

Body Mass Index (BMI) based Obesity Affecting the Cognitive Behaviour in Adolescent

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Abstract: *The term overweight and obesity are defined as abnormal or excessive fat accumulation that presents risk to health. According to World Health Organization (WHO), a body mass index (BMI) over 25 is considered as overweight, and over 30 is obese. In today's rapidly changing lifestyle, adolescent obesity is emerging as a serious concern, not only affecting physical health but also influencing mental and social development. The present study investigates and evaluates the effects of BMI based obesity on the cognitive aspects in the adolescent students from the selected schools in Adyal, Tal. Pauni Dist. Bhandara (MS). The undertaken study aimed at the comparative evaluation of effect of obesity in obese and non-obese adolescent. For the present study, initially, the sample of 300 students was selected from three different schools for the collection of primary data and information through personal visit and the distribution of questionnaire. Finally, 89 students were identified and screened as obese, based on the calculated BMI. From the identified obese students, 50 obese along with 50 matched non-obese students were randomly selected and were subjected to the test for comparative evaluation of the effects of obesity on cognitive behaviours. Standardized tools were administered to measure cognitive abilities of the students for determination of effect of obesity on intelligence level, study habits and problem-solving ability. The data obtained data was subjected to the statistical analysis for calculating the mean, standard deviation, t-test and significant level. The reported findings clearly revealed significant effect of obesity on all the studied cognitive aspects. Based on the obtained results of the study, we found an urgent need to address this issue at the holistic interventions targeting not only the physical but also the psychological and social needs of obese adolescents.*

Keywords: BMI, Obesity, mental health, adolescents, cognitive abilities

1. Introduction

Obesity, one of the emerging and prevalent issue in all parts of the world, affects the body in different ways. Some are simply the mechanical effects of having more body fats, however, other effects are subtler, such as chemical changes in the blood of an obese individual that enhance the risk of diabetes, heart diseases and strokes. It can also increase the risk of other health problems, including certain types of cancer, sleep apnea (a potentially serious sleep disorder in which breathing repeatedly stops and starts), fatty liver diseases, osteoarthritis, renal diseases and mental health disorders like anxiety and depression. Obesity can also lead to the reduction of life expectancy as well as quality of life. In the last decades, there was exponential enhancement in the childhood obesity throughout the world (Lobstein *et al.*, 2022). Garcia-Solano *et al.*, (2021) reported that 39.6% of the children between the age of 6 to 9 years are exhibiting excess weight for their sex and age. This trend seems to be continued and is now become the most important issue that obesity tends to become chronic and interferes significantly with individuals' well-being. The obesity caused due to different reasons, often correlates with psychological complications (Erskine *et al.*, 2015). Some of the worldwide reports suggested that higher rates of mental health disorders are associated with obesity. Erermis *et al.* (2004) in their studies in a Turkish adolescent sample reported a higher prevalence of mental health issues in the population-based obese samples compared to the non-obese group.

Obesity can also alter various metabolic pathways that can change the functioning of various organs. Metabolic syndrome is a common factor in obesity and contributes to many related diseases. People living with obesity have higher chances of developing a range of serious issues. The health

problems affect nearly every part of the body of obese person, including brain, blood vessels, heart, liver, gallbladder, bones and joints. Being overweight or having obesity increases the risk of strokes, which happens when blood stops flowing to the brain. Obesity is also associated with reduced quality of life. Owing to the worldwide enhancement in the cases of obesity among children and adolescent, it is considered to be one of the major public health issue. Adolescence is a period of low physical activity and there is a positive relationship between greater time spent to secondary behaviour, specially watching television, electronic games and computers. It consequently reduced the outdoor activities (Andrade, *et al.*, 2019) that eventually contributing to weight gain and overweight or obesity. Andrade, *et al.* (2019) also opined that children and adolescents with overweight or obesity exhibited higher levels of depression, lower levels of self-efficacy, self-esteem, and higher body dissatisfaction than children and adolescents with normal weight.

Consuming more calories than the required is the main cause of obesity. Besides this, there are several other factors, at the individual level, family, society or at the national level that lead to the contribution of obesity. The obesity may also be caused due to a combination of genetic, environmental, psychological, and socioeconomic factors. Poor diet, high calorie intake, sedentary lifestyle, lack of physical activity, genetic predisposition, certain medical conditions, medications, and socio-economic factors, such as limited access to healthy foods or opportunities for physical activity can all contribute to obesity. Overweight and obesity is found to be affecting the mental health of individual causing several mental disorders (Djalalinia, *et al.*, 2015). It has been observed that obesity can lead to low-esteem, mood disorder, motivational disorders, eating problems, impaired body image, interpersonal communication problems and sexual

health. All these are directly or indirectly affecting the quality of life (Hilbert, 2010). Obesity also has an impact on growth and development, educational process, employment opportunities and provision of health care. The obese individuals are most often insulted by their teachers, physicians and public. The obese persons also suffer from discrimination, ridicule, social bias, rejection and humiliation.

Obesity may lead to various problems like social isolation, low self-esteem, depression and anxiety, body image concerns, discrimination and teasing, reduced physical activities, poor communication skills, peer relationship, academic performance, etc. Obesity can have drastic adverse effects on the learning ability and educational status of the students. The obese students may found to be distracted and unfocused on their studies, resulting in the low or poor academic performance as compared to the normal weight bearing counterparts. Obesity is also found to be associated with reduced memory, and executive functions, including problem solving abilities. Considering the effect and consequence of the obesity in all age groups and more particularly, in children and adolescent, we have conceived an idea to undertake the studies on effect of BMI based obesity on different cognitive behaviours of the adolescent students. The present study would be significant in not only expansion of the knowledge by highlighting how obesity affect the physical health of the students but also potential link between obesity and cognitive behaviours like, impairment in attention leading to the low level of intelligence, memory, study habits resulting in poor academic performance, and the problem-solving abilities in the adolescent students.

2. Methodology

The present investigation was based on the survey for collection of the primary information and the data for calculation of BMI. It also included the distribution of well-prepared questionnaire.

Survey strategy: A quantitative cross-sectional study design was used to evaluate the association of obesity on cognitive behaviours in adolescent students. The study was conducted initially on 300 students aged between 12-16 years studying in 7th to 9th class from three schools located at Adyal, Taluka

Pauni, Dist. Bhandara of Maharashtra state. The selected schools were frequently visited for the collection of primary information and data on weight, height and age of the students.

Table 1: Number of students from three selected schools for collection of data.

S. No.	Name of the School	Number of students
01	Vivekanand Vidya Bhavan, Adyal	93
02	Prakash High School, Adyal	120
03	Sujata Kanya High School, Pauni	87
	Total	300

Table 2: Class-wise total number of students selected for data collection from three schools.

School Name	7 th Class	8 th Class	9 th Class
Vivekananda School	9	11	15
Sujata School	3	9	5
Prakash School	16	13	8
Total (All Schools)	28	33	28

Sampling Technique: Stratified random sampling technique based on age, gender, and BMI categories, including normal weight, overweight and obese was used. The data on weight, height and age of the adolescent students from the selected schools was collected personally and through the distribution of questionnaire. BMI calculated based on weight and height of the individual students was used for categorization of students into obese and non-obese categories. Fifty students from both the obese and non-obese sections were randomly selected for evaluating the effects of obesity on cognitive behaviours of the students, applying standardized tests.

Inclusion and Exclusion Criteria: The adolescents aged between 12–16 were selected for the present study with prior permission of the school administration and the parents, whereas, the adolescents with diagnosed psychiatric or neurological disorders and those on medication were excluded.

Data Collection and statistical analysis: Data was obtained on effect of obesity on different cognitive parameters by performing the tests was tabulated and processed for statistical analysis for calculating mean, standard deviation, t-test value and significant level.

Table 3: Standardized tests conducted to assess cognitive aspects of the adolescent

Sr. No.	Aspect	Test Name (Abbreviation)	Authors	Type
1	Cognitive	Mixed Type Intelligence Test (MTIT)	Dr. P. N. Mehrotra	Verbal & Non-verbal
2		Study Habits & Attitudes Test (SHAT)	Dr. C .P. Mathur	Questionnaire
3		Problem Solving Ability Test (PSAT)	Dr. L. N. Dubey and Dr. C. P. Mathur	Objective Test

3. Observation and Results

In all, 300 students from three different schools were selected for obtaining primary data. After calculation of the BMI of each student, the effect of obesity for three cognitive aspects such as intelligence, study habit and problem-solving ability was evaluated using standardized tests on 50 obese students compared with 50 non-obese students.

Table 4: Average, maximum and minimum BMI of the student from three different classes

School/Class	Avg. BMI	Max BMI	Min BMI
Vivekanand Class 7	30.31	46.52	22.41
Vivekanand Class 8	20.50	31.73	13.77
Vivekanand Class 9	29.98	45.63	21.31
Sujata Kanya Class 7	20.61	29.37	16.00
Sujata Kanya Class 8	22.32	31.56	16.66
Sujata Kanya Class 9	20.53	32.66	17.28
Prakash Class 7	22.20	35.98	14.34
Prakash Class 8	27.70	44.85	19.36
Prakash Class 9	26.60	37.26	18.74

The data in table 4 average BMI from 7th standard students from three schools was found to be 30.31, 20.61 and 22.70 from Vivekananda, Sujata and Prakash schools, respectively. The students from 8th standard from the three schools showed 20.50, 22.32 and 27.70 BMI, whereas, average BMI from 9th standard was reported to be 29.98, 20.50 and 26.60, respectively. The maximum BMI (46.52) was from 7th standard students from Vivekananda school, whereas, the minimum (13.77) was noted from 8th standard from the same school. The comparative scores obtained effect of obesity on cognitive behaviour of the students and its statistical analysis has been shown in table number 5 and 6.

Table 5: Comparative score for cognitive aspects in obese and non-obese students.

Group	Class	Intelligence (Mehrotra)	Study Habits (Mathur)	Problem Solving (Dubey)
Obese	7 th	95	66	61
	8 th	98	70	63
	9 th	102	72	65
Obese Average		98.3	69.3	63.0
Non-Obese	7 th	107	82	72
	8 th	110	85	75
	9 th	113	88	78
Non-Obese Average		110.0	85.0	75.0

Table 6: Statistical analysis of the score for three different cognitive aspects

Test	Mean (Obese)	SD (Obese)	Mean (Non- Obese)	SD (Non- Obese)	t-value	p-value
Intelligence	97.17	4.67	110.42	4.47	-14.49	< 0.001
Study Habit	69.41	5.25	85.91	6.55	-13.90	< 0.001
Problem Solving Ability	62.80	5.08	74.89	5.40	-11.53	< 0.001

Mean Scores and Significance Levels: Table number 6 showed the statistical analysis of the obtained score on cognitive aspects. Among the obese adolescents (N = 50), the mean of intelligence was 97.17, with a standard deviation (SD) of 4.67. On the other hand, the non-obese adolescents (N = 50) had a slightly higher mean score of 110.42, with a SD of 4.47. For Study Habit, the mean score for obese adolescents is 69.41 with a standard deviation of 5.25, while non-obese adolescents have a significantly higher mean of 85.91 and a slightly higher SD of 6.55. This suggests that non-obese adolescents not only perform better in study habits but also exhibit slightly more variability in their scores. Similarly, in Problem Solving Ability, obese adolescents show a mean score of 62.80 with an SD of 5.08, whereas non-obese adolescents score higher with a mean of 74.89 and a comparable SD of 5.40. These findings indicate that non-

The obese students from all the three classes showed slightly lower score for intelligence than the non-obese students. It was average 98.3 and in the range between 95 to 102 for obese students, whereas, 107 to 113 (average 110.0) for non-obese students. Similar trend of lower score in obese and higher in non-obese students for study habit and problem-solving ability was observed. The core for study habits in obese students averaged 69.3, while the non-obese students averaged 85.0. The problem-solving ability averaged 63.0 and 75.0 for obese and non-obese students, respectively. The scores on study habits ranged between 66 to 72 and 82 to 88 for obese and non-obese students, respectively. However, the score for problem-solving ability for obese students ranged between 61-65 and 72-78 for obese and non-obese students

obese adolescents outperform their obese counterparts in both cognitive domains, with relatively consistent performance across individuals in both groups.

Statistical Significance: Utilizing an independent samples t-test, the analysis uncovered a statistically significant difference in intelligence, Study habits and Problem-solving ability between the two groups. Specifically, the t-value was -14.49, resulting in a significance level of $p < 0.001$ indicates highly significant.

Physical Significance: The observed significance level of $p < 0.001$ underscores a strong statistical significance in the difference mean of intelligence, Study habits and Problem-solving ability scores between obese and non-obese adolescents.

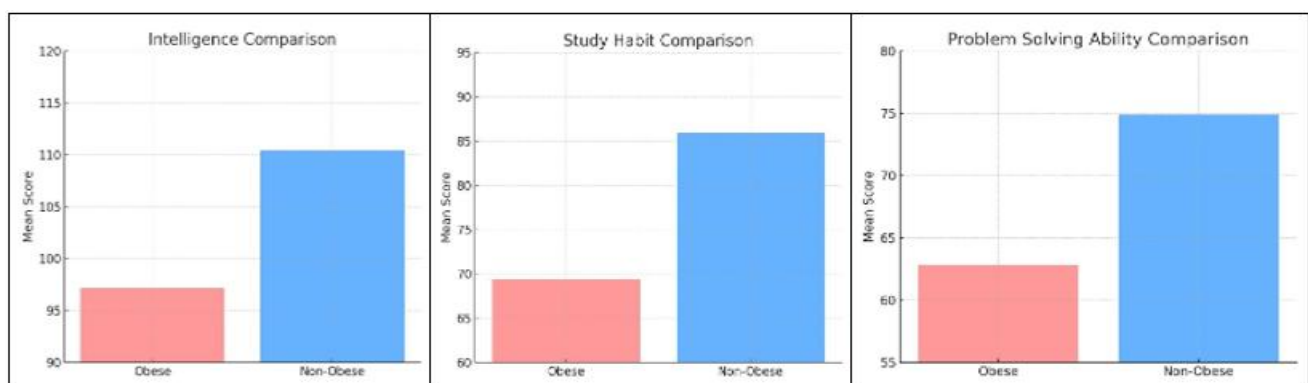


Figure 1: Graphical representation of comparative score of intelligence, study habits and problem-solving ability between obese and non-obese students

4. Discussion

Obesity is a sensitive and stigmatized topic. In today's modern society, overweight and obesity have become major health problem across the world. The fundamental cause of obesity and overweight is an energy imbalance between calories consumed and expended (Camacho and Ruppel, 2017; Noreen *et al.*, 2021). Obesity is ranked as the fifth most common leading cause of death gradually (Safaei, *et al.*, 2021). Obesity is commonly considered as a critical public health issue and has been taken as one of the core issues in the health science. Obesity not only affect the academic performance of the students but also having greater impact on the psychosocial aspects at all the stages. The studies carried out earlier have also reported adverse effects of obesity on different cognitive aspects in children and adolescent.

Adolescence is a critical period marked by rapid physical, cognitive, emotional, and social development. In recent years, the increasing prevalence of obesity among adolescents has emerged as a significant public health concern worldwide. Obesity affects millions of children worldwide and can often impact their academic performance. In the present study, obesity was found to be affecting the study habits, intelligence level as well as the problem-solving ability of the adolescent students. Van Dusen *et al.* (2011) through his studies on n association of physical fitness and academic performance among the school students and mentioned the significant and strong relationship between the physical fitness and the academic performance of the students. Similar findings of effect of obesity on reduced school and social performance in childhood have been noted by Latzer and Stein (2013). Lu Ma *et al.* (2020) in China studied overweight and obesity impairing academic performance in adolescents have recorded the lower academic performance of the overweight and obese adolescents over their counterparts. They have also observed lower test scores and poor school-life experience in obese adolescents.

Negative results of obesity on academic performance through decrease level of intelligence has been prominently observed in the present investigation. These findings confirm the effect of obesity on lower academic performance in the school going students, reported by Coetzee *et al.* (2021). These authors mentioned the small to large correlation between BMI and academic performance in the students in North-West Provinces. The findings of this study are in correlation with the reports by Marcenaro-Gutierrez (2021), who also mentioned the negative effects of obesity and overweight on academic performance of the students. In the present study, some of the girl students were also found to be obese, that also showed lower academic performance through reduced intelligence, study habits and problem-solving ability. However, Aljehani *et al.* (2022) while studying the association of academic performance with obesity and unhealthy lifestyle among female adolescent students reported no relation between academic performance and obesity. The authors have concluded that academic performance is influenced by many factors. According to them, eating yogurt more frequently and watching television and the less time for social media are the factors with the largest influence on academic performance.

Adolescent obesity has been observed to be a common issue and problem of health concern in Indian culture. Rashmi and Jaiswal (2012), while studying the correlation between obesity and academic performance in adolescent in different secondary schools from Ludhiana city in Punjab have reported equal distribution of obese and normal weight students among two sexes. The results of effect of obesity on cognitive behaviours in the adolescent students are in confirmation with the reports by Rashmi and Jaiswal (2012). They have shown significant negative correlation between BMI and academic performance of girls and boys. However, they have observed that normal-weight status adolescents have shown better academic performance than obese counterparts. Their studies also indicated that normal-weight girls were better than the normal-weight boys in academic performance. Datar *et al.* (2004) observed the poor performance of the obese students in mathematics as compared to the normal-weight adolescent students in India. Jain and Kaushik (2016) compared the cognitive functions such as memory, attention and visual retention in the obese students in Delhi. Similar results were also noted by Bhuvaneshwari and Parameshwari (2021) who examined the prevalence of overweight, obesity and the association between BMI and academic performance in Indian school going adolescents from various government and private schools of Madurai district in Tamil Nadu. The authors reported higher BMI in girl students than in boys within the same age group. They have observed close relationship between body mass index and academic performance in both of the school set up. The authors were of the opinion that academic performance as an adolescent has significant implications for future adult health and social well-being.

The results of the present study suggest that the obesity is one of the major reasons for lowering the academic performance of the obese adolescents. Further insights and scientific investigation is needed to analyse the causes of obesity and to take positive steps towards the prevention of obesity. There is an urgent need of spreading awareness at different levels among students, educator, health professionals, parents, policy makers and the society about the growing obesity in children and the adolescent.

Conclusions

The studies undertaken have revealed the significant effect of overweight and obesity on the cognitive behaviour in the selected adolescent from the three different schools. Obesity is not common only in the metropolitan cities but also reported to be in rural areas of India.

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