Lifestyle Disorders: A Case Study of Quetelet's Index and WHR in Undergraduate Students

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Abstract—*Obesity and related Non Communicable Diseases (NCDs) have assumed epidemic proportions worldwide with projections of more than one billion overweight individuals across the world by 2030. Obesity does not just adversely affect an individual's physical appearance; it also affects the health of the person. Various diseases like cardio vascular disease (CVD), Coronary Artery Disease (CAD), Diabetes Mellitus, certain types of cancer, hypertension etc. has been shown to be associated with obesity. Analysis of Body Mass Index (BMI), Waist Hip ratio (WHR) and Waist Circumference (WC) are powerful tools to assist epidemiological studies assessing the weight status and fat distribution of individuals and populations, thus aiding in timely identification, prevention and management of lifestyle disorders originating from obesity. The current study employed these tools in analyzing the 371 individuals from an age group of 17-21 pursuing undergraduate courses in Shivaji College, New Delhi. The participants were predominantly female 217(58.5%). The study showed that the BMI of 230 participants (61.99%) were in the normal range, 29 participants (7.82%) were overweight and 12 participants (3.23%) were found to be obese. A substantial number of participants (100 individuals; 26.95%) were found to be underweight, indicating malnutrition and poor eating habits. A correlation was attempted between their BMI vs WHR as well as their BMI vs WC, exploring any possible association of these anthropometric measurements with their food habits. Contrary to common perception, there was no correlation of food habits (vegetarian/non-vegetarian) with BMI, WHR or WC. A strong correlation between BMI and WC was established in this study, while a high WHR did not necessarily indicate a high BMI. All the participants with weight and fat distribution falling above or below the normal levels were made aware and educated about the various lifestyle disorders they may be predisposed to due to their condition as well as the simple but highly effective changes they can bring about to remedy the situation.*

1. INTRODUCTION

The WHO defines health as a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity. Based on their way of living and occupational habits, people are predisposed to ailments like diabetes, obesity, depression, high blood pressure, cardiovascular diseases etc. The global burden of these Non-Communicable diseases (NCDs) has been projected to account for 60% deaths worldwide [1]. The NCDs are a cause of concern for not just the affected individual and their family, but the socioeconomic structure of the entire country. The WHO estimates a loss of income of India alone to amount to 236.6 billion international dollars [1-3].

With the rapid pace of urbanization and modernization of the country in conjunction with a genetic predisposition to certain conditions like diabetes, India is suffering a rising epidemic of non-communicable diseases (NCDs). In addition to this susceptibility, major negative lifestyle factors are contributing to the alarming outbreak of cardiovascular disease (CVD) among the Asian Indian population; these factors include: 1) a diet high in added sugar, refined grains and other processed foods, 2) physical inactivity, 3) vitamin D deficiency (VDD), and 4) smoking/pollution [4]. Scientific evidence strongly indicates that a healthy diet and adequate physical activity (i.e. ≥30 minutes of moderate intensity physical activity at least 5 days a week) are effective in the prevention of these diseases [3]. Apart from these, individuals from middle and low income countries are also plagued with the problem of health ailments arising from malnutrition.

Timely assessment and awareness is essential for prevention and management of lifestyle diseases. An inexpensive, non-invasive and effective method of assessing body composition (percentage of body weight composed of adipose and lean tissue) for epidemiological studies, is the calculation of BMI of an individual. The BMI (body mass index) or Quetelet's Index is the evaluation of adipose tissue mass of individuals or populations for obesity. It is calculated by body weight (in kg) divided by stature (in m^2) and was developed as an attempt to describe the relation between body weight and stature in humans [5,6]. Studies have shown that there is a correlation between BMI, body fat and future health risks. BMI below 18.5 is considered to be underweight, that ranging from 18.5-24.9 is considered to be normal and healthy, BMI of 25-29.9 is overweight and more than 30 is obese [3]. A high BMI (correlating over weight and obesity) indicates the

predisposition to diseases like cardio vascular disease (CVD), Coronary Artery Disease (CAD), Diabetes Mellitus, certain types of cancer, hypertension, osteoarthritis, gall stones, dyslipidemia and musculoskeletal problems etc. [7-10]. Similarly, low BMI (correlating to underweight) also plays a role in affecting good health and leading to severe complications [11]. It has been associated with decrease in bone mineral density, lowered immunity, infertility, hair loss cardiac problems and risk of anemia.

Prevalence of under-nutrition and obesity are being experienced as a double whammy by several developing countries. While a segment of the population is unable to afford healthy food, the others have a lack of awareness about the nutritive content of their diet. A high fraction of the population resorts to feeding children a diet rich in sugar and fat content, which is easy to afford and high in energy levels however has very low nutrient value.

Though BMI is convenient for tracking the weight status of individuals and populations, it does not serve as a diagnostic tool as it does not measure fat directly. Therefore, other indicators are important to complement the measurement of BMI. Anthropometric measurements like the Waist-hip ratio (WHR, calculated by dividing the waist circumference with the hip circumference) and waist circumference (WC) were further employed as an additional measure for the distribution of body fat [12]. Studies have shown that the normal WHR for men is ≥ 0.9 and women are ≥ 0.8, and the normal WC for men is ≥ 102cm and for women are ≥ 88cm [13,14]. This ratio can be measured more precisely than skin folds and also provides an index of both subcutaneous and intra-abdominal fat [7]. Thus, the WHR and WC emerge as strong indicators of obesity and related diseases along with the measurement of BMI.

Our study focused on the young adult population as it has been shown that as many as 75% of obese adolescents go on to become obese adults and carry the same risk of co-morbid disease in adulthood too [7].

2. METHODOLOGY

The study was conducted at Shivaji College, a constituent of the University of Delhi, accredited with grade A by NAAC. A total of 371 students, of the age group 17-21, were included in this study. Data was obtained by requesting participants to fill a detailed questionnaire, which included general information, specific anthropometric measurements, socio-demographic profile, dietary pattern, history of diseases like diabetes, cardiovascular diseases, hypertension etc.

For the calculation of BMI as weight (kg)/square of height (m^2), height and weight of the participants were measured. The height of the individuals was measured using height measuring tape and weight was measured on Equinox digital weighing scale EB 9300. Weight was measured after removal of shoes while wearing light clothing. Height was measured without shoes in the standing position with the shoulders in relaxed position and arms hanging freely. Based on their BMI, the participants were classified as underweight, normal weight, overweight and obese. BMI of underweight individuals is further classified as mildly thin (17.0 - 18.5), moderately thin (16.0-16.9) and severely thin <16.00. The normal range of BMI lies between 18.5-24.9. Individuals with BMI between 25.0-29.9 are categorized as overweight, while obese individuals are classified as obese Class I (30.0-34.9), Obese Class II (35.0-39.9) and Obese class III (≥ 40).

For obtaining the waist-hip ratio, the waist circumference, measurement was taken at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest [2,3]. The measurement of hip circumference measurement was taken around the widest portion of the buttocks, as per WHO recommendations. Care was taken that both waist and hip measurement was taken with the tape wrapped snugly around the body, but not pulled so tight that it is constricting [2,3].

3. RESULTS

Data collected from the 371 participants were analyzed for the health related criteria using anthropometric measures [Table 1]. The data constitutes a majority of females which form about 58.5% of the total data. Males form the rest of 41.5%. The BMI was calculated according to the WHO definition using weight in kilograms and height in meters. The average BMI for the entire sample is 20.70 units.

Table 1: Descriptive characteristics of the sample*

Variables	Males n=154	Females n=217	All individuals n=371
Age (y)	18.46 □ 0.98	18.61 □ 1.79	18.55 □1.51
Weight (Kg)	60.68 □10.83	51.26 □ 10.08	55.17□11.34
Height (m)	1.70 □ 0.065	1.58 □ 0.07	1.63 □0.09
WC (cm)	30.51□ 3.20	28.36 □ 2.96	29.25 □3.24
Hip circumference (cm)	34.92 □ 3.52	34.65 □ 3.43	34.76 □ 3.47
WHR	0.88 □0.91	0.82 □ 0.08	0.85 □ 0.09
BMI (Kg/m2)	21.01□3.45	20.48 □3.69	20.70 □3.59

* $\bar{x}$ □ S.D.

The same when calculated for males and females separately was found to be 21.01 and 20.48 respectively. When the entire sample is classified according to the BMI criterion [Table 2], we find that approximately 26.95% of the individuals are underweight. The normal category individuals constitute about 61.99 % of the observations. The overweight and obese individuals form about 7.82 % and 3.23 % respectively.

Table 2: Prevalence of obesity as per Body Mass Index calculations

Obesity Category	BMI
Under weight	100 (26.95%)
Normal	230 (61.99%)
Over weight	29 (7.82%)
Obese	12 (3.23%)

Table 3: Correlation between BMI and WC and WHR for different obesity categories

Obesity Category	Correlation between BMI & WC	Correlation between BMI & WHR
Under weight	0.027	-0.067
Normal	0.319*	-0.081
Over weight	0.212	-0.208
Obese	0.489	-0.360

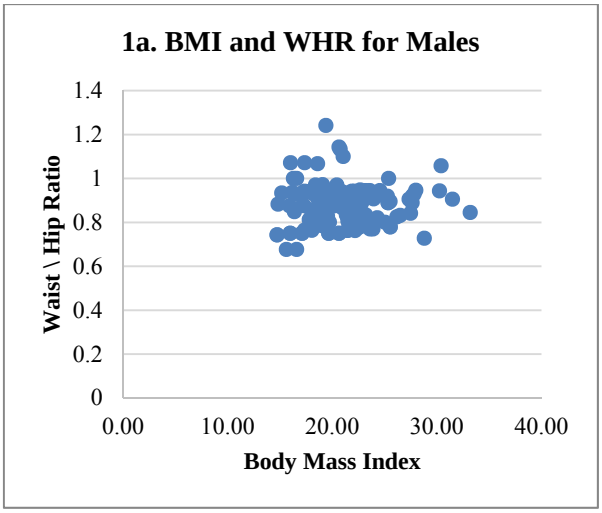
* statistically significant at the level 0.01 (two tailed)

Table 4: Correlation between BMI and WC and WHR for males and females

Gender	Correlation between BMI & WC	Correlation between BMI & WHR
Male	0.659*	0.018
Female	0.653*	0.120

* statistically significant at the level 0.01 (two tailed)

The correlation was also calculated between the BMI and the waist-hip ratio. This value is -0.012 indicating that individuals with higher BMI have lower waist to hip ratio. This correlation was calculated for the BMI classifications and the results are reported in Table 3.



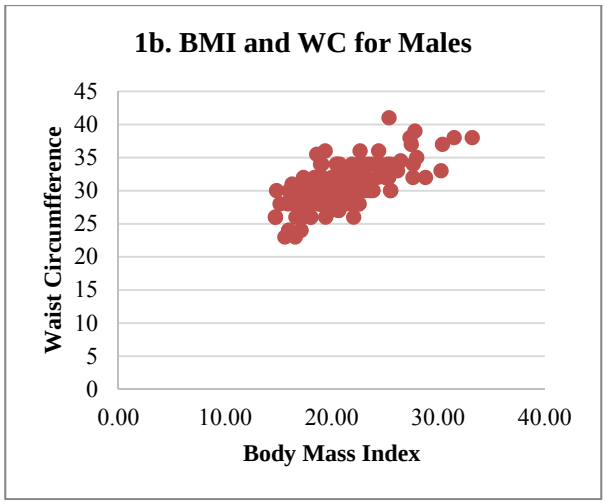
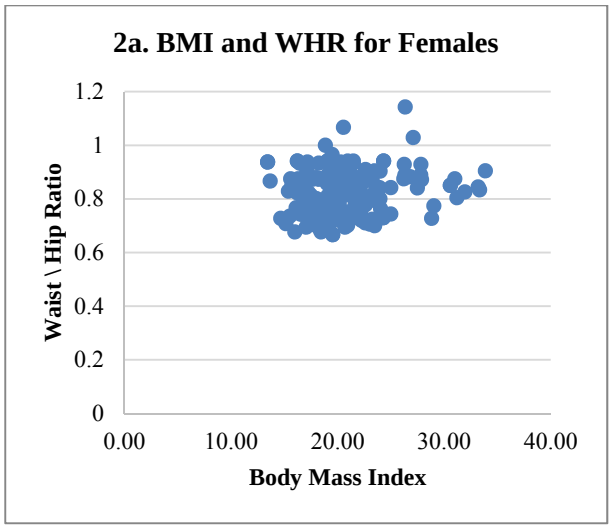


Fig. 1 (a) Plot between BMI and WHR for males; (b) Plot between BMI and WC for males.



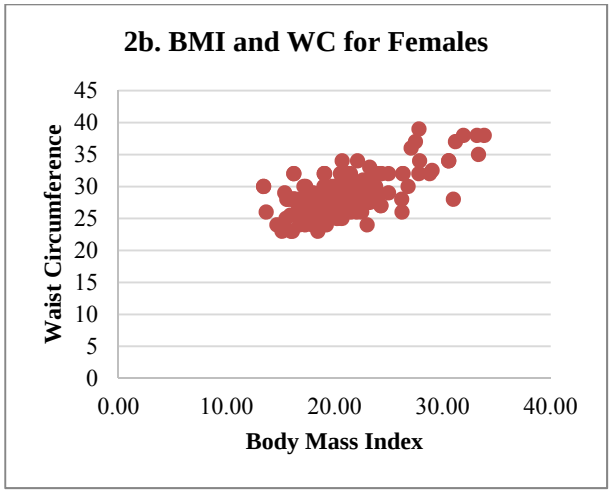


Fig. 2 (a) Plot between BMI and WHR for females; (b) Plot between BMI and WC for females.

The relationship between BMI and WC of males and females was also studied. It is observed that out of 217 females 7 females have WC more than 35. It was further observed that these females have BMI more than 25. Moreover, out of 217 females 20 females have BMI more than 25. Out of these 20 females 12 females have WC less than 35. Out of 154 males, 1 male has WC more than 40 whose BMI is also more than 25. Out of these 154 males, 20 males have BMI more than 25 but their WC is less than 40. Results are reported in Table 4 and have been plotted as well [Figures 1,2].

The overall correlation between the BMI and the waist circumference is 0.640 which is highly significant [at the level 0.01 (two tailed)]. The correlation indicates that the higher BMI is associated with a larger waist circumference and that the degree of this association is about 0.64. The overall correlation between the BMI and the waist/hip ratio is 0.095 which is not statistically significant. The correlation coefficient was also calculated for all the BMI classifications and the results are displayed in Table 3.

Relationship between BMI and Diet habits (Vegetarians and Non-vegetarians):

It is generally accepted that the non-vegetarians have higher BMI on average due to their dietary habits and lifestyles. To check for this in our data, we collected information on the dietary habits of the individuals in the survey. The individuals answered the simple question about whether they are vegetarians or non-vegetarians. The collected data reveals that out of the total 371 individuals, about 123 (33.15%) reported to be non-vegetarians. The rest of the observations were included under vegetarians which constitute the rest of 66.85% of the data. The average BMI were recorded to be 20.30 and 21.50 for vegetarians and non-vegetarians respectively. A simple t-test reveals that there is no significant difference between the average BMI for these two diet groups thus refuting the popular notion.

4. DISCUSSION

On the basis of area of fat distribution, obesity can be classified into android and gynecoid obesity [15]. In android obesity, fat is localized around the waist and in the upper body (apple shaped). It is more frequently seen in men and has a poorer prognosis for morbidity and mortality than the gynecoid type. In gynecoid obesity, fat is located in the lower half of the body (pear shaped) and is more frequently seen in women.

Energy input must equal the energy output to maintain the energy balance. Obesity occurs when extra kilocalorie are consumed than that required by the body. During the early stages of being overweight, the existing fat cells become larger, and upon further consumption of excess calories, the body starts making more adipocyte to store the fat. Once new fat cells have been created, they do not disappear with weight loss, they are ready to be refilled for future weight gain. In certain cases, obesity has been linked to resistance to leptin – a hormone which is responsible for body weight regulation. However, more commonly, obesity occurs as a result of bad life style choices, no exercise, consumption of junk food, endocrine disorders. Stress, anxiety and depression have also shown to alter feeding behaviors due to emotional eating, rather than actual need of food. Maintaining a low calorie diet in isolation is not enough for long term maintenance of weight, hence physical exercises are essential for energy expenditure of the body. Exercise reduces the percentage of fat in the body and increases the percentage of muscle mass and lean tissue. Aerobic exercise programs have been shown to significantly reduce the risk of android obesity. Converse to obesity, underweight individuals have the ailment of nutritional deficiency. A balanced diet with appropriate nutrient intake is imperative for a healthy life.

5. CONCLUSION

Our study delineates that BMI and WC measurements are significantly correlated and give meaningful interpretations in study of subjects in the age group 17- 21. BMI only serves as an initial screening for overweight and obese individuals, and other measurements such as WC are significant indicators of overall health. However, WHR did not give significant results in our study and we can hypothesize that for this age group (17-21) it is not as useful as WC. Our findings are in agreement with Janssen *et al*. as well as Hurt *et al*., who have stressed over the need to combine BMI and WC as parameters for highlighting obesity related health risks. A number of students were found to have high BMI and WC values. No substantial difference was noted for BMI of vegetarians vs non-vegetarians. Lifestyle patterns and dietary intake have profound effect on overall health of individuals. Lack of exercise, intake of food high in sugar and fat content as well as stress levels lead to obesity. Our aim of the study is also to spread awareness amongst the youth regarding their lifestyle habits that are making way for health challenges in the future.

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