AIRO JOURNALS
Free / Unpaid
Peer Reviewed
Multidisciplinary
International

ISSN: 2320-3714
Volume 3 Issue 3
September 2022
Impact Factor: 11.9
Subject : Physical Education

BODY MASS INDEX AND BEYOND: EXPLORING THE INFLUENCE OF BODY COMPOSITION ON COGNITIVE ABILITIES AND ACADEMIC ACHIEVEMENT IN ADOLESCENTS

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Abstract

Adolescence is a crucial time in an individual's life when massive changes in body composition occur. Orientation and pubertal improvement are the essential elements impacting the expansion in absolute body mass and its relative conveyance. The goal of the current study was to determine how weight affected first-year medical college students' academic performance during that academic year. Ninety-one healthy students who took every exam offered during that school year were included in the study. The body mass index (BMI) of these pupils was used to split them into three study groups. Ninety-one pupils were categorized as normal weight (BMI between 18.6 and 22.9), twenty overweight (BMI >23), and thirty-one underweight (BMI < 18.5). Their appraisal of the student, which took into account every exam they took that year, was their ultimate university result. As a result, we compared the academic accomplishment indicators of the three study groups using their final university outcome. The one-way ANOVA test was used for statistical analysis. The study's conclusions imply that overweight students perform academically less well than students of normal weight and much less well than pupils of underweight.

Keywords: *Body Mass Index, Body Composition, Cognitive Abilities, Adolescents, Academic*

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ISSN: 2320-3714
Volume 3 Issue 3
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1. Introduction

The many changes that occur in a person's life between childhood and adulthood make adolescence a critical time. Physiological and psychological changes are primarily determined by neuro-hormones during puberty; however behavior and social factors also need to be taken into account.

Global growth and maturation accelerate during adolescence, with gender-specific alterations occurring at distinct times. All adolescents have a rise in annual height velocity, weight gain, fat-free mass, and bone mineral content at this time; however, female puberty often starts earlier than male puberty.1-2 Adolescent girls typically have a higher quantity of fat mass than do boys. A rise in body fat is linked to pubertal development in girls, regardless of their actual age.2. Adolescent boys, however, exhibit a distinctive pattern of body composition that includes a decrease in body fat.

The alterations in body composition and psycho-sociological changes dictate the necessary dietary requirements as well as changes in eating and physical activity behaviors. Typical teenage behavioral patterns can occasionally lead to disruptions in both nutritional status and energy balance. Thus, dislipidemia, bulimia, anorexia nervosa, and obesity are significant changes that typically manifest in adolescence and often last into adulthood.

1.1. Body Composition Measurements

At the individual level, various reference procedures can dependably survey body composition. The most dependable ways to deal with gauge complete body fat are multicompartment models, submerged gauging, air dislodging plethysmography, marked water procedures. Body fat distribution can also be determined by magnetic resonance imaging and computed tomography, it has been demonstrated. Even now, reference methods are insufficiently appropriate for application in the field and in clinical settings. Therefore, when there is a large population, lack of funding, or need for a speedy measurement, anthropometry and bioelectrical impedance are the most often utilized techniques.

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Multidisciplinary
International
ISSN: 2320-3714
Volume 3 Issue 3
September 2022
Impact Factor: 11.9
Subject : Physical Education

Further examination should consider that adolescence is an exceptional time in life when pubescence shows, and thusly, how much body largeness and its dispersion example might be all the more unequivocally connected with orientation and pubertal improvement stage than with age. When Leather expert pubertal stage was considered, there was a critical expansion in females and a huge reduction in guys when the amount of the four skinfolds didn't change essentially with age.

The capacity of the body mass index (BMI), which is characterized as weight (kg) times level (m2), to evaluate for extra body fat in teens is canvassed later in this survey. The BMI is generally perceived as the standard index for characterizing overweight and corpulence.

Twelve Fascinating insights about the dissemination of body fat may likewise be gotten utilizing anthropometry. There is a positive relationship between's a more incorporated example of body fat conveyance and the midsection to-hip perimeter proportion, the midriff periphery alone, and the subscapular-to-rear arm muscles proportion. A circuitous sign of stomach fat, midriff perimeter has all the earmarks of being a solid anthropometric indicator for youngsters' metabolic disorder screening. The non-standard procedure, specialized and estimation impediments, the decision of suitable fat mass expectation conditions for each age gathering, and estimation disparities between techniques are only a couple of the detriments of anthropometry notwithstanding its many advantages.

1.2. Cognition and Cognitive Abilities

Cognitive abilities are the mind based capabilities expected to play out any undertaking, regardless of how troublesome. As opposed to connecting with a particular information, they are all the more firmly connected with the cycles by which we learn, recollect, take care of issues, and focus.

Specific neural networks promote cognitive skills or capacities. For example, some regions of the frontal and temporal lobes (behind the forehead) are primarily responsible for memory skills. Because damaged neural networks and areas can impair cognitive function in people with traumatic brain injuries, neurorehabilitation is crucial.

1.2.1. 4 Types of cognitive abilities

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There are four main types of cognitive abilities, including the following:

- **Attention**

The capacity to maintain concentrate on a task in the face of distractions or numerous tasks at once is known as attention. Maintaining focus is essential for effective work performance since it influences the influence you have in your career. Your ability to focus strengthens your short- and long-term memory recall. Attention is strongly related to memory function.

If you find it difficult to focus or are easily distracted, attention deficiency may be a contributing reason. Changing tasks frequently, committing errors often, and missing deadlines are three instances of cognitive skill deficiencies. You might find it helpful to increase your focus and attention span if you have ever engaged in any of these behaviors.

- **Memory**

The ability to recollect knowledge from the past (long-term memory) or from the present (short-term memory) is known as memory. Memory loss can cause perceptions of tasks, dates, and times to change.

Midway through an activity, if you find yourself having to ask for directions or reread material, you may have a short-term memory problem. It may be a sign that your long-term memory could use some work if you have trouble remembering names or crucial information.

- **Logic and reasoning**

These cognitive skills pertain to the capacity to evaluate an issue and identify a workable solution. Effective application of reasoning and logic leads directly to the development of strong problem-solving abilities.

Do you often wonder what to do next, feel overburdened, or find it difficult to follow directions? Developing your thinking and logic skills will help you think more clearly and solve complex problems more easily.

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- **Auditory and visual processing**

The act of deciphering the information we get through sight and sound is known as auditory and visual processing. Together with other cognitive processes, such as deciphering symbols (such letters and numbers) and picturing solutions, auditory and visual processing is used. The speed at which information is processed also plays a role in this cognitive ability.

Comprehending supports cognitive processes such as following instructions, reading written information, and interpreting maps. Your processing speed may need to be improved if you have trouble following directions on a map or if you find it difficult to finish math word problems on time. Strong visual and auditory processing abilities generally result in less time spent attempting to comprehend new information.

1.3. Cognition Development during Adolescence

The psychological alterations that occur in the brain throughout the course of a person's lifetime are referred to as cognitive development. More sophisticated cognitive capacities in thinking, learning, memory, information retrieval, and emotion processing are made possible by cognitive development. Starting before birth, cognitive turn of events and mind development go on as an individual develops through the phases of earliest stages, toddlerhood, youth, adolescence, and adulthood. For individuals with ordinarily developing cognitive abilities to learn and process always muddled data as they full grown, cognitive development is significant. Building a strong starting point for cognitive development in adolescence requires encouraging cognitive improvement in babies, babies, and youngsters through the arrangement of a caring climate, opportunities for social connection, play, and great instructive access.

The transitional period between childhood and maturity, adolescence typically spans from the ages of 13 to 20. Quick actual development (acclimating to the progressions welcomed on by pubescence), social changes (looking for additional autonomy from family and acknowledgment from peers), and cognitive changes (cognitive abilities turning out to be more complex) are the signs of adolescence. Adolescents' cognitive advancement is set apart by upgrades in thinking

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abilities, a better limit with respect to digest thought, and the arrangement of metacognition — the ability to examine one's own perspectives or perspectives about thinking.

1.3.1. The Process of Cognitive Development in Adolescence

Adolescents' cognitive development is characterized by several changes, including enhanced attention, better decision-making, abstract reasoning, metacognition, and moral reasoning.

- **Abstract Thinking and Reasoning**

Thinking abstractly and reasoning more effectively are traits of continued adolescent cognitive growth. Adolescents' stronger working memory allows them to process information faster. It also gets easier to generate ideas on speculative topics like the purpose of life or scientific conundrums. Teenagers are far more adept at suppressing irrelevant responses than younger children are at understanding puns, sarcasm, and metaphors.

- **Metacognition**

Adolescence is when teens start to learn how to think about thinking. We refer to this kind of thinking as metacognition. Teenagers ponder about who they are and what other people may think of them all the time. They frequently have the propensity to think that their feelings and thoughts are peculiar. Stated differently, kids can believe that their parents are incapable of understanding their feelings. This was described as a personal fable by David Elkind.

- **Moral Reasoning**

Moral reasoning is among the most important changes that occur in adolescent cognitive development. An adolescent's thinking and moral behavior start to change as their reasoning and thinking grow more abstract. Piaget thought that moral reasoning was based mostly on cognitive development. Building on Piaget's theories, Lawrence Kohlberg proposed that teenagers' moral behavior is dictated by their developing moral understanding. He created three phases for the growth of moral reasoning.

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- **Improved Attention**

Additionally, during adolescence, focus starts to get better. Adolescents learn to tune out distracting stimuli and concentrate better on the subject at hand. The capacity to pay attention to one thing while tuning out others is known as selective attention, and it gets better. Additionally, divided attention—the capacity to focus on multiple things at once—improves.

- **Decision-Making**

Decision-making abilities have somewhat improved as a result of the advancement of cognitive development in adolescence toward more critical thinking and the consideration of hypothetical situations. Nonetheless, there are surprisingly few studies on decision-making, and scholars are still working to figure out how decision-making develops over the course of a person's life. Nevertheless, until about age 25, the prefrontal cortex—which controls impulses—continues to develop in the teenage brain. Therefore, teens may be more prone to take chances even when they are just as capable as adults at recognizing repercussions. Teenagers appear to be more concerned with the prize than the results of their behavior.

1.3.2. Stages of Cognitive Development in Adolescence

A child does not instantly acquire the sophisticated cognitive skills that develop during puberty just because they reach adolescence. Every stage of adolescence—early, medium, and late—has distinct cognitive traits, and cognitive growth happens gradually.

- **Early Adolescence**

The period of early adolescence typically spans from 11 to 14 years of age. Teenagers are mostly concerned with the here and now at this point, but they are starting to show interest in careers. Their shift from concrete to formal operational thinking is only getting started, and they might start questioning parents and other authority figures. Adolescents frequently develop their own opinions and ideas about various subjects.'

- **Middle Adolescence**

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International
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The period of middle adolescence typically spans from 14 to 18 years of age. Teenagers start to think more deeply, analyze concepts from a wider philosophical perspective, and start to think critically about their own thinking. They begin to develop their own ethics and moral code as well as to analyze and question things more deeply. Teens typically begin to think longer-term and more about the future around the middle of adolescence.

- **Late Adolescence (Emerging Adulthood)**

By late adolescence, or about between the ages of 18 and 24, making decisions for oneself requires more deliberate thought than just gut feeling. Adolescents who are older have probably formed opinions on more general subjects like politics and may start arguing against other points of view. Their thoughts are primarily concentrated on choosing a vocation and determining their new grownup role.

2. Literature Review

Field assessments of physical fitness were found to be favorably correlated with academic achievement in 259 public school students in the third and fifth grades (Castallini, D. M., Hillman & Erwin, H. E., 2007). In particular, there was an inverse relationship between accomplishment and BMI, but a positive relationship with aerobic capacity. Overall academic accomplishment, arithmetic achievement, and reading achievement all showed associations, indicating that there may be a global relationship between physical fitness and preadolescent academic ability. Maximizing school performance and the ramifications for educational policies are examined in relation to the findings.

Evidence was found by Donnelly, Joseph & Hillman, Charles (2016) to support the notion that PA, fitness, cognition, and academic achievement are positively correlated. The results are contradictory, though, and more research has to be done to determine how many aspects of PA—including kind, quantity, frequency, and timing—affect cognition. How to best implement PA in schools is still a matter of much debate. For example, there are differences between active lessons and activity breaks in terms of their impact on student achievement. However, there is no evidence

ISSN: 2320-3714
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in the literature to support the idea that elevated PA has a detrimental effect on cognition or academic performance, and PA is crucial for healthy growth and development as well as overall wellbeing.

According to (McCoach et al., 2017), academic accomplishment is defined as the knowledge and abilities that students have acquired from education and training. The impact of an individual's physical makeup on their cognitive capacities is examined through the Embodied Cognition Theory.

According to learning based on this theory (Jiayi and Haosheng, 2018), the body is the subject of learning and physical health plays a significant role in influencing learners' mental activities, such as thinking, judgment, and memory. The body is not an irrelevant or obstructive factor in the learning process.

(Hsu and others, 2019) used tracking information on a person's BMI from kindergarten through the eighth grade, teenagers with steadily increasing BMIs did worse in reading and math.

3. Research Methodology

At DUPMC, there was one hundred first-year students enrolled. For the first year, they must pass exams in three subjects: anatomy, physiology, and biochemistry. Maharashtra University of Health Sciences (MUHS) prescribes the conduct of three exams at medical institutions in Maharashtra every academic year: two internal exams and one final university exam. The final evaluation of the pupils for that academic year takes into account their scores on these three exams. We used the results of their last university evaluation as a measure of academic achievement in this study. The 90 students who were still enrolled in the study group were those who had not attended the university exams for one or more topics. Prior to performing the study, written agreement was obtained from each student. In addition to a preliminary clinical assessment, anthropometric measurements of age, height, and weight were taken in order to rule out any systemic disorders that might be influencing academic performance.

3.1. Anthropometry

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(a) Body Weight

The body weight was measured with a digital scale that had an accuracy of ± 100 grams. The subjects wore light summer attire and were weighed without shoes.

(b) Height

Using a height stand, standing body height was measured without shoes to the nearest 0.5 cm, while the arms remained relaxed and the shoulders relaxed.

(c) Body Mass Index

We divided the study group into three categories based on the WHO's categorization of BMI for Asian countries: BMI > 23 was considered overweight, BMI < 18.5 was considered underweight, and BMI 18.6 to 22.9 was considered normal weight for students. Twenty pupils were overweight, 39 were normal weight, and 31 of the 90 students were underweight. The first-year academic accomplishment of these three groups was compared using their final university outcome, which is the sum of their three disciplines.

Table 1: Categorization of students on the basis of BMI

Groups	**Percentage**
Underweight	34.44%
Overweight	22.23%
Normal weight	43.33%

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ISSN: 2320-3714
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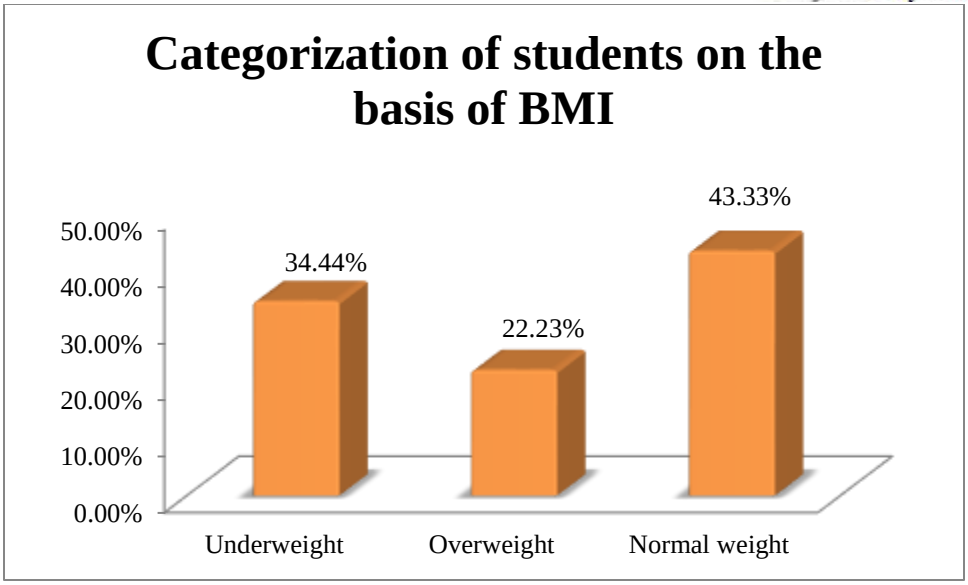

Figure 1: Categorization of students on the basis of BMI

3.2. Statistical Analysis

To evaluate and determine the impact of weight on academic performance in three heterogeneous study groups – underweight, normal weight, and overweight students – a one-way ANOVA test was conducted.

4. Data Analysis

Table 2: Comparison of descriptive statistics from three study groups to determine how body weight affects academic achievement.

BMI based Classification	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Underweight	31	341.42	44.601	8.31	321.39	349.29	269	451
Normal Weight	39	309.11	45.001	6.901	300.31	319.89	211	411

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Overweight	20	299.71	34.501	7.699	291.62	321.81	239	363
Total	90	321.51	44.403	4.595	299.33	332.59	211	451

Table 2's means values indicate that several groups received varying scores in the final evaluation, with the underweight group receiving the highest score and the overweight group receiving the lowest. Even the 95% confidence interval for the lower limit and upper limit of the mean value in the overweight group was lower than that in the underweight group and normal weight group. The lowest and highest score values of the overweight group were also lower than those of the underweight group.

Table 3: An Overview of ANOVA results to compare study groups' academic performance and body weight.

	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	15899.695	2	7971.901	4.401	0.021
Within Groups	159125.112	87	1795.498		
Total	178993.613	89			

The mean square and sum of squares values within and between groups are displayed in Table 3. We take into consideration the F value 4.401, whose significance value of 0.021 is less than alpha = 0.05, to verify whether the differences between the groups were significant. Thus, it was determined that, among the three study groups, weight had a significant impact on academic achievement at the $p<0.05$ level. [$P = 0.021$, $F(2, 87) = 4.401$].

- **Post Hoc Tests**

  Dependent Variable: Marks

Table 4: An overview of the ANOVA multiple comparisons conducted to investigate the impact of body weight on academic performance.

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	(I) group	(J) group	Mean Difference (I -J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Bonferroni	Under	Normal	25.301*	10.307	.039	.21	50.41
		Over	32.695*	12.385	.029	2.41	63.11
	Normal	Under	-25.303*	10.305	.039	-50.41	-.21
		Over	7.397	11.603	0.998	-20.79	35.69
	Over	Under	-32.691*	12.396	.028	-63.11	-2.41
		Normal	-7.391	11.602	0.998	-35.69	20.79

Table 4 presents post hoc multiple comparisons of academic achievement between the three research groups using the Bonferroni test. A mean difference value of less than 0.05 was deemed significant. Consequently, it was determined that there was a substantial mean difference (Sig. 0.039) between underweight and normal weight. Moreover, there was a significant mean difference between underweight and overweight (Sig. 0.028). The mean difference between overweight and normal weight, however, did not reach significance (Sig. 0.998).

When combined, these three tables' data indicated that a student's physical weight had a considerable impact on their academic ability. In particular, overweight pupils' academic achievement was noticeably worse than that of underweight students. Although overweight students performed less well academically than students of normal weight, the difference was not statistically significant.

Therefore, we thought of using BMI calculation as a tool to classify students as overweight, normal weight or underweight. According to the MUHS evaluation system, the final university exam and two internal exams organized by the school will determine the performance of first-year medical students. To understand their academic success throughout the year, we looked at their final results on the university assessment, which was the total score they achieved in three subjects.

The study's main finding is that overweight students do academically less well than students of normal weight and much worse than children of underweight. Our results are in line with those of

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the WHO MONICA experiment, which found a statistically significant inverse relationship between BMI and educational attainment across all groups. Essentially, the people who were thinner in both sexes also achieved better levels of educational attainment.

5. Conclusion

In this generally concise phase of human turn of events, orientation and pubertal improvement varieties concerning body composition should be considered. Moreover, during adolescence, body composition definitely changes. Estimating extra body fat in adolescents in danger for stoutness and its related metabolic issues requires a clear, exact, and exact methodology that is well defined for this age bunch. Excess body fat, and all the more particularly instinctive fat inside the mid-region, is connected to insulin obstruction, dyslipidemia, hypertension, and unfortunate glucose resistance in young people. The study discoveries demonstrate that there is a negative connection between's academic accomplishment and body weight as estimated by the BMI. Expressed in an unexpected way, with regards to academic achievement, overweight understudies perform more awful than their ordinary weight and underweight partners. It is hard to pinpoint the exact reasons for this disparity, in spite of the fact that psychosocial conduct and dormancy might be contributing variables to overweight children's more regrettable academic execution. The current study's unexpected conclusion is that underweight students achieve more academically than students of normal weight. This research suggests that academic achievement may also be influenced by other factors. According to our research, professional schools should encourage their students to enhance their health and wellness as doing so may help some students achieve better academic results.

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