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Handgrip strength and menopause are associated with cardiovascular risk in women with obesity: a cross-sectional study

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Abstract

Background While physical performance is closely linked to cardiovascular health, further research is essential to elucidate the association of physical tests in the early screening for cardiovascular risk (CVR), underscoring the potential for these assessments to enhance preventive healthcare strategies.

Objectives To investigate the association between the Handgrip Strength (HGS) test and CVR in women with obesity, as well as to evaluate the predictive value of the HGS test as a CVR screening tool in this population.

Methods Fifty-five eligible women with obesity, aged 40 to 65 years, were studied. The Framingham Global Risk Score was used to classify participants into low-risk and moderate/high-risk groups. Dual X-ray Absorptiometry was used to assess body composition. Additionally, clinical and biochemical parameters, along with HGS, were evaluated. Data were analyzed using the logistic regression analysis, and the positive and negative predictive values were calculated; accuracy was defined through the ROC curve and the Youden index. Statistical significance was set at 5%.

Results The prevalence of the moderate/high CVR was 49%. The menopause [0.14 (0.03–0.52), $p=0.003$] and handgrip strength [0.90 (0.82–0.99), $p=0.046$] were associated with cardiovascular risk, independent of the clinical and biochemical parameters. The optimal cutoff points for screening CVR were ≤ 37.8 kg for HGS [AUC = 0.73 (0.59–0.84), $p=0.003$].

Conclusion HGS and menopause are significantly associated with CVR in women with obesity, highlighting the importance of considering physical evaluation in early clinical screening for CVR. The simple measure of HGS emerged as a promising tool for cardiovascular prevention in this population.

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Keywords Coronary risk, Framingham, Physical performance, Diagnosis

Introduction

Cardiovascular disease (CVD) is among the leading causes of death and disability worldwide [1] e. Cardiovascular risk (CVR) is the probability of an individual developing cardiovascular disease or experiencing cardiovascular events during a specific period [2].

Obesity is classified when the body mass index (BMI) is greater or equal to 30 kg/m² [1]. It is one of the main factors associated with an increased risk of CVD and directly contributes to the development of dyslipidemia, type 2 diabetes, hypertension, and sleep disorders [3]. Furthermore, obesity leads to the development of CVD and cardiovascular disease-related mortality, irrespective of other risk factors [3, 4]. Obesity is a complex multifactorial disease, widely acknowledged as a severe public health issue [1, 5].

The World Health Organization (WHO) estimates that by 2025, 167 million individuals, encompassing both adults and children, will be grappling with overweight or obesity [6]. Alarmingly, women are particularly affected by the obesity epidemic [7, 8]. These sex-related differences have been attributed to nutrition, lifestyle, behavior, and environmental disparities between men and women. Women manifest heightened cardiovascular risk (CVR), particularly when overweight or obese and insulin-resistant [9].

Calculators can estimate the CVR based on the Framingham heart study (FHS) [10]. These calculators define a cardiovascular risk score for upcoming years and classify cardiovascular risk, making them an essential tool in preventive clinical practice. The Framingham calculator considers clinical and biochemical variables and cardiovascular history for the classification. However, risk stratification calculators are limited to specialists requiring the insertion of personal data and clinical and blood results [2, 10].

In this context, the search for alternative risk prediction tools is crucial. Recent studies have demonstrated the association between physical tests and CVR in people with obesity [11–14]. However, the accuracy of physical tests in predicting CVR has been insufficiently explored. Many gaps in the literature, including applicability to different groups, highlight the need for more rigorous and comprehensive research.

Muscle strength (MS) is crucial for performance in functional tests and is important in predicting health outcomes [15]. Evidence indicates that adherence to a more significant number of healthy lifestyle habits (like adequate fruit/vegetable intake, nonsmoking, low alcohol consumption, and being physically active), mainly in adults and older with CVR and CVD, can help keep or improve their MS levels [16]. Additionally, associations between MS and excess epicardial fat [15] and the association of increased strength and muscle mass with cardiovascular health [17] have already been observed in different populations.

In this regard, the handgrip strength (HGS) has stood out for being a quick, simple, and low-cost test [17–20], and it is widely used in clinical practice for screening and diagnosing various clinical conditions, including frailty, sarcopenia, sarcopenic obesity, mortality, and short- and long-term comorbidities, with different established cutoff points for men and women [21–25]. In individuals with obesity, high measures of handgrip strength have been associated with attenuating obesity-related cardiometabolic risk and cardiovascular risk [21, 26]. However, although the associations between muscle strength and CVR have already been studied, cutoff points for detecting greater cardiovascular risk in women with obesity are unknown.

Thus, considering the association with cardiovascular health, the ease of application and use of HGS by health care professionals, and given the numerous possibilities of this test as a screening strategy, the objective of this work was to investigate the association between the HGS test and CVR in women with obesity, as well as verify the predictive value of this tool with cutoff points for detecting the early screening of moderate/high cardiovascular risk in women with obesity.

Methods

Design

This is a cross-sectional study approved by the institutional ethics committee (protocol nº 34095720.0.0000.5108). It was performed from April to December 2022, following the criteria outlined in the Declaration of Helsinki. The written informed consent form was obtained from all participants.

Sample

Participants were recruited through wide dissemination with leaflets, posters, and invitations on social networks and from their registrations in the Basic Health Units (UBS) of primary care centers of the community in Diamantina, Brazil. This study complies with the recommendations of the guidelines of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) [27].

The inclusion criteria comprised adult women (≥ 40 years) with BMI ≥ 30 kg/m². The exclusion criteria included physical limitations that make it challenging to perform the physical test; histories of cardiovascular

disease such as angina, stroke, myocardial infarction, peripheral arterial disease, or heart failure [2]; respiratory conditions that require oxygen therapy or frequent use of inhalation, documented dementia or clinically significant depression, surgery, chemotherapy or radiotherapy for cancer in the last six months, and severe illness or injury on the day of the clinical, functional assessment [28].

Procedures

A preliminary analysis with an interview via telephone or approach in primary care was carried out to recruit the participants. After checking the inclusion and exclusion criteria, the assessments were scheduled. First, the informed consent form was applied, and the interview was conducted. Blood pressure was measured following the recommendations of the SBC (2020) [29]. Calibrated auscultatory stethoscope and sphygmomanometers with cuffs appropriate for arm circumference were used. Measurements were taken on both arms, considering the highest value. Body composition, anthropometric, and blood collection were assessed, and the functional evaluation was conducted.

Anthropometric assessment

Weight (kg) and height (m) were measured using an analog scale (Welmy, model 110, accuracy of 0.1 kg) with an attached stadiometer (accuracy of 0.5 cm). Participants wore a standard apron, with bare feet and free of adornments or accessories. Body mass index (BMI kg/m^2) was calculated. Obesity classification was carried out following the WHO recommendations, as follows: obesity degree 1 (BMI range: 30–34.9 kg/m^2); degree 2 (BMI range: 35–39.9 kg/m^2); degree 3 (BMI ≥ 40 kg/m^2) [1, 6].

Menopause assessment

Menopause data were considered according to the participant's self-report of informing the date of their last menstruation in a data collection instrument. This data was classified following the WHO [30] recommendations that define natural menopause as deemed to have occurred after 12 consecutive months without menstruation for which there is no other apparent physiological or pathological cause and in the absence of clinical intervention.

Assessment of body composition

Fat mass, visceral fat, and muscle mass were obtained through a Dual-Energy X-ray Absorptiometry (Lunar Radiation Corporation, Madison, Wisconsin, USA, model DPX) [31–33]. Prior guidance was given to all participants, such as fasting from food for 12 h and liquids up to 2 h before the exams, wearing light clothing, avoiding metal accessories, as they will be removed at the time of the exam, not practicing physical activity the day before the exam.

Blood collection

Blood samples were collected in the morning, after overnight fasting of 12 h, 3 mL in a tube with fluoride anticoagulant for glucose determination and 5 mL in a tube without anticoagulant for the lipid profile analysis. Serum levels of triglycerides (mg/dL), total cholesterol (mg/dL), high-density lipoprotein (HDL) cholesterol (mg/dL), low-density lipoprotein (LDL) cholesterol (mg/dL), and glucose (mg/dL) were measured by using Cobas Hitachi enzymatic colorimetric assays (Roche Diagnostics Gmbh, Mannheim, Germany).

Physical assessment

The HGS test was conducted according to the criteria of the American Society of Hand Therapists (ASHT) through the Jamar® dynamometer (Asimov Engineering Co.). The individual was seated with hips and knees at 90° of flexion, feet parallel, and back supported against the chair's backrest. The elbows were flexed at 90°, with the shoulders and wrists in a neutral position. The assessment was conducted on the dominant upper limb. Three measurements were taken at one-minute intervals, and the mean value obtained was used for analysis [34, 35].

Cardiovascular risk classification

The cardiovascular risk stratification of this study followed the 2019 guideline of the Brazilian Society of Cardiology (SBC), which includes a 10-year estimation of the first occurrence of coronary, cerebrovascular, peripheral arterial disease, or heart failure [2, 36]. The Framingham global risk score was developed based on the Framingham Heart Study (FHS) and evaluates the variables: gender, age, total and HDL cholesterol, systolic blood pressure, diabetes, smoking, and treatment for hypertension [2].

Access to the calculator is available via the following link: FHS Cardiovascular Disease (10-year risk) (https://www.framinghamheartstudy.org/fhs-risk-functions/cardiovascular-disease-10-year-risk/). Low risk is identified when the probability of a cardiovascular event in the next ten years is less than 5%; intermediate risk is between 5% and 10% for females and between 5% and 20% for males; and high risk is equal to or greater than 10% for female and over than 20% for male [2, 36]. Considering the above classification, the study population was divided into three subgroups: 1– low cardiovascular risk, 2– intermediate cardiovascular risk, and 3– high cardiovascular risk [2, 36]. No subjects were at "very high risk" [2], and this subgroup, including people with a history of significant atherosclerotic diseases (coronary, cerebrovascular, or peripheral vascular), was discarded in our exclusion criteria [2].

Sample calculation

A pilot study was carried out with ten individuals for the sample calculation. From this, the sample size was calculated considering the determination coefficient (0.25) for three predictors: alpha of 5%, beta of 10%, and loss of 10%. The number of participants required for the study was 52 individuals.

Data analysis

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 22.0 (SPSS Inc., Chicago, IL, USA) and MedCalc Statistical Software version 13.1 (MedCalc Software, Ostend, Belgium). The data distribution was verified using the Kolmogorov–Smirnov test. Continuous variables were shown as mean and standard deviation (normal distribution) or median and interquartile range (non-normal distribution). Group comparisons were performed through independent t-tests and Mann–Whitney's or Chi-Square tests.

Logistic regression analysis was carried out to evaluate the association between HSG and moderate/high CVR. If $p < 0.02$, multivariate analysis was conducted to assess the predictive value of HGS in screening for moderate/high CVR.

A receiver-operating characteristic (ROC) analysis was performed to determine the sensitivity and specificity of different cutoff values of the HSG to predict moderate/high CVR. The area under the ROC curve (AUC) and 95% confidence interval (CI 95%) were calculated for all tests, and optimal cutoffs were determined by the best combination of sensitivity and specificity using the Youden Index. An AUC more significant than 0.7 was considered acceptable, while an area greater than 0.8 was considered excellent for the proposed cutoffs [37]. Alternative cutoff points were suggested considering the combination of specificity and sensitivity. The Positive Predictive Value (PPV) and Negative Predictive Value (NPV) were calculated. Statistical significance was set at 5%.

Table 1 Comparison of the cardiovascular risk factors, sample biochemists, body composition, and physical between low RCV and moderate/high RCV groups

Variables	Total *n* = 55	Low CVR *n* = 28	Moderate/ High CVR *n* = 27	*p* Value
Cardiovascular risk factors				
Age (years)	48.96 (40–65)	44.46 (40–60)	53.62 (40–65)	0.000*
Menopause n (%)	23 (41.8)	5 (9.0)	18 (37.7)	0.000*
Diabetes n (%)	7 (12.5)	0	7 (25.9)	0.004*
Antihypertensive drugs n (%)	22 (39.3)	4 (14.3)	18 (66.7)	0.000*
SBP (mmHg)	130.00 (20.00)	126.07 ± 2.24	140.00 (10)	0.001*
Smoking n (%)	0	0	0	-
Total cholesterol (mg/dL)	195.72 (35.35)	188.96 ± 28.38	202.74 ± 40.73	0.15
HDL (mg/dL)	49.00 (14.00)	51.64 ± 12.14	50.40 ± 9.36	0.67
Biochemical				
VLDL (mg/dL)	32.00 (13.20)	32.49 ± 10.17	37.73 ± 11.22	0.07
LDL (mg/dL)	112.44 ± 35.30	106.79 ± 28.64	118.30 ± 40.81	0.23
Non-HDL (mg/dL)	147.50 ± 41.00	139.28 ± 32.58	156.03 ± 47.34	0.13
Glycemia (mg/dL)	90.40 (17.20)	87.50 ± 11.09	95.00 (19.10)	0.01*
Insulin (mg/dL)	11.35 (9.19)	10.87 (11.76)	13.54 ± 6.02	0.66
Boddy composition				
Fat %	48.34 ± 5.11	47.99 ± 5.66	49.80 (5.70)	0.36
Visceral fat	1446.00 (1042.00)	1174.50 (1117.00)	1674.37 ± 567.16	0.06*
Physical test				
HGS (Kg)	37.72 ± 6.96	38.38 ± 6.70	32.96 ± 6.20	0.003*

Data presented as mean ± SD or median (interquartile range). CVR cardiovascular risk, SBP systolic blood pressure, VLDL very low-density lipoprotein, LDL low-density lipoprotein, HDL high-density lipoprotein, HGS handgrip strength, *$p < 0.05$

Results

Main characteristics of the subjects

Initially, 60 women were recruited. Of these, 5 had a cardiovascular event history and were excluded. Fifty-five women with obesity were eligible for participation and enrolled in the study. The participants exhibited an average age of 48.96 ± 7.65 years. Among these, 27 (49%) presented moderate or high cardiovascular risk.

Characteristics of the participants are presented in Table 1. The age, systolic blood pressure, presence of menopause, presence of diabetes and hypertension, glycemia level, and visceral fat were significantly higher in the moderate/high CVR group. HGS score was significantly lower in the moderate/high CVR group.

Association between HGS and moderate/high CVR

HGS and menopause were significantly associated with moderate/high CVR in the univariate analysis and the multivariate model (Table 2). The model was not adjusted for age and biochemical variables, as these adjustments were already incorporated by the Framingham calculator itself. The model quality, measured by the Hosmer-Lemeshow test, was satisfactory ($p > 0.05$).

ROC curves for HGS

The area under the ROC curve (AUC) to identify moderate/high CVR hazards in women with obesity by HSG was 0.73 (CI 95% 0.59–0.84) ($p < 0.01$). The HGS was acceptable for screening moderate/high CVR (Fig. 1).

Table 2 Univariate and multivariate logistic regression analysis of CVR. Adjusted model: the model was adjusted for age, HDL, VLDL, and SBP using the Framingham calculator itself. The presence of menopause was included as a covariate in the multivariate model

Variable	Univariate		Multivariate	
	OR (95% CI)	*p* Value	OR (95% CI)	*p* Value
HGS (kg)	0.87 (0.79–0.96)	0.007*	0.89 (0.80–0.98)	0.029*
Menopause (yes)	-	-	9.19 (2.46–34.39)	0.001*
Model summary				
Step	**-2 Log likelihood**	**Hosmer-Lemeshow**		**Nagelkerke R Squared**
1	54.680[a]	0.65		0.43

HGS: handgrip strength, kg: kilogram, OR: odds ratio, CI: confidence interval, *$p < 0.05$

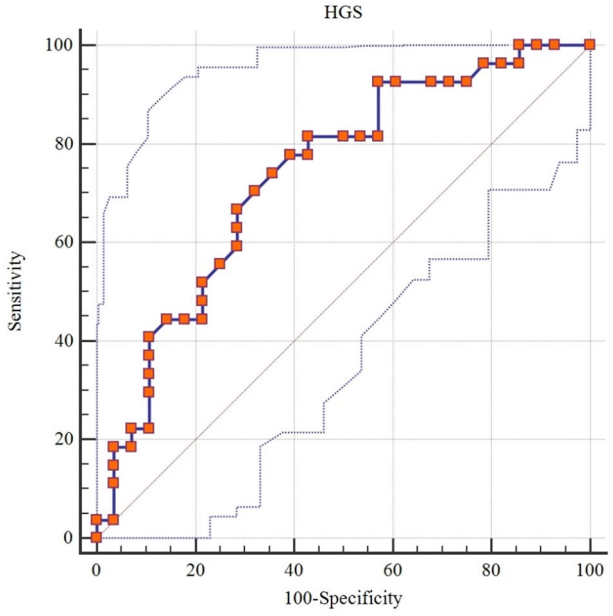

Fig. 1 ROC curves for HGS. ROC curves for HGS [AUC = 0.73 (0.59–0.84), $p = 0.003$] in cardiovascular risk screening. HGS handgrip strength

Table 3 Cutoff points, sensitivity, specificity, PPV, and NPV of HGS test to screen moderate/high CVR

Cutoff point	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)
37.8*	81.4 (61.9–93.7)	57.1 (37.1–75.5)	64.7 (53.5–74.4)	76.2 (57.6–88.2)
27	83.3 (35.8–99.5)	55.10 (40.2–69.3)	18.5 (12.4–26.7)	96.4 (81.5–99.4)
45.5	52.9 (38.4–67.0)	100.0 (39.7–100.0)	100.0 (87.2–100.0)	14.2 (11.0-18.2)

HGS: handgrip strength, AUC: area under the ROC curve, PPV: positive predictive value, NPV: negative predictive value, CI: confidence interval, *cutoff points with the best combination of sensitivity and specificity

Table 3 shows the properties of the cutoff points with the best combination of sensitivity and specificity and negative and positive predictive values of HGS tests for screening moderate/high CVR. Alternative cutoff points were proposed.

Discussion

To the best of our knowledge, the present study highlighted the predictive value of the HGS test in screening for cardiovascular risk in women with obesity. The main findings revealed that (1) women with moderate/high CVR presented a higher prevalence of menopause and lower HGS, (2) HGS and menopause were associated with CVR, and (3) the HGS test presented acceptable accuracy in the screening of the CVR, and cutoff points were proposed. These findings provide a simple, accessible tool for early screening of moderate/high cardiovascular risk in women with obesity, improving clinical decision-making and targeted healthcare interventions, especially in primary care settings.

In our first analysis, we compared women with obesity and low CVR and women with obesity and moderate/high CVR. The findings demonstrated that menopause was more prevalent and HGS significantly lower in the moderate/high CVR group. These findings were confirmed by the univariate and multivariate logistic regression analyses, which showed significant associations between menopause and HGS with moderate/high CVR. In the multivariate analysis, HGS was a protective factor, indicating that obese women with higher HGS are 11 times less likely to have moderate/high cardiovascular risk. Menopause was a risk factor, indicating that obese women post-menopause are 9.19 times less likely to have moderate/high cardiovascular risk.

Regarding the increase in CVR related to women in the menopause transition, it is well established that the risk increases significantly after this stage of life due to the decline in estrogen levels [38, 39]. The vascular effects of estrogen are predominantly mediated by estradiol, acting through estrogen receptors (ERα, ERβ, and G) via genomic mechanisms [21, 38]. Current evidence suggests that women of any age experiencing vasomotor symptoms exhibit a poorer cardiovascular risk profile [38]. Our study has indeed confirmed this relationship.

Associated with this, during the menopause transition, body composition changes, favoring lipid deposition in the liver and skeletal muscle. The increase in total fat mass (visceral and muscular) seems to be associated with the general adipose tissue dysfunction related to menopause [21]. Faced with such changes and advancing age, there is a substantial loss of muscle mass, abdominal and intramuscular fat accumulation, and a gradual decline in neuromuscular strength (dynapenia). So, studies showed that the concomitant increase in body fat with

the age-related decrease in neuromuscular strength is an important predictor of frailty [22].

As far as muscle strength is concerned, studies showed that low muscle strength was associated with poor cardiorespiratory function, decline in mobility, disability, and mortality due to an unfavorable cardiometabolic risk profile [6, 40–42]. Preserved muscle strength has been considered a robust protective factor for insulin sensitivity [43]. Handgrip strength is an important indicator of overall health and is a marker of general muscle strength and physical profile. Individuals with preserved handgrip strength exhibit better functional performance and are more active, reducing the risk of developing cardiovascular risk factors [14, 23, 34].

Physical-functional performance, mainly strength and resistance, plays an important role and has been highlighted in the context of cardiovascular health [14, 24]. Research has shown a relationship between obesity and balance deficits and increased body sway [17, 18], impaired physical functions such as walking, running, climbing stairs, sitting, and getting up from a chair [19, 25, 26], in addition to the association with reduced muscle strength [20].

Handgrip strength is a representative measure of global muscle strength. It is widely used in clinical practice for screening and diagnosing various clinical conditions, including frailty, sarcopenia, and mortality [13, 44, 45]. In individuals with obesity, adequate handgrip strength has been associated with attenuation of cardiometabolic risk [12–14, 35]. Handgrip strength showed an inverse association with cardiovascular risk and a direct mediating effect between muscle strength and cardiovascular risk, even after adjusting for adiposity [23]. Although the associations are widely reported, accuracy studies are scarce, and no study has established a specific HGS cutoff for women with obesity in detecting increased cardiovascular risk [14, 46, 47]. Given that HGS cutoff points differ between men and women, addressing this gap is crucial for improving early screening and ensuring more accurate and sex-specific clinical assessments [48, 49].

In the present study, the ideal value of the HGS cut-off point for CVR was ≤ 37.8 kg, with a sensitivity of 81.4% and specificity of 57%, with an AUC of 73%. Among patients with moderate/high cardiovascular risk, 81% had HGS ≤ 37.8 kg. Furthermore, the presented cutoff point demonstrated a PPV of 64.7%, indicating that a value of 37.8 kg or lower accurately predicts a 64.7% probability of moderate/high CVR. The NPV was 76.2%, suggesting that a value greater than 37.8 kg accurately predicts a 76.2% probability of lower CVR.

Alternative cutoff points were proposed to explore the combination of PPV and NPV and may be used as appropriate. The cutoff point ≤ 27, with a sensitivity of 83.3% and specificity of 55.1%, PPV of 18.5%, and NPV of 96.4%, indicates that a test result of 27 kg or lower accurately predicts an 18.5% probability of moderate/high CVR, and that a test result greater than 27 kg accurately predicts a 96.4% probability of lower CVR. This cutoff can be used as a tool for cardiovascular risk prevention. The cutoff point ≤ 45.5 kg, with a sensitivity of 52.9% and specificity of 100%, PPV of 100%, and NPV of 14.2%, indicates that a test result of 45.5 kg or lower accurately predicts a 100% probability of moderate/high CVR, and that a test result greater than 45 kg accurately predicts a 14.2% probability of lower CVR. Applying the proposed cutoff values can facilitate timely referrals to specialized care, particularly in primary health settings, ultimately improving early screening and personalized healthcare interventions.

This study has several strengths. The rigorous methodology for assessing body composition, muscle strength, and cardiovascular risk, adequate and robust statistical analysis, and clinical and scientific relevance. The cutoff points proposed for handgrip strength emerged as a valuable alternative tool for early screening and preventing cardiovascular health complications in women with obesity, especially in settings where the parameters required for the Framingham global risk score calculator are unavailable. Still, it highlights the significant association between cardiovascular risk and physical and functional aspects in this population.

This study has some limitations. First of all, it exclusively involved women over 40 years of age with obesity, and thus, the results cannot be generalized to other population groups. However, it is essential to highlight that the cardiovascular risk is notably higher in women compared to men with obesity. It is worth mentioning that in this age group, estrogen levels in women decrease, increasing CVR. This fact was proven by the association between women with menopause and moderate/high CVR, choosing this study group as a strong point of our work. Further research aimed at exploring this association in diverse populations is strongly recommended. Additionally, we recognize the small sample size and the preliminary nature of the findings, highlighting the need for future longitudinal studies to delve deeper into this association.

In conclusion, our study demonstrated that HGS and menopause are independent determinants of CVR in this population, emphasizing the utility of HGS measurement as a straightforward, valuable, and complementary tool for cardiovascular prevention. Highlight that the initial screening of CVR did not exclude the diagnostic confirmations. Nevertheless, further confirmations on larger study populations are necessary to confirm these preliminary and promising observations.

Abbreviations

CVR	Cardiovascular Risk
HGS	Handgrip Strength

CVD	cardiovascular disease
BMI	Body Mass Index
WHO	World Health Organization
FHS	Framingham Heart Study
UBS	Basic Health Units
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology
HDL	High-density lipoprotein
LDL	Low-density lipoprotein
ASHT	American Society of Hand Therapists
SBC	Brazilian Society of Cardiology
SPSS	Statistical Package for the Social Sciences
SBP	Systolic Blood Pressure
VLDL	Very low-density lipoprotein

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12905-025-03702-6.

Supplementary Material 1

Supplementary Material 2

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Author contributions
JPCF - Conception and design of the study, acquisition of data, analysis and interpretation of data; drafting and critical review of the article; final approval of the version to be submitted.JNVS - Conception and design of the study, acquisition of data, analysis and interpretation of data; drafting and critical review of the article; final approval of the version to be submitted. DBM - Acquisition of data, drafting and critical review of the article; final approval of the version to be submitted.GTG - Acquisition of data, analysis and interpretation of data; drafting and critical review of the article; final approval of the version to be submitted.LACT - Analysis and interpretation of data; drafting and critical review of the article; final approval of the version to be submitted.MTOF - Acquisition of data, drafting and critical review of the article; final approval of the version to be submitted.TC - Acquisition of data, drafting and critical review of the article; final approval of the version to be submitted.VKSL - Analysis and interpretation of data; drafting and critical review of the article; final approval of the version to be submitted.ALD - Analysis and interpretation of data; drafting and critical review of the article; final approval of the version to be submitted.PHSF - Conception and design of the study, acquisition of data, analysis and interpretation of data; drafting and critical review of the article; final approval of the version to be submitted.HSC - Analysis and interpretation of data; drafting and critical review of the article; final approval of the version to be submitted.AS - Conception and design of the study; drafting and critical review of the article; final approval of the version to be submitted.TJS - Acquisition of data, drafting and critical review of the article; final approval of the version to be submitted.FASJ - Acquisition of data, drafting and critical review of the article; final approval of the version to be submitted.CAF - Conception and design of the study; drafting and critical review of the article; final approval of the version to be submitted.EAE - Conception and design of the study; drafting and critical review of the article; final approval of the version to be submitted.ACRL - Conception and design of the study, acquisition of data, analysis and interpretation of data; drafting and critical review of the article; final approval of the version to be submitted. VAM - Conception and design of the study, acquisition of data, analysis and interpretation of data; drafting and critical review of the article; final approval of the version to be submitted.

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Data availability
Availability of data and materialsThe datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This is a cross-sectional study, approved by the "Comitê de Ética em Pesquisa da Universidade Federal dos Vales do Jequitinhonha e Mucuri– CEP/UFVJM" (protocol nº 34095720.0.0000.5108). The study was performed from April to December 2022, being carried out according to the criteria of the Declaration of Helsinki. The written informed consent form was obtained from all participants.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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