

Review Article

FACTORS AFFECTING HAND GRIP STRENGTH AND ITS EVALUATION: A SYSTEMIC REVIEW

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ABSTRACT

Hand is a vital and inevitable organ for humans. It functions start from a fine to gross motor activities. Many daily functions and sports events require high activity of hands. Hand and forearm muscles are important in grip strength. The American society of hand therapist (ASHT) recommended testing protocol in which the subject is seated upright against the back of a chair with flat on the floor. A literature survey covering the fields of ergonomics, medicine, biology and anthropology was conducted to develop a database. We suggest that a standard method is needed to enable more consistent measurement of grip strength and better assessment.

KEY WORDS: Hand Grip, Strength, Muscles, Hand therapist, Ergonomics, Assessment.

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INTRODUCTION

Hand is a vital and inevitable organ for humans. It functions start from a fine to gross motor activities. Many daily functions and sports events require high activity of hands. Hand and forearm muscles are important in grip strength. From sports like cricket, hockey, tennis, football, basketball, and baseball to daily activities such as carrying, turning a doorknob, and vacuuming, some degree of grip strength is necessary to be successful. Inadequate grip strength, golf players may run the risk of developing medial epicondylitis also known as golfer's elbow. Often overlooked or taken for granted, the strength of one's grip plays important role in prevention of injury and strength development. Handgrip strength is a biomarker of multiple physiological systems, its augmentation may be a feasible strategy to improve general health and decrease

likelihood of having multiple chronic diseases and hence, premature mortality, Cheung [1]. The simple method of handgrip dynamometry has been found to reveal more than an individual's handgrip strength. Researcher analysed the relation between hand grip strength, body, wrist and forearm position. Longitudinal studies concluded that the grip strength declines with increasing age, disability and it affects the health related quality of life. We therefore conducted a literature review to evaluate the extent of variation in assessment of grip strength. The American society of hand therapist (ASHT) recommended testing protocol in which the subject is seated upright against the back of a chair with flat on the floor. The shoulder adducted and neutrally rotated, the elbow flexed at 90 degree and forearm in neutral and wrist

between 0 degree and 30 degree of extension, Fess [2].

METHODS

A literature survey covering the fields of ergonomics, medicine, biology and anthropology was conducted to develop a database. Considerable effort has been made to maintain the integrity of original data.

Posture: A study examined the grip strengths were different when measured in both supine and sitting positions and the study reveals that there is no difference in grip strength in different position, Richards [3] but Teraoka [4] found that grip strength measurement for standing is more stronger than supine. Shyam kumar [5] showed a difference in grip strength in different posture due to change in length of the muscle. Balagun [6] also demonstrated that grip strength was greater in standing than sitting and supine posture.

Gender and handedness: Most of the researchers mean value of hand grip strength of adult male and female subject was higher in right hand compared to left hand in different posture and joint angle. Incel [7] stated that hand grip strength is higher in right hand dominant than left hand dominant group. However the work of Reikeras [8] and Roberts [9] reported that there is no significant difference in grip strength of dominant and non-dominant hand. Apart from the dominant or non-dominant hand the gender plays an important role. The male subjects showed greater grip strength than female counterpart. The difference in body composition such as low muscle mass and high fat mass in female leads to decreased grip strength compared to males. Shepherd [10] stated that women are 40-60% weaker in upperlimb and 25-30% weaker in lowerlimb compared to men.

Nutritional status: It also has been correlated to handgrip strength. Guo et al [11] and Kenjile et al [12] found grip strength to be a strong predictor of an individual's nutritional status. These findings draw parallel to the findings of the anthropometric measurement studies. One's nutritional status will lead to specific levels of body mass, which in turn has been found to correlate directly to grip strength. Wang et al

[13] suggested for evaluating grip strength as a nutritional marker, hand grip strength not only indicates the lean body mass but also used in conjunction with serum albumin.

Wrist and forearm position: A biomechanical perspective, the length tension relationship (LTR) of the muscles is the essential when testing the grip strength. So the wrist and forearm are position in such a way that multijoint muscle should not hinder the range of the joints. For example the flexor digitorum superficialis is crossing both the elbow and wrist, so the flexion of elbow and wrist will affect the range of finger flexion due to its shortened position. However passive insufficiency of the finger flexors due to extension of wrist and elbow also affect the grip strength. But still there is a controversy that grip strength had a significant increase in flexed elbow and neutrally placed wrist. Davide [14] claimed that wrist position significantly affect the hand grip strength and reduced strength might play an important role in predisposing repeated overload.

Arm support: Arm position also affects the grip strength. Various studies showed that the flexed shoulder position had a greater grip and even pinch grip in 0 degree position. Su [15] with 180 degree flexed shoulder has a highest grip strength than 0 degree flexion. Swanson [16] reveal that subjects grip is weaker in arm supported compared to the arm is unsupported. The reduction in hand grip strength for supported arm due to lost arm strength in keeping the arm stabilized.

Age: Hand grip strength reducing when age advances. Kamarul [17] the strongest grip in the right side dominant group of age 25-35 years whereas left hand dominant group of age between 35-44 years. But most of the researchers believed that right hand is comparatively stronger than left hand of any age.

Time factor: Grip strength performed on various time have a diurnal variation. Martin [18] stated that variation in grip strength of the individuals, grip is greater between 6.00 am to 9.00 am and decreased grip strength between 8.00 pm to 4.00 am.

Hand circumference: Hand circumference also

an important factor in grip strength. Anakwe [19] suggested that difference in forearm circumference of more than 2 cm may diminished grip strength among middle aged subjects. Vikram [20] stated that hand grip strength can be predicted by using forearm circumference and hand length for dominant and non-dominant hand among Malaysian population.

Forearm girth: Forearm girth also an important factor in determining the grip strength. Fraser [21], Mohamed [22], there is a significant correlation between grip strength and forearm girth. These findings are due to finger flexors muscle bulk that originated from forearm because strength is directly proportional to muscle mass. Anakwe [19], grip strength and forearm circumference lead us to suggest that for certain pathologies, a difference in forearm circumference greater than 2 cm may lend credence to a measurement of diminished grip strength. Vikram [20], it can be accomplished that Forearm circumference and hand length can be predicted using maximal hand grip strength for dominant and non-dominant hand among Malaysian population.

Psychological factor: Various psychologist evaluated the effect of hypnosis on hand grip strength. Hadfield [23], suggested that hypnosis can produce deleterious as well as ameliorable effect on grip strength. Watson [24], depression scores were minimally associated with diminished grip strength. Psychological factors appear to affect disability (patient-reported health status) more than they affect performance-based measures of function. Jung [25], were significant differences in height, weight, BMD, DASH, GSD-K, and SF36-MCS scores between men and women on grip strength among elderly population in Korea.

Temperature: Most of the researcher used heat and cold as a therapeutic and evaluation of muscle grip strength. Mark [26] that little or no change in muscle strength occurred with muscle temperature changes between 27 and 40° C. When the muscle temperature was decreased below 27° C, there was a resultant decrease in isometric grip strength and endurance. Deepak [27], found that hot water increases hand grip strength as compared to cold temperature in normal individual. Barter [28] stated that there

is no correlation between hand grip hold time and reduce in temperature this study is contrary to most of the studies but elevating intramuscular temperature will reduce the grip holding time duration among college aged men.

Altitude: Altitude indirectly affects the hand grip strength. Various researchers analysed the grip strength variation in different altitude. Ruff [29], grip strength start decreases at 4000 meters to 7000 meters and abruptly drop from 7000 to 9000 meters.

Oxygen: Oxygen and glucose are the main energy source for the muscles. Consolazio [30], hand grip strength will reduce to decrease in oxygen and increase in carbon dioxide level. Sokran [31], that peripheral muscle strength of the upper limb (HGS dominant and non-dominant) had different effects on MVO2 index before and after surgery. Cortopassi [32] stated that the Patients with COPD had reduced lung function, static hyperinflation, reduced HGS and 6MWD compared to the controls on both evaluations due to low oxygen level.

Fatigue: Fatigue is unavoidable part in any activity; it may affect the individual performance. Physical fatigue has been identified as a risk factor associated with the onset of occupational injury. Muscular fatigue developed from repetitive hand-gripping tasks is of particular concern. Batteries of physical test have been conducted to determine the effect of fatigue on grip strength. Burke [33] compared maximum grip strength values to grip strength endurance; the maximum grip strength endurance is approximately twice as much as grip strength endurance for a given age. Peripheral muscle fatigue directly interferes in the final result. Fernandes [34] significant reduction in strength levels occurs in course of the assessment. The best result is frequently obtained at the first trial, which indicates that the highest value obtained should be considered as the final result.

Nutrition: Nutritional status is an integral part of health and the fact that malnutrition can occur in a developed country with good standards of health care is confronting. Hand grip strength (HGS) has been found to respond to nutrition deprivation and repletion but few studies have investigated its use as an independent nutrition

assessment tool, Flood [35]. Various researchers also found that handgrip strength is positively associated with nutritional status as reported in Japan by Guo [11], in central Malawi by Chilima[36] and Navdeep [37].

Smoking: Current smokers were found to have higher risk of decreased grip strength compared with non-smokers. Saud [38], smokers demonstrated reduced grip strength and fast fatigability in comparison to non-smokers. Cigarette smoke constituents and systemic inflammatory mediators enhance proteolysis and inhibit protein synthesis leading to loss of muscle mass.

Reduced skeletal muscle contractile endurance in smokers may result from impaired oxygen delivery to the mitochondria and ability of the mitochondria to generate ATP due to interaction of carbon monoxide with haemoglobin, myoglobin and components of the respiratory chain.

Alcohol: The effects of alcohol can depend on the amount consumed, the environmental context, and on the individual. Daily consumption of up to four drinks may have a protective effect on the cardiovascular system. Nonetheless, people most commonly drink for alcohol's anxiolytic (stress-reducing) property. Conversely, alcohol has a wide spectrum of negative effects, from societal to physiological, accounting for approximately 100,000 deaths yearly in the United States. From a physiological perspective, two situations draw special attention for the fitness-oriented individual who consumes alcohol. Acutely, alcohol can cause negative effects on motor skills and physical performance. Chronically, alcohol abuse may eventually impede physical performance; individuals diagnosed with alcohol dependence have displayed varying degrees of muscle damage and weakness, ACSM [39].

DISCUSSION

Although there are several researches that examining the grip strength. Therefore the purpose of this review to help the physical therapist to frame the protocol for rehabilitation, return to work or sport, surgical success as in monitoring the effects of training. Shih [40], after warm immersion more muscle fibers could be

recruited at once during the cumulative 30 sec exertion period and then lead to a greater muscle fatigue at least. Besides hampering contractile function, smoking may have immediate beneficial effects on motor skills, which are attributable to nicotine. In contrast to pulmonary pathology, many of the effects of smoking on skeletal muscle are most likely reversible. This review showed the correlation between grip strength and anthropological factors that include psychological, physical, environmental and social factors. In many studies, the problem of fatigue influence on acquired strength. Now a day's literature is not clear evident whether the therapist should afraid of the fatigue influence on grip strength measurement using recommended standard procedure.

Results comparison of dominant and non-dominant hands is a common known criteria for analysis, such comparison can be found among others in, Armstrong [41], Josty [42]. Those test value between dominant and non-dominant grip strength confirm in their studies that superiority of dominant hand whereas Crosby [43], observed that non-dominant hand was often greater than dominant hand strength.

According to suggestion of American Society of Hand Therapists, the body mass as well as body height should be considered during tests as factors significantly influencing the value of grip strength. The lack of strong relationship between the body mass and the value of being developed grip strength may possibly point to influence of other factors such as: hobby or occupation, on values achieved. The absolute value and precision of grip strength measurements can be influenced by aspects of the protocol such as allowance for hand size and dominant, posture, joint position, effort and encouragement, frequency of testing and time of the day, and training of assessor, in addition multiple attempt, the maximum grip strength will be greater than mean values should be considered.

We suggest that a standard method is needed to enable more consistent measurement of grip strength and better assessment. A standard protocol could improve the measurements within any given study, but also enabling the generalizability of results across study populations.

CONCLUSION

We conclude that posture gender, handedness, nutritional status, wrist and forearm position, arm support, age time factor, forearm girth, psychological factor, temperature, altitude, oxygen, fatigue, nutrition, smoking, alcohol should consider while assessing and training hand grip strength.

Conflicts of interest: None

REFERENCES

- [1]. Cheung CL, Nguyen DT, Eleanor A, Tan KCB, Kung AWC. Association of handgrip strength with chronic diseases and multimorbidity-A cross-sectional study, *Age (Dordr)*. 2013;35:929-41.
- [2]. Fess EE. Grip strength. In J.S.Casanova (Ed.), *Clinical Assessment Recommendations*, American Society of Hand Therapists, Chicago. 1992;2:41-5.
- [3]. Richards LG. Posture effects on grip strength, *Arch Phys Med Rehabil*. 1997;78:1154-6.
- [4]. Teraoka, T. Studies on peculiarity of grip strength in relation to body positions and aging, *Kobe Journal of Medicine Science*. 1979;25:4-17.
- [5]. Shyam kumar AJ, Parmar V, Ahmed S, Kar S, Harper WM. A study of grip endurance and strength in different elbow positions, *J Orthop Traumatol Invest*. 2008;9:209-11.
- [6]. Balagun JA, Akomolfae CT, Amusa LO. Grip strength: effects of testing posture and elbow position, *Arch Phys Med Rehabil*. 1991;72:280-3.
- [7]. Incel NA, Ceceli E, Durukan PB, Erdem HR, Yorgancioglu ZR. Grip strength: effect of hand dominance, *Singap. Med. J*. 2002;43:234-7.
- [8]. Reikeras O. Bilateral difference of normal hand strength, *Archv Orthop. Trauma Surgery*. 1983;101:223-4.
- [9]. Roberts HC, Denison HJ, Martin HJ, Patel HP, Syddall H, Cooper C. A review of grip strength in clinical and epidemiological studies: towards a standard approach, *Age Ageing*. 2011;40:423-9.
- [10]. Shepard RJ. Exercise and training in women, Part I: influence of gender on exercise training Responses, *Canad. J. Appl. Physio*. 2000;25:19-34.
- [11]. Guo CB, Zhang W, Ma DQ, Zhang KH, Huang JQ. Hand grip strength: an indicator of nutritional state and the mix of postoperative complications in patients with oral and maxillofacial cancers, *Br J Oral Maxillofac Surg*. 1996;34:325-7.
- [12]. Kenjle K, Ghurge P, Udipi S. Grip Strength as an Index for Assessment of Nutritional Status of Children Aged 6-10 Years, *Journal of Nutrition and Science Vitaminol (Tokyo)*. 2005;51:87-92.
- [13]. Wang AY, Sea MM, Ho ZS, Lui SF, Li P, Woo J. Evaluation of handgrip strength as a nutritional marker and prognostic indicator in peritoneal dialysis patients, *Am J Clin Nutr*. 2005;81:79-86.
- [15]. Su C, Lin JH, Chein TH, Cheng KF, Sung YT. Grip strength in different position of elbow and shoulder, *Arch Phys Med Rehabil*. 1994;21:812-5.
- [16]. Swanson S, Alfred B, Ivan BM, Groot D. "The strength of hand", *JACPOC*. 1974;13:1-8.
- [17]. Kamarul T, Ahmad TS, Loh WY. A novel and improved method of predicting hand grip strength in the adult population, *Med J Malaysia*. 2006;61:37-44.
- [18]. Martin S, Neale G, Elia M. Factors affecting momentary grip strength. *Human Nutrition: Clinical Nutrition*. 1985;39C:137-47.
- [19]. Anakwe RE, Huntley JS, Mc Eachan JE. Grip strength and forearm circumference in a healthy population, *J Hand Surg Eur*. 2007;32:203-9.
- [20]. Vikram M, Noor Shafiqah S, Muhammad J, Nor Y, Leonard JH, Ida O. Forearm circumference and hand length predict maximal hand grip strength among Malaysian population, *Middle-East J. Sci. Res*. 2014;21:634-9.
- [21]. Fraser A, Vallow J, Preston A, Cooper RG. Predicting 'normal' grip strength for rheumatoid arthritis patients, *Rheumatology (Oxford)*. 1999;38:521-8.
- [22]. Mohamed SS, Umama NS, Padmakumar S, Naajil M, Manjula S. Correlation between Grip Strength and Physical Factors in Men, *Int J Health Rehabil Sci*. 2012;1:58-63.
- [23]. Hadfield JA. *The psychology of power*. New York, Macmillan Company, 1923;9-18.
- [24]. Watson J, Ring D. Influence of psychological factors on grip strength, *J Hand Surg Am*, 2008;33:1791-5.
- [25]. Jung EL, Ki WK, Nam-Jong P, Hak C J, Chong BC, Goo HB, Young HL, Hyun S. Evaluation of Factors Influencing Grip Strength in Elderly Koreans, *J Bone Metab*. 2012;19:103-10.
- [26]. Mark WC. Effect of temperature on muscle force and rate of muscle force production in men and women, *JOSPT*. 1994;20:74-80.
- [27]. Deepak BA, Tejashree B, Ashish JP. Effect of cold & hot temperature on hand grip strength in normal individuals: Cross sectional study, *VIMS Health Sci Journal*. 2015;2:13-15.
- [28]. Barter TJ, Freer PC. Effect of temperature on handgrip holding time. *Br J Sports Med*, 1984;18:91-5.
- [29]. Ruff S, Hubertus S. *Compendium of aviation medicine*, Alien property custodian. 1942;32-4:67-9.
- [30]. Consolazio WV. The effect on personnel of various concentrations of carbon dioxide and oxygen under conditions of submarine operations. *Research project X1945-349*.
- [31]. Sokran SN, Mohan V, Kamaruddin K, Sulaiman MD, Awang Y, Othman IR, Victor SJ. Hand Grip Strength and Myocardial Oxygen Consumption Index among Coronary Artery Bypass Grafting Patients, *Iran J Med Sci*. 2015;40:335-40.
- [32]. Cortopassi F, Celli B, Divo M, Pinto-Plata V. (). Longitudinal changes in hand grip strength, hyperinflation and 6-minute walk distance in COPD patients and a control group, *Chest*. 2015 May 21. doi: 10.1378/chest.14-2878.

- [33]. Burke W. The relation of grip strength and grip strength endurance to age, *Journal of Applied Physiology*. 1953;5:628-30.
- [34]. Fernandes A, Brito J, Vieira C, Marins J. Effect of peripheral muscle fatigue during the testing of handgrip strength, *Fisioter Mov*. 2014;27:407-12.
- [35]. Flood A, Chung A, Parker H, Kearns V, O'Sullivan TA. The use of hand grip strength as a predictor of nutrition status in hospital patients, *Clin Nutr*. 2014;33:106-14.
- [36]. Chilima DM, Ismail SJ. Nutrition and handgrip strength of older adults in rural Malawi, *Public Health Nutr*. 2001;4:11-7.
- [37]. Navdeep K, Shyamal K. An Association of Nutritional Status and Hand Grip Strength in Female Labourers of North India, *Anthropologist*. 2010;12:237-43.
- [38]. Saud O, Nowall S, Mohammed N. Smoking Impact on Grip Strength and Fatigue Resistance: Implications for Exercise and Hand Therapy Practice, *JPAH*. 2014;11:1025-31.
- [39]. Kozir LP. ACSM Current Comment: Alcohol and Athletic Performance.2014.
- [40]. Shih YC, Chen WL, Chi C. The Effects of Gender, Exerting type, and Temperature on Hand grip/pinch strength under the Muscular Fatigue, *ISTASC'09*. 2009; 50-55.
- [41]. Armstrong CA, Oldham JA. A comparison of dominant and non-dominant hand strengths, *J Hand Surg Br*. 1999;24:421-5.
- [42]. Josty IC, Tyler M, Shewell PC, Roberts A. Grip and pinch strength variations in different types of workers, *J Hand Surg*. 1997;22B: 266-9.
- [43]. Crosby CA, Marwan AW, Mabr W. Hand strength: Normative values, *The Journal of Hand Surger*. 1994;19:665-70.

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