Cureus
Part of SPRINGER NATURE

Open Access Original Article

Relationship Between Sedentary Behavior and Mode of Commuting Among Physical Therapy Students in Okayama Prefecture, Japan

Review began 10/06/2026
Review ended 10/20/2026
Published 10/27/2026

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DOI: 10.7759/cureus.118697

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Abstract

Introduction

The duration of sedentary behavior is closely linked to various health outcomes. The sedentary behavior of physical therapy students is suspected to increase due to their classes and other commitments. Commuting to university is considered to have a significant impact on sedentary behavior in daily life. Therefore, the present study investigated the relationship between sedentary behavior and mode of commuting among physical therapy students in Okayama Prefecture, Japan.

Methods

A total of 103 physical therapy students were enrolled in this cross-sectional study. Sedentary behavior, such as mean sedentary behavior (minutes/day), was evaluated by a tri-accelerometer. Mode of commuting was classified as walking, cycling, and rail travel. We also used a self-administered questionnaire to survey students' sex, age, one-way commute time, participation in sports clubs, and exercise habits.

Results

Mean sedentary behavior was significantly shorter in students who cycled (512.3 ± 96.4 minutes) than in those who walked (600.1 ± 99.9 minutes, $p = 0.038$). Cycling was negatively associated with mean daily sedentary behavior in adjusted analyses, although the overall regression models were not statistically significant.

Conclusion

Among physical therapy students, those who commuted by cycling had shorter mean daily sedentary behavior than those who walked. However, the small number of walking commuters and the limited explanatory power of the regression models warrant cautious interpretation.

Categories: Public Health, Preventive Medicine, Epidemiology/Public Health
Keywords: commuting, cycling, physical therapy students, sedentary behavior, walking

Introduction

Sedentary behavior, which is defined as energy expenditure <1.5 metabolic equivalents (METs) while in a sitting or reclining posture [1], is recognized as an important public health issue because it is associated with various adverse health outcomes, including cardiovascular disease, metabolic disorders, depression, and mortality [2-5]. In the Physical Activity Guide for Health Promotion 2023 founded by the Ministry of Health, Labor and Welfare, Japan, the guidelines recommend to "be mindful to avoid prolonged sitting (even for those with difficulty standing, make efforts to move the body as much as possible and to avoid long inactivity periods)" [6]. We previously performed a cross-sectional study on the relationship between the duration of sedentary behavior and quality of life in patients on chronic hemodialysis [7-9]. We also showed that sedentary behavior was closely related to all-cause mortality in patients on chronic hemodialysis in a longitudinal study [10-12].

University students are a population at risk of prolonged sedentary behavior because they spend large amounts of time attending lectures, studying, and using electronic devices in seated positions [13]. Among them, physical therapy students may be particularly vulnerable to sedentary lifestyles because of their intensive academic schedules and limited opportunities for habitual physical activity. Since these students are future healthcare professionals who will play an important role in promoting healthy lifestyles, a more

detailed understanding of the factors associated with the duration of sedentary behavior in this population is important.

Commuting to university may represent a practical opportunity to reduce sedentary time through incidental physical activity, such as walking and cycling. Previous studies examined the relationship between commuting and physical activity or sedentary behavior [14-20]. However, limited information is currently available on this relationship in physical therapy students in Japan. Furthermore, few studies have objectively assessed sedentary behavior in this population using accelerometers.

Therefore, the present cross-sectional observational study investigated the association between mean daily sedentary behavior (minutes/day), objectively measured using a triaxial accelerometer, and mode of commuting (walking, cycling, or rail travel) among physical therapy students in Okayama Prefecture, Japan.

Materials And Methods

Subjects

This cross-sectional observational study was conducted among physical therapy students at Okayama Healthcare Professional University, from October 2, 2025, to December 21, 2025.

All eligible physical therapy students at the study institution were invited to participate in the study.

The inclusion criteria were physical therapy students who provided written informed consent, completed the self-administered questionnaire, and underwent measurement of sedentary behavior using a triaxial accelerometer. Students who did not provide informed consent or did not meet the accelerometer wear-time criteria (at least 10 hours/day for seven days, including two days off) were excluded from the analysis. Of the 181 eligible students, 103 met these criteria and were included in the final analysis (Figure *1*).

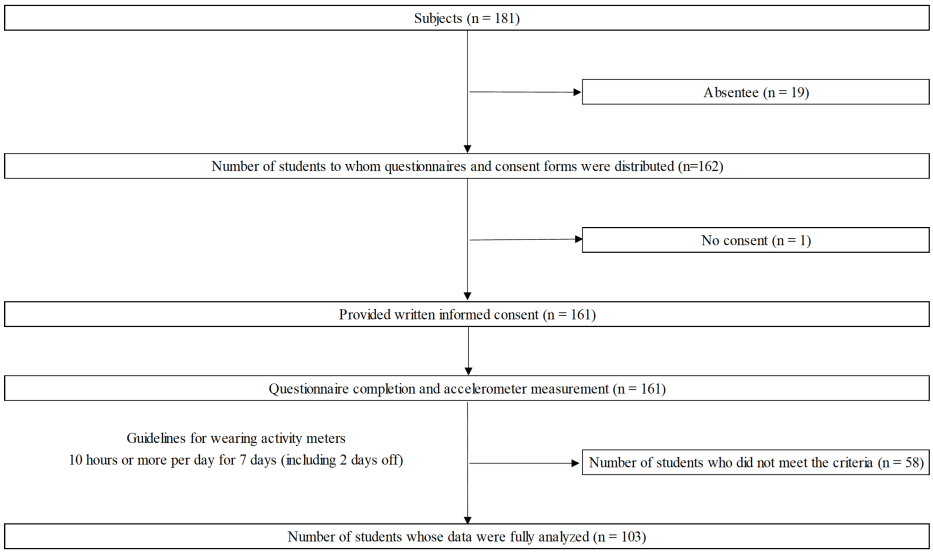


FIGURE 1: Flow diagram of the study population

No a priori sample size calculation was performed because all eligible physical therapy students at the study institution were invited to participate. The final sample size was determined by the number of students who provided informed consent and met the eligibility criteria, including the accelerometer wear-time criteria.

Ethics

Ethical approval was obtained from the Ethical Committee of Okayama Healthcare Professional University, Okayama, Japan (approval number: 0111, approval date: September 3, 2025).

Sedentary behavior

Sedentary behavior was measured using the tri-accelerometer Active Style Pro HJA-750C ® (Omron, Kyoto, Japan), the accuracy and reliability of which have been demonstrated [21, 22]. Sedentary behavior was defined as time spent at an activity intensity of less than 1.5 METs during valid accelerometer wear time. As shown in our previous studies [7, 11, 12], subjects were asked to continuously wear the device, except when

they were sleeping or bathing, for two weeks. The non-wearing time was defined as a 0 physical activity level (METs) that continued for more than 60 minutes, while the wearing time was defined as 24 hours (1440 minutes) minus the non-wearing time. Accelerometer-derived METs data were exported and processed using spreadsheet software. Sedentary behavior was calculated as the accumulated time spent at an activity intensity of less than 1.5 METs during valid wear time. Sleep and non-wear periods were excluded from the calculation. We used data from seven days, including two days off, on which they wore the tri-accelerometer for at least 10 hours a day. Mean sedentary behavior (minutes/day) was calculated by averaging the recorded sedentary behavior over seven valid days. Sedentary behavior was not adjusted for individual differences in accelerometer wear time.

Questionnaire

We evaluated clinical parameters using a self-reported questionnaire through Google Forms (Google, Mountain View, California) [23]. The main mode of commuting was self-reported using six response options: walking, cycling, bus, rail travel, car, and other. Among the 103 students included in the final analysis, the reported commuting modes were walking, cycling, and rail travel. Students' sex (male/female), age (years), one-way commute time (minutes), current participation in sports clubs (yes/no), and exercise habits (30 minutes per session, twice a week, for at least one year; yes/no) were analyzed. There were no missing questionnaire data for the variables included in the analysis among the 103 students.

Statistical analysis

Data were expressed as the mean ± standard deviation for continuous variables and as the number of subjects (%) for categorical variables. Differences in mean sedentary behavior among the three commuting modes (walking, cycling, and rail travel) were assessed using one-way analysis of variance (ANOVA), followed by the Tukey-Kramer method for multiple comparisons. Multiple regression analysis was performed to examine the association between mode of commuting and mean sedentary behavior. Walking was used as the reference category for mode of commuting in the multiple regression models. Sex, age, one-way commute time, current participation in sports clubs, and exercise habits were included as potential confounding factors. These variables were included as potential confounders based on their possible relevance to sedentary behavior. Multicollinearity among explanatory variables was assessed using variance inflation factors (VIFs). Statistical significance was set at $p < 0.05$. All statistical analyses were performed using JMP Pro 18 (SAS Institute Inc., Cary, NC, USA). The normality of residuals was assessed using normal quantile plots, and homoscedasticity was assessed by examining plots of residuals against predicted values. Influential observations were assessed using Cook's distance. Sensitivity analyses were performed by refitting each regression model after excluding the observation with the highest Cook's distance.

Results

The clinical characteristics of the 103 enrolled students are summarized in Table *1*. The study population consisted of 52 males (50.5%) and 51 females (49.5%). The main mode of commuting was walking in nine students (8.8%), cycling in 47 students (45.6%), and rail travel in 47 students (45.6%). Mean sedentary behavior was 535.9 ± 99.4 minutes/day for total days, 565.3 ± 101.1 minutes/day on weekdays, and 462.4 ± 149.8 minutes/day on holidays (Table *1*).

Variable	Value	Minimum	Maximum
Number of subjects	103	-	-
Age (years)	20.4 ± 1.3	18.0	23.0
Sex (male, %)	52 (50.5)	-	-
One-way commute time (min)	41.9 ± 32.4	3.0	150.0
Current participation in sports clubs (yes, %)	83 (80.6)	-	-
Exercise habits (yes, %)	22 (21.4)	-	-
Mode of commuting			
Walking (n, %)	9 (8.8)	-	-
Cycling (n, %)	47 (45.6)	-	-
Rail travel (n, %)	47 (45.6)	-	-
Mean sedentary behavior for total days (min/day)	535.9 ± 99.4	352.4	788.0
Mean sedentary behavior on weekdays (min/day)	565.3 ± 101.1	356.6	798.6
Mean sedentary behavior on holidays (min/day)	462.4 ± 149.8	112.5	879.5

TABLE 1: Clinical profiles of enrolled subjects

Mean ± standard deviation

We then compared mean sedentary behavior stratified by mode of commuting (Table 2). Mean sedentary behavior was significantly shorter for cycling (512.3 ± 96.4 minutes/day) than for walking (600.1 ± 99.9 minutes/day) for total days, for cycling than for rail travel on weekdays, and for cycling and rail travel than for walking on holidays.

Sedentary behavior	Walking	Cycling	Rail travel	F-value	Overall p-value	Significant post-hoc comparisons	p-value
Mean sedentary behavior for total days (min/day)	600.1 ± 99.9	512.3 ± 96.4	547.2 ± 96.9	3.686	0.029	Walking vs. cycling	0.038
Mean sedentary behavior on weekdays (min/day)	602.6 ± 99.4	537.4 ± 104.0	586.0 ± 92.8	3.560	0.032	Rail travel vs. cycling	0.049
Mean sedentary behavior on holidays (min/day)	593.9 ± 126.6	449.6 ± 135.6	450.1 ± 157.8	4.022	0.021	Walking vs. cycling	0.021
						Walking vs. rail travel	0.021

TABLE 2: Comparison of mean sedentary behavior stratified by mode of commuting

We then examined the effects of mode of commuting on sedentary behavior using a multiple regression analysis (Tables 3-5). Cycling was negatively associated with mean sedentary behavior for total days (β = -0.47, p = 0.011) and holidays (β = -0.52, p = 0.005) after adjustment for potential confounding factors. However, the explanatory power of the models was modest (R2 = 0.11), and overall model significance did not reach the conventional level of significance (Table 3, Table 5). For weekdays, the association between cycling and mean sedentary behavior did not reach statistical significance after adjustment for potential confounding factors (p = 0.065) (Table 4).

Variable	Estimated value	Standardized β	t-value	95%CI	VIF	p-value
Intercept	488.23	0.00	3.03	167.99, 808.47	-	0.003
Sex (female)	20.87	0.11	0.91	-24.56, 66.31	1.42	0.364
Age	6.94	0.09	0.89	-8.50, 22.37	1.17	0.374
One-way commute time (min)	-0.46	-0.15	-0.91	-1.46, 0.54	2.86	0.365
Current participation in sports clubs (reference: no)	-26.25	-0.10	-1.05	-75.80, 23.30	1.06	0.296
Exercise habits (reference: no)	-25.43	-0.11	-0.99	-76.63, 25.77	1.22	0.327
Cycling	-92.94	-0.47	-2.61	-163.75, -22.14	3.43	0.011
Rail travel	-36.03	-0.18	-0.84	-120.87, 48.80	4.93	0.401

TABLE 3: Factors associated with mean sedentary behavior (total days)

Walking was used as the reference category for commuting mode. R^2 = 0.11; adjusted R^2 = 0.04; F-value = 1.641; overall p-value = 0.133

CI - confidence interval; VIF - variance inflation factor

Variable	Estimated value	Standardized β	t-value	95%CI	VIF	p-value
Intercept	476.70	0.00	2.90	150.19, 803.20	-	0.005
Sex (female)	7.94	0.04	0.34	-38.38, 54.27	1.42	0.734
Age	7.88	0.10	0.99	-7.85, 23.62	1.17	0.323
One-way commute time (min)	-0.40	-0.13	-0.78	-1.42, 0.62	2.86	0.440
Current participation in sports clubs (reference: no)	-30.37	-0.12	-1.19	-80.89, 20.15	1.06	0.236
Exercise habits (reference: no)	-21.10	-0.09	-0.80	-73.31, 31.10	1.22	0.424
Cycling	-67.94	-0.34	-1.87	-140.13, 4.25	3.43	0.065
Rail travel	0.27	0.00	0.01	-86.22, 86.77	4.93	0.995

TABLE 4: Factors associated with mean sedentary behavior (weekdays)

Walking was used as the reference category for commuting mode. R^2 = 0.10; adjusted R^2 = 0.04; F-value = 1.551; overall p-value = 0.160

CI - confidence interval; VIF - variance inflation factor

Variable	Estimated value	Standardized β	t-value	95%CI	VIF	p-value
Intercept	517.20	0.00	2.13	34.94, 999.47	-	0.036
Sex (female)	53.20	0.18	1.54	-15.23, 121.62	1.42	0.126
Age	4.57	0.04	0.39	-18.68, 27.81	1.17	0.697
One-way commute time (min)	-0.61	-0.13	-0.81	-2.12, 0.90	2.86	0.423
Current participation in sports clubs (reference: no)	-15.91	-0.04	-0.42	-90.53, 58.71	1.06	0.673
Exercise habits (reference: no)	-36.26	-0.10	-0.93	-113.37, 40.84	1.22	0.353
Cycling	-155.45	-0.52	-2.89	-262.08, -48.82	3.43	0.005
Rail travel	-126.81	-0.42	-1.97	-254.57, 0.95	4.93	0.052

TABLE 5: Factors associated with mean sedentary behavior (holidays)

Walking was used as the reference category for commuting mode. R^2 = 0.11; adjusted R^2 = 0.04; F-value = 1.660; overall p-value = 0.128

CI - confidence interval; VIF - variance inflation factor

In sensitivity analyses excluding the observation with the highest Cook's distance from each regression model, the negative association between cycling and sedentary behavior remained statistically significant for total days (B = -114.72, p = 0.003) and holidays (B = -156.40, p = 0.003). For weekdays, the cycling coefficient changed from B = -67.94 (p = 0.065) to B = -90.26 (p = 0.019). For holidays, the rail travel coefficient changed from B = -126.81 (p = 0.052) to B = -148.22 (p = 0.018).

Discussion

We investigated the relationship between mean sedentary behavior and mode of commuting and found that sedentary behavior was significantly lower for cycling than for walking. This relationship was maintained after adjustments for confounding factors, suggesting an association between mode of commuting and mean sedentary behavior among physical therapy students.

Previous studies examined the relationship between sedentary behavior and mode of commuting [14-20]. Bista et al. reported that using walking, cycling, and other public transportation reduces sedentary behavior and increases physical activity compared with automobiles [17]. In addition, the shift to working from home during the COVID-19 pandemic increased sedentary behavior [19, 20]. Koyama et al. demonstrated that the risk of an increase in sedentary behavior of ⩾2 hours was 2.14-fold higher in workers who began working from home than in those who did not [19]. Fukushima et al. also showed that sedentary behavior was longer in workers who started working from home (⩾100 minutes) than in those who continued on-site work. The risk of prolonged sedentary behavior in workers was associated with their frequency of working from home [20].

Although both walking and cycling are generally considered active modes of commuting, students who cycled had shorter mean daily sedentary behavior than those who walked. However, the present study assessed total daily sedentary behavior rather than sedentary behavior during commuting alone. Therefore, the observed difference may reflect various factors related to daily activities and lifestyles beyond commuting. Because these factors were not fully assessed, the underlying reasons for the difference remain unclear. Furthermore, the small number of students in the walking group and the low explanatory power of the regression models warrant cautious interpretation. These findings should not be interpreted as evidence that cycling is superior to walking or that changing commuting modes would necessarily reduce sedentary behavior.

There are some limitations that need to be addressed. This was a cross-sectional, not longitudinal, study. Furthermore, students who participated in this study may have been more health-conscious than those who did not participate, although health consciousness was not directly assessed. In addition, the present study was performed at one healthcare university and the sample size, particularly the number of students who walked, was very small; therefore, the results obtained cannot be applied to all students in Japan and statistical stability may have been reduced. Sensitivity analyses excluding the observation with the highest Cook's distance showed changes in some regression coefficients and their statistical significance, suggesting that the findings should be interpreted with caution. Additionally, selection bias cannot be ruled out because only 103 of the 181 eligible students were included in the final analysis. Another limitation is that the factors contributing to the relationship between the duration of sedentary behavior and mode of commuting were

not clarified in this study. Moreover, the explanatory power of the multivariable regression models was low, and the overall models were not significant. Therefore, unmeasured factors may have strongly contributed to sedentary behavior. Future studies need to incorporate additional variables, including non-commuting physical activity, screen time, the residential environment, and academic demands. Nevertheless, the present findings suggest a possible association between mode of commuting and mean sedentary behavior in physical therapy students, although these results should be interpreted with caution. Further studies, such as longitudinal and large multi-facility studies, are urgently required in the future. Furthermore, sedentary behavior was not adjusted for individual differences in accelerometer wear time, which may have influenced the observed differences between commuting groups.

Conclusions

In this cross-sectional study of physical therapy students, those who commuted by cycling had shorter mean daily sedentary behavior than those who walked. Although this association was observed in adjusted analyses, the small walking group, low explanatory power, and nonsignificant overall regression models limit the strength of the findings. Further studies with larger samples and more comprehensive assessments of daily activities are needed to clarify the relationship between commuting mode and sedentary behavior.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Nobuhiro Nasu, Akihiro Yokoyama, Hiromi Suzuki, Hiroaki Kataoka, Masaki Bando, Yuji Watanabe, Nobuyuki Miyatake

Acquisition, analysis, or interpretation of data: Nobuhiro Nasu, Akihiro Yokoyama, Hiromi Suzuki, Hiroaki Kataoka, Masaki Bando, Yuji Watanabe, Nobuyuki Miyatake

Drafting of the manuscript: Nobuhiro Nasu

Critical review of the manuscript for important intellectual content: Nobuhiro Nasu, Akihiro Yokoyama, Hiromi Suzuki, Hiroaki Kataoka, Masaki Bando, Yuji Watanabe, Nobuyuki Miyatake

Supervision: Nobuyuki Miyatake

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Ethics Committee of Okayama Healthcare Professional University issued approval 0111. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** This research was supported in part by research grants from the Ministry of Education, Culture, Sports, Science and Technology, Japan (JSPS KAKENHI grant no. JP 24K13508). **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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