J Hand Microsurg (July–December 2010) 2(2):58–61
DOI 10.1007/s12593-010-0015-6

ORIGINAL ARTICLE

Age and Anthropometric Traits Predict Handgrip Strength in Healthy Normals

Baskaran Chandrasekaran · Arindam Ghosh · Chandan Prasad · Kanak Krishnan · Bidhan Chandrasharma

Received: 9 February 2010 / Accepted: 25 May 2010 / Published online: 26 October 2010

Abstract Hand grip strength is an inevitable component in the evaluation of rheumatoid arthritis, neuromuscular, preoperative, post operative patients and community dwelling older adults' functional capacity. Hand grip varies greatly with age, gender and the anthropometric measures when measured by hand dynamometer. The influence of above variables on hand grip when measured by modified sphygmomanometer is unknown. Further, the prediction of hand grip from age and anthropometric traits is unknown. 229 subjects (115 males and 114 females) with age 23±2 and 21±2 respectively were included in the study after informed c nsent. Weight and height were obtained using standard techniques. Hand grip was measured using a modified sphygmomanometer. Information regarding physical activity and health status was obtained by interview, clinical screening and stratified. Stepwise multiple regression analysis was sought out for any influence of age, height, weight and Body Mass Index (BMI) on hand grip strength. Grip strength correlated moderate to high with age (r=0.44, p=0.00), height (r=0.57, p=0.00), weight (r=0.57, p=0.00) and BMI (r=0.29, p=0.00). The regression model for handgrip strength is Hand grip= −1790.54+4.93557×Age–11.7429×Weight+1083.4×Height+34.194×BMI. Age, height and weight are the i portant determinants of the handgrip evaluation. In clinical setting, the influence of age and anthropo etric traits on handgrip shall be borne in mind when measuring handgrip by modified sphygmomanometer in age group of 20–25 year patients.

Keywords Handgrip Strength · Determinants · Age · Anthropometric Traits

B. Chandrasekaran (✉)
Department of Physical Medicine Rehabilitation, Kokilaben Dhirubhai Ambani Hospital,
Mumbai, India
e-mail: bass_99psg@yahoo.co.in

A. Ghosh · C. Prasad · K. Krishnan · B. Chandrasharma
Department of Physiotherapy, Sikkim Manipal Institute of Medical Sciences, Sikkim Manipal University,
Sikkim, India

Introduction

Handgrip strength is common clinical evaluation done by the therapists and hand surgeons for various musculoskeletal [1, 2], neuromuscular disorders [3], pre and postoperative' [4, 5], older population [6] and cardiovascular disorders [7]. Handgrip strength is also an important determinant of nutritional index and the mortality of the elderly population [8]. Handgrip strength is evaluated by a dearth of modalities in the clinical setting varied from manual muscle testing, hand dynamometer, myometer and modified sphygmomanometer.

Hand grip strength is influenced by posture, age, gender, anthropometric traits like fat percentage, body mass index and hand perimeters [9, 10]. With Jamar hand dynamometer, strong correlations between grip strength and various anthropometric traits, (weight, height, hand length etc.) are reported earlier [11, 12]. But with modified sphygmomanometer, the effects of age and anthropometric measures on handgrip strength are not yet studied.

Purpose

In our study, we attempted to establish a relation among age, anthropometric traits and hand grip strength measured by modified sphygmanometer.

Clinical Implication

Failure in the consideration of the determinants influencing the handgrip strength would decrease the reliability of handgrip measurement by modified sphygmomanometer. So, if the influencing factors of handgrip would be determined, it can be normalized during handgrip measurement of preoperative and post operative patients.

Materials and Methods

Study Setting

Department of Physiotherapy, Central Referral Hospital, 5th mile, Tadong, Sikkim, India.

Study Design

Single blind cross sectional correlation study

Sample Size

200 samples was required to find a good correlation ($r>0.8$) with the power of 90% and level of significance of 95%

Subjects

229 healthy collegiate (115 males and 114 females) aged 20–25 years were selected randomly from the Sikkim Manipal Institute of Medical Sciences, Gangtok, Sikkim. The subject randomization was through computer generated randomization to the tests. Subjects were identified as those people who were right hand dominance and without any musculoskeletal or neurological deformity leading to decrease in hand grip strength. The left hand dominance subjects were excluded to keep the sample homogenous for the correlation analysis. Students with definite history of cardiovascular diseases, metabolic disorders and seropositive spondylarthropathies were excluded. The subjects with play activities involving upper limbs like basketball, volleyball and regular gym goers less than 3 weeks were excluded as we thought inclusion would influence the results of hand grip measurements by the modified sphygmomanometer. All the study participants were recruited only after the written and informed consent. The study started after the approval of Sikkim Manipal Institution Ethics Committee.

Instrumentation

A conventional sphygmomanometer was modified by removing the outer sleeve of the cuff, folding the remaining inflatable bladder in thirds, and inserting the bladder into a cotton casing (12.5×9× 1.5 cm) [13]. The cuff was folded in such a way that there were no creases so that even pressure was created throughout the bladder. The bladder was checked for air leaks before and after each subject. The cuff with the bladder was calibrated with the graded known weights before and after each subject. The calibration was ensured by the blinded researcher to the study after every 5 subjects. Throughout the study, single sphygmanometer was used to ensure the validation of the readings. The basal inflation pressure prior to the trial is determined as 20 mmHg. Immediately after each subject's three best hand grip efforts, the cuff pressure was brought back to basal pressure of 20 mmHg.

Procedure

Subjects were explained about the procedure on the day of study. Three anthropometric traits, height, weight and BMI, and right hand grip strength were taken from each subject. The height (to the nearest 0.1 cm) and weight (to the nearest 0.1 kg) of the subjects were measured. BMI was calculated using the formula weight (kg) / height (m) ^{2}. The grip strength of right hand was measured using a standard modifiable sphygmanometer as mentioned below.

Position of the Subject The subject was in sitting position with feet on the floor. The dominant arm was placed in the table in such a position that shoulder in 0 ^{o} flexion, 20 ^{o} abduction, elbow flexed in 90 ^{o} , forearm in mid prone position and wrist slight extension. The standardization of position of the subjects was done by the American Society of Hand Therapists criteria [14].

Handgrip Measurement Room temperature was controlled at the maximum as it may influence the subject's effort.

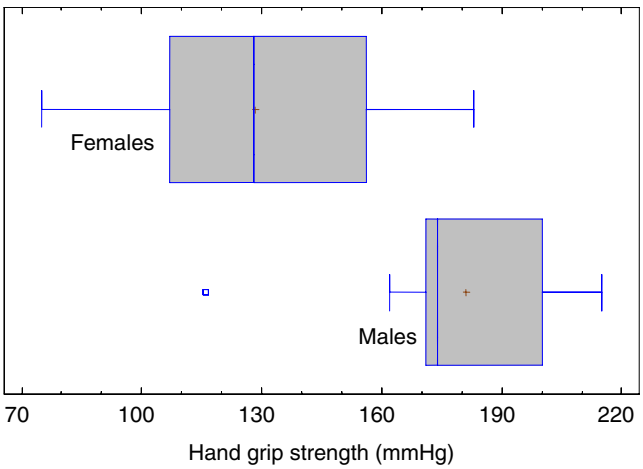

Fig. 1 Box-and-whisker plot of hand grip in males vs females

Table 1 Correlation of anthropometric traits with handgrip strength of 229 subjects

Variables correlated	Correlation coeff. (r)	Significance (p)
Age vs. Handgrip	0.44	0.0000*
Weight vs. Handgrip strength	0.57	0.0000*
Height vs. Handgrip strength	0.57	0.0000*
BMI vs. Handgrip strength	0.29	0.0000*

*Signifies $P<0.05$

The long flexors of the subject were adequately warmed up before the test administration. The subject was instructed to press the inflated bladder as much as he/she could but should sustain the same for at least 3 s. Three trials were taken with 10 min of rest between the isometrics for long flexors recovery. If the subject could not sustain the pressure, the procedure was repeated after duration of 15 min again after a period of passive recovery of intrinsic muscles of hand. The subject's best effort was measured by noting down the manometer reading (mmHg) above the preset reference pressure value (20 mmHg) during the procedure. The best of three hand grip measurement was taken as the maximal grip strength of the subject.

Statistical analysis

Phase 1 The demographic profile of the subjects such as age, sex, grip strength and variation was analyzed through *descriptive analysis*. The mean, standard deviation and coefficient of variation of the hand grip and their determinants would be presented.

Phase 2 The correlations between dependant variable handgrip strength and independent variables age and anthropometric traits viz., height, weight, body mass index (BMI) were analysed through Pearson Product—moment correlation (intra—class correlation coefficient). We added the body mass index along with height and weight because we assumed transformation of mass and height might reduce the handgrip correlation. All the determinants of hand grip strength were analyzed by step wise multiple regression model.

The statistical analysis was solved by using statistical software **"Statgraphics Centurion XVI"**

Results

All the 229 subjects completed the study. The subjects were 115 males and 114 females with the age 23±2 (19–28). The average male's height and weight were 1.65±0.08 meters and 59.78±9.61Kgs respectively. The calculated BMI from height and weight of the subjects was 22.99±2.65 (16.80–29.41). The average handgrip strength measured from the 229 subjects was 154.73±37.16 mmHg (75–215).

The age, weight, height and BMI of the females were 21.74±1.72 years, 54.79±7.22 Kgs, 1.60±0.07 meters and 21.47±2.36 respectively. The female's handgrip strength was 128.26±29.11 mmHg. The age, weight, height and BMI of the males were 23.48±1.99 years, 64.72±9.14 Kgs, 1.70±0.07 meters and 22.51±2.82 respectively. The male's handgrip strength was 180.97±22.98 mmHg. The handgrip mean value difference between males and females was clearly depicted in the Fig. 1.

Correlation Analysis

The comparison of age, weight, height and BMI with the hand grip strength showed an excellent correlation ($p<0.05$). The correlation values and significance were depicted in the Table 1.

Logistic Regression Model The best fit model for handgrip prediction when age and anthropometric traits were considered in general population aged 22–25 years is

$$\text{Hand grip} = -1790.54 + 4.93557 \times \text{Age} - 11.7429 \times \text{Weight} + 1083.4 \times \text{Height} + 34.194 \times \text{BMI}$$

The regression scatter plot was depicted in the Fig. 2

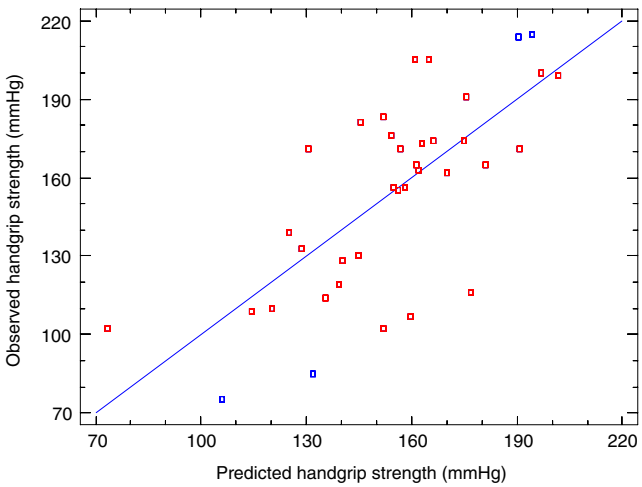

Fig. 2 Plot of predicted vs observed handgrip strength

Discussion

Our study correlated age and anthropometric traits with handgrip of subjects aged 22–25. We found an excellent correlation between age, height and weight with handgrip strength in both males and females. Sartorio et al. [9] reported that age dependent increase of hand grip strength in males and females were strongly associated with changes of muscle mass during their childhood. In case of height, a positive correlation with the hand grip strength could be the result of various factors such as with greater heights that would lead to longer arms, with greater lever arm for force generation, resulting in an efficient amount of force. Similarly, Chatterjee and Chowdhuri [17] agreed that hand grip strength when measured by Jammer hand dynamometer was positively correlated with weight, height and body surface area.

Earlier studies have established that the age, gender and anthropometric traits were the influencing factors of handgrip strength when measured with Jamar dynamometer [12, 14–16]. But the strength of these determinants of the handgrip strength was yet to be established with modified sphygmanometer. We have established a strong relation of age, anthropometric traits with the handgrip strength.

Conclusion

There was an excellent correlation when age, height and weight are compared with handgrip strength. These parameters should be considered before handgrip strength measurement in this age group as these determinants might influence the later in operative cases and therapy sessions.

References

1. MacDermid JC, Kramer JF, Woodbury MG et al (1994) Interrater reliability of pinch and grip strength measurements in patients with cumulative trauma disorders. Journal of Hand Therapy 7:10–14
2. Sande LP, Jane H, Coury CG et al (2001) Effect of musculoskeletal disorders on prehension strength. Applied Ergonomics 32:609–616
3. Boissy P, Bourbonnais D, Carlotti MM et al (1999) Maximal grip force in chronic stroke subjects and its relationship to global upper extremity function. Clinical Rehabilitation 13:354–362
4. Griffith CD, Whyman M, Bassey EJ et al (1989) Delayed recovery of hand grip strength predicts postoperative morbidity following major vascular surgery. The British Journal of Surgery 76:704–705
5. Hunt DR, Rowlands BJ, Johnston D (1985) Hand grip strength—a simple prognostic indicator in surgical patients. JPEN Journal of Parenteral and Enteral Nutrition 9:701–704
6. Rantanen T, Guralnik JM, Foley D et al (1999) Midlife hand grip strength as a predictor of old age disability. JAMA 281:558–560
7. Petrofsky JS, Lind AR (1975) Aging, isometric strength and endurance, and cardiovascular responses to static effort. Journal of Applied Physiology 38:91–95
8. Wang Angela Yee-Moon, Sea Mandy Man-Mei, Ho Zoe So-Ying et al (2005) Evaluation of handgrip strength as a nutritional marker and prognostic indicator in peritoneal dialysis patients. American Journal of Clinical Nutrition 81:79–86
9. Sartorio A, Lafortuna CL, Pogliaghi S, Trecate L (2002) The impact of gender, body dimension and body composition on hand-grip strength in healthy children. Journal of Endocrinological Investigation 25:431–435
10. Visnapuu M, Jurimae T (2007) Handgrip Strength and Hand Dimensions in Young Handball and Basketball Players. Journal of Strength and Conditioning Research 21:923–929
11. Budziareck MB, Pureza Duarte RR, Barbosa-Silva MC (2008) Reference values and determinants for handgrip strength in healthy subjects. Clinical Nutrition 27:357–362
12. Jürimäe T, Hurbo T, Jürimäe J (2009) Relationship of handgrip strength with anthropometric and body composition variables in prepubertal children. Homo 60:225–238
13. Kaegi C, Thibault MC, Giroux F, Bourbonnais D (1998) The interrater reliability of force measurements using a modified sphygmomanometer in elderly subjects. Physical Therapy 78:1095–1103
14. Spijkerman DC, Snijders CJ, Stijnen T, Lankhorst GJ (1991) Standardization of grip strength measurements. Effects on repeatability and peak force. Scandinavian Journal of Rehabilitation Medicine 23:203–206
15. Peolsson A, Hedlund R, Oberg B (2001) Intra- And Inter-Tester Reliability and Reference Values for Hand Strength. Journal of Rehabilitation Medicine 33:36–41
16. Sartorio A, Lafortuna CL, Pogliaghi S, Trecate L (2002) The impact of gender, body dimension and body composition on hand-grip strength in healthy children. Journal of Endocrinological Investigation 25:431–435
17. Chatterjee S, Chowdhuri BJ (1991) Comparison of grip strength and isometric endurance between the right and left hands of men and their relationship with age and other physical parameters. Journal of Human Ergology 20:41–50