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Research Article

# HAND ANTHROPOMETRY - A VALUABLE PARAMETER FOR GRIP STRENGTH AND HAND FUNCTIONAL ASSESSMENT

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**ABSTRACT**

**Objective:** The objective is to study the relationship between hand length (HL) and hand width with grip strength and writing speed among medical students. This plays a crucial role in evaluating functional ability and motor skills.

**Methods:** This cross-sectional observational study was conducted 255 undergraduate students (M=110, F=145); 18–25 age group was selected for the study. HL, hand width, grip strength, and handwriting speed were measured and correlated.

**Results:** The average measurement for HL was 188.2 mm and 181.43 for right and left hand, respectively. The figures for hand width were 75.59 mm and 75.37 mm for right and left hand, respectively. The average values for grip strength 19.24 kg and 19.25 kg for right and left hand, respectively. Average handwriting speed was 119.6 letters/min.

**Conclusion:** Provides normative data for hand anthropometry, handgrip strength, and handwriting speed in undergraduate medical students. Hand anthropometry correlated significantly with the grip strength. Handwriting speed is accentuated with increase in length as shown in this study.

**Keywords:** Hand anthropometry, Handgrip strength, Writing speed.

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## INTRODUCTION

Hand anthropometry finds extensive application across multiple domains, including ergonomics, biomechanics, product design, forensic science, and medical research. It plays a vital role in tailoring products, tools, and interfaces to accommodate diverse hand sizes, thereby enhancing usability and comfort [1]. The study of hand anthropometry yields valuable insights into the physical characteristics and functional capabilities of the hand, enabling the design of products and environments that optimize comfort, usability, and performance [2]. In addition, it helps establish correlations between hand dimensions and essential parameters such as grip strength, dexterity, and fine motor skills. Such knowledge has significant implications in fields such as rehabilitation, sports science, and occupational therapy. Hand anthropometry data aid in establishing normative values, creating ergonomic hand models, evaluating hand function and abilities, and assisting forensic identifications based on handprints or fingerprints [3,4].

The primary aim of this study is to analyze the association between hand length (HL) and width and grip strength in a sample of medical graduates, encompassing both genders. These hand parameters play a crucial role in evaluating functional ability and motor skills. Specifically, writing speed is a common variable assessed and linked to grip strength, as it reflects fine motor skills and manual dexterity. Grip strength serves as an indicator of upper extremity muscle strength, while handwriting speed indicates the proficiency of motor coordination.

As medical students, these individuals embark on their journey as first-generation doctors, initially practicing skilled activities in a simulated environment and gradually progressing to direct patient care. Their skill development begins in their 1st year, with extensive dissection sessions that pave the way for future surgical procedures. Throughout their learning process, they become accustomed to using various medical equipment and instruments. To facilitate their learning experience, it is crucial to provide them with ergonomically well-designed operative and training tools, ensuring ease and comfort. The design and architecture of these tools heavily rely on the hand anthropometry of the end users. Optimal accuracy, effectiveness, and productivity can only be achieved if the grip strength of an individual aligns with the requirements of the designed tool [5]. Hand dimensions directly impact grip strength, which is essential for maximizing the usability of the designed tools.

By understanding the relationship between hand dimensions and these functional measures, valuable insights can be gained for ergonomic design, rehabilitation interventions, and educational practices. This knowledge can inform the development of tools and interventions that cater to individual hand characteristics, ultimately enhancing performance and improving outcomes.

## METHODS

The present observational cross-sectional study was conducted after obtaining necessary ethical approval from the institutional ethical committee of Heritage Institute of Medical Sciences, Varanasi, Uttar Pradesh. The study was conducted at a medical school and 255 undergraduate students in the age group of 18–25 years were selected for the study. Only students who gave consent for the study were included and exclusion criteria were defined for non-consenting individuals, with any debilitating injury of the hand resulting in deformity, subjects with musculoskeletal disorders and/or with osteoarthritis or rheumatoid arthritic conditions.

- HL: It was measured as the interval between the midpoint of a line connecting the styloid process of radius and ulna bones of forearm and the tip of third finger.
- Hand breadth [HB]: It was measured as the interval between the most projecting point on the lateral part of head of second metacarpal and the most projecting point on the medial part of the head of fifth metacarpal [6].

**Table 1: Mean and standard deviation of hand anthropometric data with levels of significance**

| | Hand Length (n=255) | | | Hand width (n=255) | | |
|---|---|---|---|---|---|---|
| | **Right hand** | **Left hand** | **p-value** | **Right hand** | **Left hand** | **p-value** |
| Total sample | 188.2 (11.79) | 181.43 (16.64) | 0.010 S | 75.59 (6.98) | 75.37 (6.71) | 0.44 NS |
| As per gender | | | | | | |
| Male (n=110) | 198.54 (6.31) | 193.57 (8.94) | 0.00021S | 81.73 (7.58) | 81.11 (7.87) | 0.41 NS |
| Female (n=145) | 183.77 (2.63) | 176.37 (16.55) | 0.010 S | 73.04 (4.88) | 72.98 (4.41) | 0.47 NS |
| p-value | <0.00001 S | 0.00021 S | | <0.00001 S | <0.00001 S | |

NS=Non-significant, S=Significant

For handwriting speed test, uniform directions were given to all students. They were instructed to write the sentence "The quick brown fox jumps over the lazy dog" as "rapidly" and as "neatly" as they could for a 3-min period. Then, they were then directed to put down their pencils/pens. After a brief interval of about 30 s, they were instructed to omit two lines and restart writing the sentence again. The second period continued for 9 min [7].

Measurement of grasp power: The subject was required to squeeze the dynamometer when optimum position was achieved and the retain the position with maximum isometric strength. The average of three readings was taken for analysis (rounded off to the nearest whole number [8]).

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**Statistical analysis**

Descriptive statistics for all variables were done to assess the mean and standard deviation. Independent t-test was used to find the difference between the means and level of significance between the genders and as per dexterity. Scatter plots were created to depict differences between the right and left hand. Analysis of variance (ANOVA) was used to find the difference between the three groups of hands with the level of significance. Pearson's correlation coefficient was used for the correlation between the grip strength and HL. The Chi-square test was conducted to examine the relationship between HL and functionality and appropriate contingency tables were created. SPSS software 21 and Microsoft Excel 10 were used for statistical analysis and the level of significance was set at 0.5% at 95% confidence interval.

## RESULTS

In a total sample of 255 subjects with an age range of 18–25 years, the mean age was 23.21±3.43 years. There were 145 females and 110 males. The age difference between the genders was not significant with p>0.05 at 95% confidence interval. Table 1 presents the descriptive statistics for HL and width for both genders in the study sample. The anthropometric data of hands are represented as scatter plots (Fig. 1a and b) to show the association of variable between right and left hand. The scatter plot suggests a positive linear and moderately strong relationship as the data points are clustered around a positive slope.

The HL was used to divide the hand into small, medium, and large. The range of HL was divided into equal thirds values, below 33$^{rd}$ percentile for small hand (H1), 34$^{th}$–66$^{th}$ percentile for medium hand (H2), and 67$^{th}$ percentile (H3) and above for large hands. ANOVA was used to find the difference of means between the groups as shown in Table 2. Overall, the provided results suggest that there are significant differences between the means of the pairwise comparisons (H1:H2, H1:H3, H2:H3), based on the calculated Q values and associated p-values.

The observations for grip strength and hand functionality, referred here as handwriting speed and measured as number of letters per minute (LPM), are shown in Table 3.

**Table 2: Comparison of means for small (H1), medium (H2) and large (H3) hands (f statistics=54.15)**

| | | |
|---|---|---|
| Pairwise comparison for means of hand length | $HSD_{05}$=5.5573<br>$HSD_{01}$=7.0261 | $Q_{05}$=3.4203<br>$Q_{01}$=4.3243 |
| H1:H2<br>H1=175.93<br>H2=186.77 | 10.85 | Q=6.68 (p=0.00006) |
| H1:H3<br>H1=175.93<br>H3=200.37 | 24.44 | Q=15.04 (p=0.00000) |
| H2:H3<br>H2=186.77<br>H3=200.37 | 13.60 | Q=8.37 (p=0.00000) |

**Table 3: Mean and standard deviation of Grip strength and LPM distributed between genders**

| Gender | Hand grip strength( Kgs) | | | HWS(LPM) |
|---|---|---|---|---|
| | **Right hand** | **Left hand** | **p-value** | **Right hand** |
| Male | 26.33 (17.81) | 32.53 (19.38) | 0.18 NS | 124.87 (14.2) |
| Female | 16.28 (9.77) | 13.72 (8.5) | 0.12 NS | 117.42 (9.29) |
| p-value | 0.0062 S | <0.00001S | | 0.015618 S |

NS=Non-significant, S=Significant, HWS=Writing speed, LPM=Letters per minute

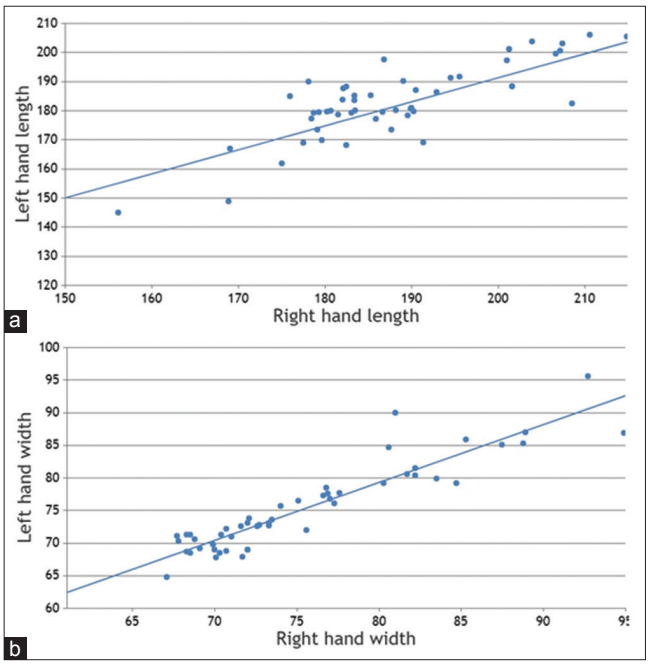


**Fig. 1: Scatter plot for hand anthropometry (a) for hand length (b) for hand width**

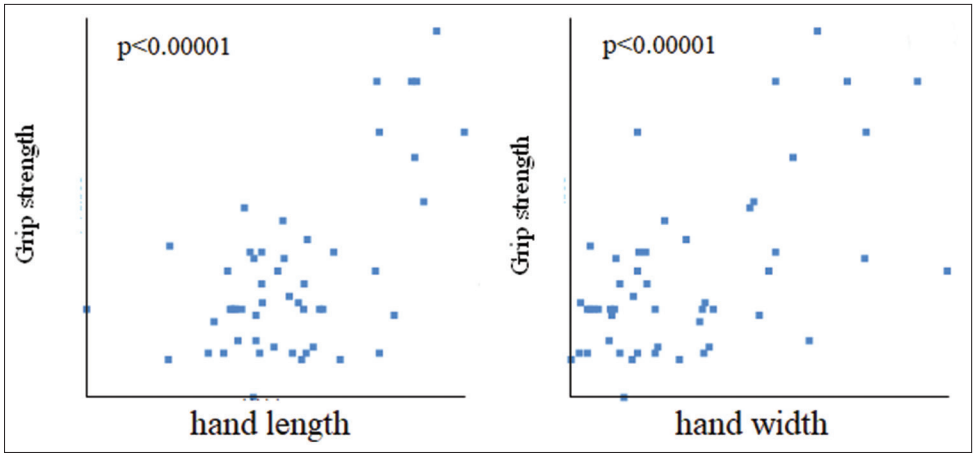


**Fig. 2: Correlation of hand length and width with grip strength**

**Table 4: Frequency table for hand classification as per size and functionality**

| Classification as per Hand length | Poor | Fair | Good | Row Total |
|---|---|---|---|---|
| Small size hand | 25 (14.71) (7.21) | 40 (47.06) (1.06) | 10 (13.24) (0.79) | 75 |
| Medium size hand | 15 (18.63) (0.71) | 65 (59.61) (0.49) | 15 (16.76) (0.19) | 95 |
| Large size hand | 10 (16.67) (2.67) | 55 (53.33) (0.05) | 20 (15.00) (1.67) | 85 |
| Total | 50 | 160 | 45 | 255 |

The numbers in parentheses represent the observed frequencies, and the numbers in square brackets represent the expected frequencies

The grip strength and handwriting speed were statistically significantly different between the genders. The correlation between grip strength and HL and width is shown in Fig. 2.

The hand functionality was graded as poor, fair, and good with respect to handwriting speed (LPM), LPM between 91 and 110 as poor, 111–130 as fair, and 131–150 as good. The Chi-square analysis was conducted to examine the relationship between HL and functionality. The frequencies and percentages of each hand category (Small, Medium, and Large) across the functionality levels (Poor, Fair, Good) are presented in the contingency table below (Table 4).

## DISCUSSION

Researchers across various fields have utilized hand anthropometry to enhance their work, including sports, glove manufacturing, and the design of handles, keyboards, and computer mice with specific technical specifications [9]. These measurements are pivotal in determining the most suitable models that promote optimal performance with minimal strain and consistent efficiency. In the medical profession, proficient hand skills are essential, particularly for surgeons who perform intricate procedures such as dental carving, extractions, and the manipulation of surgical instruments. Moreover, precise hand maneuvers are critical for operating technical equipment such as probes and scopes, where achieving successful outcomes hinges on accuracy and dexterity. The present study contributes valuable insights by examining HL and width in medical graduates and evaluating its significance in maintaining grip strength.

In the present study, the HL was found to be greater in males than females and the difference between right and left hand was found to be statistically significant. A study done on 500 Indian medical graduates also presented with similar results where right HL was greater than left hand [10]. A study on Iranian population has also delivered similar results for HL [11].

When comparing the results between the genders, the results were statistically significant as was observed by various other researchers in their studies [12-14]. Hand anthropometry correlates significantly with grip strength, though the grip strength for the right and left hand does not show any significant difference. Hand grip strength measurement is non-invasive, easy, and inexpensive, and it may allow exploration of acute nutrition status changes and help with evaluating and providing prognoses for muscle strength in juvenile idiopathic arthritis, congenital myotonic dystrophy, and traumatic hand injuries [15-18]. Similar results have been stated by earlier researchers [19,20]. The functionality of the hand is associated significantly with the length of the hand in the present study. Handwriting is a language skill, in part reliant on the acquisition and fast retrieval of accurate orthographic information. At the same time, it is a perceptual-motor ability, requiring the execution of precise hand movements guided by the visual input provided by the produced letter shapes. Grip strength and hand anthropometry play an important role writing speed In addition to other factors [21-23]. As the length of the hand increases, it accentuates the writing speed for an individual, as is suggested by the present study.

## CONCLUSION

This study provides normative data for hand anthropometry, handgrip strength, and handwriting speed in undergraduate medical students. Hand anthropometry correlated significantly with the grip strength. Handwriting speed is accentuated with increase in length as shown in this study.

## REFERENCES

1. Chandra A, Chandna P, Deswal S. Analysis of hand anthropometric dimensions of male industrial workers of Haryana state. Int J Eng 2011;5:242-56.
2. Abd Rahman NI, Dawal SZ, Yusoff N, Mohd Kamil NS. Anthropometric measurements among four Asian countries in designing sitting and standing workstations. Sādhanā 2018;43:10. doi: 10.1007/s12046-017-0768-8
3. Anuar FS, Soni G. A study of anthropometric measurement of hand length and their correlation with stature of university students. Malays J Sci 2018;8:32-8.
4. Asha KR, Prabha RL, Rajagopal GM. Sex determination from hand dimensions in Indian population. Indian J Public Health Res Dev 2012;3:28-30.
5. Constansia RD, Hentzen JE, Buis CI, Klaase JM, de Meijer VE, Meerdink M. Is surgical subspecialization associated with hand grip strength and manual dexterity? A cross-sectional study. Ann Med Surg (Lond) 2022;73:103159. doi: 10.1016/j.amsu.2021.103159, PMID 34976387

6. Geetha GN, Swathi AS, Athavale SA. Estimation of stature from hand and foot measurements in a rare tribe of Kerala State in India. J Clin Diagn Res 2015;9:HC01-4. doi: 10.7860/JCDR/2015/13777.6582. PMID 26557539, PMCID PMC4625258
7. O'mahony P, Dempsey M, Killeen H. Handwriting speed: Duration of testing period and relation to socio-economic disadvantage and handedness. Occup Ther Int 2008;15:165-77. doi: 10.1002/oti.255, PMID 18613264
8. Massy-Westropp NM, Gill TK, Taylor AW, Bohannon RW, Hill CL. Hand grip strength: Age and gender stratified normative data in a population-based study. BMC Res Notes 2011;4:127. doi: 10.1186/1756-0500-4-127, PMID 21492469
9. Chandra A. Application of hand anthropometric data of hand tools-Indian context. J Recent Act Prod 2021;6:17-22.
10. Rastogi P, Nagesh KR, Yoganarasimha K. Estimation of stature from hand dimensions of north and south Indians. Leg Med (Tokyo) 2008;10:185-9. doi: 10.1016/j.legalmed.2008.01.001, PMID 18291701
11. Hajaghazadeh M, Taghizadeh M, Khalkhali H, Mohebbi I. Hand anthropometry survey in Iranian adults and comparisons with other populations. Work 2021;70:633-44. doi: 10.3233/WOR-213599, PMID 34657844
12. Aboul-Hagag KE, Mohamed SA, Hilal MA, Mohamed EA. Determination of sex from hand dimensions and index/ring finger length ratio in Upper Egyptians. Egypt J Forensic Sci 2011;1:80-6. doi: 10.1016/j.ejfs.2011.03.001
13. Babu B, Balendran K, Sreedevi CS. Relationship between stature and hand parameters in adults- an autopsy study. J Clin Diagn Res 2022;16:HC05-9. doi: 10.7860/JCDR/2022/51181.15863
14. Varu PR, Manvar PJ, Mangal HM, Kyada HC, Vadgama DK, Bhuva SD. Determination of stature from hand dimensions. J Med Res 2015;1:104-7.
15. Lee-Valkov PM, Aaron DH, Eladoumikdachi F, Thornby J, Netscher DT. Measuring normal hand dexterity values in normal 3-, 4-, and 5-year-old children and their relationship with grip and pinch strength. J Hand Ther 2003;16:22-8. doi: 10.1016/s0894-1130(03)80020-0, PMID 12611442
16. Hoeksma AF, van Rossum MA, Zinger WG, Dolman KM, Dekker J, Roorda LD. High prevalence of hand- and wrist-related symptoms, impairments, activity limitations and participation restrictions in children with juvenile idiopathic arthritis. J Rehabil Med 2014;46:991-6. doi: 10.2340/16501977-1879, PMID 25188280
17. Johnson NE, Butterfield R, Berggren K, Hung M, Chen W, DiBella D, *et al*. Disease burden and functional outcomes in congenital myotonic Dystrophy: A cross-sectional study. Neurology 2016;87:160-7. doi: 10.1212/WNL.0000000000002845, PMID 27306634
18. Jensen KC, Bellini SG, Derrick JW, Fullmer S, Eggett D. Handgrip strength and malnutrition (undernutrition) in hospitalized versus nonhospitalized children aged 6-14 years. Nutr Clin Pract 2017;32:687-93. doi: 10.1177/0884533617698098, PMID 28459651
19. Mahmoud AG, Elhadidy EI, Hamza MS, Mohamed NE. Determining correlations between hand grip strength and anthropometric measurements in preschool children. J Taibah Univ Med Sci 2020;15:75-81. doi: 10.1016/j.jtumed.2020.01.002, PMID 32110186
20. Jha S, Sethi R. Correlative study between handgrasp power and handwriting speed and legibility among medical student. Int J Health Clin Res 2021;4:88-91.
21. Afonso O, Martínez-García C, Cuetos F, Suárez-Coalla P. The development of handwriting speed and its relationship with graphic speed and spelling. Cogn Dev 2020;56:100965. doi: 10.1016/j.cogdev.2020.100965
22. Summers J, Catarro F. Assessment of handwriting speed and factors influencing written output of University students in examinations. Aust Occup Ther J 2003;50:148-57. doi: 10.1046/j.1440-1630.2003.00310.x
23. Gokulakrishnan J, Franklin J. A study on upper limb strengthening exercises on hand writing speed for undergraduates. J Physiother Res 2020;4:3.