ORIGINAL RESEARCH PAPER

Nutritional Science

ASSOCIATION OF PERCEIVED STRESS AND SLEEP DURATION WITH BMI AMONG SCHOOL-GOING ADOLESCENTS: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Perceived stress and sleep duration are recognized as significant factors which impact physical and mental health. They also pose a potential risk for the promotion of overweight and obesity in adolescents they are more prone to stress due to increased academic workload and competition. This study aimed to assess the association of perceived stress and sleep duration with BMI among 14-16 year-old school-going adolescents. **Methods:** This cross-sectional study assessed the perceived stress levels and sleep duration of 215 purposively recruited adolescents by the Perceived Stress Scale and Pittsburgh Sleep Quality Index respectively. Anthropometric measurements were analyzed to assess the nutritional status. **Results:** The prevalence of obesity among boys and girls was 13.6% and 6.7% respectively. 30% of participants were underweight, whereas 13.3% of the girls and 17.3% of the boys were overweight. Girls reported having higher moderate to severe perceived stress than boys; and 74.4% of participants had poor sleep quality. The data showed a significantly positive association between perceived stress and body fat percentage (P<0.05). Sleep quality was also positively associated with BMI, waist circumference, and body fat percentage but results were not significant. **Conclusion:** The results showed that higher levels of perceived stress were significantly and positively associated with body fat percentage. Also, the study inferred an association of poor sleep quality with higher stress. It, therefore, remains paramount to plan stress and sleep management interventions during the adolescence stage, to foster better health among adolescents.

INTRODUCTION:

There has been an alarming increase in obesity rates worldwide making it a major public health epidemic. It is an independent risk factor for cardiovascular disease (CVD) and is associated with an increased risk of morbidity and mortality as well as many adverse health outcomes including type 2 diabetes, hypertension, dyslipidaemia and types of cancers [1]. Thus, the identification of modifiable risk factors of obesity could help in developing preventive strategies. Prior research indicates numerous factors, including the role of diet, physical activity and overindulgence in indoor leisure activities (like television viewing, social media, and computer games) in mitigating obesity risk [2]; while recently, factors like sleep duration and perceived stress have also been associated with obesity in adolescents [3].

Perceived stress is the state of threatened or perceived as threatened homeostasis and is associated with activation of the stress system [4]. It can affect one's physical, as well as psychological well-being. Sleep is a restorative process that is vital for healthy functioning of the body, and factors like perceived stress can have a negative impact, and consequently influence weight gain and the onset of obesity [5-7]. Moreover, adolescents are more prone to stress due to increased academic workload and competition which also has a detrimental impact on sleep quality and duration. For example, the excessive amount of assignments/ homework [8] along with the grade competition, failures, and poor interrelationships with peers represent sources of stress [9].

The prevalence of overweight and obesity has increased among children and adolescents [10-12]. In India, Comprehensive National Nutrition Survey (CNNS) 2016-18 reported the prevalence of overweight and obesity among adolescents aged 10–19 years to be 4.8% and 1% respectively. In addition, India is undergoing major epidemiological, nutritional, and demographic transitions[13]. These transitions tend to promote obesity in all age groups.

Perceived stress and sleep duration are proposed as possible contributing factors to the increased risk of overweight and obesity. Sleep is increasingly recognized as an important lifestyle contributor to health. Short or disrupted sleep has repeatedly been linked to an increased risk of developing obesity in adolescence and can impact the risk of chronic diseases [14,15]. Short sleep duration has emerged as being related to adverse cardio-metabolic risk, including obesity, hypertension, type 2 diabetes mellitus, and cardiovascular disease [16].

Furthermore, perceived stress is one factor that can seriously impact sleep quality and sleep duration. The stress system normally functions in a circadian manner and interacts with other systems to regulate behavioral, endocrine, metabolic, immune, and cardiovascular functions. However, the experience of acute, as well as chronic stress, may lead to the development of several psychological conditions, including anxiety, sleeplessness, or other negative adjustments [4,17]. As a coping mechanism, many people may resort to eating practices that may increase their risk for obesity [17]. A previous study reported that stress-related eating among adolescents can increase the consumption of sweets and fatty foods and alcohol more often than their peers without stress-driven eating behavior [18]. Therefore, due to its effect on eating behavior, it can directly influence over-or under-eating, and preferentially selecting highly palatable foods for satiety, weight gain, and the onset of obesity [19,20].

Moreover, the last two decades have witnessed a dramatic increase in healthcare costs due to obesity and its related co-morbidities [21]. Therefore, it is important to tap factors that can increase the risk of obesity as early as possible in the life cycle and to make stress management and adequate sleep a priority while emphasizing on the benefits of a healthy lifestyle.

Thus, in the present study, the perceived stress levels and sleep duration of adolescents and their association with nutritional status was analyzed to create evidence for planning nutrition, stress, and sleep management interventions during the adolescence stage.

MATERIAL AND METHODS:

Study Design:

This was a cross-sectional study with the primary objective to assess the association of perceived stress and sleep duration

with nutritional status among 14-16 year-old school-going adolescents. Purposively three schools (one public and two government schools) of Delhi were selected, who agreed to participate in the study. The data was collected for one month (December 2019 - January 2020). Ethical clearance was obtained from the Institutional Ethics Committee. Informed written consent was obtained from the participants as well as the parents, and a study information sheet was explained and given to them.

Sampling Procedure:
The study population consisted of 215 participants selected using purposive sampling. The sample size was calculated based on the percentage of under-nutrition, overweight and obese adolescents aged 10-19 years using the Comprehensive National Nutrition Survey (CNNS) 2016-18 and National Family Health Survey-4 (NFHS) 2015-16 [22-24].

The formula used for sample size calculation, $n = \frac{(Z_{\alpha/2}^2 \times p \times (1-p))}{d^2}$

[n = sample size, Z = statistic corresponding to level of confidence, p = expected proportion in population based on previous studies, d = absolute error or precision]

The total sample size according to CNNS (2016-18) and NFHS-4 (2015-16) is **472** and **1044** respectively**.** But due to time constraints, the sample size taken was **215**.

The inclusion criterion was students of both genders in the age group of 14-16 years, who gave their assent to participate in the study. The informed consent was obtained from the parents before the study was administered. Adolescents with any acute or chronic illness or having featured suggestive of the genetic or endocrinal origin of obesity or on medication and taking prescribed anti-depressants and sleeping pills were excluded from the study.

Data Collection:
Following information was gathered from the participants:
I. Demographic Profile: A questionnaire was used to gather information regarding the participant's general profile, eating habits, and physical activity. The information on the education status and occupation of parents was collected using Modified Kuppuswamy Scale 2019 [25].

ii. Perceived Stress: Perceived stress levels were assessed by using the perceived stress scale 10 (PSS-10) [26]. Responses were made on a 5 point scale (never, rarely, sometimes, often, and very often), and the items are then summed to give a total perceived stress score. According to the total score obtained the subjects were divided into:
- 0-10: No Stress
- 11-20: Mild Stress
- 21-30: Moderate Stress
- 31-40: Severe Stress

iii. Sleep duration: The Pittsburgh Sleep Quality Index (PSQI) was used to measure the quality and patterns of sleep duration. It differentiates "poor" from "good" sleep by measuring seven domains: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, and sleep disturbances, use of sleep medication, and daytime dysfunction over the last month. Scoring of the answers is based on a 0 to 3 scale, whereby 3 reflect the negative extreme. A global sum of "5" or greater indicates a "poor" sleeper [27].

iv. Anthropometric Measurements: Weight, Height, Waist and Neck circumference and Body Fat Percentage were taken, and Body Mass Index was calculated and compared with reference cutoff values of the World Health Organization (2007) and Indian Academy of Pediatrics (2015) [28-30]. The weight of participants was measured using a portable weighing machine, with a sensitivity of 0.1 kg, and height was

measured using a stature meter, with a sensitivity of 0.1 cm. A non-stretchable measuring tape was used to measure neck and waist circumference. The waist circumference cut-offs for boys were 70.75 cm and 69.25 cm for girls [29]. The cut-off values of neck circumference for screening adolescent obesity in boys and girls were 30.75 cm and 29.75 cm respectively [29]. To measure body fat percentage, Tanita Body Composition Analyzer was used in this study. The cut-off of 75th and 85th percentile of body fat percentage was used to detect excess fatness [30].

Statistical Analysis:
The data was entered into Microsoft Excel followed by analysis using IBM SPSS Statistics for Windows, version 23.0 (Armonk, New York, USA). The statistical methods used in this study included calculation of means, frequency and standard deviation, Pearson Correlation coefficients, chi-square test, and percent distributions; < 0.05 was considered statistically significant.

RESULTS:
In this study, 215 adolescents in the age group of 14-16 years were selected. Out of them, 51.2 % were boys and 48.8 % were girls. The subject characteristics are presented in Table 1. The mean weight and height of the study population were found to be 50.83 ± 11.88 kg and 159.55 ± 8.68 cm respectively. The cut-off values of neck circumference for screening adolescent obesity revealed that all participants were below the cut-offs, hence they were not overweight or obese. The mean neck circumference for boys was 12.76 cm ± 1.0 SD and 11.62 cm ± 0.8 SD for girls.

Table 1. Subject characteristics of the participants (n = 215).

Variable	Mean ± SD
Height of the Participant (in cms)	159.55 ± 8.68
Weight of the Participant (in kgs)	50.83 ± 11.88
BMI of the Participant (kg/m2)	20.51 ± 4.26
Neck Circumference (cm)	12.20 ± 1.08
Waist Circumference (cm)	27.88 ± 3.52
Body Fat Percentage	21.31 ± 10.50

The distribution of participants according to waist circumference and body fat percentage is depicted in Table 2. According to waist circumference, boys (25.4 %) were more overweight or obese compared to girls (12.3 %). Body fat percentage of the participants was assessed and a majority of them (85.5% boys and 85.7% girls) reported normal levels; followed by moderate body fat (10% boys and 9.5% girls). Only 5% of boys and girls reported having elevated body fat percentages.

Table 2. Waist Circumference and Body Fat Percentage of the Participants (n=215)

Variable		Girls	Boys
Waist Circumference	Overweight/Obese	13 (12.38%)	28 (25.45%)
	Normal	92 (87.61%)	82 (74.54%)
Body Fat Percentage	Normal Body Fat	90 (85.7)	94 (85.5)
	Moderate Body Fat	10 (9.5)	11 (10.0)
	Elevated Body Fat	5 (4.8)	5 (4.5)

Figures in the parenthesis are percentages.

BMI of the Participants: According to the Indian Academy of Paediatrics (IAP) Cut-offs for BMI, among girls, 30.5% were underweight, 49.5% were normal, 13.3% were overweight and 6.7% were obese. Whereas among boys, 30.9% were underweight, 38.2% were normal, 17.3% were overweight and 13.6% were obese.

BMI of the participant according to WHO 2007 Cut-Offs showed that among girls, 33.3% were underweight, 57.1%

were normal, 6.7% were overweight and 2.9% were obese. In the same way between boys, 30.9% were underweight, 47.3% were normal, 20% were overweight and 1.8% were obese.

Perceived Stress Levels and Sleep Quality of the Participants: It was observed that only a small percentage of participants (5.7% of girls and 4.5% of boys) reported no stress. The majority of them revealed mild stress followed by moderate stress. Girls reported having higher moderate to severe stress than boys.

The sleep quality of the participants was scored in the good or poor categories; wherein the majority (75.2% girls and 73.6% boys) reported poor sleep quality. The data has been summarized in Table 3.

Table 3: Perceived Stress Score and Sleep Quality of the Participants (n=215)

Variable		Girls	Boys
Perceived Stress Score	No Stress	6 (5.7%)	5 (4.5%)
	Mild Stress	52 (49.5%)	69 (62.7%)
	Moderate Stress	45 (42.9%)	35 (31.8%)
	Severe Stress	2 (1.9%)	1 (0.9%)
PSQI scores	Poor Quality of Sleep	79 (75.2%)	81 (73.6%)
	Good Quality of Sleep	26 (24.8%)	26 (24.8%)

Figures in the parenthesis are percentages.

Association of Sleep Quality with Perceived Stress: A positive correlation between sleep quality score and perceived stress among participants was seen, though the results were not significant in the present study.

Association between Perceived Stress and Sleep Quality with Nutritional Status: Perceived stress was significant and positively associated with body fat percentage (Table 4). A positive association was found between perceived stress scores with BMI and waist circumference of the study population but the result was not significant. Sleep quality was also positively associated with BMI, waist circumference, and body fat percentage however the results were not significant. The results are summarized in Table 4.

Table 4. Association between Perceived Stress and Sleep Quality with Nutritional Status (n=215)

		BMI of the Participants	Waist Circumference	Body Fat Percentage
Perceived Stress	Pearson Correlation	.107	.085	.161*
	Sig. (2-tailed)	.117	.213	.018
Sleep Quality	Pearson Correlation	.048	.041	.011
	Sig. (2-tailed)	.485	.550	.873

*$p \leq 0.05$; **$p \leq 0.01$

DISCUSSION:
Obesity and its associated health risks have risen dramatically in the past few decades[10-12]. Easy accessibility to highly palatable nutrient-dense foods and lifestyle factors like perceived stress, physical inactivity, and poor sleep duration create an environment that promotes overweight and obesity [31]. The purpose of this cross-sectional study was to assess the association of perceived stress and sleep duration with nutritional status among 14-16 year school-going adolescents in Delhi. Information from the participants was collected regarding their general profile, anthropometric measurements, perceived stress levels, and sleep duration and quality.

The present study showed higher level of overweight and obesity among school-going adolescent boys, according to the IAP classification of BMI (2015) and waist circumference classification cutoffs [29]. Previous studies have also reported a similar higher prevalence of obesity among boys, compared to girls [32-33]. The number of subjects in the underweight category remained roughly the same according to national and international classifications and a majority had normal body fat percentages. Further, according to neck circumference, no participant was reported into the overweight/obese category. However, according to waist circumference classification, more boys were overweight or obese.

It was found that girls reported having higher moderate to severe perceived stress levels than boys. Previous studies also stated that girls perceive more stress than boys [32,34]. A majority of the participants (75.2% girls and 73.6% boys) reported poor sleep quality. However, evidence from a previous study in India among adolescents (aged 12–17 years) has shown the prevalence of poor sleep quality[33] to be around 37.6%.

Furthermore, a positive correlation was found between sleep quality score and perceived stress among participants though the results were not significant in this study. Similarly, a previous study has also reported that the prevalence of stress was high among adolescents and it was negatively influencing their sleep pattern [35].

Perceived stress was found to be positively and significantly associated with body fat percentage (p<0.05). It can be thus inferred that higher levels of perceived stress can cause greater adiposity. These study results are consistent with previous studies that reported associations of perceived stress with weight gain and general adiposity during adolescence [36]. It was also found that perceived stress was associated with BMI and waist circumference though the results were not significant. Similarly, other studies have also found that perceived stress was associated with increased measures of general and abdominal adiposity and a higher waist circumference in adolescents [21,36]. The major limitation of this study was its cross-sectional design and to understand the causation effect, longitudinal studies are required. In addition, the findings of the study were based on the self-reported information of the participants.

The findings of the present study identified the role of a balanced diet with adequate and good quality sleep and reduced stress levels for overall development among adolescents. Interventional strategies targeting lifestyle factors such as stress management, time management, and sleep deprivation should be adopted by educational organizations. Good sleep hygiene should be promoted among the students and regular sleep schedules should be maintained. Adopting regular physical activity may help reduce perceived stress levels, may improve sleep quality and also will prevent weight gain. In addition, avoiding high-fat and high-sugar foods will prevent obesity and a proper balanced diet will promote a healthy lifestyle.

Further, future research is needed to understand the pathways through which sleep duration influences weight gain and to understand whether improving sleep quality is preventive to weight gain. Stronger evidence is needed for the association of high perceived stress level, poor sleep quality with increased BMI in adolescents.

CONCLUSION:
The study highlights that majority of the adolescents had mild to moderate stress. Our results showed that higher levels of perceived stress were positively associated with BMI and waist circumference and significantly associated with body

fat percentage among 14-16 year old adolescents. Sleep quality was also positively associated with BMI, waist circumference, and body fat percentage but the results were not significant.

Ethical Statements
Declaration Of Interest Statement
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Disclosure of interest
The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Availability of data and materials
The raw data are not publicly available due to them containing information that could compromise the privacy of research participants.

Ethical approval
Ethical clearance was obtained from the Institutional Ethics Committee.

Patient consent
Before administering the questionnaire, informed written consent was taken from the students as well as the parents and a study information sheet was explained and given to the participants and parents before data collection.

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