Preplanned Studies

Handgrip Strength and Low Muscle Strength Rate in Chinese Adults — China, 2020

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Summary

What is already known on this topic?

Handgrip strength (HS) serves as a diagnostic marker for low muscle strength rate (LMSR) and reflects the level of skeletal muscle. Over the past two decades, global data indicate a downward trend in HS across various countries.

What is added by this report?

According to the latest national data, the mean HS among Chinese adults aged 20 years and older was recorded at 40.4 kg for males and 25.1 kg for females in 2020. A decline in HS was observed with increasing age, particularly among women. Additionally, lower HS values were reported in rural areas, whereas LMSR was more prevalent in these regions.

What are the implications for public health practice?

The analysis of HS and LMSR among Chinese adults is essential for the development and implementation of targeted interventions aimed at improving HS prevalence rates. This analysis is highly significant for public health, contributing to increased public awareness of LMSR and the promotion of preventative measures.

Handgrip strength (HS) significantly influences quality of life and is a critical determinant of overall human health (*1*). Research has established that low HS is linked with heightened risks of all-cause mortality and cardiovascular disease (*2*). This study draws on data from the 2020 Chinese National Survey on Adults' Fitness, the most comprehensive nationally representative survey in China. HS measurements were conducted using the Jianmin II device (Beijing Municipality, China). Findings from 2020 show that the mean HS among Chinese adults was 32.8 kg with a standard deviation of 13.2 kg, representing a decrease of 3.1 kg from 2000 (*3*). Additionally, the low muscle strength rate (LMSR) markedly increases with age; individuals aged 75 to 79 have an LMSR 13.7 times higher than those aged 20 to 24. Investigating the current condition of HS and LMSR among Chinese adults holds significant public health importance, as it aids in devising strategies to prevent or delay the decline in muscle strength, thereby reducing disease burden and enhancing population health.

This study adopted a complex, stratified multistage probability cluster sampling design detailed in previous reports (*4*), with further elaboration provided in Supplementary Material (available at https://weekly.chinacdc.cn/). It then adjusted the 2020 survey data weighting based on gender and age distributions in 5-year increments as per the 7th National Population Census, reported by the National Bureau of Statistics in 2020, covering 31 provincial-level administrative divisions (PLADs). For measuring HS, this study employed a Jianmin II HS measurement device (Beijing, China) to assess the maximal HS in the dominant hand. Prior to testing, participants adjusted the grip width to an appropriate force with their dominant hand, stood upright with feet apart at shoulder width, and arms naturally positioned, inclining 10–30° from the trunk. The maximal HS value was recorded after three consecutive tests (in kg, rounded to the nearest 0.1 kg), ensuring a minimum rest interval of two minutes between tests. Low muscle strength (LMS) was classified following the Asian Working Group for Sarcopenia (AWGS) guidelines, diagnosing males with HS under 26 kg and females under 18 kg as LMS. This study calculated the LMSR for 2020 using a weighted logistic regression model, with diagnostic status as the outcome. The prevalence odds ratio (POR) was determined by gender and by comparing urban versus rural residency, using males and urban residents as reference categories. Two POR models were applied: a crude model leveraging only sampling weights and an adjusted model that included additional covariates such as urban or rural residence, minority status, education level, occupation, economic level by PLADs, along with sampling weights (Supplementary Table S1, available at https://weekly.chinacdc.cn/). Outliers in the HS and weight data that exceeded 1.5 times the interquartile range were excluded as per Tukey's method. In 2020, out of

158,720 potential participants aged 20 to 79 contacted, 128,759 agreed to participate, resulting in a response rate of 81.1%. Non-responders — those who refused to participate, did not respond, were physically or mentally unable to participate, did not reside at their registered address, or provided three or more missing or implausible responses in the questionnaire — were excluded from the analysis (*5*) (Supplementary Figure S1, available at https://weekly.chinacdc.cn/). The name of sampling cities (districts and counties) in Supplementary Table S2 (available athttps://weekly.chinacdc.cn/). The study's protocol involving human participants was ethically approved by the General Administration of the Sports of China, with informed consent obtained from all participants. Kernel density estimation was employed for the density map (Table 1). Statistical significance was set at a two-sided *P* value of less than 0.05. All statistical analyses were conducted using R software (version 4.1.1; R Foundation for Statistical Computing, Vienna, Austria), with results reported as odds ratios (*OR*s) for dichotomous outcomes and associated 95% confidence intervals (*CI*).

TABLE 1. Basic data on handgrip strength and the low muscle strength rate in China, 2020.

Items	Handgrip strength, Mean (SD), kg	Low muscle strength rate, % (95% *CI*)
Total (*n*=128,759)	32.8 (13.2)	9.0 (8.8, 9.1)
Sex		
Male (*n*=64,679)	40.4 (8.7)	8.1 (7.9, 8.3)
Female (*n*=64,080)	25.1 (5.4)	9.1 (8.8, 9.3)
Rural and Urban		
Rural (*n*=68,598)	31.7 (10.6)	11.6 (11.4, 11.9)
Urban (*n*=60,161)	34.0 (10.9)	5.3 (5.1, 5.5)
Age group		
20–24 (*n*=10,159)	35.1 (9.3)	2.7 (2.4, 3.0)
25–29 (*n*=10,738)	35.5 (10.6)	2.9 (2.6, 3.2)
30–34 (*n*=11,016)	35.9 (12.0)	2.5 (2.2, 2.8)
35–39 (*n*=10,599)	35.6 (10.5)	2.5 (2.2, 2.8)
40–44 (*n*=10,740)	35.4 (10.1)	2.9 (2.6, 3.3)
45–49 (*n*=10,779)	34.9 (10.9)	3.0 (2.7, 3.4)
50–54 (*n*=10,186)	33.9 (11.0)	3.8 (3.5, 4.2)
55–59 (*n*=9,696)	33.1 (9.8)	5.0 (4.6, 5.5)
60–64 (*n*=11,426)	29.7 (9.6)	12.8 (12.1, 13.4)
65–69 (*n*=11,476)	28.3 (9.1)	17.2 (16.5, 17.9)
70–74 (*n*=11,258)	26.4 (7.1)	28.7 (27.8, 29.6)
75–79 (*n*=10,686)	24.9 (5.8)	37.1 (36.1, 38.1)

Abbreviation: SD=standard deviation; *CI*=confidence interval.

For HS as shown in Table 1, the average HS in males is significantly higher than in females (*P*<0.001). In 2020, HS in the 20–24 age group was noted to decrease by 10.2 kg, from 35.1 kg to 24.9 kg in those aged 75–79. The peak HS occurs between ages 30–34. Additionally, urban residents have a mean HS that is 2.3 kg greater than that of rural residents (*P*<0.001). Figure 1 depicts the distribution of HS across various demographics. For the LMSR, data presented in Tables 1 and 2 indicate similarities with the HS findings. Using the male LMSR data as a benchmark, the adjusted model reveals that the *OR* for females is 0.96 (95% *CI*: 0.92, 1.00), suggesting that males are more likely to have higher LMSR than females. Among Chinese adults, those in the 75–79 age group exhibit the highest LMSR, being 13.4 times greater than those in the 20–24 age group, according to the adjusted model. Furthermore, there is a pronounced increase in LMSR after the age of 60.

DISCUSSION

Utilizing the latest nationally representative data, this research explored HS levels and LMSR among Chinese adults. The findings revealed that Chinese males exhibited significantly higher HS levels (40.4 kg) compared to Chinese females (25.1 kg). Additionally, a decline in HS was observed at an earlier age among Chinese adults, with the peak HS reached between the ages of 30–34, followed by a gradual decrease with advancing age. Moreover, adults living in urban areas showed higher HS levels and lower LMSR compared to their rural counterparts.

HS varies significantly between China and other countries. In a 2015 prospective urban epidemiological study, HS was assessed among 125,462 adults aged 35–70 years from diverse regions globally. The highest median HS levels were observed in Europe and North America at 30.0 kg (25%–75th percentile: 26.0–35.0 kg) (*6*). In contrast, the average HS in China was reported as 32.8 kg with a standard deviation of 13.2 kg. Furthermore, a Brazilian study indicated that the HS for males and females aged over 20 years was 42.8±0.4 kg and 25.4±0.3 kg, respectively (*7*). Such discrepancies in HS can be attributed to various factors including social and economic conditions, environmental influences, methods of HS measurement, sampling conditions, and behavioral habits. Therefore, regional HS assessments should be considered as primarily reference values. Trends in HS levels across different regions suggest significant

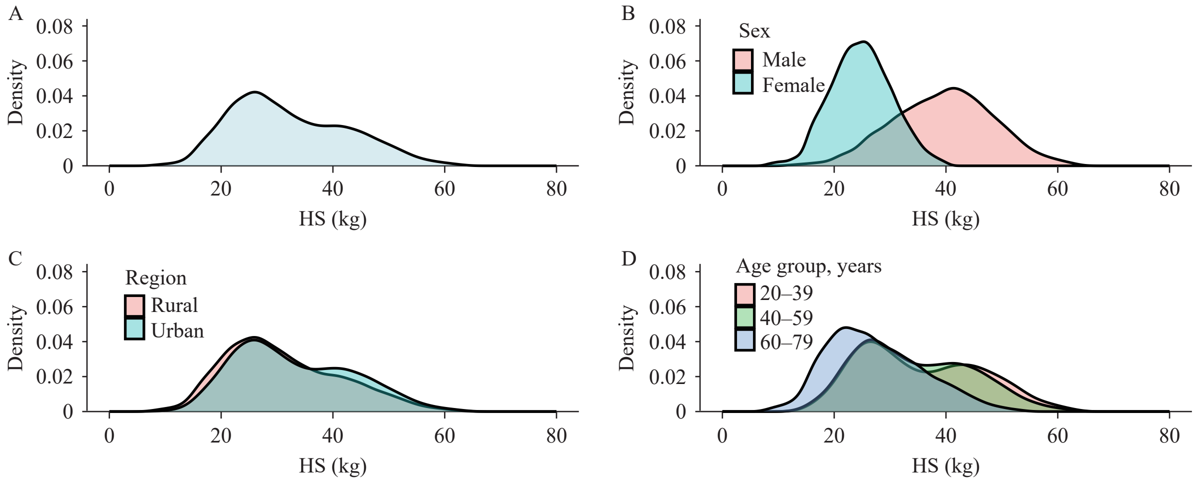

FIGURE 1. Handgrip strength distributions across various groups in China, 2020.
(A) Handgrip strength distribution; (B) Handgrip strength distribution of different sex; (C)Handgrip strength distribution between rural and urban areas; (D) Handgrip strength distribution between different age groups.

TABLE 2. Analysis of the POR of low muscle strength rate among various groups of Chinese adults in 2020.

Items	Crude model POR (95% *CI*)	Adjusted model POR (95% *CI*)
Sex		
Male (*n*=64, 679)	Ref.	Ref.
Female (*n*=64, 080)	1.13 (1.09, 1.17)	0.96 (0.92, 1.00)
Rural and urban		
Rural (*n*=68, 598)	Ref.	Ref.
Urban (*n*=60, 161)	2.35 (2.25, 2.45)	1.16 (1.10, 1.22)
Age, years		
20–24 (*n*=10, 159)	Ref.	Ref.
25–29 (*n*=10, 738)	1.08 (0.91, 1.28)	1.11 (0.93, 1.32)
30–34 (*n*=11, 016)	0.93 (0.78, 1.11)	0.96 (0.81, 1.15)
35–39 (*n*=10, 599)	0.92 (0.77, 1.10)	0.94 (0.79, 1.13)
40–44 (*n*=10, 740)	1.10 (0.92, 1.30)	1.06 (0.89, 1.26)
45–49 (*n*=10, 779)	1.13 (0.95, 1.34)	1.05 (0.89, 1.26)
50–54 (*n*=10, 186)	1.44 (1.23, 1.70)	1.34 (1.13, 1.58)
55–59 (*n*=9, 696)	1.93 (1.65, 2.26)	1.80 (1.53, 2. 12)
60–64 (*n*=11, 426)	5.33 (4.65, 6.12)	4.91 (4.23, 5.23)
65–69 (*n*=11, 476)	7.55 (6.59, 8.65)	6.65 (5.73, 7.72)
70–74 (*n*=11, 258)	14.61 (12.79, 16.70)	12.62 (10.90, 14.63)
75–79 (*n*=10, 686)	21.42 (18.75, 24.47)	18.44 (15.91, 21.37)

Note: Crude model: only sampling weights are considered; adjusted model: based on the sample population, urban and rural areas, ethnic groups, occupations, educational levels, economic conditions in the PLADs.
Abbreviation: *CI*=confidence interval; POR=prevalence odds ratio; PLAD=provincial-level administrative division; Ref.=reference group.

changes. From 2000 to 2017, data revealed a declining trend in several countries: China showed a percent decrease per decade of −4.0 (95% *CI*: −4.3, −3.7), Japan −0.6 (−0.9, −0.3), England −6.3 (−7.2, −5.4), Western Europe −2.3 (−3.0, −1.6), Canada −4.7 (−5.3, −4.1), and the USA −1.5 (−2.3, −0.7). Conversely, Northern Europe and Southern Europe exhibited growing trends at rates of 3.3 (2.8, 3.8) and 7.0 (6.1, 7.9), respectively (*8*). Despite improvements in quality of life, health status as measured by HS is not improving in most regions. Predominantly, HS research has been concentrated in high-income countries, with a paucity of data from low and middle-income nations. Future studies should focus on contemporary HS levels, and explore interventions and cohort studies to enhance HS. Resistance training and scientifically informed nutritional intake have been demonstrated to effectively boost HS and muscle mass. Important nutritional factors include protein, vitamin D, omega-3 fatty acids, magnesium, adherence to a Mediterranean diet, and increased consumption of fruits and vegetables (*9*–*10*). It is advisable for China to promote resistance training and these nutritional practices, especially among women, to improve HS.

Exercise remains the cornerstone of sarcopenia management. The study indicated an age-related escalation in the LMSR among Chinese adults. Specifically, the LMSR in individuals aged 55–59 was approximately 7.4 times higher than in those aged 75–79. Additionally, females demonstrated a significantly higher risk than males. *The European Working Group on Sarcopenia in Older People* has previously highlighted the prevalence of sarcopenia in the elderly, noting its strong correlation with both disability and mortality (*11*). Thus, it is vital to focus on enhancing muscle mass and strength, especially in older women, to improve their quality of life.

HS often manifests as an external indicator of various skeletal muscle system diseases (*12*). HS is recognized as an indicator of healthy aging (*13*). Research has shown that HS has a stronger association with overall mortality and cardiovascular disease mortality than either systolic blood pressure or total physical activity levels (*2*). Musculoskeletal disorders are increasingly recognized as major public health challenges, impacting the burden of disease and overall health status. According to the World Health Organization (WHO) in 2019, the disability-adjusted life years (DALYs) attributable to musculoskeletal disorders saw a 65.74% increase from 1990 to 2017, highlighting its significance as a global health issue (*14*). Consequently, it is essential to explore preventative strategies against muscle weakness in adults, underlining the need for extensive research on muscle strength.

The strength of this study is derived from its use of contemporary data collected from all 31 PLADs, municipalities, and districts across China, which enhances its credibility.

However, it does present certain limitations that warrant attention. First, this study is a cross-sectional study, so we cannot explain causal relationship. Then, we collected covariates using a self-reported questionnaire, which might have led to recall bias. Specifically, the classification of LMSR is overly simplistic and would benefit from a more nuanced categorization into mild, moderate, and severe levels to facilitate more effective intervention strategies.

In conclusion, this study provides an up-to-date assessment of the prevalence of HS and LMSR across China as of 2020, on a national and population-based scale. Consequently, it is recommended that further policies be developed to improve HS and skeletal muscle levels among women, the elderly, and rural communities.

Conflicts of interest: No conflicts of interest.

doi: 10.46234/ccdcw2024.178

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Submitted: February 06, 2024; Accepted: July 01, 2024

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SUPPLEMENTARY MATERIAL

Handgrip Strength (HS) and Weight Measurement

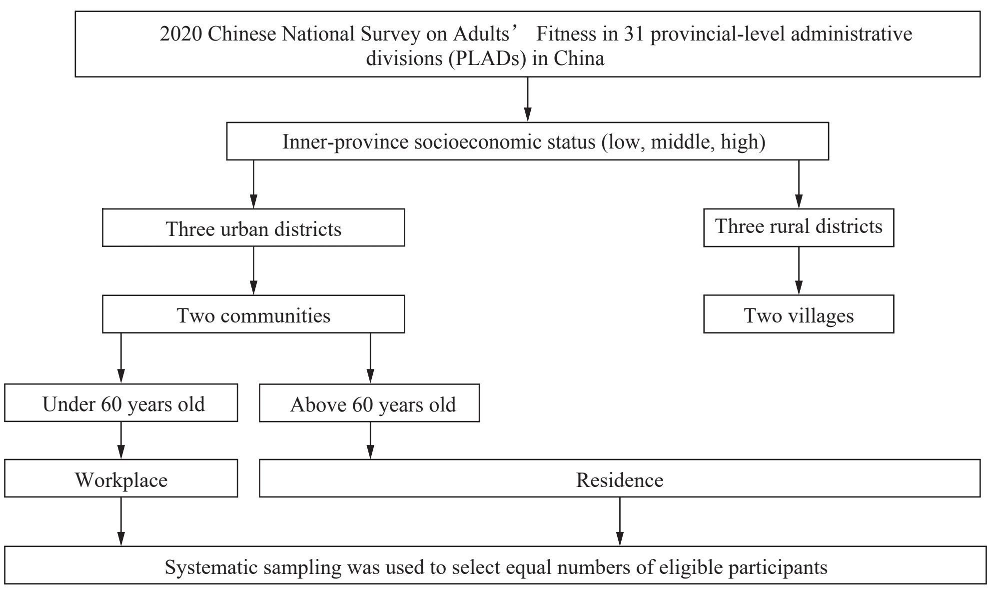
We used a handgrip strength measurement device (Jianmin II, Beijing Municipality, China) to measure the HS in the dominant hand. Before the measurement, the participants held the grip handles with their dominant hand and adjusted the grip width by applying an appropriate grip force. Participants remained upright, with feet naturally separated at shoulder width and arms dropped naturally and inclined at a 10–30° angle from the trunk. After three consecutive tests, we recorded the maximal value for each participant (HS in kg, rounded up to 0.1 kg) with adequate rest intervals (2 min or longer)(*1*).

Study Design and Participants

Using a complex stratified multistage probability cluster sampling design, we analyzed data from the 2020 Chinese National Survey on Adults' Fitness, the largest nationally representative survey of civilians in China, which was conducted from August to November 2020. The details of recruitment have been described elsewhere (*2*).

Briefly, 31 provincial-level administrative divisions (PLADs) were covered in the first stage. In the second stage, three sub-provincial or prefectural-level cities ranked between PLADs and counties in the administrative structure of China were randomly selected from each province, based on their economic positions weighted by the gross domestic product assessment, which constitutes the inner-provincial socioeconomic status (low, middle, and high). Three urban districts (or three rural counties) in each city were selected in the third stage. Three city streets (or rural towns) were chosen for the fourth stage. Two-street community societies (or villages) were selected for the fifth stage. In the final stage, systematic sampling was used to select equal numbers of eligible participants from each workplace or residence to be followed up for at least 3 years. The retirement age in China is 60 years. Participants who were younger than 60 years and living in cities were chosen from the sampling sites based on their workplaces, and participants older than 60 years and living in rural areas were chosen from the sampling sites based on their home addresses. All participants were chosen on the basis of the principles described above and represented Chinese people living in rural and urban areas (Supplementary Figure S1).

After receiving explanations from trained investigators, participants completed a questionnaire to provide information about demographic characteristics (sex, age, nationality, education level, and career). Each participant signed an informed consent form prior to enrolment. The study protocol was approved by The General Administration of Sport of the People's Republic of China (*3*).



SUPPLEMENTARY FIGURE S1. Flow chart of sampling design in the 2020 Chinese National Survey on Adults' Fitness.

SUPPLEMENTARY TABLE S1. Information of covariates.

Covariate group	*n*
Inner-provincial socioeconomic status	
High	42,104
Middle	43,294
Low	41,536
Education level	
Primary school or lower	32,034
Junior high school	28,051
Senior high school	22,406
University and above	44,791
Career	
Technical staff	46,809
Business people	8,595
Agricultural personnel	36,359
Other occupations	35,336
Nationality	
Han	113,221
Minority	16,538

SUPPLEMENTARY TABLE S2. Name of sampling cities (districts and counties) of PLADs.

Code	PLADs	First class cities (districts, counties)	Second class cities (districts, counties)	Third class cities (districts, counties)
11	Beijing	Haidian, Fangshan	Chaoyang, Miyun	Fengtai, Yanqing
12	Tianjin	Hepin, Beichen	Hexi, Jinnan	Nankai, Jinghai
13	Hebei	Shijiazhuang	Cangzhou	Chengde
14	Shanxi	Taiyuan	Datong	Yuncheng
15	Nei Monggol	Hohehot	Chifeng	Bayannur
21	Liaoning	Shenyang	Dandong	Chaoyang
22	Jilin	Changchun	Jilin	Yanbian
23	Heilongjiang	Harbin	Shuangyashan	Suihua
31	Shanghai	Xuhui, Songjiang	Jiading, Pudong	Yangpu, Fengxian
32	Jiangsu	Nanjing	Wuxi	Xuzhou
33	Zhejiang	Hangzhou	Wenzhou	Jiaxing
34	Anhui	Hefei	Fuyang	Huangshan
35	Fujian	Fuzhou	Xiamen	Sanming
36	Jiangxi	Nanchang	Shangrao	Ganzhou
37	Shandong	Jinan	Yantai	Binzhou
41	Henan	Zheng zhou	Sanmenxia	Shangqiu
42	Hubei	Wuhan	Huanggang	Shiyan
43	Hunan	Changsha	Zhuzhou	Zhangjiajie
44	Guangdong	Guangzhou	Zhanjiang	Shaoguan
45	Guangxi	Nanning	Guilin	Yulin
46	Hainan	Sanya	Qionghai	Danzhou, Ledong
50	Chongqing	Yuzhong, Yongchuan	Nanan, Fengdu	Jiulongpo, Qianjiang

Continued

Code	PLADs	First class cities (districts, counties)	Second class cities (districts, counties)	Third class cities (districts, counties)
51	Sichuan	Chengdu	Zigong	Guangyuan
52	Guizhou	Guiyang	Liupanshui	Qiannanzhou
53	Yunnan	Kunming	Puer	Lincang
54	Xizang	Lhasa	Nyingchi	Nagqu
61	Shaanxi	Xi'an	Yan'an	Ankang
62	Gansu	Lanzhou	Tensui	Wuwei
63	Qinghai	Xining	Haixi	Guoluozhou, Xunhuazhou
64	Ningxia	Yinchuan	Shizuishan, Wu Zhong	Guyuan
65	Xinjiang	Urumqi	Kashgar	Altay

Abbreviation: PLAD=provincial-level administrative division.

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