ORIGINAL ARTICLE ASIAN JOURNAL OF MEDICAL SCIENCES

Handgrip strength in medical students: Correlation with body mass index and hand dimensions

Jasim N Al-Asadi

Professor, Community Medicine Department, College of Medicine, University of Basrah, Basrah, Iraq

Submitted: 13-11-2017 Revised: 17-12-2017 Published: 01-01-2018

ABSTRACT

Background: Handgrip is a predictor of physical fitness, hand functions, and nutritional status. It is affected by many factors including age, sex, body mass index, and hand dimensions. **Aims and Objectives:** To assess the handgrip strength among medical students and to examine its correlation with body mass index and hand dimensions. **Materials and Methods:** This cross-sectional study included 256 students of both sexes selected from College of Medicine, Basrah University, Iraq using non-probability purposive sampling method. Their anthropometric parameters including height, weight, and hand dimensions were assessed using routine techniques. The handgrip was measured by using a handheld dynamometer. Hand preference was determined by asking which hand was used to write. **Results:** The mean age of the participants was 21.1 ± 1.9 years. The mean of handgrip strength was 34.1 ± 11.9 Kg. Males had significantly ($P < 0.001$) greater handgrip strength than females. Statistically significant correlation was detected between body mass index, hand dimensions and handgrip strength. The right-handed students scored significantly higher grip strength with their preferred hand. While among left-handed students, no significant difference in handgrip strength was noticed between left and right hands. Multivariate logistic regression analysis showed that gender, hand span, height, and body mass index were independent determinants of handgrip strength. They accounted for 70.6% of the variation in handgrip strength. **Conclusion:** A significant effect of body mass index and hand span on handgrip strength among medical students was observed.

Key words: Anthropometric, Body mass index, Dynamometer, Handgrip, Hand span

Access this article online

Website: http://nepjol.info/index.php/AJMS

DOI: 10.3126/ajms.v9i1.18577

E-ISSN: 2091-0576

P-ISSN: 2467-9100

INTRODUCTION

Developing countries are witnessing a challenge of overweight and obesity in addition to persistent burden of under- nutrition.[1] Handgrip strength (HGS) is a reliable clinical parameter to assess nutritional status and physical fitness.[2] In addition to its use in evaluation of musculoskeletal and neuromuscular disorders,[3,4] it was used as a predictive factor of postoperative complications,[5] risk of mortality in patients on hemodialysis[6] and critically ill patients.[7]

Handgrip strength is "the maximal power of forceful voluntary flexion of all fingers under normal biokinetic conditions".[8]

Several factors were found to affect handgrip strength such as age, gender, muscle mass, body mass index, and hand dimensions.[9]

Proper handgrip strength is essential for carrying precise hand functions such as gripping and pulling. It is considered a crucial factor in maximizing performance and control of many daily activities and sporting.[10,11]

The relation between body mass index and handgrip strength is controversial. Some researchers found a positive relation while others reported partial positive or no significant relationship.[12,13]

Address for correspondence:
Prof. Jasim Naeem Al-Asadi, Department of Community Medicine, College of Medicine, Basrah University, Al-Bradheia, Basrah, Iraq 61004. **Mobile:** 00964 780 1404284. **E-mail:** jnk5511@yahoo.com

Such discrepancy in results of studies about the relationship between body mass index and handgrip strength, in addition to scarcity of local studies on this issue in Basrah, Iraq signify a research specific to Basrah.

The aim of this study was to examine the correlation between body mass index, hand dimensions and handgrip strength in medical students.

MATERIALS AND METHODS

Study design and participants

This cross-sectional study was done at College of Medicine, Basrah University, Iraq during the period from 1st of March to 30th of May 2016. A convenient sample of 256 medical students of both sexes from stage one to six was chosen using non-probability purposive sampling method. Objectives of the study were explained to participants. They were assured that information obtained would be anonymous and confidential

Data collection

Data were collected using a special questionnaire designed for the purpose of the study. It includes socio-demographic information (name, age, sex, smoking status, and physical activity pattern).

Those who were involved in active muscle training exercises and those who had a history of fracture in the past 3 months, a deformity, or pain at rest or movement in the upper arms were excluded.

Anthropometric measurements

Height was measured to the nearest centimeter using a tape measure while the subject is in standing position without footwear and heals together. The weight was measured to the nearest 0.5 Kg, with light clothes and without footwear, by using a portable weighing scale.

The body mass index (BMI) was calculated using Quetelet's index.[14] Depending on their BMI; the subjects were classified into four groups. The subjects with a BMI of less than 18.5 were classified as underweight, the subjects with a BMI of 18.5 - 24.99 (Kg/m^2) were classified as the normal, those who had a BMI of 25 - 29.99 (Kg/m^2) were classified as overweight, and those with BMI of ≥30 Kg/m^2 were classified as obese.[15] The hand length was measured using measuring tape in each subject, defined as the distance between the mid-point of the distal wrist crease and the tip of the middle finger.[16] The hand width also measured using tape measure just below the knuckles excluding the thumb. Hand span was measured in dominant hand from the tip of the thumb to the tip of the small finger with the hand opened as wide as possible.[17]

The handgrip strength in kilogram of the dominant hand was measured by using a handgrip dynamometer (Camry, Digital dynamometer, Amazon). Measurement was done while the participant in standing position with shoulder adducted and neutrally rotated and elbow in full extension. The participants were asked to press the handle of the dynamometer with maximum strength. The maximal voluntary contraction was sustained for at least 3 seconds and it was recorded as the handgrip strength in kilograms (kg). Three readings were taken with a gap of 10 minutes and the maximum reading was taken for analysis.[18]

The Ethical Committee of College of Medicine, Basrah University approved the study. Verbal consent was obtained from each participant before staring the study.

Statistical analysis

Statistical analysis was done using SPSS Version 23 (IBM Corp., Chicago, Illinois, USA). The results were presented in tables and charts. Frequencies and percentages were calculated for the categorical variables, while continuous variables were expressed as means and standard deviations. Chi square test was used to assess the relationship between categorical variables. Analysis of variance and t- test were used to compare continuous variables, while a paired *t* test compared between right- and left-hand grip strength in each handedness group. Correlations between HGS and anthropometric measures were examined by Pearson's correlation analysis. A *P* value <0.05 was considered statistically significant.

RESULTS

As shown in Table 1, the mean age of the studied population was 21.1 ± 1.9 years, while the mean of handgrip strength

Table 1: General characteristics of the study population

Character		Range
Age (years), mean±SD	21.1±1.9	17-28
Sex, no. (%)		
Male	124 (48.4)	
Female	132 (51.6)	
Handedness, no. (%)		
Right	235 (91.8)	
Left	21 (8.2)	
Height (cm), mean±SD	167.5±9.7	145-198
Weight (kg), mean±SD	64.9±13.5	40-115
BMI (kg/m²), mean±SD	23.1±3.6	16.30-40.00
Hand span (cm), mean±SD	20.3±1.9	16-26
Hand length (cm), mean±SD	18.9±1.4	15-25
Hand width (cm) mean±SD	9.1±0.9	7-13
HGS (Kg), mean±SD	34.1±11.9	13-69
Males HGS (kg), mean±SD	44.1±7.8	26-69
Females HGS (kg), mean±SD	24.8±6.0	13-58

BMI=Body mass index, HGS=Handgrip strength

was 34.1 ± 11.9 Kg. Females constituted 51.6% of the study population. Of the participants, 235 (91.8%) were found to be right handed and only 21 (8.2%) were left handed. In males, 113 (91.1%) and 11 (8.4%) were found to be right handed and left handed respectively. In females, 122 (92.4% and 10 (7.6%) were found to be right and left handed respectively.

As shown in Table 2, all the studied variables: age, male gender, height, weight, hand span, hand width, and hand length were significantly correlated with handgrip strength at the 0.01 level.

In right-handed students, a significant difference was found between right and left handgrip strength (34.2±11.9 vs. 30.1±11.8, P < 0.001). The difference was 11.9%. However, in the left-handed students, no significant difference was found between right and left handgrip strength (30.8±12.2 vs. 32.3±11.6, P=0.065). The difference was 4.6%. [Figure 1]

To examine the independent effects of the studied variables on HGS, a stepwise linear multiple regression analysis was done. Gender, hand span, height, and BMI were found to be significant predictors of handgrip strength. They explained 70.6% of the variation in handgrip strength. [Table 3]

DISCUSSION

The mean handgrip strength of the medical students in Basrah was 34.1±11.9 Kg (44.1±7.8 for males and 24.8±6.0

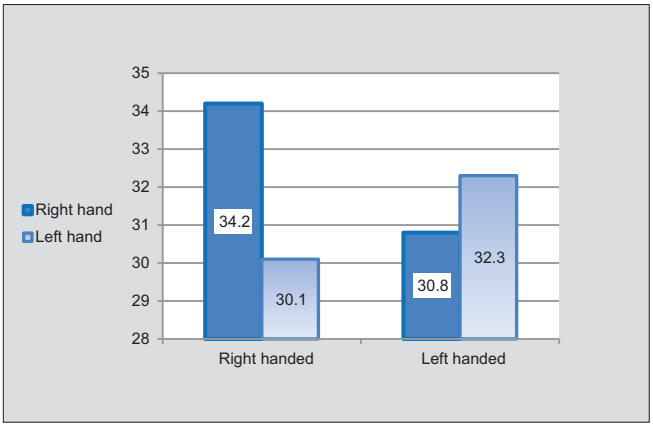

Figure 1: Handgrip strength according to handedness

Table 2: Correlation of age, sex, physical activity, and anthropometric variables with handgrip strength

	Age	Sex	Height	Weight	BMI	Hand span	Hand length	Hand width	Activity	HGS
Age										
Pearson correlation	1									
Sig. (2-tailed)										
Sex										
Pearson correlation	–0.157*	1								
Sig. (2-tailed)	0.012									
Height										
Pearson correlation	0.168**	–0.797**	1							
Sig. (2-tailed)	0.007	0.000								
Weight										
Pearson correlation	0.340**	–0.600*	0.641**	1						
Sig. (2-tailed)	0.000	0.000	0.000							
BMI										
Pearson correlation	0.330**	–0.212**	0.114	0.823**	1					
Sig. (2-tailed)	0.000	0.001	0.070	0.000						
Hand span										
Pearson correlation	0.052	–0.584**	0.624**	0.532**	0.258**	1				
Sig. (2-tailed)	0.408	0.000	0.000	0.000	0.000					
Hand length										
Pearson correlation	–0.076-	–0.530**	0.623**	0.471**	0.167**	0.819**	1			
Sig. (2-tailed)	0.224	0.000	0.000	0.000	0.008	0.000				
Hand width										
Pearson correlation	–0.057-	–0.524**	0.581**	0.462**	0.190**	0.658**	0.724**	1		
Sig. (2-tailed)	0.364	0.000	0.000	0.000	0.002	0.000	0.000			
Activity										
Pearson correlation	0.117	–0.229**	0.216**	0.055	–0.040	0.149*	0.146*	0.082	1	
Sig. (2-tailed)	0.061	0.000	0.001	0.380	0.520	0.017	0.020	0.191		
HGS										
Pearson correlation	0.185**	–0.811**	0.739**	0.593**	0.252**	0.614**	0.548**	0.510**	0.223**	1
Sig. (2-tailed)	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

*.Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed)

Table 3: Multiple regression analysis

Variable	Beta	R^2	P-value
Gender	–0.548	0.658	<0.001
Hand span	0.149	0.688	0.001
Height	0.202	0.698	0.001
BMI	0.075	0.706	0.040

BMI: Body mass index

for females, P <0.001). This result is in line with that reported for collegiate students in Nigeria[12] and Punjab, India[18] but it was weaker than that reported for Western population,[19,20] suggesting that handgrip strength differs in different populations.[19] Genetic factors and environmental factors such as socio-economic status and nutrition may contribute to such inter-population differences.[21,22]

In addition, differences in protocol and handgrip strength measures used in different studies may affect not only the precision and reproducibility of the measurements but also the ability to compare absolute values reported for grip strength between different study populations.[17]

This study revealed that handgrip strength is directly and significantly correlated with age, a result that agreed with what was previously reported by others.[23,24] Sartario et al.[24] suggested that the age related increase of hand grip strength is strongly associated with changes of muscle mass during childhood.

Sex wise, males showed a higher mean value for handgrip strength than females, a result that agrees with the study conducted by Koley and Singh.[18] One possible explanation for this finding was the difference in the type of activity of each gender.[12]

Men were found to possess greater strength for all muscles than women[25,26] due to difference in muscle mass because of the male testosterone hormone which enlarges muscles and increases type II fibers with high activity of glycolytic enzymes.[27-29]

In accordance with what had been previously described,[30,31] height was directly correlated with handgrip strength. Greater height leads to longer arms and greater lever arms resulting in an efficient force generation.[24]

In agreement with other researches[32,33] our study showed that handgrip strength was positively and significantly correlated with body mass index.

All hand measurements (hand length, span, and width) were found to be correlated with handgrip strength, a result that agrees with that reported by others.[34-36]

Bechtol in 1954[37] suggested that, on average, the dominant hand is approximately 5 -10% stronger than the non-dominant hand. A general rule, which was referred to as 10% rule[38,39] is confirmed in this study (HGS differences between dominant and non -dominant hands ranged from 4.6% to 11.9%) similar to that reported by other studies.[18,40] In our study, no significant difference in handgrip strength had been found between the dominant and non-dominant hands in left-handed students. A result, which had been revealed by others[41,42] This can be attributed to that most tools and appliances in daily living are designed for the right hand. Therefore, the left-handed people are compelled to use their non-dominant hands for many daily activities.[11]

In agreement with the results of Liao,[43] regression analysis results indicated that the independent variables; gender, hand span, height, and BMI can explain 70.6% of the variances of the HGS. The most significant factor affecting HGS was found to be gender with a beta value of - 0.548 (P < 0.001), followed by hand span and height. BMI, with a beta value of 0.075 (P = 0.040) was found to be the least significant factor.

One limitation may be addressed in this study is that it was a cross-sectional study; therefore, a causal effect among variables is difficult to be identified.

CONCLUSION

The study found that gender and personal anthropometric variables; height, hand span, and BMI have a significant correlation with HGS, with gender being the most significant factor.

REFERENCES

1. Jafar TH, Qadri Z, Islam M, Hatcher J, Bhutta ZA and Chaturvedi N. Rise in childhood obesity with persistently high rates of under nutrition among urban school aged Indo-Asian children. Arch Dis Child 2008; 93:373–378.
2. Flood A, Chung A, Parker H, Kearns V and O'Sullivan TA. The use of handgrip strength as a predictor of nutrition status in hospital patients. Clin Nutr 2014; 33(1):106–114.
3. Espinoza F, Le Blay P, Coulon D, Lieu S, Munro J, Jorgensen C, et al. Handgrip strength measured by a dynamometer connected to a smart phone: a new applied health technology solution for the self-assessment of rheumatoid arthritis disease activity. Rheumatology (Oxford) 2016; 55(5):897–901.
4. Alperovitch-Najenson D, Carmeli E, Coleman R and Ring H. Handgrip strength as a diagnostic tool in work-related upper extremity musculoskeletal disorders in women. Scientific World Journal. 2004; 4:111–117.
5. Cha SM, Shin HD, Ahn JS, Beom JW, Kim DY. Cha SM, et al. Differences in the Postoperative Outcomes According to the Primary Treatment Options Chosen by Patients With Carpal

Tunnel Syndrome: Conservative Versus Operative Treatment. Ann Plast Surg 2016; 77(1):80–84.

6. Matos CM, Silva LF, Santana LD, Santos LS, Protásio BM, Rocha MT, et al. Handgrip strength at baseline and mortality risk in a cohort of women and men on hemodialysis: a 4-year study. J Ren Nutr 2014; 24(3):157–162.
7. Ali NA, O'Brien JM Jr, Hoffmann SP, Phillips G, Garland A, Finley JC, et al. Acquired weakness, handgrip strength, and mortality in critically ill patients. Am J Respir Crit Care Med 2008; 178(3):261–268.
8. Sengupta DS, Maity P, Pal P and Dhara PC. Effect of Body Posture on Hand Grip Strength in Adult Bengalee Population. Journal of Exercise Science and Physiotherapy 2011; 7(2):79–88.
9. Fallahi AA and Jadidian AA. The effect of hand dimensions, hand shape and some anthropometric characteristics on handgrip strength in male grip athletes and non-athletes. J Hum Kinet 2011; 29:151–159.
10. Blackwell JR, Kornatz KW and Heath EM. Effect of grip span on maximal grip force and fatigue of flexor digitorum superficialis. Appl Ergon 1999; 30(5):401–405.
11. Crosby CA, Wehbe MA and Mawr B. Hand strength: normative values. J Hand Surg Am 1994; 19(4):665–670.
12. Oseloka IA, Bello BM, Oliver HW, Emmanuel UU and Abraham MS. Association of handgrip strength with body mass index among Nigerian students. Int J Pharm Biol Sci 2014; 9(1):1–7.
13. Günther CM, Bürger A, Rickert M, Crispin A and Schulz CU. Grip strength in healthy Caucasian adults: reference values. J Hand Surg Am 2008; 33(4):558-565.
14. Garrow JS and Webster J. Quetelet's index as a measure of fatness. Int J Obes 1985; 9(2): 147–153.
15. WHO. Obesity: Prevention and managing the global epidemic. Technical reports series 894, WHO, Geneva, Switzerland, 2000. Available at: http://apps.who.int/iris/bitstream/10665/42330/1/WHO_TRS_894.pdf?ua=1&ua=1.
16. Sirajudeen MS, Shah UN, Pilla PS, Mohasin N and Shantaram M. Correlation between Grip strength and physical factors in men. Int J Health Rehabil Sci 2012; 1(2): 58–63.
17. Roberts HC, Denison HJ, Martin HJ, Patel HP, Syddall H, Copper C, et al. A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardized approach. Age Ageing 2011; 40(4):423–429.
18. Koley S and Singh AP. Effect of Hand Dominance in Grip Strength in Collegiate Population of Amritsar, Punjab, India. Anthropologist 2010; 12(1):13–16.
19. Massy-Westropp NM, Gill TK, Taylor AW, Bohannon RW and Hill CL. Hand Grip Strength: age and gender stratified normative data in a population-based study. BMC Res Notes 2011; 4: 127.
20. Werle S, Goldhahn J, Drerup S, Simmen BR, Sprott H and Herren DB. Age- and gender-specific normative data of grip and pinch strength in a healthy adult Swiss population. J Hand Surg Eur 2009; 34(1):76–84.
21. Carmelli D and Reed T. Stability and change in genetic and environmental influences on handgrip strength in older male twins. J Appl Physiol 2000;89(5):1879–1883.
22. Quan S, Jeong J-Y and Kim DH. The relationship between smoking, socioeconomic status and grip strength among Community-dwelling elderly men in Korea: Hallym Aging Study. Epidemiol Health 2013; 35: e2013001.
23. Gerodimos V. Reliability of handgrip strength test in Basketball Players. J Hum Kinet 2012; 3:25–36.
24. Sartorio A, Lafortuna CL, Pogliaghi S and Trecate L. The impact of gender, body dimension and body composition on handgrip strength in healthy children. J Endocrinol Invest 2002; 25(5):431–435.
25. McArdle WD, Katch FI and Katch VL. Exercise Physiology: Nutrition, Energy, and Human Performance. 5th Edition. Philadelphia: Lippincott Williams and Wilkins, 2001; pp: 506–507.
26. Bohannon RW, Peolsson A, Massy-Westropp N, Dastrosiers J and Bear – Lehman J. Reference values for adult grip strength measured with a Jamar dynamometer; a descriptive meta-analysis. Physiotherapy 2006; 92:11–15.
27. Griggs RC, Kingston W, Jozefowicz RF, Herr BE, Forbes G and Halliday D. Effect of testosterone on muscle mass and muscle protein synthesis. J Appl Physiol 1989;66(1):498–503.
28. Yu J-G, Bonnerud P, Eriksson A, Sta˚l PS, Tegner Y and Malm C. Effects of Long Term Supplementation of Anabolic Androgen Steroids on Human Skeletal Muscle. PLoS ONE 2014;9(9): e105330.
29. Sinha-Hikim I, Cornford M, Gaytan H, Lee ML and Bhasin S. Effects of Testosterone supplementation on skeletal muscle fiber hypertrophy and satellite cells in Community-Dwelling older men. J Clin Endocrinol Metab 2006; 91(8):3024 –3033.
30. Luna-Heredia E, Martin-Pena G and Ruiz-Galiana, J. Handgrip dynamometer in healthy adults. Clin Nutr 2005; 24(2):250–258.
31. Miyatake N, Miyachi M, Tabata I, SakanoN, Hirao T and Numata T. Relationship between muscle strength and anthropometric, body composition parameters in Japanese adolescents. Health 2012; 4(1):1-5.
32. Lad UP, Satyanarayana P, Shisode-Lad S, Siri Ch C and Kumari NR. A study on the correlation between the body mass index (BMI), the body fat percentage, the handgrip strength and the handgrip endurance in underweight, normal weight and overweight adolescents. J Clin Diagn Res 2013; 7(1): 51–54.
33. Rai SS, Kadu SS and Anap D. Evaluation of normative grip strength in students of Vikhe Patil Institute of Medical Sciences, Ahmednagar, Maharashtra. Int J Educ Res Health Sci 2016;2(4):87-90.
34. Leong DP, Teo KK, Rangarajan S, Kutty VR, Lanas F, Hui C, et al. Reference ranges of handgrip strength from 125,462 healthy adults in 21 countries: a prospective urban rural epidemiologic (PURE) study. J Cachexia Sarcopenia Muscle 2016; 7**:** 535–546.
35. Alahmari KA, Silvian SP, Reddy RS, Kakaraparthi VN, Ahmad I and Alam MM. Hand grip strength determination for healthy males in Saudi Arabia: A study of the relationship with age, body mass index, hand length and forearm circumference using a hand-held dynamometer. J Int Med Res 2017; 45(2): 540–548.
36. España-Romero V, Artero EG, Santaliestra-Pasias AM, Gutierrez A, Castillo MJ and Ruiz JR. Hand span influences optimal grip span in boys and girls aged 6 to 12 years. J Hand Surg Am 2008;33(3):378–384.
37. Bechtol CO. Grip Test: the use of a dynamometer with adjustable handle spacing. J Bone Joint Surg Am 1954; 36: 820–832.
38. Amstrong CA and Oldham JA. A comparison of dominant and non-dominant hand strengths. J Hand Surg 1999; 24: 421–425.
39. Petersen P, Petrick M, Connor H and Conklin D. Grip strength and hand dominance: challenging the 10% rule. Am J Occup Ther 1989; 43: 444–447.
40. Incel NA, Ceceli E, Durukan PB, Erdem HR and Yorgancioglu ZR. Grip strength: Effect of hand dominance. Singapore Med J 2002; 43: 234–237.
41. Ziyagil MA, Gürsoy R, Dane Ş, Türkmen M and Çebi M. Effects of handedness on the handgrip strength asymmetry in Turkish

athletes. Comprehensive Psychology 2015; 4: 20.

42. Vingerhoets G, Acke F, Alderweireldt AS, Nys J, Vandemaele P and Achten E. Cerebral lateralization of praxis in right- and left-handedness: same pattern, different strength. Hum Brain Mapp 2012;33(4):763–777.
43. Liao K. Handgrip strength in low, medium, and high body mass index males and females. Middle East J Rehabil Health 2016; 3(1): e33860.

Authors Contribution:
JNA-Concept and design of the study, data analysis, manuscript preparation and critical revision of the manuscript.

Work attributed to:
Professor, Department of Community Medicine, College of Medicine, University of Basrah, Basrah, Iraq

Orcid ID:
Prof. Jasim Naeem Al-Asadi: https://orcid.org/0000-0003-1507-9738

Source of Support: Nil, **Conflict of Interest:** None declared.