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ORIGINAL RESEARCH

Short Sleep Duration is Inversely Associated with the Prevalence of Underweight in a Young Japanese Population

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Study Objectives: Many studies have shown that sleep disorders including short sleep duration are associated with obesity. However, evidence regarding the association between sleep duration and underweight is limited and inconsistent. This study investigated the relationship between sleep duration and body mass index (BMI), focusing on the prevalence of underweight and obesity in a young Japanese population.

Methods: We enrolled 12,496 students at Ehime University between April 2015 and May 2017. Information on sleep duration, sleep disorders, alcohol consumption, smoking, and exercise habits were collected using self-reported questionnaires. Logistic regression analysis was used to estimate crude odds ratios (ORs) and 95% confidence intervals (CIs) for the association between sleep duration and BMI, using 7–<8 hours as the reference. Age, sex, drinking habits, smoking, exercise habits, and sleep disorders were considered confounding factors.

Results: The prevalences of underweight (BMI <18.5) and obesity (BMI ≥25) were 14.3% and 10.5%, respectively. Short sleep durations remained significantly positively associated with obesity (6–<7 h: OR 1.19, 95% CI: 1.03–1.37 and 9 h or more OR 0.74, 95% CI: 0.56–0.97; *p* for trend = 0.001). Longer sleep duration remained significantly positively associated with underweight (6–<7 h: OR 0.86, 95% CI: 0.76–0.99; 8–<9 h: OR 1.15, 95% CI: 1.01–1.31; and 9 h or more: OR 1.40, 95% CI: 1.16–1.69; *p* for trend = 0.001). In men but not women, sleep duration was independently inversely associated with obesity (9 hours or more OR: 0.70; 95% CI: 0.50–0.96; p = 0.003). Positive association between sleep duration (9 hours or more) and underweight was found (men OR: 1.47; 95% CI: 1.12–1.92; p = 0.001, and women OR: 1.37; 95% CI: 1.04–1.79; p = 0.001).

Conclusion: Sleep duration was significantly positively associated with the underweight and inversely associated with obesity in the young Japanese population.

Plain Language Summary: Numerous studies have examined the relationship between sleep duration and obesity; however, few have focused on sleep duration and underweight. The prevalence of obesity in Japan is lower compared to Western countries, while the increasing rate of underweight among young individuals presents a significant public health concern. This cross-sectional study among Japanese university students demonstrates a positive association between sleep duration and underweight. Our findings suggest that sleep may play a crucial role in interventions aimed at addressing underweight.

Keywords: sleep duration, body mass index, obesity, underweight

Introduction

Sleep plays multiple essential roles, including conserving energy, supporting bodily repair, clearing metabolic waste from the brain, enhancing immune function, and promoting memory consolidation. Inadequate sleep duration also disrupts

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hormonal regulation involved in appetite and metabolism—elevating ghrelin and cortisol while reducing leptin—leading to increased hunger, impaired glucose metabolism, and reduced energy expenditure, all of which may contribute to weight gain and metabolic dysregulation.[1–3] Obesity is a major risk factor for various health problems, including type 2 diabetes and cardiovascular and metabolic conditions.[4] Conversely, underweight is a risk factor for infections, respiratory diseases, osteoporosis, and sarcopenia.[5–7] In young women, underweight also increases the risk of obesity, hypertension, and hyperlipidemia in the next generation of children.[8,9] While the prevalence of obesity in Japan remains lower than in Western countries,[10] the persistently high rate of underweight among young women—reported at 16.5–20.2% in recent national surveys—continues to pose a relevant public health concern.[11]

Health behaviors including sleep often decline during adolescence and young adulthood, yet once established,[12] they tend to remain stable over time.[13] Therefore, investigating the association between sleep characteristics and health indicators among university students provides critical insight into the early determinants of chronic disease risk.

Multiple systematic reviews and meta-analyses have consistently demonstrated that short sleep duration is associated with an increased risk of obesity and greater adiposity across various age groups. In adolescence, multidimensional aspects of sleep—such as timing and quality—have also been implicated in excessive adiposity and an elevated risk of obesity.[14–17] Conversely, findings on the association between sleep duration and underweight are inconsistent.[18–21] Evidence regarding the effects of sleep on underweight is limited, underscoring the need for further research in this area. The aim of this study was to investigate the association between sleep duration and BMI, including obesity and underweight, in a young Japanese population.

Methods

Study Population

This study enrolled 12,724 students (All students were aged 18 or over) who underwent health examinations at Ehime University (Ehime, Japan) between April 2015 and May 2017. A questionnaire addressing sleep duration and sleep disorders was sent to all participants at the time of their health checkup. The final analysis included 12,496 participants, after excluding 228 participants with incomplete data. Informed consent was obtained in the form of opt-out on the website. All participants had the option to withdraw, and the study protocol was developed in accordance with the ethical guidelines of the Declaration of Helsinki. This study was approved by the ethics committee of the Ehime University Graduate School of Medicine (approval no. 1610012).

Measurements

Information on alcohol consumption, smoking, exercise habits, sleep duration, and sleep disorders was collected using self-report questionnaires. Participants were asked to report on their lifestyle behaviors over the preceding six months. Smoking status was assessed using the following response options: “Non-smoker”, “Sometimes”, “Up to 1 pack per day”, or “More than 1 pack per day.” Alcohol consumption was categorized as: “Do not drink at all”, “Do not drink regularly”, “Less than 1 flask of sake or 1 beer per day”, or “1 flask of sake or 1 beer or more per day.” Exercise frequency was evaluated with the options: “None”, “1–2 times per month”, “1–3 times per week”, or “4 or more times per week.”. Current drinking was defined as the habitual consumption of alcoholic beverages, corresponding to responses of either “Less than 1 flask of sake or 1 beer per day” or “1 flask of sake or 1 beer or more per day.” Current smoking was defined as any response other than “Non-smoker.” Exercise habits are defined as engaging in physical activity at least once per week.

Body Mass Index and Definitions of Underweight and Obesity

Height was measured to the nearest millimeter using a height gauge with participants standing upright. Weight was measured with participants wearing light clothing. BMI was calculated by dividing weight in kilograms by height in meters squared. Referencing the definition of the Japan Society for the Study of Obesity, underweight and obesity were defined as BMI <18.5 and BMI ≥ 25.0, respectively.[22]

Self-Reported Sleep Duration and Sleep Disorders

A self-administered questionnaire was used to collect data on sleep duration and sleep disorders. Sleep duration and sleep disturbance were assessed using the following questions: 1) Sleep duration: "How many hours do you sleep on average?" [Answer: number of hours], 2) Sleep disturbance: "How do you sleep?" [Answer: "with no problems" or "with problems"].

Statistical Methods

BMI was classified into three categories; underweight: (BMI <18.5), normal (≤18.5 BMI <25.0), and obesity (BMI ≥25.0). (2) Sleep duration was classified into five categories: less than 6 h, 6–<7 h, 7–<8 h (reference), 8–<9 h, and 9 h or more.[23] Multicollinearity among covariates was assessed using variance inflation factors (VIFs) derived from a linear regression model. Model calibration was evaluated using the Hosmer–Lemeshow goodness-of-fit test. A p-value greater than 0.05 was considered to indicate adequate fit. The model's discriminative ability was assessed using the C-statistic (area under the receiver operating characteristic curve, AUC). Analyses were performed separately for models predicting obesity and underweight status. Estimation of crude odds ratios (ORs) and their 95% confidence intervals (CIs) for the associations between obesity or underweight and sleep duration was performed using logistic regression analysis. Potential confounding factors included age, gender, alcohol consumption, smoking, exercise habits, and sleep disorders. SAS software package version 9.4 (SAS Institute Inc, Cary, NC, USA) was used for the statistical analysis.

Results

The characteristics of the participants are presented in Table 1. The total number of participants was 12,496. The mean age and BMI were 20.1 years and 21.37 kg/m^2, respectively. The proportions of males, lean individuals, and individuals with obesity were 60.4%, 14.3%, and 10.5%, respectively. Self-reported sleep durations of less than 6 h, 6–<7 h, 7–<8 h, 8–<9 h, and 9 h or more were 6.2%, 26.9%, 37.7%, 22.1%, and 7.0%, respectively. The prevalence of sleep disorders was 11.4%. Table 2 shows variables according to sleep durations. There are increasing trends in age, smoking, and drinking and a decreasing trend in exercise.

Crude and adjusted ORs and 95% CIs for obesity in relation to sleep duration are shown in Table 3. The percentage of individuals with obesity (BMI ≥25) was 12.2%, 11.7%, 10.0%, 10.2%, and 7.5% in the categories of less than 6 h, 6–<7 h, 7–<8 h, 8–<9 h, and 9 h or more of sleep duration, respectively. After adjusting for confounding factors (Model 1), short sleep durations were significantly positively associated with obesity (6–<7 h: OR 1.20, 95% CI: 1.03–1.37 and

Table 1 Clinical Characteristics of 12,496 Study Participants

	Total (N=12,496)
Age, years, mean ± SD	20.1 ± 3.1
Sex (Male/Female)	7547/4949
Body mass index	21.37 ± 3.08
Underweight (<18.5)	1307 (14.3)
Normal (18.5–25.0)	9408 (75.3)
Obesity (≥25.0)	1307 (10.5)
Smoking, %	670 (5.4)
Drinking, %	1254 (10.0)
Exercise habit, %	4851 (38.8)
Self-reported sleep time (hour)	6.98 ± 1.08
Less than 6 hours, %	772 (6.2)
6-<7 hours, %	3365 (26.9)
7-<8 hours, %	4715 (37.7)
8-<9 hours, %	2767 (22.1)
9 hours or more, %	877 (7.0)
Sleep disorder, %	1427 (11.4)

Abbreviations: SD, standard deviation; N, number.

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Table 2 Association Between Sleep Duration and Characteristics

Variable	Age	Sex (Man, %)	Smoking (%)	Drinking (%)	Exercise (%)
Self-reported sleep time (hour)					
Less than 6 hours, %	20.4 ± 3.3	439/772 (56.9)	38/772 (4.9)	88/772 (11.4)	327/772 (42.4)
6-<7 hours, %	20.0 ± 3.6	2027/3365 (60.2)	164/3365 (4.9)	300/3365 (8.9)	1348/3365 (40.1)
7-<8 hours, %	19.9 ± 3.2	2946/4715 (62.5)	201/4715 (4.3)	412/4715 (8.7)	1915/4715 (40.6)
8-<9 hours, %	20.3 ± 2.4	1628/2767 (58.8)	188/2767 (6.8)	335/2767 (12.1)	989/2767 (35.7)
9 hours or more, %	20.2 ± 1.9	507/877 (57.8)	79/877 (9.0)	119/877 (13.6)	272/877 (31.0)
p for trend	0.001	0.001	0.001	0.001	0.001

Notes: For continuous variables, a linear trend was used; for categorical variables, a Mantel-Haenszel $\chi 2$-test used.

Table 3 Association Between Sleep Duration and the Prevalence of Obesity

Variable	Prevalence (%)	Crude OR (95% CI)	Model 1 Adjusted OR (95% CI)	Model 2 Adjusted OR (95% CI)
Obesity (BMI ≥25.0)				
Less than 6 hours, %	94/772 (12.2)	1.25 (0.98–1.57)	1.26 (0.99–1.59)	1.24 (0.97–1.57)
6-<7 hours, %	393/3365 (11.7)	1.19 (1.03–1.37)	1.20 (1.04–1.38)	1.19 (1.03–1.37)
7-<8 hours, %	472/4715 (10.0)	1.00	1.00	1.00
8-<9 hours, %	282/2767 (10.2)	1.02 (0.87–1.19)	1.03 (0.88–1.21)	1.03 (0.88–1.21)
9 hours or more, %	66/877 (7.5)	0.73 (0.56–0.95)	0.75 (0.57–0.98)	0.74 (0.56–0.97)
p for trend			0.001	0.001

Notes: Model 1 Odds ratios were adjusted for age, sex, drinking, smoking, and exercise habits.Model 2Odds ratios were adjusted for age, sex, drinking, smoking, exercise habits, and sleep disorders.
Abbreviation: BMI, body mass index.

9 h or more OR 0.74, 95% CI: 0.57–0.98; *p* for trend = 0.001). Even after further adjustment for the confounding factors mentioned above and sleep disorders (Model 2), short sleep durations remained significantly positively associated with obesity 6–<7 h: OR 1.19, 95% CI: 1.03–1.37 and 9 h or more OR 0.74, 95% CI: 0.56–0.97; *p* for trend = 0.001). However, sleep duration of less than 6 hours was not statistically significant, although the association was marginal.

Table 4 presents crude and adjusted ORs and 95% CIs for underweight individuals in relation to sleep duration. The percentage of individuals with underweight (BMI <18.5) was 12.3%, 12.5%, 14.1%, 15.8%, and 18.7% in the categories of less than 6 h, 6–<7 h, 7–<8 h, 8–<9 h, and 9 h or more of sleep duration, respectively. Sleep duration was significantly positively associated with underweight (6–<7 h: OR 0.86, 95% CI: 0.76–0.99; 8–<9 h: OR 1.15, 95% CI: 1.01–1.31; and 9 h or more: OR 1.40, 95% CI: 1.16–1.69; *p* for trend = 0.001). After adjusting for the previously mentioned confounding factors and sleep disorders (Model 2), longer sleep duration remained significantly positively associated with

Table 4 Association Between Sleep Duration and Underweight

Variable	Prevalence (%)	Crude OR (95% CI)	Model 1 Adjusted OR (95% CI)	Model 2 Adjusted OR (95% CI)
Underweight (BMI <18.5)				
Less than 6 hours, %	95/772 (12.3)	0.86 (0.68–1.07)	0.87 (0.68–1.09)	0.87 (0.69–1.09)
6-<7 hours, %	420/3365 (12.5)	0.87 (0.76–0.99)	0.86 (0.76–0.99)	0.86 (0.76–0.99)
7-<8 hours, %	665/4715 (14.1)	1.00	1.00	1.00
8-<9 hours, %	437/2767 (15.8)	1.14 (1.00–1.30)	1.15 (1.01–1.31)	1.15 (1.01–1.31)
9 hours or more, %	164/877 (18.7)	1.40 (1.16–1.69)	1.40 (1.16–1.69)	1.40 (1.16–1.69)
p for trend			0.001	0.001

Notes: Model 1 Odds ratios were adjusted for age, sex, drinking, smoking, and exercise habits.Model 2 Odds ratios were adjusted for age, sex, drinking, smoking, exercise habits, and sleep disorders.
Abbreviation: BMI, body mass index.

underweight (6–<7 h: OR 0.86, 95% CI: 0.76–0.99; 8–<9 h: OR 1.15, 95% CI: 1.01–1.31; and 9 h or more: OR 1.40, 95% CI: 1.16–1.69; *p* for trend = 0.001; *p* for trend = 0.001).

The results of the sex-stratified analysis are presented in Table 5. In men, sleeping 9 hours or more was independently and inversely associated with obesity after adjustment for age, smoking, drinking, and sleep disorders (OR: 0.70; 95% CI: 0.50–0.96; p = 0.003). Positive association between sleep duration and underweight was found (9 hours or more OR: 1.47; 95% CI: 1.12–1.92; p = 0.001). In women, no consistent association was found between sleep duration and obesity (p = 0.08), but sleep duration was independently and positively associated with underweight (9 hours and more OR: 1.37; 95% CI: 1.04–1.79; p = 0.001).

The variance inflation factors for all covariates were below 2.0, suggesting no significant multicollinearity. The Hosmer–Lemeshow test indicated a good model fit for the obesity model (p = 0.21), while the fit for the underweight model was marginal (p = 0.046). The C-statistic for the underweight model was 0.606. After excluding participants with BMI < 16.0 or > 39.0, similar associations were observed in the remaining 12,386 participants (data not shown).

Table 5 Association Between Sleep Duration and Underweight or Obesity Stratified by Sex

Variable	Prevalence (%)	Crude OR (95% CI)	Model 1 Adjusted OR (95% CI)	Model 2 Adjusted OR (95% CI)
Male				
Obesity (BMI ≥25.0)				
Less than 6 hours, %	66/439 (15.0)	1.25 (0.93–1.65)	1.22 (0.91–1.61)	1.20 (0.93–1.59)
6-<7 hours, %	289/2027 (14.3)	1.17 (0.99–1.38)	1.15 (0.97–1.36)	1.15 (0.97–1.36)
7-<8 hours, %	366/2946 (12.4)	1.00	1.00	1.00
8-<9 hours, %	205/1328 (12.6)	1.01 (0.85–1.22)	0.99 (0.82–1.19)	0.99 (0.82–1.19)
9 hours or more, %	47/507 (9.3)	0.72 (0.52–0.98)	0.71 (0.51–0.96)	0.70 (0.50–0.96)
p for trend			0.002	0.003
Female				
Obesity (BMI ≥25.0)				
Less than 6 hours, %	28/333 (8.4)	1.44 (0.92–2.19)	1.40 (0.89–2.13)	1.33 (0.85–2.04)
6-<7 hours, %	104/1338 (7.8)	1.32 (1.00–1.75)	1.32 (1.00–1.75)	1.30 (0.98–1.72)
7-<8 hours, %	106/1769 (6.0)	1.00	1.00	1.00
8-<9 hours, %	77/1139 (6.8)	1.13 (0.84–1.54)	1.14 (0.84–1.54)	1.13 (0.83–1.53)
9 hours or more, %	19/370 (5.1)	0.85 (0.50–1.37)	0.86 (0.50–1.39)	0.85 (0.50–1.37)
p for trend			0.06	0.08
Male				
Underweight (BMI <18.5)				
Less than 6 hours, %	51/439 (11.6)	0.94 (0.68–1.28)	1.00 (0.73–1.36)	0.99 (0.72–1.35)
6-<7 hours, %	227/2027 (11.2)	0.91 (0.76–1.08)	0.92 (0.77–1.09)	0.91 (0.76–1.09)
7-<8 hours, %	360/2946 (12.2)	1.00	1.00	1.00
8-<9 hours, %	215/1628 (13.2)	1.09 (0.91–1.31)	1.17 (0.97–1.40)	1.16 (0.97–1.40)
9 hours or more, %	81/507 (16.0)	1.37 (1.05–1.77)	1.49 (1.13–1.93)	1.47 (1.12–1.92)
p for trend			0.001	0.001
Female				
Underweight (BMI <18.5)				
Less than 6 hours, %	44/333 (13.2)	0.73 (0.51–1.02)	0.74 (0.52–1.03)	0.75 (0.53–1.05)
6-<7 hours, %	193/1338 (14.4)	0.81 (0.66–0.98)	0.81 (0.66–0.98)	0.81 (0.67–0.99)
7-<8 hours, %	305/1769 (17.2)	1.00	1.00	1.00
8-<9 hours, %	222/1139 (19.5)	1.16 (0.96–1.41)	1.15 (0.95–1.40)	1.15 (0.95–1.40)
9 hours or more, %	83/370 (22.4)	1.39 (1.05–1.82)	1.36 (1.03–1.78)	1.37 (1.04–1.79)
p for trend			0.001	0.001

Notes: Model 1 Odds ratios were adjusted for age, drinking, smoking, and exercise habits. Model 2 Odds ratios were adjusted for age, drinking, smoking, exercise habits, and sleep disorders.

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Discussion

The present study of a young Japanese population found that sleep duration was significantly and inversely associated with obesity prevalence, while it was significantly and positively associated with underweight prevalence. This is the first study to demonstrate the relationship between sleep duration and underweight in a young population.

Evidence regarding the association between sleep duration and obesity is well established. Meta-analyses and systematic reviews report a strong association between short sleep and increased obesity risk.[14–17] Short sleep duration is associated with an increased risk of obesity through several physiological mechanisms. Short sleep elevates ghrelin and reduces leptin, increasing appetite and caloric intake. It also impairs glucose metabolism and insulin sensitivity, promoting fat accumulation. Additionally, short sleep may reduce daytime activity and energy expenditure, contributing to a positive energy balance and weight gain.[1,14–17] However, our findings showed a weaker association between sleep duration and obesity, which may reflect differences in population characteristics (eg, age, low prevalence of obesity, and ethnicity) or residual confounding.

Evidence regarding the association between sleep duration and underweight remains limited. A few studies have investigated this relationship. In a cross-sectional study of 1,044 Bangladeshi adolescents aged 13 to 17, individuals with short sleep duration (<7 h) had a lower prevalence of being lean compared to those with longer sleep durations (≥8 h).[18] Similarly, an Australian cross-sectional study of 3,884 children and adolescents aged 9 to 18 showed a positive association between sleep duration and being lean.[19] A Norwegian cross-sectional study of 9,875 adolescents aged 16 to 19 found that sleep duration among lean and obese individuals was shorter than in the normal weight group.[20] In a Korean study of 107,718 subjects, sleep duration was significantly positively associated with underweight.[21] Importantly, these studies were limited to children and adolescents, with no studies focusing on adults. The present study builds on this limited evidence, showing that sleep duration is independently and positively associated with underweight, even after adjusting for sleep disorders.

The mechanisms underlying the association between long sleep duration and underweight are not well understood. However, several findings suggest a beneficial link. While we hypothesized that sleep duration may influence BMI, the possibility of reverse causality—whereby individuals with lower BMI exhibit altered sleep patterns due to metabolic or lifestyle factors—should also be considered. Ghrelin level is increasing in subjects with diet-induce weight loss.[24] Ghrelin has sleep-promoting effects, and its circulating levels increase in response to weight loss.[25] Given that energy expenditure during sleep is lower than during wakefulness, it is plausible that sleep is promoted as a physiological mechanism to conserve energy and prevent further weight loss.[26] Furthermore, prolonged sleep may be required when underweight itself reflects a compromised physiological condition that necessitates greater restorative rest.[27] A meta-analysis examining the relationships between BMI, habitual sleep duration, and primary nutrient intake found that long sleep duration was associated with reduced saturated fatty acid intake in young adults and decreased energy content from carbohydrates, total fat, and other unsaturated fatty acids in older women.[28] Adequate sleep duration has been linked to higher daily energy consumption through increased daytime activity.[29] However, further research regarding sleep duration and underweight is needed to explore these associations.

This study has several limitations. First, as a cross-sectional study, it cannot establish a causal relationship between sleep duration and underweight. Second, sleep duration and sleep disorders were assessed by self-reported questionnaires, which capture subjective perceptions of sleep but lack evidence from objective measures such as polysomnography (PSG). Although self-reported sleep duration is subject to recall bias and tends to overestimate sleep time compared to objective methods such as PSG or actigraphy. Studies have shown that self-reported sleep is, on average, 20–30 minutes longer than PSG-derived sleep duration.[30] However, in this study, we used a non-validated questionnaire to assess sleep duration, and it was evaluated only once. The data regarding detail sleep status including sleep chronotype and social jetlag was lacking. Third, low BMI is a known risk factor for sarcopenia,[6] but this study did not assess sarcopenia. Fourth, data on energy intake and socioeconomic status was not available in this cohort. In the Japanese population, socioeconomic status has been associated with underweight, obesity, and sleep patterns, and therefore may serve as a potential confounding factor in this study.[31–33] Fifth, the underweight model showed limited fit (Hosmer–Lemeshow $p = 0.046$) and low discriminative ability (C-statistic = 0.606), possibly due to unmeasured confounders and

inaccuracies in self-reported sleep duration. Further studies with more comprehensive data are needed to improve model performance. Lastly, the study population comprised university students, which may limit generalizability. Nevertheless, the BMI distribution in this cohort closely resembled the proportions of obesity and underweight reported in the National Health and Nutrition Survey of Japan during the study period.[9] Asian individuals tend to have higher body fat percentages and greater risk of obesity-related comorbidities at lower BMI levels compared to Western populations.[34] In this study, we defined obesity as BMI ≥25 kg/m², which aligns with the criteria commonly used in Asian populations. Thus, the study population was limited to university students in Japan, which may restrict the generalizability of the findings to other age groups or cultural settings.

Conclusions

Sleep duration was significantly positively associated with the prevalence of underweight and inversely associated with the prevalence of obesity in the young Japanese population. The findings suggest that maintaining an appropriate sleep duration may be beneficial for preventing both obesity and underweight, which could in turn help reduce the risk of related health issues. Sleep duration may therefore be a relevant factor to consider in efforts to support healthy body weight and overall health. However, causality cannot be inferred, and further longitudinal studies are needed to clarify these associations. Further studies including interventional and longitudinal studies are warranty in the future.

Data Sharing Statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Author Contributions

Conceptualization: SF; Methodology: SF; Formal analysis: SF, TM, OY, YM, AK (Kanamoto), MM, AS, HN, HS, KM, MK, YN, MK, TK, BM, YH; Investigation: SF, AK (Kato), and KK; Data Curation: SF, AK (Kato), and KK; Writing-original draft: SI; Writing-review & editing: SI, SF, TM, OY, YM, AK (Kanamoto), MM, AS, HN, HS, KM, MK, YN, MK, AK(Kato), KK, TK, BM, and YH; Visualization: SI and SF; Supervision: SF; Project administration: SF. All authors gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agreed to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no conflicts of interest.

References

1. Spiegel K, Tasali E, Penev P, Van Cauter E. Sleep curtailment in healthy young men is associated with decreased leptin levels, elevated ghrelin levels, and increased hunger and appetite. *Ann Intern Med*. 2004;141(11):846–850. doi:10.7326/0003-4819-141-11-200412070-00008
2. Leproult R, Van Cauter E. Role of sleep and sleep loss in hormonal release and metabolism. *Endocr Dev*. 2010;17:11–21. doi:10.1159/000262524
3. Chaput JP, McHill AW, Cox RC, et al. The role of insufficient sleep and circadian misalignment in obesity. *Nat Rev Endocrinol*. 2023;19(2):82–97. doi:10.1038/s41574-022-00747-7
4. Piché ME, Tchernof A, Després JP. Obesity phenotypes, diabetes, and cardiovascular diseases. *Circ Res*. 2020;126(11):1477–1500. doi:10.1161/CIRCRESAHA.120.316101
5. Chiu CT, Lee JI, Lu CC, Huang SP, Chen SC, Geng JH. The association between body mass index and osteoporosis in a Taiwanese population: a cross-sectional and longitudinal study. *Sci Rep*. 2024;14(1):8509. doi:10.1038/s41598-024-59159-4
6. Curtis M, Swan L, Fox R, Warters A, O'Sullivan M. Associations between body mass index and probable sarcopenia in community-dwelling older adults. *Nutrients*. 2023;15(6):1505. doi:10.3390/nu15061505
7. Yang WS, Chang YC, Chang CH, Wu LC, Wang JL, Lin HH. The association between body mass index and the risk of hospitalization and mortality due to infection: a prospective cohort study. *Open Forum Infect Dis*. 2020;8(1):ofaa545. doi:10.1093/ofid/ofaa545

8. Yasuda T. Desire for thinness among young Japanese women from the perspective of objective and subjective ideal body shape. *Sci Rep*. 2023;13(1):14129. doi:10.1038/s41598-023-41265-4
9. Oshita K, Ishihara Y, Seike K, Myotsuzono R. Associations of body composition with physical activity, nutritional intake status, and chronotype among female university students in Japan. *J Physiol Anthropol*. 2024;43(1):13. doi:10.1186/s40101-024-00360-9
10. Ogawa W, Hirota Y, Miyazaki S, et al. Definition, criteria, and core concepts of guidelines for the management of obesity disease in Japan. *Endocr J*. 2024;71(3):223–231. doi:10.1507/endocrj.EJ23-0593
11. Ministry of Health. Labour and welfare. national health and nutrition survey. 2017. Available from: Accessed May 20, 2025. [https://www.mhlw.go.jp/content/001066645.pdf].
12. Frech A. Healthy behavior trajectories between adolescence and young adulthood. *Adv Life Course Res*. 2012;17(2):59–68. doi:10.1016/j.alcr.2012.01.003
13. Lee S, Smith CE, Wallace ML, et al. Ten-year stability of an insomnia sleeper phenotype and its association with chronic conditions. *Psychosom Med*. 2024;86(4):289–297. doi:10.1097/PSY.0000000000001288
14. Gale EL, James Williams A, Cecil JE. The relationship between multiple sleep dimensions and obesity in adolescents: a systematic review. *Sleep Med Rev*. 2024;73:101875. doi:10.1016/j.smrv.2023.101875
15. Guimarães KC, Silva CM, Latorraca COC, Oliveira RÁ, Crispim CA. Is self-reported short sleep duration associated with obesity? A systematic review and meta-analysis of cohort studies. *Nutr Rev*. 2022;80(5):983–1000. doi:10.1093/nutrit/nuab064
16. Fatima Y, Doi SA, Mamun AA. Sleep quality and obesity in young subjects: a meta-analysis. *Obes Rev*. 2016;17(11):1154–1166. doi:10.1111/obr.12444
17. Wu Y, Zhai L, Zhang D. Sleep duration and obesity among adults: a meta-analysis of prospective studies. *Sleep Med*. 2014;15(12):1456–1462. doi:10.1016/j.sleep.2014.07.018
18. Anam MR, Akter S, Hossain F, et al. Association of sleep duration and sleep quality with overweight/obesity among adolescents of Bangladesh: a multilevel analysis. *BMC Public Health*. 2022;22(1):374. doi:10.1186/s12889-022-12774-0
19. Olds T, Blunden S, Dollman J, Maher CA. Day type and the relationship between weight status and sleep duration in children and adolescents. *Aust N Z J Public Health*. 2010;34(2):165–171. doi:10.1111/j.1753-6405.2010.00502.x
20. Sivertsen B, Pallesen S, Sand L, Hysing M. Sleep and body mass index in adolescence: results from a large population-based study of Norwegian adolescents aged 16 to 19 years. *BMC Pediatr*. 2014;14:204. doi:10.1186/1471-2431-14-204
21. Park SK, Jung JY, Oh CM, McIntyre RS, Lee JH. Association between sleep duration, quality and body mass index in the Korean population. *J Clin Sleep Med*. 2018;14(8):1353–1360. doi:10.5664/jcsm.7272
22. Matsuzawa Y, Inoue S, Ikeda Y, et al. New diagnostic criteria for obesity and obesity disease (*Atarashii himan no hantei to himanshou no shindan kijun*). *J Jpn Soc Study Obes*. 2000;6:18–28.
23. Paruthi S, Lj B, D'Ambrosio C, et al. Consensus statement of the American Academy of sleep medicine on the recommended amount of sleep for healthy children: methodology and discussion. *J Clin Sleep Med*. 201;12(11):1549–1561. doi:10.5664/jcsm.6288
24. Cummings DE, Weigle DS, Frayo RS, et al. Plasma ghrelin levels after diet-induced weight loss or gastric bypass surgery. *N Engl J Med*. 2002;346(21):1623–1630. doi:10.1056/NEJMoa012908
25. Weikel JC, Wichniak A, Ising M, et al. Ghrelin promotes slow-wave sleep in humans. *Am J Physiol Endocrinol Metab*. 2003;284(2):E407–E415. doi:10.1152/ajpendo.00206.2002
26. Jung CM, Melanson EL, Frydendall EJ, et al. Energy expenditure during sleep, sleep deprivation and sleep following sleep deprivation in humans. *J Physiol*. 2011;589(Pt 1):235–244. doi:10.1113/jphysiol.2010.197517
27. Tolle V, Kadem M, Bluet-Pajot MT, et al. Balance in ghrelin and leptin plasma levels in anorexia nervosa patients and constitutionally thin women. *J Clin Endocrinol Metab*. 2003;88(1):109–116. doi:10.1210/jc.2002-020791
28. Dashti HS, Follis JL, Smith CE, et al. Habitual sleep duration is associated with BMI and macronutrient intake and may be modified by CLOCK genetic variants. *Am J Clin Nutr*. 2015;101(1):135–143. doi:10.3945/ajcn.114.095026
29. Cruz J, Llodio I, Iturricastillo A, Yanci J, Sánchez-Díaz S, Romaratezabala E. Association of physical activity and/or diet with sleep quality and duration in adolescents: a scoping review. *Nutrients*. 2024;16(19):3345. doi:10.3390/nu16193345
30. Matthews KA, Patel SR, Pantesco EJ, et al. Similarities and differences in estimates of sleep duration by polysomnography, actigraphy, diary, and self-reported habitual sleep in a community sample. *Sleep Health*. 2018;4(1):96–103. doi:10.1016/j.sleh.2017.10.011
31. Kachi Y, Otsuka T, Kawada T. Socioeconomic status and overweight/obesity among Japanese adolescents: a cross-sectional study. *BMC Public Health*. 2015;25(7):463–469. doi:10.1186/s12889-015-2593-z
32. Mizuta A, Fujiwara T, Ojima T. Association between economic status and body mass index among adolescents: a community-based cross-sectional study in Japan. *BMC Obes*. 2016;3:47. doi:10.1186/s40608-016-0127-z
33. Doi Y, Minowa M, Tango T. Impact and correlates of poor sleep quality in Japanese white-collar employees. *Sleep*. 2003;26(4):467–471. doi:10.1093/sleep/26.4.467
34. Yoon KH, Lee JH, Kim JW, et al. Epidemic obesity and type 2 diabetes in Asia. *Lancet*. 2006;368(9548):1681–1688. doi:10.1016/S0140-6736(06)69703-1