International Journal of Community Medicine and Public Health
Arora S et al. Int J Community Med Public Health. 2026 Oct;13(10):xxx-xxx
https://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20263289

Original Research Article

Evolution of grip strength across transition between teenage and adulthood: gender-based analysis

Shubha Arora[1,2], Neha Jain[1]*

[1]Mahatma Gandhi Occupational Therapy college, Mahatma Gandhi University of Medical Sciences and Technology, Jaipur, Rajasthan, India
[2]Jamia Hamdard University, Delhi, India

Received: 13 August 2026
Accepted: 15 September 2026

***Correspondence:**
Dr. Neha Jain,
E-mail: drnehajain@mgumst.org

ABSTRACT

Background: Hand grip strength is an important indicator of hand and overall muscular function and is influenced by factors such as age and sex. The transition from teenage to adulthood represents an important developmental period during which changes in grip strength may occur. The objective was to examine and compare the differences in hand grip strength between teenage and adult participants and to compare grip strength between males and females.
Methods: A cross-sectional comparative research design. was conducted among 220 healthy participants aged 17–25 years, including 97 males and 123 females. Participants were divided into teenage (17–19 years) and adult (20–25 years) groups. Grip strength was assessed for both the hands using a Jamar hand dynamometer under standardized testing conditions. The mean of three trials for each hand was used for analysis, and differences between group grip strength were statistically evaluated.
Results: Males demonstrated greater mean grip strength than females in both age groups for both hands. Adult males showed significantly greater grip strength than teenage males, with mean differences of 4.46 kg for the right hand and 3.0 kg for the left hand ($p<0.001$). In females, the differences between teenage and adult groups were not statistically significant.
Conclusions: Grip strength differed according to sex and age. Males demonstrating greater strength and a significant increase from teenage to adulthood. These findings highlight the importance of considering age- and sex-specific values during hand-strength assessment and rehabilitation planning.

Keywords: Hand grip strength, Teenage, Adults, Hand dynamometer

INTRODUCTION

The human hand plays a central role in how we interact with and adapt to our environment, much as it did in our extinct ancestors. Its remarkable dexterity sets it apart from the hands of other living primates and is thought to have developed through a combination of evolutionary changes.[1] These include adaptations associated with the transition to bipedal locomotion, which reduced the selective demands placed on the hands for movement, as well as the increasing complexity of tool making and tool use among hominins—our modern human lineage and closely related extinct relatives.[1,2] Effective tool use involves more than simple motor control Hand dexterity is particularly dependent on the coordinated movement of the thumb and fingers. Precise thumb–finger coordination allows individuals to grasp, stabilize, manipulate, and release objects according to the demands of a task. Appropriate regulation of grip force is equally important; as excessive force may reduce efficiency. Thus, skilled hand function reflects the complex interaction of anatomical structure, neuromuscular control, sensory feedback, cognitive processing, and learned motor strategies The ability to generate and appropriately regulate grip strength is therefore an important component of functional hand performance. Understanding the

development of grip strength with respect to age will provide valuable insight about hand dexterity into changes in upper-limb function across different stages of development, particularly during the transition from teenage to adulthood.

Hand size, shape, and skeletal dimensions vary considerably among individuals and can influence how effectively tools are held and manipulated. Hand size has been consistently linked to grip strength in both males and females, with individuals who have greater hand length and breadth generally producing greater grip force. In addition to reflecting muscular strength, grip strength is increasingly considered a useful indicator of neuromuscular function and motor control.[3] Human hands also show considerable variation in size and shape, as well as in underlying bone morphology, across different populations.[4] These differences may contribute to variations in functional performance and should be considered when assessing hand strength and designing hand-related tools or equipment. Hand size can have a significant influence on physical performance, highlighting the importance of designing tools and equipment based on up-to-date anthropometric measurements.[5] Similarly, individuals with relatively longer fingers and larger joint surfaces may require less force when producing stone tools compared with those with shorter fingers.[6]

Grip strength is a key determinant of tool performance, influencing the force required to hold and operate a tool as well as the time needed to complete a task. Hand dimensions may also affect performance, as individuals with longer fingers and larger joint surfaces may achieve more effective force distribution and mechanical leverage, potentially reducing the force required during tool use.

Grip strength is commonly assessed in clinical and sports settings as an indicator of hand and overall muscular strength. It is influenced by several factors, including age, sex, physical activity, hand dominance, and hand dimensions. In both males and females, grip strength differed between the two hands, with the dominant hand—defined as the hand most commonly used for manipulating objects—being approximately 10% stronger than the non-dominant hand.[7] Furthermore, larger hand dimensions have been consistently associated with greater grip strength in both males and females.[8] However, most earlier studies on grip strength have focused on specific populations or age groups, leaving broader patterns across different stages of development less explored.[9,10] These methods not only enhance our understanding of health but also offer insights into the evolutionary relationship between form and function.

Grip strength does not remain constant throughout the lifespan. It develops progressively during childhood and adolescence, continues to increase during early adulthood, reaches a peak during adulthood, and subsequently declines with advancing age.[11] Mathiowetz et al established widely used normative values for adult grip and pinch strength, with peak grip strength reported among individuals aged 25–39 years.[12] Grip strength was significantly influenced by sex and hand dominance, but not by handedness.[13]

There is one age stage in the life when participants when participants are at the end of teenage age i.e. end of the teenage and enter into adult hood, have 4-5 years of adult age. Here in this study concentration of the study is what was the grip strength at the end of teenage and how good the grip strength remained the next 4 to 5 years. Based on findings from previous research, this study hypothesizes that: males will demonstrate significantly greater hand grip strength than females; and teenage will demonstrate significantly greater grip strength than participants in the adult age group with respect to gender.

METHODS

The study adopted was cross-sectional comparative research design, and participants were selected using a random sampling method. The study included participants aged 17–25 years who were able to understand and only right-handed dominant participants were selected, participants who follow the testing instructions and perform a maximal voluntary handgrip contraction. Participants were also required to have no current upper-limb injury affecting grip performance and to provide informed consent or assent. Participants were excluded if they had a history of upper-limb fracture, surgery, or major trauma; neurological or musculoskeletal conditions affecting hand function; current pain in the hand, wrist, elbow, or shoulder; or any other condition that could prevent them from safely performing maximal grip testing. The materials used for data collection included a Jamar handgrip dynamometer for measuring grip strength, a chair for standardized seating, a table for positioning the dynamometer at an appropriate height, and paper recording sheets and pens for documenting the measurements obtained during testing.

Procedure

Study was cleared from MGUMST Institutional ethical committee Jaipur Rajasthan. Written informed consent were taken from healthy subjects those were selected for grip strength measurement of age 17 to 25 years. All 220 subjects who were selected for Ph.D. study from Mahatma Gandhi college of occupational therapy, MGUMST Jaipur, Rajasthan having 123 females and 97 males were also selected for this project. Out of males and female subjects having the age of 17 and 19 years were separated from the total data. it was found, out of 123 female subjects 61 are of age 17 to 19 years and out of 97 males, 56 subjects are of 17-19 years of age, forms the teenage groups and rest are of age group 20- 25 years form adult age groups. This way two groups of each gender were made out of total subjects (i.e. teenage group 17-19 years and adult group 20-25 years' age.) Mean grip strength of teen age group

was statically compared with adult age of same gender to see the effect of the adult age stage.

Grip strength measurement

Grip strength was assessed using a Jamar dynamometer with participants seated in a standardized position. The grip span was adjusted to suit each participant's instrument was set for zero testing before start of measurement. The examiner demonstrated the correct sitting posture and instructed participants on how to hold and operate the dynamometer, with the elbow maintained at 90° flexion.[13,14] A poster illustrating the recommended posture and hand position was also provided for reference. Participants were then asked to squeeze the dynamometer with their maximum effort for approximately 2 seconds. Grip strength was recorded in kgs for both the hands. After a rest period of approximately one minute, the measurement was repeated for each hand. The mean of the three trials for each hand was calculated and used for analysis.

Statistical analysis

Data analysis was done using statistical package for the social sciences (SPSS) statistics version 22.0 including the Z-test and comparison of mean grip strength between the study groups.

RESULTS

Basic characteristics

Total of 220 subjects were selected as per inclusion and exclusion criteria. Out of 220, 97 were males and remaining were females. Two group were formulated i.e. teenage and adults and accordingly gender-based population were divided as reflected in Table 1.

Gender based analysis

The mean grip strength of the right and left hands was calculated separately for males and females. Teenage participants' performance was compared with adults of the same sex based on the mean difference in grip strength. The corresponding standard error was calculated for applying Z-test statistic and p value to determine the statistical significance of the observed differences. The results are presented in Table 1.

The analysis showed that adult males had greater grip strength than teenage males, with a mean difference of 4.46 kg for the right hand and 3.0 kg for the left hand (Figure 1). These differences were statistically significant ($p<0.001$). In contrast, among females, the mean difference was −0.11 kg for the right hand and 0.15 kg for the left hand (Figure 2), with neither difference reaching statistical significance ($p>0.05$). These findings suggest that the transition from teenage to adulthood was associated with a significant increase in grip strength among males, whereas no statistically meaningful difference was observed among females. The small differences observed in females may therefore be attributable to chance error.

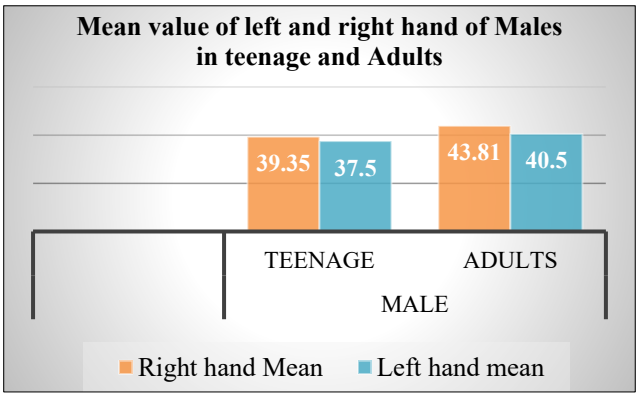

Figure 1: Mean value of males: right and left hand for both the groups.

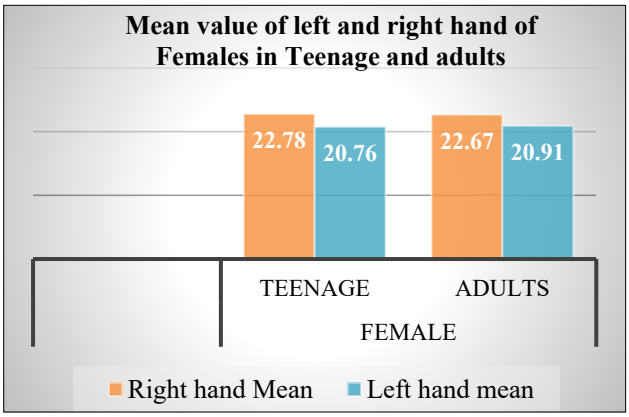

Figure 2: Mean value of females: right and left hand for both the groups.

The results further demonstrated that males had greater mean grip strength than females in both age groups, for both the right and left hands. These findings are presented in Table 1 and illustrated in Figures 3 and 4.

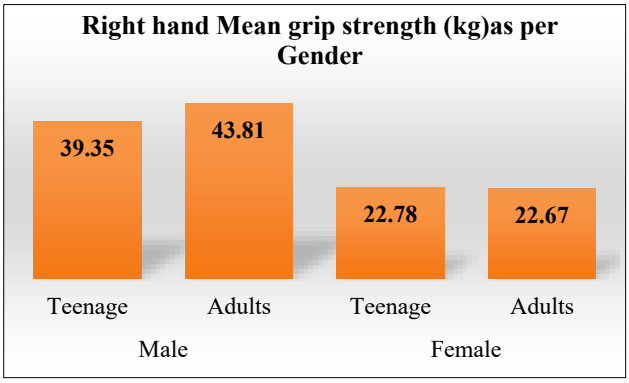

Figure 3: Right hand: mean grip strength as per gender for both groups.

Table 1: Mean of grip strength; level of significance for each group as per gender.

Gender and group	N	Right hand					Left hand				
		Mean grip strength (kg)	Diffe-rence	SE	Z statistic	P value (two tailed)	Mean	Diffe-rence	SE	Z statistic	P value (two tailed)
Male											
Teenage	56	39.35	+4.46	0.93	4.32	0.000*	37.5	+3.0	0.88	3.41	0.000*
Adults	41	43.81					40.5				
Female											
Teenage	61	22.78	-0.11	0.54	-0.2	0.8	20.76	+0.15	0.52	0.3	0.7
Adults	62	22.67					20.91				

*P<0.001: highly statistically significant

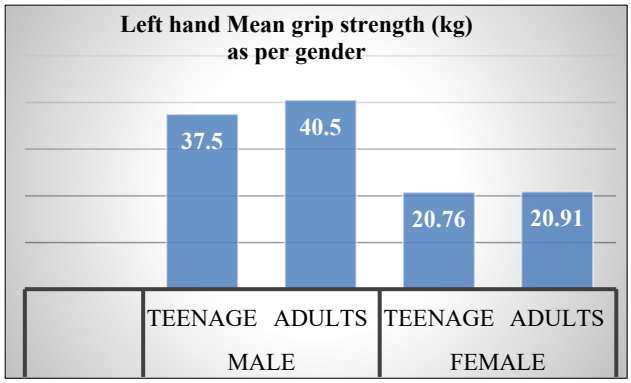

Figure 4: Left hand: mean grip strength as per gender for both groups.

DISCUSSION

Grip strength varies considerably with gender and age, with males generally demonstrating greater grip strength than females. In Indian children and adolescents aged 5–18 years, grip strength increased progressively with age, and boys consistently demonstrated higher values than girls. The difference between age groups was statistically significant, indicating that grip strength increases during growth and maturation.[17] In adults, grip strength generally reaches its highest levels in young adulthood and subsequently declines with advancing age. Wang et al. reported significantly greater grip strength in men than women and higher values among younger adults compared with older adults.[14] More recent Indian normative data have similarly demonstrated higher grip strength in males than females, with age-related variation across adulthood.[16] All the above supports study results as males were stronger than females in both the groups i.e. adolescence and adulthood were as the above studies also supported that adult males were stronger than teenage boys for both right and left hand, which were statistically significant at p value ≤0.01 whereas females does not demonstrated difference in mean grip strength for teen age and adulthood.

The present study is relevant to rehabilitation because grip strength is influenced by age-related physical development and sex-related differences in muscle strength. Establishing these differences can help rehabilitation professionals to interpret grip-strength measurements more accurately and avoid comparing individuals solely with general population values. Understanding age- and gender related differences can support individualized assessment, goal setting, exercise prescription, and monitoring of rehabilitation outcomes. For teenage group, grip-strength values can provide a reference for normal physical development and identify potential weakness that may affect functional activities. In adults, particularly older individuals, grip-strength assessment can help identify age-related reductions in strength and guide appropriate strengthening and functional interventions. Thus, recognizing the influence of gender on grip strength can contribute to more accurate clinical decision-making and personalized rehabilitation planning.

CONCLUSION

The present study highlights the influence of gender on hand grip strength across the transition from teenage to adulthood. Males demonstrated greater grip strength than females in both age groups and for both hands. Adult males also showed significantly higher grip strength than teenage males, whereas no significant age-related difference was observed among females. These findings suggest that grip strength develops differently according to sex and age. From a rehabilitation perspective, the findings emphasize the importance of considering sex-specific reference values when assessing hand strength, setting individualized goals, prescribing strengthening interventions, and monitoring functional recovery. Further studies with larger and more diverse samples are recommended to establish robust normative values and better understand the factors contributing to changes in grip strength across different stages of life.

ACKNOWLEDGEMENTS

The authors thank all the participants who willingly took part in this study.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Marzke MW, Wullstein KL, Viegas SF. Evolution of the power ("squeeze") grip and its morphological correlates in hominids. Am J Phys Anthropol. 1992;89(3):283-98.
2. Marzke MW. Tool making, hand morphology and fossil hominins. Philos Trans R Soc Lond B Biol Sci. 2013;368(1630):20120414.
3. Dewangan KN, Patel T, Vidhu KP, Khumukcham BS, Lusang I, Sumpi N, et al. An investigation of the hand anthropometric database of agricultural workers and integration of the database into tools and protective gear designs. Work. 2023;74(4):1461-80.
4. Dianat I, Nedaei M, Nezami MAM. The effects of tool handle shape on hand performance, usability and discomfort using masons' trowels. Int J Ind Ergon. 2015;45:13-20.
5. Kong YK, Lowe BD. Optimal cylindrical handle diameter for grip force tasks. Int J Ind Ergon. 2005;35:495-507.
6. Rolian C, Lieberman DE, Zermeno JP. Hand biomechanics during simulated stone tool use. J Hum Evol. 2011;61(1):26-41.
7. Petersen P, Petrick M, Connor H, Conklin D. Grip strength and hand dominance: challenging the 10% rule. Am J Occup Ther. 1989;43(7):444-7.
8. Kong YK, Kim DM. The relationship between hand anthropometrics, total grip strength and individual finger force for various handle shapes. Int J Occup Saf Ergon. 2015;21(2):187-92.
9. Mitsionis G, Pakos EE, Stafilas KS, Paschos N, Papakostas T, Beris AE. Normative data on hand grip strength in a Greek adult population. Int Orthop. 2009;33(3):713-7.
10. Cuesta-Vargas A, Hilgenkamp T. Reference Values of Grip Strength Measured with a Jamar Dynamometer in 1526 Adults with Intellectual Disabilities and Compared to Adults without Intellectual Disability. PLoS One. 2015;10(6):e0129585.
11. 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;9(12):e113637.
12. Mathiowetz V, Kashman N, Volland G, Weber K, Dowe M, Rogers S. Grip and pinch strength: normative data for adults. Arch Phys Med Rehabil. 1985;66(2):69.
13. Bardo A, Kivell TL, Town K, Donati G, Ballieux H, Stamate C, et al. Get a Grip: Variation in Human Hand Grip Strength and Implications for Human Evolution. Symmetry. 2021;13(7):1142.
14. Wang YC, Bohannon RW, Li X, Sindhu B, Kapellusch J. Hand-grip strength: normative reference values and equations for individuals 18 to 85 years of age residing in the United States. J Orthop Sports Phys Ther. 2018;48(9):685-93.
15. Roshan PSB, Sricharan KN, Muhammad Mussamil AM. Relationship between hand grip strength, cognition, and hand dexterity in older adults: a pilot study. Indian J Physiother Occup Ther. 2021;15(1):118-24.
16. Rajendiran S, Pai GM, Verma V, Rajappa S, Bhat A, Gaba S, et al. Normative Data of Grip Strength and Pinch Strength in the Indian Population. Indian J Plast Surg. 2024;57(4):256-62.
17. Shetty M, Balasundaran S, Mullerpatan R. Grip and pinch strength: Reference values for children and adolescents from India. J Pediatr Rehabil Med. 2019;12(3):255-62.

Cite this article as: Arora S, Jain N. Evolution of grip strength across transition between teenage and adulthood: gender-based analysis. Int J Community Med Public Health 2026;13:xxx-xx.