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Hypertension, Inadequate Sleep, and Smoking are Commonly Associated with being Overweight and Obese among University Students in India

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Abstract

Background: Obesity is one of the major global health issues causing significant economic burden in both developed and developing countries. The prevalence of obesity is often associated with lifestyle and family history of obesity or related co-morbidities.

Methods: The study involving 786 volunteers between July 2015 and June 2016 was conducted at the Vellore Institute of Technology, Vellore, India based on a survey questionnaire along with anthropometric measurements, such as height, weight, waist and hip circumference and blood pressure.

Results: Our findings revealed the prevalence of general obesity based on body mass index with 16.2% of the study population categorized as overweight and 29.9% as obese. However, abdominal obesity based on waist circumference and waist-to-hip ratio turned out to be 26.5% and 24.8%, respectively. Hypertension ($p < 0.001$), high fat/sugar diet in females ($p = 0.035$), inadequate sleep ($p < 0.001$), and smoking ($p = 0.001$) were all observed more frequently among obese individuals who also had a family history of obesity-related medical condition(s) when compared to normal individuals.

Conclusion: Increase in the prevalence of both general and abdominal obesity was influenced by poor food choices, lifestyle changes, and inadequate sleep which pose a serious risk for the development of cardiovascular disorders among young adults in India.

Keywords: Obesity; Hypertension; Smoking

Introduction

Obesity has emerged as one of the major global health problems affecting several millions today. Since 1975, the prevalence of obesity worldwide has almost tripled rising to pandemic proportions. According to a 2016 report by the World Health Organization (WHO), more than 1.9 billion adults, 18 years and older were overweight, of which about 650 million were obese [1]. The global prevalence of overweight and obesity has been projected to reach 2.16 billion and 1.12 billion respectively, by the end of that decade [2]. Apart from malnutrition and infectious diseases, obesity is the major cause for morbidity, mortality, and reduced quality of life throughout the world [3-5]. In the year 2010, 3.4 million deaths occurred as a result of being either overweight or obese which had contributed to 3.8% of disability-adjusted life years globally [6,7]. Obesity has long been referred to as a medical condition until 2013 when several medical societies, including the American Medical Association and the American Heart Association, classified it as a disease [8]. Obesity is often associated with several other co-morbidities including diabetes, cardiovascular disorders, cancers, dyslipidaemia, reproductive disorders, and liver diseases [4,9,10]. The WHO considers obesity as the fifth major risk factor contributing to the global burden of chronic diseases. Recent studies have also revealed that 44% of diabetes, 23% of cardiovascular disorders, and 7-41% of certain types of cancer could be attributed to overweight and obesity [11].

India being home to a large population of diabetic individuals, both young and old, a sharp increase in the prevalence of obesity has become an alarming public health concern [12-15]. According to a study conducted on the global burden of diseases in 2013, India has been ranked third for having the most number of obese individuals [16]. INDIAB (India Diabetes), a study conducted in three representative states and one union territory of India during 2008-10 (Phase I) by the Indian Council of Medical Research estimated that 7.33% of the population were overweight while the prevalence of general obesity, abdominal obesity, and combined obesity were 11.25%, 12.92%, and 8.92%, respectively [12]. The financial burden of obesity is huge at the individual, national, and international levels. In 2014, the world gross domestic product incurred an estimated loss of 2.8% due to the disease burden brought by obesity [17,18]. In 2005, India suffered a $9 billion loss in its national income due to the burden of heart diseases, stroke, and diabetes which is expected to increase multi-fold in the near future [19,20].

Obesity is characterized by an unusual body weight gain with serious implications on the normal health of individuals. It results from an abnormal or excessive accumulation of fat in the adipose tissues [21]. Several studies have shown that apart from genetics, epigenetic factors, such as diet, environmental toxins, physical activity, and lifestyle also contribute greatly to the development of obesity [22,23]. During the course of urbanization over the past few decades, wealthy populations have experienced an epidemiological transition towards obesity [24]. Urbanization and modern lifestyle have a very strong and harmful impact among school and university students gravely affecting their overall health. Indeed, urbanization has led to several deleterious changes in lifestyle, physical activity, and calorie intake of the millennials [25,26].

The aim of this study was to assess the prevalence of overweight and obesity and identify possible risk factors among university students in India. It was also conducted to bring awareness about the potential healthcare implications of poor food choices and lifestyle changes in a growing population of young adults in the country.

Participants, Materials, and Methods

Ethical approval

This study was conducted with the approval of the Institutional Ethical Committee for Studies on Human Subjects (Ref.No.VIT/IECH/02/May23,2014) at the Vellore Institute of Technology (VIT), Vellore, India. It was based on a survey questionnaire along with anthropometric measurements which was carried out after obtaining written informed consent from all the participants as per the guidelines of the Declaration of Helsinki [27].

Study design and human subjects

The study was conducted on university students in VIT Vellore who hailed from different parts of the country (Table 1). While individuals of both genders between the ages of 18 and 32 years were included, pregnant and lactating females as well as foreign nationals were excluded from this study. Participants were divided into three age groups, namely 18-22, 23-27, and 28-32 years comprising of students in bachelor's, master's, and doctoral programmes. Between July 2015 and June 2016, a total of 786 volunteers participated in the study which consisted of a survey questionnaire covering different sections related to food

habits, awareness about obesity and its risk factors, physical activity, medical history of the individual and their family members, drinking and smoking habits, and socio-economic status. Anthropometric measurements, such as height, weight, waist circumference, hip circumference, and blood pressure were taken using standard procedures (Table 2).

Table 1: Distribution of participants from across the states of India

S. No.	State of Origin	Number of Participants (%)
1.	Tamil Nadu	298 (37.91)
2.	West Bengal	74 (9.41)
3.	Maharashtra	50 (6.36)
4.	Kerala	49 (6.23)
5.	Uttar Pradesh	43 (5.47)
6.	Karnataka	36 (4.58)
7.	Andhra Pradesh	32 (4.07)
8.	New Delhi	30 (3.82)
9.	Odisha	15 (1.91)
10.	Madhya Pradesh	13 (1.65)
11.	Bihar	12 (1.53)
12.	Haryana	11 (1.40)
13.	Assam	10 (1.27)
14.	Telangana	10 (1.27)
15.	Gujarat	8 (1.02)
16.	Jharkhand	7 (0.89)
17.	Rajasthan	7 (0.89)
18.	Chhattisgarh	5 (0.64)
19.	**Others	76 (9.67)

** Puducherry, Punjab, Uttarakhand, Himachal Pradesh, Tripura, Andaman and Nicobar Islands, Arunachal Pradesh, Meghalaya and undisclosed states

Table 2: Anthropometric data of study participants

	Underweight (N = 94)		Normal (N = 330)		Overweight (N = 235)		Obese (N = 127)	
	Male Mean (SD) (N = 34)	**Female** Mean (SD) (N = 60)	**Male** Mean (SD) (N = 97)	**Female** Mean (SD) (N = 233)	**Male** Mean (SD) (N = 90)	**Female** Mean (SD) (N = 145)	**Male** Mean (SD) (N = 53)	**Female** Mean (SD) (N = 74)
Age **(years)**	19.82 (1.7)	19.82 (1.94)	20.16 (2.02)	20.1 (1.88)	21.04 (2.65)	20.41 (1.9)	21.91 (3.72)	20.5 (1.89)
Body weight **(kg)**	51.7 (5.25)	44 (7.09)	61.9 (5.56)	52 (5.21)	72.03 (6.06)	61.61 (6.07)	89.33 (15.32)	76.02 (8.88)
Height **(cm)**	173 (6.81)	158 (6.47)	172 (6.4)	158.3 (6.65)	170.22 (6.20)	158.2 (6.30)	170.53 (10.79)	157.84 (5.71)
BMI	17.27 (1.07)	17.14 (0.87)	20.8 (1.24)	20.74 (1.21)	24.83 (1.07)	24.58 (1.18)	30.98 (5.28)	30.51 (3.28)
WC **(cm)**	69.8 (10.88)	64.5 (8.76)	76 (4.77)	71.74 (9.56)	84.12 (8.84)	79.98 (15.31)	99.65 (13.65)	93.19 (13.71)
HC **(cm)**	79.67 (8.44)	82.1 (6.99)	84.6 (5.38)	87.77 (9.72)	90.23 (11.04)	93.84 (12.26)	103.54 (13.96)	104.3 (9.99)
W/H	0.88 (0.06)	0.81 (0.19)	0.9 (0.05)	0.82 (0.15)	0.92 (0.10)	0.86 (0.20)	0.96 (0.05)	0.9 (0.18)
SBP **(mm Hg)**	116.9 (10.8)	103 (10.29	119.6 (12.2)	105 (10.71)	124.5 (12.49)	108.8 (12.16)	128.33 (12.13)	118.8 (11.76)
DBP **(mm Hg)**	69.7 (8.4)	67.13 (8.42)	68.4 (7.44)	66.8 (8.44)	71.98 (8.87)	71.53 (10.46)	76.22 (10.27)	76.54 (9.86)

BMI: Body mass index; WC: Waist circumference; HC: Hip circumference; W/H: Waist-to-hip ratio; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure

Measurement of body mass index

Height and body weight measurements were done to calculate the body mass index (BMI). A BMI (kg/m^2) of < 18.5 is considered as underweight, 18.5-22.9 as normal, 23-26.9 as overweight and > 27 as obese according to the BMI Guidelines for Asians and Asian Americans [28].

Measurement of waist circumference and waist-to-hip ratio

Waist circumference (WC) and hip circumference measurements were done using a non-stretchable measuring tape. The normal cut-off values for WC (cm) and waist-to-hip ratio (W/H) are 90 and 80, and 0.9 and 0.8 for males and females, respectively [29,30].

Measurement of blood pressure

Blood pressure (BP) was recorded using an electronic blood pressure monitor. Individuals with a systolic BP ≥ 140 and/or a diastolic BP ≥ 90 mm Hg were considered as hypertensive [31].

Sleep duration

Based on sleep duration, individuals were categorised into those getting less sleep (< 7 h), normal sleep (7-9 h), and more sleep (> 9 h) based on the recommendations of the National Sleep Foundation [32].

Socioeconomic status

Socioeconomic status was determined based on the annual family income of the participants. It was classified into low (< ₹60,000), lower-middle (₹60,000-₹1,80,000), middle (₹1,80,000-₹6,00,000), upper-middle (₹6,00,000-₹12,00,000) and high-income (> ₹12,00,000) groups.

Statistical analysis

All statistical analysis was performed using SPSS 16.0 software (IBM, Chicago, USA). Descriptive statistics such as percentages for categorical variables and mean ± SD for continuous variables were calculated. Pearson's chi-squared test was used to find association among variables. Student's t-test for difference in means was also used. For all the tests, a two-sided p-value of 0.05 or less was considered statistically significant.

Results

Anthropometric analysis

A cross-sectional study on the prevalence of overweight and obesity and associated risk factors was conducted among 786 student volunteers in VIT Vellore. The study consisted of participants in the age group of 18-32 years, except pregnant and lactating females. The study population consisted of 274 males (34.86%) and 512 females (65.14%).

Prevalence of overweight and obesity

General obesity based on BMI revealed 11.96% to be underweight (12.4% male and 11.7% female), 41.98% normal (35.4% male and 45.5% female), 16.2% overweight (19.3% male and 14.5% female), and 29.9% obese (33.8% male and 28.3% female), p = 0.033 and p = 0.041, respectively (Figures 1A and B). A significant difference in the age-wise distribution of individuals across the various BMI categories was observed. While a larger proportion of individuals in the 28-32 and 23-27 age groups were overweight and obese, respectively, majority of the 18-22 age group were normal, p = 0.006 (Figure 1C).

Measurement of WC among participants indicated that 26.5% of the study population had WC values higher than the normal cut-off. The percentage of population with abnormal WC values was significantly higher among the overweight and obese (47.1% and 34.1%, respectively) when compared to the underweight and normal categories (4.3% and 14.4%, respectively), p < 0.001 (Figure 2A). Abnormal WC values were higher among females (28.9%) when compared to males (21.9%) (Figure 2B). On the other hand, 211 participants (24.8%) had W/H ratios higher than the normal cut-off. The percentage of population with abnormal W/H ratios was also significantly higher among the overweight and obese (31.3% and 35.5%, respectively) when compared to the underweight and normal categories (4.7% and 28.4%, respectively), p < 0.001 (Figure 2C). Abnormal W/H ratios were higher among males (30.7%) when compared to females (24.8%) (Figure 2D).

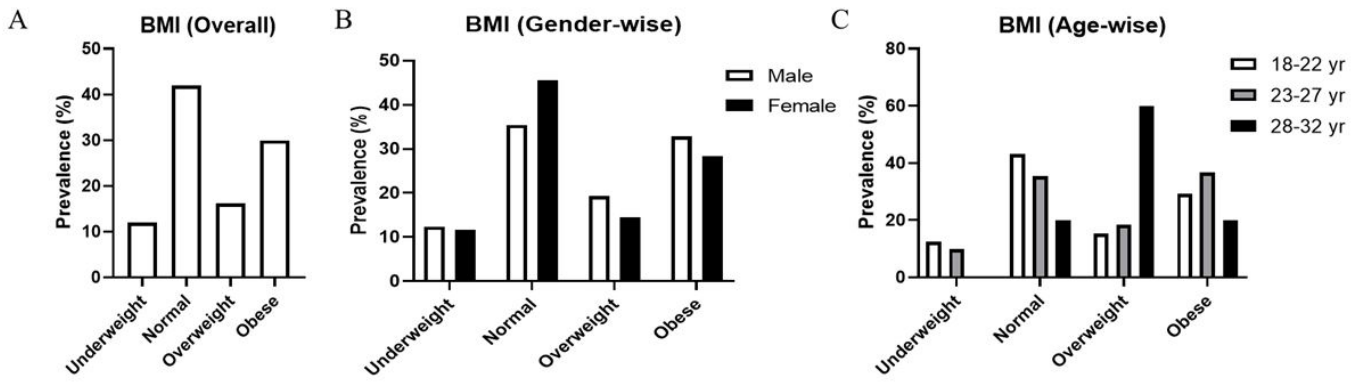

Figure 1: Prevalence of underweight, normal, overweight, and obese individuals based on BMI **(A)** Overall prevalence between different categories (p = 0.033); (**B)** Prevalence among males and females (p = 0.041); (**C)** Prevalence within age groups, 18-22, 23-27, and 28-32 years (p = 0.006)

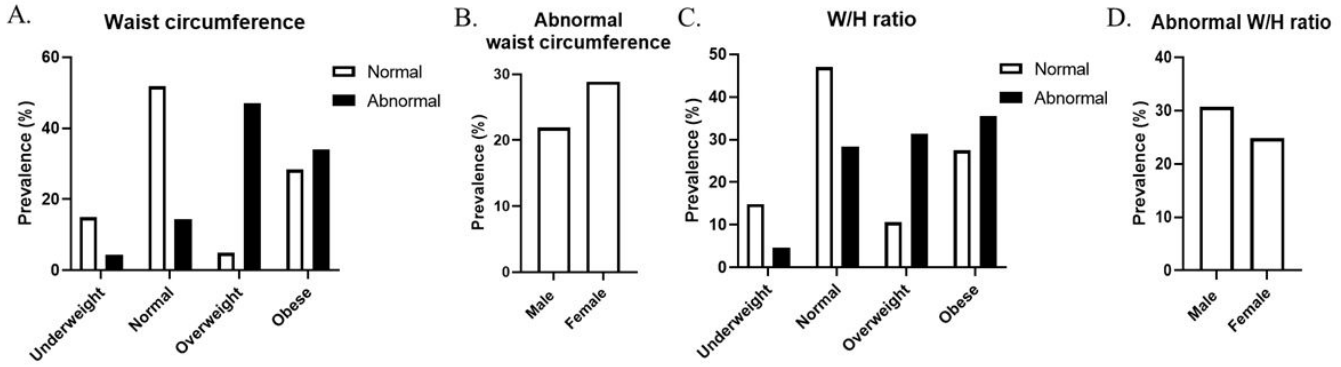

Figure 2: Assessment of abdominal obesity based on WC and W/H ratios (**A)** Proportion of individuals with normal and abnormal WCs across different categories based on BMI (p < 0.001); (**B)** Proportion of males and females with abnormal WC; (**C)** Proportion of individuals with normal and abnormal W/H ratios across different categories based on BMI (p < 0.001); (**D)** Proportion of males and females with abnormal W/H ratios

Blood pressure

In the study, 6.23% of the population had hypertension which was more common in the overweight and obese categories, i.e., out of 49 participants with hypertension, 23 were overweight and 19 were obese (46.9% and 38.8%), whereas it was 1 and 6 in underweight and normal categories, respectively (2% and 12.2%), p < 0.001 (Figure 3A).

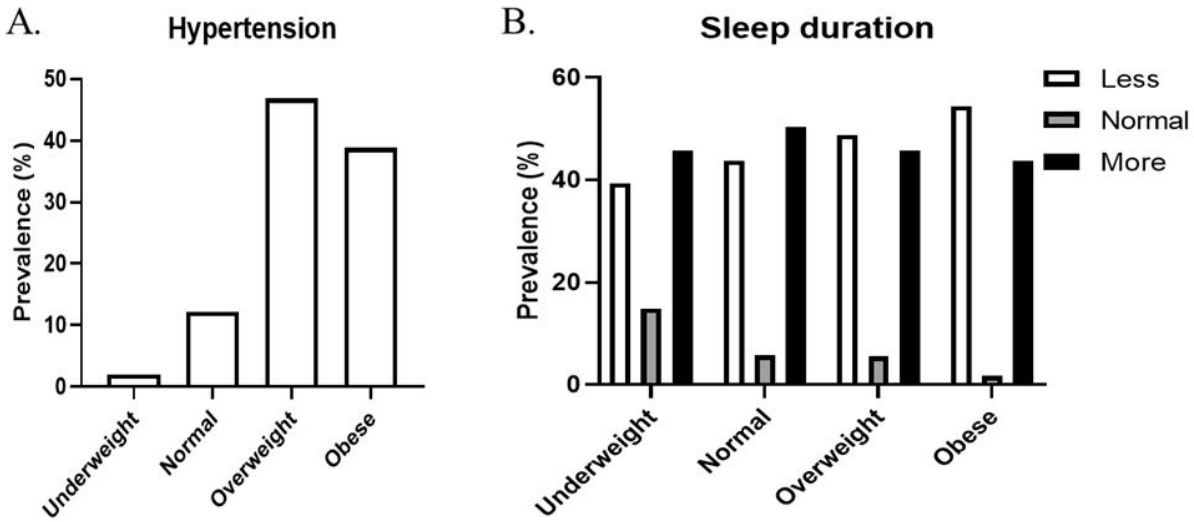

Figure 3: Hypertension prevalence and sleep duration **(A)** Proportion of individuals with hypertension across different categories (p < 0.001); (**B)** Proportion of individuals based on their sleep duration across different categories (p < 0.001)

Sleep duration

It was observed that individuals with higher BMI did not get adequate sleep when compared to others. For instance, the obese category had the lowest number of individuals (1.7%) who slept for the recommended duration (7-9 h), and highest numbers who slept less (< 7 h, 54.5%) when compared to the underweight and normal categories (39.4% and 43.8%). However, the number of individuals who slept for longer duration (> 7 h) did not differ much between the categories, $p < 0.001$ (Figure 3B).

Food choices

Food preferences, such as vegetarian, non-vegetarian, and fast foods, as well as frequency of fast foods consumed by them were not significantly different across the BMI categories (data not shown). However among females, overweight and obese individuals seemed to prefer a significantly higher proportion of fat/sugar in their diet compared to other foods (71.6% and 64.8%, respectively), $p = 0.035$ (Figures 4A,B and C).

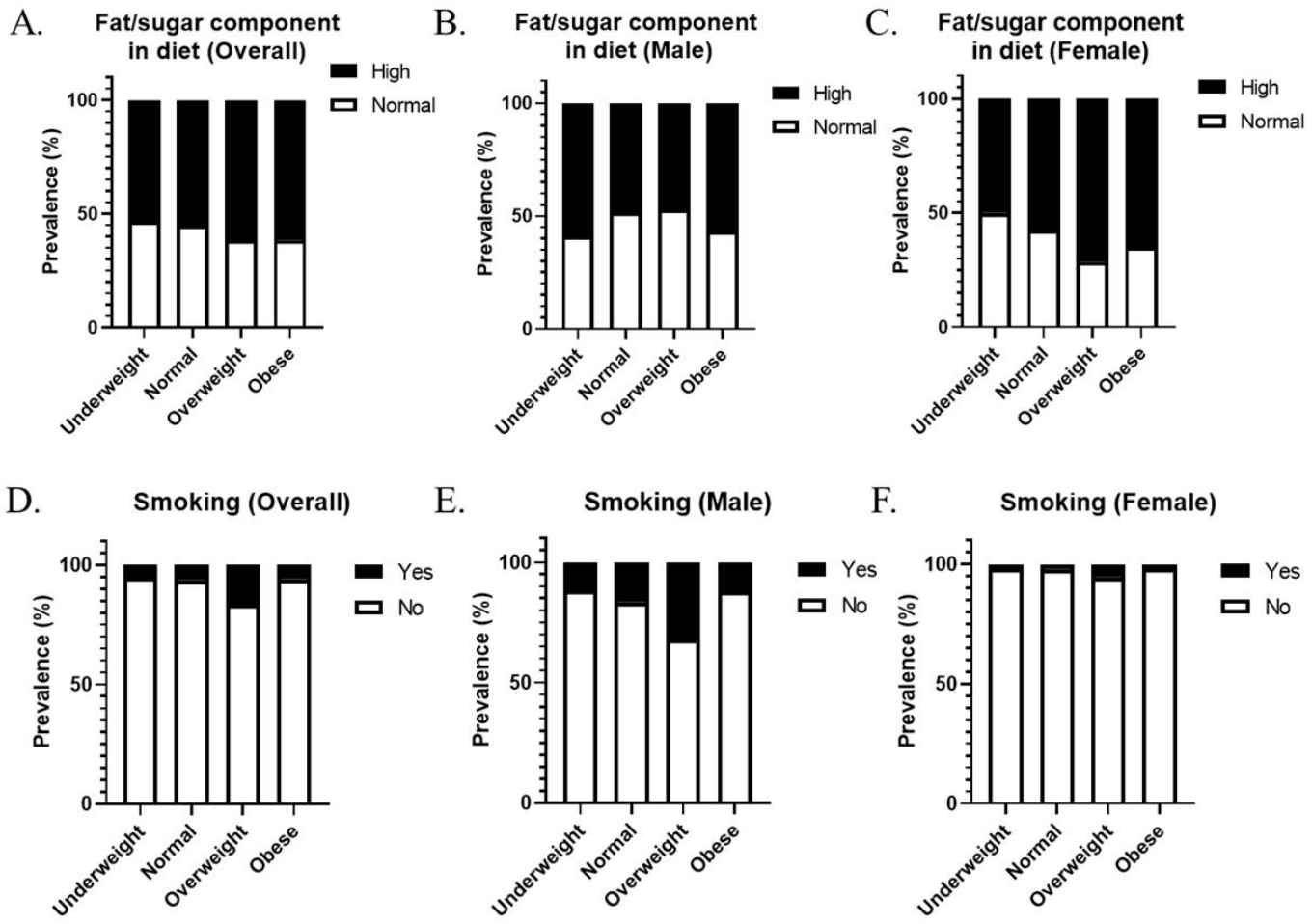

Figure 4: High fat/sugar diet and smoking habit among different categories **(A)** Overall proportion of individuals consuming high fat/sugar diet across different categories ($p = 0.246$); (**B and C)** Proportion of males and females consuming high fat/sugar diet ($p = 0.494$ & $p = 0.035$, respectively); (**D)** Overall proportion of individuals based on their smoking habit ($p = 0.001$); (**E and F)** Proportion of males and females based on their smoking habit ($p = 0.016$ & $p = 0.405$, respectively)

Alcohol consumption and smoking

While alcohol consumption did not differ significantly between the categories, smoking habit was higher in the overweight category (16.54%) compared to others (5.32%, 6.36%, and 5.96% of underweight, normal, and obese categories, respectively), p = 0.001. Similarly, the proportion of males who smoked was more in the overweight category (32.08%) compared to others (11.76%, 16.49%, and 12.22% of underweight, normal, and obese categories, respectively), p = 0.016. However, this trend was not observed among females, p = 0.405 (Figures 4D,E and F).

Medical history

In the study population, 13.2% had a family history of obesity which was higher among the overweight and obese (37% and 25.53%, respectively) when compared to the underweight and normal categories (7.44% and 19.09%, respectively), p < 0.001 (Figure 5A). On the other hand, 34.7% had a family history of obesity-related medical condition(s) which was also higher among the overweight and obese (66.93% and 55.32%, respectively) when compared to the underweight and normal categories (48.94% and 49.7%, respectively), p = 0.007 (Figure 5B).

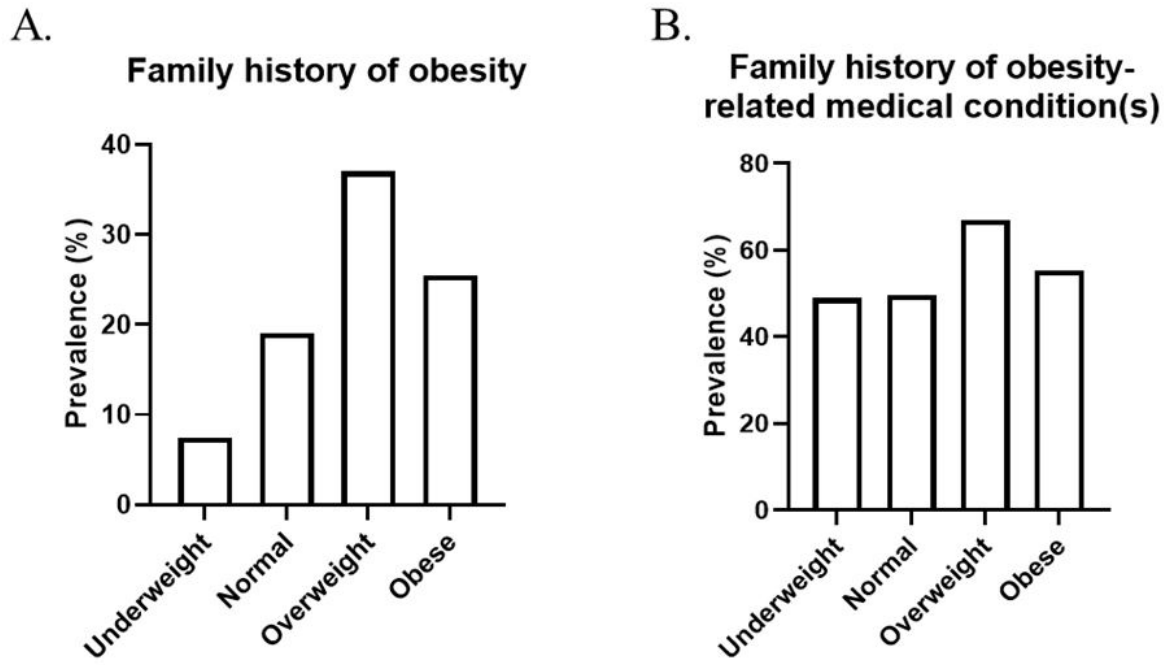

Figure 5: Family history of obesity and obesity-related medical condition(s) **(A)** Proportion of individuals with a family history of obesity across different categories (p < 0.001); (**B)** Proportion of individuals with a family history of obesity-related medical condition(s) across different categories (p = 0.007)

Socioeconomic status

Prevalence of obesity among individuals belonging to the high-income group was higher when compared to that of other income categories, although statistically insignificant (p = 0.212).

Discussion

Increasing prevalence of obesity in different parts of the world has made it a major cause of morbidity and mortality, irrespective of age and gender. An alarming rise in its prevalence has also been observed in India over the past couple of decades [12,14,26]. The period when students enter universities is very crucial since reduced parental control gives them enough freedom to explore different kinds of lifestyles that include consuming unhealthy foods thereby posing them at higher risk towards excessive weight gain [33]. Many studies aimed at the prevalence of overweight and obesity among university students have reported that a significant proportion of the population were overweight [34-36]. Overweight or obesity at a young age imposes a serious health threat as it could prolong disability-adjusted life years leading to both reduced quality of life as well as life expectancy [37]. The present study was conducted to assess the prevalence of overweight and obesity and identify possible risk factors among university students in India.

In our study population, we observed the prevalence of both general as well as abdominal obesity based on BMI, WC, and W/H ratio which was found to be higher compared to a previous study [12]. Students when they move from schools to universities far away from their homes often get attracted by the smell and sight of high-calorie, unhealthy, and unhygienic foods that are commonly available in street stalls or nearby restaurants [33]. A large number of students are forced to move out of their hometowns for one reason or another in pursuit of higher education [38]. Individuals staying in hostels are the most affected as they do not have access to home-made healthy foods, unlike junk foods that are easily available [39]. Many of the participants in our study indicated poor food choices and overeating as major causes for their weight gain.

Lack of awareness about obesity and its associated risk factors among our participants could be another reason for the increased prevalence of overweight or obesity reported here. We also found that 13.2% of the study population had a family history of obesity which was more pronounced in the above normal BMI categories. Co-morbidities like type 2 diabetes and heart disease were also found to be more prevalent in the families of individuals with above normal BMI. Alcohol consumption and smoking are risk factors commonly associated with several diseases. While we could not find any significant association between alcohol consumption and obesity, we observed smoking to be significantly associated, especially among males. This is not surprising since the disease risk associated with both of these factors is expected to only increase with age. Although few research studies have reported contradicting associations between alcohol consumption and obesity, it has been recently shown that obesity is associated only with high alcohol consumption [40]. The association with smoking is quite complex as light smokers were less likely to gain weight compared to heavy and non-smokers, whereas ex-smokers showed much more weight gain than all the above mentioned groups [41].

Sleep duration is another factor that has an impact on body weight gain. Many studies have reported a positive correlation between reduced amount of sleep and the prevalence of overweight and obesity [42]. In contrary, longer sleep duration was also found to be associated with obesity [43]. Our study also found that obese individuals slept for less duration compared to the normal ones. Lack of sleep induces appetite and food intake due to alterations in the levels of leptin and ghrelin which regulate energy homeostasis by suppressing or inducing appetite, respectively [44,45]. Shorter sleep duration is also associated with chronic emotional stress, fatigue, and reduced physical activity [46,47].

Obesity-associated hypertension is a well-known risk factor for the development of cardiovascular disorders among many obese individuals. It has also been a major cause of mortality across the globe in recent decades [48,49]. Our observations also suggest a higher occurrence of hypertension among obese individuals when compared to the normal ones. Increases in systolic and diastolic pressure due to altered food habits and modern lifestyle could also affect normal functioning of the heart and kidneys.

Our physical state of being overweight or obese potentially exposes us to a variety of lifestyle-associated illnesses. India being a developing nation harbouring a large population of diabetic individuals and an increasing incidence of cardiovascular disorders, rise in the prevalence of overweight and obesity among young adults is bound to make a serious impact on the healthcare system and government policy. Hence, a periodic assessment of the prevalence and constant public awareness would be necessary for the well-being of society. Our study is an attempt in this direction which clearly indicates a rise in the prevalence of overweight and obesity among young adults compared to some of the studies conducted in the past [12,50-55]. We have also identified poor lifestyle as being the major cause for overweight and obesity which includes poor food choices, inadequate sleep, and smoking that were also reported in other studies. This lifestyle is becoming more and more common among young adults across the world. We also found a significant association between hypertension and obesity which could be of serious concern since it may predispose individuals to cardiovascular disorders in the future. Although our study was limited to a small number of participants belonging to a single academic institute, representation from the various states points to a nationwide trend in overweight and obesity prevalence in the country. However, similar such studies on larger populations could shed more light on the health status and thereby further increase the awareness in the society.

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Conflict of Interest

The authors declare that they have no conflict of interest to disclose with respect to the research study and the data that is published here.

Transparency Declaration

The corresponding author affirms that this manuscript is an honest, accurate, and transparent account of the study being reported. The reporting of this work is compliant with STROBE2 guidelines.

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