Original Article

Association of Sleep with Visceral Fat in Young Adolescents of Gujarati Ethnicity

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Abstract

Background and Aim: Habitual short sleep duration is a common practice linked to weight gain and risk of obesity. The objective of the study was to find out the association between sleep and visceral fat in young adolescents of Gujarati ethnicity. **Methods:** We used cross-sectional, experimental study data from students of Gujarati ethnicity from different parts of Gujarat in the same institution (n = 608). We assessed the association between sleep duration (<7.5 h and >7.5 h) and visceral obesity (visceral fat 0–9 as normal and 9 and above as visceral obese). Young healthy adolescents of Gujarati ethnicity were enrolled in the study and divided as per the areas of Gujarat. We measured visceral fat using the body composition monitor of Omron. We measured sleep by asking them the number of hours they sleep in 24 h. Data were analyzed using SPSS software. An explorative, descriptive analysis was done; univariate analysis and logistic regression were also performed. **Results:** Univariate analysis showed that there was a negative correlation seen with Visceral fat (-0.038), Systolic pressure (-0.044) and Diastolic pressure (-0.075); while negative correlation with sleep was seen in only female population; even though the results were not statistically significant. We found the sleep in hours in our population to be a higher mean of 7.3 h in males, while it was found to be 7.1 h in females. The range of sleep was 6 h– 9 h as the 5th and 95th percentile and 7 h as the 50th percentile in both males and females. **Conclusion:** The sleep is associated negatively with visceral fat in the female population. Hence, adequacy of sleep for >7.5 h, a potentially modifiable behavior to prevent obesity needs to be considered. Detailed longitudinal studies tracking other activities that contribute to obesity also need to be done.

Keywords: Adolescence, sleep, visceral fat

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Introduction

The 21st century has seen an epidemic of obesity as well as a reduction in sleep duration and poor sleep habits due to various reasons. An association between short duration of sleep and obesity or adiposity during early childhood has been demonstrated in various epidemiological studies over the last decade.[1] Most of these studies, however, have been carried out in developed countries and definitive literature is lacking in India.[2] The recommendation for adolescents aged 13–18 years of age is a sleep duration of 8–10 h per 24 h on a regular basis so that optimal health outcomes are achieved.[3] Adequate duration and good quality of sleep lead to improved attention, behavior, learning, memory, emotional regulation, quality of life, and mental and physical health in all age groups. Hypertension, diabetes, obesity, and mental health problems such as depression are seen in those adolescents who regularly sleep either less or more than recommended sleep levels.[3] Studies of sleep duration–obesity associations during adolescence have given mixed results, vastly because of methodological differences such as parameters for assessing sleep and parameters for obesity. There are also variations in results depending on age groups and sex groups studied. The mechanisms through which short duration of sleep may predispose to obesity risk during adolescence are complex.

There are small-scale laboratory studies in young adults, which have shown that sleep restriction over several days alters energy regulatory hormones (e.g., leptin and ghrelin) in a manner, which is consistent with increased appetite and thus may

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predispose young adults to weight gain. In this study, "sleep restricted to 4 h per night over 2 days led to an 18% decrease in leptin and a 28% increase in ghrelin, which corresponded with a 24% increase in hunger and a 23% increase in appetite".[4]

While poor sleep duration or excess sleep duration can lead to obesity with various mechanisms, obesity can by itself leads to chronic sleep restriction through sleep-disordered breathing (e.g., obstructive sleep apnea [OSA]).[5] OSA is identified by recurrent episodes of the upper airway resistance and obstruction in sleep, which leads to hypopneas, apneas, disturbed sleep pattern, and impaired gas exchange. Left untreated OSA in children can lead to failure to thrive and cor pulmonale in addition to hyperactivity, behavioral difficulties, and poor academic performance. In obese children, neck-to-waist circumference ratio predicts OSA while total body fat is not suggesting that the distribution of fat may correspond to OSA and thus sleep disturbances.[6]

While studies have looked at the external distribution of fat, there is only a single published study in recent times, which has looked at the visceral fat and its association with obesity. Visceral fat is shown to be associated with sleep disordered breathing as early as in adolescence.[7] We report on the associations of visceral fat with sleep parameters in our large sample of Gujarati adolescents.

Materials and Methods

The current cross-sectional study was conducted on young adolescents of Gujarati ethnicity studying in the various institutions of the Charutar Arogya Mandal in Anand, Gujarat, and between the age group of 17–21. We present a part of the large study which studied many physiological parameters. All students with Gujarati ethnicity were invited to participate in the study, and all gave informed written consent. We excluded participants from the study those with any acute or chronic diseases, smoking, and alcoholic habits. We used Omron HBF-362 Body Composition Monitor with Weighing Scale. The monitor provides the visceral fat level and visceral fat analysis and measures weight in 100-g increments. It is based on full body sensing technology and used Bioimpedance for the same. We measured the blood pressure using a Sphygmomanometer of Omron T8 (with intellisense technology). Blood pressure was recorded in the sitting position in the right arm to the nearest 1 mm Hg using the electronic Omron machine T8 with intellisense technology (Omron Corporation, Tokyo, Japan). Self-reported sleep duration in the number of hours was noted down, and then, it was categorized as >7.5 h or <7.5 h. Sleep was categorized as below 7.5 h/day in the risk zone and above 7.5 as being of no risk. The participants were grouped into high visceral fat and low visceral fat groups using Omron visceral fat monitor. The students were categorized according to the regions of Gujarat they came from.

Statistical analysis of data

All of the statistical analyses for this study were conducted with SPSS software (version 18.0, SPSS Inc., Chicago, IL, USA). $P < 0.05$ was considered statistically significant, and all of the P values were two-sided. All statistical analyses were stratified by sex because previous studies suggested sex differences in sleep outcomes. Baseline characteristics were compared between sex subgroups using one-way analysis of variance for continuous variables and Pearson's Chi-square tests for categorical variables. Baseline characteristics were also compared between good and poor sleep quality using one-way analysis of variance for continuous variables and Pearson's Chi-square tests for categorical variables. Univariate analysis was done to find associations. Analysis of covariance and logistic regression were performed to assess the association of self-reported sleep duration with visceral fat.

Results

A total of 608 students had complete data which could be analyzed in the study. Of this, 246 were male and 362 were female. Of all the students, 32% were in low risk and 54.9% males were at low risk for the duration of sleep. We found the sleep in hours in our population to be a higher mean of 7.3 h in males, while it was found to be 7.1 h in females [Table 1]. The range of sleep was 6 h–9 h as the 5th and 95th percentile and 7 h as the 50th percentile in both males and females.

For visceral fat – most females were in the low-risk zone (98%). A comparison of sleep versus visceral fat is given in Table 2.

The mean sleep (standard deviation) is statistically significantly lower ($P < 0.0001$) in females 7.14 (0.96) than in male 7.46 (1.11). Sleep in hours was found to be higher mean of 7.3 h in males and lower 7.1 h in females. The range of sleep was from 6 to 9 h as 5th and 95th percentile and 7 h was at the 50th percentile for females, while the range in males was 6–9 h as 5th and 95th percentile and 7 h was at the 50th percentile.

Maximal number of students from Eastern Gujarat followed by South Gujarat was having their sleeping hours <7.5 h. While maximum students from Saurashtra followed by North Gujarat had their sleeping hours >7.5 h. Total risk score

Table 1: Duration of sleep in males and females

	Female, *n* (%)	Male, *n* (%)	Total, *n* (%)
Below 7.5 h	246 (68)	111 (45.1)	357 (58.7)
7.5 h and above	116 (32)	135 (54.9)	251 (41.3)
Total (*n*)	362	246	608

Table 2: Duration of sleep versus visceral fat - descriptive analysis

	Overall		Female		Male		*P*
	Mean	SD	Mean	SD	Mean	SD	
VF	3.83	3.352	2.92	2.481	5.18	3.974	<0.001
Sleep	7.269	1.036	7.139	0.9603	7.461	1.1128	<0.0001

Analysis of data was done by one-way ANOVA. $P<0.05$ was considered statistically significant. VF: Visceral fat, SD: Standard deviation, ANOVA: Analysis of variance

ranking: Eastern Gujarat-1, South Gujarat-2, Central Gujarat-3, North Gujarat-4, and Saurashtra-5 [Table 3].

There was a negative correlation seen with visceral fat (−0.038), systolic pressure (−0.044), and diastolic pressure (−0.075) with sleep seen in only female population although the results were not significant [Table 4]. We found the sleep in hours in our population to be a higher mean of 7.3 h in males, while it was found to be 7.1 h in females. The range of sleep was 6 h to 9 h as the 5th and 95th percentile and 7 h as the 50th percentile in both males and females.

Discussion

Very few studies have looked at the distribution of fat and sleep duration, and the current study is the first, which has evaluated the relation between duration of sleep and visceral fat. Our data show that there is little if any correlation between the duration of sleep and presence of visceral fat. In females, it is a negative correlation which is not expected. It is likely that the reduction in sleep was not significant enough to reduce weight loss and may have been offset by poor intake of food. In a large population-based study from China, it was found that the Global Pittsburgh Sleep Quality Index for females was not affected by abdominal obesity, while it was affected for males.[8] Experimental studies where volunteers had five or fewer hours of sleep have shown excess weight gain in the immediate period. After sleeping for 4 h/night on five consecutive nights, they gained 1 kg more than controls due to the consumption of extra calories (130% of daily caloric requirements). The increased daily energy intake was due to more meals are eaten, especially during late night hours with an overall consumption of an extra 550 calories.[9] In a randomized crossover trial in children aged 8–11 years, it was seen that compared to reducing sleep duration by 1.5 h/night, increasing sleep duration by 1.5 h/night over a week resulted in lower food intake and consequent lower body weight.[10] Two systematic reviews of sleep duration have tried to quantify the cross-sectional association between sleep duration and obesity in the pediatric population including adolescents. One of them reported a pooled odds ratio (OR) of 1.89 (95% confidence interval [CI] 1.43–1.68) for short sleep duration and its association with obesity.[11] The other one also published around the same time (a decade back) showed that children and adolescents with smaller sleep duration had a pooled OR of 1.58 (95% CI 1.26–1.98) for overweight/obesity, and those with shortest sleep durations had an even higher risk when compared with those having longer sleep durations (OR 1.92; 95% CI 1.15–3.20).[12] A recent systematic review of 42 prospective studies (of which three were in adolescents and involving 26,652 participants) showed that short sleep duration is a risk factor or marker of the development of obesity in infants, children, and adolescents.[1] Another systematic review published recently showed that apart from duration sleep quality also matters and can influence obesity.[13] We did not monitor sleep quality, and hence, it is likely that even short duration of sleep may be good quality and can hence not cause obesity in the current study.

The current study is probably the first, which focuses on ethnicity and visceral fat. Ethnicity and other ethnographic parameters are important as they contribute to food habits, other concepts, and habits which have an important bearing on obesity. The onset of modernism in India and the subsequent globalization is causing homogenization of food habits and activities; and in the process, we may lose many features which may be protecting native populations from obesity, and hence, it is important to focus on them. This is one of the strengths of the study, and we found that the sleeping hours were not too less for the adolescent population. Our institution is located in a rural area, and hence, the findings may not be generalizable to urban India.

Conclusion

Adequacy of sleep for >7.5 h, a potentially modifiable behavior to prevent obesity needs to be considered. Detailed longitudinal studies tracking other activities that contribute to obesity also need to be done.

Limitations of the study

The study has several limitations such as the design, which allows us to only establish associations and not causation. Since we did not have to follow-up built-in into the study, we are not able to track sleep patterns and quality over a period.

In the future, it may be possible to have studies with a better design. Much of this can be contributed by the technological innovations that have happened in smartphones and wearable

Table 3: Region-wise categories of sleep duration

	Central Gujarat (*n*=261)	East Gujarat (*n*=105)	North Gujarat (*n*=64)	South Gujarat (*n*=51)	Saurashtra (*n*=100)	Kutch (*n*=8)
Below 7.5 h	59	73.3	53.1	62.7	46	37.5
7.5 h and above	41	26.7	46.9	37.3	54	62.5

Table 4: Correlation of parameters with visceral fat, systolic pressure, and diastolic pressure

	VF	VF female	VF male	SP	SP female	SP male	DP	DP female	DP male
Sleep	0.047	−0.038	0.012	0.114	−0.044	0.119	0.042	−0.075	0.12

VF: Visceral fat, SP: Systolic pressure, DP: Diastolic pressure

technology. We suggest using activity trackers coupled to fitness apps on smartphones to track adolescents over longer periods of time, such as the entire duration of the course. Using input related to diet from apps and repeated examinations of fat distribution and triangulating this data with examinations, exam scores, sports activities, etc., it may be possible to build models which contribute to poor habits and then design specific interventions to improve sleep durations, diet, etc.

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Conflicts of interest

There are no conflicts of interest.

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