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Low handgrip strength is associated with falls after the age of 50: findings from the Brazilian longitudinal study of aging (ELSI-Brazil)

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Abstract

Aim This study examined the association of low handgrip strength (HGS) for falls in middle-aged adults and older adults every half-decade of life.

Methods This cross-sectional study was conducted using the public data from the first wave of the Brazilian Longitudinal Study of Aging (ELSI-Brazil). The participants were allocated into seven age groups 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, and ≥ 80 years. Binary logistic regression analysis was performed to identify the odds ratio (OR) of low HGS to the falls regardless of confounding variables such as sex, balance, gait speed, and total number of health conditions.

Results A total of 8,112 participants aged 50–105 years (median = 62.0 years): 3,490 males (median = 60.0 years) and 4,622 females (median = 63.0 years) attended the study. Altogether, 21.5% of participants experienced at least one fall. HGS gradually decreases over each half-decade of life. In addition, low HGS presented a significative OR ($p < 0.05$) for falls for age groups, until 80 s, even when considering confounding variables.

Conclusions Low HGS is associated with falls in middle-aged adults over their 50 s and remained a strong measure of falls across each subsequent half-decade of life, until 80 s.

Keywords Adults, Aged, Accidental falls, Muscle strength, Physical functional performance

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Text box 1. Contributions to the literature

1 - Low handgrip strength (HGS) is associated with falls in middle-aged adults and older adults, regardless of sex, functional performance, and health conditions, significantly contributing to the understanding of fall prevention in public health.

2 - We highlight HGS as a risk marker throughout aging, especially for falls, which is relevant in preventive health policies.

3 - Including HGS in risk assessment can guide interventions and public health policies, emphasizing the need to strengthen musculature to reduce the impact of falls in middle-aged adults and older adults.

Background

The global demographic landscape is undergoing a significant shift characterized by an increasing aging population. This phenomenon is ubiquitous, with every nation experiencing a rise in both the absolute number and relative proportion of older adults within their demographic composition [1]. Projections from the World Health Organization indicate that, by the year 2050, an estimated 80% of the older population will be concentrated in low- and middle-income countries [1]. According to World Health Organization forecasts, the worldwide population aged 60 and above is anticipated to reach 2 billion by 2050, constituting a noteworthy one-fifth of the global populace [1]. Furthermore, data from the Ministry of Health reveals that Brazil ranked fifth globally in terms of its older population in the year 2016 [2]. Projections suggest that by 2030, the number of older adults in Brazil will surpass the total count of children aged zero to 14 [2]. This demographic shift demands careful consideration and strategic planning to address the ensuing implications for public health.

Aging is characterized by a complex interplay of many physiological changes and by the accumulation of chronic conditions over time that impact overall well-being and functional abilities in older adults [3, 4]. Amongst others, falls are important age-related outcomes strongly associated with disability, and institutionalization [5]. In terms of the epidemiology of falls, a global meta-analysis [6] assessed the occurrence of falls in community-dwelling older adults aged over 65 years. In the review of 104 studies, encompassing a total sample size of 36,740,590 individuals, a global prevalence of falls in older adults was noted at 26.5%. There was a notable variation in fall rates across countries and by sex [6]. In a meta-analysis published in 2019, which examined 37 studies assessing falls in older adults in Brazil, it was found that over a 12-month period, there was a prevalence of 27% in the occurrence of falls. Falls were more frequent in females, individuals of advanced age, and participants from the Central region of Brazil [7].

Despite the multifactorial etiology of falls, substantial evidence indicates that they are predominantly attributed to physiological changes associated with the natural aging process. This suggests that over 70% of falls could be anticipated and potentially prevented through early identification and intervention [8]. To this end, falls can be predicted through clinical assessments such as physical function performance tests, since deficits associated with physical function performance significantly increase the falls risk [9]. Physical function, which encompasses cardiorespiratory capacity, gait speed, and muscular strength, has been proposed as a biomarker of healthy aging, as it is predictive of adverse health events, disability, morbidity, and mortality [10]. Similarly, muscular grip strength (also known as handgrip strength; HGS), is a measure of body function that has also been suggested as a biomarker of healthy aging [11–13]. Because of its practical and inexpensive use, and its value as a prognostic tool of future adverse health outcomes, HGS assessment and performance has long been the focus of researchers and clinicians [13–15].

For instance, in aging adults, reduced muscular strength or significant muscular strength asymmetry, measured as HGS, has been strongly associated with a variety of poor health outcomes including but not limited to functional disabilities and falls [16–19]. For example, researchers have recently observed in a large sample of middle-aged and older adults (i.e., ≥ 50 years) that HGS asymmetry and low HGS increased the likelihood of developing future disability to perform activities of daily living [17]. In terms of falls and risk of falls, a study of meta-analysis conducted in the past observed that low HGS was associated with 53% higher risk for falls in older adults [20]. Similarly, a more recent study conducted in the central-west region of Brazil by Neri et al. [18] evaluated 195 community-dwelling females (68.1 ± 6.2 years). The authors observed that poor HGS was independently associated with a higher risk of falls in older females.

Although some Brazilian studies, such as Neri et al. [18], Benedetti et al. [21], and Carneiro et. al. [22], have investigated the occurrence of falls in Brazilian older adults, these inquiries have primarily centered on individuals aged 60 and over. Additionally, previous studies consistently revealed an elevated incidence of falls among individuals with low/poor HGS; however, these investigations have predominantly focused on high-income countries. Thus, it is imperative to conduct further studies involving Brazilian older adults to assess diverse approaches to the relationship between HGS and the occurrence of falls. Additionally, not much is known about the association between low HGS and falls in low-to-middle income countries and middle-aged adults (≥ 50 years old) examining such association every half-decade (i.e., 5 years). This is important because muscular weakness is regarded as the most significant risk factor for falls. Because previous work has demonstrated a strong association between low HGS and lower limb strength [23] it would provide an early window of opportunity for fall prevention strategies and interventions.

Muscular strength begins to decline around the age of 30 [11] and accelerates its decline with each passing year, being an underappreciated measure until before the age of 60–65 [17]. However, monitoring HGS in adults, starting in their 50 s, can be an important marker for predicting falls and, consequently, a starting point for appropriate interventions to prevent falls at ages when the outcome can be more detrimental. We hypothesize that low HGS is associated with falls in adults upon their 50 s and in the following years of their lives, regardless of confounding variables such as sex, balance, gait speed, and total number of health conditions. Therefore, this study aimed to examine the association of low HGS for falls in middle-aged adults and older adults every half-decade of life.

Methods

ELSI-Brazil

The ELSI (Estudo Longitudinal da Saúde do Idoso) survey was initiated in 2015 in Brazil. It is a longitudinal study designed to assess the health and aging of the Brazilian older population. The survey was established to be conducted every three years, aiming to provide insights into the health conditions, lifestyles, and various aspects affecting the aging process over an extended period. Details about ELSI-Brazil can be founded on the research homepage (https://elsi.cpqrr.fiocruz.br/en/home-english/).

Study design

This cross-sectional study was conducted using data from the first wave of the ELSI-Brazil, conducted in 2015–2016. To ensure that the sample represented the urban and rural areas of the small, medium, and large municipalities, the ELSI-Brazil adopted a multistage stratified cluster sampling design. The municipalities were allocated in four strata according to their population size. For the first three strata (municipalities up to 750,000 inhabitants), the sample was selected in three stages: municipality, census tract, and household. In the fourth stratum, which included the largest municipalities, the sample selection was performed in two stages: census tract and household. The drawing of households occurred in a systematic way, which consisted of a jump of four houses after an interview was carried out or after three unsuccessful contact attempts. The systematic jump was not performed in cases of refusal or ineligibility [(1) when there was no resident aged 50 years and over; (2) when the household was vacant; (3) when the household was collective (pension, asylum, republic, shelter, or hostel); (4) when the interviewee had some disability that prevented him/her from answering the questionnaire and there was no substitute informant (proxy)]. When the interviewer found any of these cases, he/she proceeded to the next household, following the right-hand rule. All residents aged 50 years and over in the selected households, including those with disabilities, bedridden, and wheelchair users, were eligible for research. The ELSI-Brazil is a nationally representative study of 9,412 people aged 50 years or older, residing in 70 municipalities across the five Brazilian regions. Further details on the ELSI Brazil's sample and its national representativeness have been previously published [24]. Other details can also be seen on the research homepage (http://elsi.cpqrr.fiocruz.br/en/home-english/). ELSI-Brazil was approved by the ethics board of FIOCRUZ, Minas Gerais (CAAE: 34,649,814.3.0000.5091). Participants signed separate informed consent forms for the interviews and physical measurements, and access to administrative records.

Data collection

Sociodemographic and anthropometric variables

Face-to-face interviews verified sociodemographic characteristics including age (years), and sex (male; female). Additionally, through self-reported data gathered from the participants, we collected information on their medical history, including diagnoses for health conditions such as hypertension, diabetes, hypercholesterolemia, history of heart attack, angina, cardiac insufficiency, stroke, asthma, emphysema, bronchitis, lung disease, arthritis, rheumatism, osteoporosis, chronic back problems or pain, depression, cancer, chronic renal failure, Parkinson's disease, and Alzheimer's disease. We then compiled all health conditions reported by each participant to create a new variable: the total number of health conditions.

Height was measured in centimeters (cm) using a portable vertical stadiometer (NutriVida®, Brazil) with the participants barefoot with legs and feet parallel, weight distributed on both feet, arms relaxed at the sides, palms facing the body, and head in the Frankfurt horizontal plane. Weight was measured in kilograms (kg) using a portable digital scale (SECA®, Germany) with participants barefoot. Body mass index (BMI) was calculated as the ratio between weight in kilograms (kg) and height in square meters (m^2). BMI cutoff points were based on the World Health Organization recommendation: underweight (< 18.5 kg/m^2), eutrophic (18.5 to < 25.0 kg/m^2), overweight (25.0 to < 30.0 kg/m^2), and obese (≥ 30.0 kg/m^2) [25]. We dichotomized the BMI's participants in < 30.0 kg/m^2 (normal) and (≥ 30.0 kg/m^2) obese. Obesity was also included in the number of health conditions. All anthropometric variables were measured twice during the home visit by trained interviewers and the average of the measurements was used in the analyses. Further information can be seen in the handbook on the survey homepage (http://elsi.cpqrr.fiocruz.br/en/home-english/questionnaires/).

Falls

The study's dependent variable was the occurrence of at least one fall, which was obtained from the question: "In the last 12 months, have you had any falls?" Falls were defined as "an unintentional displacement of the body to a lower level than the initial position, with an inability to correct promptly, determined by multifactorial circumstances that compromise stability" [26].

Handgrip strength

HGS was measured by trained interviewers during the home visit using a hydraulic hand dynamometer with an adjustable handle (SAEHAN®, South Korea) JAMAR. The participants performed the test in a sitting position in an armless chair with the test arm held at the side of the body, the elbow flexed at 90º, the forearm in a neutral position (thumb up), and the wrist in a comfortable position. The mobile handle of the device was placed in the second position or adjusted, if necessary, according to the size of the participant's hand. The test was performed with the dominant hand and participants were instructed to squeeze the dynamometer handle as hard as possible for two seconds. Dominant hand was determined by asking participants if they were right- or left-handed. The examiner provided verbal encouragement during the test. After demonstrating the test to the respondent, three measurements were taken with a one-minute rest interval between each test. All readings were taken in kilograms (kg). The highest value among the three measurements was used in the current analyses. In the current study, participants with HGS values lower than the 20th percentile by age group and sex were considered as having muscle weakness [27].

3-m Gait speed test

All participants were evaluated in their homes. The test was carried out in a flat area, free of irregularities on the floor, and without other obstacles that made walking difficult. A 3-m steel chain was used to delimitate the space required for the test performance. Masking tapes were placed on the floor to indicate the starting and ending points of the course. Participants were instructed to wear the footwear they usually use (shoes, sneakers, sandals, or slippers) and to walk with their gait assistance device (cane or walker), if necessary. The evaluator explained the test procedures to the participants, who performed one or two walks for learning purposes. After a few minutes of rest, the participants were positioned standing with their feet aligned, looking forward, behind the starting line. The following verbal command was provided: "Walk at the same speed as your regular walk daily (usual pace), without running or leaving the path. Attention, go, now!" The timer was started when the participants' first foot touched the floor immediately after the starting line and was stopped when either foot crossed the finishing line. The evaluator walked behind the participants to prevent falls if they lost balance. The test was performed twice with no acceleration and deceleration distances and with a one-minute rest interval between measurements. Gait speed (m/s) was calculated as distance (3 m) divided by the time taken to walk (seconds). We classified the gait speed performance of the participants in normal > 0.8 m/s, and low ≤ 0.8 m/s [28].

Balance test

ELSI-Brazil adopted the first three stages from the four-stage balance test (Four-Stage) [29]. For this study, we considered the last stage. In that stage participant's balance was assessed at the position "one foot behind the other, touching the toes on the heel". The maximum completion time for this test was 10 s for the participant's age ≥ 70 years old, and 30 s for the participant's age < 69 years old. For scoring the balance, participants received 1 point for holding the position < 9 or 29 s and 0 points for holding $= 10$ or 30 s, respectively for ages ≥ 70 and < 69 years old [29].

Statistical analysis

After downloading ELSI's Brazil data into a Microsoft Excel® spreadsheet format, two researchers independently coded the data. Validation was performed by double-checking in Microsoft Excel® to minimize the risk of bias in data tabulation. The Kolmogorov–Smirnov test was used to assess the normality of the data distribution. The variables, including sex (male [code = 0]; female [code = 1]), age group (50 to 54; 55 to 59; 60 to 64; 65 to 69; 70 to 74; 75 to 79; and ≥ 80 years); falls (no [code = 0]; yes [code = 1]); BMI (kg/m^2) (eutrophic and overweight [code = 0]; obese [code = 1]); HGS (normal [code = 0]; low [code = 1]); balance (normal [code = 0]; low [code = 1]), and gait speed (normal [code = 0]; low [code = 1]) were presented as absolute (n) and relative (%) frequency, and were considered independent variables. The total number of health conditions was presented as a continuous variable, and it was considered as independent variable as well. Binary logistic regression was conducted to indicate the odds ratio (OR) of people with low

HGS to the occurrence of fall. Thus, for logistic regression, the following independent variables were included as "confounding variables". The statistical analysis was performed using the SPSS® version 20.0 program with a significance level of α = 5%.

Results

Figure 1 describes the flowchart of the participants throughout the study. A total of 1300 was excluded according to the reasons below.

The data did not show normal distribution. Our analytical sample was composed of 8,112 participants aged 50–105 years (median = 62.0 years]): 3,490 males (median = 60.0 [min = 50.0; max = 105.0 years]) and 4,622 females (median = 63.0 [min = 50.0; max = 105.0 years]). In Table 1, a similar value for the number of falls (21.5%) was observed regardless of age group. The highest frequency of falls occurred in people aged 75–79 (23.4%), and the lowest frequency in those aged 65–69 (19.1%). There is a higher proportion of females in the sample (*n* = 4622) and a greater proportion of females within each age bracket. Approximately one-third of the sample within each age group was classified as obese. Regarding HGS, the absolute values (median kilograms) are around 24.3, with the 25th – 75th percentiles ranging from 18.3 to 34.0, respectively. The relative frequency of individuals classified as having low grip strength gradually decreases with each half-decade of life. As for balance, there is a proportional distribution, with only one-third of individuals classified as having poor balance in each age grouping. Concerning gait speed, there is an approximately twofold higher frequency of individuals with low gait speed between each age grouping. Regarding the total number of health conditions, the median value stands at 2 diseases within each age group, with the highest variation occurring in the age group of 50 to 54 years, ranging from 0 to 14 health conditions.

In Table 2, it can be observed that low HGS was associated with falls in all age groups except those ≥ 80. HGS increased the odds of this occurrence by 36%, 106%, 78%, 85%, 72%, and 113% for the age groups 50–54, 55–59, 60–64, 65–69, 70–74, and 75–79 years, respectively, even when considering the confounding variables. The confounding variable "total health conditions" was statistically significant across all age groups. For the 55–59 age group, the variables sex, balance, and gait speed were significant. For the 70–74 age group, gait speed was significant. For the 75–79 age group, the balance was significant.

For didactic purposes, the odds ratio of low HGS is presented in Fig. 2, showing an observed increase in the likelihood of falls in each half-decade of life.

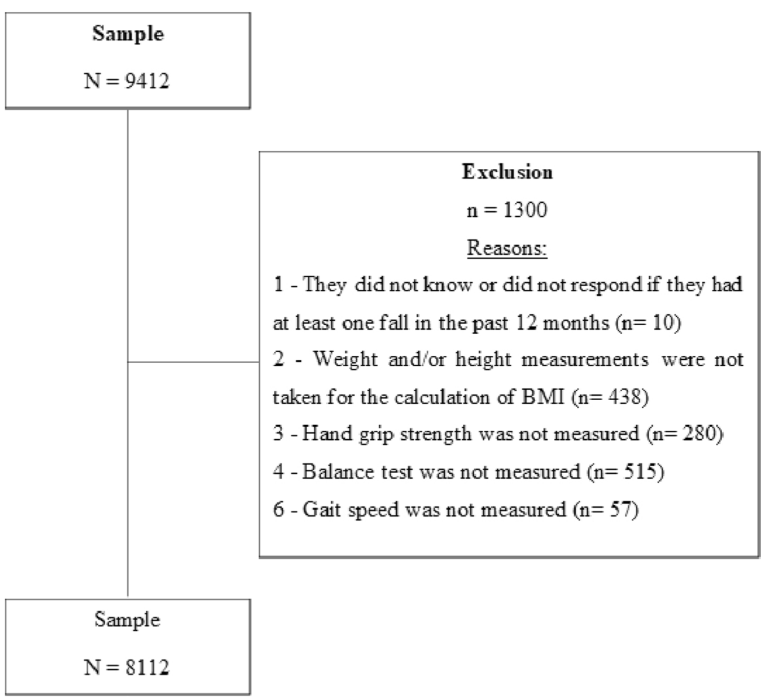

Fig. 1 Study flowchart

Table 1 Sex, falls, BMI, total number of health conditions, and performance test classification by age grouping. ELSI-Brazil 2015–2016

Variables		Clas	Age grouping (years)						
			50–54 (n = 1903)	55–59 (n = 1503)	60–64 (n = 1340)	65–69 (n = 1115)	70–74 (n = 880)	75–79 (n = 691)	≥ 80 (n = 680)
Falls	**n; %**	**No**	1490; 78.3	1174; 78.1	1044; 77.9	902; 80.9	690; 78.4	529; 76.6	539; 79.2
		Yes	413; 21.7	329; 21.9	296; 22.1	213; 19.1	190; 21.6	162; 23.4	141; 20.9
Sex	**n; %**	**Male**	920; 48.3	723; 48.1	539; 40.2	443; 39.7	341; 38.8	266; 38.5	258; 38.2
		Female	983; 51.7	780; 51.9	801; 59.8	672; 60.3	539; 61.3	425; 61.5	422; 61.8
BMI	**n; %**	**Eutr. Over**	1330; 69.9	1060; 70.5	931; 69.5	790; 70.9	622; 70.7	502; 72.6	495; 72.8
		Obese	573; 30.1	443; 29.5	409; 30.5	325; 29.1	258; 29.3	189; 27.4	185; 27.2
HGS	**Kg (median); 25th – 75th**		24.7; 18.7–33.3	24.0; 18.3–31.7	23.7; 18.3–31.7	24.3; 19.3–33.3	25.0; 19.3–32.3	24.7; 18.3–34.0	24.0; 18.4–31.4
HGS	**n; %**	**Normal**	1109; 58.3	901; 59.9	880; 65.7	800; 71.7	699; 79.4	563; 81.5	625; 92.1
		Low	794; 41.7	602; 40.1	460; 34.3	315; 28.3	181; 20.6	128; 18.5	55; 7.9
Balance	**n; %**	**Normal**	1363; 71.6	1035; 68.9	956; 71.3	786; 70.5	628; 71.4	499; 72.2	485; 71.6
		Low	540; 28.4	468; 31.1	384; 28.7	329; 29.5	252; 28.6	192; 27.8	195; 28.4
Gait speed	**n; %**	**Normal**	672; 35.3	539; 35.9	499; 37.2	410; 36.8	323; 36.7	233; 33.7	241; 35.5
		Low	1231; 64.7	964; 64.1	841; 62.8	705; 63.2	557; 63.3	458; 66.3	439; 64.5
Total number of health conditions	**Median**	**Continuous**	2	2	2	2	2	2	2
	Min–Max		0–14	0–11	0–12	0–10	0–10	0–10	0–10

Clas Classification, *BMI* Body Mass Index, *Eutr. Over* Eutrophic and Overweight, *HGS* Handgrip strength, *Min* Minimum, *Max* Maximum, *Kg* Kilogram

Table 2 The odds ratio for the occurrence of falls in individuals with low hand grip strength, considering age group and the presence of cofounding variables. ELSI-Brazil, 2015–2016

Independent variable[a]	Age grouping (years)	Wald	*p*-value	OR	95% C.I. for OR	
					Lower	Upper
HGS (normal = 0; low = 1)	50–54	5.528	**0.019**	1.362	1.053	1.763
	55–59	21.771	**< 0.001**	2.067	1.524	2.805
	60–64	13.286	**< 0.001**	1.783	1.307	2.434
	65–69	10.592	**0.001**	1.855	1.279	2.692
	70–74	6.398	**0.011**	1.720	1.130	2.618
	75–79	9.368	**0.002**	2.138	1.314	3.478
	≥ 80	1.775	0.134	1.821	0.495	4.173

Occurrence of Fall is the outcome (dependent) variable

HGS Handgrip strength, *OR* Odds Ratio, bold = statistically significant ($p < 0.05$)

[a] The independent variable is: HGS (main), adjusted for cofounding's, sex, balance, gait speed, and total number of health conditions

Discussion

Low HGS is associated with falls in adults (from their 50 s) and at every half-decade of life, until before the 80 s. Even after controlling for confounding variables, including sex, balance, gait speed, and total number of health conditions, low HGS remained high associated with falls. To the best of our knowledge, this is the first study to examine the odds ratio of low HGS for fall occurrence every five years of life, highlighting HGS as an important measure for fall monitoring in adults starting from their 50 s. Our findings emphasize the need for monitoring muscular strength from the age of 50 and the importance of implementing appropriate intervention strategies to enhance strength and mitigate the likelihood of falls. Moreover, our study substantiates the significance of assessing HGS as an indicator of overall strength, encompassing the muscles of the lower limbs [30, 31]. Therefore, training interventions should consider the overall quality of muscular work, considering both upper and lower limb muscles.

Findings of the current study showed a prevalence of ~ 21% of fallers (Table 1), which is like the values found for older adults around the world (26.5% [95% CI 23.4–29.8%]) and in the Americas specifically (27.9%

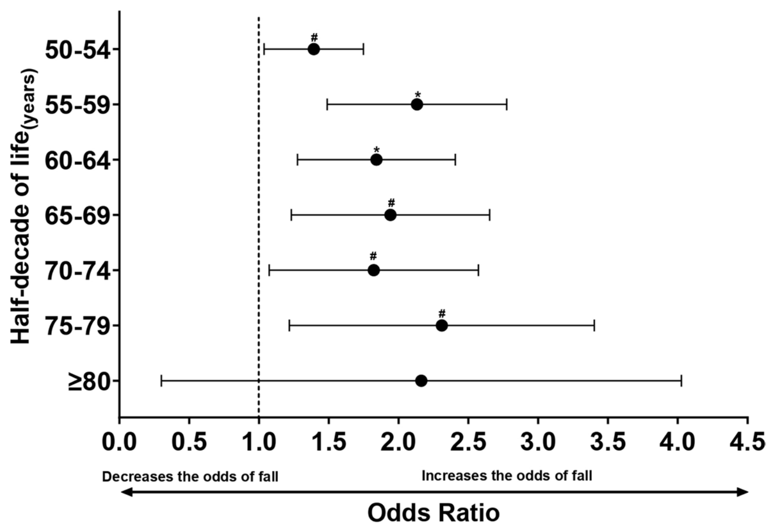

Fig. 2 - Odds ratio for low handgrip strength to increase the chance of falls grouped by half-decade of life. Note: * = $p < 0.001$; # = $p < 0.005$

[95% CI 22.4–34.2%]) [6]. The prevalence rates of falls vary across countries due to differences in population demographics, healthcare systems, environmental factors, and cultural influences [30]. Regarding sex differences in the occurrence of falls, although females commonly report more falls [6], sex-based distinctions in fall incidence among older populations may diminish with advancing age [32]. Despite the identification of risk factors for falls, such as low bone mineral density and increased gait variability in females [33], there is currently no consensus on the general mechanisms that underlie the heightened frequency of falls among females. A study of community-dwelling older adults in the US showed that approximately 3.5 million reported recent falls, with over a third expressing moderate to high levels of fear of falling [34]. Additionally, the study reported concern among older adults who experienced falls, as they did not make changes to their lifestyle (i.e., physical activity and nutrition) after the fall [34]. Therefore, the prevalence of falls among middle-aged and older adults warrants attention, primarily due to the lack of subsequent behavior modification. For instance, individuals who experience a fall may not proactively address contributing factors or adopt preventive measures. This lack of behavior change can result in persistent muscle weakness and diminished mobility [35]. Additionally, our study aligns with other findings in the literature that have shown an increase in the prevalence of low HSG with each five-year age increment. In other words, the occurrence of participants with low strength was higher in older age groups. This suggests that, beyond being a potential predictor of falls, HSG could also be considered an indicator of mortality [36, 37].

Low HGS, indicative of reduced muscular function and overall physical frailty, is physiologically associated with an increased risk of falls due to multiple factors. These include impaired balance and coordination, diminished proprioception, reduced muscle mass and strength, slower reaction times, and weakened neuromuscular control. Additionally, individuals with low HGS may experience joint instability and decreased endurance, further compromising their ability to maintain posture and recover from perturbations. These factors collectively contribute to a heightened susceptibility to falls [37, 38]. Lower HGS was associated with a high occurrence of falls (27%) in both sexes even after being adjusted by sociodemographic, anthropometric, physical activity, and health state variables [37]. Like in our study, gait speed was weakly associated with fall risk in comparison to HGS [37]. Cross Sectionally, fallers Egyptian seniors have low HGS in both hands compared to non-fallers, being the correlation between the mean HGS and the number of falls negative ($p = 0.003$) [39]. The HGS decline in one year is an independent risk factor for predicting a fall even in chronic liver disease patients ($n = 100$; 71 ± 10.2 years) living independently. HGS could be a simple and inexpensive method to predict falls. In a prospective Brazilian study, 195 females (68.1 ± 6.2 years) were accompanied for 18 months, and 27% had at least one fall [18]. Low HGS was associated with approximately threefold increased risk for falls, being impaired balance females exhibited even greater risk for falls (~ fourfold increased risk) [18]. Even in physically active older females ($n = 135$; 50- 90 years old) a cross-sectional study demonstrated that HGS is significant associated with falls (Tinetti scale) [40]. 1-kg increase in maximum HGS after adjusting for age and sex showed a protective factor (3%) for risk of falls within the last 12 months in a three years follow-up conducted with 808 individuals (≥65 years) from the KORA-Age Study [41]. In the KORA-Age Study [41], the association between HGS and falls is partially mediated by balance problems. In our study, balance showed a significant association with falls in the group age 55–59 and 75–79. A study evaluating 93 older females diagnosed with knee osteoarthritis in the central region of Minas Gerais, Brazil, investigated factors correlated with the fear of falling. Among multiple variables including fall history, obesity, and medication use, diminished HGS emerged as an independent predictor for the onset of the fear of falling [42]. A prospective study conducted in São Paulo, Brazil, assessed factors influencing the occurrence of falls in 91 older adults undergoing hemodialysis. It was observed that most falls transpired among individuals exhibiting sarcopenic obesity (BMI > 27 kg/m^2 in conjunction with diminished HGS or reduced leg circumference) [43]. This pattern, elucidating the association between diminished HGS and the occurrence of falls among older adults, irrespective of pre-existing health conditions, is similarly corroborated by findings in international research studies. In a longitudinal study which verified the association between HGS, gait speed and risk of serious falls in a community-dwelling older population, 16,445 participants (75.29 ± 4.36 years) followed by 4.0 ± 1.3 years, 1,533 had at least one serious, (involving hospital presentation) [37].

The current investigation has several strengths. As far as we know, this is the first national and international study that examines the odds ratio of low HGS for fall occurrence every five years of life in middle-aged and older adults. Additionally, we highlight the relevance of our findings in a representative population from a low-to-middle-income country like Brazil. This emphasizes the importance of implementing a cost-effective and easily operable muscular strength monitoring tool, such as HGS, which holds potential as a predictive indicator for falls. This implies that HGS could be a crucial measure for fall monitoring in middle-aged and older adults, especially in low-to-middle-income countries. Another positive point is the sample size included a large range of ages and characteristics amplifying the generalizability of our findings. Despite all the research efforts in this study, there were still some limitations. Firstly, the cross-sectional design must be considered when interpreting the results of the study. Furthermore, although the ELSI-Brazil study provides self-reported data on health conditions, it was not the objective of our study to examine which health conditions may increase the risk of falling. Another limitation is the assessment of falls based on HGS. We utilized absolute values, which might misrepresent the strength of middle-aged and older adults with smaller body sizes [44]. This approach tends to categorize lighter and shorter individuals as having low strength, potentially mischaracterizing those who maintain motor independence. Conversely, heavier and taller individuals might be underestimated in terms of their health risk [45]. To address this issue, considering allometry or power scaling to characterize the nonlinear relationship between HGS and body size could be beneficial [44, 45]. However, our study did not explore this method, presenting a methodological constraint that requires further consideration.

Our findings reinforce the value of employing simple and quick measures, such as HGS assessments, to monitor falls in middle-aged and older adults. Geriatric healthcare professionals can use HGS data to identify high-risk groups, tailor individualized interventions, and evaluate the effectiveness of these interventions. Additionally, public policies and health promotion programs can leverage this information to propose educational initiatives aimed at maintaining adequate HGS levels. Integrating this approach with technologies, such as smartphone apps, can enhance fall monitoring and prevention efforts within the population. For future research, we suggest carrying out the same experimental design in other nationalities and with other simple and quick measures (e.g., chair stand test, walking in 6 min, Short Physical Performance Battery). Moreover, longitudinal studies could investigate if HGS is associated with falls over time.

Conclusion

Our study supports the hypothesis that low HGS is significantly associated with occurrence of falls in adults aged ≥ 50 years regardless of sex and other confounding variables. We found that low HGS is associated with falls in adults starting from their 50 s and remained a strong measure associated with falls across each subsequent half-decade of life, up until before the 80 s. These results highlight the need to initiate monitoring of HGS in adulthood, particularly from the age of 50 onwards to mitigate the likelihood of falls that occur with aging.

Abbreviations

HGS	Handgrip strength
ELSI-Brazil	Nationally representative Brazilian Longitudinal Study of Aging
BMI	Body mass index

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Authors' contributions

All authors on this paper meet the four criteria for authorship as identified by the International Committee of Medical Journal Editors; all authors have contributed to the drafting or been involved in revising it, reviewed the final version of this manuscript before submission, and agree to be accountable for all aspects of the work. Conceptualization and Methodology: A.P. Santos, J.F.C.

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Availability of data and materials
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
ELSI-Brazil was approved by the ethics board of FIOCRUZ, Minas Gerais (CAAE: 34649814.3.0000.5091). Participants signed separate informed consent forms for the interviews and physical measurements, and access to administrative records.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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