Abstract  To investigate the level of walking activity among residents of the Tohoku district in northern Japan, where no widespread public transport system has been developed, winter is severe. The participants were 50 town hall employees with an average age of 43.6 ± 10.8 (SD) years. The walking activity of each participant was assessed using a pedometer for one week in summer and one week in winter. The participants’ lifestyles, including their commuting methods, were assessed using a questionnaire. Forty-six participants (92%) usually commute to work by private car. The average numbers of steps/day on workdays and holidays were, in summer, 6,560 ± 2,600 and 7,016 ± 4,679, respectively, and, in winter, 5,236 ± 2,253 and 4,770 ± 3,039; these numbers were somewhat lower than those recorded in previous reports. We observed a significant reduction in walking during winter (F = 19.016, p < 0.0001), but no significant differences between workdays and holidays (F = 0.001, p = 0.966). A significant correlation between BMI and steps/day (r = -0.420, p < 0.01) was obtained on workdays in winter. We observed a significant reduction in walking during winter (F = 19.016, p < 0.0001), but no significant differences between workdays and holidays (F = 0.001, p = 0.966). A significant correlation between BMI and steps/day (r = -0.420, p < 0.01) was obtained on workdays in winter. The unexpectedly low level of these participants’ physical activity, especially in winter, is probably due to the fact that most of them commute by private car, which is likely a cause of the high incidence of obesity in this district. In addition, a seasonal effect should also be considered when physical activity is assessed, especially in cold climates. J Physiol Anthropol 29(1): 43–46, 2010 http://www.jstage.jst.go.jp/browse/jpa2 [DOI: 10.2114/jpa2.29.43]

Keywords: pedometer, seasonal change, Tohoku district

Introduction

It is well known that there are significant geographic gradients in the incidence of obesity (World Health Organization, 2000). Many factors are implicated in these differences, including genetics, diet, climate, social class, and physical activity levels. Low physical activity in particular is widely recognized as a cause of lifestyle-related diseases such as obesity. A number of studies have reported that reduced walking activity is frequently observed among overweight and/or obese people of all ages, from children to adults (Tudor-Locke et al., 2001; Hornbuckle et al., 2005; Clemes et al., 2007; Al-Hazzaa, 2007; Mitsui et al., 2008).

According to Shokoku Hakusho, a white paper on food and nutritional education (Cabinet Office, Government of Japan., 2008), rural areas of Japan generally have a higher incidence of obesity. For example, the incidence obesity with BMI ≥ 25 kg/m² among male residents of Tokyo and Osaka are 27.3% and 24.2%, respectively. On the other hand, provincial prefectures such as Iwate and Tokushima have 41.2% and 36.3%. Lifestyle will cause this discrepancy because of relatively small genetic diversity among the Japanese population.

Given that the same government report also indicates that the residents of metropolitan areas such as Tokyo and Osaka take more steps/day (>8,000) than do the residents of provincial areas (6,000–6,500), we hypothesized that the higher incidence of obesity in the Tohoku district may be related to a reduced average level of physical activity among its residents. It seems likely that the lack of a developed public transportation system in the Tohoku district reduces the likelihood of walking to work; in addition, outdoor activity is largely restricted during winter because of the low temperatures and heavy snowfall in the district. Although the climate of any given district in Japan varies depending on the time of the year, the white paper and the nutritional survey give no information on seasonal effect. As a result, variation in walking activity by season is not known. Therefore, the main purpose of this study was to evaluate levels of walking activity on type of day (i.e., workday and holiday) and the effect of seasonal changes among residents in a northern rural town in Tohoku.
Methods

The study was conducted in Hashikami Town, Aomori Prefecture, in June 2008 and February 2009. This town is located on the border with Iwate Prefecture and faces the Pacific Ocean. According to the town’s website (http://www.town.hashikami.aomori.jp/) and report, the population is 14,794 (as of March 3, 2009). Over the last decade, the average temperature in August has been 22.1°C, and the average temperature in February has been −0.7°C. The incidence of obesity among adult males is 35.2%, which is rather higher than the nation’s average, 27.3% (Ministry of Health, Labour and Welfare, 2006).

Our participants were 51 men, all of whom are regular employees of the town hall. These 51 participants constituted 91.1% of the 56 town hall employees. As one participant eventually lost interest in this study and dropped out, data from 50 participants were used in our statistical analysis. All were ambulatory and free from serious diseases. All participants were asked to record the number of steps they took each day using a pedometer (Yamasa EM-180, Yamasa, Tokyo, Japan), from rising in the morning to retiring in the evening, for one week at a time, except during water-oriented activities and intense exercise. After the first week of measurement, which occurred in the summer, all the pedometers were collected. Heights and body weights were measured with participants wearing light clothes. Body mass index (BMI) was calculated by dividing weight in kilograms by height in meters squared. In addition, life habits such as smoking, drinking, exercise, and commuting method were assessed using a questionnaire. During the study period, we asked the participants not to change these aspects of their lifestyles insofar as was possible. This study was approved by the ethics committee of Hashikami Town and written informed consent was obtained from all participants.

All data are expressed as the mean±SD. Anthropometrics recorded in summer and winter were compared with a paired t-test. The numbers of daily steps recorded were compared using 2 (workday and holiday)×2 (summer and winter) repeated measures ANOVA. Correlation coefficients between BMI and type of day in each season were calculated. KaleidaGraph Version 3.6 (HULINKS Inc., Tokyo, Japan) was used for the t-test and regression analysis, and ANOVA4 (Kiriki, 2002) was used for two-way repeated measures ANOVA. p<0.05 was considered to be statistically significant.

Results

The average age of participants was 43.6±10.8 years, and the average height was 170.0±5.3 cm. The body weights and BMIs were 69.4±9.9 kg and 24.0±3.4 kg/m² in summer, and 69.4±11.6 kg and 24.0±3.9 kg/m² in winter. There were no significant differences in anthropometrics between seasons. No participants had BMI<18.5 kg/m², and there were 18 obese participants (36%) with BMI≥25.0 kg/m² in summer and 17 (34%) in winter, respectively. The number of participants who smoked was 24 (48%), who drank alcohol more than twice a week was 23 (46%), and those who engaged in regular exercise was 9 (18%). Forty-six (92%) usually commuted by private car, while the remaining four walked to work; those who walked, however, took 5 minutes or less to commute. The number of steps/day in summer were 6,560±2,600 and 7,016±4,679, and the number of steps/day in winter were 5,236±2,253 and 4,770±3,039, on workdays and holidays, respectively (Fig. 1). The type of day had no significant main effect, F(1, 49)=0.001, p=0.993, but the main effect for the season was statistically significant, F(1, 49)=19.016, p=0.0001. There was no significant interaction between type of day and season, F(1, 49)=3.519, p=0.0666. Correlation coefficients between BMI and type of day in each season were −0.124, −0.152, −0.420, and −0.147, respectively. A significant relationship was only observed on workdays in winter (p<0.01).

Discussion

Although there is measurement error and some difference in accuracy among pedometers, the main advantage of using pedometers to measure walking activity is the ability to objectively compare measurements among different groups (Schneider et al., 2003). Tudor-Locke and Bassett (2004) classified daily walking activity as follows: sedentary:<5,000 steps; low-active: 5,000–7,499 steps; somewhat active: 7,500–9,999 steps; and active: >10,000 steps. According to these guidelines, our participants in this study were generally low-active, especially in winter.

As mentioned above, the relatively higher level of walking activity observed in urban areas in Japan is probably due to the
existence of well-organized public transportation systems, and to the inconvenience of owning a private car in large cities, where parking shortages, especially near downtown office buildings, make the high cost of car maintenance less attractive. Commuters who use public transportation engage in a considerable amount of walking; in fact, the walking portion of such a commute constitutes a considerable part of a commuter's daily physical activity (Kriska, 2000). Therefore, these commuters usually engage in more physical activity on workdays than on holidays. For example, Nawata et al. (2006) showed that the number of steps/day taken by 310 male white-collar workers in the Tokyo area was 10,682±4,365 (SD) on workdays and 7,135±4,536 on holidays. In contrast, the number of steps/day taken by participants in our study was not reduced on holidays, because they were not active on workdays, due to the fact that most of them are desk workers who commute in private cars. In addition, some participants enjoy walking and/or hiking on holiday. A higher prevalence of inactivity and obesity in rural areas has been observed in the United States as well (Patterson et al., 2004). Sherman et al. (2007) reported that the mean number of daily steps of rural women (n=60) was approximately 6,300, which was less active and lower than those of Americans from other regions, who walk 7,000–13,000 steps/day. Eyler A (2003) hypothesizes that increased automation of the agriculture industry, lack of formal exercise programs, and lack of street lights and sidewalks prevent people in rural areas from being more physically active.

Bad weather conditions such as cold, heat, rain, and high wind undoubtedly restrict outdoor activity, too, and thereby reduce physical activity. However, there have been few pedometry studies that address the seasonal effect. Recently, Hamilton et al. (2008) observed that the mean number of daily steps taken by 96 UK adults in summer was 10,417±3,055 (SD), a figure significantly higher than that recorded in winter (9,132±2,841). We also observed reduced walking activity in winter, from the relatively lower level of walking in summer. Moreover, a highly significant relationship between BMI and steps/day on workdays in winter was seen. We recently reported that a relationship between BMI and steps/day is rather difficult to obtain in the Japanese population, especially males, probably because the BMI of Japanese is relatively lower than that of Caucasians and Africans (Mitsui et al., 2008). We do not know why a significant relationship was observed only on workdays in winter, but extremely reduced physical activity in winter may play a key role in the high incidence of obesity in this area.

In this study had several limitations. First, the scale of the study was relatively small. The high rate of participation (91.1% of town hall employees), however, means that they can collectively be regarded as a typical assortment of desk workers in this area. A larger study using a randomized sample is needed to generalize our observations. Second, the social class of our participants may have been relatively high compared to the average of all district residents, because our participants were all local government employees. Third, 6 of the participants had been using pedometers prior to this study, and it is possible that their previous experience may have affected the measurements they recorded during this study. Although it has been shown that using a pedometer can motivate subjects to increase their physical activity, it does not, however, make them more likely to reduce their physical activity (Bravata et al., 2007). Because the first measurements in this study were taken in summer, any significant reduction in steps/day that occurred during winter was considered to be due to the seasonal effect.

In summary, the walking activity of male white-collar workers in the Tohoku district seems to be low, especially in winter. In addition, our participants did not walk any more or less on holidays than on workdays, though most people walk less on holidays. The widespread use of private cars for commuting and the cold winter weather may be partly responsible for these habits, which may lead to the higher incidence of obesity in this area. In addition, we propose that daily physical activity is definitely affected by weather conditions such as cold, heat, snow, rain, and wind, all of which should be taken into account in assessments of walking activity.

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References

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