

## Original Research Article

# Analysis of muscle strength and endurance in healthy young adults and association of muscle strength with muscle endurance

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## ABSTRACT

**Background:** Muscle strength has been studied as a predictor of general health and many diseases. Data on muscle strength of healthy adults are scarce in Assam. Aim of the study was to describe normative data for hand grip muscle strength and endurance among healthy young males and females of age group 18-21. Also, to find out any correlation between muscles strength and endurance.

**Methods:** We have selected 79 healthy volunteers of both sexes of age group 18-21 years. We have measured muscle strength by hand grip dynamometer. Muscle endurance was calculated by asking the subjects to hold the dynamometer at one third of their muscle strength as long as they can.

**Results:** In this study there were 46 males and 33 females. Mean muscle strength among the males is 27.09(SD7.05) and among the females is 10.76(SD6.19). Similarly mean endurance among males is 41.78(SD31.72) and among females is 16.15(SD9.81). These higher values of muscle strength and endurance in males are statistically significant. We have also found positive correlation between muscle strength and endurance in both the sexes.

**Conclusions:** In this study we have seen that muscle strength and endurance of healthy young males are more than that of females. And also, muscle endurance increases with increase in muscle strength.

**Keywords:** Muscle strength, Muscle endurance hand grip dynamometer

## INTRODUCTION

Hand Grip strength (HGS) is an index of the power, the hand can exert.<sup>1</sup> Handgrip strength is common clinical evaluation done by the therapists and hand surgeons for various musculoskeletal, neuromuscular disorders, pre and postoperative, older population and cardiovascular disorders.<sup>3-7</sup> Grip strength measurements using a hand grip dynamometer can be informative with regard to nutritional status, muscle mass, physical function, and health status.<sup>8-12</sup> Thus, it should be routinely used as a vital sign throughout the life stages.<sup>13</sup> Weak HGS is also associated with high case-fatality rates in individuals who develop any of a range of major illnesses suggesting that

low muscle strength may be an important indicator of vulnerability to disease and of fatality.<sup>14</sup> Its simplicity of measurement with minimal training, portability, and low cost make it an attractive clinical test to evaluate an individual's overall health in clinical or epidemiologic settings.

Hand grip strength is influenced by posture, age, gender, anthropometric traits like fat percentage, body mass index and hand perimeters.<sup>15</sup>

Reference values for grip strength are essential for making informed decisions about the normality of an individual's status relative to the population. Published

reference values for hand grip strength are available for many countries; in most cases, they are divided into age, sex, right and left hand, or dominant and non-dominant hand.<sup>16-20</sup> From various studies it is seen that normative reference values developed for one country may not be applicable to other countries.<sup>21</sup>

To our knowledge, data on hand grip strength of healthy young adults are scarce in Assam. There is need to establish normative grip strength values. These values would be of great help to health professionals and clinicians in clinical and epidemiologic settings.

So, the aim of this study was to analyse hand grip strength of young healthy individuals aged 18-21 years and to determine the relationship between hand grip strength and muscle endurance.

**METHODS**

In this cross sectional study, subjects; boys and girls who were in the age group of 18-21 years, were recruited randomly. The study protocol was ethically approved by the institutional ethical committee. An informed consent of the volunteers was taken.

**Study population and study period**

In this study the study population was first year medical and paramedical students of age group 18-21 years. The study was conducted in the department of Physiology, Gauhati Medical College, Guwahati during the period September 2018 to December 2018.

**Exclusion criteria**

The students with cardiovascular and respiratory disorders, those who were involved in active muscle training exercises and those who had a history of fracture in the past 3 months or a deformity in the upper arms were excluded. All the students were right handed.

**Hand grip strength and endurance recording**

The handgrip strength and endurance of the dominant hand was measured by using a handgrip dynamometer (INCO India Ltd. Ambala). In standing posture, the arm was positioned at the side of the body, the dynamometer was held with elbow flexed at 90° and they were asked to press the handle of the dynamometer with maximum strength. The maximal voluntary contraction was sustained for at least 3seconds and it was recorded as the handgrip strength in kilograms (kg).

Three readings were taken with a gap of 10minutes and the maximum reading was taken for analysis. The hand grip endurance was determined by asking the subject to maintain 1/3<sup>rd</sup> of maximal voluntary contraction for as long as he/she could and the time was recorded in seconds by using a stop watch.<sup>22</sup>

**Statistical analysis**

Mean ±standard deviation was obtained from the values. Student unpaired ‘t’ test was done for estimating p-Values. Pearson correlation coefficient was done to correlate the parameters using Microsoft Excel software. p-values <0.05 was considered as significant.

**RESULTS**

In this study we got 79 volunteers fulfilling the eligible criteria. Out of that 46 were male and 33 were female of age group 18-21. Unpaired t-test was done for statistical analysis.

In this study, we found that mean muscle strength among the 46 males is 27.09(SD7.05) kg and among the 33 females is 10.76(SD6.19) kg which is shown in Table 1. This higher value of muscle strength in males is statistically significant as p<0.05.

**Table 1: The mean values of muscle strength and endurance in males and females.**

Parameters	Male	Female	P-value
Muscle strength	27.09 ±7.05	10.76±6.19	<0.05*
Muscle endurance	41.78±31.72	16.15±9.81	<0.05*

\*p-value <0.05 is statistically significant

Similarly, mean endurance among 46 males is 41.78(SD31.72) seconds and among 33 females is 16.15(SD9.81) seconds. This higher value of muscle endurance in males is statistically significant as (p<0.05). This is shown in Table 1.

Pearson correlation coefficient was done to correlate muscle strength and endurance, we have found positive correlation between muscle strength and endurance both in the males (r=0.32) and the females (r=0.31) which are shown in Table 2.

**Table 2: Pearson correlation coefficient of muscle strength and muscle endurance in male and female.**

Sex	Pearson correlation coefficient(r)
Males	0.32
Females	0.31

**DISCUSSION**

Our study established normative reference value of muscular grip strength and endurance of healthy young adults aged 18-21 years. This normative value will help the clinicians to evaluate an individual's overall health in clinical or epidemiologic settings.

In this study, we found that mean muscle strength among the males of age group 18-21 is 27.09(SD7.05)kg and

among the females of age group 18-21 is 10.76(SD6.19)kg, which is less than a Korean study where they found 42.5kg for males and 25.9kg for females between ages 20 and 24years.<sup>23</sup> Normative data collected from 12 British studies identified peak median grip strength values of 51kg for males between ages 29 and 39 years and 31kg for females between ages 26 and 42 years.<sup>24</sup>

These results are close to the normative values from the U.S. NHANES by Peterson and Krishnan.<sup>25</sup> The Canadian Health Measures Survey, using reference equations for Canadians aged 6-79 years, reported median maximum grip strength values of 48.4kg for males and 28.5kg for females between ages 40 and 44 years.<sup>26</sup> German Socio-Economic Panel, representative data for the German population showed that pooled means for men are about 54kg (ages 30-49 years) and about 34.5kg (ages 35-44 years).<sup>27</sup> The grip strength values obtained in the current study were lower than those reported in other population-based studies.<sup>28,29</sup> The use of another dynamometer might explain the lower results of our study. Previous works demonstrated statistically significant differences in grip strength according to dynamometer type and whether measurements were taken in a seated or standing position.<sup>30</sup> The Jamar hand dynamometer (Lafayette Instrument Company, USA) is the most widely cited in the literatures. Earlier studies have established that the age, gender and anthropometric traits were the influencing factors of handgrip strength when measured with dynamometer.<sup>31-35</sup> The reasons for the low grip strength value in our population should be investigated in the future.

In our study we have found significant difference in muscle strength between males and females with more muscle power in males than females. This is same as that of the Korean study.<sup>29</sup> Another study shows that the strength of males and females is similar until adolescence, after which males began to gain strength more rapidly to a higher peak median of 51kg between ages 29 and 39, compared to the peak female median grip of 31kg between ages 26 and 42.<sup>24</sup> Similarly, mean endurance among males is 41.78(SD31.72) seconds and among females is 16.15(SD9.81) seconds in this study, which is statistically significant difference. We have not found any studies on analysing the reference value for endurance. So, we cannot comment whether it is more or less in comparison to other populations.

We have also found positive correlation between muscle strength and endurance in both the sexes. We have not found any previous studies on finding the correlation between hand grip muscle strength and endurance.

## CONCLUSION

In this study we have found the reference values of muscle strength and endurance among males and females

of healthy adults of age group 18-21. The reference values are more in males than females and there is positive correlation between hand grip muscle strength and endurance.

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## REFERENCES

1. MacDermid JC, Kramer JF, Woodbury MG, McFarlane RM, Roth JH. Interrater reliability of pinch and grip strength measurements in patients with cumulative trauma disorders. *J Hand Therapy.* 1994;7:10-4.
2. Sande LP, Coury HJ, Oishi J, Kumar S. Effect of musculoskeletal disorders on prehension strength. *Applied Ergonomics.* 2001;32:609-16.
3. Boissy P, Bourbonnais D, Carlotti MM, Gravel D, Arseneault BA. Maximal grip force in chronic stroke subjects and its relationship to global upper extremity function. *Clinical rehabilitation.* 1999 Aug;13(4):354-62.
4. Griffith CD, Whyman M, Bassey EJ, Hopkinson BR, Makin GS. Delayed recovery of hand grip strength predicts postoperative morbidity following major vascular surgery. *British J Surg.* 1989 Jul;76(7):704-5.
5. Hunt DR, Rowlands BJ, Johnston D. Hand grip strength-a simple prognostic indicator in surgical patients. *JPEN.* 1985;9:701-4.
6. Rantanen T, Guralnik JM, Foley D, Masaki K, Leveille S, Curb JD, et al. Midlife hand grip strength as a predictor of old age disability. *JAMA.* 1999 Feb 10;281(6):558-60.
7. Petrofsky JS, Lind AR. Aging, isometric strength and endurance, and cardiovascular responses to static effort. *J Applied Physiol.* 1975;38:91-5.
8. Matos LC, Tavares MM, Amaral TF. Handgrip strength as a hospital admission nutritional risk screening method. *Eur J Clin Nutr.* 2007;61:1128-35.
9. Collins J, Porter J, Truby H, Huggins CE. How does nutritional state change during a subacute admission? Findings and implications for practice. *Eur J Clin Nutr.* 2016;70:607-12.
10. Harris T. Muscle mass and strength: relation to function in population studies. *The J Nutri.* 1997 May 1;127(5):1004S-6S.
11. Ishizaki T, Watanabe S, Suzuki T, Shibata H, Haga H. Predictors for functional decline among nondisabled older Japanese living in a community during a 3-year follow-up. *J Am Geriatr Soc.* 2000;48:1424-9.
12. Taekema DG, Gussekloo J, Maier AB, Westendorp RG, de Craen AJ. Handgrip strength as a predictor of functional, psychological and social health. A

- prospective population-based study among the oldest old. *Age Ageing.* 2010;39:331-7.
13. Bohannon RW. Hand-grip dynamometry predicts future outcomes in aging adults. *J Geriatr Phys Ther.* 2008;31:3-10.
  14. Leong DP, Teo KK, Rangarajan S, Lopez-Jaramillo P, Avezum A Jr, Orlandini A, et al. Prognostic value of grip strength: findings from the Prospective Urban Rural Epidemiology (PURE) study. *Lancet.* 2015;386:266-73.
  15. Sartorio A, Lafortuna CL, Pogliaghi S, Trecate L. The impact of gender, body dimension and body composition on hand-grip strength in healthy children. *J Endocrinological Investigation.* 2002;25:431-5.
  16. Gunther CM, Burger A, Rickert M, Crispin A, Schulz CU. Grip strength in healthy caucasian adults: reference values. *J Hand Surg Am.* 2008;33:558-65.
  17. Ploegmakers JJW, Hepping AM, Geertzen JHB, Bulstra SK, Stevens M. Grip strength is strongly associated with height, weight and gender in childhood: a cross sectional study of 2241 children and adolescents providing reference values. *Journal of Physiotherapy.* 2005;59:255-61.
  18. 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.
  19. Spruit MA, Sillen MJ, Groenen MT, Wouters EF, Franssen FM. New normative values for handgrip strength: results from the UK Biobank. *J Am Med Dir Assoc.* 2013;14:775 e775-711.
  20. Steiber N. Strong or Weak Handgrip? Normative Reference Values for the German Population across the Life Course Stratified by Sex, Age, and Body Height. *PLoS One.* 2016;11:e0163917.
  21. Dodds RM, Syddall HE, Cooper R, Kuh D, Cooper C, Sayer AA. Global variation in grip strength: a systematic review and meta-analysis of normative data. *Age and ageing.* 2016 Jan 19;45(2):209-16.
  22. Bandyopadhyay A. Body composition and hand grip strength in male brick-field workers. *Malaysian J Medical Sciences.* 2008;15(1):31-6.
  23. Kim M, Won CW, Kim M. Muscular grip strength normative values for a Korean population from the Korea National Health and Nutrition Examination Survey, 2014-2015. *PloS one.* 2018;13(8):e0201275.
  24. Dodds RM, Syddall HE, Cooper R, Benzeval M, Deary IJ, Dennison EM, et al. Grip strength across the life course: normative data from twelve British studies. *PloS one.* 2014 Dec 4;9(12):e113637.
  25. Peterson MD, Krishnan C. Growth charts for muscular strength capacity with quantile regression. *Am J Preventive Med.* 2015 Dec 1;49(6):935-8.
  26. Wong SL. Grip strength reference values for Canadians aged 6 to 79: Canadian Health Measures Survey, 2007 to 2013. *Health reports.* 2016 Oct 1;27(10):3.
  27. Steiber N. Strong or weak handgrip? Normative reference values for the German population across the life course stratified by sex, age, and body height. *PloS one.* 2016 Oct 4;11(10):e0163917.
  28. Bohannon RW, Peolsson A, Massy-Westropp N, Desrosiers J, Bear-Lehman J. Reference values for adult grip strength measured with a Jamar dynamometer: a descriptive metaanalysis. *Physiotherapy.* 2006;92(1):11-5.
  29. Bohannon RW, Bear-Lehman J, Desrosiers J, Massy-Westropp N, Mathiowetz V. Average grip strength: a meta-analysis of data obtained with a Jamar dynamometer from individuals 75 years or more of age. *J Geriatr Phys Ther.* 2007;30(1):28-30.
  30. Kim M, Shinkai S. Prevalence of muscle weakness based on different diagnostic criteria in community-dwelling older adults: A comparison of grip strength dynamometers. *Geriatr Gerontol Int.* 2017;17(11):2089-95.
  31. Jürimäe T, Hurbo T, Jürimäe J. Relationship of handgrip strength with anthropometric and body composition variables in prepubertal children. *Homo.* 2009;60:225-38.
  32. Kaegi C, Thibault MC, Giroux F, Bourbonnais D. The interrater reliability of force measurements using a modified sphygmomanometer in elderly subjects. *Physical Therapy.* 1998;78:1095-103.
  33. Spijkerman DC, Snijders CJ, Stijnen T, Lankhorst GJ. Standardization of grip strength measurements. Effects on repeatability and peak force. *Scandinavian J Rehabilitation Med.* 1991;23:203-6.
  34. Peolsson A, Hedlund R, Oberg B. Intra- and inter-tester reliability and reference values for hand strength. *J Rehabilitation Medicine.* 2001;33:36-41.
  35. Sartorio A, Lafortuna CL, Pogliaghi S, Trecate L. The impact of gender, body dimension and body composition on hand-grip strength in healthy children. *J Endocrinol Investigation.* 2002;25:431-5.

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