

Influence of body mass index and waist circumference on academic achievement of the first year medical students

Laxmikant J. Borse¹, G. Deepak Bansode², K. Hitesh Modak¹

¹Assistant Professor, Department of Physiology, Seth G S Medical College and KEM Hospital, Parel, Mumbai, ²Professor and Head, Department of Physiology, Govt. Medical College, Solapur, Maharashtra, India

ABSTRACT

Background: Future of the adolescence is mainly decided by their academic achievement hence teachers, students, and their parents are always conscious about that. Many studies have shown the relationship of obesity/overweight which is growing problem in developed as well as in developing countries with various diseased and non-diseased conditions. **Aims and Objectives:** The present study was performed to find the influence of body mass index (BMI) and waist circumference (WC) on academic achievement of the first year medical college students. **Materials and Methods:** The study included 92 healthy students, 59 males and 33 females. Considering cut-off value for BMI and WC for Asian Indian adults they were divided into different study groups. On the basis of BMI, Group I was with higher BMI ($>23 \text{ kg/m}^2$) and Group II with lesser BMI ($<23 \text{ kg/m}^2$). On the basis of WC, Group I was with higher WC (males $>85 \text{ cm}$, females $>80 \text{ cm}$) and Group II with lesser WC (males $<85 \text{ cm}$, females $<80 \text{ cm}$). Final university result of the student was considered as their academic achievement indicator. Their final results were compared between males, females and total students in different study groups. **Statistical Analysis:** Student's unpaired *t*-test was applied for statistical analysis. The outcomes were presented as a mean (standard deviation), and $P < 0.05$ was considered as significant. Correlation of critical flicker frequency with visual and auditory reaction time was found out by coefficient of correlation. **Result and Conclusion:** Our study concluded that academic achievement was significantly lower in students with higher BMI and WC. But gender wise consideration showed no significant relation between females with higher and lesser WC. Causes for these results were difficult to explain but along with psychosocial factors, adiposity and lack of physical activity causing low cognition and brain dysfunction may be responsible for lower academic achievement seen in students with higher BMI and WC. More research work is needed to obtain precise relationship between BMI, WC, and academic achievement.

Key words: Academic achievement, Adiposity, Body mass index, Obesity, Waist circumference

INTRODUCTION

Students are the strength of academic institutes as well as the nation. Student's academic achievement plays an important role in producing the best quality graduates who will become great leaders and manpower for the country thus responsible for the countries over all development.^[1] Achievement in school is affected by a number of factors from inside and outside school, including quality of the school, characteristics of the student and student's family such

as socioeconomic status, parent's educational level,^[2,3] and school background.^[4] Inverse relationship between absenteeism and academic achievement has been found by researchers.^[5] Web use had positive effects mainly on the motivation for learning and interest in the lessons and positive effect on academic achievement.^[6] Presence of a support system in the institute can enhance the learning capacity of adolescent students by helping them to develop or improve their coping mechanisms.^[7] All of these studies have shown

Address for Correspondence:

Laxmikant J. Borse, Department of Physiology, Seth G S Medical College and KEM Hospital, Parel, Mumbai, Maharashtra, India.
Phone: +91-7738323108. E-mail: borselaxmikant@gmail.com

the relationship of academic achievement with factors which are not directly related to the health.

Many studies have shown that academic achievement is also influenced by health-related issues. In low achievers, both psychological and health related factors were found to be more prevalent.^[8] Regular breakfast consumption has been linked with improvement in academic achievement, psychosocial functioning, and cognition.^[9] Self-esteem was positively influenced by physical activity and the consumption of fruits and vegetables. In contrast, poor dietary habits negatively influenced self-esteem and academic achievement, and self-esteem was negatively influenced by increase in body mass index (BMI).^[10] Combination of health behaviors may have a positive influence on academic performance in adolescent girls.^[11] Having a healthy, balanced diet improves brain capacity, maximizes cognitive capabilities, and improves academic performance in school-age children.^[12]

Obesity should be defined as excess body fat or adipose tissue; it is this which is associated with the comorbid conditions.^[13] This is further complicated by is central (also described as intra-abdominal, or visceral) fat which is more pathogenic.^[13,14] Between 1980 and 2008, the worldwide prevalence of obesity almost doubled and by 2008, 10% of men and 14% of women (half a billion people) in the world were obese, compared with 5% of men and 8% of women in 1980.^[15] Overweight and obesity have been also linked with the academic achievement. Overweight children had significantly lower math and reading scores compared with non-overweight children.^[16] Obesity at the age of 14^[17] and over weighted youths^[18] had shown lower educational outcomes.

Most of the first year students of medical colleges come after finishing their higher secondary. Being a professional college, method of teaching is different and syllabus to which these students are exposed is also vast compared to higher secondary. Most of the students have to stay away from their homes, and so there might be many factors which may be affecting their academic achievement. There is converging interest among public health scientists and school policy makers in the health status of adolescents and its impact on their academic achievement.^[19] The purpose of this study was to find out influence of BMI and waist circumference (WC) on academic achievement of the first year medical college students. The knowledge of study result can be used by students, parents at their personal level and by policymakers, administrators, and others for information or policy

making of not only medical colleges but also for other institutes.

MATERIALS AND METHODS

The present study was conducted in the Department of Physiology, Dr. Ulhas Patil Medical College (DUPMC), Jalgaon. The study was approved by the Institutional Ethical Committee. There were total 109 first year students studying in DUPMC. They have to face examination of three subject anatomy, physiology, and biochemistry for the first year. According to the rules of Maharashtra University of Health Sciences (MUHS) in medical colleges of Maharashtra three examinations, two internal and one final university examination are conducted in every academic year. Marks of these three examinations are considered for the final assessment of the student for that academic year. In this study, we have considered their final university assessment result as their academic achievement indicator. Students who were absent for university or internal examinations of one or more subjects were excluded from the study and remaining 92 healthy students were included in the study groups. Written informed consent was taken from all the participants before conducting the study. Anthropometrical measurements age, height, weight and WCs were recorded along with preliminary clinical examination to exclude any systemic disorder affecting academic achievement.

Anthropometry

The age of the student was determined from their reported date of birth. A digital weighing scale was used to measure body weight with an accuracy of ± 100 g. Subjects were weighed without their shoes and with light summer clothing. Standing body height was measured without shoes to the nearest 0.5 cm using height stand with shoulders in relaxed position, arms hanging freely. BMI was calculated as body weight in kilograms divided by square of height in meters. The circumferences in waist were obtained using a retractable measuring tape to the nearest 0.1 cm, maintaining close contact with skin and without compressing underlying tissues. The waist was measured horizontally between lower costal rib and upper border of iliac crest. Subjects were in standing position and measurement was made at normal minimal respiration. In females, measurements were taken by the female author.

Currently used general and central obesity anthropometric measures for assessing adiposity-related

risk include: BMI, WC, hip circumference, waist-to-hip ratio (WHR), and many more.^[20] But BMI or WC is most commonly used to measure body fatness.^[21] Various studies have given various cut-off values for BMI and WC in different population on the basis of prone to various chronic metabolic disorders.^[22] Study in Asian Indian adults concluded that the cutoff value for normal BMI for men and women was 23 kg/m² and cutoff values for WC were 85 cm for men and 80 cm for females.^[23-25] In our study, we selected 92 students (59 males and 33 females) and divided them on the basis of their BMI^[23-25] and WC.^[23] According to BMI Group I with BMI >23 kg/m² and Group II with BMI <23 kg/m² and on the basis of WC^[23] we divide them as Group I with WC >85 cm and Group II with WC <85 cm. When BMI was considered out of 92 students, 25 males and 15 females were with BMI >23 (Group I) and 34 males and 18 females were with BMI <23 (Group II) as shown in Figure 1. On the basis of WC out of 59 males, 26 were with WC >85 cm (Group I) and 33 were with WC <85 cm (Group II) and out of 33 females 15 were with WC >80 cm (Group I) and 18 were with WC <80 cm (Group II) as shown in Figure 1. Student's first year academic achievement indicated by their final university result (sum total marks of all three subjects), was compared in these different study groups.

Statistical analysis

Data analysis was performed using SPSS version 16.0 (SPSS Inc., Chicago, USA) software. Student's unpaired *t*-test was applied to compare academic performance in study groups. The outcome of analysis

was presented as a mean (standard deviation [SD]) and **P* < 0.05) was considered as significant.

RESULTS

Tables 1 and 2 depict the statistical analysis for anthropometric parameters of the males, females and total students in between Groups I and II which were expressed as mean and SD for both the study groups.

Table 1 shows that when BMI was basis of classification, groups were homogeneous with respect to age and height but shows a significant difference for weight and BMI.

Table 2 shows that when WC was the basis of classification, there was no significant difference between study groups with respect to age but difference is significant for WC.

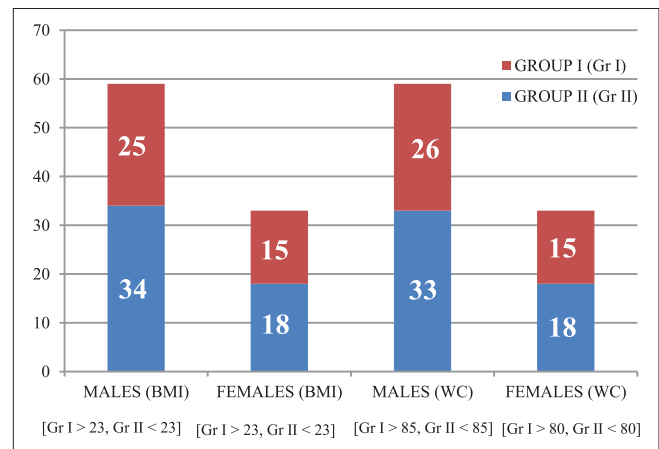


Figure 1: Study group's males and females classified on the basis of their body mass index and waist circumference

Table 1: Statistical analysis of anthropometric parameters when BMI was basis of classification

Demographic parameters	Age (years)	Weight (kg)	Height (cm)	BMI (kg/m ²)
Males				
Group I (n=25) mean (SD)	19.8 (1.27)	74.2 (5.99)	174 (6.12)	24.6 (1.56)
Group II (n=34) mean (SD)	19.8 (1.18)	55.4 (6.14)	174 (4.67)	18.3 (1.63)
<i>t</i> value	0.53	11.8	0.12	14.7
<i>P</i> value	0.96	0.0001*	0.91	0.0001*
Females				
Group I (n=15) mean (SD)	19.0 (0.63)	60.1 (4.52)	157 (4.98)	24.5 (1.36)
Group II (n=18) mean (SD)	19.3 (0.83)	46.5 (6.35)	158 (7.50)	18.6 (1.86)
<i>t</i> value	1.32	6.96	0.52	10.1
<i>P</i> value	0.20	0.0001*	0.60	0.0001*
Total students				
Group I (n=40) mean (SD)	19.5 (1.14)	68.9 (8.77)	167 (10.1)	24.5 (1.47)
Group II (n=52) mean (SD)	19.6 (1.09)	52.3 (7.49)	168 (9.51)	18.4 (1.71)
<i>t</i> value	0.56	9.79	0.39	18.0
<i>P</i> value	0.57	0.0001*	0.70	0.0001*

**P*<0.05 Group I – BMI>23; Group II – BMI<23. BMI: Body mass index, SD: Standard deviation

Table 2: Statistical analysis of age and WC when WC was basis of classification

Demographic parameters	Age (years)	WC (cm)
Males		
Group I (n=26) mean (SD)	19.8 (1.21)	89.3 (4.11)
Group II (n=33) mean (SD)	19.8 (1.22)	72.9 (5.52)
t value	0.26	12.6
P value	0.79	0.0001*
Females		
Group I (n=15) mean (SD)	18.9 (0.44)	85.3 (3.56)
Group II (n=18) mean (SD)	19.2 (0.73)	71.6 (5.62)
P value	0.11	0.0001*
t value	1.64	8.19
Total students		
Group I (n=41) mean (SD)	19.5 (1.10)	87.8 (4.31)
Group II (n=51) mean (SD)	19.6 (1.10)	72.4 (5.53)
P value	0.72	0.0001*
t value	0.36	14.6

* $P < 0.05$ Group I – WC: >85 cm males, >80 cm females and both together
Group II – WC: <85 cm males, <80 cm females and both together. WC: Waist circumference, SD: Standard deviation

Table 3 depicts the statistical analysis for comparison of academic achievement in male, female and total students with BMI >23 (Group I) and BMI <23 (Group II) which were expressed as mean and SD for both the groups. In the table, “t” is calculated test value and if the calculated value is more than table value at desired degree of freedom (df), the difference is statistically significant.

The study found a very significant difference in academic achievement of Groups I and II male students; $t(57) = 3.56$, $P = 0.0008^*$ and significant difference in academic achievement of Groups I and II female students; $t(31) = 3.01$, $P = 0.0052^*$. When total students were considered study also found a significant difference in academic achievement of Groups I and II students; $t(90) = 4.38$, $P = 0.0001^*$. Specifically our results suggest that academic achievement is significantly less in male, female and total students with BMI >23 compared to those with BMI <23 .

Table 4 depicts the statistical analysis for comparison of academic achievement in male students with WC >85 cm (Group I) and WC <85 cm (Group II), female students with WC >80 cm (Group I) and WC <80 cm (Group II) and total students of Group I (males with WC >85 cm and females with WC >80 cm) and Group II (males with WC <85 cm and females with WC <80 cm) which were expressed as mean and SD for both the groups. In the table “t” is calculated test value and if the calculated value is more than table value at desired degree of freedom (df), the difference is statistically significant.

Table 3: Statistical analysis of academic achievement in male, female and total students study groups classified on the basis of BMI

Academic achievement	Mean (SD)		t (df) value	P value
	Group I	Group II		
Males	287 (39.5)	322 (36.1)	3.56 (57)	0.0008*
Females	309 (41.2)	352 (40.7)	3.01 (31)	0.0052*
Total students	295 (41.1)	333 (40.0)	4.38 (90)	0.0001*

* $P < 0.05$ (Males: Group I n=25, Group II n=34; Females: Group I n=15, Group II n=18; total students: Group I n=40, Group II n=52). BMI: Body mass index, SD: Standard deviation

Table 4: Statistical analysis of academic achievement in male, female and total students study groups classified on the basis of WC

Academic achievement	Mean (SD)		t (df) value	P value
	Group I	Group II		
Males	283 (37.1)	323 (33.7)	4.31 (57)	0.0001*
Females	320 (49.2)	343 (41.3)	1.45 (31)	0.16
Total students	297 (45.0)	330 (37.4)	3.88 (90)	0.0002*

* $P < 0.05$ (Males: Group I n=26, Group II n=33; Females: Group I n=15, Group II n=18; Total students: Group I n=41, Group II n=51). WC: Waist circumference, SD: Standard deviation

The study found a very significant difference in academic achievement of Group I and II male students; $t(57) = 4.31$, $P = 0.0001^*$. Specifically our results suggest that in male students, academic achievement is significantly less in those with WC >85 cm compared to those with WC <85 cm.

The study found a difference in academic achievement of Groups I and II female students; $t(31) = 1.45$, $P = 0.16$. Here, the mean value of Group I was less than that of Group II, but the P value was not less than 0.05 so by conventional criteria, this difference was considered to be not statistically significant. These results suggest that WC does have an effect on academic achievement of female students. Specifically, our results suggest that in female students, academic achievement is less in those with WC >80 cm compared to those with WC <80 cm but difference is not significant.

When total students were considered study found a very significant difference in academic achievement of Groups I and II students; $t(90) = 3.88$, $P = 0.0002^*$. Specifically our results suggest that academic achievement of students with higher WC (males with WC >85 cm and females with WC >80 cm) is significantly less than those with lesser WC (males with WC <85 cm and females with WC <80 cm).

Taken together, these results of all the tables and Figure 1 suggested that study groups were homogeneous as per as age and height was considered,

whereas values of weight, BMI, and WC in study groups were significantly different. Academic achievement was significantly influenced by BMI and WC of the student. Specifically academic achievement of students with higher BMI and WC was significantly less than those with lesser BMI and WC. When considered gender wise separately, in males academic achievement was significantly less in those with higher BMI and WC. In females, academic achievement was significantly less in those with higher BMI and also less in those with higher WC, but the difference was not significant.

DISCUSSION

Most of the students participated in our study are staying away from their homes. Many of them are away from their family for the first time and also taking their meals from the mess. All these factors also might be affecting the academic achievement of the students. Even at the preliminary stage of medical training, the medical students find aspects of medical course stressful.^[26] In the present study, we have tried to find out the influence of BMI and WC, which are indicators of physical health on academic achievement of the first year medical college students. Our study has shown that BMI and WC do have negative relationship with academic achievement of the first year medical college students. In other words, Physical health of the adolescent has an effect on his or her ability to learn and to achieve academically.

Many studies have shown the importance of measurement of BMI and WC to assess adiposity and risk for various chronic diseases. The International Task Force on Obesity has agreed that BMI is the most practical tool available to define overweight or obesity and to screen for it.^[27,28] It is observed that Indians have higher upper-body adiposity measured as the WC or WHR, although they have lean body mass.^[29] Simple clinical anthropometric measurements, such as WC, WHR and BMI may be conveniently used to assess regional adiposity.^[30] Measurement of WC is a simple and reliable test to identify risk for Type 2 diabetes and cardiovascular disease and should be used more frequently in daily practice in primary care to identify individuals at risk and when planning health counseling and interventions.^[31,32] Anthropometric indices (BMI and WC) are useful screening tools for obesity, metabolic syndrome or its components, and cardiovascular disease risk factors.^[33] Therefore, we have considered calculation of BMI and WC as a tool to classify the students in two groups, one with higher

and other with lesser BMI and WC than ideal cut off values for Asian Indians adults. As per the MUHS pattern two internal and one final university, total three examinations are conducted in an academic year. Marks of these three examinations are considered for final result of the student. Therefore, we have considered their final university result, the sum total of marks obtained in all three subjects to get an idea about their academic achievement throughout the first year.

Key finding of this study is academic achievement in students with higher BMI, and WC is significantly less than those with lesser BMI and WC. When considered gender wise separately, in males we find a significant difference in study groups but in females difference is significant only in BMI based classified groups. Although mean value of academic achievement is less in those females with higher WC but difference was not significant. Our findings are consistent with the finding of Esteban-Cornejo *et al.*,^[34] Álfgeir Logi Kristjánsson *et al.*,^[10] Emad Maghsoudi *et al.*^[35] and Florin TA *et al.*^[36] all of them have concluded that either BMI or WC or both has negative relationship with academic achievement. Among pre-school children in Germany, higher BMI was associated with reduced skill attainment and lower academic performance.^[37]

We find many studies that have shown the academic achievement is influenced by several factors.^[2-4] Hence, it is difficult to conclude why students with higher BMI and WC achieve academically low. Adolescents teased about their weight are at risk for disordered eating behaviors, thoughts and psychological morbidities.^[38] Obese females as adolescents may be at increased risk for development of depression or anxiety disorders.^[39] Cognitive ability and social factors contribute to poor academic achievement during the early school years.^[40] Potential social isolation has been observed in overweight adolescents.^[41] Therefore, behavioral and psychosocial factors may be responsible for the low academic achievement in students with higher BMI and WC.

Cognition and self-esteem have also influence on academic achievement.^[9,10,12] Several possible explanations have been put forward for an association between adiposity and lower cognitive function. Adiposity-related cardiometabolic dysfunction may result in impaired vascular supply to the brain and adiposity could have some adverse effect on brain function, possibly due to the secretion of hormones, pro-inflammatory cytokines or growth factors by adipose tissue that can cross the blood-brain barrier.^[42] Intrahippocampal interleukin (IL1) receptor antagonist

prevented synaptic dysfunction, pro-inflammatory priming, and cognitive impairment which support a central role for IL1-mediated neuroinflammation as a mechanism for cognitive deficits in obesity and diabetes.^[43] Lower cognitive performance and reductions in brain structural integrity among adolescents with metabolic syndrome was documented, thus suggesting that even relatively short-term impairments in metabolism, in the absence of clinically manifest vascular disease, may give rise to brain complications.^[44] Physical activity can have an impact on the important components of academic performance and classroom behavior.^[45] Study on nationally representative sample in the United States has shown that the obesity in adolescence is linked with poor physical quality of life.^[46] All these studies have shown that certain chemical mechanisms due to adiposity in obese/overweight and lack of physical activity cause low cognition and brain dysfunction which may be responsible for low academic achievement seen in student with higher BMI and WC.

An unexpected finding which we came across was mean value for academic achievement of females with higher WC was less than those with lesser WC, but difference was not statistically significant. Reasons for this finding is difficult to explain, but one of the studies suggested that male mice are more vulnerable than the females to the impacts of high fat diet on weight gains, metabolic alterations and deficits of learning, and hippocampal synaptic plasticity.^[47] Researchers have argued that women receive higher grades than men because they work harder and attend class more frequently.^[48] Females have better study skills than the male students.^[49] Hence hard working, sincerity and better study skill might be responsible for better performance in females giving us the non-significant result.

We realize that our study does not answer all the questions, but we believe it will be useful to the decision-makers and planners who know that academic success is a multifactorial issue. Our study suggests that students with higher BMI and WC should be encouraged to make healthy changes in their life style so that their academic achievement may be improved along with the psychosocial behavior. Though this not primary strategy for improving academic achievement, it is possible that modification of health-related behaviors could help improve health-related risks, quality of life, and academic achievement of students. This could be pushed by university through the provision of easily accessible work out equipment and affordable healthy food options. It is hoped that the alteration of lifestyle of all college students would result in a healthier adult population in future.

The limitation of the present study was in its design. This was a small group study which was carried out in a single institute. A larger sample size from multiple institutes and a longitudinal study will definitely be of a great value in predicting the influence of BMI and WC on academic achievement. We are planning to expand the study considering their achievement of previous and next few academic years. We are also planning to include other obesity anthropometric measures and various parameters as their attendance in the academic sessions, birth history, family income, parent's education, nutritional history, family culture, and living environment so as to obtain more precise correlation between factors affecting academic achievement.

CONCLUSION

The present study is based on the premise that the BMI and WC of a student have an effect on his or her ability to learn and to achieve academically. Specifically, the purpose of this study is to examine influence of BMI and WC on academic achievement of the first year medical college students. Based on results of this study, BMI and WC have a significant negative influence on academic achievement of the student. Causes for this negative relationship are difficult to explain but possible explanations may be the behavioral, psychosocial factors and low cognition, brain dysfunction due to adiposity and lack of physical activity causes lower academic achievement seen in students with higher BMI and WC. But when considered gender wise this negative relationship is not significant in female students with higher WC. Our study suggests that professional institutes should encourage the students to improve health and wellness. This will help the medical students to cope up better with the stress during studying as well as in their future and also result in improved academic outcomes for some students.

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