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Trabajo Original

Valoración nutricional

Handgrip strength of Colombian university students

Valores de fuerza prensil por dinamometría manual en universitarios de Colombia

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Abstract

Introduction: Handgrip strength (HGS), evaluated with a handgrip dynamometer, is a marker of current nutritional status and cardiometabolic risk, as well as of future morbidity and mortality.

Objectives: We present reference values for HGS of Colombian university students.

Methods: Cross-sectional study. The sample comprised a number of students (n = 5,647, 58.5% women) who were apparently healthy (mean age, 20.6 ± 2.7 years) attending public and private institutions in the cities of Bogota and Cali (Colombia). HGS was measured using a manual dynamometer, adjusted for each individual according to hand size. Sex- and age-specific normative values for HGS were calculated using the LMS method and expressed as tabulated percentiles from 3 to 97 and as smoothed centile curves (P_3, P_{10}, P_{25}, P_{50}, P_{75}, P_{90} and P_{97}).

Results: The mean HGS value was significantly higher in men (37.1 ± 8.3 kg) when compared to women (24.2 ± 8.1 kg) ($p < 0.001$). HGS increased with age in both sexes and was significantly higher for men in all age categories. The results were generally more homogeneous among men than women. Sex- and age-specific handgrip strength normative values among healthy young Colombian adults are defined.

Conclusion: This information may be helpful in future studies of secular trends in HGS and in identifying clinically relevant cut points for poor nutritional and elevated cardiometabolic risk in a Latin American population. Evidence of a decline in HGS before the end of the third decade of life is of concern and warrants further investigation.

Key words:

Adults. Dynamometer. Grip strength. Reference values.

Resumen

Introducción: la evaluación de la fuerza de prensión realizada comúnmente mediante dinamometría manual actualmente es considerada como un indicador del estado nutricional y como un marcador temprano en la morbimortalidad de la enfermedad cardiometabólica.

Objetivos: en este estudio, se presentan valores de la fuerza prensil por dinamometría manual en una muestra de estudiantes universitarios de Colombia.

Método: estudio descriptivo y transversal realizado en 5.647 estudiantes universitarios aparentemente sanos (58,5% mujeres, edad media 20,6 ± 2,7 años) pertenecientes a instituciones privadas y públicas de Bogotá y Cali (Colombia). La fuerza prensil se midió utilizando dinamómetro manual, ajustado para cada individuo según el tamaño de la mano. Se calcularon percentiles (P_3, P_{10}, P_{25}, P_{50}, P_{75}, P_{90} y P_{97}) y curvas centiles ajustado por edad y sexo.

Resultados: el valor medio de fuerza prensil fue significativamente mayor en los hombres (37,1 ± 8,3 kg) en comparación con las mujeres (24.2 ± 8.1 kg) ($p < 0,001$). En ambos sexos, la fuerza prensil aumentó con la edad y fue significativamente mayor y homogénea en los hombres en todas las categorías de edad. Adicionalmente, se presentan tablas de referencia que pueden ser empleadas para identificar estudiantes con niveles de fuerza saludable.

Conclusión: este trabajo puede ser tenido en cuenta como referencia para estudiar las tendencias seculares y las variaciones de la fuerza prensil en universitarios y para identificar puntos de corte clínicamente relevantes en el estado nutricional y como un marcador de manifestaciones tempranas asociadas a la enfermedad cardiometabólica en la población Suramericana.

Palabras clave:

Adultos. Dinamometría. Fuerza prensil. Valores de referencia.

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INTRODUCTION

Low handgrip strength (HGS), is recognized as a marker of poor nutritional status and an early marker of nutritional deprivation (1). Low HGS is a predictor of poor clinical outcomes in hospitalized patients, including a longer length of stay, complications and mortality (1-3). Lower HGS in middle-aged and elderly subjects has been shown to predict functional limitations, disability (2,3) and cardiovascular and all-cause mortality (4). There is also accumulating evidence that from an early age, HGS is inversely associated with cardiometabolic risk factors (5-7) and that lower HGS in young adulthood is a predictor of cardiovascular disease and mortality (8,9) in adulthood, independent of body mass index and cardiorespiratory fitness (10). For example, after controlling for body fat, central obesity, physical activity, and muscle mass, strength (as measured by handgrip dynamometer) was independently inversely associated with metabolic syndrome and accounted for 14% of population attributable risk in adults 35 -81 years old (9). Therefore, the assessment of muscle function or "muscle quality" permitted by handgrip dynamometry may be an earlier and more sensitive marker of poor outcomes associated with malnutrition (1,9-11). The relatively low cost and the simplicity and speed with which HGS can be measured also make it an attractive tool in clinical or naturalistic settings (11).

Numerous studies have evaluated the association between HGS and current or future health in different age groups, both in healthy populations and in those with disease, and in diverse geographic regions (12,23). These analyses consistently show a higher HGS in males at all ages, except children, with peak grip strength observed in the fourth decade of life followed by a gradual decline in both genders (12-23). These studies indicate that strength improvements may be important for public health, and grip strength is a suitable and viable strength measure. However, there is a paucity of data regarding reference values for handgrip strength for Latin American populations and a standardized protocol, such as that of the American Society of Hand Therapists (ASHT) (18), is needed. Normative grip strength data across childhood and adulthood, as well as estimates of the population may be useful for physical education programming for youth and may inform physical activity intervention for both children and adults.

Therefore, the principal aim of this study was to establish reference values for handgrip strength of Colombian university students. We also aimed to evaluate sex- and age-related differences among the population.

METHODS

EXPERIMENTAL APPROACH TO THE PROBLEM

A cross-sectional study was conducted for 5,647 apparently healthy young adult volunteers (2,330 men and 3,317 women) aged 18-29 years (mean, 20.6 ± 2.7 years). Participants were students from the Universities Rosario, Manuela Beltrán and Santo Tomas in Bogota, and the University of Valle in Cali, Colombia, who were recruited via research advertisements and invitations. Inclusion criteria were: a) no movement restriction in the upper extremities and b) no self-reported history of inflammatory joint disease, neurological disorder or injury to the upper extremities. Athletes participating at an elite level were excluded from the study. Subjects with a medical or clinical diagnosis of a major systemic disease (including malignant conditions such as cancer), type 1 or 2 diabetes mellitus, high blood pressure, hypothyroidism/hyperthyroidism, a history of drug or alcohol abuse, regular use of multivitamin preparations, a body mass index (BMI) ≥ 35 $kg \cdot m^{-1}$, or inflammatory (trauma, contusions) or infectious conditions were also excluded from the study. Written informed consent was obtained from all subjects and ethical approval was granted by the Medical Ethics Committee of the University of Manuela Beltrán (Approval number: 102-1902-2014). The study conforms to the principles outlined in the Declaration of Helsinki.

EXPERIMENTAL PROCEDURES

Anthropometric measurements

All measurements were obtained at the same time of day (between 7:00 and 9:00 am). Anthropometric measurements were performed with the participants wearing light apparel and no shoes. Body weight was measured to the nearest 0.05 kg, using a calibrated scale (Tanita BWB-800A®; Tanita, Corp., Tokyo, Japan). Height was measured to the nearest 0.1 cm using a stadiometer (SECA 220®; Seca, Ltd., Hamburg, Germany), and body mass index (BMI) was calculated.

Handgrip strength assessment

Handgrip strength was measured using a T-18 TKK SMEDLY III® (Takei Scientific Instruments Co., Ltd, Niigata, Japan), which is a standard, adjustable-handle, analog handgrip dynamometer previously shown to have high reliability in young men (r = 0.88-0.98) (4). Handgrip strength was measured with the subject in a standing position with the shoulder adducted and neutrally rotated and the arms parallel but not in contact with the body. The device handle was adjusted to accommodate participants' hand size such that the index finger of each hand was at 90º flexion between proximal and middle phalangeal joint. Two trials were performed on each side, alternately, with a rest period of at least 1 min between trials of the same hand. The participant was then instructed in one practice trial, using submaximal effort, to ensure understanding of proper procedure. Thus, the reference values of handgrip strength presented here combine the results of left- and right-handed subjects, without consideration of hand dominance. Average handgrip strength represents the combined-hand maximal grip strength achieved for each hand over two trials. The data were collected over a period of 16 months (between November 2012 and March 2014), during which time the handgrip dynamometers were calibrated periodically. Five assessors were trained in the use of the dynamometer and the implementation of the protocol, which they practiced prior to the assessments.

Statistical analyses

Anthropometric characteristics and handgrip strength of the study sample are presented as the mean with standard deviation (SD) and 95% confidence intervals (CI 95%), unless otherwise indicated. We analyzed sex- and age-group differences in the anthropometric and handgrip strength variables by two-way analysis of variance, unless otherwise stated. Analyses of handgrip strength were performed by age and gender. The Kolmogorov-Smirnov test was used to assess normality for all variables. To provide percentile values for sampling, we analyzed handgrip strength outcome data by maximum penalized likelihood using the LMS statistical method for men and women separately. The maximum power required to obtain normality was calculated for each age-group series, and the trend was then summarized by a smooth (L) curve. The trends observed for the mean (M) and the coefficient of variation (S) were similarly smoothed. These LMS curves contained information to enable any centile curve to be drawn and to convert measurements into exact standard deviation scores. For the construction of the percentile curves, data were imported into the LmsChartMaker software (V. 2.3; by Tim Cole and HuiqiPan), and the L, M and S curves were estimated. Test and retest (T1 and T2) were compared between men and women by means of Bland-Altman plots in a sub-sample of 294 subjects (144 men and 150 women) over a 7-day period between test administrations. Bland-Altman plots represent the differences between the handgrip strength values measured during the test and retest sessions against the means of these values. Except for the LMS method calculations, we used SPSS V. 21.0 software for Windows (SPSS, Chicago, Illinois, USA) and the significance level was set at 0.05.

RESULTS

Anthropometric characteristics and handgrip strength outcomes of the study sample by sex are shown in table I. Mean values were 20.6 SD 2.7 years of age, 61.5 SD 11.4 kg weight, 1.59 SD 0.06 m height, 22.7 SD 3.3 kg·m^{-1} BMI and 24.2 SD 8.1 kg handgrip strength. Overall, all variables were significantly higher in men.

Overall, handgrip strength was significantly higher in men. The handgrip strength and age values were not Gaussian-distributed (panel A and B) (Fig. 1).

Figure 2 shows the Bland-Altman plot in a sub-sample of 294 subjects (144 men and 150 women) over a 7-day period between test administrations. The limits of agreement (95% CI) between trial 1 (T1) and trial 2 (T2) are shown for the average strength (mean difference: 1.935 SD 7.705 [95% limits of agreement -17.040 to 13.178]).

Table II show the normative values for handgrip strength in young adults, classified according to sex and age and expressed as percentiles from 5 to 97. Relative increase in handgrip strength following peak was initially slightly steeper among men than women aged 24-25 years ($p < 0.05$) but it became comparable after age 28-29 years old. Average handgrip strength was 9.7 kg, 8.9 kg, 6.9 kg and 6.5 kg less for women aged 18, 19, 20, and 22, respectively, as compared to women aged 28 (all comparisons significant $p < 0.05$). Among men, strength was 8.0 kg, 6.8 kg, 9.3 kg and 7.3 kg less for ages 18, 19-20, 24 and 27, respectively, as compared to men aged 26 years.

Figure 3 show smoothed centile curves (P_3, P_{10}, P_{25}, P_{50}, P_{75}, P_{90} and P_{97}) for handgrip strength according to sex and age categories. The figures show that handgrip strength is higher and generally more homogenous in men than in women.

DISCUSSION

The main objective of this study was to establish age and sex reference values for handgrip strength among healthy young

Table I. Characteristics of the study sample by sex

Characteristics	All (n = 5,647)	Men (n = 2,330)	Women (n = 3,317)	Sex difference	Age trend
Age (years)	20.6 ± 2.7 (20.5 - 20.7)	20.9 ± 2.9 (20.7 - 21.0)	20.4 ± 2.6 (20.4 - 20.5)	>	>
Body mass (kg)	61.5 ± 11.4 (61.2 - 61.8)	67.6 ± 11.2 (67.2 - 68.1)	57.2 ± 9.4 (56.9 - 57.6)	>	>
Height (m)	1.59 ± 0.06 (1.59 - 1.59)	1.72 ± 0.06 (1.59 - 1.59)	1.59 ± 0.06 (1.59 - 1.59)	>	>
Body mass index (kg·m^{-1})	22.7 ± 3.3 (22.6 - 22.8)	22.9 ± 3.3 (22.7 - 23.0)	22.6 ± 3.3 (22.5 - 22.7)	>	>
Left handgrip strength (kg)	28.5 ± 10.4 (28.3 - 28.8)	35.9 ± 8.6 (35.6 - 36.3)	23.3 ± 8.2 (23.1 - 23.6)	>	>
Right handgrip strength (kg)	30.4 ± 10.8 (30.1 - 30.7)	38.1 ± 8.9 (37.7 - 38.4)	25.1 ± 8.7 (24.8 - 25.3)	>	>
Average handgrip strength (kg)	24.2 ± 8.1 (23.9 - 24.5)	37.1 ± 8.3 (36.6 - 37.3)	24.2 ± 8.1 (24 - 24.5)	>	>
Normalized handgrip strength	0,49 ± 0.19 (0.48 - 0.50)	0.58 ± 0.2 (0.57 - 0.59)	0.43 ± 0.16 (0.42 - 0.43)	>	>

Data are shown as mean ± standard deviation, 95% confidence interval (95% CI). Symbol > in the "sex difference" column: the variable is significantly ($p < 0.05$) higher in men than in women; Symbol > in the "age trend" column: the variable tends to increase by increases in age. Average handgrip strength represents the combined-hand maximal grip strength achieved for each hand over two trials.

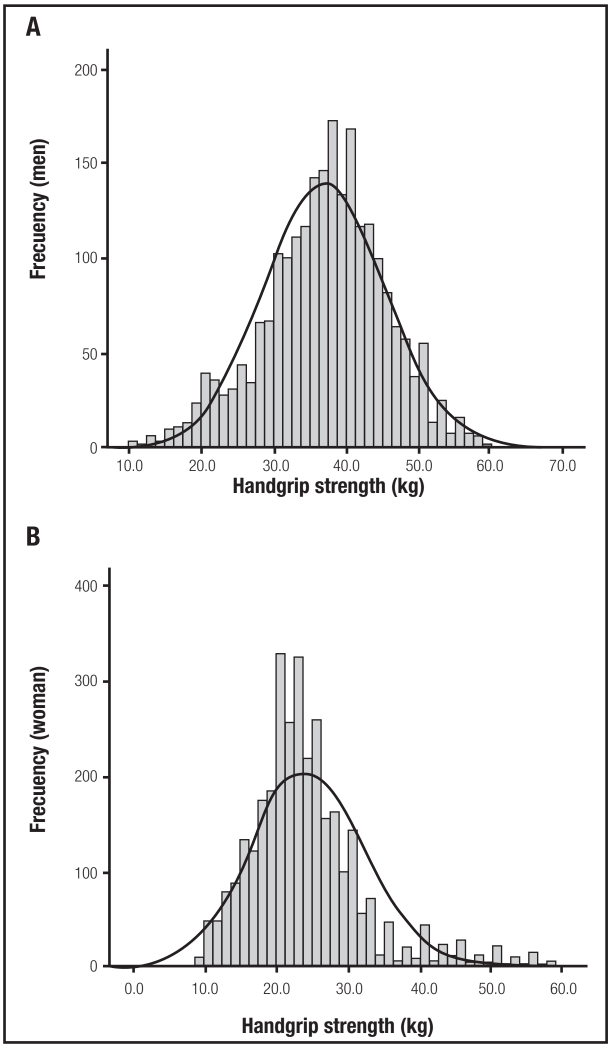

Figure 1.

Normal distribution by sex of handgrip strength. Panel A: men; Panel B: women.

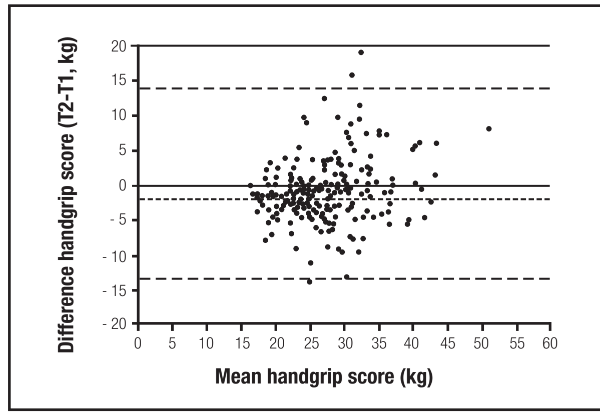

Figure 2.

Reliability of weight's trials of handgrip test by Bland-Altman plots (n = 294 subjects). Central line represents mean difference (bias). Upper and lower broken lines represent 95% limits of agreement (mean difference ± 1.96 SD of differences). Mean handgrip test (mean difference - 1.935 SD 7.705, 95% limits of agreement - 17.040 to 13.178).

Colombian adults and to compare values across the age range sampled. The mean HGS value was significantly higher in men (37.1 ± 8.3 kg) when compared to women (24.2 ± 8.1 kg) ($p < 0.001$). Greater height and body mass in men (particularly lean body mass), which are both strong correlates of HGS (2,5,6,13-23), are the principal explanations for these differences. Furthermore, recreational physical activity levels are also positively associated with HGS and are generally lower in women (19). Consistent with other studies, absolute grip strength and the ascent of strength from young to adulthood was greater among males than females (13,23). In addition, the right-hand *vs* left-hand strength differences are in accordance with previous studies by Mathiowetz et al. (13,15). In general, the 10% rule states that the dominant hand possesses 10% greater grip strength than the non-dominant hand. This rule has been used for many years to assist therapists in setting strength goals for patients with injured hands. In our study, results showed an overall 2.4% in men and 2.1% in women grip strength difference between dominant and non-dominant hands. These findings are consistent with reports indicating that women lose upper extremity strength at a lower rate than lower extremity strength while men evidence parallel decline in upper and lower body strength (13).

Several previous reports suggest that HGS peaks in early adulthood and declines progressively after the third decade of life (1,11,13,25-26). Normative data for grip strength are usually presented in table format or as centile curves as a function of age (13-23). Across the age categories sampled in the present study, the highest values were slightly lower than those in two relatively recent studies of HGS in Brazilian men aged 18-30 (20) and 20-29 (21) and in Italian University students (22) and substantially lower than those reported for Danish men aged 19-29 (19). In contrast, mean values among women in the present study were similar to the means reported by Montalcini et al. (22) and Schlussel et al. (21), slightly lower than those reported by Aadahl et al. (19) and slightly higher than those reported by Budziarek et al. (20).

While international comparisons of HGS using the same methodology are lacking, varying values for HGS in different regions and ethnicities are evident (23,24). These may be attributed to anthropometric differences (13-23), such as height and body composition, that vary between populations and ethnicities (19,23-25) and are important determinants of HGS (19-26). In addition, epigenetic factors such as early life social conditions (25) and birthweight (26,27) are also associated with HGS, making it difficult to draw conclusions about the source of international or inter-ethnic differences (19,26), particularly if potential differences in the socioeconomic backgrounds of the subjects are not taken into consideration.

Methodological differences, such as those associated with the specific dynamometer used, the measurement protocol or

Table II. Selected percentiles (P) of tests assessing handgrip strength stratified by age categories and sex

Test	N	Mean	SD	P_3	P_{10}	P_{25}	P_{50}	P_{75}	P_{90}	P_{97}
Men (age, years)										
18 +	457	36.8	7.0	23.0	26.7	32.0	37.5	42.0	45.5	49.5
19 +	419	37.3	7.2	22.9	27.6	32.5	37.5	42.0	47.0	50.9
20 +	367	37.3	7.4	21.5	27.5	32.5	37.5	42.4	47.3	51.2
21 +	290	38.2	7.2	24.9	28.9	33.2	38.0	43.0	49.0	50.9
22 +	177	37.5	6.8	21.8	27.9	32.5	37.8	42.9	45.6	49.7
23 +	143	38.4	7.0	23.5	29.0	34.5	38.0	43.0	47.9	50.0
24 +	107	36.3	7.7	22.0	25.8	30.5	37.0	42.5	46.8	50.6
25 +	93	38.9	7.6	21.5	28.7	34.0	40.1	44.0	47.7	52.5
26 +	81	40.0	6.5	26.3	31.6	34.0	40.0	45.5	47.9	50.5
27 +	71	37.1	5.8	25.0	31.0	34.3	36.3	39.9	47.5	50.5
28 +	67	35.9	5.6	21.0	28.0	31.9	36.5	40.0	42.7	44.3
29 +	58	38.2	6.7	27.5	27.5	32.5	39.5	42.4	49.0	49.0
Women (age, years)										
18 +	802	22.3	5.9	12.0	14.5	18.8	22.3	25.5	30.0	35.0
19 +	617	22.5	6.1	11.9	14.5	18.0	22.5	26.3	30.1	35.0
20 +	544	23.0	6.1	11.0	15.0	19.0	22.5	27.0	31.0	35.7
21 +	366	23.8	5.8	13.0	17.0	20.0	23.3	27.5	31.3	37.5
22 +	232	23.1	6.1	12.0	15.2	20.0	22.0	26.4	31.0	37.5
23 +	181	24.1	6.1	12.2	16.6	20.0	23.8	27.7	31.0	38.5
24 +	129	23.4	5.6	12.5	16.5	20.0	23.3	25.9	31.0	37.7
25 +	90	24.5	7.1	11.0	16.1	19.1	24.4	29.0	32.4	40.0
26 +	101	23.5	5.6	14.1	15.8	20.0	22.3	27.0	30.9	37.6
27 +	106	22.4	6.6	11.5	15.4	17.5	21.4	25.1	31.3	40.7
28 +	98	24.7	6.3	13.0	15.5	20.3	25.0	29.9	32.0	37.5
29 +	51	24.6	6.7	17.0	17.4	21.6	23.3	25.9	39.9	40.8

Average handgrip strength represents the combined-hand maximal grip strength achieved for each hand over two trials.

the summary data (*i.e.*, mean or peak values) reported, may also contribute to variations in reported values and make comparisons of normative data difficult to interpret (13-23). Systematic bias has been reported when comparing different dynamometers (18), while differences in joint and body position modulate force output in the handgrip test (28).

Amongst the substantial normative handgrip strength publications (13-23,25,29), few summarize data are obtained with instrumentation, procedures or measurements recommended by the ASHT (18). Standardization is important to allow valid comparisons within or between countries, to assess longitudinal or secular trends and to reliably detect poor strength in the clinical setting and identify individuals who may gain particular benefit from interventions. However, the maximum value among these trials has commonly been used by many previous researchers (13,26), and the US National Health and Nutrition Survey (NHANES) reports the maximum of the left- and right-hand combined strength (29). Similarly, assessment with the elbow extended results in higher force output and it is used in a number of studies of HGS to assess strength and health in youth fitness test batteries (29).

These studies tend to use age bands of 10 years or larger, making it difficult to identify the age at which peak grip strength is attained or at which the most significant or largest decline in handgrip strength occurs (11,19). To evaluate age-related changes across young adulthood, as well as to establish age-related reference values in adults more precisely, we assessed and compared HGS among relatively narrow age bands. We observed that the average handgrip strengths in 27- to 29-year-old men were

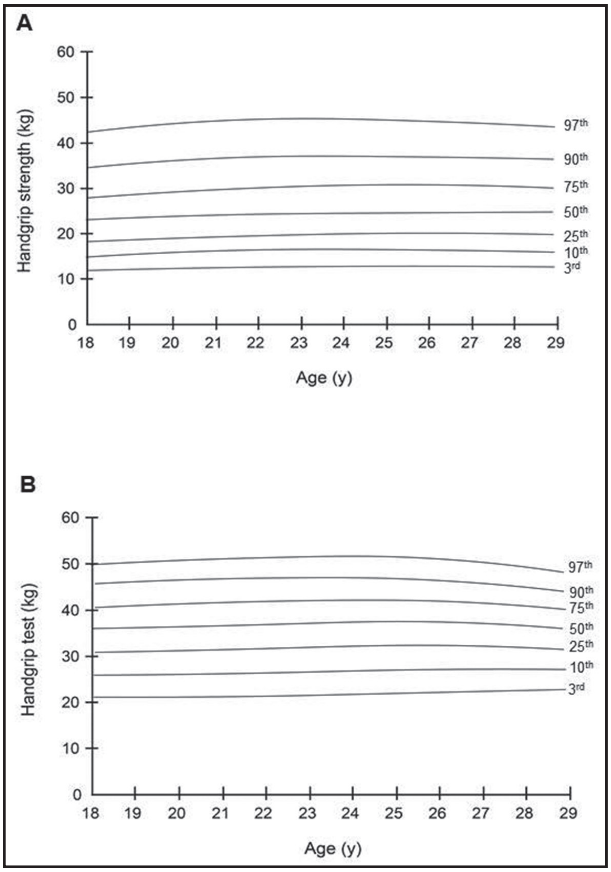

Figure 3.

Smoothed (LMS method) centile curves (from the bottom to the top: P_3, P_{10}, P_{25}, P_{50}, P_{75}, P_{90} and P_{97}) of handgrip strength. Panel A: men; Panel B: women.

significantly lower than those of men aged 18 to 20 (Table II) but not those of the intermediate age category (X to Y). Similarly, women aged 21 to 23 showed significantly higher levels of mean strength compared with those aged 18 to 29, and their hand grip scores were lower than those aged 18 to 20 but higher than those aged 27 to 29 (Table II). These findings appear to suggest the attainment of peak HGS in the middle of the third decade of life and evidence of strength decline in the current population at an earlier age than reported in a number of previous cross-sectional studies (11,19). This finding needs to be interpreted with caution, however, because the present study is not longitudinal and it may also reflect secular changes in muscle strength that have been reported internationally (19). There are also limited contemporary data with which to compare the present findings, and few studies span both late adolescence and the 3rd decade of life, with HGS data generally reported for age bands of 10 years or more. Recent data in a representative sample of Brazilian adults (n = 3,050) showed that mean HGS was higher in the 30-39 age category than in the 20-29 age category, with lower values observed from age 40 and above (21,23). Similarly, in a population-based sample of Danish adults (n = 3,471), mean values in those aged 30-39 were higher than in those aged 20-29, with peak values reached in the 30-39 age category in women and 40-49 in men, with declines evident thereafter (19). In this context, our findings of declining HGS during the third decade of life, which only appear to concur with a study in a sample of 300 Brazilian adults Budziareck et al. (6) that observed a significant reduction in HGS each decade after age 21, should be confirmed in a larger and more representative sample of Colombian adults.

Correct interpretation of HGS data requires comparing the score obtained from an individual with normative values for the general population of the same sex and age (19,21-23). Despite the lack of a universal clinical cut point for HGS, the utility of handgrip strength as an auxiliary procedure to assess the nutritional status in clinical practice is evident (1,11). Klidjian et al. (30) used the value equal to 85% of handgrip strength mean values observed in a healthy sample as the cut point to identify patients at elevated risk of complications in the post-surgical period. Despite its non-physiologic rationale, this cut point was very useful clinically, and HGS was the most sensitive of a number of functional tests in the prediction of complications (1). Poor HGS has also been shown to be related to current cardiometabolic health in youth and adults and to risk of future morbidity and mortality (2-5). In most of these studies (2,9), the lower tertile or quartile was associated with elevated risk. On this basis, the 20th or 25th percentile curves obtained in this study could be used as a cut point, below which the level of handgrip strength can be considered inadequate (30). Norman et al. (11) showed that patients who presented HGS values in the lowest quartiles (1 and 2) of the sample distribution at admission were at increased risk of being nutritionally at-risk.

A limitation of this study was that participants were recruited from three universities in two cities, which may affect generalizability of our results to the Colombian population as whole. The present study sample was compared to corresponding cohorts of 18- to 30-year-old university students in the Colombian national data registry (DANE: Departamento Administrativo Nacional de Estadistica) for the years 2010 to 2012 with regard to age, education and place of residence. It was determined that the present sample was not fully representative due to the underrepresentation of individuals from the central region of the country. Handgrip strength protocol differences should be considered in comparing and interpreting population estimates since protocols vary in terms of position, use of both versus single dominant hand, and number of trials which may affect results. For example, standing position has been used in many normative studies (8,19), whereas seated position has been used in some studies and has been recommended for frail populations (10). Therefore, additional work is needed to more fully characterize HGS within the Colombian population and to identify population-specific cut points for "healthy" and "adequate" HGS and for other components of muscular fitness, ideally combined with an evaluation of markers of nutritional or cardiometabolic health or prospectively with clinical outcomes (1,11). It is important to note that, despite the common use of handgrip strength as a tool for assessment of muscle function in clinical settings and its considerable attention as an indicator of current nutrition status and cardiometabolic health and of future risk of morbidity and mortality (1,11), few studies examining these associations have included people from Latin America (10,11). Lastly, as with all cross sectional studies, the design limits the degree to which causal and age related inferences can be drawn.

In short, the new preliminary normative values for handgrip strength in men and women aged 18 to 29 years will be useful in clinical practice. However, our study might pave the way to the diffusion of the handgrip strength assessment for more clinical uses, and it might be useful to identify people who could benefit from early nutritional or pharmacological programs (30). In conclusion, this study presents age-, gender- and side-specific reference values for handgrip strength for young Colombian or Latin American adults. The norms can be used in lieu of more limited data previously available from individual studies with smaller samples.

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