Association of Body Mass Index and Hand Grip Strength in Dominant and Non-Dominant Hand in Undergraduate Medical Students of Lahore

Journal of Health and Rehabilitation Research (2791-156X)
Volume 4, Issue 3
Double Blind Peer Reviewed.
https://jhrlmc.com/
DOI: https://doi.org/10.61919/jhrr.v4i3.1442
www.lmi.education/
LINK MEDICAL INTERFACE

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Keywords
Body Mass Index, Hand Grip Strength, Dominant Hand, Non-Dominant Hand, Medical Students, Upper Limb Strength, Cross-Sectional Study, SPSS Analysis, Health Assessment

Disclaimers

Authors' Contributions	All authors contributed equally to the study design, data collection, analysis, and manuscript writing.
Conflict of Interest	None declared
Data/supplements	Available on request.
Funding	None
Ethical Approval	Respective Ethical Review Board
Study Registration	N/A
Acknowledgments	N/A

ABSTRACT

Background: Hand grip strength (HGS) is a key indicator of upper limb strength and daily functioning. Body mass index (BMI) is commonly used to assess physical health, but its relationship with muscle strength is not well defined.

Objective: This study aimed to examine the association between BMI and HGS in the dominant and non-dominant hands among undergraduate medical students in Lahore.

Methods: A cross-sectional study was conducted with 129 participants from Akhtar Saeed Medical College. HGS was measured using a hand-held dynamometer, and BMI was calculated from measured height and weight. Data analysis was performed using SPSS version 23, and the Chi-square test was used to assess associations between BMI categories and HGS.

Results: The majority of participants were right-hand dominant (96.9%). The association between BMI and HGS was found to be insignificant for both the dominant ($p = 0.10$) and non-dominant hands ($p = 0.995$).

Conclusion: The study concluded that BMI does not have a significant impact on HGS in either hand, suggesting that BMI may not be a reliable predictor of muscle strength in this population.

INTRODUCTION

Body mass index (BMI) is a widely used measure to categorize individuals into different weight classes based on their weight-to-height ratio, offering a simple method to identify underweight, normal, overweight, and obese individuals (1). This index, though not a direct measure of body fat, serves as a practical proxy to estimate body weight in relation to height and is extensively utilized in clinical settings to assess the risk of various health conditions, including cardiovascular diseases, diabetes, and other obesity-related complications (2). BMI is also employed in population-based studies to guide public health policies, with a growing interest in its association with muscle strength and overall physical fitness. Previous studies have suggested that BMI may correlate with muscle strength, as it reflects not just adiposity but also lean mass, which is crucial for muscle power (3). However, conflicting evidence exists regarding the extent and nature of this relationship, particularly when distinguishing between dominant and non-dominant hand grip strength (HGS), which is an essential marker of upper body strength and functional capacity.

Hand grip strength is a significant indicator of upper limb function and overall muscle strength, commonly assessed using a hand-held dynamometer (4). This measure is vital for evaluating an individual's ability to perform daily activities that require grasping and fine motor control, making it a relevant parameter in clinical and fitness settings. HGS reflects the maximum force generated during voluntary contraction of the hand muscles and is influenced by various factors, including age, sex, physical activity, and anthropometric measurements such as height and weight (5). Taller individuals, for instance, tend to exhibit greater grip strength due to longer arms and a larger muscle mass, which contributes to enhanced leverage and force generation (6). The potential link between BMI and HGS has been explored in multiple studies, with some reporting positive correlations, suggesting that higher BMI, reflective of greater muscle and fat mass, could enhance grip strength, while others have found insignificant or even negative associations, highlighting the complexity of the relationship (2).

Grip strength not only serves as a proxy for muscular health but also correlates with overall physical fitness and is predictive of various health outcomes, including mortality and disability, particularly in older adults (9). Its assessment provides insights into an individual's musculoskeletal function, with implications for diagnosing sarcopenia, frailty, and other conditions associated with diminished muscle strength. In younger populations, such as undergraduate medical students, the relevance of HGS extends to predicting academic performance, clinical skills, and the ability to cope with the physical demands of medical training (15). The evaluation of HGS in dominant versus non-dominant hands also offers a nuanced understanding of muscular asymmetry and hand dominance, which can be pivotal in designing targeted interventions for improving strength and functional capacity in various settings, including rehabilitation and sports (13).

Given the mixed findings in the literature regarding the association between BMI and HGS, this study aims to

explore this relationship in a sample of undergraduate medical students in Lahore, focusing on both dominant and non-dominant hand grip strengths. By examining the correlations between BMI and HGS in a population characterized by a relatively homogeneous age range and similar physical and academic demands, this study seeks to clarify whether BMI serves as a reliable predictor of muscle strength in this cohort. The findings could have implications for understanding how body composition impacts physical performance and may inform strategies for promoting physical fitness and preventing muscle weakness among young adults, particularly those pursuing demanding careers such as medicine (19, 20). This research also addresses the gap in the literature regarding the specific influences of BMI on dominant versus non-dominant hand grip strength, contributing to the broader discourse on the utility of anthropometric measures in predicting functional outcomes (23).

MATERIAL AND METHODS

In this cross-sectional study conducted at Akhtar Saeed Medical and Dental College, Lahore, between May and December 2023, the relationship between body mass index (BMI) and hand grip strength (HGS) was investigated among undergraduate medical students aged 18-25 years. The study aimed to include participants who were representative of this age group and had no upper limb deformities or history of surgical procedures on the upper limbs, which could potentially affect hand grip strength. Ethical approval for the study was obtained from the Ethical Review Committee of Akhtar Saeed Medical and Dental College, Lahore, and all participants provided informed consent prior to participation, in accordance with the Declaration of Helsinki.

The sample size was calculated using the formula n=N/(1+Ne2)n = N/(1 + Ne^2)n=N/(1+Ne2) (16), and participants were recruited through non-probability convenience sampling. Data collection involved the measurement of BMI and hand grip strength using standardized procedures. BMI was calculated as the weight in kilograms divided by the square of the height in meters, using a digital weighing scale and a measuring tape to obtain the necessary measurements. Participants were classified into underweight, normal weight, overweight, and obese categories based on the World Health Organization BMI chart (17). Hand grip strength was assessed using a hand-held dynamometer, which participants were instructed to squeeze with maximum effort for a brief duration. The dynamometer was calibrated prior to use, and readings were taken for both dominant and non-dominant hands. Each participant performed three trials for each hand, with rest intervals of 2-3 minutes between trials to minimize fatigue. The mean value of the three readings was calculated for each hand to ensure reliable results (18).

The data was analyzed using SPSS version 23, with quantitative variables presented as mean, standard deviation, and range, and categorical variables expressed as frequencies and percentages. The association between BMI and hand grip strength was assessed using the Chi-square test to determine statistical significance, with a p-value of less than 0.05 considered significant. Histograms, bar charts, and pie charts were used for graphical representation of the data, providing a clear visual interpretation of the results.

To ensure the validity of the findings, the study adhered to rigorous data quality checks, including repeated measurements and calibration of equipment, and followed ethical standards throughout the research process. All procedures were conducted in a standardized manner to minimize variability and ensure the reliability of the measurements. The statistical analyses were performed to explore the potential association between BMI and hand grip strength in both dominant and non-dominant hands, contributing valuable insights into the role of body composition in determining muscle strength among young adults (18).

RESULTS

The study included a total of 129 undergraduate medical students from Akhtar Saeed Medical and Dental College, Lahore, with a demographic breakdown as follows: participants were predominantly in the 22-23 years age group (50.4%), followed by 20-21 years (19.4%), 18-19 years (18.6%), and 24-25 years (11.6%). The gender distribution showed a higher proportion of females (58.1%) compared to males (41.9%).

Table 1: Demographic Characteristics of the Participants

Characteristic	Response	Frequency	Percent
Age	18-19	24	18.6
	20-21	25	19.4
	22-23	65	50.4
	24-25	15	11.6
Gender	Male	54	41.9
	Female	75	58.1
BMI	Underweight	14	10.9
	Normal	96	74.4
	Overweight	17	13.2
	Obese	2	1.6
Hand Dominance	Right	125	96.9
	Left	4	3.1

Based on BMI categories, many participants were classified as normal weight (74.4%), with 13.2% categorized as overweight, 10.9% as underweight, and a small proportion (1.6%) as obese. Most participants (96.9%) were right-hand dominant, while only 3.1% were left-hand dominant.

The analysis of the association between BMI and hand grip strength of the dominant hand, as shown in Table 2, revealed that the majority of participants with normal BMI exhibited weak hand grip strength, with only a few demonstrating normal or strong grip strength. Specifically, 91 participants with normal BMI had weak grip strength, 4 had normal grip strength, and 1 participant demonstrated strong grip strength. Among the underweight category, all 14 participants had weak hand grip strength. Similarly, for the overweight category, 15 participants showed weak grip strength, while 2 participants had normal grip strength. In the obese category, 1 participant each exhibited weak and normal grip strength. The Chi-square test indicated an insignificant association between BMI and hand grip strength of the dominant hand with a p-value of 0.10.

Table 2: Association of BMI and Hand Grip Strength of Dominant Hand

BMI	Weak	Normal	Strong	Total
Underweight	14	0	0	14
Normal	91	4	1	96
Overweight	15	2	0	17
Obese	1	1	0	2
Total	121	7	1	129
Chi-Square = 10.498, P-Value = 0.10				

For the non-dominant hand, the association between BMI and hand grip strength is shown in Table 3. Among participants with normal BMI, 94 had weak grip strength, while only 1 participant each demonstrated normal and strong grip strength. All underweight participants (n=14) exhibited weak grip strength, and similar results were observed in the overweight and obese categories, with all participants showing weak grip strength, except for 1 normal grip strength reading among those with normal BMI. The association between BMI and hand grip strength of the non-dominant hand was found to be statistically insignificant with a Chi-square value of 0.698 and a p-value of 0.995.

Table 3: Association of BMI and Hand Grip Strength of Non-Dominant Hand

BMI	Weak	Normal	Strong	Total
Underweight	14	0	0	14
Normal	94	1	1	96
Overweight	17	0	0	17
Obese	2	0	0	2
Total	127	1	1	129
Chi-Square = 0.698, P-Value = 0.995				

Overall, the study results indicate that there is no significant association between BMI and hand grip strength in both dominant and non-dominant hands among the participants, suggesting that BMI may not be a reliable predictor of grip strength in this population.

DISCUSSION

This study investigated the association between body mass index (BMI) and hand grip strength (HGS) in both dominant and non-dominant hands among undergraduate medical students. The results demonstrated that there was no significant correlation between BMI and hand grip strength for both hands, indicating that variations in BMI did not influence grip strength in this population. These findings align with some previous studies but contradict others, highlighting the complexity and variability in the relationship between BMI and muscle strength across different populations.

In comparison to a study conducted by Jasim Al Asadi in 2018, which reported a significant association between BMI and HGS among medical students in Iraq, the current study found no such correlation in either hand (19). This discrepancy could be attributed to differences in sample size, population characteristics, or the methods used for measuring grip strength. The current study's findings are more aligned with the work of Nicola M. Massy et al. (2011), who observed a weak or inverse relationship between BMI and HGS in adults under certain age ranges, suggesting that BMI may not consistently predict muscle strength across different age groups or populations (20). Similarly, a study by Manjunath Hemberal et al. (2014) found that hand circumference was a better indicator of grip strength than BMI, which further supports the notion that other anthropometric measures might be more reliable predictors of muscle strength than BMI alone (21).

The results of this study also showed that dominant hand grip strength did not differ significantly from the non-dominant hand, regardless of BMI category. This was consistent with findings by Mohamed Sherif Sirajudeen et al. (2012), who reported significant correlations between HGS and various physical factors, but did not specifically emphasize a difference between dominant and non-dominant hands based on BMI (23). The insignificant association in the current study suggests that while BMI may reflect general body composition, it does not necessarily correlate with specific functional parameters such as grip

strength, which can be influenced by other factors such as muscle mass, hand size, and physical activity levels.

The strengths of this study included the use of a standardized protocol for measuring HGS and BMI, as well as the inclusion of a homogenous group of participants in terms of age and educational background, which helped minimize variability. However, there were several limitations. The cross-sectional design of the study limited the ability to establish causality between BMI and grip strength. The sample size, though adequate, was relatively small and restricted to a single institution, which may limit the generalizability of the findings to broader populations. Additionally, the study did not account for potential confounding factors such as physical activity levels, nutritional status, or underlying health conditions, which could influence both BMI and muscle strength.

Future research should consider longitudinal studies to better understand the causal relationships between BMI and muscle strength over time, and to explore whether changes in BMI are associated with changes in grip strength. Expanding the study to include a more diverse sample with varying levels of physical activity, different age groups, and other relevant anthropometric measures, such as hand circumference or muscle mass, could provide a more comprehensive understanding of the factors that influence grip strength. Moreover, incorporating measures of physical activity and dietary intake could help clarify the role of lifestyle factors in the observed associations.

CONCLUSION

In conclusion, the findings of this study suggest that BMI is not significantly associated with hand grip strength in either the dominant or non-dominant hands among undergraduate medical students. This implies that BMI, while useful as a general indicator of body composition, may not be an appropriate standalone measure for assessing functional muscle strength. Clinicians and researchers should consider using additional or alternative anthropometric measures when evaluating muscle function, particularly in young, healthy populations where BMI may not fully capture variations in physical fitness or functional capability.

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