

Association between Sleep Duration and Body Mass Index and Waist Circumference

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Abstract

Insufficient sleep may lead to adverse cardio-metabolic effects by influencing body weight, blood pressure, and glucose tolerance. We aimed to assess the relation between sleep duration and indices of obesity including body mass index (BMI) and waist circumference in a sample population in central Iran. We selected a sub-sample of 1770 individuals from Isfahan Healthy Heart Program. The data regarding the sleep duration was collected by using a validated questionnaire. The relation of sleep duration with BMI and waist circumference was examined by using categorical logistic regression with adjustment for sex, BMI, and daily calorie intake. Sleep duration time less than 5 hours/day compared with 7-8 hours/day increased the odds ratio for abdominal obesity in people aged under 60 years [OR=2.49 (95%CI 1.40-4.43)]. In individuals aged under 60 years, this relation was significant for both men, [OR=2.64 (95%CI 1.16-6.02)] and women [OR=2.38 (95% CI 1.05-5.39)]. In addition, in women, sleep time > 9 hours was negatively related to waist circumference. Sleep duration time less than 5 hours per day increased odds ratio of overweight only in women [OR=1.75 (95% CI 1.07-2.85)]. Sleep duration time under 5 hours in people aged less than 60 years was positively associated with waist circumference. In women, sleep duration time over 9 hours was negatively associated with waist circumference. Only in women, sleep time under 5 hours /night increased BMI. Short sleep duration was associated with abdominal obesity and this was independent of its relation to BMI.

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Keywords • Sleep • obesity • gender differences

Introduction

More than 40 years ago for the first time it was documented that short sleep duration is linked to mortality.¹ In the past 5 years, however, evidence from large-scale cohort studies further supported the link between short sleep duration and mortality.^{2,3} Short sleep duration increases the incidence of diabetes,⁴ coronary heart disease,⁵ hypertension,⁶ obesity, and metabolic syndrome.⁷⁻⁸

Insufficient sleep may lead to adverse health effects and influence body weight. In population studies a dose-response relationship between short sleep duration and high body mass index (BMI) has been reported among all age groups.⁹⁻¹⁵ In one of the largest studies, elevated BMI was positively associated with sleep duration less than 7-8 hours/day.¹⁰

Sleep deprivation during the postpartum period affects maternal postpartum weight retention. Sleeping duration

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≤5 hours/day at 6 months after delivery was strongly associated with retaining over 5 kg at 1 year postpartum.¹⁶

Sleep-body fat relationship progressively becomes less detectable with increasing in age. Chaput and co-workers studied 90 women aged ≥50 years and concluded that short sleep duration did not predict an increased risk of overweight/obesity in older women.¹⁷

We hypothesized that the relationship between waist circumferences and sleep duration differs in populations with different socioeconomic and cultural aspect. Therefore, the present study was designed to investigate the correlation between sleep duration and BMI and waist circumference in a representative sample of Iranian population who live in central cities of Iran (Isfahan, Najaf Abad, and Arak).

Subjects and Methods

This cross-sectional study was conducted as a part of Isfahan Healthy Heart Program (IHHP). It is a six-year comprehensive integrated community-based program for cardiovascular disease (CVD) prevention and control via reducing CVD risk factors and improvement of cardiovascular healthy behaviors in a target population. The baseline survey was conducted in 2000-2001.¹⁸ The participants in the baseline survey of IHHP were 12514 individuals aged over 19 years. The study population comprised 6123 men and 6391 women who were randomly selected from central cities of Iran including Isfahan, Arak, and Najafabad. The present study was conducted on a sub-sample of 1770 individuals who had completed the nutritional assessment data.

Individuals with debilitating diseases including cancer, renal failure, and congestive heart disease, those with eating disorders such as anorexia nervosa and thyroid diseases in form of hyper- or hypothyroidism, and individuals with congenital obesity were excluded from the study.

The data regarding the sleep duration were collected by using a validated questionnaire.¹⁸ The weight measured by a Seca scale, and

waist circumference was measured at the part of the trunk located midway between the lower costal margin (bottom of the lower rib) and the iliac crest (top of the pelvic bone) while the person was standing, with feet about 25-30 cm apart. Body mass index was calculated as weight/height² (kg/m²).

Dietary data were obtained with the help of software named Iranian Food Consumption program (IFCP),¹⁹ the questionnaire was completed by the study subjects with the help of a trained operator. The total daily caloric intake for every participant was calculated by the software.

The relationship between sleep duration time, and BMI and waist circumference was determined by using categorical logistic regression with adjustment for sex, and daily caloric intake.

Results

The participants of our study (49.9% male and 51.1% female) had a mean age of 38.89±4.93 years. Overall, 61% of the participants reported to sleep 7-8 hours per night, 30.3% reported to sleep ≤6 hours, and 8.7% reported a sleep duration time of ≥9 hours. Individuals with lower sleep duration times were older and had a higher BMI and waist circumference (P<0.01; table 1).

Compared with sleep duration time of 7-8 hours per night, sleep duration time ≤5 hours per night was associated with a higher odds ratio for abdominal obesity. This association remained significant for co-variants such as age, sex, BMI, and daily energy intake. Only in women, sleep duration time ≥9 hours was inversely associated with abdominal obesity (table 2).

Only in women, sleep duration time ≤5 hours was associated with increases in BMI (table 3). Secondary analyses after stratification for sex and age demonstrated that in those individuals younger than 60 years, the association between sleep duration time ≤5 hours and

Table 1: Usual sleep duration time (hours per night) and its relation with the participants characteristics

Characteristics	≤5	6	7-8	9	Total	P value
Number of participants (%)	188 (10.6)	371 (21)	1058 (59.8)	153 (8.6)	1770	NA
Age (year)*	48.64±16.16	38.86±13.30	32.82±16.05	35.83±13.86	37.56±14.69	<0.001
Female sex**	114 (60.6)	194 (52.3)	568 (53.7)	100 (65.4)	976 (55.1)	<0.012
Body mass index ≥30	56 (30.4)	67 (18.1)	184 (17.6)	27 (18)	334 (19.1)	<0.001
Waist circumference** **For male >102 cm For female >88 cm	102 (54.5)	164 (44.2)	409 (38.8)	57 (37)	732 (41.5)	<0.001

*Mean±(SD), P value by ANOVA test; **Number (%), P value by Chi-square test

Table 2: The relationship between waist circumference and usual sleep duration time by logistic regression

Variable	Reported usual sleep duration per night (hours)				P value
	≤5	6	7-8	≥9	
Sex:					
Male	2.36 (1.17,4.76)	1.04 (0.56,1.91)	1	2.29 (0.74,7.10)	0.060
Female	1.38 (0.63,2.99)	1.41 (0.82,2.42)	1	0.29 (0.12,0.74)	0.020
Age:					
<60 Years	2.49 (1.40,4.43)	136 (0.89,2.05)	1	0.62 (0.30,1.32)	0.004
≥60 Years	1.56 (0.49,4.90)	0.99 (32,3.07)	1	0.29 (0.02,4.19)	0.650

Data are given as odds ratio (95% confidence interval) for the presence of waist girth >88 cm for women and waist circumference >102 cm for men relative to normal waist from logistic regression using 7-8 hours of sleep duration per night as reference. Category analysis was adjusted for age, sex, body mass index and daily total energy intake.

Table 3: The relationship between body mass index and usual sleep duration time by logistic regression

Variable	Reported usual sleep duration per night (hours)				P value
	≤5	6	7-8	≥9	
Sex:					
Male	0.68 (0.32,1.45)	0.63 (0.32,1.24)	1	1.39 (0.51,3.81)	0.350
Female	1.75 (1.07,2.85)	0.97 (0.65,1.44)	1	2.02 (0.97,4.24)	0.040
Age:					
<60 Years	1.36 (0.78,2.37)	0.67 (0.43,1.04)	1	1.73 (0.79,3.75)	0.055
≥60 Years	0.97 (0.32,2.90)	0.75 (0.24,2.35)	1	3.08 (0.59,16.10)	0.500

Data are given as odds ratio (95% confidence interval) for the presence of obesity relative to normal body mass index from categorical logistic regression using 7-8 hours of sleep per night as reference. Category analysis was adjusted for age, sex, waist circumference, and total daily energy intake

waist circumference in men and women was significant after adjustment for age, sex, waist circumference, and BMI, but this association was not significant for those aged ≥60 years (table 2).

Discussion

In our study, sleep duration time <5 hours/day in people aged under 60 years increased the odds ratio for abdominal obesity. Until now, the only other study on relationship between abdominal obesity and sleep duration has been performed on children, which showed that sleep duration had an independent effect on waist circumference in children.²⁰

We found that sleep duration time < 5 hours increased the odds ratio of overweight only in women. In contrast to our study, Hordaland Health Study showed that short sleep duration was associated with elevated BMI and increased prevalence of obesity in both male and female participants.²¹

According to our study, only in women sleep duration time over 9 hours was negatively associated with waist circumference. There are several neuro-hormonal mechanisms to explain the relationship between sleep duration and obesity. It has been shown that short sleep duration is associated with overweight as well as with decreased leptin and increased ghrelin levels.^{22,23} Leptin is released by adipocytes in response to acute caloric surplus or shortage, and

influences hypothalamic hunger-sensing areas, causing changes in satiety.^{21,24} Ghrelin, the peptide produced by the stomach, stimulates appetite.²⁴ Reduced sleep duration increases hunger that strongly correlates with increase in ghrelin-to-leptin ratio. This may be an explanation for the relationship between short sleep duration and overweight.

Increase in body weight may also occur in association with cortical effects on lipogenesis, or because of other associated alternations in the stress responses.²⁵ Nocturnal growth hormone secretion is dependent on sleep and is predominately secreted during the first half of the night.²⁶ Sleep deprivation significantly decreases the secretion of growth hormone, an anabolic hormone essential for maintaining lipolysis.²⁷ Serum growth hormone secretions have been recorded as being lower in obese children than in normal children.^{22,23,28} In one study, BMI was positively associated with stage 1 sleep and negatively associated with stage 4 sleep.²⁹

It should be noted that our study had two potential limitations. First, the study utilized cross-sectional design and might not prove a casual relationship. Second, as sleep duration was self-reported and not directly measured, patient cooperation might be a confounding factor.

Conclusion

By an undefined mechanism, short sleep duration was associated with abdominal obesity and

this effect was independent of its relation to BMI. Therefore, sleep deprivation would have a significant effect on progression of atherosclerosis and in future it may be considered as a novel risk factor for ischemic heart disease.

Conflict of Interest: None declared

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