

# Obesity Prevalence and Determinants among Young Adults, with Special Focus on Normal-Weight Obesity; A Cross-Sectional Study in Mumbai

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## Abstract

**Background:** India has >135 million obese individuals at present. Body mass index (BMI) has been used to assess obesity until recent times. Later, studies have shown that central body fat (BF) measurements as a reliable predictor of metabolic diseases. Hence, normal-weight obesity (NWO) is defined. Those with a normal range of BMI but increased fat percentage are found to be having metabolic syndromes at a very early life. The young adult group is specifically focused on the study with diet and physical activity as potential determinants; as an intervention at the right time can prevent the development of many noncommunicable diseases. **Objectives:** The aim of this study is to estimate the prevalence of obesity and its determinants with special reference to NWO. **Materials and Methods:** A cross-sectional study was conducted based on diet, physical activity, and other lifestyle factors on a sample of 269 young adults. Using Harpenden skinfold calipers, BF percentage was calculated based on Jackson and Pollock and Siri's equation. Binary logistic regression was also applied appropriately. **Results:** The proportion of obesity was 42.01%, and that of NWO was 16.1%. Sex, high protein diet, number of restaurant visits, less homemade tiffin intake, heavy physical activity, alcohol intake were found to be significantly associated with obesity. Intake of fish, physical activity, protein diet, day-time sleep were found to be significantly associated with NWO. **Conclusion:** The study emphasizes the need for including BF percentage in addition to BMI in regular clinical practice. It may help in preventive and promotive efforts.

**Keywords:** Body calipers, central adiposity, dietary intake, lifestyle diseases, normal-weight lean

## INTRODUCTION

Obesity is one of the major public health problem affecting every region of the globe. Currently, India is facing the double burden of undernutrition as well as over nutrition. There are >135 million people who are obese in India.<sup>[1]</sup> Obesity, a prevalent form of malnutrition, can lead to adverse metabolic effects. The risk of heart disease and diabetes increases steadily with increasing body mass index (BMI).<sup>[2]</sup> These diseases, directly and indirectly, burden the already weak health system of the country. The WHO developed BMI classification of obesity, which is as follows: <18.5 - underweight, 18.5–24.9 - normal weight, 25–29.9 overweight, and >30 obesity; developed mainly on Western standards.<sup>[3]</sup> Later, the WHO suggested a lower cutoff for therapeutic interventions in Asians because obesity-related complications develop among Asians at lower BMI.<sup>[3]</sup> In order to find out comparison in research, the WHO classification continued to be used in various obesity studies

across the globe. The WHO Asian modification of BMI defines obesity as BMI >25 kg/m<sup>2</sup><sup>[4]</sup> which is applied in the study to determine the combined values of overweight and obesity.

Obesity is often expressed in terms of BMI, which has very high specificity and low sensitivity. Later, studies demonstrate the importance of central body fat (BF) measurements as a reliable predictor of metabolic diseases. BMI cannot differentiate with lean muscle mass from BF. Those with enhanced muscle mass and lower BF may be misclassified as obese and those with lower muscle mass and higher fat

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content as normal also.<sup>[5]</sup> Ruderman *et al.*, in 1981, derived the concept of metabolically obese normal weight, for whom BMI is normal but having deranged metabolic parameters like dyslipidemia and elevated blood sugar.<sup>[6]</sup> Then, the concept of normal-weight obesity (NWO) was defined for those individuals with normal body weight and BMI (18.5–24.9) with increased BF %, i.e., >17.6% males and >31.6% in females. In India, very few studies are done on NWO. The prevalence of metabolic syndrome is four times higher in NWO individuals than the normal population.<sup>[7]</sup> Hence, the main objective of this study is to find the prevalence of obesity and its determinants with a special focus on NWO among the young adult population at a medical teaching institute and also to give recommendations based on the findings.

## MATERIALS AND METHODS

After obtaining the ethical clearance, this descriptive cross-sectional study was conducted in a medical college in Mumbai. This institution has 900 undergraduate students and those between the age group of 18–24 years were enrolled. There were no exclusion criteria for the study. For the purpose of sample selection, systematic random sampling was used based on the admission muster in the academic section. Using the formula  $Z^2pqN/[e^2(N - 1) + Z^2pq]$ , sample size was 269 where  $Z = 1.96$  by taking confidence interval (CI) as 95%, estimated prevalence ( $p$ ) taken as 50%,  $q = 100 - P = 50$ ,  $e$  = relative precision (10% of prevalence) = 5,  $N$  total number of students (900).<sup>[8]</sup> The first person was selected randomly between 1 and 10 from the junior-most batch, and then every 3<sup>rd</sup> person was selected. Sampling interval “3” was calculated by dividing the total number of students by the estimated sample size. The study period was from September 2016 to October 2018.

Height, weight, and waist circumference were measured using stadiometer, digital weighing machine, and nonstretchable measuring tape, respectively, as per the standard protocol. A Harpenden caliper was used for accurately measuring skinfold thickness. Up to 80 mm thickness, this caliper gives 99% accuracy if used repeatedly, compared to other methods of BF estimation.<sup>[4]</sup> Using skin-fold thickness, BF percentage was calculated using the Jackson and Pollock method. This is most commonly used to estimate body composition using the sum of skinfolds. This method estimates body density (BD) from the sum of skinfolds and age. Once BD was derived, the Siri two-component model was used to convert BD to percentage BF. NWO is taken as BMI in the normal range and BF >17.6% for males and 31.6% for females. Those below these cutoff were taken as normal-weight lean (NWL).

Despite the limitations of skinfold assessment, it is a method widely used in research as it is easy to use, less expensive, high accuracy in repeated measurements, and no complex machinery required.<sup>[9]</sup> Statistical analysis was performed using SPSS software version 16. Developer: IBM Corporation, New York City, New York, United States. To find the interaction between different exposure variables on the outcome, different approaches have been used.

Binary logistic regression was applied in the first method, making the outcome variables categorical and binary. NWL and underweight were combined and coded, similarly normal weight obese, overweight, and obese were also combined into a single variable.

## RESULTS

Of 269 study samples, 53.5% were male with a mean age of 21.1 ( $\pm 1.75$ ) years and 46.5% were female with a mean age of 20.55 ( $\pm 2.14$ ) years. About 20.1% were from 1<sup>st</sup> year, 21.9% were from the 2<sup>nd</sup> year, 20.1% of students were from 3<sup>rd</sup> year, 20.1% were from the final year and 23.4% interns. About 22.68% of the participants belong to upper lower, 3% of students belong to the lower middle class, 40.89% of the study participants belong to the upper-middle-class and 33.46% of students belong to Upper class as per the Modified Kuppaswamy scale. About 86.2% of students were residing at the hostel, while 13.8% were day scholars. Mean weight and height of males and females was 73.33 ( $\pm 12.5$ ) kg, 171.1 ( $\pm 6.4$ ) cm and 68.9 ( $\pm 12.8$ ) kg, 165.14 cm ( $\pm 5.9$ ), respectively.

### Prevalence of obesity

The proportion of obesity (BMI >30) in the present study was 10.03%, that of overweight and obesity (BMI >25) was 42.01% (51.4% males, 31.2% females). The prevalence of NWO was 16.4% (males 11.1%, females 22.4%). NWL and underweight constitute 28.6% and 13.01%, respectively. Male participants had a higher prevalence of obesity ( $P = 0.001$ ), whereas, for NWO, females had a higher prevalence. Age of the participant, religion, academic year of the study, socioeconomic status, and obesity in first-degree relative was not found to be having a statistically significant association with obesity. A mixed or vegetarian diet was also not found to be significantly associated with obesity. Table 1 shows the association of various factors related to diet and lifestyle with obesity. Binomial logistic regression was performed to ascertain the effects of various factors on the likelihood that participants have obesity. The logistic regression model was statistically significant,  $P < 0.0005$ . The model explained 63.0% (Nagelkerke  $R^2$ ) of the variance in obesity and correctly classified 82.9% of cases. From these predictor variables, five were statistically significant, as shown in Table 2.

Table 3 illustrates the comparison of NWO among normal-weight individuals-based on sociodemographic, diet, and lifestyle-related factors. Sex, snacking pattern, skipping breakfast, fish consumption, intake of high protein and high fiber, restaurant visit, physical activity, and sleep habits were seen to be significantly associated with NWO.

## DISCUSSION

### Prevalence of obesity

The study has found the prevalence of obesity to be 10.03%, whereas the prevalence of overweight or obese (i.e. BMI  $\geq 25$  kg/m<sup>2</sup>) is 42.01. As per Asian BMI classification, prevalence of obesity is 42.01%. This is in agreement with the

**Table 1: The association between obesity and diet, lifestyle-related factors**

Factors	P	$\chi^2$	Factors	P	Significance
Fish consumption	0.9	0.002	Light exercise	0.3	2.3
Green leafy vegetables in the diet	0.00001	70.3	Moderate exercise	0.000001	27.5
Fruits in diet	0.6	0.16	Vigorous exercise	0.00002	58.4
High fibre cereals in the diet	0.00004	78.4	Alcohol consumption	0.00001	20.1
Protein-rich diet	0.000005	67.4	Smoking	0.3	2.17
Homemade tiffins daily	0.00001	73.9	Motivation to keep healthy	0.00001	22.1
Regular restaurant visits	0.0001	22.32	Perceiving life as stressful	0.02	5.1
Snacks between meals	0.6	0.27	Perception of overweight	0.2	1.4
Skipping breakfast	0.00001	8.0	Over dependency on gadgets	0.01	6.4
Junk foods	0.00005	22.08	Minimum of 6 h of sleep	0.01	7.6
			Day-time sleeping habit	0.8	0.02

**Table 2: Binary logistic regression analysis of risk factors for obesity**

Variables	P	B	Exp (B)	95% CI	
				Lower	Upper
Male sex	0.02	0.86	0.423	0.2	0.8
Not taking homemade tiffins	0.002	1.500	4.480	0.597	2.886
Vigorous exercise					
<2/week	0.073	1.405	4.074	-0.726	3.680
2-4/week	0.918	-0.073	0.930	-1.971	1.750
Low protein intake	0.243	0.623	3.231	-0.631	4.680
High protein intake	0.007	0.741	8.845	0.849	5.650
High fiber cereals <3 days/week	0.002	1.693	5.436	0.646	2.936
Not having 6 h of daily sleep	0.037	2.083	8.030	0.247	2.624

CI: Confidence interval

**Table 3: Comparison of normal-weight obesity among normal-weight individuals**

Variables	Normal-weight obesity		P	$\chi^2$
	Yes (n=44)	No (n=77)		
Sex				
Male	16 (27.1)	43 (72.9)	0.04	4.23
Female	28 (45.2)	34 (54.8)		
Hostelite	35 (34.0)	68 (66.0)	0.19	1.6
Homemade tiffin consumers	16 (27.6)	42 (72.4)	0.54	3.7
Mid meal snacks	25 (54.3)	21 (45.7)	0.001	10.3
Skipping breakfast	20 (66.7)	10 (33.3)	0.001	15.8
Vegetarian	20 (42.6)	27 (57.4)	0.2	1.27
Fish consumption (yes)	19 (27.5)	50 (72.5)	0.02	5.4
Green leafy veg >3/week	36 (33.3)	72 (66.7)	0.05	3.9
Protein intake >60 g/day	4 (8.5)	43 (91.5)	0.001	29.6
High fibre cereals >3/week	21 (28.0)	54 (72.0)	0.015	5.9
Fruits intake >3/week	13 (43.3)	17 (56.7)	0.36	0.84
Restaurant visit >3/week	11 (64.7)	6 (35.3)	0.004	10.8
Junk food >3/week	14 (56.0)	11 (44.0)	0.06	5.3
Alcohol intake regularly	39 (41.9)	54 (58.1)	0.06	5.5
Not getting 6 h of sleep	14 (87.5)	2 (12.5)	0.001	20.8
Day time sleeping (yes)	19 (51.4)	18 (48.6)	0.023	5.2
Vigorous physical activity	3 (10.0)	27 (90.0)	0.005	55.2

presumed prevalence of the study. The findings of the study are comparable to the systematic review conducted by Poobalan

*et al.*<sup>[10]</sup> The prevalence of obesity among males was almost double that of females, which adds to the existing literature.<sup>[11]</sup>

The overall prevalence of NWO was 16.4%; prevalence among females was double that of males. This is almost similar to the findings of the study conducted by Marques-Vidal *et al.*<sup>[12]</sup> among young adults. We did not find published Indian data for comparison of the prevalence of NWO.

Obesity was more prevalent among males, whereas NWO among females, despite having higher cutoff for BF. This is contrary to the popular belief that females are heavier. This emphasizes the importance of BF assessment for early intervention, as BMI can be misleading for females.

### Determinants of obesity

Taking a mixed diet was not a determinant of either obesity or NWO, which is supported by the literature.<sup>[11]</sup> Decreased prevalence of obesity among those taking homemade tiffin might be attributed to the quantity of oil and the other ingredients used in tiffin services. Contrary to the finding by Bo *et al.*<sup>[13]</sup> among Italian adolescents, mid-meal snacking was not found to be associated with obesity but seen to be significant for increased adiposity.

Even though no association was seen between fish consumption and BMI, adiposity was seen well associated with it, as two-third fish consumers were NWL. Fish diet has increased omega-3 fatty acids, and currently, there are very few evidence to prove its anti-obesity effect.<sup>[14]</sup> Simultaneously, the less omega-3 fatty acid in the diet has seen to be having increased adiposity.<sup>[15]</sup> Regular breakfast consumers were found to be on the normal spectrum of BMI, supported by the WHO technical report on obesity.<sup>[16]</sup> One-third NWO used to skip breakfast regularly. This may slow down metabolism and also lead to overconsumption of food later, leading to overweight.<sup>[17]</sup>

Frequent restaurant visitors were found to be on the heavier side, which supports the findings of Binkley *et al.*<sup>[18]</sup> This emphasizes the need for healthy food options for students and the working population. Consistent with literature<sup>[18,19]</sup> it has been found that consuming junk food for more than twice a week may contribute to obesity. Increased frequency of restaurant visits and junk food intake found to be one of the determinants of NWO.

One of the most significant findings to emerge from the study is that two-third of the participants who consumed green leafy vegetables regularly were nonobese. However, leafy veggie consumption was not significant for determining NWO.

Majority of those who consume high fiber cereal in the diet were nonobese. Diet rich in high fiber cereals was found to have an effect on BMI, supported by the literature<sup>[20,21]</sup> The association between dietary protein intake and BMI was shown to be inverse in a larger multicenter trial.<sup>[19]</sup> Diet with low protein and less high fiber cereal were found to be more common among participants with NWO.

In accordance with the findings of ICMR study,<sup>[22]</sup> majority of the participants who did the moderate and heavy physical activity for >4 days a week were nonobese. Most of the normal-weight participants who did the heavy physical activity

for more than 3 days a week were NWL and was found to be a protective factor against adiposity. This ascertains the importance of providing recreational space and gymnasiums for young adults in their work or study area.

Alcohol intake has found to be associated with obesity but not with NWO. Supporting the literature, a minimum 6 h of sleep regularly has an impact on BMI.<sup>[23]</sup> Irregular sleep pattern or inadequate sleep increases the risk of overweight and obesity, as poor sleep cause altered metabolic responses in the body and may contribute to the deposition of increased fat. Day-time sleep has no effect on obesity in this study. Majority of the normal-weight participants who were not getting adequate sleep and more than half of the normal-weight participants who used to sleep during day time were NWO. This will help us understand the importance of quality and pattern of sleep in adiposity.

The scope of this study was limited in terms of sample size and localized to a particular institute. Notwithstanding the relatively limited sample, this study offers valuable insights into the determinants of obesity as well as NWO among young adults, which is not that extensively studied in this part of the world. This involves domains of physical activity, dietary habits, dietary, and other lifestyle-related factors. The method of BF assessment using body calipers is a simple and cost-effective tool and can be repeated in the same individual for better results over time, unlike other imaging techniques.

### CONCLUSION

The study has identified that males had more obesity, whereas NWO was more among females. Diet-related factors like eating more protein diet, high fiber, fish diet, green leafy vegetables, having regular breakfast have shown to protect against obesity. Less physical activity, inadequate sleep, and alcohol addiction also may contribute to obesity as well as NWO. Similar studies with larger sample sizes across the country can estimate the real burden of NWO in the country.

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### Conflicts of interest

There are no conflicts of interest.

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