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Original Study

Reference Values of Grip Strength, Prevalence of Low Grip Strength, and Factors Affecting Grip Strength Values in Chinese Adults

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A B S T R A C T

Objectives: The objectives of this study were to update the reference values of grip strength, to estimate the prevalence of low grip strength, and to examine the impact of different aspects of measurement protocol on grip strength values in Chinese adults.
Design, Setting, and Participants: A cross-sectional survey of Chinese men (n = 714) and women (n = 4014) aged 18–102 years was undertaken in different community settings in Hong Kong.
Measurements: Grip strength was measured with a digital dynamometer (TKK 5401 Grip-D; Takei, Niigata, Japan). Low grip strength was defined as grip strength 2 standard deviations or more below the mean for young adults. The effects of measurement protocol on grip strength values were examined in a subsample of 45 men and women with repeated measures of grip strength taken with a hydraulic dynamometer (Baseline; Fabrication Enterprises Inc, Irvington, NY), using pair *t*-tests, intraclass correlation coefficient, and Bland and Altman plots.
Results: Grip strength was greater among men than among women ($P < .001$) and the rate of decline differed between sexes ($P < .001$). The prevalence of low grip strength also increased with age, reaching a rate of 16.5% in men and 20.6% in women aged 65+. Although the TKK digital dynamometer gave higher grip strength values than the Baseline hydraulic dynamometer ($P < .001$), the degree of agreement between the 2 dynamometers was satisfactory. Higher grip strength values were also observed when the measurement was performed with the elbow extended in a standing position, compared with that with the elbow flexed at 90° in a sitting position, using the same dynamometer ($P < .05$).
Conclusions: This study updated the reference values of grip strength and estimated the prevalence of low grip strength among Chinese adults spanning a wide age range. These findings might be useful for risk estimation and evaluation of interventions. However, grip strength measurements should be interpreted with caution, as grip strength values can be affected by type of dynamometer used, assessment posture, and elbow position.

Grip strength is a noninvasive marker of skeletal muscle strength and function and recommended as a simple assessment in clinical setting. Research has shown that low grip strength is associated with poor nutritional status,[1] low levels of fitness,[2] and a range of adverse outcomes including increased functional limitations,[3,4] disability,[5] prolonged length of stay in hospitalized patients,[6] as well as mortality.[7] Low grip strength also forms a part of sarcopenia,[8] the loss of skeletal muscle mass and strength as a result of aging. In this regard, reference values for muscle strength have been measured in healthy and unhealthy individuals and in different age groups.[9–17] Pooled analyses have been conducted to combine reference values for grip strength that were derived from multiple studies.[18–21] Reference values for grip strength across populations from different countries have also been compared.[21,22] However, most of these studies have been undertaken in predominantly Caucasians. There is a paucity of reference values for grip strength

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for Chinese population. To our knowledge, only 1 study has reported the reference values for grip strength for Hong Kong Chinese adults 20 years ago,[23] but the data may be insufficient to serve as reference values for individuals in the current generation because of changes in socioeconomic and environmental factors (eg, lifestyles and nutritional factors) over time. Therefore, updated reference data is warranted.

In terms of cut points for low grip strength, there is no universal consensus. Currently, different cut points are being used to define low grip strength,[24–26] based on data across different studies using a variety of instruments and methods of measurement.[27–30] Nevertheless, ethnic and geographic variations in grip strength exist.[31] This raises the question of whether or not these cut points are also applicable in other populations, who may differ significantly in terms of anthropometry and lifestyles.

The objectives of this study were to update the reference values of grip strength, to examine the prevalence of low grip strength, and to examine the impact of different aspects of measurement protocol (eg, type of dynamometer used, assessment posture, and elbow position) on grip strength values in Hong Kong Chinese adults.

Methods

Design and Participants

The present study was based on secondary data collected in a community-based grip strength assessment survey being carried out in Hong Kong in 2015. The grip strength assessment survey is cross-sectional in design, and the target population consisted of a convenience sample of community-dwelling individuals aged 18 years and above. A total of 4787 men and women aged 18 years and older were recruited using a combination of private solicitation and public advertising from social and community centers, housing estates, and the community in Hong Kong. The assessments were conducted in different community settings including community halls, healthcare institutions, shopping malls, and public spaces. Institutional-dwelling population, individuals who were mentally incapable to participate in the study, and those who had visible limitations for either hand were excluded. Age/age group were based on self-report. Blood pressure and bone mineral density (*T* score) were measured. Compared with the general population, the study population had higher proportions of older adults (aged 65+) and female; otherwise, it matched the general elderly population of Hong Kong in terms of prevalence of hypertension. Sex-specific grip strength values of 223 men and women aged 18–39 years were used to derivate grip strength *T* scores for middle-aged and older individuals for prevalence estimation (Figure 1). The present study used deidentified data; therefore, the Cluster Research Ethics Committee/Institutional Review Board at the Chinese University of Hong Kong exempted it from review.

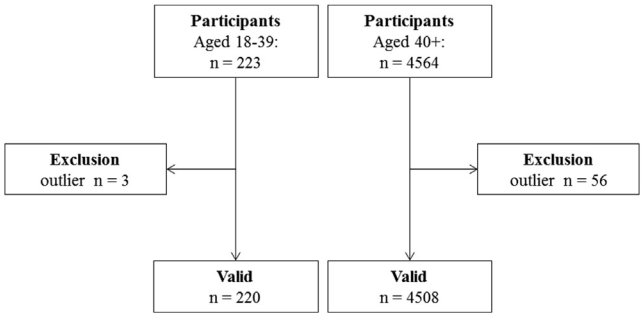

Fig. 1. Recruitment flow chat.

Measurement of Grip Strength

Grip strength was measured with a digital dynamometer (TKK 5401 Grip-D; Takei, Niigata, Japan). It measures between 5.0 and 100.0 kg force and has an adjustable grip span, ranging from 4 to 7 cm. The reported precision is 0.1 kg. During the assessment, participants were requested to stand upright with feet shoulder-width apart and look forward, with elbow fully extended. The dynamometer was held by the testing hand with the grip meter indicator faceing outward, and away from any part of the body. Participants were allowed 1 practice trial for each hand. Participants then performed 2 trials for each hand alternatively and always starting with the dominant hand. Participants were instructed to squeeze the grip with full force and continuously for at least 2 seconds. They were requested not to swing the grip dynamometer during the test and not to hold their breaths. The time between each trial was approximately 30 seconds. The time interval between trials of the same hand was approximately 1 minute. Assessors gave verbal encouragement during the measurement to ensure maximal performance from the participants. The average readings showing on the display of the TKK dynamometer were recorded for statistical analysis.

To examine the impact of the types of dynamometers used on the grip strength values, a sub-sample of 45 participants were also measured with a hydraulic dynamometer (Baseline hydraulic hand dynamometer; Fabrication Enterprises Inc, Irvington, NY), after the assessment using the TKK dynamometer. The Baseline dynamometer measures between 0.0 and 90.0 kg force with 5 fixed positions of grip spacing from 3.5 to 8.6 cm. The reported precision is 2 kg. Previous studies indicated that Jamar (Fit System Inc, Calgary, Canada) and Baseline dynamometers measure grip strength equivalently and can be used interchangeably.[32,33] According to the standard procedures recommended by the American Society of Hand Therapists, participants were requested to sit down and hold the dynamometer with the elbow flexed at 90°. To further examine the impact of assessment postures and elbow positions on the grip strength values, participants were reassessed with the Baseline dynamometer. During the reassessment, participants were requested to stand during the entire test with the arm straight down at the side, with the elbow in full extension. Similar to the assessment using the TKK dynamometer, participants performed 2 trials for each hand alternatively and always starting with the dominant hand. Participants were also instructed to squeeze the grip with full force and continuously for at least 2 seconds. The time between each trial was approximately 30 seconds. The time interval between trials of the same hand was approximately 1 minute. Verbal encouragement was given during the tests to ensure maximal performance from the participants. All the 4 readings for the 2 trials per each hand were recorded for statistical analysis. The time between measurements was approximately 5 minutes.

Table 1
Characteristics of the Study Population by Sex (N = 4728)

Characteristics	Men (n = 714)	Women (n = 4014)	*P**
Age, y	63.0 ± 12.3	60.3 ± 12.1	<.001
18–29	15 (2.1)	39 (1.0)	/
30–39	32 (4.5)	134 (3.3)	/
40–49	54 (7.6)	463 (11.5)	/
50–59	182 (25.5)	1334 (33.2)	/
60–69	230 (32.2)	1188 (29.6)	/
70–79	135 (18.9)	556 (13.9)	/
80+	66 (9.2)	300 (7.5)	/
Hypertension, %	199 (29.1)	968 (24.5)	.010
BMD, *T* score	−0.8 ± 1.2	−0.7 ± 1.2	.048

BMD, bone mineral density.
Values are reported as mean ± SD/number (%). Number of missing observations for age (n = 45), hypertension (n = 73), and BMD (n = 235).
**P* for differences between sex groups.