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RESEARCH ARTICLE

Association of Handgrip Strength with Body Composition and Physical Fitness among First-Year MBBS Students: A Cross-Sectional Study

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ABSTRACT

Background: Handgrip strength is a simple and non-invasive measure of muscular strength and may reflect overall muscular and functional fitness. Body composition and physical fitness are important determinants of physical performance in young adults. The present study was undertaken to assess the association between handgrip strength, body composition and physical fitness among first-year MBBS students.

Materials and Methods: A cross-sectional observational study was conducted among 120 first-year MBBS students aged 17–20 years. Height and weight were measured and body mass index (BMI) was calculated. Body composition was assessed using bioelectrical impedance analysis, including body-fat percentage, skeletal muscle mass and fat-free mass. Handgrip strength was measured using a calibrated handgrip dynamometer. Physical fitness was assessed using the six-minute walk test, and the distance covered in six minutes was recorded. Pearson correlation was used to assess the relationship between handgrip strength and body-composition and physical-fitness parameters. A p-value <0.05 was considered statistically significant.

Results: The mean age of the participants was 19.1 ± 0.8 years. The mean handgrip strength was 29.8 ± 8.2 kg, while the mean six-minute walk distance was 570.1 ± 61.5 m. Handgrip strength showed a strong positive correlation with skeletal muscle mass ($r=0.68$, $p<0.001$) and fat-free mass ($r=0.64$, $p<0.001$). A weak positive correlation was observed with BMI ($r=0.29$, $p=0.001$), while body-fat percentage showed a weak negative correlation ($r=-0.24$, $p=0.008$). Handgrip strength also showed a moderate positive correlation with six-minute walk distance ($r=0.37$, $p<0.001$).

Conclusion: Handgrip strength was positively associated with skeletal muscle mass, fat-free mass and physical fitness among first-year MBBS students. It may serve as a simple and practical indicator of muscular and functional fitness in young adults.

Keywords: Handgrip strength; body composition; skeletal muscle mass; physical fitness; medical students; six-minute walk test.

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INTRODUCTION

Handgrip strength (HGS) is a simple, non-invasive and easily measurable indicator of muscular strength. It is commonly assessed using a handheld dynamometer and provides an objective measure of the force-generating capacity of the muscles of the hand and forearm. Although grip strength primarily reflects upper-limb muscle function, it is also considered a useful indicator of general muscular strength and functional capacity[1].

Muscular strength is influenced by several factors, including age, sex, body size, skeletal muscle mass, nutritional status and habitual physical activity. During young adulthood, variations in muscle development and body composition contribute to differences in muscle strength. Assessment of handgrip strength in young individuals can therefore provide useful information regarding their muscular and functional status[2].

Body composition describes the relative proportions of fat mass, fat-free mass and skeletal muscle in the

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body. Skeletal muscle is the principal tissue responsible for voluntary force generation, making muscle mass an important determinant of muscular strength. Fat-free mass also contributes substantially to physical performance, whereas excess body fat increases body weight without directly contributing to force production. Therefore, differences in body composition may influence both absolute and relative handgrip strength[3].

Body mass index (BMI) is widely used to assess body size and nutritional status, but it cannot distinguish between muscle mass and fat mass. Bioelectrical impedance analysis can provide additional information such as body-fat percentage, skeletal muscle mass and fat-free mass. Assessment of these parameters together with handgrip strength can provide a better understanding of the relationship between body composition and muscular performance[4].

Physical fitness is a multidimensional concept that includes muscular strength, cardiorespiratory endurance, flexibility and body composition. Cardiorespiratory fitness reflects the ability of the cardiovascular, respiratory and muscular systems to deliver and utilize oxygen during physical activity. Although muscular strength and cardiorespiratory fitness represent different components of physical fitness, both may be influenced by body composition and habitual physical activity[5].

The six-minute walk test (6MWT) is a simple, practical and inexpensive method of assessing functional exercise capacity. It measures the distance an individual can walk during six minutes and reflects the integrated response of the cardiovascular, respiratory and musculoskeletal systems to submaximal exercise. Because it requires minimal equipment and is relatively easy to perform, it is suitable for assessing physical fitness in young adults[6].

Medical students represent a young population that may experience prolonged sitting, extensive academic work and limited opportunities for regular physical activity. Such lifestyle factors may influence body composition, muscular strength and physical fitness. Assessment of handgrip strength together with body-composition parameters and physical fitness may therefore provide useful information regarding the functional health of young medical students. Determining whether handgrip strength is associated with skeletal muscle mass, body-fat percentage and physical fitness may also help establish its usefulness as a simple indicator of muscular and functional capacity.

Therefore, the present study was undertaken to assess the association of handgrip strength with body composition and physical fitness among first-year MBBS students.

MATERIALS AND METHODS:

Study Design and Setting

A cross-sectional observational study was conducted over a period of 4 months among first-year MBBS students in the Department of Physiology at a tertiary care hospital. The study was conducted after obtaining approval from the Institutional Ethics Committee.

Study Population

First-year MBBS students aged 17–20 years were invited to participate in the study. Both male and female students were included. Written informed consent was obtained from all participants before enrollment.

Sample Size

A total of 120 first-year MBBS students were included in the study. The final sample size may be modified according to the actual number of eligible students and the sample-size calculation based on the expected correlation between handgrip strength and body-composition parameters.

Inclusion Criteria

- First-year MBBS students aged 17–20 years.
- Apparently healthy students of either sex.
- Students willing to participate in the study.
- Students who provided written informed consent.

Exclusion Criteria

- Students with any of the following were excluded:
- Known cardiovascular or respiratory disease.
- Neuromuscular disorders.
- Musculoskeletal disorders or recent injury involving the upper limb or lower limb.
- Any acute illness at the time of assessment.
- Conditions limiting the ability to perform the six-minute walk test.
- Current medication likely to significantly affect muscle strength or exercise performance.

Study Procedure

All measurements were performed in a comfortable laboratory environment under standardized conditions. Participants were instructed to avoid strenuous physical activity before testing and to wear comfortable clothing. Measurements were preferably performed at approximately the same time of day to minimize physiological variation.

Anthropometric Measurements

Height was measured without footwear using a calibrated stadiometer and recorded to the nearest 0.1 cm. Body weight was measured using a calibrated digital weighing scale, with participants wearing light clothing.

Body mass index (BMI) was calculated using the formula:

- BMI = weight (kg) / height^2 (m^2)
- Assessment of Body Composition

Body composition was assessed using a bioelectrical impedance analysis (BIA) body-composition analyzer according to the manufacturer's instructions.

The following parameters were recorded:

- Body-fat percentage
- Skeletal muscle mass
- Fat-free mass

Measurements were performed under standardized conditions. Participants were advised to avoid vigorous exercise before the assessment and to follow the manufacturer's recommendations regarding food and fluid intake.

Measurement of Handgrip Strength

Handgrip strength was assessed using a calibrated handgrip dynamometer.

Participants were seated comfortably with the shoulder adducted and neutrally rotated, elbow flexed to approximately 90°, forearm in a neutral position and wrist in a comfortable position. The dynamometer was held firmly in the dominant hand.

Participants were instructed to squeeze the dynamometer maximally for approximately 3–5 seconds. Three trials were performed for each hand, with adequate rest between successive attempts to minimize fatigue.

The highest value obtained from the three trials was recorded as the maximum grip strength for that hand. The same procedure was repeated for the opposite hand. The mean of the maximum right- and left-hand grip strength values was used as the overall handgrip strength for correlation analysis.

Assessment of Physical Fitness

- Physical fitness was assessed using the six-minute walk test (6MWT) according to standardized guidelines[7].
- The test was performed on a flat, straight walking course. Participants were instructed to walk continuously for six minutes at their own comfortable pace and to cover as much distance as possible during the allotted time.
- Standardized instructions were given to all participants. Rest was permitted if required, but the test duration continued to be counted.
- The total distance walked in six minutes was recorded in metres and considered the primary measure of functional physical fitness.

Heart rate and oxygen saturation, if available, were recorded before and immediately after the test. Blood pressure may also be recorded before and after the test.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS 23.0 software. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages.

The independent t-test was used to compare continuous variables. The Pearson correlation test was used to assess the relationship between handgrip strength and body-composition parameters and six-minute walk distance.

A p-value <0.05 was considered statistically significant.

RESULTS:

A total of 120 first-year MBBS students aged 17–20 years were included in the study. The mean age of the participants was 19.1 ± 0.8 years. The study included both male and female students.

The mean height was 165.9 ± 8.2 cm and the mean body weight was 62.1 ± 10.1 kg. The mean BMI was 22.5 ± 3.1 kg/m². The mean body-fat percentage was 24.6 ± 7.2%, while the mean skeletal muscle mass and fat-free mass were 25.5 ± 5.1 kg and 47.0 ± 8.0 kg, respectively. The mean handgrip strength was 29.8 ± 8.2 kg, and the mean six-minute walk distance was 570.1 ± 61.5 m. (Table 1)

Pearson correlation analysis was performed to determine the relationship between handgrip strength and body-composition and physical-fitness parameters.

Handgrip strength showed a significant positive correlation with skeletal muscle mass ($r = 0.68$, $p < 0.001$) and fat-free mass ($r = 0.64$, $p < 0.001$). A weak positive correlation was observed between handgrip strength and

Table 1: Anthropometric, body-composition and physical-fitness characteristics of the study participants (n=120)

Parameter	*Mean ± SD*
Age (years)	19.1 ± 0.8
Height (cm)	165.9 ± 8.2
Weight (kg)	62.1 ± 10.1
BMI (kg/m²)	22.5 ± 3.1
Body-fat percentage (%)	24.6 ± 7.2
Skeletal muscle mass (kg)	25.5 ± 5.1
Fat-free mass (kg)	47.0 ± 8.0
Handgrip strength (kg)	29.8 ± 8.2
Six-minute walk distance (m)	570.1 ± 61.5

Table 2: Correlation of handgrip strength with body-composition and physical-fitness parameters

Variable	*Pearson correlation (r)*	*p-value*
BMI	0.29	0.001
Body-fat percentage	−0.24	0.008
Skeletal muscle mass	0.68	<0.001
Fat-free mass	0.64	<0.001
Six-minute walk distance	0.37	<0.001

BMI ($r = 0.29$, $p = 0.001$). Handgrip strength showed a weak negative correlation with body-fat percentage ($r = -0.24$, $p = 0.008$). A significant positive correlation was also observed between handgrip strength and six-minute walk distance ($r = 0.37$, $p < 0.001$). (Table 2)

DISCUSSION

The present study evaluated the association between handgrip strength, body composition and physical fitness among first-year MBBS students. Handgrip strength showed a positive association with skeletal muscle mass and fat-free mass. A positive relationship was also observed between handgrip strength and six-minute walk distance, whereas body-fat percentage showed a weak inverse association.

Handgrip strength is a simple and practical measure of muscular strength that can be assessed using a handheld dynamometer. Although it primarily measures the force-generating capacity of the hand and forearm muscles, it is also influenced by overall muscle mass, body size, sex and physical activity. Standardization of body position, dynamometer handling and testing procedure is important for obtaining reliable measurements[8].

The strongest association observed in the present study was between handgrip strength and skeletal muscle mass. This finding is physiologically plausible because skeletal muscle is the major tissue responsible for voluntary force generation. Individuals with greater skeletal muscle mass generally possess greater capacity for force production. Muscle strength and muscle mass are important components of physical function, and changes in muscle quantity and quality can influence functional performance[9].

Handgrip strength also demonstrated a strong positive association with fat-free mass. Fat-free mass represents the non-adipose components of the body and includes skeletal muscle, which contributes substantially to force generation. Bioelectrical impedance analysis provides a practical method for estimating body-composition parameters such as fat-free mass and skeletal muscle mass, although measurements may be influenced by hydration and other physiological conditions[10].

A weak positive correlation was observed between handgrip strength and BMI. BMI represents body mass relative to height but does not distinguish between muscle and adipose tissue. Therefore, individuals with a higher BMI may have either greater muscle mass or greater fat mass. This limitation may explain why BMI showed a weaker relationship with handgrip strength than skeletal muscle mass and fat-free mass[11].

Body-fat percentage showed a weak negative association with handgrip strength in the present study. Excess adipose tissue contributes to body weight but does not directly contribute to voluntary force production. Consequently, a higher proportion of body fat may be associated with lower muscular performance relative to body size. However, the relationship between absolute grip strength and adiposity is complex because individuals with greater overall body size may also demonstrate greater absolute strength[12].

The present study also demonstrated a significant positive association between handgrip strength and six-minute walk distance. The six-minute walk test is a simple measure of functional exercise capacity and involves the integrated action of the cardiovascular, respiratory and musculoskeletal systems. Standardized procedures for performing the six-minute walk test have been recommended by the American Thoracic Society to improve the reliability and reproducibility of measurements[13].

The positive association between handgrip strength and six-minute walk distance may indicate that students with greater muscular strength also possess better functional exercise capacity. Physical fitness is influenced by several factors, including muscle mass, habitual physical activity, body composition and cardiorespiratory capacity. Regular physical activity contributes to the maintenance of muscle strength and cardiorespiratory fitness, whereas prolonged sedentary behavior may have adverse effects on these parameters[14].

CONCLUSION

The present study demonstrated that handgrip strength was positively associated with skeletal muscle mass, fat-free mass and physical fitness among first-year MBBS students. A weak inverse association was observed between handgrip strength and body-fat percentage. These findings suggest that handgrip strength may serve as a simple and practical indicator of muscular fitness and functional capacity in young adults. Handgrip dynamometry, combined with basic body-composition assessment and the six-minute walk test, may be useful for assessing physical fitness among medical students.

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