HOSTED BY
ELSEVIER

Available online at www.sciencedirect.com
ScienceDirect

Journal of Sport and Health Science 9 (2020) 345−351

Sport Health Science
www.jshs.org.cn

Original article

Validity of long-term and short-term recall of occupational sitting time in Finnish and Chinese office workers

Ying Gao [a,*], Neil J. Cronin [a], Nina Nevala [b], Taija Finni [a]

[a] Neuromuscular Research Center, Faculty of Sport and Health Sciences, University of Jyväskylä, Jyväskylä FI-40014, Finland
[b] Finnish Institute of Occupational Health, Helsinki FI-00250, Finland

Received 24 August 2016; revised 10 November 2016; accepted 15 May 2017
Available online 27 June 2017

Abstract

Background: As sedentary behavior is a global health issue, there is a need for methods of self-reported sitting assessment. The accuracy and reliability of these methods should also be tested in various populations and different cultural contexts. This study examined the validity of long-term and short-term recall of occupational sitting time in Finnish and Chinese subgroups.

Methods: Two cohort groups of office-based workers (58.6% female, age range 22−67 years) participated: a Finnish group (FIN, $n = 34$) and a Chinese group (CHI, $n = 36$). Long-term (past 3-month sitting) and short-term (daily sitting assessed on 5 consecutive days) single-item measures were used to assess self-reported occupational sitting time. Values from each participant were compared to objectively measured occupational sitting time assessed via thigh-mounted accelerometers, with Spearman's rho (ρ) used to assess validity and the Bland-Altman method used to evaluate agreement. Coefficients of variation depicted day-to-day variability of time spent on sitting at work.

Results: In the total study sample, the results showed that both long-term and short-term recall correlated with accelerometer-derived sitting time ($\rho = 0.532$, 95% confidence intervals (CI): 0.336−0.684, $p < 0.001$; $\rho = 0.533$, 95%CI: 0.449−0.607, $p < 0.001$, respectively). Compared to objectively measured sitting time, self-reported occupational sitting time was 2.4% (95%CI: −0.5% to 5.3%, $p = 0.091$) and 2.2% (95%CI: 0.7%−3.6%, $p = 0.005$) greater for long-term and short-term recall, respectively. The agreement level was within the range −21.2% to 25.9% for long-term recall, and −24.2% to 28.5% for short-term recall. During a 5-day work week, day-to-day variation of sitting time was 9.4% ± 11.4% according to short-term recall and 10.4% ± 8.4% according to accelerometry-derived occupational sitting time.

Conclusion: Overall, both long-term and short-term self-reported instruments provide acceptable measures of occupational sitting time in an office-based workplace, but their utility at the individual level is limited due to large variability.

Keywords: Accelerometry; Daily recall; Office workers; Questionnaire; Self-report; Sitting time; Validity

1. Introduction

A large amount of time spent in sedentary behaviors is associated with several deleterious health outcomes including all-cause mortality; cardiovascular disease incidence or mortality; cancer incidence or mortality; and type 2 diabetes in adults.[1] Sedentary behavior is usually defined as any waking behavior in sitting or reclining posture with low energy expenditure (≤1.5 metabolic equivalents).[2] On average, adults spend over half of their waking hours sedentary and their sedentary time accrues across multiple domains.[3,4] In particular, occupational sitting is a major contributor to total daily sitting time among office-based workers.[5−7] As objective measurements are often impractical, there is a need to develop and evaluate the accuracy and reliability of self-report measures of occupational sitting.[8] Such measures should allow comparisons across different populations and cultures and be applicable in epidemiologic research.[9]

Questionnaires are the most common self-report method for assessing sedentary time.[10−12] Unfortunately, the majority of questionnaires exhibit a weak or low correlation between sedentary time and the criterion measure (range of correlation coefficients from 0.16 to 0.44).[9] When compared with questionnaires assessing recall over the past week or longer, shorter-term recall has been suggested to reduce reporting errors in estimates of usual levels of behavior.[13] However, studies are required to evaluate and compare the differences

Peer review under responsibility of Shanghai University of Sport.
*Corresponding author.
E-mail address: yigao@jyu.fi (Y. Gao).

https://doi.org/10.1016/j.jshs.2017.06.003
Cite this article: Gao Y, Cronin NJ, Nevala N, Finni T. Validity of long-term and short-term recall of occupational sitting time in Finnish and Chinese office workers. *J Sport Health Sci* 2020;9:345−51.

over varying time frames of self-report assessment, such as long-term recall of habitual sedentary behavior *vs.* short-term recall on a daily basis.[9] In fact, short-term recall can bring new insights into individual day-to-day variation of occupational sitting time, which may facilitate workplace interventions targeting intra- and inter-individual variability of sedentary behavior at work.[13]

Previous ergonomics studies have identified individual work postures (e.g., sitting, standing, *etc*.), and concluded that instruments were sufficiently accurate for studying those work postures in relation to health effects in epidemiologic studies.[14,15] Similarly, Reis et al.[16] developed the Occupational Physical Activity Questionnaire to identify the amount of time spent in specific occupational categories:[17] "1) sitting or standing, 2) walking, and 3) heavy labor", where the Spearman correlation with sitting or standing was 0.37 against 7-day occupational physical activity (PA) records.[16] Further examination of separated occupational sitting and standing is required, particularly for the assessment of self-administered occupational sitting time, as sit−stand workstations have been recently introduced in workplace settings.[18] Chau et al.[19] assessed 2 brief instruments including an Occupation Sitting and Physical Activity Questionnaire, which quantifies percentage time spent in different activities at work. The results showed moderate correlations for measuring occupational sitting and standing time (Spearman's rho (ρ) = 0.65 and 0.49, respectively), suggesting that it is a suitable method for measuring sitting and standing as discrete indicators.[19] In addition, the questions were sufficiently valid and responsive to changes over time in the sit−stand transition when compared with stronger relevant criterion measures of different postures.[20] However, their validation studies were mainly conducted in Australia, which may limit the generalizability of the results to different populations. The concepts and contextualization may vary in different cultural contexts, which could affect self-reported sedentary time.[21] Thus it is important to examine and compare methods of self-reported occupational sitting assessment in different countries.

Most studies have used hip- or waist-worn accelerometers as criterion measures based on body movement, where sedentary time is usually classified as accelerometer counts per minute less than 100.[9] However, this may result in misclassification of low intensity non-sedentary behaviors. As these devices do not detect body position, they cannot distinguish sitting time from standing.[22] Thus, the absolute difference between self-reported and accelerometer-measured values may have been under- or overestimated.[9] Recently, direct measures of postural aspects of sedentary behaviors have been developed. In particular, thigh-mounted accelerometry can identify distinct postures.[23−26] However, only a few recent validity studies have examined self-reported sitting time at work compared with thigh-mounted accelerometry as criterion measures.[20,27]

This study assessed the validity of 2 brief instruments for measuring occupational sitting time. We evaluated the criterion validity of long-term and short-term recall of occupational sitting time by comparing the results with thigh-mounted accelerometry in Finnish and Chinese office-based workers.

2. Methods

2.1. Recruitment, study sample, and procedures

This study was conducted between February and October 2013. Recruitment for the study took place in the cities of Jyväskylä, Finland and Hangzhou, China. Jyväskylä is located in central Finland with a population of 135,591 in 2015 (Population Register Center of Finland). Hangzhou is the capital and largest city of Zhejiang Province in Eastern China with a registered population of 9,018,000 in 2015 (www.zj.stats.gov.cn). Recruitment was achieved by advertising the study on webpages, placing flyers in public places, and individually by word-of-mouth. The study received ethics approval from the Ethics Committee of the University of Jyväskylä. No monetary incentive was offered to the participants.

A total of 131 individuals responded to an internet-administered questionnaire, of whom 70 agreed to attend an initial interview (participation response 53.4%) where they provided written informed consent to participate in the study, and all of them completed the study components including objective measurements. Participants in this study were office-based workers, over 18 years old, ambulatory, and non-pregnant. The sample of 70 contained 2 cohort groups: a Finnish group (FIN, n = 34) and a Chinese group (CHI, n = 36). In the FIN group, participants were mostly university employees (82% Finnish), and included researchers, teachers, administrative workers, assistants, professors, and technical workers. In the CHI group, participants (100% Chinese) had office-based occupations from different workplace settings, such as office workers, administrative workers, bankers, and IT workers.

The timeline of the procedures is shown in Fig. 1. All participants attended an initial interview where they were instructed to wear a triaxial accelerometer (X6-1a; Gulf Coast Data Concepts Inc., Waveland, MS, USA) secured to the mid-anterior thigh by using a flexible bandage (Pharmacare Sport, Oriola Oy, Espoo, Finland) for 5 consecutive workdays (by default a typical work week with 5 workdays), except when sick or not at work. Participants were individually given verbal and written instructions on how to position the accelerometer. They were asked to wear the device continuously from when they arrived at the workplace until the end of the workday. In addition, they were asked to keep a daily activity log where they recorded what time they came to and left the office, the exact time when they put on and took off the accelerometer, and other events. If they removed the device during work time, this information was also recorded in logs, accompanied by

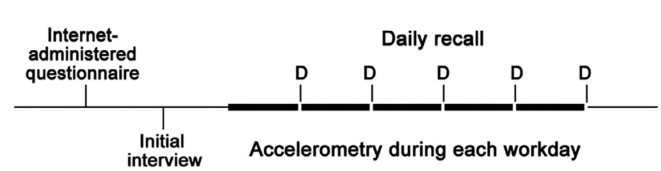

Fig. 1. Timeline of the procedures. The internet-administered questionnaire to assess long-term occupational sitting was administered before the initial interview, and the daily recall of occupational sitting time (D) was assessed at the end of each workday. Accelerometer data was obtained during each workday.

the reasons (e.g., noon nap in CHI group). They were further asked about the type of their workstation, and those who used a sit–stand workstation were asked to note the time when it was used to sit or stand at work. All the materials were translated to Finnish, English, or Chinese language and checked by native speakers. The questionnaire versions were pilot tested before the validity study.

2.2. *Demographic and physical characteristics*

The questionnaire was implemented electronically using SPSS Dimension mrInterview Version 5.5 (IBM Corp., Armonk, NY, USA), as used previously.[28] This system was based on the e-mail distribution of a link to the actual survey and completed via a web browser on the Internet. It included age, height, body mass, gender, education, overall health status, and PA level.[29] Body mass index (BMI) was calculated.

2.3. *Self-reported occupational sitting time*

Long-term recall was assessed using an internet-administered question: "How much of your entire workday, on average, did you sit during the last 3 months? (0–100% of worktime)." Short-term recall of occupational sitting time, which was assessed after each workday, involved a single-item question: "How much of your entire workday, on average, did you sit today? (as a percentage 0–100%)." The duration of work time was obtained from each individual's daily activity logs.

2.4. *Accelerometer-measured occupational sitting time*

Thigh-mounted accelerometer data, recorded during the same days as the assessment of short-term recall, were used to classify an individual's activity into sitting or activity (standing or walking), and to calculate these values as a percent of recorded work time. The initial utilities setting of the accelerometer was low gain (± 6 G) at a sampling frequency of 20 Hz with 16-bit resolution (sensitivity: 0.000183105 G), and the internal clock of the accelerometer was synchronized with a local online computer. All data analysis was performed using a custom-made script called OpenSALTO (https://github.com/mhavu/OpenSALTO), where data were transformed into a polar coordinate system. Inclination in the sagittal plane was low-pass filtered with 1 Hz cutoff. Sitting and upright positions (standing or walking) were discriminated on the basis of the angle of inclination of the thigh relative to gravity. A threshold of 45˚ from horizontal was set for the transition from sedentary to upright posture or the reverse, as done previously.[26] The analysis was set to detect a given posture with a minimum 5 s duration. This method is highly valid for classifying body postures to measure sitting time in adults by comparison with direct observation (mean difference of 0.19%, limits of agreement: −0.68% to 1.06%), both in the laboratory[30] and in the free-living setting,[31,32] and was confirmed in pilot tests to work accurately with the device used in the present study. All results were exported to Microsoft Excel 2010 (Microsoft, Redmond, WA, USA) with date- and time-stamped information, where non-wear time was discarded based on individually reported non-wear episodes in their logs. Data was considered valid if participants wore the accelerometer for at least 3 workdays during working hours, which is considered to be sufficient to determine habitual PA among adults.[33] Accelerometer data was compared on a day-to-day basis with short-term recall results so that 3–5 comparisons were performed for each participant, while the questionnaire for long-term recall was compared to the accelerometer data averaged over the measurement days.

2.5. *Statistics*

Statistical analyses were conducted using IBM SPSS for Windows Version 22.0 (IBM Corp., Armonk, NY, USA). A probability level of $p < 0.05$ (two-tailed) was considered statistically significant. Values are presented as means ± SD or % (n) unless otherwise indicated. Differences in participant characteristics between groups were tested using an independent t test (normal data) or Mann-Whitney U test (non-normal data) for continuous variables, and χ^2 test or χ^2 test with Fisher's exact test for categorical variables. For day-to-day variability, coefficients of variation (CV) were calculated for short-term recall and thigh-mounted accelerometer-measured occupational sitting time. The absolute difference between the long-term recall results was compared to the averaged daily short-term recall occupational sitting time using Wilcoxon signed-rank test. For validity, Spearman's rho (ρ) was calculated for self-reported (long-term and short-term) and accelerometer-measured occupational sitting time in the total study sample and the 2 cohort groups. The 95% confidence intervals (CI) for the correlations were calculated using Fisher transformation. The strength of correlation as indicated by Spearman's rho (ρ) was interpreted as weak (<0.30), low (0.30–0.49), moderate (0.50–0.69), strong (0.70–0.89), or very strong (≥0.90).[34] Agreement between self-reported and accelerometer-measured occupational sitting time was calculated for the total sample with 2 cohort groups using the Bland-Altman method.[35] Plots were presented with mean difference and 95% limits of agreement (±1.96 SD).

3. Results

Participant characteristics and occupational sitting time are presented in Table 1. Participants were 58.6% female, aged 22–67 years, and had a BMI of 17.1–30.1 kg/m^2. All reported their education to be above college level, thus education level was further classified as college or university level and higher education level, which included academic degree and academic postgraduate qualifications. Compared with FIN group, CHI group was younger ($p < 0.001$) and shorter ($p = 0.043$), and had lower weight ($p < 0.001$), BMI ($p = 0.001$), education level ($p < 0.001$), self-rated health ($p < 0.001$), and fewer met PA guidelines ($p < 0.001$).[29]

Valid accelerometer data for at least 3 workdays were obtained from 68 participants (78% completed 5 workdays). In total, data were analyzed from 322 days (FIN: 162 days; CHI: 160 days). The length of recorded work time averaged 455.4 ± 61.0 min per workday in the total sample, and there

Table 1
Participant characteristics and occupational sitting time.

	Total ($n = 70$)	FIN ($n = 34$)	CHI ($n = 36$)	p values
Age (year)	33.1 ± 10.7	39.6 ± 11.5	26.9 ± 4.6	<0.001
Height (cm)	168.3 ± 8.5	170.5 ± 8.6	166.3 ± 7.9	0.043
Body mass (kg)	63.3 ± 12.5	68.2 ± 10.8	58.6 ± 12.4	<0.001
BMI (kg/m^2)	22.2 ± 3.0	23.4 ± 2.5	21.0 ± 3.0	0.001
Proportion of females	58.6 (41)	58.8 (20)	58.3 (21)	0.967
Education				<0.001
College or university level	38.6 (27)	5.9 (2)	69.4 (25)	
Academic graduate level	61.4 (43)	94.1 (32)	30.6 (11)	
Self-rated health				<0.001
Very good or rather good	62.9 (44)	88.2 (30)	38.9 (14)	
Average, rather poor, or very poor	37.1 (26)	11.8 (4)	61.1 (22)	
Use of sit−stand workstation	18.6 (13)	38.2 (13)	0.0 (0)	<0.001
PA level[a]	21.4 (15)	41.2 (14)	2.8 (1)	<0.001
Occupational sitting time				
Long-term recall (%)	79.0 ± 13.5	76.2 ± 14.7	81.8 ± 11.8	0.120
Short-term recall (%)	79.3 ± 14.3	77.3 ± 16.4	81.2 ± 12.0	0.309
Accelerometer measured (%)[b]	76.6 ± 12.4	73.2 ± 12.8	80.1 ± 11.1	0.017
Recording time (min/workday)[b]	455.4 ± 61.0	447.3 ± 54.7	463.5 ± 66.6	0.280

Note: Data was shown as mean ± SD or % (n).
[a] Meeting the updated physical activity and health recommendations.[29]
[b] Missing $n = 2$ in CHI group.
Abbreviations: BMI = body mass index; CHI = Chinese group; FIN = Finnish group; PA = physical activity.

was no difference between groups. No differences were found in long-term or averaged daily short-term recall of occupational sitting time between groups, however FIN group had ~7% less sitting time according to accelerometer data ($p = 0.017$). Furthermore, ~39% of Chinese participants reported that they removed the device on at least 1 workday due to work−rest schedules (e.g., noon nap during work time) for an average of 101.5 ± 48.4 min (range 17−204 min) per day per person. None of the CHI group used a sit−stand workstation, whereas ~39% of participants in the FIN group did.

The day-to-day variation was 9.4% ± 11.4% for short-term recall and 10.4% ± 8.4% for accelerometer-measured occupational sitting time for the total sample. Fig. 2 shows subject-specific differences between daily short-term recall and accelerometer-measured occupational sitting time. FIN group exhibited higher day-to-day variation in both short-term recall (12.8% ± 14.1% *vs*. 6.3% ± 6.8%, $p = 0.012$) and accelerometer-based sitting time (13.3% ± 10.0% *vs*. 7.6% ± 5.2%, $p = 0.012$) than CHI group. No absolute difference was found between long-term and averaged daily short-term recall occupational sitting time ($p = 0.815$).

Long-term recall and accelerometer-measured sitting time at work correlated in the total study sample ($\rho = 0.532$, 95%CI: 0.336−0.684, $p < 0.001$), as well as in FIN group ($\rho = 0.450$, 95%CI: 0.132−0.684, $p = 0.008$) and CHI group ($\rho = 0.515$, 95%CI: 0.214−0.727, $p = 0.002$). Similarly, short-term recall and accelerometer-measured sitting time for each workday correlated in the total study sample ($\rho = 0.533$, 95%CI: 0.449−0.607, $p < 0.001$), in FIN group ($\rho = 0.600$, 95%CI: 0.491−0.691, $p < 0.001$), and in CHI group ($\rho = 0.459$, 95% CI: 0.326−0.574, $p < 0.001$).

Fig. 3 shows the Bland-Altman plots for long-term and daily short-term recall and accelerometer-measured occupational sitting time for the total study sample separated by groups. The mean difference between long-term recall and averaged accelerometer-measured results was 2.4% (95%CI: −0.5% to 5.3%, $p = 0.091$) for the total sample, 3.0% for FIN group (95%CI: −1.6% to 7.5%, $p = 0.180$), and 1.8% for CHI group (95%CI: −2.1% to 5.6%, $p = 0.293$). The agreement level was generally within the −21.2% to 25.9% range (±1.96 SD). Similarly, the mean difference between each short-term recall and the corresponding daily accelerometer-measured value was 2.2% (95% CI: 0.7%−3.6%, $p = 0.005$) for the total sample, 4.0% for FIN

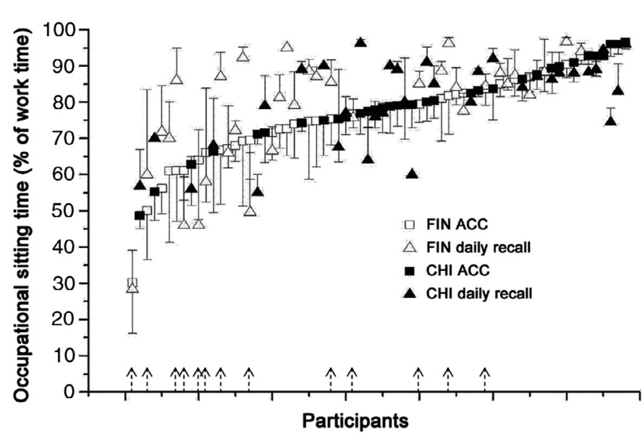

Fig. 2. Differences between averaged daily short-term recall (triangles) and accelerometer-measured occupational sitting time (squares) for each participant. Data was organized according to the amount of objectively measured sitting time so that participants who sat the most are on the right side and those who sat the least are on the left. Standard deviations denote day-to-day variation (3−5 workdays) in occupational sitting time. Dashed arrows indicate participants who used adjustable sit−stand workstations. ACC = accelerometer; CHI = Chinese group; FIN = Finnish group.

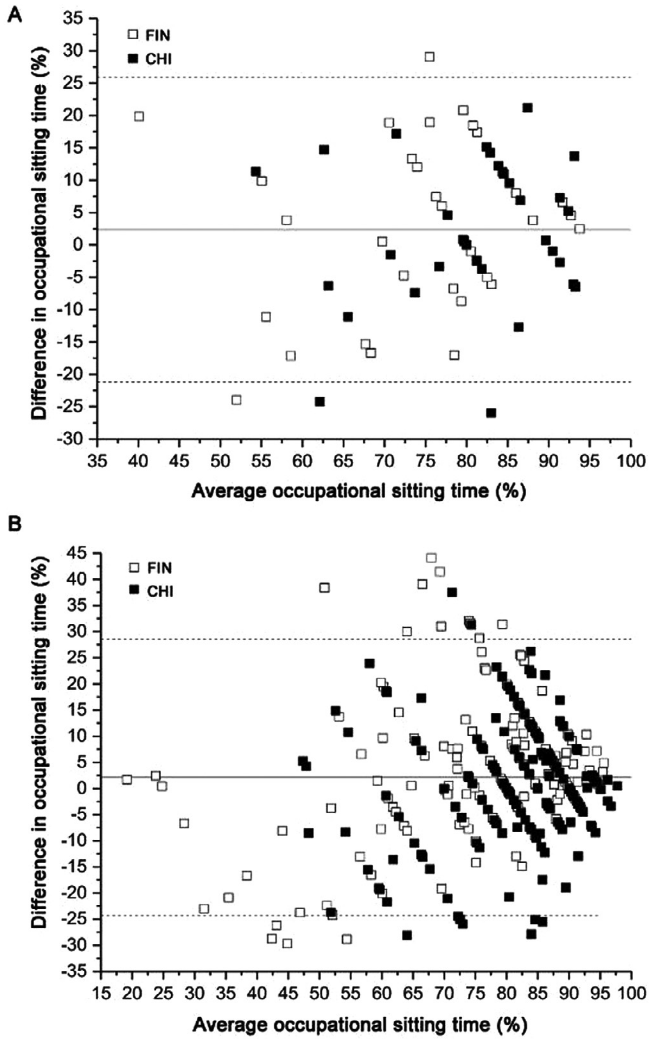

Fig. 3. Bland-Altman plot of absolute agreement of occupational sitting time for all participants' data separated by groups. The *y* axis shows the difference between long-term (A) and daily short-term (B) recall and accelerometer-measured occupational sitting time as a percentage of work time. The *x* axis is the average of them (%). The solid line represents the mean and the dashed lines represent the 95% limits of agreement (±1.96 SD). CHI = Chinese group; FIN = Finnish group.

group (95%CI: 1.8%−6.2%, $p < 0.001$), and 0.3% for CHI group (95%CI: −1.7% to 2.2%, $p = 0.807$). Agreement levels were generally within the −24.2% to 28.5% range (±1.96 SD).

4. Discussion

This study examined the criterion validity and absolute agreement of 2 brief self-reported measures of occupational sitting time, assessed by long-term and short-term recall, in a sample of Finnish and Chinese office-based workers. Criterion measures were compared with thigh-mounted accelerometer data, which were used to isolate sitting time. The findings suggest that both self-reported measures are acceptable (<3% difference compared to accelerometry) for assessing the proportion of work time spent sitting at a group level, but not necessarily at an individual level. Similar moderate correlations with objective measures were observed regardless of whether workers were asked about short- or long-term occupational sitting time.

Both long-term and short-term recall resulted in an average occupational sitting time of 79%, indicating that short-term recall adequately represented habitual occupational sedentary behavior. In addition, from the results of day-to-day variations in occupational sitting time, the overall range of CV% was less than 15% (6%−13%) of short-term recall and accelerometer-measured data from 5 workdays. This is comparable with a previous validation study that reported differences in CV% between past day recall and activPAL measured sedentary time of 16%−19% among adults.[36] In the present study, FIN group exhibited higher variations in daily occupational sitting time compared with CHI group. This may have been caused by several potential factors such as differences in sociocultural determinants, where work culture possibilities affect one's habitual occupational sedentary behavior.[4] For example, participants in the FIN group were mostly university employees, and they may have had more flexible work schedules than those in CHI group, who were employed by companies with fixed work schedules. Importantly, some participants from FIN group used sit-stand workstations and it seems that they tended to have lower occupational sitting time, which likely also contributed to the greater variation, as noted previously.[28]

The validity of detailed workplace-specific measures to assess occupational sitting time has been reported in some studies.[19,37] While quantifying the time spent in different postures may help to elucidate the associations between occupational sitting time and health outcomes,[38] few validity studies have examined subjective measures against accurate criterion measures that can distinguish between postures such as sitting or standing still.[20] Our study allowed us to separate sitting and upright postures to quantify sitting time at work. Overall, the long-term recall questionnaire and short-term recall single-item question exhibited similar validity. The range of Spearman's rho (ρ) was 0.336−0.684 in the total sample. Although the correlations found in our study were low to moderate, they seem to be at least as strong as those for global sitting time measured with the International Physical Activity Questionnaire or Global Physical Activity Questionnaire in the general population ($\rho = 0.07-0.61$).[10,11,39] Our results are also comparable to those of other studies that have examined the criterion validity of office-based sedentary time with accelerometry ($\rho = 0.27-0.65$).[19,37] Furthermore, we used a brief single-item question about occupational sitting time administered at the end of each work day. Shorter term recall has been suggested to improve self-report accuracy.[13] Although we found similar results of short- and long-term recall in the total sample, the difference between short-term recall and accelerometer-measured occupational sitting time was smaller in CHI group (mean difference 0.3% (equal to less than 2 min) *vs*. 4.0% in FIN). This may have been caused by large day-to-day individual variability in occupational sitting time, which was larger in FIN than in CHI.

Long-term and short-term recall occupational sitting time estimates were both close to the accelerometer-measured proportion of sitting time at work (mean differences were 2.4% and 2.2% respectively, equal to 11 min). This level of accuracy is comparable with results from the majority of occupational validation studies, which reported mean differences from 2 min/day to 27 min/day,[19,37,40] suggesting that our method is suitable for surveillance purposes in large populations where it is desirable to estimate occupational sitting time at a group level. However, the limits of agreement were wide, whereby over- or underestimation generally varied between −24.2% and 28.5% (±1.96 SD), which is equal to more than 100 min. Thus, these measures may be less useful in studies that require a high level of accuracy at the individual level, such as smaller scale intervention studies. In these cases, self-report measures may be more appropriate as complementary information to objective measures. Overall, our brief single-item question about occupational sitting time may be sufficient to rank office-based workers on the basis of sitting time in large-scale workplace population studies.

In the current study, we quantified the amount of sitting time as a proportion of worktime. This may be a useful instrument in large population based studies, which are limited by space constraints for questionnaire items.[19] Furthermore, when a standardized approach to measure sedentary behavior is required,[9] the use of continuous variables may make it possible to directly compare various studies regarding the proportion of work time spent sitting.[19] However, further examination of the units used to report sedentary and active time, for absolute and relative variables, is required to enable appropriate comparisons. In addition, there is limited research about intra- and inter-individual variability of sedentary behavior.[22] In the current study, we identified subject-specific differences between subjective and objective sitting time, and individual day-to-day variation of occupational sitting time. These results may improve understanding of how office workers individually accumulate their daily total sitting time at work. Furthermore, an important contribution of this study is the comparison between self-report instruments and accelerometer measures of sitting and upright postures (sitting and activity time) in the workplace; these simple self-report measures could feasibly be used in large population studies, which may ultimately help to establish associations between postural allocations and occupational health outcomes.[38,41]

However, the current study also has some limitations. Although this study used 2 cohort groups, which included participants from Finland and China, the study samples were small and may not be representative of the larger population. Participants were office-based workers, so these findings may not be representative of other occupations. Further examination of the utility of self-reported measures is recommended in different occupations with more varied patterns of sitting. Although the current study used 2 brief instruments to assess occupational sitting time, both of them may have been susceptible to random and systematic reporting errors.[9] While questionnaires containing several questions at a time may be associated with contamination, the 2 self-report measures used in this study were administered at different time points, which minimizes this potential bias. In addition, few studies have examined the ability of self-report measures to detect behavior changes over time.[20] Although in the current study we did not assess responsiveness to changes in occupational sitting, in our previous study we found that self-reported occupational sitting time decreased by ~14% after 6 months of daily use of a sit−stand workstation.[28] This difference is large compared to the mean difference of 2.2%−2.4% between self-report and objective measures in the present study, suggesting that our self-report measures could be sensitive enough to detect longitudinal changes in sitting time at the population level. However, further studies are needed to test this hypothesis.

5. Conclusion

A brief questionnaire about estimated sitting time at work, based on either long-term or short-term recall, may be suitable for different population health surveys, prospective cohort studies, and other studies that rely on questionnaire items.

Acknowledgments

Ying Gao was supported by the China Scholarship Council (No.201206320092), China. We thank Marko Havu, M.Sc., for assistance with data analysis.

Authors' contributions

YG designed the study, translated the questionnaire, carried out data collection, performed analysis, and drafted the manuscript; NJC designed the study, conducted conceptual development of variables, and critically revised the manuscript; NN designed the study, translated the questionnaire, and critically revised the manuscript; TF designed the study, conducted conceptual development of variables, and critically revised the manuscript. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Competing interests

The authors declare that they have no competing interests.

Appendix. Supplementary material

Supplementary data to this article can be found online at doi:10.1016/j.jshs.2017.06.003.

References

1. Biswas A, Oh PI, Faulkner GE, Bajaj RR, Silver MA, Mitchell MS, et al. Sedentary time and its association with risk for disease incidence, mortality, and hospitalization in adults: a systematic review and meta-analysis. *Ann Intern Med* 2015;**162**:123–32.
2. Cart L. Letter to the editor: standardized use of the terms "sedentary" and "sedentary behaviours". *Appl Physiol Nutr Metab* 2012;**37**:540–2.
3. Matthews CE, Chen KY, Freedson PS, Buchowski MS, Beech BM, Pate RR, et al. Amount of time spent in sedentary behaviors in the United States, 2003−2004. *Am J Epidemiol* 2008;**167**:875–81.

4. Owen N, Sugiyama T, Eakin EE, Gardiner PA, Tremblay MS, Sallis JF. Adults' sedentary behavior determinants and interventions. *Am J Prev Med* 2011;**41**:189–96.
5. Bennie JA, Pedisic Z, Timperio A, Crawford D, Dunstan D, Bauman A, et al. Total and domain-specific sitting time among employees in desk-based work settings in Australia. *Aust N Z J Public Health* 2015;**39**:237–42.
6. Clemes SA, Patel R, Mahon C, Griffiths PL. Sitting time and step counts in office workers. *Occup Med (Lond)* 2014;**64**:188–92.
7. Parry S, Straker L. The contribution of office work to sedentary behaviour associated risk. *BMC Public Health* 2013;**13**:296. doi:10.1186/1471-2458-13-296.
8. Marshall SJ, Ramirez E. Reducing sedentary behavior: a new paradigm in physical activity promotion. *Am J Lifestyle Med* 2011;**5**:518–30.
9. Healy GN, Clark BK, Winkler EAH, Gardiner PA, Brown WJ, Matthews CE. Measurement of adults' sedentary time in population-based studies. *Am J Prev Med* 2011;**41**:216–27.
10. Rosenberg DE, Bull FC, Marshall AL, Sallis JF, Bauman AE. Assessment of sedentary behavior with the International Physical Activity Questionnaire. *J Phys Act Health* 2008;**5**(Suppl. 1):S30–44.
11. Cleland CL, Hunter RF, Kee F, Cupples ME, Sallis JF, Tully MA. Validity of the Global Physical Activity Questionnaire (GPAQ) in assessing levels and change in moderate-vigorous physical activity and sedentary behaviour. *BMC Public Health* 2014;**14**:1–11.
12. Rosenberg DE, Norman GJ, Wagner N, Patrick K, Calfas KJ, Sallis JF. Reliability and validity of the Sedentary Behavior Questionnaire (SBQ) for adults. *J Phys Act Health* 2010;**7**:697–705.
13. Matthews CE, Moore SC, George SM, Sampson J, Bowles HR. Improving self-reports of active and sedentary behaviors in large epidemiologic studies. *Exerc Sport Sci Rev* 2012;**40**:118–26.
14. Laperrière E, Messing K, Couture V, Stock S. Validation of questions on working posture among those who stand during most of the work day. *Int J Ind Ergonom* 2005;**35**:371–8.
15. Mortimer M, Hjelm EW, Wiktorin C, Pernold G, Lbom Å, Vingård E. Validity of self-reported duration of work postures obtained by interview. *Appl Ergon* 1999;**30**:477–86.
16. Reis JP, Dubose KD, Ainsworth BE, Macera CA, Yore MM. Reliability and validity of the occupational physical activity questionnaire. *Med Sci Sports Exerc* 2005;**37**:2075–83.
17. Centers for Disease Control and Prevention. *Behavioral risk factor surveillance system survey questionnaire*. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention; 2001.p.22–3.
18. Pronk NP, Katz AS, Lowry M, Payfer JR. Reducing occupational sitting time and improving worker health: the Take-a-Stand Project, 2011. *Prev Chronic Dis* 2012;**9**:E154 doi:10.5888.pcd9.110323.
19. Chau JY, Van Der Ploeg HP, Dunn S, Kurko J, Bauman AE. Validity of the occupational sitting and physical activity questionnaire. *Med Sci Sports Exerc* 2012;**44**:118–25.
20. van Nassau F, Chau JY, Lakerveld J, Bauman AE, van der Ploeg HP. Validity and responsiveness of four measures of occupational sitting and standing. *Int J Behav Nutr Phys Act* 2015;**12**:144. doi:10.1186/s12966-015-0306-1.
21. Curry WB, Duda JL, Thompson JL. Perceived and objectively measured physical activity and sedentary time among South Asian women in the UK. *Int J Environ Res Public Health* 2015;**12**:3152–73.
22. Edwardson CL, Winkler EAH, Bodicoat DH, Yates T, Davies MJ, Dunstan DW, et al. Considerations when using the activPAL monitor in field based research with adult populations. *J Sport Health Sci* 2017;**6**:162–78.
23. Edwardson CL, Rowlands AV, Bunnewell S, Sanders J, Esliger DW, Gorely T, et al. Accuracy of posture allocation algorithms for thigh- and waist-worn accelerometers. *Med Sci Sports Exerc* 2016;**48**:1085–90.
24. Rowlands AV, Olds TS, Hillsdon M, Pulsford R, Hurst TL, Eston RG, et al. Assessing sedentary behavior with the GENEActiv: introducing the sedentary sphere. *Med Sci Sports Exerc* 2014;**46**:1235–47.
25. Steeves JA, Bowles HR, McClain JJ, Dodd KW, Brychta RJ, Wang J, et al. Ability of thigh-worn actigraph and activPAL monitors to classify posture and motion. *Med Sci Sports Exerc* 2015;**47**:952–9.
26. Skotte J, Korshøj M, Kristiansen J, Hanisch C, Holtermann A. Detection of physical activity types using triaxial accelerometers. *J Phys Act Health* 2014;**11**:76–84.
27. Wijndaele K, De Bourdeaudhuij I, Godino JG, Lynch BM, Griffin SJ, Westgate K, et al. Reliability and validity of a domain-specific last 7-d sedentary time questionnaire. *Med Sci Sports Exerc* 2014;**46**:1248–60.
28. Gao Y, Nevala N, Cronin NJ, Finni T. Effects of environmental intervention on sedentary time, musculoskeletal comfort and work ability in office workers. *Eur J Sport Sci* 2016;**16**:747–54.
29. Haskell WL, Lee I, Pate RR, Powell KE, Blair SN, Franklin BA, et al. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Circulation* 2007;**116**:1081–93.
30. Grant PM, Ryan CG, Tigbe WW, Granat MH. The validation of a novel activity monitor in the measurement of posture and motion during everyday activities. *Br J Sports Med* 2006;**40**:992–7.
31. Kozey-Keadle S, Libertine A, Lyden K, Staudenmayer J, Freedson PS. Validation of wearable monitors for assessing sedentary behavior. *Med Sci Sports Exerc* 2011;**43**:1561–7.
32. Lyden K, Kozey Keadle SL, Staudenmayer JW, Freedson PS. Validity of two wearable monitors to estimate breaks from sedentary time. *Med Sci Sports Exerc* 2012;**44**:2243–52.
33. Trost SG, McIver KL, Pate RR. Conducting accelerometer-based activity assessments in field-based research. *Med Sci Sports Exerc* 2005;**37**:531–43.
34. Pett MA. *Nonparametric statistics for health care research: Statistics for small samples and unusual distributions*. California, CA: SAGE Publications; 1997.
35. Bland JM, Altman D. Statistical methods for assessing agreement between two methods of clinical measurement. *The Lancet* 1986;**327**:307–10.
36. Matthews CE, Keadle SK, Sampson J, Lyden K, Bowles HR, Moore SC, et al. Validation of a previous-day recall measure of active and sedentary behaviors. *Med Sci Sports Exerc* 2013;**45**:1629–38.
37. Clark BK, Thorp AA, Winkler EA, Gardiner PA, Healy GN, Owen N, et al. Validity of self-reported measures of workplace sitting time and breaks in sitting time. *Med Sci Sports Exerc* 2011;**43**:1907–12.
38. Van Uffelen JG, Wong J, Chau JY, van der Ploeg HP, Riphagen I, Gilson ND, et al. Occupational sitting and health risks: a systematic review. *Am J Prev Med* 2010;**39**:379–88.
39. Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, et al. International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc* 2003;**35**:1381–95.
40. Chau JY, van der Ploeg HP, Dunn S, Kurko J, Bauman AE. A tool for measuring workers' sitting time by domain: the Workforce Sitting Questionnaire. *Br J Sports Med* 2011;**45**:1216–22.
41. Castillo-Retamal M, Hinckson EA. Measuring physical activity and sedentary behaviour at work: a review. *Work* 2011;**40**:345–57.