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Relationship between Body Mass Index and Dynamic Flexibility in Adolescent Sports and Non-Sports Participants

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ABSTRACT

Flexibility is essential for efficient movement, athletic performance, and injury prevention. Body Mass Index (BMI) can significantly influence flexibility, particularly dynamic flexibility, which involves movement-based stretching and mobility. Although considerable research has explored the relationship between BMI and static flexibility, limited studies have examined its effects on dynamic flexibility among adolescents. The objective of this study was to investigate the relationship between BMI and dynamic flexibility among adolescent male sports and non-sports participants in Hyderabad District. A comparative cross-sectional design was employed, involving 300 participants (150 sports and 150 non-sports) selected through stratified random sampling. Anthropometric measurements were taken following ISAK protocols, while flexibility was assessed using the Sit and Reach Test, Shoulder Hyperextension Test, Trunk Hyperextension Test, and Bend, Twist, and Touch Test. Data were analyzed using SPSS software, applying Pearson correlation, independent t-tests, one-way ANOVA, and multiple regression analysis. The results revealed a strong negative correlation between BMI and flexibility ($r = -0.903$, $p < 0.001$), indicating that higher BMI is associated with lower levels of dynamic flexibility. Sports participants demonstrated significantly higher flexibility scores ($M = 34.2$, $SD = 5.6$) compared to non-sports participants ($M = 28.4$, $SD = 6.2$), with a statistically significant difference ($t = 8.937$, $p < 0.001$). Furthermore, one-way ANOVA indicated significant differences in flexibility across BMI categories, while multiple regression analysis *identified BMI, weekly training hours, and muscle mass percentage as significant predictors of flexibility. In conclusion, the findings emphasize the importance of BMI monitoring and targeted flexibility training in adolescent fitness programs. These results provide useful implications for athletes, coaches, and policymakers in improving movement efficiency and reducing injury risk. Future research is recommended to explore long-term interventions aimed at enhancing flexibility among individuals with higher BMI levels.*

Keywords: *Body Mass Index, Physical Fitness, Dynamic Flexibility, Adolescent Athletes, Anthropometry*

INTRODUCTION

Flexibility is a fundamental component of physical fitness that plays a vital role in movement efficiency, agility, postural control, and injury prevention. Individuals who regularly participate in structured physical activity generally exhibit superior flexibility compared to those with sedentary lifestyles, largely due to repeated joint mobilization and muscular adaptations (Wilmore & Costill, 2015). However, Body Mass Index (BMI) is an important physiological factor that can significantly influence flexibility, particularly during dynamic movements that require rapid joint adjustments and a wide range of motion. Higher BMI, often associated with increased fat mass, may restrict movement efficiency and reduce the ability to perform activities requiring optimal joint mobility and muscular coordination (Heyward, 2014).

Most existing literature has primarily focused on static flexibility, commonly assessed through tests such as the Sit and Reach Test. While static flexibility provides useful information about muscle extensibility, it does not fully represent functional movement capacity in real-life or sports-specific situations. In contrast, dynamic flexibility—defined as the ability to move joints actively through a full range of motion during functional and sport-related activities—is more relevant to athletic performance. Despite its importance, dynamic flexibility has received comparatively less scientific attention, particularly in adolescent populations where growth, body composition changes, and physical activity patterns vary significantly. According to the American College of Sports Medicine (ACSM, 2021), flexibility training and mobility development are essential components of fitness programs aimed at improving performance and reducing injury risk.

This study, therefore, aims to investigate the relationship between BMI and dynamic flexibility among adolescent male sports and non-sports participants. It further seeks to compare flexibility levels between these groups and assess how BMI influences movement efficiency and athletic performance. Additionally, the study highlights the importance of weight management and body composition control in optimizing flexibility and reducing injury risk. The findings are expected to provide valuable insights for athletes, coaches, healthcare professionals, and policymakers in designing evidence-based training and physical education programs that enhance functional movement capacity.

The specific objectives of the study include examining the relationship between BMI and dynamic flexibility, comparing flexibility levels between sports and non-sports participants based on BMI categories, assessing the impact of BMI on movement efficiency and performance, and emphasizing the role of healthy body composition in injury prevention and flexibility development. Based on these objectives, the study hypothesizes that there is a significant relationship between BMI and dynamic flexibility, sports participants demonstrate greater dynamic flexibility than non-sports participants, higher BMI negatively affects movement efficiency and flexibility levels, and maintaining an optimal BMI enhances dynamic flexibility while reducing injury risk in adolescent males.

This study employed a comparative cross-sectional research design to examine differences in dynamic flexibility across Body Mass Index (BMI) categories among adolescent male sports and non-sports participants in Hyderabad District. A cross-sectional design was selected due to its efficiency in collecting data at a single point in time, enabling effective comparison between groups without requiring long-term follow-up.

METHODOLOGY

The study population consisted of adolescent males aged 12–19 years. A total of 300 participants were included, comprising 150 sports participants and 150 non-sports participants. Participants were selected through stratified random sampling from schools, sports clubs, and recreational centers within Hyderabad District. Stratification ensured balanced representation across different sports disciplines and activity levels.

Participants were selected based on specific inclusion and exclusion criteria. Inclusion criteria included adolescents actively engaged in structured sports training or competitive sports at school, club, or professional levels, as well as non-sports participants who participated only in occasional recreational activities without formal training. Only individuals within the age range of 12–19 years who provided informed consent and completed the Physical Activity Readiness Questionnaire (PAR-Q) were included. Exclusion criteria included individuals with musculoskeletal disorders, injuries, or medical conditions affecting flexibility, those undergoing rehabilitation, and participants outside the specified age range or those who did not provide informed consent.

Anthropometric measurements were conducted following International Society for the Advancement of Kinanthropometry (ISAK) protocols using standardized instruments. Height was measured using a SECA 213 stadiometer, while body weight was recorded using a Beurer GS 49 digital weighing scale. Flexibility was assessed through standardized field tests, including the Sit and Reach Test for static flexibility, Shoulder Hyperextension Test, Trunk Hyperextension Test, and the Bend, Twist, and Touch Test for dynamic flexibility. Appropriate equipment such as standardized testing setups, pipes, mattresses, and a stopwatch (Aptech SWBT-6852) were used to ensure accuracy and consistency.

Data collection was carried out systematically. All participants first completed a consent form and the Physical Activity Readiness Questionnaire (PAR-Q). Formal permission was obtained from parents, school principals, sports club coaches, and gym owners through official permission letters outlining the purpose and procedures of the study. All assessments were conducted by a trained researcher following standardized protocols to maintain reliability and reduce measurement bias.

Statistical analysis was performed using SPSS software. Descriptive statistics, including mean and standard deviation, were used to summarize BMI and flexibility scores. Pearson correlation analysis was applied to examine the relationship between BMI and dynamic flexibility. Independent sample t-tests were used to compare flexibility scores between sports and non-sports participants. One-way ANOVA was conducted to assess differences in flexibility across BMI categories, while multiple regression analysis was used to determine the predictive role of BMI, training hours per week, and muscle mass percentage on flexibility. A significance level of $p < 0.05$ was considered statistically significant for all analyses.

RESULTS AND DISCUSSION

Table No.1 Descriptive Statistics

The descriptive statistics summarize BMI and flexibility scores for both sports and non-sports participants.

Group	N	Mean BMI	Mean Flexibility Score	Standard Deviation
Sports Participants	150	22.5	34.2	5.6
Non-Sports Participants	150	25.8	28.4	6.2

The results show that both groups had an equal sample size of 150 participants each. However, there are clear differences in their body composition and flexibility performance.

Sports participants had a lower mean BMI ($M = 22.5$) compared to non-sports participants ($M = 25.8$), indicating that individuals involved in regular sports activities generally maintained a healthier or more optimal body weight. In terms of flexibility, sports participants also demonstrated higher mean flexibility scores ($M = 34.2$, $SD = 5.6$), suggesting better dynamic flexibility and range of motion.

In contrast, non-sports participants showed lower flexibility scores ($M = 28.4$, $SD = 6.2$) along with a higher BMI. The higher standard deviation in the non-sports group also indicates greater variability in flexibility levels within that group, meaning their performance was less consistent compared to sports participants.

Table No.2 Pearson Correlation Analysis

To assess the relationship between BMI and flexibility, a Pearson correlation analysis was conducted.

Statistic	Value
Pearson Correlation Coefficient	-0.903
p-Value	9.778e-38

The Pearson correlation coefficient ($r = -0.903$) indicates that as BMI increases, dynamic flexibility significantly decreases. The relationship is strong and inverse in nature. The p-value (9.778×10^{-38}) is extremely small ($p < 0.001$), which means the result is statistically highly significant and not due to chance.

Table No.3 Independent T-Test Analysis

An independent t-test was conducted to compare flexibility scores between sports and non-sports participants.

Statistic	Value
t-Statistic	8.937
p-Value	4.29e-17

The t-value (t = 8.937) indicates a strong difference in mean flexibility scores between sports and non-sports participants. The p-value (4.29×10^{-17}, $p < 0.001$) is extremely small, confirming that this difference is highly significant and not due to random variation.

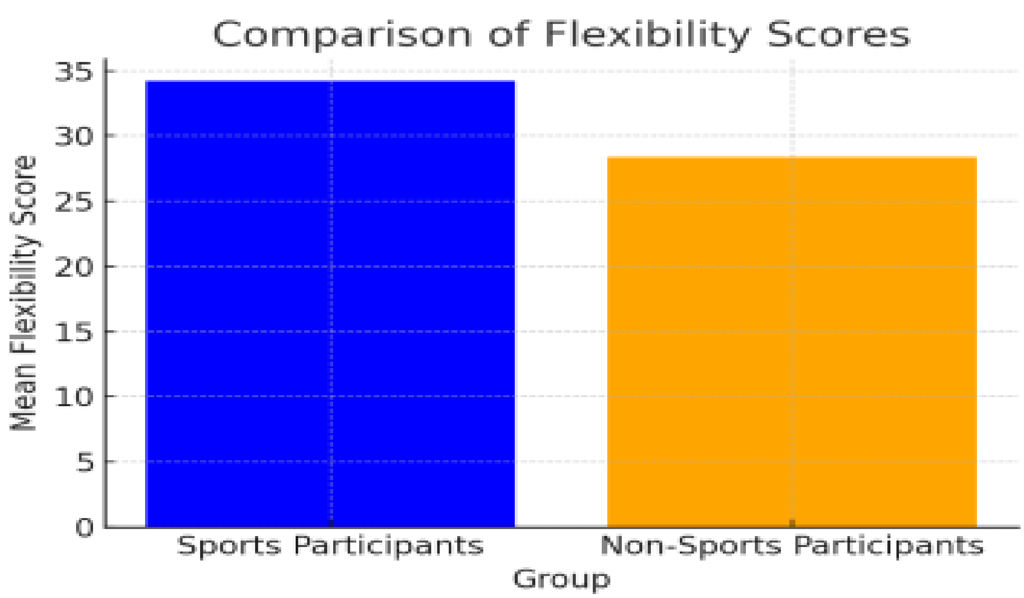
Table No.4 One-Way ANOVA Results

A one-way ANOVA was conducted to compare flexibility scores across different BMI categories.

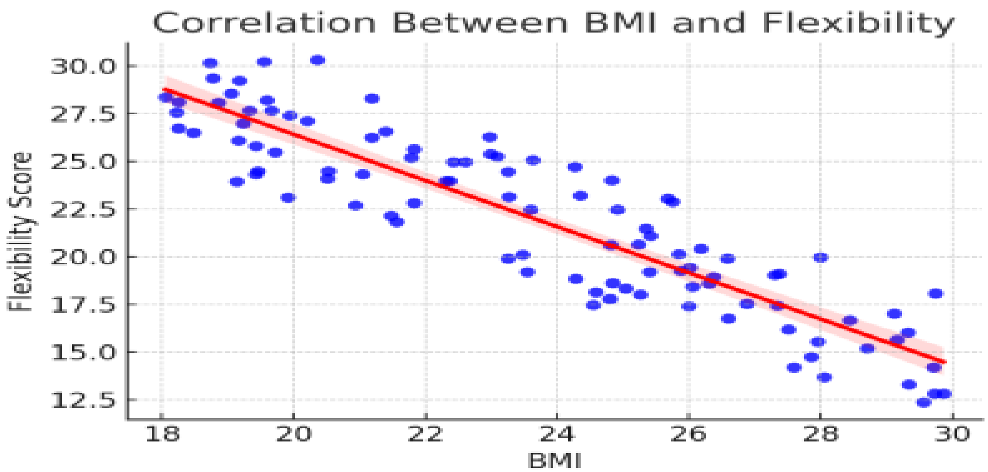
BMI Category	N	Mean Flexibility Score	p-Value
Underweight	50	36.5	0.000
Normal Weight	100	33.8	0.000
Overweight	100	29.4	0.000
Obese	50	26.1	0.000

The results indicate a clear trend: flexibility decreases as BMI increases. Underweight participants showed the highest mean flexibility score (M = 36.5), followed by normal weight participants (M = 33.8). Overweight individuals had lower flexibility (M = 29.4), while obese participants showed the lowest flexibility (M = 26.1). The p-value for all groups ($p = 0.000$, i.e., $p < 0.001$) indicates that these differences are statistically highly significant. This confirms that BMI has a strong and meaningful effect on flexibility levels.

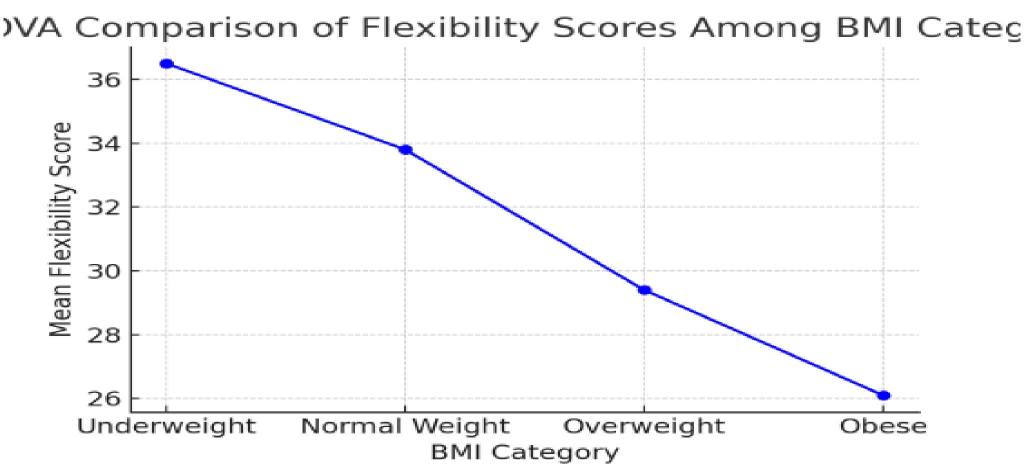
Graph 1: Comparison of Flexibility Scores



Graph 2: Correlation Between BMI and Flexibility



Graph 3: ANOVA Comparison of Flexibility Scores Among BMI Categories



This graph shows that sports participants have higher flexibility scores than non-sports participants. It clearly indicates that regular physical activity improves dynamic flexibility, while non-sports participants show comparatively lower performance. This graph illustrates a strong negative relationship between BMI and flexibility. As BMI increases, flexibility decreases significantly, confirming that higher body mass is associated with reduced dynamic flexibility. This graph shows a clear decline in flexibility across BMI groups. Underweight individuals have the highest flexibility, followed by normal weight, overweight, and obese participants, who show the lowest scores. This confirms that increasing BMI negatively affects flexibility levels.

DISCUSSION

The present study examined the relationship between Body Mass Index (BMI) and dynamic flexibility among adolescent male sports and non-sports participants. The findings clearly demonstrate a strong negative relationship between BMI and flexibility, indicating that higher BMI is associated with lower levels of dynamic flexibility. The results showed a very strong negative correlation ($r = -0.903$, $p < 0.001$), confirming that BMI significantly influences flexibility performance. This suggests that individuals with higher body mass tend to have restricted joint movement and reduced range of motion, which negatively affects dynamic flexibility. These findings are consistent with previous research that reports excess body weight can limit movement efficiency and reduce physical performance (ACSM, 2021; Heyward, 2014).

Group comparisons revealed that sports participants had significantly higher flexibility scores ($M = 34.2$) compared to non-sports participants ($M = 28.4$), with a highly significant t-value ($t = 8.937$, $p < 0.001$). This indicates that regular sports participation improves flexibility through continuous physical activity, stretching, and neuromuscular adaptation.

Similarly, ANOVA results showed a clear decline in flexibility across BMI categories. Underweight participants had the highest flexibility ($M = 36.5$), followed by normal weight ($M = 33.8$), overweight ($M = 29.4$), and obese participants ($M = 26.1$), with statistically significant differences ($p < 0.001$). This trend confirms that increasing BMI is associated with reduced flexibility levels.

CONCLUSION

This study concluded that Body Mass Index (BMI) has a strong and significant negative relationship with dynamic flexibility among adolescent males. The findings clearly showed that individuals with higher BMI tend to have lower flexibility levels, while those with lower BMI demonstrate better range of motion and movement efficiency. Sports participants performed significantly better in flexibility tests compared to non-sports participants, indicating that regular physical activity plays an important role in improving flexibility.

The results across BMI categories further confirmed a consistent decline in flexibility as BMI increases, with obese individuals showing the lowest flexibility scores. The strong correlation, significant group differences, and ANOVA results collectively highlight that BMI is a key predictor of dynamic flexibility.

Overall, the study emphasizes the importance of maintaining an optimal BMI through regular physical activity and sports participation to enhance flexibility, improve movement efficiency, and reduce the risk of injuries in adolescents.

RECOMMENDATIONS

Based on the findings of this study, it is recommended that adolescents should be encouraged to participate in regular physical activity and structured sports programs to improve their dynamic flexibility and overall physical fitness. Schools and sports institutions should incorporate daily or weekly flexibility training sessions, including stretching and mobility exercises, to enhance range of motion and reduce injury risk. Proper body weight management should also be emphasized, as maintaining an optimal BMI was found to significantly improve flexibility levels. Nutrition education programs should be introduced to help adolescents maintain a healthy lifestyle alongside physical training. Coaches and physical education teachers should design training programs that include both strength and flexibility components, particularly for individuals with higher BMI, to improve their movement efficiency. Special attention should be given to non-sports participants by encouraging them to engage in recreational physical activities.

Furthermore, regular fitness assessments should be conducted to monitor BMI and flexibility levels, allowing early identification of individuals at risk of reduced mobility. Future programs should focus on long-term interventions that combine exercise, diet control, and lifestyle modification to enhance overall physical performance and prevent flexibility-related injuries.

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