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Article

Hand dimensions and dominant handgrip strength (DHGS) among Bangladeshi female laborers and non-laborers

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Abstract: Hands are vital tools for work, playing a crucial role in performing diverse manual, functional, and skilled tasks necessary for occupational and daily activities. Their morphology and functional properties are important determinants of physical performance. Dominant handgrip strength (DHGS) is a straightforward and cost-effective measure that offers valuable insights into the condition of muscles, nerves, bones, and joints, and also reflects general body strength. The objective of this study was to assess the association between DHGS and designated hand dimensions among adult Bangladeshi female laborers and non-laborers. It was hypothesized that larger hand dimensions would be positively associated with higher DHGS. A total of 100 healthy females (50 laborers and 50 non-laborers) living in various slums of Dhaka city, Bangladesh, participated in this cross-sectional study conducted from March 2019 to February 2020. Right-hand dimensions and DHGS were measured using standardized tools and protocols according to the study methodology. Data were analyzed using Pearson's correlation coefficient. Among laborers, DHGS showed significant positive correlations with most hand dimensions, including hand breadth (r = 0.398), wrist breadth (r = 0.493), and hand span (r = 0.388) ($P < 0.01$). In non-laborers, significant correlations were found with hand breadth (r = 0.291), palm breadth (r = 0.330), and wrist breadth (r = 0.504). DHGS was positively associated with most hand dimensions in both groups, and female laborers had significantly greater handgrip strength and hand measurements than non-laborers. These findings provide useful baseline data for clinical assessment, rehabilitation, and ergonomic tool design for women.

Keywords: grip dynamometry; hand anthropometry; occupational hand strength; manual strength; ergonomics

1. Introduction

The human hand is a highly specialized anatomical structure capable of performing a wide range of precise and powerful movements essential for daily living, occupational performance, and social interaction. It consists of a complex network of bones, muscles, tendons, and joints that enable dexterity, coordination, and strength (Lee and Su, 2020). A unique feature of humans is the ability to oppose the thumb across the palm, allowing it to touch the other fingers and generate a powerful grip (Almécija and Sherwood, 2018). This dexterity facilitates tool use in various tasks. The remarkable dexterity of the human hand distinguishes humans from other species,

and handgrip strength (HGS) serves as a straightforward, dependable, and objective measure of overall muscle strength and neuromuscular performance (Syddall *et al*., 2021). HGS reflects not only the performance of the hand and forearm muscles but also general physical fitness, nutritional status, and health outcomes across populations (Bohannon, 2019). Measuring dominant handgrip strength (DHGS) is important for understanding upper limb function and work capacity (Vaishya *et al*., 2024).

Handgrip strength varies considerably among individuals due to intrinsic and extrinsic factors. Anatomical parameters such as hand length, palm breadth, and wrist circumference influence the mechanical advantage of muscles and tendons during gripping (Doğan *et al*., 2025). Additionally, age, sex, body size, hand dominance, occupation, and habitual physical activity also affect grip performance (Shin *et al*., 2024). Furthermore, the integrity and fitness of the musculoskeletal system of the upper extremities are crucial for performing daily activities and maintaining grip strength (Bansode *et al*., 2014). Recent studies have demonstrated a positive correlation between anthropometric variables of the hand and HGS, indicating that individuals with larger hand dimensions tend to generate greater grip force (Bhattacharjya and Goswami, 2022; Quattrocchi *et al*., 2024; Alahmari *et al*., 2019). However, the strength of this association varies according to population characteristics, occupational exposure, and measurement conditions (Akter *et al*., 2021). Moreover, DHGS serves as a valuable tool for assessing and monitoring patients with upper limb musculoskeletal or neuromuscular disorders and plays an important role in evaluating the effectiveness of various therapeutic and rehabilitation interventions for hand function (Vaishya *et al*., 2024).

Occupation plays a substantial role in shaping the morphology and functional capacity of the hand. Individuals engaged in manual labor—such as agricultural, industrial, or domestic work—tend to develop stronger hand muscles and more robust hand structures due to repeated mechanical loading (Saremi and Rostamzadesh, 2018; Oliveira *et al*., 2023). In contrast, non-laborers performing sedentary or light tasks often exhibit comparatively lower grip strength and smaller anthropometric dimensions (Fathima *et al*., 2017). Examining these groups allows for a better understanding of how regular physical labor influences the anatomy and functional capacity of the hand.

In Bangladesh, women constitute a significant portion of the workforce in both formal and informal sectors. Female laborers in agriculture, garment factories, and household work heavily rely on hand strength for repetitive and physically demanding tasks. Despite their economic contributions, scientific evidence regarding the relationship between hand dimensions and DHGS among Bangladeshi women is limited (Shazzad *et al*., 2018). Understanding this association is crucial for ergonomics, rehabilitation, and occupational health assessments, particularly in resource-limited settings (Alam and Khan, 2025). This study addresses the issue of insufficient empirical data on how hand morphology influences functional strength among Bangladeshi women engaged in various occupational activities. The guiding research question was, is there a significant association between hand dimensions and DHGS among Bangladeshi female laborers and non-laborers? Based on previous findings, we hypothesize that larger hand dimensions are positively associated with higher DHGS in both occupational groups. Furthermore, we expect that female laborers will demonstrate greater hand dimensions and stronger grip strength compared to non-laborers due to their regular engagement in manual work. This study aims to investigate the association between specific hand measurements and DHGS in Bangladeshi female laborers and non-laborers. The findings will provide baseline anthropometric and strength data for Bangladeshi women, which can support ergonomic tool design, occupational safety guidelines, and rehabilitation programs. Additionally, this research may assist health professionals and policymakers in assessing work-related functional capacity and preventing musculoskeletal strain among female workers.

2. Material and Methods

2.1. Ethical approval and informed consent

The study received approval from the Institutional Review Board (IRB) of Bangladesh Medical University (BMU), Dhaka (Approval No. BSMMU/IRB/184/2019, dated July 6, 2019). All participants provided informed consent before data collection.

2.2. Study area and periods

A cross-sectional study was performed across several slum areas in Mirpur, Dhaka city, between March 2019 and February 2020 (Figure 1).

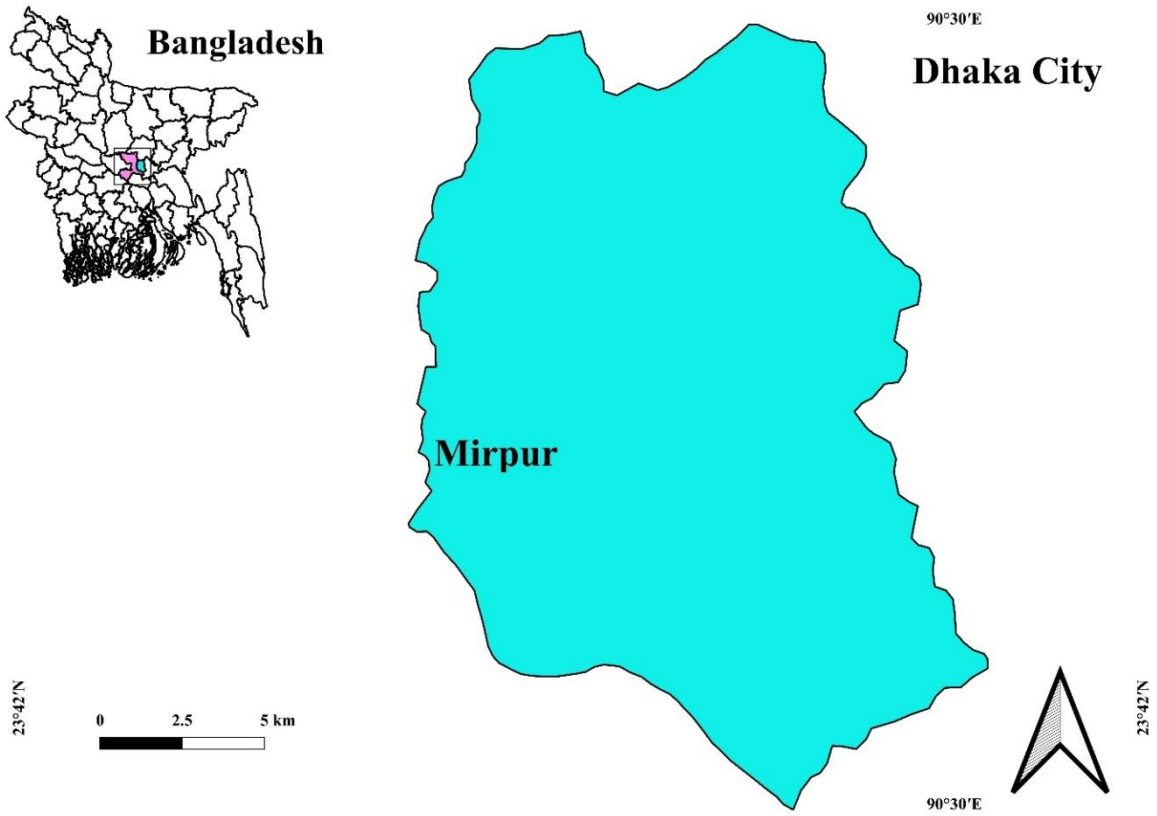

Figure 1. The study was conducted in the Mirpur, Dhaka city, Bangladesh.

2.3. Research design

A total of 100 Bangladeshi females aged between 18 and 45 years were recruited and divided into two groups according to the nature of their work. The laborer group (n = 50) included participants whose occupations required substantial physical effort and frequent use of forceful handgrip strength rather than intellectual labor. This group comprised women engaged in physically demanding tasks such as brick breaking, mud cutting at construction sites, large-scale cooking, dough kneading, dishwashing in hotel, hostel, or hospital kitchens, spice grinding, laundry work, and household cleaning. The non-laborer group (n = 50) consisted of participants performing relatively less strenuous activities, including garment factory workers, domestic cooks, vegetable vendors, homemakers, and college students. Measurements were conducted from 3:00 PM to 6:00 PM to reduce the effects of daily fluctuations in muscle strength. Data analysis was accompanied at the Department of Anatomy, BMU, Dhaka, Bangladesh. Only right-handed participants were included in the study to maintain consistency in hand dominance. Participants with a history or clinical features of congenital anomalies, genetic disorders, neurological or endocrine diseases, autoimmune conditions, trauma, surgery, or musculoskeletal impairments that could affect hand anthropometry were excluded from the study.

2.4. Anthropometric measurements

Participants placed their right hand flat on a table with fingers extended and slightly apart for hand measurements. All measurements were performed using a digital sliding caliper (Model: 500-196-20, Mitutoyo Corporation, Japan) with 0.01 mm precision. Hand length was determined from the midpoint of the distal wrist crease to the tip of the middle finger. Hand breadth was measured as the distance between the outer edge of the second metacarpal head and the inner edge of the fifth metacarpal head (Reckelhoff *et al*., 2015). Hand span was calculated from the tip of the thumb to the tip of the little finger with fingers fully extended and spread apart. Palm length was measured from the midpoint of the distal wrist crease to the midpoint of the basal crease of the middle finger. Palm breadth was recorded from the lateral end of the proximal transverse (thenar) crease at the radial side to the medial end of the distal transverse crease at the ulnar side. Wrist breadth was measured as the distance between the radial and ulnar styloid processes (Akter *et al*., 2021). DHGS was assessed using a standard adjustable digital handgrip dynamometer (Camry, Model EH101, Camry Electronic Co. Ltd., Guangdong, China). Participants stood comfortably with shoulders relaxed and adducted, elbows fully extended, and wrists in a neutral position. The dynamometer was held in the dominant hand without contact with the body.

After a deep breath, participants applied maximum grip force for 4–5 seconds, keeping the body stable. The device automatically displayed the peak force in kilograms. Each participant performed two trials with a 30-second rest interval, and the higher value was used for analysis.

2.5. Statistical analysis

Statistical analyses were conducted using the SPSS, version 24.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics, including the mean and standard deviation (Mean ± SD), were calculated for all continuous variables, including, hand length (cm), hand breadth (cm), hand span (cm), wrist breadth (cm), palm length (cm), palm breadth (cm), and dominant handgrip strength (DHGS, kg). The Shapiro–Wilk test was performed to assess the normality of the data distribution. Since the variables exhibited a normal distribution, Pearson's correlation coefficient (r) was utilized to examine the linear relationship between DHGS (dependent variable) and each of the six selected hand dimensions (independent variables) separately for female laborers and non-laborers. The strength and direction of the associations were interpreted based on the correlation coefficient values, with statistical significance established at $P < 0.05$.

3. Results

3.1. Hand anthropometry and grip strength characteristics of female laborers and non-laborers

Female laborers exhibited slightly greater mean values in several measurements compared to non-laborers, hand length (16.50 ± 0.62 cm vs. 16.44 ± 0.53 cm), hand breadth (7.17 ± 0.34 cm vs. 7.04 ± 0.34 cm), hand span (17.38 ± 0.70 cm vs. 17.32 ± 0.82 cm), wrist breadth (4.90 ± 0.27 cm vs. 4.70 ± 0.22 cm), palm length (9.45 ± 0.38 cm vs. 9.39 ± 0.41 cm), and palm breadth (7.63 ± 0.33 cm vs. 7.44 ± 0.31 cm). Additionally, the DHGS was notably higher in laborers (27.28 ± 2.10 kg) than in non-laborers (23.90 ± 3.42 kg), with greater variability observed in the non-laborer group (Table 1).

Table 1. Descriptive statistics (Mean ± SD) of hand measurements and dominant handgrip strength among Bangladeshi female laborers and non-laborers (n = 50 in each group).

Variable	Female laborer group (n = 50)	Non-laborer group (n = 50)
Length of the hand (cm)	16.50 ± 0.62	16.44 ± 0.53
Breadth of the hand (cm)	7.17 ± 0.34	7.04 ± 0.34
Hand span (cm)	17.38 ± 0.70	17.32 ± 0.82
Breadth of the wrist (cm)	4.90 ± 0.27	4.70 ± 0.22
Length of the palm (cm)	9.45 ± 0.38	9.39 ± 0.41
Breadth of the palm (cm)	7.63 ± 0.33	7.44 ± 0.31
DHGS (kg)	27.28 ± 2.10	23.90 ± 3.42

SD*: standard deviation; values presented as mean ±SD.

3.2. Correlation between hand dimensions and dominant handgrip strength in female laborers

Wrist breadth exhibited the strongest positive correlation with DHGS (r = 0.493; $P < 0.001$), indicating that individuals with wider wrists tend to have higher handgrip strength. Significant positive correlations were also observed for hand breadth (r = 0.398; $P = 0.004$), hand span (r = 0.388; $P = 0.005$), and palm breadth (r = 0.384; $P = 0.006$), suggesting that larger hand dimensions are linked to stronger grip. Conversely, hand length (r = 0.248; P = 0.082) and palm length (r = 0.224; $P = 0.117$) showed positive but non-significant correlations with DHGS (Table 2).

Table 2. Correlation coefficient (r) of six selected hand dimensions with DHGS of the female laborers group (n = 50).

Variable	Correlation coefficient (r) with DHGS	*P* value
Length of the hand (cm)	0.248	0.082
Breadth of the hand (cm)	0.398	0.004*
Hand span (cm)	0.388	0.005*
Breadth of the wrist (cm)	0.493	0.000**
Length of the palm (cm)	0.224	0.117
Breadth of the palm (cm)	0.384	0.006*

If $P \leq 0.05$, it is considered as significant. **P<0.001, *P<0.05.

3.3. Correlation between hand dimensions and dominant handgrip strength in female non-laborers

Among non-laborers, wrist breadth showed the strongest positive correlation with DHGS (r = 0.504; $P < 0.001$), indicating that individuals with wider wrists tend to have greater handgrip strength (Table 3). Significant positive correlations were also found for palm breadth (r = 0.330; $P = 0.019$) and hand breadth (r = 0.291; $P = 0.041$), suggesting that broader hand dimensions are linked to higher grip strength. In contrast, hand length (r = 0.121; $P = 0.403$), hand span (r = 0.005; $P = 0.972$), and palm length (r = 0.168; $P = 0.245$) exhibited positive but non-significant correlations with DHGS.

Table 3. Correlation coefficient (r) of six selected hand dimensions with DHGS of the female non-laborers group (n = 50).

Variable	Correlation coefficient (r)) with DHGS	*P* value
Length of the hand (cm)	0.121	0.403
Breadth of the hand (cm)	0.291	0.041*
Hand span (cm)	0.005	0.972
Breadth of the wrist (cm)	0.504	0.000**
Length of the palm (cm)	0.168	0.245
Breadth of the palm (cm)	0.330	0.019*

If $P \leq 0.05$, it is considered as significant; **$P<0.001$; *$P<0.05$.

4. Discussion

The present study demonstrated that Bangladeshi female laborers exhibited higher mean values in nearly all hand anthropometric measurements, along with greater DHGS, compared to non-laborers. These findings suggest that occupational physical activity and regular manual work play a crucial role in enhancing grip strength and muscular performance. Similar associations between physical activity and grip strength have been reported in previous studies (Alahmari *et al*., 2019; Bhattacharjya and Goswami, 2022; Quattrocchi *et al*., 2024).

The higher DHGS observed among laborers (27.28 ± 2.10 kg) compared to non-laborers (23.90 ± 3.42 kg) aligns with previous research indicating that individuals engaged in regular physical or manual labor develop stronger hand musculature and improved neuromuscular coordination. Shin *et al*. (2024) also identified a positive relationship between physical activity and handgrip strength in a nationwide Korean population, reinforcing the notion that occupational activity enhances muscular function.

Our results further revealed that wrist breadth exhibited the strongest positive correlation with DHGS in both laborers and non-laborers. This finding is consistent with studies suggesting that larger wrist and hand dimensions provide biomechanical advantages that enhance grip force generation (Alahmari *et al*., 2019; Doğan *et al*., 2025). Additionally, Saremi and Rostamzadeh (2018) reported similar associations, highlighting that greater hand breadth and wrist width improve mechanical leverage during gripping tasks.

The present findings revealed that hand breadth, palm breadth, and hand span significantly correlated with grip strength, while hand length and palm length did not reach statistical significance. Comparable trends were reported by Akter *et al*. (2021) among Bangladeshi female laborers and by Rashid *et al.* (2021) among female garment workers, suggesting that hand width measurements are more predictive of grip performance than length parameters in females. In a similar study, Rawat *et al.* (2016) reported that hand breadth, rather than hand length, was significantly associated with DHGS in a sample of 375 Indian women working in offices. The results of the current study align with these observations and are supported by findings from several other investigations (Gaurav *et al.*, 2015; Akter *et al*., 2021). Regarding hand span, a significant association with DHGS was observed in 121 healthy Indian adults (Bansode *et al.*, 2014). These findings align with those observed in the laborer group of the present study. Repeated physical activity tends to enhance muscle mass, thus improving handgrip strength. A wider hand span provides a greater surface area for holding objects during grip-related tasks, and in this study, female laborers frequently engaged in activities that required higher grip strength (Quattrocchi *et al*., 2024).

Moreover, the stronger associations observed in the laborer group may reflect adaptive musculoskeletal responses to repetitive occupational tasks (Shazzad *et al.*, 2018; Quattrocchi *et al.*, 2024). Chronic manual activity has been shown to promote hypertrophy of intrinsic and extrinsic hand muscles, thereby enhancing force output (Bohannon, 2019; Oliveira *et al.*, 2023). In contrast, non-laborers, who engage in fewer physically demanding activities, exhibited lower mean grip strength and greater variability, indicating less muscular conditioning (Liu and Chu, 2006; Ezzatvar *et al*., 2021).

From a biomechanical perspective, handgrip strength relies on the interplay of joint alignment, muscle cross-sectional area, and lever mechanics (Lee and Su, 2020). The current findings support this understanding, demonstrating that broader hands and wrists enhance the force transmission pathway during grip. Additionally, grip strength is recognized as a reliable biomarker for physical health and functional capability, particularly in adults (Bohannon, 2019; Syddall *et al*., 2021).

This study reinforces the hypothesis that occupational activity and larger hand dimensions, especially wrist and palm breadth, are strong predictors of DHGS in Bangladeshi women. These findings align with earlier studies in diverse populations and highlight the value of considering work-related physical activity when developing ergonomic designs and health promotion programs (Fathima *et al*., 2017; Alahmari *et al*., 2019; Rashid *et al*., 2021; Bhattacharjya and Goswami, 2022; Doğan *et al*., 2025). Subsequent studies should include more participants and investigate how dietary habits and hormonal status affect the development of handgrip strength.

5. Conclusions

Female laborers exhibited greater handgrip strength and larger hand, wrist, and palm dimensions compared to non-laborers. Handgrip strength showed positive associations with the majority of hand measurements, particularly in the laborer group. These results emphasize the significance of hand size and grip capacity for occupational performance and their applications in clinical evaluation, rehabilitation, and ergonomic tool development. Future studies should explore the occupational, nutritional, and training factors that influence hand dimensions and grip strength to further optimize health and functional outcomes.

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Data availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request. All relevant data were generated and analyzed at the Department of Anatomy, Bangladesh Medical University (BMU), Dhaka, Bangladesh, and are stored in institutional archives in accordance with ethical and data protection guidelines. Due to participant confidentiality and ethical restrictions, the raw data are not publicly available.

Conflict of interest

None to declare.

Authors' contribution

Mst. Taslima Akter designed the study, sample collection, interpretation of data, and drafting the write up of the article. Nahid Farhana Amin guided and directed in different steps of the study. Ahsan Arif, Rowshon Ara Naznin, Maskura Benzir and Anamika parvin talukder helped in writing the article. All authors have read and approved the final manuscript.

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