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THE RELATION BETWEEN SHORT SLEEP DURATION AND BODY MASS INDEX IN ALMADINA

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ABSTRACT

Objective: Obesity is a serious public health issue which, in the long term, can significantly reduce quality of life. There is evidence of an association between increased BMI and chronic loss of sleep, and a number of hypotheses have been advanced to explain this. The objective of this study is to investigate the prevalence of overweight and obesity among the residents of Almadina, Saudi Arabia, and assesses the relation between sleep duration and both BMI and gender.

Methods: Data was collected through an online survey using snowball technique. Data about sleep duration and quality, weight and height were obtained by self-report while BMI was measured objectively. Microsoft Excel was used for data entry, and the analysis was performed using SPSS version 20. Chi square test was used to assess the relation between the duration of sleep and both BMI and gender.

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Results: Of the study's 398 participants, 50% were females and 50% were males. The mean age of participants was 31.43 (SD± 12.39), and the average of participants was overweight, with a mean BMI of 26.55 (SD ± 7.105). No correlation was found between sleep duration and both BMI and gender.

Conclusion: Unlike most previous studies, these findings indicate no relation between short sleep duration and both BMI and gender for this population. However, the observed high rate of overweight among residents of Almadina points to a need for a primary prevention strategy to reduce obesity and its consequences.

Introduction

During the last decade, obesity - defined as body mass index (BMI) ≥ 30 kg/m2) [1] has been described as a global pandemic.[2] According to the World Health Organization (WHO), it is considered as a serious public health problem. [3,4] The prevalence of overweight and obesity is rising [5-8], and resulted in about 3.4 million deaths globally in 2010.[9] If obesity is not treated, it may result in reduction of life expectancy, also it represents a major precipitating factor for many endocrinal and cardiovascular diseases.[10-12]

Researchers have identified many factors that may lead to obesity. [13] As there is evidence that increased prevalence of obesity is associated with a marked decrease in sleep duration [14], sleep has recently been identified as a risk factor for obesity. [15] Less than 6 hours of sleep increases one's chances of becoming obese; [16] according to the National Sleep Foundation, the appropriate sleep range for adults is 7–9 hours per day. [17] Short sleep duration is known to have an adverse effect on body systems and metabolic functions. [18, 19] Sleep plays a major role in regulating appetite, weight and energy preservation. [18-20]

The cyclical pattern of sleep includes two main stages, non-rapid eye movement sleep (NREM) ,also known as quiet sleep, and rapid eye movement sleep (REM), also known as active sleep. National Sleep Foundation has divided NREM into four stages. [17-21] Each stage has unique defining features including brain waves patterns which were discovered with the use of electroencephalographic (EEG) recording, eye movements and muscle tone. [21] There is a considerable change in initiation and maintenance of each stage of sleep with age from infancy to adulthood as shown in (**Figure 1**). [21]

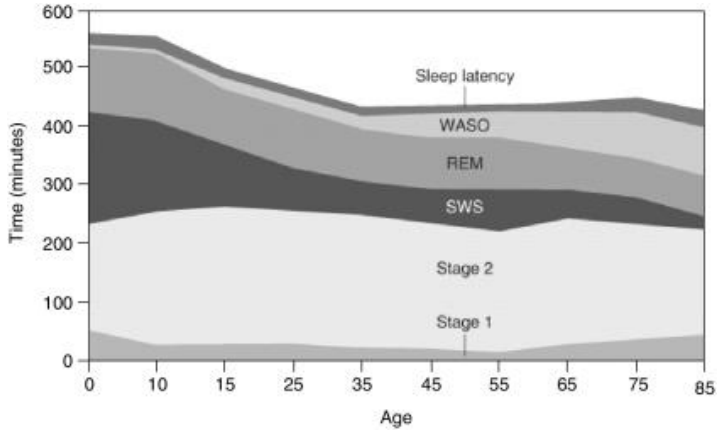

Figure 1. Sleep architecture from infancy to adulthood [21]

Reasons of decreased sleep quality are poorly understood despite the general trend that sleep quality declines with age. Awakenings for a short duration may be experienced by young adults which are minor and occur close to an REM sleep transition and therefore they wouldn't affect sleep consolidation. There is a protecting mechanism that prevent awakening during NREM sleep, so adults may have arousal during REM sleep. This productive impact appears to decrease with aging. [21] Several hypotheses have been advanced to explain how increased BMI relates to sleep duration, such as increased systemic pro-inflammatory biomarkers including TNF-α, CRP, IL-1, IL-6, and IL-17, coagulation molecules, visfatin and cellular adhesion molecules, [22] decreased Leptin levels and/or increased Ghrelin levels[23] or increased daytime sleeping hours and the associated decrease in activity levels. [24] There is also evidence that reduced sleeping hours increase calorie intake, leading to obesity in the absence of energy expenditure. [25] Leptin is a hormone produced by adipocytes that causes suppression of appetite. Low leptin level increases appetite and therefor increases risk of obesity as observed in people who sleep for short periods. Whereas, Ghrelin is a substance produced by the stomach and causes stimulation of appetite. Elevated levels of Ghrelin level lead to appetite stimulation resulting in increased BMI. [23]

Studies of adults and children have identified a relationship between BMI and chronic lack of sleep, [26,27] and one meta-analysis of cross-sectional associations between sleep duration and BMI showed an increased risk of obesity among people who sleep for a shorter time. [28] While some studies of gender-specific associations between sleep and BMI have shown a positive association in men but not in women, [29] others have found a stronger positive relation between BMI and short sleep duration in women. [30] In contrast, some studies have reported a negative association between number of sleep hours and BMI. [31, 32]

The present study investigated whether the prevalence of overweight and obesity among residents of Almadina city might be explained in part by reduced hours of sleep.

Materials and Methods

Study design:

It is a cross-sectional study conducted over 6 months duration, the requisite sample size was calculated with a confidence level of 95% and 5% margin of error. Population size was obtained from the General Authority of Statistics Website. [33]

Study population and sampling:

Data was collected through an online survey using snowball technique. The participants were 398 healthy adult of whom 50% were females and 50% were males from Almadina City, Saudi Arabia. The exclusion criteria encompassed candidates who had a medical condition that might cause obesity (e.g. hypothyroidism, Cushing's syndrome, or depression), pregnant women and those on certain medications (e.g. anti-depressant drugs, corticosteroids, anti- hypertensive drugs, anti-psychotic drugs, or anti- convulsant drugs). [30]

Ethical considerations:

All participants had signed informed consent before starting to fill in the questionnaire. To ensure privacy, the questionnaire did not have a question about the name of the participant. This study was approved by Taibah University institutional review board.

Measurement:

Using open questions, sleep duration was categorised as *very short* (≤ 4h), *short* (5–6h), *average* (7–8h) or *long* (≥ 9h). [34] Weight was recorded in kilograms and height was recorded in centimetres. We calculated BMI by division of weight by the square of height, [1] and according to it, participants were classified into either obese, overweight, normal or underweight. [35]

Questionnaire:

Responses were obtained by self-reported online questionnaire, which included items of the following types.

1- Questions about specific medical conditions and medications (exclusion criteria).

2- Demographic questions (age, gender).

3- Questions to assess weight and height.

4- Questions to assess ranges of sleep duration in weekdays and weekends.

5- Questions about current sleep problems or chronic diseases that might affect sleep.

6- Questions about previous diagnosis with sleep disorder or using sleeping pills.

Data management and analysis:

Statistical analysis was performed using SPSS (version 20) program. In analysis, the sleep duration and BMI were considered as quantitative variables. The gender was considered as qualitative variable. Chi square test was used to assess the relation between sleep duration and both BMI and gender. Statistical significance was set at $p<0.05$. We calculated the mean and standard deviation for BMI, age and sleep duration on weekdays and weekends. Also, we calculated the frequency of sleep problems, chronic diseases and using of sleeping pills.

Results

The aim of the study was to detect any relationship between short sleep duration and BMI, among 398 adult participants in Almadina, Saudi Arabia, of whom (as shown in **table 1**) 50% were females and 50% were males. The mean age of participants was 31.43 (SD ± 12.39). On average, the participants were overweight, with a mean BMI of 26.55 (SD ± 7.105) .

Table 1. Shows the participants distribution according to their gender, mean age, height, weight and BMI.

Age	***Mean ± SD***	31.43 ± 12.39
weight		72.33 ± 20.65
Length		1.65 ± 0.099
BMI		26.55 ± 7.105
Gender	***Frequency***	***Percent***
Male	199	50.0
Female	199	50.0
Total	**398**	**100.0**

The results in **table 2** shows the distribution of participants according to the number of sleep hours per day on weekdays (Sunday to Thursday), where we note that 53.8% sleep for 5-6 hours, 34.4% sleep for 7-8 hours, 6.8% sleep for 9 hours and more, and 5% sleep for less than 4 hours. In a like manner, the table also shows the participants' distribution according to the number of sleep hours per day on weekends, where we note that 45% sleep for 7-8 hours, 34.4% sleep for 9 hours and more, 18.6% sleep for 5-6 hours, and 2% sleep for less than 4 hours.

Table 2. The participants' distribution according to the number of sleep hours per day on weekdays and weekends.

Sleep hours	***weekdays***		***weekends***	
	Frequency	***Percent***	***Frequency***	***Percent***
Less than 4 h	20	5.0	8	2.0
5 - 6 h	214	53.8	74	18.6
7 - 8 h	137	34.4	179	45.0
9 h and more	27	6.8	137	34.4
Total	**398**	**100.0**	**398**	**100**

The main current sleep problems of the participants are shown in **figure 2** as follows: Feeling very sleepy during the day 20%, Difficulty at the beginning of sleep19%, Difficulty getting back to sleep after waking up 18%, frequent waking up 16%, snoring 7%, nightmares 6%.

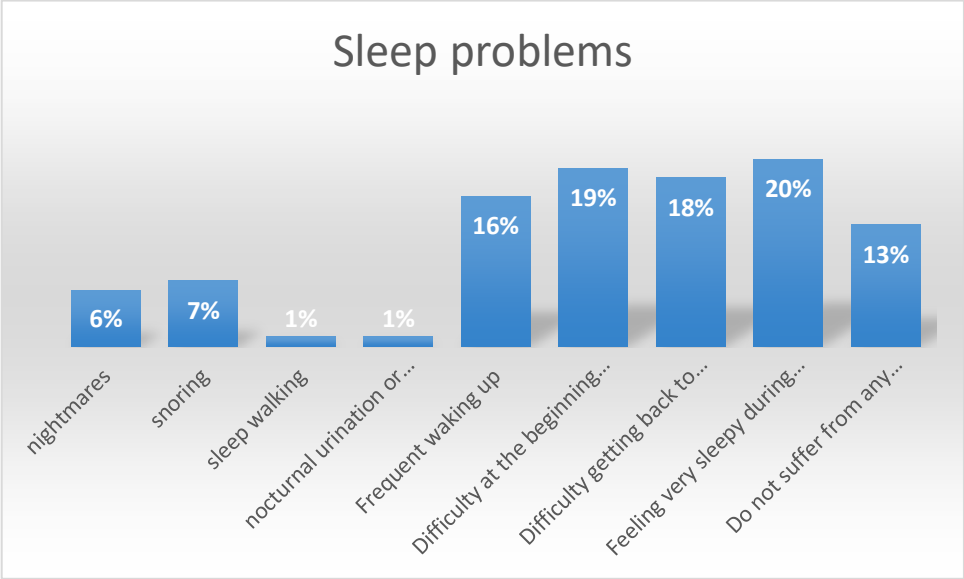

Figure 2: Current sleep problems

Figure 3 shows the percentage of chronic diseases that the participants are suffering from and may affect the sleep indirectly. The most important of these diseases are: Asthma 7%, Gastro oesophageal Reflux Disease 6%, Neurological diseases 2%, Obstructive Sleep Apnea 1%, Rheumatoid Arthritis 1, Psychiatric diseases 1%.

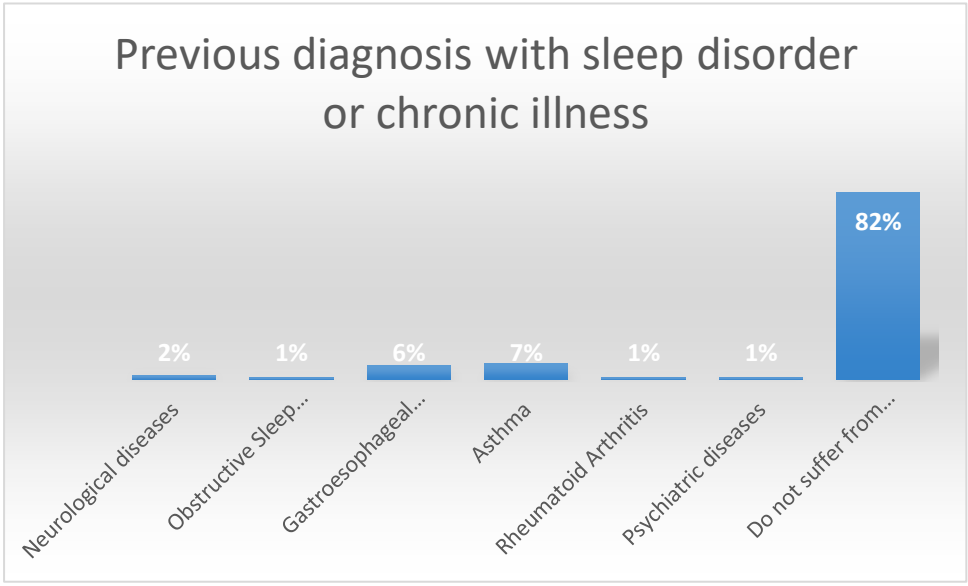

Figure 3: Previous diagnosis with sleep disorder or chronic illness.

Regarding the use of sleep-assisting drugs, 88.4% of participants never used drugs that help sleep, 10.8% sometimes use drugs that help sleep, and 0.8% always use drugs that help sleep. In addition, we noted that 98.7% of the participants were not diagnosed with sleep disorders, while 1.3% were diagnosed with sleep disorders. **Table 3** shows the association between sleep hours during weekdays and weekends and BMI, where we note that there is no relationship between BMI and sleep duration in weekdays, (P = 0.320). As well as no relationship between BMI and sleep duration in weekend, (P = 0.068).

Table 3. Shows the relationship between BMI and sleep duration in weekdays and weekends.

		BMI				P-value
		< 18.5	18.5 - 24.9	25-29.9	> 30	
Sleep Duration from Sunday - Thursday	Less than 4 h	4 (1.0%)	10 (2.5%)	3 (0.8%)	3 (0.8%)	.320
	5 - 6 h	14 (3.5%)	79 (19.8%)	64 (16.1%)	57 (14.3%)	
	7 - 8 h	11 (2.8%)	55 (13.8%)	40 (10.1%)	31 (7.8%)	
	9 h and more	3 (0.8%)	12 (3.0%)	4 (1.0%)	8 (2.0%)	
Sleep Duration on weekend	Less than 4 h	1 (0.3%)	0 (0.0%)	5 (1.3%)	2 (0.5%)	.068
	5 - 6 h	3 (0.8%)	23 (5.8%)	23 (5.8%)	25 (6.3%)	
	7 - 8 h	15 (3.8%)	70 (17.6%)	51 (12.8%)	43 (10.8%)	
	9 h and more	13 (3.3%)	63 (15.8%)	32 (8.0%)	29 (7.3%)	

Finally, **table 4** shows the relationship between gender and sleep duration in weekdays and weekends, where there's no relationship between gender and sleep duration in weekdays, (P = 0.428), as well as no relationship between gender and sleep duration in weekend, (P = 0.597).

Table 4. Shows the relationship between gender and sleep duration in weekdays and weekends.

		Gender		P-value
		Male	Female	
Sleep Duration from Sunday - Thursday	Less than 4 h	10 (2.5%)	10 (2.5%)	.428
	5 - 6 h	105 (26.4%)	109 (27.4%)	
	7 - 8 h	74 (18.6%)	63 (15.8%)	
	9 h and more	10 (2.5%)	17 (4.3%)	
Sleep Duration on weekend	Less than 4 h	4 (1.0%)	4 (1.0%)	.597
	5 - 6 h	36 (9.0%)	38 (9.5%)	
	7 - 8 h	96 (24.1%)	83 (20.9%)	
	9 h and more	63 (15.8%)	74 (18.6%)	

Discussion

The present study was motivated by the general view that obesity, which is a risk factor for many medical conditions, is an increasing public health issue worldwide. [36] The results of previously conducted studies to assess the association between the duration of sleep and body weight, were incompatible. While most of them identified a negative association between sleep duration and BMI, some found no correlation, and others reported a positive association. To address this issue, the present study investigated the relationship between sleep duration and BMI among residents of Almadina. As most previous studies assumed that the relationship between sleep duration and BMI diminishes with age, [37] adults population were targeted here.

The present findings show no correlation between sleep duration and BMI among male and female participants. This aligns with the results of a Japanese cohort study (N = 11,325) analysing the relation between sleep duration and mortality.[38] It seems likely that this observed absence of any association between sleep duration and BMI may reflect differences in population

characteristics, as many of the large studies were conducted in Europe, America and Southeast Asia.[39,40] In addition, definitions of normal sleep vary across different studies from 6 hours to 9 hours, [41,42] and there is no agreed category scheme for sleep duration.[30]

On the other hand, a meta-analysis of 30 studies (of which 17 adult studies looked at 22 population samples) covering a total of 604,509 adult participants from 12 different countries showed a significant negative relation between BMI and the duration of sleep in adults. [28] One prospective cohort study followed more than 68,000 women over a 16-year period and found that mean weight increase (in kilograms) was greater in women with a short sleep duration. [29] Also, the results of a study conducted in Korea to assess the relation between sleep duration and overweigh in adults, showed that there is a relation between lower BMI and longer sleep duration. [43] The only reported finding of a positive association between these variables was a Japanese cohort study of 43,852 males and 60,158 females, which showed that 7 hours of sleep was associated with low BMI for both genders. [40]

The present findings show no significant correlation between BMI and sleep duration. The mean of sleep duration during weekdays was less than during the weekends; about 53.8% of the participants were reported to have shorter sleep duration on weekday while on weekends, most of participants (45%) have longer sleep duration regardless of gender. These findings are inconsistent with a self-report study of Korean adolescents which found that females get 0.49 hours more catch-up sleep. [43]

Some previous studies reported gender differences; for instance, one French study found no association between sleep and BMI in males but reported a weak relationship in the female group. For females who sleep for a short time, the average increase in mean BMI did not exceed 0.63 kg/m2. [30] Also, there is a study conducted by Heslop, P., [44] and its results showed a relationship between high BMI and short sleep duration but only among males not females.

One limitation of the present study relates to the absence of objective measurements of sleep and BMI, as we used a self-report questionnaire that may affect the accuracy of our results. Our review of the literature identified only one study that measured sleep duration objectively (using Actigraphy). [45] Another limitation of the present study relates to the variability in sleep duration and quality from night to night for each individual, which is likely to lead to basic statistical error. Additionally, the questionnaire did not ask about levels of physical activity or frequency of napping. Although, the study was confined to a limited population, it is the first to investigate the relationship between short sleep duration and BMI in Saudi Arabia.

Conclusion

The present study found no correlation between shorter sleep and both BMI and gender among adult population in Almadina. Future studies of this kind should use objective measurements of BMI and sleep duration in different regions of the Kingdom of Saudi Arabia, controlling for any confounding factors that may affect BMI.

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