ORIGINAL ARTICLE

Correlation of Hand Dominance and Body Mass Index on Maximal Isometric Handgrip Strength among Students of SKIMS Medical College, Srinagar, India

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ABSTRACT

Background: Handgrip strength (HGS) serves as an essential indicator of overall muscular strength and is influenced by factors such as Body Mass Index (BMI). This study examines the relationship between BMI and HGS in both dominant and non-dominant hands and investigates potential gender differences in these associations.

Methods: Participants underwent HGS testing in both hands and had their BMI measured. Descriptive statistics and correlation analyses were used to assess the association between BMI and HGS, with additional analysis to explore gender-based differences.

Results: The mean HGS was significantly higher in the dominant hand (36.41 kg) than in the non-dominant hand (34.03 kg, $p = 0.05$). In females, BMI correlated positively with dominant hand HGS ($r = 0.245$, $p = 0.044$) but not with the non-dominant hand. In males, BMI was strongly correlated with dominant hand HGS ($r = 0.514$, $p < 0.001$) and weakly correlated with the non-dominant hand ($r = 0.284$, $p = 0.042$).

Conclusion: BMI is associated with handgrip strength, primarily in the dominant hand, with notable gender differences. Males demonstrate stronger correlations across both hands, whereas females show a significant link only in the dominant hand.

Keywords: Handgrip strength, Body Mass Index, Hand dominance, Isometric strength, Gender differences, Muscular strength, Correlation analysis

INTRODUCTION

Maximal isometric handgrip strength (MIHGS) is a reliable indicator of overall muscular strength and has been widely used in various fields such as sports science, rehabilitation, and occupational health. It is often considered a quick and non-invasive measure of an individual's physical health and muscular fitness.[1] Hand dominance plays a significant role in determining handgrip strength. Dominant hand, the one preferred for tasks such as writing, eating, and tool handling, is generally stronger than the non-dominant hand due to its more frequent use in everyday activities. Studies have consistently shown that individuals exhibit greater strength in their dominant hand, with some reports suggesting that the dominant hand can be up to 10% stronger than the non-dominant one. [2,3] This difference is primarily attributed to the increased neuromuscular efficiency and muscle coordination gained through repetitive use of the dominant hand.[4] Neuromuscular adaptations in the

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dominant hand allow for improved mechanical efficiency and muscle recruitment, further enhancing its strength compared to the non-dominant hand.[4] For clinicians and physiotherapists, understanding the impact of hand dominance on MIHGS is crucial for assessing muscle imbalances, planning effective treatment, and establishing realistic recovery goals. Additionally, in fields such as ergonomics, handgrip strength serves as an indicator of an individual's capacity to perform manual tasks that may require the repetitive use of one hand.

BMI, a widely used measure of body fat based on an individual's height and weight, is another key factor affecting MIHGS. Several studies have demonstrated a positive correlation between BMI and handgrip strength, suggesting that individuals with higher BMI tend to have stronger handgrip strength. [5,6] This relationship is often explained by the association between higher BMI and increased muscle mass, which allows for greater force production during isometric contractions.[7] However, the relationship between BMI and MIHGS is not always linear. While higher BMI can indicate greater muscle mass, it can also reflect increased body fat, which may reduce physical performance, especially in individuals with higher fat-to-lean body mass ratios. Studies on healthy individuals have shown that those within a normal BMI range tend to exhibit optimal handgrip strength, while both underweight and obese individuals may show reduced strength due to insufficient muscle mass or excess body fat. [8,9]

The effect of hand dominance and BMI on MIHGS is particularly relevant when studying young adults, as this group represents individuals at the peak of their physical development and muscular strength. Although much of the research on handgrip strength focuses on older populations due to the relationship between declining strength and functional impairment with age, it is important to establish normative data for young adults as a benchmark for future assessments. Moreover, examining hand dominance and BMI in young adults provides insight into the factors that influence muscular performance early in life and can help shape interventions to improve or maintain strength over time. In this context, this study aims to investigate the effect of hand dominance and BMI on maximal isometric handgrip strength in normal young adults. By exploring these relationships, the research seeks to provide a clearer understanding of the physiological factors influencing handgrip strength and offer valuable insights for applications in fitness, rehabilitation, and ergonomic assessments

MATERIALS AND METHODS

The present study was conducted in the Department of Physiology at SKIMS Medical College and Hospital, Srinagar, over a period of six months. A total of 120 healthy individuals, both male and female, aged 18 to 26 years, were selected as the study population. All participants were free from any lesions or impairments in their upper limbs and met the following inclusion and exclusion criteria. Ethical clearance was not required for this study because it involved non-invasive assessments of healthy individuals who provided written consent prior to participation.

Inclusion criteria included being aged between 18 and 26 years, being healthy individuals of either sex, having no restrictions in the movement of upper limbs, and no history of rheumatoid arthritis or inflammatory joint diseases. Additionally, participants were required to have no self-reported neurological disorders or injuries to the upper extremities. Exclusion criteria included being below 18 or above 26 years of age, being smokers or alcoholics, being pregnant females, being ambidextrous individuals, experiencing pain or aching in the shoulder, arm, or hand either at rest or during movement on most days of the month, and having joint stiffness.

A complete history and preliminary examinations were conducted for all subjects. The procedure was explained thoroughly in simple language, ensuring comprehension, and written informed consent was obtained from each participant. All measurements and assessments were performed in the morning hours after the participants had a light breakfast. Body weight was measured using a portable human weighing scale. The machine was placed on a flat surface, and participants were instructed to remove any heavy outer garments and shoes. They stood upright at the center of the scale with their hands at their sides, facing forward. Height was measured using an anthropometric rod. Participants were asked to remove their shoes and stand erect, with their feet together and head positioned straight ahead. The vertical distance from the floor to the top of the head (vertex) was recorded.

BMI was calculated from the recorded weight and height of each participant using the formula: BMI=Weight (kg)/Height^2(m).

Hand grip strength was measured using a handheld dynamometer. The strength of both the dominant and non-dominant hands was assessed for each participant using a standard adjustable digital hand grip dynamometer. Before the measurements, participants were asked to sit comfortably on a chair with a straight back, feet flat on the floor, and no armrests. The proper posture included the shoulder adducted and neutrally rotated, elbow flexed at 90 degrees, forearm in a neutral position, and wrist positioned between 0-30 degrees of extension and 0-15 degrees of ulnar deviation. Participants were instructed to hold the dynamometer in the specified position and squeeze it as hard as possible without moving their body. The final grip strength was recorded from the dynamometer scale once the pointer stopped moving. Each subject performed three attempts, alternating between the right and left hands, with a 1-minute rest between attempts to prevent fatigue. The mean of the three trials was taken as the final reading. No visual or verbal feedback regarding performance intensity was given to participants. The parameters studied included handgrip strength in both the dominant and non-dominant hands, as well as body mass index (BMI). A sampling frame was initially prepared, and every third student was randomly selected for participation.

RESULTS

The results of the study are described as below. The distribution of respondents by gender reveals that 56.67% of the participants were male (n=68), while the remaining 43.33% were female (n=52) (Table 1).

In terms of descriptive statistics, the mean age of the participants was 20.06 years with a standard deviation of 1.15. The average weight was recorded at 61.46 kg, with a standard deviation of 11.14 kg, while the mean height was 1.64 meters, showing a standard deviation of 0.08 meters. Additionally, the mean Body Mass Index (BMI) was calculated at 22.66, with a standard deviation of 3.73, reflecting the overall physical characteristics of the study population (table 2).

The study compared handgrip strength between dominant and non-dominant hands. The mean strength for the dominant hand was 36.41 kg (SD = 7.83), while for the non-dominant hand it was 34.03 kg (SD = 10.77). An independent t-test revealed a p-value of 0.05, indicating a statistically significant difference. This suggests that, on average, the dominant hand is stronger than the non-dominant hand, consistent with the expectation that increased use and activity contribute to greater strength in the dominant hand.

The mean BMI of the female participants was 22.04 with a standard deviation of 3.28. The average handgrip strength for the dominant hand was 34.88 kg, with a standard deviation of 10.04, while for the non-dominant hand, the mean HGS was 23.87 kg, with a standard deviation of 7.20. A weak positive correlation was observed between BMI and dominant hand HGS (r=0.245, p=0.044), indicating a statistically significant relationship. However, no significant correlation was found between BMI and non-dominant hand HGS (r=0.128, p=0.298), suggesting that BMI does not significantly affect non-dominant hand strength in this group of female subjects.

Table 1: Showing distribution of respondents as per gender

Sex	Participants (%)
Male	68 (56.67)
Female	52 (43.33)
Total	120 (100.00)

Table 2: Descriptive Statistics for Age, Weight, Height, and BMI

Parameter	Mean	SD
Age	20.06	1.15
Weight	61.46	11.14
Height	1.64	0.08
BMI	22.66	3.73

Table 3: Showing difference in Between Handgrip Strength (HGS) in Dominant and Non-Dominant Hands

	N	Mean	Std. Deviation
Dominant HGS	120	36.4143	7.83025
Non-Dominant	120	34.0303	10.77067

Independent t test; -value=0.05

Table 4: Descriptive Statistics and Correlation Between BMI and Handgrip Strength (HGS) in Dominant and Non-Dominant Hands Among Female Subjects

	Mean	SD	r	p-value
BMI	22.0426	3.27794		
Dom-HGS	34.8894	10.04059	0.245*	0.044
Non-Dom HGS	32.8717	7.20082	.128	.298

SD- Standard deviation

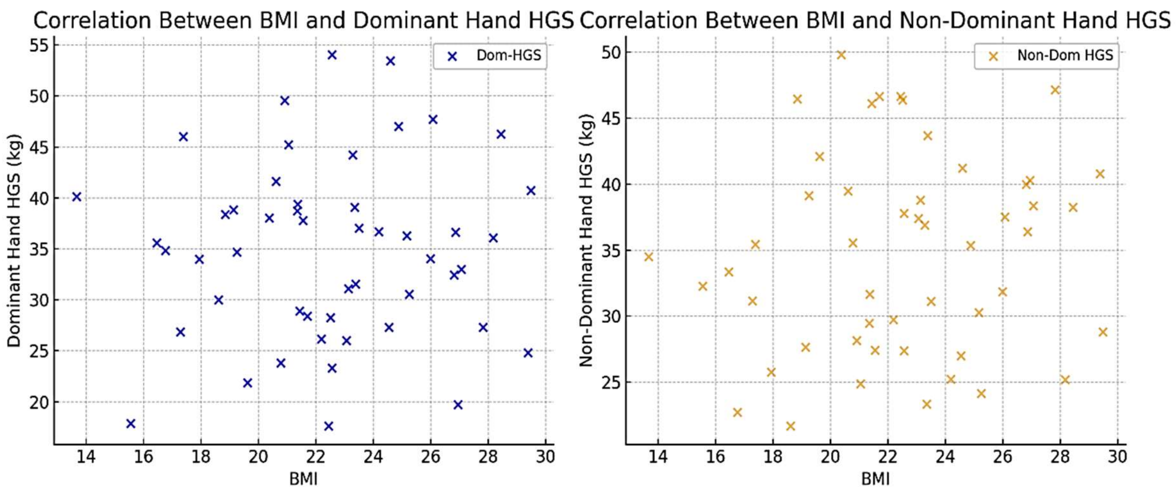

Figure 1: Correlation between BMI and Handgrip Strength (HGS) in Dominant and Non-Dominant Hands Among Female Subjects

Table 5: Descriptive Statistics and Correlation Between BMI and Handgrip Strength (HGS) in Dominant and Non-Dominant Hands Among Male Subjects

	Mean	Std. Deviation	r	p-value
BMI	23.4654	4.15026		
Dom-HGS	39.1234	7.22778	.514	.000
Non-Dom HGS	33.3734	11.32668	.284	.042

Table 6: Showing Descriptive Statistics and Overall Correlation Between BMI and Handgrip Strength (HGS) in Dominant and Non-Dominant Hands

	Mean	SD	N	r	p-value
BMI	22.6592	3.73267	120		
Dominant HGS	36.4143	7.83025	120	0.262	0.004
Non-Dominant	34.0303	10.77067	120	0.052	0.57

The mean BMI for the male participants was 23.47 (sd 4.15). The mean handgrip strength for the dominant hand was 39.123 kg (sd 7.2), while for the non-dominant hand, the mean HGS was 33.87 kg (sd 11.32). A strong positive and statistically significant correlation was found between BMI and dominant hand HGS ($r=0.514$, $p<0.001$), indicating that BMI is significantly associated with dominant hand strength in male subjects. Additionally, a weak positive correlation was observed between BMI and non-dominant hand HGS ($r=0.284$, $p=0.042$), which was also statistically significant. This suggests that BMI has a measurable influence on handgrip strength in both hands for male participants, with a stronger effect on the dominant hand. The descriptive statistics and overall correlation between Body Mass Index (BMI) and Handgrip Strength (HGS) in both dominant and non-dominant hands for the study sample are presented.

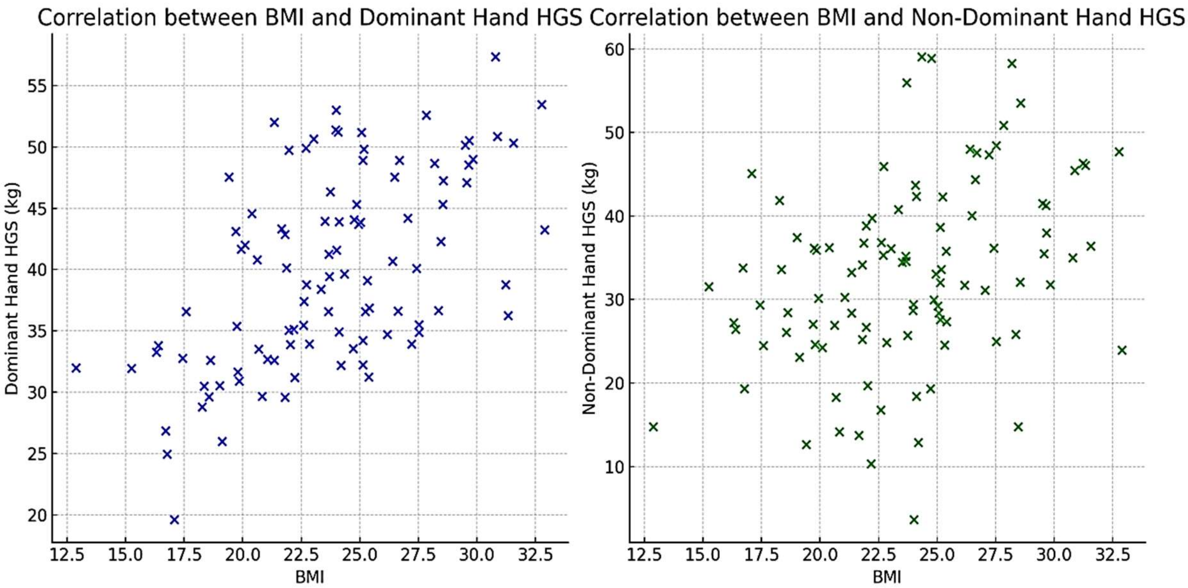

Figure 2: Correlation between BMI and Handgrip Strength (HGS) in Dominant and Non-Dominant Hands Among Male Subjects

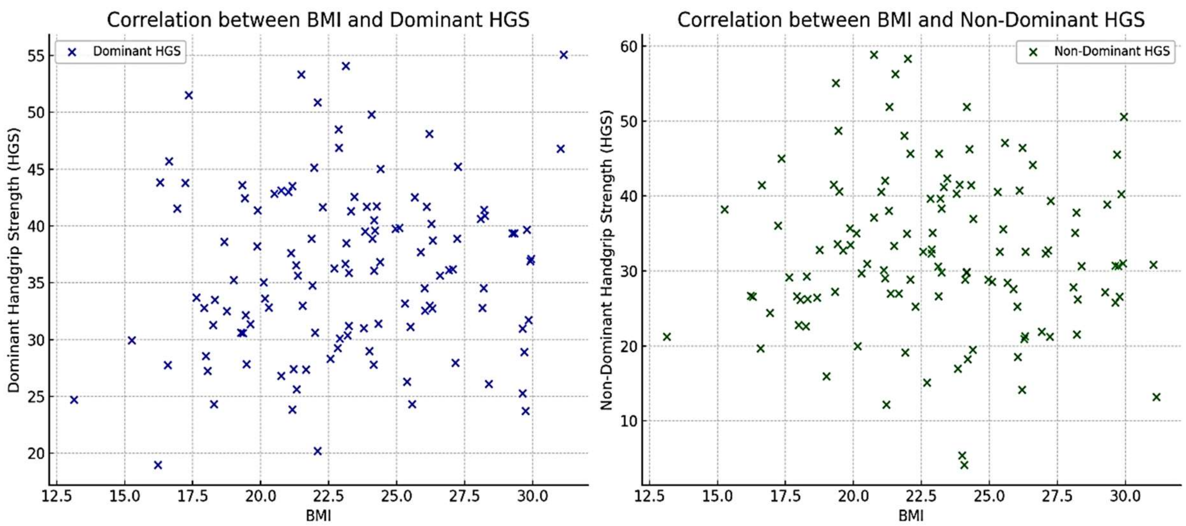

Figure 3: Overall Correlation between BMI and Handgrip Strength (HGS) in Dominant and Non-Dominant Hands

The mean BMI was 22.66 with a standard deviation of 3.73. The mean handgrip strength for the dominant hand was 36.41 kg, with a standard deviation of 7.83, while for the non-dominant hand, the mean HGS was 34.03 kg, with a standard deviation of 10.77. There was a weak but statistically significant positive correlation between BMI and dominant hand HGS (r=0.262, p=0.004), suggesting that higher BMI is associated with stronger handgrip in the dominant hand. However, no significant correlation was found between BMI and non-dominant hand HGS (r=0.052, p=0.57), indicating that BMI has little to no influence on handgrip strength in the non-dominant hand for the overall sample.

DISCUSSION

Handgrip strength (HGS) is a widely accepted measure of overall muscular strength and has been associated with various health outcomes. In this study, the influence of hand dominance and body mass index (BMI) on maximal isometric handgrip strength in normal adults was evaluated. Our findings revealed a significant difference in handgrip strength between dominant and non-dominant hands, consistent with previous research that suggests greater strength in the dominant hand. The dominant hand showed higher maximal grip strength compared to the non-dominant hand across the sample, which aligns with the notion that repetitive use and greater functional activity of the dominant hand leads to superior neuromuscular coordination and muscle hypertrophy. This discrepancy between the dominant and non-dominant hands is well-supported in the literature, where dominance has been linked to greater muscle fiber recruitment, coordination, and endurance during forceful exertions. [4,10,11] This dominance-related strength difference has practical implications, especially in occupations or daily activities that require repeated, forceful hand use. Understanding these variations is crucial in assessing functional capacity, developing rehabilitation protocols, and setting appropriate strength training goals for both hands. The findings highlight the importance of considering hand dominance in both clinical and research settings when evaluating muscle strength and prescribing interventions.

The study also assessed the relationship between BMI and handgrip strength in both dominant and non-dominant hands. A significant positive correlation was found between BMI and dominant handgrip strength, indicating that individuals with a higher BMI tend to have stronger grip strength in their dominant hand. The study's finding of a significant positive correlation between BMI and dominant handgrip strength aligns with previous research in the field of human performance and body composition. Numerous studies have reported similar relationships between higher BMI and increased muscle strength, particularly in the dominant hand. For instance, a study by Mishra et al. (2019) demonstrated that individuals with higher BMI tend to exhibit greater muscle mass, which directly correlates with stronger grip strength, especially in the dominant hand, where neuromuscular coordination and muscle hypertrophy are more pronounced due to frequent use.[2] Additionally, a meta-analysis by Agtuahene MA et al (2023) concluded that grip strength generally increases with higher BMI, but the relationship is more robust in the dominant hand, possibly due to the differential use patterns between dominant and non-dominant hands.[13] This observation suggests that higher BMI may reflect greater overall body mass, including lean muscle mass, which contributes to functional strength, particularly in the hand used most frequently. These consistent findings across multiple studies highlight that while BMI can be a useful indicator of handgrip strength, it is most predictive in the dominant hand, likely due to the combined effects of increased muscle mass and daily functional use. Therefore, the current study's results support the growing body of literature suggesting that individuals with higher BMI tend to have stronger handgrip strength in their dominant hand, a factor that could be considered in clinical assessments and strength training programs. However; other studies, such as that by Gulzar et al. (2022), reported incongruent results, they found a negative and statistically significant association between BMI and handgrip strength (HGS) in both the dominant hands, which contrasts with the positive correlation observed in the current study.[14] This discrepancy may stem from differences in sample characteristics, such as higher body fat in their participants, which could impair muscle function. Additionally, variations in age, sex, and fitness levels, as well as methodological differences, may explain the differing results. This highlights the complexity of the BMI-HGS relationship. It is important to note that BMI does not differentiate between fat mass and lean muscle mass, and while higher BMI may be associated with greater muscle mass, it can also reflect increased adiposity, which does not contribute to strength.[15,16] Future studies may benefit from using more specific measures of body composition, such as lean body mass, to better understand the relationship between body size and strength.

In this study, we examined the relationship between Body Mass Index (BMI) and handgrip strength (HGS) in both female and male participants, revealing notable gender-based differences. Our findings indicate that BMI has a differential impact on HGS depending on the gender and the hand being assessed. For female participants, the mean BMI was 22.04 ± 3.28. A weak but statistically significant positive correlation was observed between BMI and dominant hand HGS ($r = 0.245$, $p = 0.044$). This suggests that higher BMI is associated with stronger grip strength in the dominant hand. However, there was no significant correlation between BMI and non-dominant hand HGS ($r = 0.128$, $p = 0.298$), indicating that BMI does not affect strength in the non-dominant hand for females. These results are consistent with prior studies indicating that dominant hand strength often shows a closer relationship with BMI. This is likely due to greater usage and muscle adaptation in the dominant hand, which is more frequently engaged in daily activities (Agtuahene MA et al, Shin YA et al.). [13,17] Furthermore, the lack of a significant correlation in the non-dominant hand could be attributed to differences in muscle mass distribution and hand usage between the two hands, with the non-dominant hand receiving less frequent engagement and thus showing less adaptation to BMI changes. For male participants, the mean BMI was slightly higher at 23.47 ± 4.15. Males demonstrated a stronger and statistically significant positive correlation between BMI and dominant hand HGS ($r = 0.514$, $p < 0.001$), as well as a weak but significant correlation between BMI and non-dominant hand HGS ($r = 0.284$, $p = 0.042$). This suggests that BMI influences handgrip strength in both hands for males. The stronger correlations observed in males could be explained by gender-specific differences in body composition. Males generally have a higher proportion of muscle mass, which is more directly linked to strength measures like HGS. Physiological factors such as higher testosterone levels and differences in physical activity patterns contribute to these gender differences in muscle mass and strength (Boisseau N et al and Ben Mansour G et al).[18,19] Previous research supports the notion that muscle mass and BMI are stronger predictors of HGS in men than in women (Das and Dutta).[20] These findings align with studies indicating that physiological differences and higher muscle mass in males lead to a more pronounced correlation between BMI and HGS. Contrastingly, studies such as those by Shetty et al. have found a significant negative correlation between HGS and BMI in overweight males and a positive correlation between HGS and BMI in underweight males.[21] These variations highlight the complex interplay between BMI and HGS, influenced by factors such as body composition and weight categories. In summary, our study highlights gender-based differences in the relationship between BMI and handgrip strength. For females, BMI correlates weakly with dominant hand strength but not with non-dominant hand strength, whereas for males, BMI shows significant correlations with strength in both hands. These findings underscore the need for further research to explore the underlying mechanisms driving these gender differences and the impact of muscle mass distribution on grip strength.

LIMITATIONS

This cross-sectional study design provides a snapshot but doesn't allow for observation of changes over time, which could be relevant for understanding the impact of BMI on handgrip strength across different life stages. Moreover, the exclusion of individuals with upper limb impairments, smokers, alcoholics, pregnant females, and those with pain or joint stiffness reduces the generalizability of findings to the general population with varying health backgrounds.

CONCLUSION

This study assessed the relationship between Body Mass Index (BMI) and handgrip strength in both dominant and non-dominant hands, revealing distinct gender-based differences. On average, the dominant hand was stronger than the non-dominant hand, which aligns with expectations of increased usage and muscle adaptation. In females, a weak but significant positive correlation was found between BMI and dominant hand strength, indicating that higher BMI is associated with stronger grip strength in the dominant hand. No significant relationship was observed between BMI and non-dominant hand strength. In males, BMI showed a stronger positive correlation with handgrip strength in both hands, with a more pronounced effect on the dominant hand. This suggests that BMI has a notable influence on grip strength in males, likely due to greater muscle mass. These results highlight the importance of considering gender differences in the relationship between BMI and handgrip strength, emphasizing the need for further research to explore these interactions.

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Individual Authors' Contributions

Each author contributed significantly to the study: MG led the study design, data collection, and manuscript drafting. FA assisted with data interpretation and literature review. JHB provided critical revisions and final approval of the manuscript. All authors reviewed and approved the final version.

Availability of Data

The data supporting the findings of this study are available upon reasonable request from the corresponding author.

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