedentary behaviour (i.e., sitting) and physical inactivity (i.e., standing), the findings were similar to what we observed in our study. Specifically, when examining our Bland-Altman plots in minutes as opposed to percentages, our 95% limits of agreement ranged from  $-162.69$  to  $122.26$  min (284.95-min range) for the measurement excluding transportation time and  $-196.89$  to  $115.95$  min (312.84- minute range) when including transportation time. In sum, we observed similar results to the study by Chau et al. (2012) in regard to agreement for time spent sitting; however, the spearman correlations were stronger than the current study for sitting and standing time ( $\rho = 0.65$  and  $0.49$  respectively) and similar for walking time ( $\rho = 0.29$ ).

A later study also sought to validate the OSPAQ against a device-based measure using a sample of full-time university office workers ( $n = 41$ ) (Jancey et al., 2014). Similar to Chau et al. (2012), the correlations reported were stronger than the current study for sitting standing and walking (i.e., moving) ( $r = 0.58$ ,  $r = 0.45$ ,  $r = 0.45$  respectively).

Contrary to Chau et al. (2012), Jancey et al. (2014) concluded a moderate level of agreement for standing and walking time, but systematic variation for sedentary time. It is important to note that the device used in this study was also an Actigraph, which makes the ability to measure posture impractical, as previously stated. These observations differ from the current study as we found systematic underestimation for standing time, while observing overall poor level of agreement for sitting and moving (i.e., walking). The 95% limits of agreement reported by Jancey et al. (2014) for sitting time were  $-784.7$  to  $733.9$  min (1518.6-min range), which is much greater than both Chau et al. (2012) (326.81) and the present findings (312.84). For standing time, they reported 95% limits of agreement of  $-324.6$  to  $269.7$  min (594.3- minute range) compared to our findings of  $-180.80$  to  $49.64$  min (230.44-min range). For time spent walking, their 95% limits of agreement were  $-269.2$  to  $280.8$  min (550-min range), much larger than our findings of moving time with  $(-56.15$  to  $105.79$  min; range of 161.94) and without  $(-52.74$  to  $104.06$  min; range of 156.80) cycling time included.

The most recent validation study for the OSPAQ used a sample of both sedentary ( $n = 65$ ) and non-sedentary ( $n = 331$ ) workers (Maes et al., 2020). Consistent with the previous studies, the correlations reported were stronger than the current study for sitting, standing and walking ( $\rho = 0.53$ ,  $\rho = 0.53$ ,  $\rho = 0.49$  respectively). The authors did not interpret the results of their Bland-Altman plots, but we examined the supplementary data file in order to make comparisons to the current study. For the purpose of relevance, we only further discuss results obtained from the sedentary worker data. The 95% limits of agreement for sitting appeared to range from approximately  $-45\%$ – $50\%$  (95% range), compared to our  $\sim 60\%$  range. For time spent standing, 95% limits of agreement appeared to be around  $-45\%$ – $30\%$  (75% range) compared to our  $\sim 45\%$ . This is the biggest discrepancy as we found systematic underestimation for standing time whereas their plot appeared randomly scattered. For time spent walking, it appears that the 95% limits of agreement ranged from about  $-20\%$  to  $45\%$  (65% range), larger than our  $\sim 30\%$ . While the Maes et al. study is an improvement in terms of the device used to measure sedentary behaviour time compared to the previously mentioned studies, it still poses the risk of misinterpretation as it is not stated how the Axivity AX3 accelerometer compares to the activPAL4™.

The only other validation study that has used an activPAL™ was conducted by van Nassau et al. (2015), using staff from a non-government health agency ( $n = 42$ ) to compare the two device measures across a number of time points. In terms of correlations, they report similar findings to the present study for sitting ( $\rho = 0.37$ ) and a weaker correlation for standing ( $\rho = 0.20$ ). Correlations for walking or moving time were not reported. Unfortunately, this study also did not formally interpret their Bland-Altman plots, so in order to make comparisons we had to approximate numbers from the figure in their paper. Overall, the 95% limits of agreement appeared similar to those of Chau et al. (2012) and the present study. For sitting, values ranged from  $-120$  to  $210$  min ( $\sim 330$ -min). For standing, values ranged from around  $-75$  to  $75$  min ( $\sim 150$ -min).

#### 4.2.1. Implications and future directions

Overall, the above-mentioned findings, along with the present findings, are consistent in demonstrating acceptable validity for measuring sitting and standing with the modified OSPAQ at a group level. However, the large 95% limits of agreement between the modified OSPAQ and activPAL™ or other related devices limits its use at the individual level, particularly with respect to intervention work. Previous studies targeting sedentary behaviour have only resulted in reductions of  $\sim 40$  min or less (Brakenridge et al., 2018; Chu et al., 2016; Jancey et al., 2016). This reduction in sedentary behaviour unfortunately falls well within the 95% limits of agreement shown in our study and the other research discussed. Put another way, based on the lack of OSPAQ sensitivity (accuracy) evidence at the individual level, intervention studies are likely not powerful enough to show sedentary behaviour

change outside the limits of agreement to be statistically significant.

There are a number of reasons as to why the questionnaire may not be performing adequately at the individual level. First, it could be the case that a one-week recall is too long. Future studies should look to validate the questionnaire when occupational behaviours are recalled at the end of each day as opposed to each week. Previous work has shown increased levels of agreement when implementing self-reported questionnaires in this fashion (Moulin et al., 2020). Second, there may be an educational piece necessary when administering this questionnaire. People may misinterpret or misunderstand the questions, unaware of whether to include certain aspects of their workday in the recall (i.e., lunch break). Thus, future studies should investigate as to whether educating or providing a quick tutorial or example beforehand would improve agreement. Third, Bland-Altman advises authors to reproduce their results (Bland and Altman, 1999). In other words, under the same circumstances, when re-administered a month or two later is the agreement level the same? Although van Nassau et al. (2015) touched upon this in their paper, their lack of interpretation of Bland-Altman plots highlights the need for future work to incorporate this kind of paradigm. Lastly, as the OSPAQ only assesses total sitting time, it is important to note that break frequency and duration also are key behaviours related to health outcomes that should be targeted. Therefore, while research continues to assess the OSPAQ and other similar questionnaires, questionnaires such as the revised SitQ-7 (Sui and Prapa-[vessis 2016](#)) that assesses break frequency and duration also need to be assessed and validated in this population.

#### 4.3. Strengths and limitations

The main strength of this study was the use of the activPAL4™ device, which is the gold standard for measuring sedentary time. We were also the first to investigate the validity of the OSPAQ in a sedentary occupation working from home. While working from home was first intended to be temporary due to the COVID-19 pandemic, it seems as though this shift in work environment from the office to home could persist into the foreseeable future and beyond. Because of this shift in how office work is being conducted, it is important to evaluate how this may affect the validity of self-report sedentary questionnaires. A further strength is that the average number of valid days that were required to be included in the analysis was higher than previous studies. Lastly, our sample size and the variability of the sample is a strength, as it makes our study more generalizable given the wide array of sedentary workers that were recruited, compared to previous studies that only recruited office workers from a single company or office space.

This study also had limitations that should be taken into account when interpreting the findings. First, participants were not asked to record their start and end time of each working day while wearing the device. Therefore, participants' self-reported start and end times might not be exact to their actual workday and thus, could be why the observed findings were not strong at the individual level. Additionally, our inclusion criteria only required a 50% or more work-from-home status; as participants did not record their workdays, we have no way of controlling for, or separating the work in office or at home days collected during the valid days. Lastly, practice effects could have impacted the results, as participants filled out the questionnaire four times prior to the assessment included in this secondary analysis. Thus, they may have improved their ability to recall their behaviour over the 4-week intervention period, leading to better levels of agreement at week 4 than what we might have seen at baseline. Alternatively, without feedback from previously self-reported sedentary behaviour, participants may have not optimally learned how to self-evaluate and thus improve the assessment of the targeted behaviour. We were unable to shed light on this issue as the sequence of measuring activPAL4™ device data and OSPAQ data was not harmonized at baseline (i.e., OSPAQ was assessed before activPAL4™).

## 5. Conclusion

The modified OSPAQ shows acceptable criterion validity for accurate estimates of overall sitting and standing time but not moving time in the context of at-home office working adults. The 95% limits of agreement for percentage of time spent sitting, standing and moving (i.e., walking) were large ( $\pm 15$ –30%) indicating that the OSPAQ may not be appropriate for measuring occupational sedentary and active behaviours at the individual level in this workplace setting. With home-based office work predicted to be a permanent feature for desk-based workers (Anderson et al., 2021) and the cost and burden associated with administering devices to large populations, it is imperative to have a validated self-report measure to allow for accurate assessment of movement patterns during work hours. Although further validation is required (i.e., responsiveness to change), the modified OSPAQ is an easily administered and acceptable self-report method for measuring at-home sitting and standing time at a group level.

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## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.apergo.2021.103551>.

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