



BRIEF REPORT

Exposure to prolonged sedentary behavior on weekdays rather than weekends in white-collar workers in comparison with blue-collar workers

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Abstract

Objectives: Objectively measured sedentary behavior (SB) on weekdays and weekends has been mainly assessed in white-collar workers, while data in blue-collar workers are sparse. Therefore, this study presented the difference in accelerometer-measured SB levels between weekdays and weekends, stratified by white- and blue-collar occupations.

Methods: This study was a sub-analysis of accelerometer data from 73 workers (31 blue-collar and 42 white-collar) at a Japanese manufacturing plant. SB was defined as ≤ 1.5 metabolic equivalents estimated using an accelerometer, and compared between weekdays and weekends by using mixed models adjusted for confounders. The proportion of workers who sat for ≤ 8 h/day on weekdays and weekends were compared using McNemar's test.

Results: In white-collar workers, SB time on weekdays was significantly longer than that on weekends (598 vs 479 min/day, $P < .001$). In blue-collar workers, there was no significant difference in SB time between weekdays and weekends (462 vs 485 min/day, $P = .43$). The proportion of workers who achieved the recommended SB levels (≤ 8 h) was only 4.8% for white-collar workers on weekdays and 54.8% on weekends ($P = .04$), while that of blue-collar workers was 45.2% and 58.1% respectively ($P > .99$).

Conclusions: White-collar workers were exposed to significantly longer SB time on weekdays than on weekends, which was not the case in blue-collar workers. It may be rather challenging for white-collar workers to limit their SB time to the level recommended by the latest guidelines for better health, especially on weekdays.

KEYWORDS

accelerometer, blue-collar workers, physical activity, weekdays, weekends

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1 | INTRODUCTION

A large amount of sedentary behavior (SB) is associated with an increased risk of all-cause mortality; cardiovascular disease incidence and mortality; incident diabetes; and incidence of cancers of the colon, endometrium, and lungs.¹ Recently, physical activity (PA) guidelines have been updated in the USA,² Canada,³ and in the World Health Organization database,⁴ to promote not only moderate-to-vigorous PA (MVPA) but also to reduce SB for better health outcomes. In particular, the new Canadian guidelines, released as the Canadian 24-Hour Movement Guidelines, make specific recommendations to limit SB to 8 h or less for adults.³

SB occurs in various domains, such as leisure time, transport, domestic, and occupational.⁵ Among these domains, the latitude of workers for occupational sitting seems to be restricted during their working time, whereas they are able to control their leisure-time sitting more freely. To confirm this occupational burden regarding SB on workdays, comparing SB time between weekdays and weekends is warranted. A review article summarized the differences in objectively measured SB time between weekdays and weekends⁶; however, those participants were exclusively office workers. We have reported the SB time in both white- and blue-collar workers⁷; however, only the data on weekdays (working days) were used. A recently published systematic review, that included our study, reported the accelerometer-measured SB time in blue-collar workers⁸; however, this review also exclusively included data on working days. To date, detailed information on the difference in accelerometer-measured SB time between weekdays and weekends across different occupations is rather limited.

Although this study was a sub-analysis of accelerometer-measured data among workers at a Japanese manufacturing plant,⁷ the data on weekends have not been previously analyzed. This descriptive study, therefore, aimed to evaluate and compare accelerometer-determined SB and PA levels between weekdays and weekends, stratified by white- and blue-collar occupations.

2 | METHODS

2.1 | Participants

The detailed sampling procedure has been described elsewhere.⁷ Participants who voluntarily wore a triaxial accelerometer (Active style Pro HJA-350IT; Omron Healthcare, Kyoto, Japan) throughout the week were included in this sub-analysis study. Briefly, participants were 18- to 69-year-old full-time employees at an electric machinery and apparatus manufacturing and sales plant in Nagano Prefecture, Japan. This study was conducted from

September 30 to October 6, 2014. The plant has six business departments: general affairs, accounting, sales, engineering, quality assurance, and production. Details of workers' tasks were directly inspected by the researcher through site visits, in the company of the plant manager, and classified according to the 10 major group categories of the International Standardized Classification of Occupations. Then, the workers were dichotomized into white-collar workers (managers, professionals, technicians, clerks, and sales workers) and blue-collar workers (crafts, machine operators, and assemblers). Prior to the study's initiation, the Tokyo Medical University Ethics Committee approved the study protocol, and all participants provided written informed consent.

2.2 | Measurements of PA and SB

Participants wore the accelerometer on their waists during waking hours, but not during water activities, such as bathing or swimming, or during contact sports, for safety reasons. The accelerometer estimated the intensity of PA based on metabolic equivalents (METs), for which the estimation accuracy was validated by the Douglas bag method.⁹ PA was classified into three intensity categories based on METs: sedentary (≤ 1.5 METs), light-intensity PA (LPA) (1.6–2.9 METs), and MVPA (≥ 3.0 METs); the data were collected in 60-s epochs. If no acceleration signal was obtained for ≥ 60 consecutive minutes, the period was defined as “non-wear.” The participants' records were considered valid when the device was worn for at least 10 h/day. Valid records collected over four or more working days and at least one weekend day were included in the analysis.

2.3 | Covariates and sociodemographic variables

General demographic information (age, sex, weight, height, smoking status, and educational attainment) was obtained using a self-report questionnaire. Body mass index (BMI) was calculated as weight/height^2 (kg/m^2).

2.4 | Statistical analysis

We calculated the mean of the total daily minutes of SB, LPA, and MVPA on weekdays and weekends. The proportions of SB, LPA, and MVPA times were calculated by dividing the time spent on each behavior by the accelerometer wearing time. The proportion of workers who sat for ≤ 8 h/day, based on the SB level recommended in the Canadian 24-Hour Movement Guidelines,³ was confirmed.

Comparisons between blue- and white-collar workers, or that between weekdays and weekends, were conducted using unpaired or paired *t* tests for continuous variables, and the χ^2 or McNemar test for categorical variables. The normality of the variable distribution was verified using the Shapiro-Wilk test, and the false discovery rate *P*-value adjustment by Benjamini-Hochberg method was used. First, the crude mean time spent on SB, LPA, and MVPA, and the accelerometer wearing time were descriptively compared between weekdays and weekends, stratified by blue- and white-collar workers. Analyses were then performed using linear mixed models that accounted for repeated measures and were adjusted for confounders, such as age, sex, BMI (continuous variable), educational attainment (more or less than high school), smoking status (currently smoking or not), and accelerometer wearing time (min/day). We categorized sociodemographic variables and interaction effects of sex (men and women), age (≥ 40 years), BMI status (categorized into ≥ 25 kg/m²), smoking status (current smoker or not), and educational attainment (more or less than high school) and occupational category (white-collar or blue-collar) with estimated SB, LPA, and MVPA. For all analyses, *P*-values $< .05$ were considered statistically significant. Statistical analyses were performed using IBM SPSS Statistics for Windows, version 27.0 (IBM Corp., Armonk, NY).

3 | RESULTS

3.1 | Participants

Of the original sample of 102 full-time workers,⁷ 73 workers (31 blue- and 42 white-collar workers) voluntarily wore the accelerometer throughout the week, and 29 workers (17 blue- and 12 white-collar workers) removed the accelerometer on weekends. Participants who removed the accelerometer on weekends were younger than those who wore the accelerometer throughout the week (mean [SD]: 39.8 [9.1] vs 47.1 [12.2] years, *P* = .036). Additionally, there were no significant differences in sex, BMI, educational attainment, smoking status, and occupational category (blue- or white-collar occupation) between them. In this study, 52 workers (21 blue- and 31 white-collar workers) wore the accelerometer on two weekends and 21 workers (10 blue- and 11 white-collar workers) wore the accelerometer on a weekend day. All workers wore the accelerometer for at least four working days. Most participants were male (87.7%), and the proportion of male white-collar workers (95.2%) was significantly higher than male blue-collar workers (77.4%). There were no significant differences between blue- and white-collar workers in terms of age (45.7 [12.9] vs 48.1 [11.7] years, *P* = .40), BMI (22.8 [2.4] vs 23.5 [3.2] kg/m², *P* = .32), and

smoking habits (current smokers: 13.7% vs 9.6%, *P* = .12). White-collar workers had higher educational attainment than blue-collar workers (more than high school degree: 66.7% vs 29.0%, *P* = .001).

3.2 | Comparisons of SB, LPA, and MVPA times between weekdays and weekends stratified by blue- and white-collar workers

The time spent on each activity and the proportion of participants in each category are presented in Table 1. The crude descriptive data showed that the mean duration of accelerometer wearing time on weekdays was significantly longer than that on weekends by approximately 60 min in both blue- and white-collar workers. There were no significant differences in SB and LPA times between weekdays and weekends among blue-collar workers. However, distinct significant differences were observed in SB (approximately 160 min more) and LPA time (approximately 77 min less) between weekdays and weekends among white-collar workers. Both blue- and white-collar workers spent significantly more time doing MVPA on weekends than on weekdays, and the amount of time spent doing MVPA by blue- and white-collar workers was similar on weekdays (blue- vs white-collar workers: 49.1 [18.3] vs 49.5 [22.8] min) and weekends (66.2 [39.4] vs 63.6 [37.9] min). Similar results were observed for each behavior. Additionally, time spent on SB, LPA and MVPA during the weekend were not significantly different between blue- and white-collar workers (*P* = .82, .84, and .78 respectively). After adjusting for age, gender, BMI status, current smoking habit, educational level, and accelerometer wearing time, the differences in SB and LPA time between the weekdays and weekends remained significant among white-collar workers, with a trade-off relationship (approximately 120 min equivalent exchange in SB and LPA time). No statistically significant interactions were found for gender; age; BMI status; smoking status; educational attainment and occupational category with SB, LPA, and MVPA.

3.3 | Proportion of participants who met the guidelines for SB on weekdays and weekends

Figure 1 presents the proportion of participants who met the SB recommendations of the Canadian 24-Hour Movement Guidelines for Adults aged 18-64 years (ie limiting SB to ≤ 8 h/day).³ On weekends, more than half of both blue- and white-collar workers met the guidelines regarding SB time. However, on weekdays, only 4.8% and 45.2% of white- and blue-collar workers, respectively, met the guidelines.

TABLE 1 Comparison of times/proportions of sedentary behavior and intensity-specific physical activity between weekdays and weekends, stratified by work category

Time (min/day)	Crude mean (SD) time (min/day) for each behavior			Adjusted mean (95% CI) time (min/day) for each behavior								
	Blue-collar workers (n = 31)		White-collar workers (n = 42)	Blue-collar workers (n = 31)		White-collar workers (n = 42)						
	Weekday	Weekend	P-value	Weekday	Weekend	P-value						
Wearing time	887.9 (113.6)	833.2 (113.2)	.003	904.4 (94.3)	844.3 (121.3)	.004	—	—	—			
SB	485.7 (158.6)	454.5 (163.8)	.17	623.8 (96.4)	463.3 (165.5)	<.001	462.1 (411.4, 512.8)	485.3 (429.5, 541.0)	.43	598.4 (543.5, 653.3)	479.4 (416.8, 542.1)	<.001
LPA	353.1 (91.4)	312.5 (103.5)	.08	231.2 (71.5)	317.5 (102.0)	<.001	351.2 (304.2, 398.3)	311.9 (263.5, 360.4)	.14	233.4 (184.9, 281.9)	336.1 (281.8, 390.5)	<.001
MVPA	49.1 (18.3)	66.2 (39.4)	.02	49.5 (22.8)	63.6 (37.9)	.028	44.7 (36.6, 54.6)	54.6 (44.7, 73.7)	.08	40.4 (30.0, 60.3)	49.9 (33.1, 73.7)	.22
Proportion (%)												
SB	53.8 (13.3)	54.0 (16.7)	.94	69.0 (8.0)	54.1 (15.7)	<.001	53.5 (47.7, 59.4)	56.3 (49.3, 63.3)	.44	68.3 (62.1, 74.4)	53.7 (46.4, 60.9)	<.001
LPA	40.6 (12.3)	37.8 (13.2)	.30	25.5 (7.0)	38.2 (12.7)	<.001	40.9 (35.4, 46.4)	36.1 (30.1, 42.1)	.14	26.8 (21.3, 32.2)	39.4 (33.1, 45.6)	<.001
MVPA	5.7 (2.4)	8.2 (5.5)	.008	5.5 (2.7)	7.7 (5.0)	.005	5.7 (4.4, 7.0)	7.8 (5.8, 9.8)	.044	5.2 (3.1, 7.3)	7.0 (4.7, 9.4)	.032

Values are presented as mean (standard deviation) in the crude (unadjusted) model or adjusted mean (95% confidence interval) in the adjusted model.

Variables were adjusted for age, sex, BMI, educational attainment (more than high school or less), smoking status (currently smoking or not), and accelerometer wearing time (min/day) in the adjusted model.

Abbreviations: LPA, light-intensity physical activity; MVPA, moderate-to-vigorous physical activity; SB, sedentary behavior.

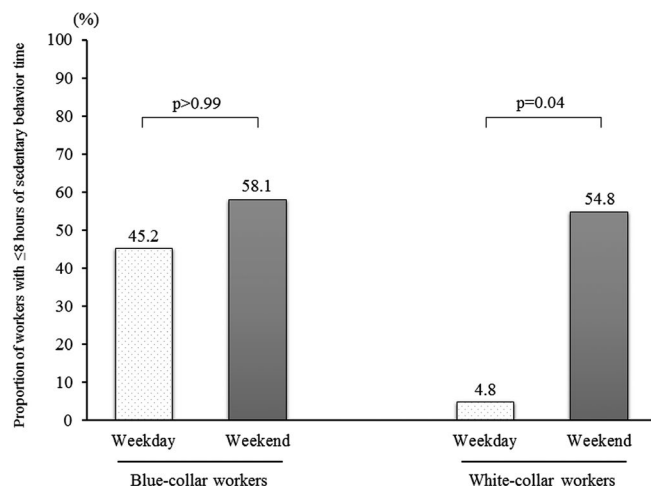


FIGURE 1 Comparisons of the proportions of meeting the guidelines for sedentary behavior (SB) in weekdays and weekends, stratified by blue-, and white-collar workers. Cut-off value for SB ≤ 8 h were based on the Canadian 24-Hour Movement Guidelines for Adults aged 18-64 years (ie limiting sedentary time to 8 h/day). SB, sedentary behavior

4 | DISCUSSION

This study showed that there was an approximately 2-h (120 min) difference in SB time between weekdays and weekends among white-collar workers, while no significant differences were observed in blue-collar workers after adjusting for covariates. In addition, there were no significant differences in the time spent on SB, LPA, and MVPA on weekends between blue- and white-collar workers, suggesting that the patterns of SB and PA on weekends, in which workers could conduct their behaviors freely, were similar regardless of the occupation category. Our findings would propose that occupational SB in white-collar workers is a measurable occupational exposure that is associated with various adverse health outcomes.

The 2-h difference in SB time between weekdays and weekends in white-collar workers is similar to the amount of SB time that the expert statement recommended to replace with standing and light activity (light walking) during working hours, for workers' health promotion.¹⁰ Interestingly, the difference in workday SB time between the occupational categories (blue- and white-collar workers) was also close to 2 h. To achieve this recommendation,¹⁰ a Cochrane review by Shrestha et al indicated that sit-stand desks reduce occupational sitting time by 100 min/day and increase occupational standing time by 89 min/day over the short term (≤ 3 months) and 53 min/day over the medium term (3-12 months).¹¹

The new Canadian guidelines are the first to clearly recommend limiting SB to ≤ 8 h/day³; however, only 4.8% of white-collar workers could meet this recommendation on weekdays, suggesting that limiting SB time to ≤ 8 h/day for

white-collar workers on weekdays would be challenging. Although a certain SB threshold could potentially be identified from the existing dose-response evidence, one should consider that most SB evidence reviewed by the Canadian guidelines was from cross-sectional studies.¹² Furthermore, longitudinal studies are required to examine the association between ≤ 8 h/day of SB and public health outcomes.

There were some limitations to this study. First, data may have been affected by selection bias because participants who initially wore the accelerometer throughout the week were significantly older than those who removed the accelerometer on weekends, and an older age is reportedly associated with increased SB.¹³ Furthermore, we did not evaluate SB time while in transport (eg while driving a car). Therefore, environmental factors, such as living in urban or rural areas, might have affected our results. In this study, participants were living in a relatively rural area (Nagano Prefecture, Japan), which has been associated with longer transport-related sitting time.¹³

5 | CONCLUSIONS

White-collar workers were exposed to significantly longer SB time on weekdays than on weekends, whereas blue-collar workers were not. Our findings suggest that reducing SB time on weekdays would play a crucial role in promoting better workers' health, especially in white-collar workers. Substantial occupational health initiatives by not only workers themselves but also by employers (possibly, employers should be more proactive in reducing occupational SB than workers) are required to reduce excessive occupational SB time on weekdays in white-collar workers.

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DISCLOSURE

Approval of the research protocol: This study was approved by the Ethics Committee of Tokyo Medical University, Tokyo, Japan (No: SH2790). *Informed consent:* Informed consent was obtained from all the participants. *Registry and the Registration No. of the study/trial:* N/A. *Animal studies:* N/A. *Conflict of interest:* The authors declare no conflict of interests for this article.

AUTHOR CONTRIBUTIONS

NF and SI conceived the ideas; NF and MK collected the data; SA and MM performed the data cleaning; NF and HK analyzed the data; NF wrote the first draft of the manuscript;

and all the authors revised the manuscript and approved the final version.

DATA AVAILABILITY STATEMENT

The data are not publicly available due to privacy or ethical restrictions.

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