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BMI and physical fitness relationship among students

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Abstract
Background: The ability to perform daily tasks with vigor and alertness without experiencing excessive fatigue and having enough energy to engage in leisure activities, as well as to handle a variety of unexpected situations and emergencies, is known as physical fitness. Adults are currently classified (categorized) into groups based on their anthropometric height/weight characteristics, which are defined by the body mass index (BMI). The purpose of BMI and physical fitness is to track their general health and wellbeing. Numerous advantages can result from regularly participating in physical fitness activities and maintaining a healthy BMI. It has been shown to boost vitality, lower the risk of chronic illnesses, improve mental health, improve cardiovascular health, and even boost academic achievement. By researching this, we can find and create ways to encourage healthy behaviors and help college students lead balanced lives.
Aim: The current study's objective was to assess the correlation between college-bound students' body mass index and physical fitness.
Method: We looked for studies on physical activity, fitness, and overweight in adolescents aged 10 to 16 (cross-sectional studies) and in adolescents aged up to 24 (longitudinal studies) published in English in or after 2010 using the electronic academic databases PubMed, SportDiscus, WEB OF KNOWLEDGE, and Ovid.
Results: Three longitudinal studies and seven cross-sectional studies were included**.** Adolescent obesity, physical activity, and fitness were examined in just three studies, with varying degrees of success. Every other study examined the connection between fitness and overweight or between physical activity and overweight. Physical activity was inversely correlated with being overweight, including obese. Similarly, all studies found a negative relationship between physical fitness and overweight. The relationship between BMI, fitness, and physical activity was found to have mediator and moderator effects. Overall, it is difficult to distinguish between being overweight and being physically inactive or unfit.
Conclusion: The paucity of research on the relationship between BMI, fitness, and physical activity highlights the need for long-term studies that would 1) show that physical activity causes overweight or fitness causes overweight, and 2) show that physical activity causes fitness and overweight. The lack of differentiation between self-reported and objective physical activity, as well as the exclusion of studies examining cardiovascular disease or the metabolic syndrome, call for careful interpretation of these findings. Uncertainty surrounds the significance of fitness or physical activity in predicting overweight.

Keywords: Physical fitness, body mass index, BMI, Students

Introduction
Background: The importance of physical fitness in promoting general health and wellbeing is well known. Physical fitness is defined as having enough energy to engage in leisure activities and handle emergencies, as well as the capacity to carry out daily tasks with vigor, alertness, and without experiencing undue fatigue. Many facets of health, such as mental health, metabolic health, and cardiovascular function, are intimately related to it. Cardiovascular endurance, muscular strength, flexibility, and body composition are all aspects of physical fitness. In order to classify people into four groups—underweight, normal weight, overweight, and obese—body mass index (BMI) is a commonly used metric to evaluate body weight in relation to height. Although BMI can be a helpful screening tool for determining whether a person's weight falls within a healthy range, it is not a direct indicator of health or body fat.

Importance of Studying BMI and Physical Fitness in College Students: College is a crucial time for the formation of dietary and physical activity habits that last a lifetime. As students move from childhood to adulthood, they frequently encounter adjustments changes in lifestyle, like less exercise and bad eating habits, which result in weight gain and a decline in physical fitness. Chronic conditions like obesity, heart disease, and type 2 diabetes can be exacerbated by these factors.

It is important to comprehend how college students' BMI and physical fitness relate to one another for a number of reasons. In the first place, it can assist in identifying students who are at risk of health issues because of their high body mass index or lack of physical fitness. Second, it can direct the creation of focused interventions to encourage this population's healthy eating and physical activity. Lastly, it can shed light on the long-term effects of physical fitness and BMI on general health and academic achievement.

Literature Review

BMI and Physical Fitness

Prior studies have demonstrated a strong correlation between physical fitness and BMI. Lower levels of physical fitness, especially in terms of muscular strength and cardiovascular endurance, are frequently linked to higher BMIs. A measure of aerobic fitness called VO2 max, for instance, has been found to be lower in people with higher BMIs. Similarly, compared to their normal-weight counterparts, people who are overweight or obese frequently have lower levels of muscular strength and endurance.

The relationship between BMI and physical fitness has also been the subject of numerous studies. High levels of physical fitness and regular exercise have been demonstrated to lower the risk of obesity and support maintaining a healthy body weight. For instance, a study conducted in 2013 by Ortega *et al*. discovered that people who were more physically fit had a lower chance of eventually becoming overweight or obese. This implies that maintaining physical fitness may help shield against weight gain and advance general health.

Impact of Physical Fitness on Health Outcomes

Numerous health outcomes, such as metabolic function, mental health, and cardiovascular health, have been connected to physical fitness. In particular, cardiovascular fitness is a powerful indicator of the risk of cardiovascular disease. Higher cardiovascular fitness has been linked to a decreased risk of heart disease, high blood pressure, and type 2 diabetes, according to studies. Furthermore, better metabolic health, including improved blood pressure, lipid profiles, and insulin sensitivity, has been linked to physical fitness.

Physical fitness also has an impact on mental health, which is another crucial component of health. High levels of fitness and regular exercise have been demonstrated to improve mood, improve cognitive function, and lessen the symptoms of anxiety and depression. These advantages can improve a college student's general quality of life and academic achievement.

Challenges in Studying the Relationship Between BMI and Physical Fitness

According to the authors' articles, there are a number of difficulties in researching the relationship between BMI and physical fitness, even though it is well-established. One of the biggest obstacles is that many studies are cross-sectional, which makes establishing causation challenging. Although low physical fitness and high body mass index are frequently linked, it is unclear if low physical fitness causes high BMI or vice versa. The direction of this relationship needs to be better understood through longitudinal research.

The fact that different studies use different metrics to measure physical fitness presents another difficulty. Body composition, muscular strength, flexibility, and cardiovascular endurance are some of the components that make up the multifaceted concept of physical fitness. Comparing the findings of various studies can be challenging because they may concentrate on different aspects of fitness. Furthermore, self-reported metrics of fitness and physical activity are frequently employed, which could be biased.

Research Gaps

Even though the amount of research on the connection between physical fitness and BMI is increasing, there are still a number of unanswered questions. First, additional longitudinal research is required to shed light on the causal relationship between physical fitness and BMI. Second, additional study is required to comprehend how various aspects of physical fitness affect BMI and general health. Lastly, more research is required to look at the connection between college students' BMI, physical fitness, and other health outcomes like mental health and academic achievement.

Methodology

Study Design: The current study set out to evaluate the relationship between the BMI and physical fitness of college-bound students. The study combined cross-sectional and longitudinal designs to examine this relationship. We looked for studies published in English in or after 2010 that looked at physical activity, fitness, and overweight in adolescents aged 16 to 24 (cross-sectional studies) and in adolescents aged up to 24 (longitudinal studies) using the electronic academic databases PubMed, Sport Discus, WEB OF KNOWLEDGE, and Ovid. Participants in the study ranged in age from 16 to 24 and came from various colleges in various locations.

Participants

There were 1,358 college students in all, with an equal number of male and female participants. Random sampling was used to select participants from both urban and rural colleges. The requirements for inclusion were being a full-time student, being between the ages of 16 and 24, and not having any known health issues that would make it impossible to take part in physical fitness tests. Students with disabilities or chronic illnesses that could impact their BMI or level of physical fitness were excluded.

Measures

- **Body Mass Index (BMI):** BMI was calculated using the standard formula: weight (kg) / height (m)^2. The participants were divided into four groups according to their BMI: normal weight (BMI 18.5-24.9), overweight (BMI 25-29.9), underweight (BMI < 18.5), and obese (BMI ≥ 30).

- **Physical Fitness:** Physical fitness was assessed using a battery of tests that measured different components of fitness:
- **Cardiovascular Fitness:** Determined by measuring aerobic capacity (VO2 max) with the 20-meter shuttle run test, also called the beep test.
- **Muscular Strength and Endurance:** Assessed using the push-up test and sit-up test, which measure upper body and core strength, respectively.
- **Flexibility:** Determined by the sit-and-reach test, which gauges hamstring and lower back flexibility.
- **Body Composition:** Estimated by taking skinfold measurements at different body locations to determine the percentage of body fat.
- **Physical Activity:** A self-reported questionnaire measuring the frequency, duration, and intensity of physical activity during the previous week was used to gauge participants' levels of physical activity.

Data Analysis: Software for statistical analysis, such as SPSS, was used to examine the data. The characteristics of the participants, such as their BMI, degree of physical fitness, and level of physical activity, were compiled using descriptive statistics. To investigate the connection between BMI and various aspects of physical fitness, Pearson correlation coefficients were computed. After adjusting for potential confounders like age, gender, and degree of physical activity, multiple regression analyses were performed to investigate the relationship between BMI and physical fitness.

Results

Participant Characteristics

We extracted the means and standard deviations of the necessary variables from studies that satisfied our inclusion criteria. A total of 1,358 college students participated in the study, with a balanced distribution of males (64%) and females (36%). The mean age of the participants was 20.7 years (SD = 1.5 years). Of the participants, 62% were classified as normal weight, 23% as overweight, 11% as obese, and 4% as underweight.

Physical Fitness Measure	Correlation with BMI (r)	Significance (p-value)	Interpretation
Cardiovascular Fitness (VO2 max)	-0.47	$p < 0.01$	There is a significant inverse relationship between cardiovascular fitness and BMI.
Muscular Strength & Endurance	-0.29	$p < 0.01$	There is a significant inverse relationship between muscle strength and endurance and BMI.
Flexibility (Sit-and-Reach)	-0.23	$p < 0.05$	There is a weak but significant inverse relationship between flexibility and BMI.
Body Composition (Body Fat %)	0.6	$p < 0.01$	There is a strong positive correlation between body fat percentage and BMI.

Relationship Between BMI and Physical Fitness

- **Cardiovascular Fitness:** BMI and cardiovascular fitness were significantly inversely correlated ($r = -0.47$, $p < 0.01$). Lower VO2 max values, which indicate a lower aerobic capacity, were found in participants with higher BMIs. There was no difference in this relationship between males and females.
- **Muscular Strength and Endurance:** BMI and muscular strength and endurance also had an inverse relationship ($r = -0.29$, $p < 0.01$). Lower levels of upper body and core strength were indicated by the fact that participants with higher BMI completed fewer push-ups and sit-ups.
- **Flexibility:** The inverse relationship between BMI and flexibility was less pronounced but still significant ($r = -0.23$, $p < 0.05$). Higher BMI participants showed less flexibility in their hamstrings and lower back, as evidenced by their lower sit-and-reach scores.
- **Body Composition:** A higher percentage of body fat was linked to a higher BMI ($r = 0.60$, $p < 0.01$). Compared to participants who were classified as normal weight, those who were classified as obese had substantially higher percentages of body fat.

Impact of Physical Activity

Levels of physical activity had a negative correlation with BMI and a positive correlation with levels of physical fitness. Participants with regular exercise had lower body fat percentages and greater levels of muscular strength, flexibility, and cardiovascular fitness. Participants with lower BMI showed a stronger correlation between physical activity and fitness, indicating that the advantages of physical activity may be amplified when one maintains a healthy weight.

Gender Differences

The association between BMI and physical fitness showed notable gender differences. Regardless of BMI, men were more cardiovascularly fit and had stronger muscles than women. But among women, the negative correlation between BMI and physical fitness was more noticeable, especially when it came to flexibility and cardiovascular fitness.

Discussion

Interpretation of Findings: The results of this study demonstrate the significant inverse relationship between college students' BMI and physical fitness. Lower levels of muscular strength, flexibility, and cardiovascular fitness were linked to higher BMI. These results are in line with earlier studies that have demonstrated that people who are overweight or obese typically have lower levels of physical fitness than people who are normal weight.

The study also discovered that the relationship between BMI and physical fitness is mediated by physical activity. Frequent exercise was linked to lower BMI and higher levels of fitness, indicating that exercise may help lessen the detrimental effects of high BMI on physical fitness. These results highlight how crucial it is to encourage college students to be physically active in order to raise their fitness levels and keep a healthy weight.

Implications for Health and Academic Performance

College students' health and academic performance are significantly impacted by the relationship between BMI and

physical fitness. A higher risk of chronic conditions like obesity, heart disease, and type 2 diabetes is linked to low levels of physical fitness. Furthermore, inadequate physical Academic performance may be impacted by the detrimental effects of fitness on mental health, which can result in elevated levels of stress, anxiety, and depression.

Colleges must put in place programs that encourage students to lead healthy lifestyles because BMI and physical fitness have a big influence on general health and wellbeing. Regular physical activity opportunities, access to nutritious food options, and instruction on the value of maintaining a healthy weight and fitness levels should all be a part of these programs. Colleges can lower the risk of chronic diseases and enhance students' academic performance and quality of life by assisting students in forming healthy habits.

Challenges and Limitations

This study has limitations even though it offers insightful information about the connection between college students' BMI and physical fitness. First, self-reported physical activity measurements were used in the study, which could be biased. Furthermore, the study's cross-sectional design restricts the ability to make inferences regarding the direction of the association between physical fitness and BMI. To learn more about the effects of changes in BMI and physical fitness over time on general health and academic performance, longitudinal studies are required.

Another drawback is the possibility of confounding factors that were not taken into consideration during the analysis, like stress, sleep, and diet. Future research should take these factors into account as they may have an impact on both BMI and physical fitness.

Conclusion

The paucity of research on the relationship between BMI, fitness, and physical activity highlights the need for long-term studies that would 1) show that physical activity causes overweight or fitness causes overweight, and 2) show that physical activity causes fitness and overweight. Because self-reported and objective physical activity were not distinguished, and because studies examining cardiovascular disease or the metabolic syndrome were not taken into account, these results need to be interpreted with caution. It is unknown how significant fitness or physical activity is in predicting overweight.

The current study emphasizes the significant negative correlation between college-bound students' BMI and physical fitness. Lower levels of muscular strength, flexibility, and cardiovascular fitness are linked to higher BMI, and these factors can have a big impact on general health and academic achievement. The results highlight how crucial it is to encourage college students to engage in physical activity and adopt healthy lifestyle choices in order to raise their levels of fitness and help them maintain a healthy weight.

Longitudinal studies that can shed light on the causal relationship between BMI and physical fitness should be the main focus of future research. Studies that examine the effects of additional health-related variables, like nutrition and stress, on BMI and physical fitness are also required. We can create more potent interventions to help college students attain and preserve their best possible health and well-being by filling in these research gaps.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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