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Correlation between Hand Grip Strength and Fine Grip Strength in Right Handed and Left Handed Normal Individuals with Different Body Mass Index (BMI) Categories

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Abstract

Background: Hand grip strength and fine grip strength are important indicators of hand function and may be influenced by hand dominance and body composition. BMI may also affect grip performance; however, the relationship between these factors is not fully established.

Aim: To determine the relationship between hand dominance, BMI, hand grip strength, and fine grip strength in normal individuals aged 18–30 years.

Methodology: A cross-sectional study was conducted on 94 normal individuals aged 18–30 years. After obtaining informed consent, demographic details and hand dominance were recorded. Height and weight were measured using a stadiometer and weighing scale, respectively, and BMI was calculated. Hand grip strength was assessed using a hand dynamometer, while fine grip strength was assessed using a Pinch dynamometer. Measurements were recorded for both hands under standardized conditions. The collected data were statistically analyzed to compare hand grip parameters and determine the correlation between BMI and grip strength.

Results: BMI did not show a statistically significant difference between right- and left- dominant participants ($p > 0.05$). Hand grip strength was also comparable between the right and left hands (24.22 ± 9.63 kg and 24.44 ± 9.41 kg, respectively; $p > 0.05$). Fine grip strength was higher in the right hand (8.10 ± 4.42 kg) than in the left hand (7.56 ± 3.73 kg), with a statistically significant difference ($p < 0.05$). BMI showed weak positive significant correlations with right and left hand grip strength ($r = 0.264$, $p = 0.010$; $r = 0.246$, $p = 0.017$) and with right and left fine grip strength ($r = 0.281$, $p = 0.006$; $r = 0.224$, $p = 0.030$).

Conclusion: Hand dominance was not associated with significant differences in BMI or overall hand grip strength. However, fine grip strength was significantly higher in the right hand. BMI demonstrated weak positive associations with both hand grip and fine grip strength. Assessment of both gross and fine grip strength may therefore provide a more comprehensive evaluation of hand function.

Keywords : Hand dominance, BMI, Hand grip strength, Fine grip strength, Hand function

Introduction

Muscular strength is an important component of health-related physical fitness and refers to the ability

of muscles to generate force during different activities. Grip strength is commonly used to assess the muscular strength of the hand. Hand grip strength is mainly produced by the flexor muscles of the palmar, thenar, and hypothenar regions, while the extensor mechanism and the intrinsic muscles of the hand also contribute, although their role is comparatively smaller [1].

Pinch strength is the force generated when the thumb works together with one or more fingers, and it plays an important role in the precise hand movements and fine motor activities required in everyday life. Three main pinch patterns are described: tip pinch, key pinch, and palmar pinch. Tip pinch involves contact between the tips of the thumb and index finger, key pinch occurs when the thumb pad presses against the side of the index finger, and palmar pinch involves the thumb pad working against the pads of the index and middle fingers. Among these, key pinch strength is considered a useful and sensitive measure of intrinsic hand muscle function and is widely used in clinical practice and research [2].

Assessing hand strength is an important part of hand rehabilitation, because it helps clinicians to identify functional problems, establish realistic treatment goals, select appropriate interventions, and evaluate treatment outcomes. Hand grip strength is also associated with several important health outcomes, including mortality, disability, and the ability to perform activities of daily living. Reliable measurement of grip strength is therefore essential for understanding an individual's functional abilities and for supporting appropriate clinical decision-making [3].

Hand grip strength (HGS) is influenced by several factors, including age, gender, body size, hand dominance, physical activity, grip span, height, and body mass. Associations between grip strength and anthropometric characteristics such as body weight, height, and hand length have been reported in previous studies. Hand dominance is another important factor, since the hand used more frequently for daily activities generally shows greater grip strength than the non-dominant hand. However, the relationship between body mass index (BMI) and grip strength may differ depending on individual characteristics and the population being studied [3]

Although the right and left sides of the human body are structurally similar, differences in their functional abilities may develop because of habitual use. The dominant hand is generally the hand preferred for routine activities such as writing, eating, and handling objects, and its frequent use may contribute to better coordination, control, and strength. As a result, the dominant hand generally produces greater grip force than the non-dominant hand, with some studies reporting approximately 6% greater grip strength in the dominant hand [4]

Body mass index (BMI) is another factor that may be associated with muscular performance and hand grip strength. A positive relationship between BMI and grip strength has been reported in some studies, particularly among overweight and obese females. This suggests that body weight and body composition may influence muscular strength, although the relationship may vary among individuals and different population groups [5]

However, the association between BMI and muscular strength is not consistent across all studies. Some research has found that adolescents who are underweight or overweight have lower grip strength and muscular endurance than those with a normal body weight, which suggests that both low and high BMI may be associated with differences in muscular performance. Considering BMI alongside hand dominance and grip strength may therefore provide a better understanding of the factors associated with hand function [6]

Handgrip strength (HGS), a standard indicator of muscular strength, is essential in rehabilitation and is closely linked to health outcomes such as disability and functional independence. HGS is influenced by

age, gender, and BMI, with evidence showing mixed and sometimes contradictory associations across populations. However, the literature on the relationship between HGS and BMI remains limited and inconsistent. This gap highlights the need for further research to establish clearer associations and to strengthen the clinical utility of HGS as a functional marker.

The research question of the study was whether there is a correlation between hand grip strength and fine grip strength among right-handed and left-handed normal individuals across different BMI categories.

The aim of the study was to compare hand grip strength and fine grip strength in right-handed and left-handed individuals with different BMI categories. The objectives were to determine the correlation between BMI and hand grip strength in right-hand-dominant and left-hand-dominant individuals, and to determine the correlation between BMI and fine grip strength in right-hand-dominant and left-hand-dominant individuals.

The null hypothesis $(H0)$ was that there is no significant correlation between hand grip strength and fine grip strength among right-handed and left-handed normal individuals across different BMI categories, whereas the alternative hypothesis $(H1)$ was that there is a significant correlation between hand grip strength and fine grip strength among right-handed and left-handed normal individuals across different BMI categories.

This observational, cross-sectional study was conducted on healthy adults (18–30 years of age) in Latur city, Maharashtra, India, over a period of 6 months. The sample size was 94 and was calculated using the formula $n_1 = [(Z_{1-\alpha/2})^2 \times (SD_1^2 + SD_2^2 \div r)] \div \varepsilon^2$. The materials used were a hand dynamometer, a pinch dynamometer, a stadiometer, a weighing scale, a pen, a consent form, and a data collection sheet.

The inclusion criteria were an age of 18–30 years, healthy adults, right-handed and left-handed individuals, and categorization into BMI groups using the World Health Organization (WHO) cut-off [2]. The exclusion criteria were a history of upper limb trauma, surgery, or deformity within the past 5 years, inability to move through the full range of the shoulder, elbow, wrist, or finger joints, and deformities or disability of the upper limb [2].

Hand grip strength was measured with a hand dynamometer, fine grip strength with a pinch dynamometer, weight with a weighing scale, and height with a stadiometer. BMI was calculated in the metric unit kg/m^2 and categorized according to WHO guidelines as underweight (16.0 to 18.4 kg/m^2), normal weight (18.5 to 24.9 kg/m^2), overweight (25.0 to 29.9 kg/m^2), and obese (30.0 kg/m^2 and above).

Procedure

Ethical approval was obtained from the Institutional Ethics Committee of Maharashtra Institute of Physiotherapy, Latur, before the study commenced. Participants were recruited according to the predetermined inclusion and exclusion criteria. The purpose and methodology of the study were explained to all participants, and written informed consent was obtained before data collection. The height and body weight of each participant were measured using a stadiometer and a weighing scale, respectively, and BMI was then calculated using the following formula:

$$BMI = \text{Weight (kg)} \div \text{Height}^2 \text{ (m}^2\text{)} \quad (1)$$

According to the calculated BMI values, participants were categorized into the predefined BMI groups. Hand dominance was identified from the hand each participant preferentially used for routine daily activities.

Assessment of Hand Grip Strength

Hand grip strength was measured using a hand dynamometer. Participants were seated upright on a chair with their feet flat on the floor and their backs supported. The shoulder was kept in adduction with neutral rotation, the elbow was flexed to 90°, the forearm was held in a neutral position between pronation and supination, and the wrist was maintained in a neutral position or slight extension of approximately 0–30°. The dynamometer handle was adjusted to the second position for most adult participants. The instrument was held vertically and aligned with the forearm, and neither the arm nor the dynamometer was supported by a table or armrest during testing. Participants were instructed to exert maximum gripping force on the device. Three trials were conducted for each hand, with approximately one minute of rest between successive trials to minimize muscular fatigue. All readings were documented, and the mean or peak value specified in the study protocol was used for statistical analysis.

Assessment of Fine Grip Strength

Fine grip strength was evaluated using a pinch dynamometer under standardized testing conditions. Participants were positioned comfortably and instructed to apply maximum pinch force to the instrument. Measurements were obtained from both hands, with three trials performed for each hand and adequate rest periods between trials to reduce the effects of fatigue. The recorded measurements were documented for subsequent analysis.

Data Recording and Statistical Analysis

All measurements, including BMI, hand grip strength, and fine grip strength, were systematically entered into the master chart and then analyzed statistically to evaluate the study variables according to the objectives of the research. Data were collected using a structured proforma, entered into an MS Excel sheet, and analyzed using SPSS version 24.0 (IBM, USA). Qualitative data were expressed as proportions, and quantitative data were expressed as mean and standard deviation. After data collection, the correlation coefficient test was used to interpret the data. A p-value of <0.05 was considered statistically significant, and a p-value of <0.001 was considered highly significant.

Result

The present study examined the correlation between hand grip strength and fine grip strength in right-handed and left-handed normal individuals with different BMI categories. The sample size was 94, and the results are presented in the tables below.

Correlation between Body Mass Index (BMI) and Hand Grip Strength

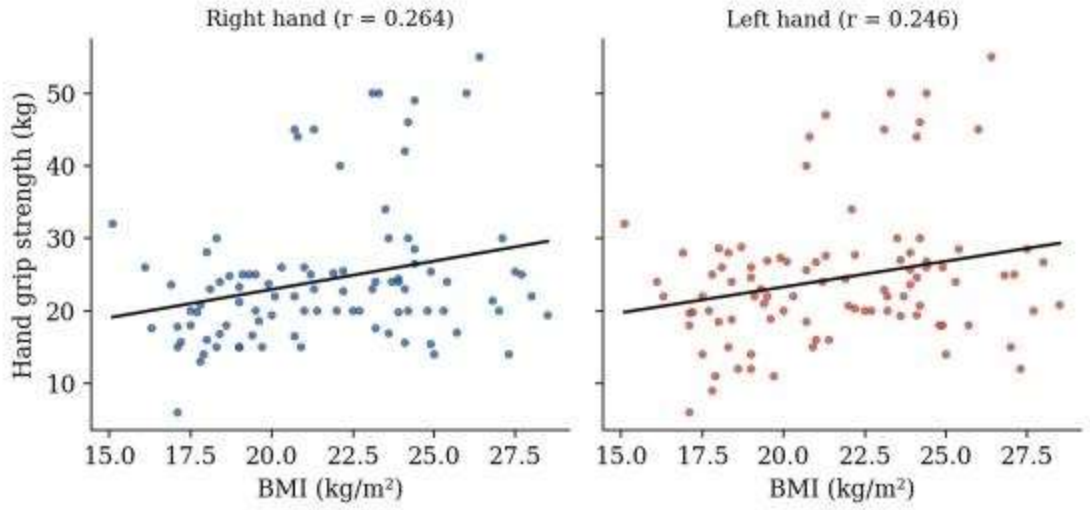
Table 1 shows the correlation betweenBody Mass Index (BMI) and hand grip strength.

Table 1: Correlation between Body Mass Index (BMI) and Hand Grip Strength (N = 94)

Hand Side	Correlation Coefficient (r)	p-value	Significance
Right	0.264	0.010	Significant
Left	0.246	0.017	Significant

Interpretation: A positive correlation was observed between BMI and hand grip strength. For the right hand, the correlation coefficient was r = 0.264, indicating a weak positive relationship that was statistically significant (p = 0.010). A similarly weak positive correlation was observed for the left hand (r = 0.246, p = 0.017). These findings indicate that higher BMI was associated with a modest increase in hand grip strength, although the relationship was weak.

Figure 1: Correlation between Body Mass Index (BMI) and Hand Grip Strength in the Right and Left Hands



Correlation between Body Mass Index (BMI) and Fine Grip Strength

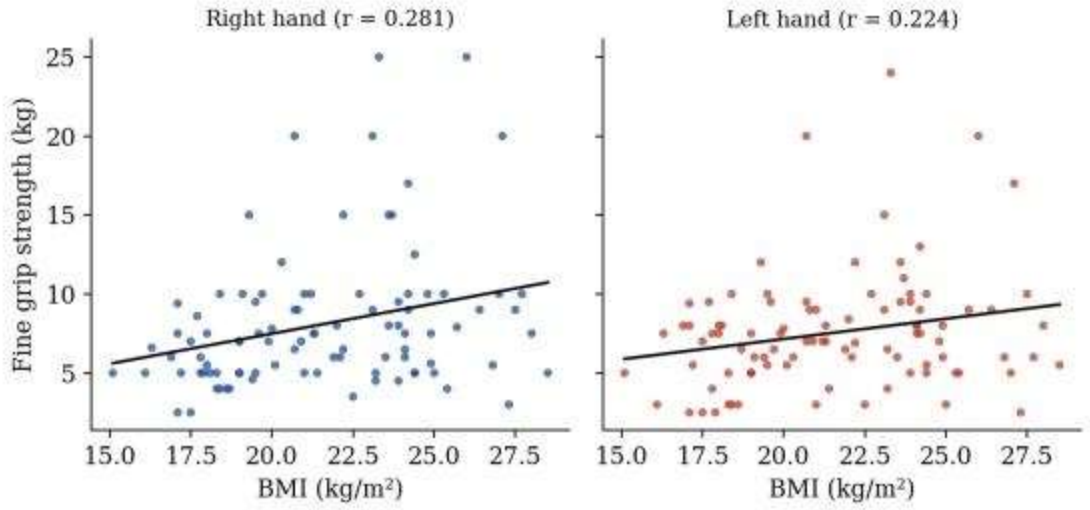
Table 2 shows the correlation between Body Mass Index (BMI) and fine grip strength.

Table 2: Correlation between Body Mass Index (BMI) and Fine Grip Strength (N = 94)

Hand Side	Correlation Coefficient (r)	p-value	Significance
Right	0.281	0.006	Significant
Left	0.224	0.030	Significant

Interpretation: BMI showed a positive relationship with fine grip strength for both hands. A weak positive correlation was observed for the right hand (r = 0.281, p = 0.006), and a positive correlation was also seen for the left hand (r = 0.224, p = 0.030). Higher BMI was thus associated with slightly greater fine grip strength, and the relationship was somewhat stronger for the right hand. The correlations remained weak, indicating that BMI alone does not strongly determine fine grip strength.

Figure 2: Correlation between Body Mass Index (BMI)and Fine Grip Strength in the Right and Left Hands



Summary of Findings

Table 3 summarizes the main findings of the study. The significance level was set at $p < 0.05$.

Table 3: Summary of Findings

Table	Main Finding	Significance
Table 1	BMI positively correlates with hand grip strength	Significant
Table 2	BMI positively correlates with fine grip strength	Significant

Discussion

This cross-sectional study of 94 healthy adults aged 18–30 years examined how BMI relates to gross hand grip strength and fine grip strength. BMI showed weak but statistically significant positive correlations with both grip measures in the right and left hands.

BMI correlated weakly but significantly and positively with gross grip strength (right r = 0.264, left r = 0.246) and with fine grip strength (right r = 0.281, left r = 0.224). This agrees with Agtuahene et al. (2023), who found that grip strength rose with BMI and height [2], and with Zaccagni et al. (2020), who reported that hand grip strength correlated strongly with anthropometric and body composition variables in young adults [8]. People with larger bodies tend to carry more muscle, which could explain the modest rise in absolute grip force as BMI increases.

The correlation with fine grip strength was somewhat stronger for the right hand (r = 0.281) than for the left hand (r = 0.224). Pinch strength depends not only on muscle force but also on finger coordination, motor control, and the intrinsic hand muscles, and greater pinch strength in the dominant hand has been described in earlier work [3, 12]. Since most people are right-handed, the slightly stronger association on the right may partly reflect the predominance of right-handed participants, although hand dominance was not compared directly in the present analysis. It should also be noted that these are associations and cannot establish causation.

Even so, BMI explained only about 5–8% of the variation in grip strength, and the wider literature shows that the relationship is not straightforward. Prakash et al. (2022) found a significant positive correlation only among overweight and obese women and none in normal-weight men or women, concluding that BMI reflects weight status but does not fully explain differences in muscle strength [5]. A key limitation is that BMI cannot distinguish lean mass from fat mass. In a large Mendelian randomization analysis of UK Biobank participants, higher body fat percentage and central adiposity were causally linked to weaker grip, whereas higher BMI and waist circumference were associated with stronger grip in men [13]. Lad et al. (2013) also reported reduced grip endurance in both underweight and overweight adolescents compared with those of normal BMI [6], suggesting that the relationship may not be linear across the BMI range. Measures of body composition, such as body fat percentage and fat-free mass, may therefore explain grip strength better than BMI alone [8, 13].

In hand rehabilitation, grip and pinch strength are used to guide diagnosis, goal setting, and monitoring of recovery [3]. The weak positive association between BMI and both grip measures suggests that BMI may be considered when interpreting grip and pinch strength, and that both gross and fine grip should be assessed to give a fuller picture of hand function. Standardized positioning and reliable instruments are essential for accurate measurement [7, 11] .

This study has some limitations. The sample size was fairly small (N = 94), so the findings may not hold true for the wider population. The study was cross-sectional, so it can only show that two things are related and cannot tell whether one causes the other. BMI was the only body measure used, and it cannot distinguish muscle from fat, so it may not give a true picture of each participant's body composition. Age, sex, physical activity, occupation, and nutritional status can all affect grip strength, but none of them were controlled for. The correlations between BMI and grip strength were weak, so the results should be interpreted carefully. Only healthy individuals took part, so the results may not apply to people with nerve, muscle, bone, or joint problems. Grip and fine grip testing also depends on the effort and cooperation of each participant on the day, which may have caused some variation in the readings.

Future studies should include more participants, with similar numbers of right-handed and left-handed individuals, so that the results are stronger and easier to generalize, and people of different ages and both sexes can be studied, with age and sex included as variables in the analysis. Measures such as body fat percentage, skeletal muscle mass, or waist-hip ratio can be used along with BMI to describe body composition more accurately, and multiple regression or similar methods can be used to find out which factors independently predict hand grip and fine grip strength. The same measurements can be taken in people with conditions such as stroke, carpal tunnel syndrome, arthritis, or peripheral nerve injury, and future work can look at how a person's occupation or sport affects grip performance in the dominant and non-dominant hands. Long-term or interventional studies can check whether hand strengthening and fine motor training actually improve grip performance, and reference values for hand grip and fine grip strength can be developed for the local population.

Conclusion

It is concluded that BMI showed weak but significant positive correlations with both hand grip strength and fine grip strength in the right and left hands, indicating that greater BMI was associated with slightly higher grip strength. Overall, the findings suggest that BMI may have a modest influence on grip strength. Evaluation of both gross and fine grip strength therefore provides a more comprehensive assessment of hand function.

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