The relationship between hand grip strength and anthropometric parameters in men

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Summary

Introduction: Hand grip strength (HGS) is a standard parameter for hand function evaluation. It is commonly used to assess the efficacy of different surgical procedures and treatments, such as the working capability of patients with either arm or hand lesions, or in clinical conditions, such as rheumatoid arthritis or muscular dystrophy.
Purpose: To verify whether a relationship exists between hand grip strength and certain anthropometric parameters in Brazilian men, to evaluate whether differences exist between the right and left hands and between the dominant and non-dominant hands, and to gather data concerning normal HGS in Brazilian men.
Methods: A total of 1279 male (27.5 ± 10.1 years) volunteers in Brazil were evaluated. We examined the hand grip strength values in the left and right hands with a dynamometer. The data collection followed the recommendations of the American Society of Hand Therapists (ASHT). The height, weight and body mass index (BMI) of each participant were measured.
Results: The registered grip strength (in kgf) was 47.6 (8.1) for the right hand; 46.3 (8.2) for the left hand; 47.8 (8.2) for the dominant hand; and 46.1 (8.1) in the non-dominant hand. A weak and positive association was observed between the dominant hand grip strength and height (Spearman's r= 0.28, p<0.01), weight (Spearman's r=0.316, p<0.01), and BMI (Spearman's r= 0.19, p<0.01) was observed.
Conclusion: A weak association was observed between the hand grip strength of the dominant hand and the anthropometric parameters of height, weight and BMI in Brazilian men. In this population, the studied anthropometric variables may be less relevant than the other physiological factors that influence the HGS. The dominant and right hands showed greater grip strength compared to the non-dominant and left hands, respectively.

Key words:
Grip strength.
Reference values.
Dynamometer.
Healthy brazilians.
Anthropometric.
Dominant hand.

Relación de fuerza de prensión manual frente a parámetros antropométricos en hombres

Resumen

Introducción: La fuerza de prensión manual (FPM) es un parámetro estándar para la evaluación de la función de la mano. Se utiliza comúnmente para evaluar la eficacia de diferentes procedimientos y tratamientos quirúrgicos, como la capacidad de trabajo de los pacientes con cualquier lesión en las manos e los brazos, o en condiciones clínicas tales como la artritis reumatoide o la distrofia muscular.
Objetivo: Comprobar sí existe relación entre la fuerza de prensión manual y determinados parámetros antropométricos en hombres brasileños. Evaluar si hay diferencias entre las manos derecha e izquierda y entre las manos dominante y no dominante. Establecer los datos relativos normales a FPM en hombres brasileños.
Métodos: Fueron evaluados 1.279 hombres (27,5 ± 10,1 años) voluntarios en Brasil. Se han examinado los valores de fuerza manual de la mano izquierda y derecha, por medido de dinamometría. La recolección de datos siguió las recomendaciones de la *American Society of Hand Therapists* (ASHT). Se registraron la talla, peso e IMC.
Resultados: Se registraron una fuerza manual en kgf de 47,6 (8,1) para la mano derecha; 46,3 (8,2) mano izquierda; 47,8 (8,2) mano dominante; 46,1 (8,1) y mano no dominante. Hubo una asociación débil y positiva entre fuerza de prensión manual dominante con la talla (Spearman r= 0,28, p<0,01), el peso (Spearman r =0,316, p<0,01) y el IMC (Spearman r= 0,19, p<0,01).
Conclusión: Fue posible establecer que existe una débil asociación entre la fuerza de prensión manual de la mano dominante frente a los parámetros antropométricos talla, peso e IMC en hombres brasileños. Para esta población variables antropométricas pueden ser menos relevante que otros factores fisiológicos que influyen en FPM. La mano dominante y la mano derecha mostraron mayor fuerza de prensión en comparación con la mano no dominante y la izquierda, respectivamente.

Palabras clave:
Fuerza de prensión.
Puntos de referencia.
Dinamómetro.
Saludables brasileños.
Antropométrica.
La mano dominante.

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Introduction

Hand grip strength (HGS) is a standard parameter for hand function evaluation[1-3]. It is commonly used to assess the efficacy of different surgical procedures and treatments, such as the working capability of patients with either arm or hand lesions, or in clinical conditions, such as rheumatoid arthritis or muscular dystrophy[4,5].

HGS can be quantified by measuring the amount of isometric force generated by the hand around a dynamometer[6]. Hand dynamometry is a reliable measuring process when methods are standardised and calibrated equipment is employed, even when testing is performed by different assessors[7].

Establishing a database with reference values regarding HGS in a normal population of subjects can be used to interpret data acquired when evaluating patient health. HGS may help to determine the best course of treatment, to set realistic goals in the recovery process, and to predict the patient's overall strength and endurance[6,8].

Different extrinsic factors may interfere in muscle strength, such as motivation[9], time of day[10-12], type of training[13], nutrition[14] and anabolic steroids[13]. The intrinsic factors include muscle hypertrophy[13], muscle cross-sectional area (MCSA)[13,15], range of motion[13], muscle coordination[13], muscle shortening velocity[13], muscle fibre type[13,15], gender[6,13] and age[6,13].

In addition to these factors, some researchers have assessed whether HGS varies according to certain anthropometric characteristics, such as body weight, height and body mass index (BMI)[1,8,16-19]. In some cases, a prediction equation has been proposed HGS to reflect these anthropometric characteristics[1,8,16,17,19-22]. In our view, however, the use of variables (e.g., weight, height and BMI) to predict HGS may result in errors because muscle strength may be affected by several factors in addition to those mentioned.

Given the variety of factors that may influence the behaviour of muscle strength, several studies have reported HGS normative data in populations from different parts of the world[1,14,16,19,23,24]; however, the strength values varied according to each population studied[25]. In this manner, this study may provide important information about HGS levels in a population of Brazilian men and assess whether anthropometric characteristics have a significant degree of influence on HGS.

Thus, the aim of this study was to verify the associations of the dominant hand values with weight, height, and BMI. The differences between the right and left hands and between the dominant and non-dominant hands were also evaluated. Another aim was to gather data concerning normal HGS in men from the Zona da Mata region of the state of Minas Gerais, Brazil.

Materials and methods

The Ethics Committee at the Federal University of Viçosa, Brazil, approved this study (case number 043/2011). This study followed the ethical standards. The participants provided informed consent (according to Resolution 196/96 of the National Health Council). The sample was randomly selected from the data collected at stations placed in strategic points throughout areas with the greatest movement of people in the cities of Viçosa and Ubá, both of which are located the *Zona da Mata* region, in the state of Minas Gerais, Brazil.

This study evaluated 1279 adolescents and men aged between 14 and 59 years. Table 1 details the patient characteristics. The right hand proved dominant in 1200 individuals (93.8%), while 79 (6.2%) participants reported the left hand as dominant. No one claimed to be ambidextrous. The following exclusion criteria were applied: not performing physical exercise for 24 hours prior to the test, any history of inflammatory joint diseases, neurological disorders, impaired range of motion, or any abnormality in the upper limbs. Because of subject availability and the variation of HGS over time[10], data were collected between 8:00 to 11:00 am.

Weight (kg) and height measurements were performed, and age and hand dominance were also recorded. The dominant hand was defined as the hand favoured for performing daily activities, such as writing, eating, and handling heavy objects, although HGS was measured bilaterally. A Jamar® hydraulic dynamometer (PC5030J1, Fit Systems Inc., Calgary, Canada) was used to assess calibration throughout the study.

To standardise the test, the following guidelines were established. The arm positioning followed the American Society of Hand Therapists guidelines, with the subject comfortably seated with the shoulder slighted forward and the elbow bended at a 90° angle, the forearm and wrist were in a neutral position[26,27]. The dynamometer handle was kept at the second position for all subjects. Alternately, three maximum efforts were performed for each arm, with three-second contractions and sixty-second rest periods between the attempts; for the analysis, only the best of three attempts was recorded. The following test instructions were provided: "you must squeeze the handle as hard as possible keeping both your body and arm in position". The same tone was used during the briefings, and no verbal encouragement was offered. The results were recorded in Kgf. The instrument calibration was assessed periodically throughout the study.

The statistical analysis was performed using the Statistical Package for Social Sciences (SPSS 17.0, Chicago, IL, USA). To ensure anonymity, the participants were unidentified using a numbering codification scheme. The Kolmogorov-Smirnov test was used for the data normality test. The Mann-Whitney U-test for independent samples was applied to determine the existence of significant discrepancies between the values for both hands. Spearman's correlation coefficients were calculated for the nonparametric data and abnormally distributed data. Relationships between age, height, weight, height and BMI and dominant HGS were analysed using linear regression. A one-way analysis of variance (ANOVA) was used to compare the dominant HGS in the groups. The significance level was $\alpha<0.05$.

Results

Right hand grip strength was higher than that of the left, and dominant HGS was higher than that of non-dominant HGS.

There was weak and positive association between height and grip strength of the dominant hand (Spearman $r= 0.28$, $p<0.01$) (Figure 1A). In the sample, for every centimetre increase in height, a 0.35 Kgf increase occurred in dominant HGS (95% CI, 0.22-0.49, $p<0.01$).

Table 1. Characteristics of 1279 men recruited from Minas Gerais, Brazil.

	Mean (SD)
Age	27.5 (10.1)
Height (cm)	173.6 (6.9)
Weight (kg)	69.3 (9.3)
BMI	22.9 (2.8)
GS right hand	47.6 (8.1)
GS left hand	46.3 (8.2)*
GS dominant hand	47.8 (8.2)
GS non-dominant hand	46.1 (8.1)**

Grip strength (GS)
*Significantly different from the right hand p<0.05.
**Significantly different from the dominant hand p<0.05.

A moderate and positive association between the dominant HGS and body weight was observed (Spearman's r =0.316, p<0.01) (Figure 1B). For each kilogram of body weight increase there was a 0.29 Kgf increase (95% CI, 0.14-0.44, p<0.01) in the grip strength of the dominant hand.

A weak, positive association between the BMI and dominant HGS was observed (Spearman's r= 0.19, p<0.01). For every BMI unit increase, a 0.48 Kgf increase occurred in the dominant HGS; (95% CI, 0.41-0.55, p<0.01).

Our sample included men ranging in age from 14 to 59 years. We divided them into age groups to provide a general view of these data. Table 2 shows the sample's main characteristics, divided into eight age groups.

Figure 1. (A) A scatter plot showing a weak and positive association between height and dominant HGS and (B) a scatter plot showing a moderate and positive association between weight and of dominant HGS.

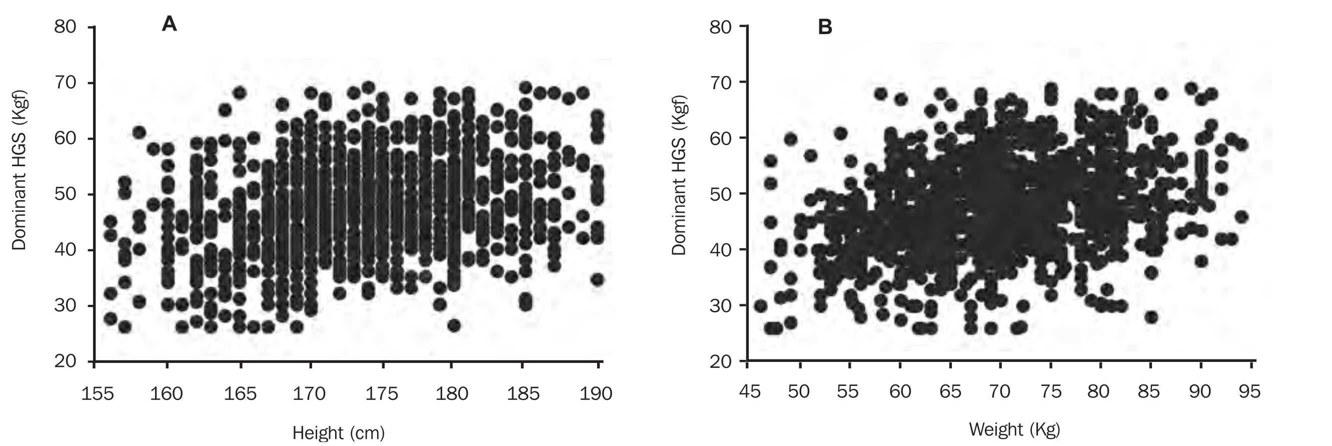

Table 2. Characteristics of the study sample by age groups. All values are presented as average. The hand grip strength is represented in Kgf with mean (SD).

Groups	N	%	Age	Height (cm)	Weight (kg)	BMI	GSRH	GSLH	GSHDom	GSHNDom
14-19	431	33.7	17.9	174.5	66.5	21.7	46.6 (8.0)	45.3 (7.9)	46.8 (8.1)	45.0 (7.9)
20-24	223	17.4	22.0	174.7	72.7	23.8	48.6 (8.9)	47.5 (8.8)	48.8 (8.9)†	47.3 (8.8)
25-29	165	12.9	26.8	174.0	71.5	23.6	50.4 (9.3)	48.9 (9.2)	50.5 (9.2)**	48.7 (9.1)
30-34	129	10.1	31.9	173.5	70.9	23.6	47.7 (7.9)	46.8 (7.8)	47.9 (7.9)	46.5 (7.8)
35-39	119	9.3	37.1	172.0	69.0	23.4	47.1 (9.0)	45.5 (8.8)	47.1 (9.1)	45.5 (8.9)
40-44	115	9.0	41.6	171.7	68.9	23.4	45.6 (8.2)	44.5 (8.2)	45.7 (8.4)	44.3 (8.4)
45-49	61	4.8	46.6	170.9	68.3	23.4	43.9 (8.6)	42.8 (8.4)	43.9 (8.6)††	42.8 (8.4)
>50	36	2.8	53.4	169.3	68.5	23.9	41.4 (9.8)	39.5 (9.6)	41.3 (9.8)*	39.6 (9.6)

GSRH: grip strength right hand; GSLH: grip strength left hand; GSHDom: Grip strength dominant hand; GSHNDom: Grip strength non-dominant hand. *Significantly different p<0.05 between >50 vs. others groups. **Significantly different p<0.05 between 25-29 and 14-19; 30-34; 35-39; 40-44; 45-49. †Significantly different p<0.05 between 20-24 and 14-19; 40-44; 45-49. ††Significantly different p<0.05 between 45-49 and 14-19; 30-34; 35-39.

Discussion

When the associations between the HGS, height and body weight were analysed, a weak and positive correlation between these two anthropometric variables was found.

These results show that for this population, the use of these variables in equations for predicting HGS or classification tables must be viewed with caution. These same associations were found in other studies[1,19,23,28-30], in which the correlation values obtained were greater than those presented in this study.

Our study also demonstrated a positive association between HGS and BMI. Similar results were also observed by[24,30-32]; however, in the studies by[1,19,23,33] no association between the two variables was ever noted. As the result indicates a disagreement in the literature, we suggest future studies in which a more valid measure, such as the percentage of lean muscle mass, could be used to evaluate the relationship between body composition and HGS.

The adolescent and adult men in this study reflected the worldwide trend for significantly greater right HGS[1,19,23,26]. In this study, the average difference was 3%. This strength difference between hands appears to be a constant, regardless of ethnicity. Significant differences in values were found between the dominant (47.8 Kgf) and non-dominant hands (46.2 Kgf, a 3.5% difference). Similar findings were noted in the aforementioned published studies.

After comparing the Brazilian results with other studies conducted with different populations in the same age groups, it was noted that these values may be lower for the right (55.8 Kgf) and left (50.4 Kgf) hands in a Greek population[23], or similar for both hands (46.7 Kgf) in an Australian population[34]. After comparing these results with other studies conducted with different populations in the same age group, it was noted that these values may be lower for the dominant (55.9 Kgf) and left (50.4 Kgf) hands in a Greek population[23]. The dominant right and left HGS were (53.0 Kgf) and (50.3 Kgf), respectively, in a Swiss population[35]. Moreover, there was a decrease in values in a Nigerian population[30] for the dominant (35.2 Kgf) and non-dominant (31,6 Kgf) hands compared with the present study.

One explanation for the ethnic disparity could be that the Australian, Swiss and Greek samples may have included larger and heavier men. The other explanation may be that the recruitment strategies used in the different studies resulted in slightly different types of participants. The only other explanation for the different values between countries is that different ethnicities do have different HGS, which supports the need for gathering reference values from all countries.

When HGS data in all age groups of this study are aligned with the study by Caporino *et al.*[36], who sampled a Brazilian population, and with the methodology of similar data collections, we demonstrate that the values are similar in all age groups, indicating that normal HGS data are presented here.

A comparison of the HGS in all age groups in this study with the research of Caporino *et al.*[36], who sampled a population of Brazilians using a similar methodology of data collection, shows similar values in all age groups, indicating that normal HGS data are presented here.

The human hand has the ability to perform various complex movements that requires a breakdown of operations allowing human beings to carry out different tasks, such as writing, typing, and many others. In this sense, the normative data are essential for the clinical practice in terms of enabling the appraiser to determine the impact of the different types of injuries or treatments, either in the musculoskeletal or the neurological systems[23].

Although no statistical associations between age and HGS were identified in this study, it has been well documented in the literature that a curvilinear relationship with age exists, resulting in an initial increment of HGS with the increase in age reaching a peak during the third decade, followed by a decrease as the aging process progresses, and culminating with decline after the fifth decade[1,16,19,24,25,33,35]. This pattern can be observed in our data when the sample was divided by age groups; however, the most advanced age groups are not well represented in this sample (Table 2).

Importantly, the data presented may have suffered interference of intrinsic and extrinsic factors mentioned above, factors that are independent of anthropometric characteristics.

A limitation of the present study was that it did not use any technique to measure the MCSA or circumference of the upper limbs, which could expand upon the data analysis. In addition, data were collected only in one region of Brazil; this country has continental dimensions and different biotypes among the regions. Thus, more studies should be developed to establish more general data of the male Brazilian population. It is also suggested that a similar study be conducted in the female population.

Conclusion

In conclusion, a weak and positive association between dominant HGS and height, weight, and BMI was observed. For this studied population, anthropometric variables may be less relevant than the other physiological factors that influence HGS. The dominant hand and right hand showed higher grip strength compared to the non-dominant hand and left hand, respectively. The normative values for HGS in this Brazilian male population add important information to the international effort to establish coefficients for HGS evaluation.

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