Association between employment status and objectively measured physical activity and sedentary behavior – The Maastricht Study

Running title: Employment status and physical activity

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Conflict of interest interests

None declared.

Abstract

Objective: To examine the association between employment status and physical activity and sedentary behavior. **Methods:** We included 2045 participants from The Maastricht Study, who used a thigh-worn accelerometer. We compared time spent sedentary, standing, stepping and higher intensity physical activity between participants with different employment status (non-employed or low-, intermediate- or high-level occupation) with ANOVA. **Results:** Participants in low-level occupations were less sedentary and standing and stepping more than those in other occupational categories and non-employed participants. Among the employed, the differences were mostly observed on weekdays, whereas the differences in sedentary time and standing between those in low-level occupations and non-employed participants were evident both on weekdays and weekend days. **Conclusions:** Those in low-level occupational category were less sedentary and more active than non-employed and those in other occupational categories, especially on weekdays.

Keywords: Physical activity, sedentary behavior, activity domains, accelerometer, work, employment

INTRODUCTION

Physical inactivity and sedentary behaviour can occur in three activity domains, namely work, leisure and transport.[1,2] They represent independent risk factors for adverse health outcomes such as coronary heart disease and type 2 diabetes.[2-4] Although occupation-related physical activity has decreased markedly in recent decades,[5] it is still estimated that work accounts for about 40% of the time spent in moderate-to-vigorous physical activity.[6] On the other hand, work done in sitting position has become very common[7] and among those with sedentary jobs, work can greatly contribute to total daily sitting time.[8]

Levels of physical activity and sedentariness vary between different socioeconomic and occupational level categories. Several studies have shown that highly educated people and those with high income spend more total or leisure time in physical activity than people with lower education or income.[1,9,10] However, when occupational level is used as a measure of socioeconomic status, the association becomes less clear[10] or is even reversed, with people in the lower-level occupational levels accumulating more total physical activity than people in the high-level occupational category.[11]

The literature on physical activity and sedentary behaviour across different socioeconomic or occupational categories has mostly relied on self-reported measures,[9-11] which have low precision and are prone to bias.[12,13] Furthermore, non-working adults, who form a large part of the general population, have typically been excluded from these studies.[9] Excluding the non-employed could lead to underestimation of occupational differences, since non-working adults often belong to the lower-level occupational categories.[14]

A few studies have reported objectively measured physical activity and sedentary behaviour on weekdays and weekend days in relatively small samples of specific occupational groups, such as office[8,15-18] or construction[13] workers or both,[19] office and customer service employees,[20] nurses[21] or police officers.[22] One study investigated objectively measured occupational activity for self-reported occupational categories in a nationally representative sample, but it did not focus on differences between weekdays and weekend days.[23] Thus, there was a need for a study including a large sample of both non-employed and employed participants from various occupations and including measurements on weekdays and weekend days.

To address this gap in the literature, we used 7-day measurements with thigh-worn activPAL3™ accelerometers in a large sample that included both non-employed and employed people. The aim of the study was to examine the association between employment status and objectively measured sedentary behaviour and physical activity, on average days as well as on weekdays and weekend days. We also examined the differences in activity levels between week and weekend days within and between employment statuses, using weekdays to approximate physical activity during working days and weekend days to estimate physical activity during non-working days. Our hypothesis was that those in the low-level occupational category would accrue less sedentary time and more physical activity on weekdays than those in higher-level occupational categories whereas those in the high-level occupational category would engage in more physical activity on weekend days than those in low-level occupational category.

METHODS

Participants

We used data from The Maastricht Study, a prospective population-based observational cohort study. The rationale and methodology have been described elsewhere.[24] Briefly, the study focuses on the etiology, pathophysiology, complications and comorbidities of type 2 diabetes mellitus (T2DM) and is characterized by an extensive phenotyping approach. Eligible for participation were all individuals aged between 40 and 75 years and living in the southern part of the Netherlands. Participants were recruited through mass media campaigns and from the municipal registries and the regional Diabetes Patient Registry via mailings. Recruitment was stratified according to known T2DM status, with an oversampling of individuals with T2DM, for reasons of efficiency.

The present report includes cross-sectional data from the first 2778 participants, who completed the baseline survey between November 2010 and September 2013 and who were offered accelerometers. The examinations of each participant were performed within a time window of three months. We excluded participants who had missing information on non-employment sub-group, occupational category or the covariates (age, sex, diabetes status and presence of mobility limitations, n = 501) or who did not have a minimum of four valid days of accelerometer data (n = 232), leaving 2045 people in the analyses. The study has been approved by the institutional medical ethics committee (NL31329.068.10) and the Minister of Health, Welfare and Sports of the Netherlands (Permit131088-105234-PG). All participants gave written informed consent.

Assessment of physical activity and sedentary behavior

Daily activity levels were measured using the activPAL3™ physical activity monitor (PAL Technologies, Glasgow, UK). The activPAL3™ is a small (53 × 35 × 7 mm), lightweight (15 g) triaxial accelerometer that records movements along the vertical, anteroposterior and mediolateral axes, and also determines posture (sitting or lying, standing and stepping) based on acceleration information. The device was attached directly to the skin on the front of the right thigh with transparent 3M Tegaderm™ tape, after the device had been waterproofed using a nitrile sleeve. Participants were asked to wear the accelerometer for 8 consecutive days, without removing it at any time. To avoid inaccurately identifying non-wear time, participants were asked not to replace the device after they had removed it. Data were uploaded using the activPAL software and processed using customized software written in MATLAB R2013b (MathWorks, Natick, MA, USA). Data from the first day were excluded from the analysis because participants performed physical function tests at the research center after the device was attached. In addition, data from the final wear day providing ≤ 14 waking hours of data were excluded from the analysis. Participants were included if they provided at least 4 valid (≥ 10 h of waking data) days, including minimum of 1 valid weekday and 1 valid weekend day.

The total sedentary time was based on the sedentary postures (sitting or lying), and calculated as the percentage (%) of time spent in a sedentary positions during waking time per day. Percentage was used instead of absolute time because waking wear time differed between participants with different employment status and between weekdays and weekend days. The method used to determine waking time has been described elsewhere.[25] The total standing time was based on the standing posture, and calculated as the proportion of time spent standing during waking time per day. The total amount of stepping was based on the stepping posture, and calculated as the proportion of time spent stepping

during waking time per day. Stepping time (physical activity) was further classified into higher-intensity physical activity (HPA, % of minutes with a step frequency >110 steps/min during waking time).[26] The daily means were averaged over all valid days, weekdays (from Monday through Friday) and weekend days (Saturday and Sunday) to obtain the proportion of time spent at each activity level for average days, weekdays and weekend days.

Assessment of employment status

Employment status was assessed with a questionnaire. Participants were asked to classify their current employment status as self-employed, working for the government, salaried worker, disabled, rentier, retired, homemaker, unemployed or "other". Those who selected the disabled, rentier, retired, homemaker or unemployed options were classified as currently non-employed. Those in the "other" category were excluded from the analysis because their employment status could not be confirmed. Those who reported being self-employed, salaried workers or working for the government were further classified as currently employed, and their occupational category was identified based on the question "What category is your job?" and categorized as low [including response options "unskilled" (including e.g. cleaners, waitresses), "skilled" (including e.g. plumbers and construction workers) and "lower-level employee"], intermediate or high level, or self-employed.

Covariates

Age and sex were derived from questionnaires. Diabetes status was assessed by an oral glucose tolerance test.[24] The presence of mobility limitations (some trouble walking or not able to walk during the past week) or the absence of such limitations (no trouble walking during the past week) was

assessed by the EuroQol-5D questionnaire. Level of education was derived from the questionnaires and categorized as low, intermediate or high. Health behavioral factors were also derived from the questionnaires. Smoking status was categorized as never, former or current smoker, and alcohol consumption as none, low (≤ 14 or ≤ 7 alcoholic drinks per week for men and women, respectively) or high (> 14 or > 7 alcoholic drinks per week for men and women, respectively). A research assistant measured the participants' body weight and height at the research center, and body-mass index (BMI, kg/m^2) was calculated from this information. Frequency of shift work was assessed by asking "Did/do you have to work different shifts?".

Data processing and analysis

Normally distributed descriptive variables were summarized as means with standard deviations (SD), variables with skewed distribution as medians and interquartile ranges (IQR) and categorical variables as numbers and percentages. We compared baseline characteristics between non-employed participants and participants in different occupational categories by one-way ANOVA (continuous, normally distributed variables), Kruskal-Wallis test (continuous variables with skewed distribution) and $\chi 2$ test (categorical variables).

First, we compared the time spent sedentary, standing, stepping and in HPA between non-employed participants and participants in the low-, intermediate- or high-level occupational categories, on average days during the entire week (ANOVA), on weekdays (repeated measures ANOVA) and weekend days (repeated measures ANOVA), and compared the weekdays and weekend day activity levels within these groups (repeated measures ANOVA). Second, we repeated the analyses focusing on the non-employed, and examined differences across the non-employed sub-groups: retired,

homemakers, disabled, unemployed and rentiers. The results are shown as adjusted means and their 95% confidence intervals (CI) for the proportion of waking wear time spent being sedentary, standing, stepping and in HPA. The models were adjusted for age, sex, presence of diabetes and presence of mobility limitations. We also conducted sensitivity analyses adjusting additionally for (1) education and (2) health behavioral factors: smoking status, alcohol consumption and BMI. As a third sensitivity analysis to account for uncertainties regarding our assumption that weekdays represented working days and weekend days represented non-working days, we repeated the weekdays vs. weekend day comparisons excluding those who were employed and reported doing shift work often or always (n = 100), or who did not provide information on shift work (n = 9). Since we found no interactions between sex and overall sedentary time or physical activity, we present all the analyses for men and women combined. All the analyses were performed using SAS 9.4 statistical software (SAS Institute Inc., Cary, NC, USA).

RESULTS

Table 1 presents the descriptive characteristics of the participants by employment status. Mean (SD) age of all participants was 60.2 (8.0) years, and mean (SD) daily waking wear time over valid days for the entire week was 942 min (53). Non-employed participants were generally older and were more likely to have diabetes and mobility limitations than the employed. The 733 participants excluded due to missing information were slightly younger (mean age 59.5 years, SD 8.6), included about equal proportions of men (53%), were more likely to have a low educational level (40%), and were more likely to have diabetes (41%) and mobility limitations (21%) than the 2045 who were included in the analysis.

Time spent sedentary and at different activity levels, stratified by employment status, is presented in Table 2, for average days and for weekdays and weekend days. Overall, those in the low-level occupational category were less sedentary and spent more time standing and stepping than those in other occupational categories and those who were non-employed. Furthermore, those in the high-level occupational category engaged in more HPA than those in the intermediate occupational category or non-employed participants, although the latter difference was no longer significant in the second sensitivity analysis, adjusting the model additionally for health behavioral factors (Supplemental Digital Content Tables S1 and S2).

The above differences in total physical activity and sedentary time between employment groups stemmed mostly from weekdays (Table 2). Participants in low-level occupational category were less sedentary and spent more time standing and stepping than those in other occupational categories and non-employed participants on weekdays. In addition, participants in high-level occupational category were more sedentary than non-employed on weekdays, and non-employed participants and those in the high-level occupational category spent more time stepping than self-employed on weekdays. Furthermore, those in the high-level occupational category had more HPA than non-employed participants and those in the intermediate occupational category on weekdays. We observed only few differences on weekend days: those in the low-level occupational category were less sedentary and spent more time standing than non-employed participants and those in the high-level occupational category had more HPA than those in the intermediate occupational category (Table 2). The main result remained robust in the three sensitivity analyses, with additional adjustments to the models (Supplemental Digital Content Tables S1, S2) and excluding those who had shift work (Supplemental Digital Content Table S3): those in the low-level occupational category were less sedentary and more active than all the other participants on weekdays but not on weekend days.

Physical activity and sedentary time during weekdays and weekend days for each employment status are depicted in figure 1, with statistically significant differences marked by an asterisk. Non-employed participants and those in the low-level occupational category were less sedentary and spent more time standing and stepping during weekdays than during weekend days. Non-employed participants engaged in more HPA on weekdays than on weekend days. The reverse pattern was observed in the self-employed and high occupational category participants. Both self-employed participants and those in high occupational category were more sedentary and spent less time stepping on weekdays than on weekend days. In addition, self-employed participants also spent less time standing on weekdays than on weekend days.

The percentages of time spent sedentary, standing, stepping and in HPA on average days among the non-employed participants are presented in Table 3. Homemakers were less sedentary than retired and disabled participants. In addition, homemakers spent more time standing than retired and disabled participants and rentiers.

DISCUSSION

In this cross-sectional study, we objectively assessed the time spent sedentary and at different activity levels on weekdays and weekend days, among Dutch adults with different employment status. We found a clear pattern showing that those in the low-level occupational category were less sedentary and more active than all the other groups. Among the employed participants, the differences in activity levels between occupational categories were observed for total time and weekdays, but not for weekend

days, suggesting that occupational physical activity was the driving factor of the differences between employed people.

Other studies have also demonstrated that blue-collar workers and those working in retail,[27-29] construction,[19] or agriculture[30] are less sedentary and more active than other employees on working days. In our study, this difference in weekday activity levels was also reflected in total physical activity, which was higher among those in the low-level occupational category than among the others. Similar findings have been reported regarding police officers compared to higher ranking police staff,[22] retail and blue collar workers compared to office and university workers[29] and construction workers compared to employees of financial service providers or research institutes.[19] Thus, although people with low socioeconomic status generally have poorer health than those with higher status,[14,31] those in the low-level occupational category may still paradoxically be more physically active and less sedentary than those in the higher-level occupational categories. This emphasises the need for further research into occupational differences in physical activity and sedentary behaviour using objective measures. Furthermore, such research should take into account that some types of occupational physical activity, such as heavy lifting, may also be harmful.[32-34]

We did not find differences in activity levels between occupational categories on weekend days. This is in contrast to a systematic review showing that those employed in non-manual occupations had more leisure-time physical activity than those in manual occupations.[11] The discrepancy might be explained by different outcome measures: we used objective measurement of physical activity and used weekends as a proxy for leisure time, whereas the studies included in the systematic review mainly relied on self-reports and the questions were specifically about leisure time. Our findings are in line with those of other studies using objective measures to compare persons with active vs. sedentary jobs[30,35] or police

officers vs. higher-ranking police staff,[22] which revealed differences in physical activity on working days, but not on non-working days.

The weekdays vs. weekend day differences, where non-employed participants and those in the low-level occupational category were less sedentary and more active during weekdays than on weekend days, while self-employed participants were more sedentary and less active on weekdays than on weekend days, are in accordance with some previous studies. Swiss workers in the moderate and high occupational intensity groups[30] and Australian blue collar workers, technicians and scientists[28] were more active on weekdays than weekend days, while the opposite was reported for Swiss workers in low occupational intensity groups[30] and office workers from the UK,[15] Singapore[17] and Australia.[8,20] Conversely, we found very few differences between weekdays and weekend days among those in the intermediate or high-level occupational categories, which is in agreement with studies among British office-workers, whether including both sexes [16] or only women.[18]

Apart from differences between those in the low-level occupational category and the non-employed, the activity levels were fairly similar for non-employed and employed participants. This is contrast to several other studies using objective methods to assess physical activity. For example, in an American study, employed men were more active than non-employed healthy men, although such a difference was not found among women.[35] Furthermore, employed people had a higher step count than unemployed persons in Belgium,[36] and also when compared with homemakers and disabled persons in Finland.[37] Additionally, British retirees were found to be less sedentary and more active than employed people.[38] The differences between our findings and those of previous studies could be explained by the variety of sub-groups included in our non-working category, with homemakers being less sedentary and more active than disabled and retirees.

Strengths of this study include the objective measurement of both sedentary time and time spent at different activity levels, using a thigh-worn accelerometer, as well as the ability to distinguish between weekdays and weekend day activity levels, and the diverse study sample, which included a wide variety of occupational categories and non-employed people. Thigh-worn accelerometers provide reliable measurement of sedentary time, and enable distinguishing between sitting and standing time.[39] Furthermore, accelerometers provide detailed information on activity over time, allowing comparison of activity between weekdays and weekend days. Including the non-employed resulted in a broader assessment of occupational category, although the currently non-employed could have been previously employed in many different occupational categories.

Weaknesses of the study include the use of self-reports of rather crudely defined employment status, which did not use any standardized occupational classifications. Also, we were not able to confirm working days or hours or domains of physical activity. However, the differences in activity levels between occupational categories were mainly observed on weekdays but not on weekend days, and this finding remained robust after we excluded those who reported shift work. This provides some evidence that weekdays and weekend days did represent typical working and non-working days, respectively, with sufficient precision. HPA was based on step frequency, which may be less precise than using acceleration to determine intensity levels. It has, however, been demonstrated that a step frequency higher than ~110 steps/minute equals a metabolic equivalent of task (MET) value of ≥3.0,[26] it may therefore be interpreted as an approximation of MVPA. In addition, while our algorithm to automatically determine wake and bed time in 24-hour activPAL™ data could be used as an accurate measure to identify waking time,[25] it may still have led to some misclassification between sleeping and sedentary time. About 25% of those who were offered the accelerometer were excluded from the

analysis because of missing information. If anything, non-response could have weakened the association between occupational category and physical activity, given that those excluded were less educated than those included, and thus more likely to be non-employed or in the low-level occupational category. The participants of this study were Dutch people aged 40–75 years, which may limit the generalizability of the findings to other age groups and non-European populations.

CONCLUSIONS

We found that adults in the low-level occupational category were less sedentary and more active than those in higher-level occupational categories and those who were non-employed, especially on weekdays. However, we did not find evidence of participants in higher-level occupational categories being more physically active on weekend days than those in low-level occupational category. As physical activity or sedentary behavior can relate to different domains, i.e. leisure time or work, it can have different health effects, and can be influenced by different types of interventions. For example, people who have a high-level occupational category are likely to have sedentary jobs and can benefit from workplace interventions, whereas people in the low-level occupational category and physically demanding work may need interventions focusing on leisure-time physical activity. In order to cover occupational physical activity and occupational sedentariness, which have to date scarcely been studied, future studies should combine objective physical activity and sedentary behavior measurements with accurate information on occupational category and actual working hours.

Table 1 Descriptive characteristics of the study sample, stratified by employment status

Variable	Total (*n* = 2045)	Non-employed (*n* = 1200)	Low occupational category (*n* = 110)	Intermediate occupational category (*n* = 128)	High occupational category (*n* = 308)	Self-employed (*n* = 299)	P-value
Age, mean years (SD)	60.2 (8.0)	64.3 (6.3)	53.8 (5.9)	54.4 (7.0)	53.6 (6.0)	55.0 (6.3)	<0.0001
Male sex, n (%)	1037 (51)	604 (50)	60 (55)	54 (42)	135 (44)	184 (62)	<0.0001
Level of education[1]							<0.0001
Low, n (%)	650 (32)	510 (43)	55 (50)	19 (15)	59 (19)	7 (2)	
Intermediate, n (%)	565 (28)	285 (24)	46 (42)	61 (48)	131 (43)	42 (14)	
High, n (%)	819 (40)	396 (33)	8 (7)	47 (37)	118 (38)	250 (84)	
Type 2 diabetes, n (%)	534 (26)	379 (32)	30 (27)	23 (18)	45 (15)	57 (19)	<0.0001
Mobility limitation, n (%)	316 (15)	243 (20)	15 (14)	15 (12)	24 (8)	19 (6)	<0.0001
Number of valid accelerometer wear days, median (IQR)	7 (6 to 7)	7 (6 to 7)	7 (6 to 7)	6 (6 to 7)	7 (6 to 7)	7 (6 to 7)	0.005
Daily waking wear time, mean minutes (SD)	942 (53)	934 (54)	945 (50)	951 (51)	955 (48)	958 (49)	<0.0001

[1]Missing information from 11 participants

SD, standard deviation; IQR, interquartile range

Table 2 Percentage of waking time, with 95% confidence interval (CI), spent sedentary, standing, stepping and in higher-intensity physical activity on average days, weekdays and weekend days by employment status

	Non-employed (*n* = 1200)			Low occupational category (*n* = 110)			Intermediate occupational category (*n* = 128)			High occupational category (*n* = 308)			Self-employed (*n* = 299)			P-value[1]
	Mean	95% CI		Mean	95% CI		Mean	95% CI		Mean	95% CI		Mean	95% CI		
Average day																
Sedentary	62.1	61.4	62.8	56.7	54.9	58.6	62.7	60.9	64.4	62.5	61.2	63.7	63.5	62.3	64.8	<0.0001
Standing	26.4	25.9	27.0	30.3	28.9	31.8	26.5	25.2	27.9	26.0	25.0	26.9	25.6	24.6	26.6	<0.0001
Stepping	11.5	11.2	11.8	13.0	12.2	13.8	10.8	10.1	11.6	11.6	11.0	12.1	10.9	10.3	11.4	<0.0001
HPA	1.9	1.7	2.0	2.1	1.8	2.5	1.6	1.3	1.9	2.3	2.0	2.5	2.0	1.8	2.2	0.003
Weekday																
Sedentary	61.5	60.7	62.2	55.5	53.5	57.5	62.6	60.8	64.5	62.7	61.4	64.0	64.3	62.9	65.6	<0.0001
Standing	26.8	26.2	27.4	31.1	29.5	32.6	26.6	25.1	28.0	25.8	24.8	26.9	25.2	24.2	26.3	<0.0001
Stepping	11.7	11.4	12.1	13.4	12.6	14.3	10.8	10.0	11.6	11.4	10.9	12.0	10.5	9.9	11.1	<0.0001
HPA	1.9	1.8	2.1	2.1	1.8	2.5	1.6	1.3	2.0	2.3	2.1	2.6	2.0	1.8	2.3	0.003
Weekend day																
Sedentary	63.4	62.6	64.3	60.0	57.7	62.2	62.4	60.4	64.5	61.9	60.4	63.4	61.6	60.1	63.1	0.03
Standing	25.6	25.0	26.3	28.3	26.5	30.0	26.7	25.0	28.3	26.1	25.0	27.3	26.5	25.3	27.7	0.07
Stepping	10.9	10.6	11.3	11.8	10.8	12.7	10.9	10.0	11.8	11.9	11.3	12.6	11.9	11.2	12.5	0.02
HPA	1.7	1.6	1.9	2.1	1.6	2.5	1.5	1.1	1.9	2.2	1.9	2.5	2.0	1.6	2.3	0.03

The models have been adjusted for age, sex, presence of diabetes and presence of mobility limitations.

1 P-value for overall differences between different employment status

Table 3 Percentage of waking time, with 95% confidence interval (CI), spent sedentary, standing, stepping and in higher-intensity physical activity, on average days, for the non-employed. The models have been adjusted for age, sex, presence of diabetes and presence of mobility limitations

	Retired (*n* = 704)			Homemaker (*n* = 233)			Disabled (*n* = 136)			Unemployed (*n* = 74)			Rentier (*n* = 53)			P-value[1]
	Mean	95% CI		Mean	95% CI		Mean	95% CI		Mean	95% CI		Mean	95% CI		
Sedentary	62.9	61.9	63.8	60.1	58.7	61.5	63.6	61.9	65.4	62.0	59.5	64.4	64.0	61.4	66.5	0.003
Standing	25.9	25.2	26.6	28.1	27.0	29.2	25.2	23.8	26.6	27.1	25.2	29.0	24.7	22.7	26.7	0.001
Stepping	11.2	10.8	11.6	11.8	11.2	12.5	11.1	10.4	11.9	11.0	9.9	12.0	11.3	10.2	12.5	0.43
HPA	1.8	1.7	2.0	1.9	1.6	2.1	1.6	1.3	2.0	1.8	1.3	2.2	1.8	1.3	2.3	0.83

[1] P-value for overall differences between different employment status

HPA, higher-intensity physical activity

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Figure 1. Percentage of waking time (95% CI) spent sedentary, standing, stepping and in higher-intensity physical activity, by employment status, on weekdays and weekend days.

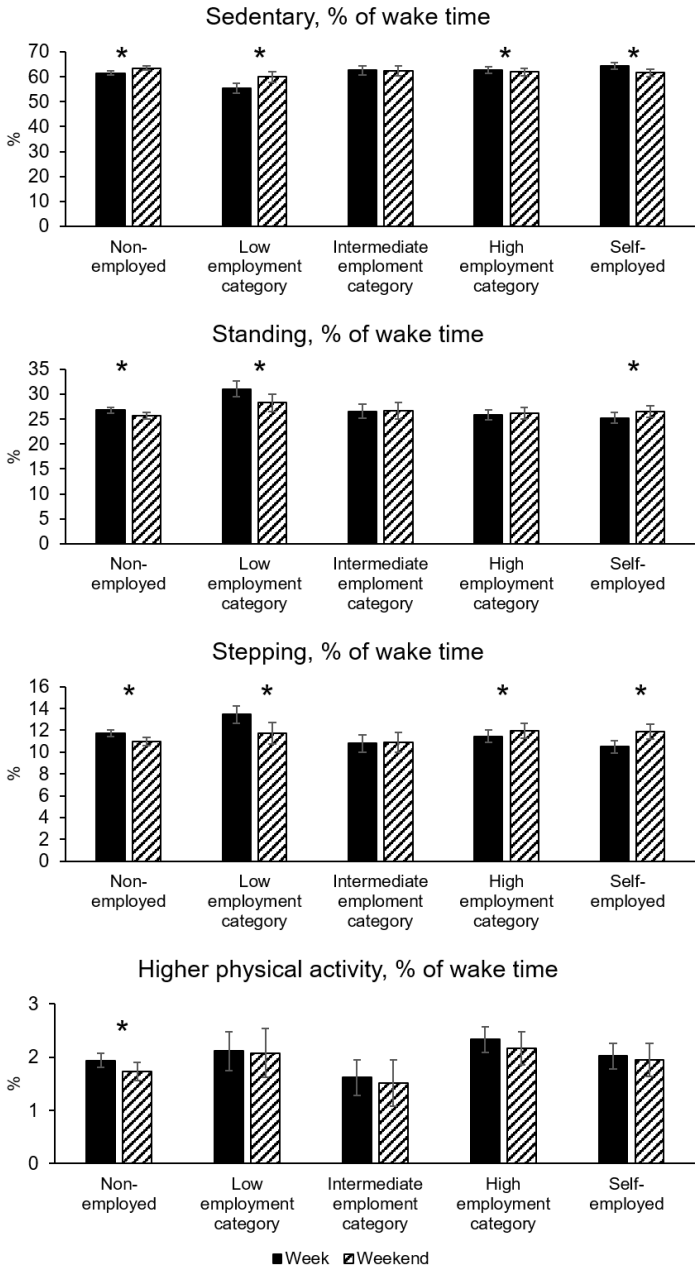

Figure 1 legend: Solid bars represent % of time on weekdays and hatched bars % of time on weekend days. Statistically significant differences between weekdays and weekend days in each subgroup are marked with *.

CI: Confidence interval.

List of supplemental Digital Content

PA in different occupations SDC Tables S1, S2 and S3.docx