

# Seasonal Differences in Time Spent Indoors and Physical Activity in Female Japanese Students

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## Introduction

Recently, people tend to spend most of their time indoors. Shiozu et al. (1998) investigated time spent indoors and physical activity in about 2000 Japanese adults using a questionnaire survey, and found the percentage of daily time spent indoors was 90% on weekdays and 88% on weekends. Dörre (1997) also reported that German students spent about 93% of their time indoors. On the other hand, Belanger et al (2009) reported that physical activity in adolescents was lower during winter and increased during warmer months. Although the variations of physical activity among seasons might affect the daily time spent indoors/outdoors, little research has examined seasonal differences in daily time spent indoors. The purpose of this study was to clarify the seasonal differences in time spent indoors and physical activities in young Japanese females.

## Methods

### **Subjects:**

Twenty-seven female students, mean (SD) age 21.6 (0.7), range 20 to 23 years, participated in the study. They lived in Fukuoka city. The survey was carried out for 5 days (3 weekdays and 2 weekends) in summer (July to August), autumn (October to November) and winter (December to January).

### **Data collection:**

A diary was used to assess time and activity patterns of subjects. The diary logs consisted of 7 rows representing physical activities (1: sleep, 2: meal, 3: commute, 4: study, 5: work (part-time job), 6: sports, 7: others) and 24 columns representing the hour of day. For time spent indoors, there were also 2 rows representing location (1: indoors including

in trains/automobiles, 2: outdoors) on the diary sheet.

Physical activity was measured every minute by an accelerometer (Actiwatch, Mini Mitter) worn on a nondominant hand. The subjects wore the Actiwatch all day, except while taking a bath or sleeping. Physical activities were recorded as counts per minute. The air temperature surrounding subjects was also recorded every 5 minutes using a small data logger (3650, HIOKI).

### **Data analyses:**

A three-way analysis of variance (ANOVA) was performed to assess the influence of season, type of day (weekday or weekend) and time spent indoors and physical activity. The relationship between time spent indoors and physical activity were analyzed by Pearson's correlation coefficient test. The level of statistical significance was set at  $P < 0.05$ .

## Results

Figure 1 shows the ambient temperatures surrounding the subjects in the three seasons. Surrounding ambient temperatures were significantly different among seasons ( $P < 0.001$ ). The interaction between season and type of day was also statistically significant ( $P < 0.05$ ). In the winter season, surrounding ambient temperatures on weekdays were significantly high than those on weekends ( $P < 0.05$ ).

Figure 2 shows the time spent indoors in the three seasons. The mean (SD) time spent indoors on weekdays was 1373(39), 1384(35) and 1389(24) minutes in summer, autumn and winter, respectively. On the other hand, mean (SD) time spent indoors on weekends was 1349(76), 1376(67) and 1385(40) minutes in each season, respectively, which was slightly shorter than on weekdays. In all cases, the subjects spent about 95% of their time indoors. On

weekends, the length of time spent indoors in the summer was significantly longer than in the winter ( $P < 0.05$ ).

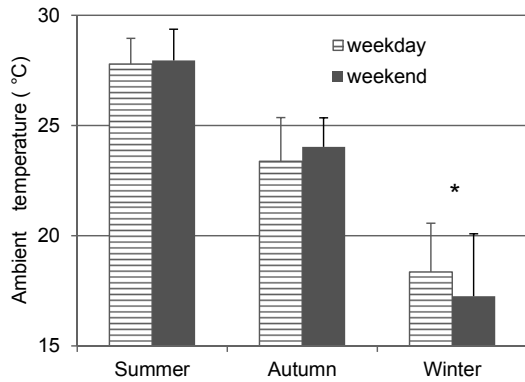


Figure 1. Ambient temperature surrounding subjects in summer, autumn and winter on weekdays and weekends. Values are means and SD. \*indicates a significant difference between weekdays and weekends in winter. \* $P < 0.05$

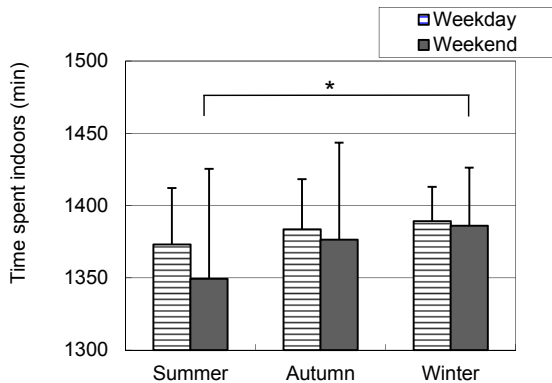


Figure 2. Time spent indoors in each season. Values are means of subjects (SD). \*indicates a significant difference between summer and winter on weekends. \* $P < 0.05$

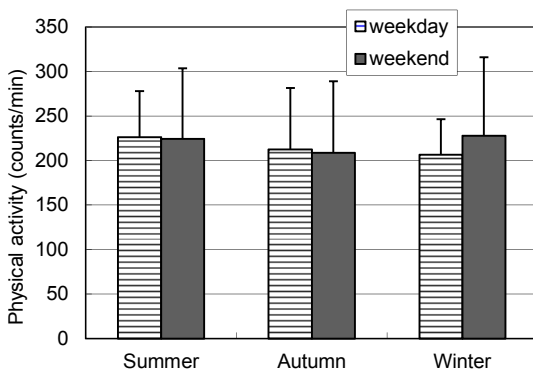


Figure 3. Mean physical activity in the three seasons on weekdays and weekends. Values are means of subjects (SD).

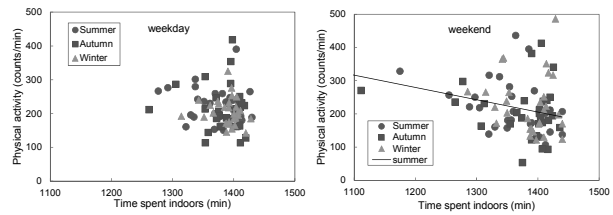


Figure 4. Relationship between time spent indoors and physical activity on weekdays (left) and weekends (right).

Figure 3 shows the physical activity in the three seasons. Physical activity was recorded as 0 to 1500 counts per minute, and was averaged for 24 hours, except during sleep. There were no significant differences among the seasons or between weekdays and weekends.

The relationship between time spent indoors and physical activity is shown in Figure 4. A significant relationship ( $R = -0.358$ ,  $P < 0.05$ ) was only found in the summer on weekends.

## Discussion

In Japan, nationwide time use surveys are executed by the Japanese government and NKH every 5 years (Ministry of Internal Affairs and Communications 2006; NHK 2010). Although the length of time spent in activities such as work, leisure, etc. are recorded in these surveys, there is no information on the location where activities occurred. Moreover, these surveys are carried out in October, and the seasonal differences in activities are not evaluated.

In this study, the mean time spent indoors on weekdays was 1373, 1384 and 1389 minutes in the summer, autumn and winter, respectively. On weekends, these times decreased to 1349, 1376 and 1385 minutes, which was shorter compared to weekdays and equivalent to about 95% of a day (Figure 2). Shiozu et al. (1998) found the percentage of daily time spent indoors was 90% on weekdays and 88% on weekends. They also reported that Japanese students spent around 95% and 94% of their time indoors on weekdays and weekends, respectively. Dörre (1997) reported that German students spent about 93% of their time indoors. Wu et al. (2010) surveyed the time-location pattern of residents in Camden, USA, and showed that employment status played a fundamental role in determining time-location patterns. The university students might spend more time indoors compared with other groups of people (children, adult working full time, elderly, etc.).

The length of time spent indoors in the summer was shortest among the seasons, and a significant difference was observed between summer and winter on weekends (Fig. 2). Quackenboss et al. (1986) reported that time spent outdoors accounted for 3.3 hours (1242 minutes indoors) per day in summer and 0.8 hours (1392 minutes indoors) per day in winter in American adults in Wisconsin, USA. Echols et al. (1999) reported that time spent outdoors was 2.2 hours (1308 minutes indoors) in the summer and 1 hour (1380 minutes indoor) in the winter in Maryland. American adults also spent longer time indoors in winter than in summer. Although the time spent indoors in winter in this study was similar to those in American adults, Japanese female students tend to spend time indoors in the summer in comparison with Americans. These differences may be partially attributed to different geographic locations and/or weather conditions of each study group. Fukuoka city is located in the south and has a hotter summer season compared with the cities in Wisconsin and Maryland. The mean ambient temperature surrounding subjects in summer was about 28°C and exceeded 30°C in the daytime (Fig. 1). The hot thermal conditions might lead to shorter time spent outdoors.

There were no significant differences in physical activity among the seasons (Fig 3). Belanger et al. (2009) followed 1293 students, initially aged 12 to 13 years over 5 years, who completed a 7-day physical activity recall checklist every 3 months. They reported that the average number of physical activity sessions per day was 1% to 2% higher for every 10°C increase in temperature, and physical activity was lower during winter and increased during warmer months. Carson et al (2010) surveyed seasonal variation in physical activity among preschool children in a northern Canadian city, and found that children were significantly more likely to be physically active in the summer, spring and fall, relative to winter. Cooper et al (2010) studied time spent outdoors and physical activity in English children after school using GPS receivers and accelerometers. They determined that outdoor physical activity was higher in the summer than the winter, while there was no seasonal variation in indoor physical activity. Similar physical activities in the summer, autumn and winter in this study were attributed to the length of time spent indoors in the three seasons, 95% per day, which caused low physical activity levels.

A significant relationship between time spent indoors and physical activity was only found in the summer on weekends (Fig. 4). The time spent indoors was relatively small on

weekdays compared with on weekends. The standard deviation in time spent indoors on weekday was 76 minutes in summer, 67 minutes in autumn and 32 minutes in winter, respectively. On the other hand, those on weekdays were 39 minutes in summer, 35 minutes in autumn and 24 minutes in winter, respectively (Fig. 2). The large individual variation in time spent indoors in the summer season on weekends may lead to a significant relationship between time spent indoors and physical activity.

## Summery

Seasonal differences in physical activity and length of time spent indoors were studied in 29 female students in the summer, autumn and winter. The subjects were asked to fill in activities and locations on a chart for this 24-hour time-study. The activities and locations were classified into 7 activities (sleep, meal, commute, study, work, sports, others) and 2 locations (outdoor, indoor). Their physical activity was measured using an accelerometer on a non-dominant hand. The survey was conducted for 5 days (3 weekdays and 2 non-business days) in each season.

The mean (SD) time spent indoors on weekdays was 1373(39), 1384(35) and 1389(24) minutes in summer, autumn and winter, respectively. On the other hand, mean (SD) time spent indoors on weekends was 1349(76), 1376(67) and 1385(40) minutes in each season, respectively, which was slightly shorter than for weekdays. In all cases, the subjects spent about 95% of their time indoors. On weekends, the length of time spent indoors in summer was significantly longer than that in winter ( $P < 0.05$ ). There were no significant differences in the physical activities per day among the seasons. On weekends in summer, there was a significant relationship between the length of time spent indoors and physical activities per day. The subjects who spent less time indoors had a tendency to do more physical activities in the summer.

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