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Association of cardiovascular health with anthropometric markers, cardiorespiratory fitness and quality of life of university workers

Associação da saúde cardiovascular com marcadores antropométricos, aptidão cardiorrespiratória e qualidade de vida de trabalhadores universitários

Asociación de la salud cardiovascular con marcadores antropométricos, aptitud cardiorrespiratoria y calidad de vida de trabajadores universitários

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ABSTRACT

Objective: To evaluate cardiovascular health (CVH) in university workers at a higher education institution in relation to other health-related factors. **Methods:** Cross-sectional study consisting of 121 workers. CVH was assessed by seven measures [food consumption, physical activity level (PAL), smoking, total cholesterol, blood glucose, systemic blood pressure (BP), and body mass index (BMI)]. The independent variables waist circumference (WC), waist-hip ratio (WHR), HDL-c, LDL-c, triglycerides, maximal oxygen consumption (VO_{2max}), workload, and health related quality of life (HRQoL) were assessed. **Results:** Overall, 25% of the sample had poor CVH. The ideal CVH group had lower WC ($p<0.001$) and WHR ($p<0.001$), and higher VO_{2max} ($p=0.041$). The physical component score was higher in the groups with intermediate ($p=0.036$) and ideal ($p=0.002$) CVH. Daily workload was higher in the poor CVH group ($p=0.05$). CVH score was directly related to VO_{2max} ($p=0.001$) and physical component ($p=0.020$), and inversely related to WC ($p<0.001$), WHR ($p<0.001$), LDL-c ($p<0.001$), and triglycerides ($p< 0.001$). **Conclusion:** Implementation of educational practices, and promotion of physical activity, adequate dietary intake, and other lifestyle habits can help to improve CVH and the physical component of HRQoL.

Keywords: Cardiovascular health, Cardiorespiratory fitness, Cardiovascular disease prevention, Quality of life, Workers.

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RESUMO

Objetivo: Avaliar a saúde cardiovascular (SCV) em trabalhadores universitários de uma instituição de ensino superior em relação a outros fatores relacionados à saúde. **Métodos:** Estudo transversal composto por 121 trabalhadores. A SCV foi avaliada por sete medidas [consumo de alimentos, nível de atividade física (NAF), tabagismo, colesterol total, glicemia de jejum, pressão arterial sistêmica (PA) e índice de massa corporal (IMC)]. As variáveis independentes circunferência da cintura (CC), relação cintura-quadril (RCQ), HDL-c, LDL-c, triglicerídeos, VO_{2max}, carga de trabalho e qualidade de vida relacionada a saúde (QVRS) foram avaliadas. **Resultados:** 25% tiveram pobre CVH. O grupo com SCV ideal apresentou menor CC (p<0,001) e RCQ (p<0,001) e maior VO_{2max} (p=0,041). O escore do componente físico foi maior nos grupos com SCV intermediária (p=0,036) e ideal (p=0,002). A carga de trabalho diária foi maior no grupo com pobre SCV (p=0,05). A escore da CVH foi diretamente relacionada ao VO_{2max} (p=0,001) e ao componente físico (p=0,020), e inversamente relacionada à CC (p<0,001), RCQ (p<0,001), LDL-c (p<0,001) e triglicérides (p<0,001). **Conclusão:** A implementação de práticas educacionais e a promoção da atividade física, a ingestão alimentar adequada e outros hábitos de vida podem ajudar a melhorar a SCV e o componente físico da QVRS.

Palavras-chave: Saúde cardiovascular, Aptidão cardiorrespiratória, Prevenção de doenças cardiovasculares, Qualidade de vida, Trabalhador.

RESUMEN

Objetivo: Evaluar la salud cardiovascular (SCV) en trabajadores universitarios de una institución de enseñanza superior en relación con otros factores relacionados con la salud, como medidas antropométricas de obesidad, FRCV, carga de trabajo y calidad de vida relacionada con la salud (CVRS). **Métodos:** Estudio transversal compuesto por 121 trabajadores. La SCV se evaluó mediante siete medidas [consumo de alimentos, nivel de actividad física (NAC), tabaquismo, colesterol total, glucemia, presión arterial sistémica (PA) e índice de masa corporal (IMC)]. Se evaluaron las variables independientes perímetro de cintura (PC), relación cintura-cadera (RCC), HDL-c, LDL-c, triglicéridos, $VO_{2máx}$, carga de trabajo y CVRS. **Resultados:** En general, el 25% de la muestra tenía una SCV deficiente. El grupo con HVC ideal presentaba menor PC (p<0,001) y RCC (p<0,001), y mayor $VO_{2máx}$ (p=0,041). La puntuación del componente físico fue mayor en los grupos con SCV intermedia (p=0,036) e ideal (p=0,002). La carga de trabajo diaria fue mayor en el grupo con SCV deficiente (p=0,05). La puntuación de SCV estaba directamente relacionada con el $VO_{2máx}$ (p=0,001) y el componente físico (p=0,020), e inversamente relacionada con la PC (p<0,001), el RCC (p<0,001), el LDL-c (p<0,001) y los triglicéridos (p<0,001). **Conclusiones:** La implementación de prácticas educativas y la promoción de la actividad física, la ingesta dietética adecuada y otros hábitos de vida pueden ayudar a mejorar la SCV y el componente físico de la CVRS.

Palabras clave: Salud cardiovascular, Condición física cardiorrespiratoria, Prevención de enfermedades cardiovasculares, Calidad de vida, Trabajadores.

INTRODUCTION

Cardiovascular disease (CVD) is the leading cause of premature death worldwide (ROTH GA, et al., 2020). In 2019, the increase in CVD cases affected 523 million people and cause 18.6 million deaths (ROTH GA, et al., 2020). In addition, these comorbidities lead to approximately 350,000 sudden deaths per year in the United States of America and 20,000 in Australia (ZAMAN S, et al., 2019).

According to the Pan American Health Organization, several countries suffer from these clinical events and the magnitude of these diseases in Brazil is high, with 31% of deaths from isolated CVDs, related to chronic non-communicable diseases (WHO, 2014).

In order to improve the quality and life expectancy of the population and reduce public health costs, the American Heart Association (AHA), in 2010, established seven parameters, divided into behavioral factors

(diet, smoking, PAL, and body mass index) and biological factors (glycemia, total cholesterol, and systemic BP) with the aim of predicting the state of CVH (LLOYD-JONES, et al., 2010). The AHA has also set a goal of reducing the prevalence of CVD by 20% in the year 2020 (LLOYD-JONES, et al., 2010). Thus, there is evidence that a cascade of CVDs can be avoided if these factors are controlled (ARNETT DK, et al., 2019), especially with regard to sedentary behavior, which is at high risk in university workers (ALKHATIB A, 2013).

Research on CVH has reported the importance of optimal health parameters to prevent CVD in pre-diabetic and diabetic individuals (WANG T, et al., 2019), as well as non-alcoholic liver disease associated with elevated liver enzymes (gamma-glutamyl transferase, alanine aminotransferase) and accumulation of fat in the liver (GARCA-HERMOSO A, et al., 2017). However, the results on CVH are still only estimates and more accurate information should be explored so that preventive programs for human health can be implemented.

In relation to the present study, there are reports of university professionals with persistent and masked hypertension (TRUDEL X, et al., 2020) and increased risk of CVD with 10 hours or more hours of work per day (LEE D, et al., 2019; VIRTANEN M, KIVIMKI M, 2018). In addition, long working hours reduce satisfaction, increase perceived stress, work-life balance, and are factors that influence the quality of life of workers (BARNETT RC, 2006; HSU YY, et al., 2019).

University workers have been studied in terms of health promotion, with the focus to date, being on the health and well-being of academics (HANSON M, 2013). It is known that the context and work environment of these employees can influence not only their lifestyle, but also other aspects that are inherent to people's general well-being, such as physical activity, diet and working hours (COOPER K, BARTON GC, 2015).

Thus, studies on health in the work environment of university employees are relevant, given that they have extensive workloads with accumulation of services (number of tasks with little time to perform them), generating stress and making it difficult to organize a less sedentary life, with good nutrition and controlled stress (MÁTÓ V, et al., 2021).

Therefore, the literature supports that a good CRF helps to control blood glucose, total cholesterol (triglycerides and LDL-c), systemic blood pressure, anthropometric markers of obesity and improves HRQoL, and is associated with a lower risk of coronary heart disease and atrial fibrillation (TIKKANEN E, et al., 2018; PEREIRA DE LIMA M, et al., 2020), being an important protective factor for the cardiovascular system.

However, to the best of our knowledge, this is the first study to investigate the relationship of both CRF, anthropometric measures, and HRQoL with CVH scores in university workers.

It is also important to mention that good CRF has an inverse correlation with the risk factors for CVD (TIKKANEN E, et al., 2018).

Regarding working hours, a better distribution of work and rest time, the implementation of educational practices, the encouragement of physical activity, adequate dietary intake, and other lifestyle habits will help to improve CVH and the physical aspects. With the periodic assessment, the institution will be able to identify employees with poor CVH and include them in health monitoring programs that encourage better health-related behaviors.

It is worth mentioning that the factors used to assess CVH (diet, physical activity, smoking history, body mass index, blood pressure, fasting blood glucose, total cholesterol) are cost-effective and easy to implement in any institution. Therefore, the objective was to evaluate the cardiovascular health of workers in a higher education institution in relation to other health-related factors, such as anthropometric measures of obesity, CRF, workload and quality of life.

METHODS

This is a cross-sectional study conducted among workers of a higher education institution located in the city of Anápolis-GO, Brazil. At the time of the research, 302 out of 1726 employees of the university were approached, but only 133 agreed to participate in the study. Of the 133 participants, 12 were excluded because

they reported the continuous use of medication for hyperension and diabetes mellitus. A convenience sample of 121 healthy employees, 50 (41.3%) men and 71 (58.7%) women) was recruited for this study.

Inclusion criteria were being employment at the institution for at least 6 months and age between 18 and 59 years. Eligible workers were excluded if they had physical limitations (osteoarthrosis of the lower limbs, rheumatoid arthritis) that prevented them from performing the CRF test, a clinical diagnosis of unstable cardiovascular disease (unstable angina and arrhythmia), or chronic lung disease (in exacerbation) were excluded.

The sample calculation was performed in GPower software (version 3.1, Universitat Dusseldorf, Germany), free to download, and was considered the analysis type (multiple linear regression analysis, F test family, R^2 deviation from zero and three predictors). A sampling power of 95%, mean effect size (f^2 =0.15), and significance level of 5%, requiring 107 employees. However, 121 employees were evaluated, and the sample ended up with a power of 96%.

Ethics and Research Committee of the Universidade Evangélica de Goiás - UniEVANGÉLICA approved the project under number 4.512.382/2021 and CAAE 39734320.6.0000.5076. All participants signed Consent Form in accordance with Resolution of the National Health Council 466/12.

Data collection took place between January and July 2021, on pre-scheduled days, according to the availability of the workers, in the morning, afternoon, and evening periods. Sociodemographic and anthropometric data were collected, as well as the application of the cardiorespiratory test and questionnaires Short Form-36 (CICONELLI RM, et al., 1999), Mediterranean diet (PANAGIOTAKOS DB, et al., 2006), and IPAQ-short (MATSUDO S, et al., 2001) version.

In addition, blood samples were taken only in the morning and were performed by a laboratory specialized in clinical analysis. These procedures took place individually, in air-conditioned and reserved environments (laboratory of physiotherapeutic practices and in the multisport gym), in order not to embarrass the participants and to reduce the risks of contamination by the coronavirus disease – 2019 (COVID-19).

An identification form was completed with data on sex, age, educational level (primary school, high school, incomplete higher education, complete higher education, and postgraduate), monthly income (one minimum wage, two minimum wages, three minimum wages, four or more minimum wages), continuous medication use, existing comorbidities, and workload (calculated during working hours, from Monday to Saturday, using the time record of the last month worked).

CVH was assessd according to the recommendations of the AHA: diet, smoking history, PAL, and BMI, and the three biological include total cholesterol, systemic BP, and glycemia (LLOYD-JONES DM, et al., 2010). These parameters were categorized as poor (0 points), intermediate (1 point), and ideal (2 points) (Supplementary Material 1).

The scores were added together to determine the CVH of the subjects, categorized as poor, intermediate, and ideal, corresponding to 2 to 8, 9 to 10, and 11 to 14 points, respectively.

The dietary assessment was adapted from the Cardioprotective Food Manual, developed by the Ministry of Health in collaboration with the Heart Hospital (HCor) for the Brazilian population (MINISTÉRIO DA SAÚDE, 2018). The food groups that are considered healthy in this manual are the same as those used in the Mediterranean Diet Questionnaire 20 that was applied (Supplementary Material 2).

Smoking was assessed using a self-report questionnaire (never smoked or quit smoking more than 12 months ago, former smokers who quit smoking less than 12 months ago, and current smokers), BMI was calculated (weight (kg)/height m2), body mass was measured using a digital scale (G-Tech brand, model Balgl10, São Paulo, Brazil), and height was measured using a portable stadiometer (Sanny brand, São Paulo, Brazil).

The International Physical Activity Questionnaire - short version (IPAQ-short version), which assesses the frequency and duration of vigorous, moderate, and leisure-time physical activity was used to assess PAL

(MATSUDO S, et al., 2001). Total cholesterol and blood glucose were measured from blood samples using by the enzymatic colorimetric method after at least 8 hours of fasting. Resting systolic and diastolic blood pressures were measured using a semi-automatic device (brand, OMRON, model HEM 705CP, Kyoto, Japan).

WC and hip circumference (HC) were measured using an inextensible measuring tape measure (Cescorf brand, São Paulo, Brazil), the first being at the midpoint between the superior iliac crest and the last palpable rib at the end of a resting expiration, and second, in the hip region at the area of greatest protuberance (WHO, 2008). The WHR ratio was calculated using the WC/HC division (WHO, 2008), with reference values for WHR in men were < 0.91 cm and in women < 0.76 cm from normal values and for WC ≥88 cm in women and ≥102 cm in men (WHO, 2008).

CRF was assessed using the 20-meter shuttle run test, validated for adults (LÉGER LA, et al., 1988). This test identifies maximal aerobic power through multiple stages, involving a flat 20-meter. A metronome was used to play sequences of beeps of increasing intensity, starting at 8.5 km/h. The number of laps increased with each of the 20 stages, which lasted 3 minutes. If two consecutive laps were not completed, the test was stopped, and the speed of the last lap completed was used to calculate VO_{2max} using the following formula:

Equation 1: VO_{2max} = - 24.4 + 6 x (speed) ml/kg/min

The Short Form-36 (SF-36) questionnaire, validated for the Brazilian population (CICONELLI RM, et al., 1999), was used to assess HRQoL. All the questions in the questionnaire refer to the previous 4 weeks and require a perception of one's own health.

Two components can be calculated from the eight domains, physical (PCS) and mental (MCS). The PCS includes domains related to physical aspects, pain, and activities of daily living, while the MCS includes social, emotional/mental aspects, and vitality (POOL LR, et al., 2019). SF-36 item scores range from 0 to 100, with lower scores corresponding to poorer HRQoL, and higher scores reflecting better HRQoL (CICONELLI RM, et al., 1999).

Data are expressed as mean, standard deviation, median, minimum, maximum, frequencies, and percentages. Delta (Δ) variations were calculated to express differences. The Kolmogorov-Smirnov test was used to test the normality of the data.

The Student t test for independent samples (symmetric distribution) and the Mann-Whitney U test for independent samples (asymmetric distribution) were used to compare the sexes.

Cohen's d was used to determine the effect size between groups, which were classified as nonsignificant, small, medium, large, and very large, corresponding to values < 0.19, 0.20 - 0.49, 0.50 - 0.79, 0.80 - 1.29, and > 1.30, respectively (ROSENTHAL JA, 1996). One-way ANOVA with Tukey's post hoc (symmetric distribution) and Kruskal-Wallis test for independent samples with Mann-Whitney's post hoc were used to compare the poor, intermediate, and ideal CVH groups.

Associations of categorical variables between sex and CVH metrics were performed using the chi-squared test. Multiple linear regression models were performed with CVH scores as dependent and independent variables (WC, WHR, HRQoL, LDL, HDL, triglycerides, and VO2max). Multicollinearity was avoided by testing independent variables separately. Thus, sex and age were adjusted to avoid confounding between dependent and independent variables. A p <0.05 value was considered, and the software used for analysis was the Statistical Package for the Social Science (SPSS).

RESULTS

The CVH of the workers was classified as poor, intermediate and ideal in 25.6%, 27.2% and 47.1%, respectively (**Table 1**). Body mass values were lower in the intermediate (Δ= 11.4 kg; p= 0.021) and ideal (Δ= 15.1 kg; p< 0.001) CVH groups compared with the poor CVH group. In addition, educational level was associated with CVH (p=0.014), as most workers with incomplete higher education (65.5%) and postgraduates (55.6%) had ideal CVH.

Table 1- Sociodemographic characteristics of the university workers (n=121).

Sociodemographic variables	Cardiovascular health			
	Poor (n= 31)	Intermediate (n= 33)	Ideal (n= 57)	
	Mean (SD)	Mean (SD)	Mean (SD)	p
Age (years)	37.4±11.1	38.4±9.4	33.9±9.7	0.070
Body Mass (kg)	83.0±22.8	71.6±14,4	67.9±14.3	0.001
Height (cm)	165.0±10.9	167.0±10.5	167.8±9.9	0.578
Sex				
Male	14 (28.0)	14 (28.0)	22 (44.0)	
Female	17 (23.9)	19 (26.8)	35 (49.3)	0.827
Level of education				
Primary School	02 (50.0)	0 (0)	02 (50.0)	
Middle School	07 (35.0)	08 (40.0)	05 (25.0)	
Incomplete higher education	06 (20.7)	04 (13.8)	19 (65.5)	0.014
Completed higher education	12 (37.5)	09 (28.1)	11 (34.4)	
Postgraduate	04 (11.1)	12 (33.3)	20 (55.6)	
Job Role				
Teacher	01 (8.3)	04 (33.3)	07 (58.3)	
Administrative	24 (26.4)	21 (23.1)	46 (50.5)	0.085
General Services	06 (33.3)	08 (44.4)	04 (22.2)	
Month income (dolla – R$)				
$214	15 (30.0)	14 (28.0)	21 (42.0)	
$428	08 (19.5)	10 (24.4)	23 (56.1)	
$642	04 (44.4)	02 (22.2)	03 (33.3)	0.641
≥ $856	04 (19.0)	07 (33.3)	10 (47.6)	
Comorbidities				
Respiratory tract	01 (20.0)	01 (20.0)	03 (60.0)	
Metabolic	0 (0)	02 (100.0)	0 (0)	
Depression/anxiety	01 (10.0)	03 (30.0)	06 (60.0)	0.129
Others	02 (66.7)	0 (0)	01 (33.3)	
Medicines				
Contraceptives	03 (30.0)	03 (30.0)	04 (40.0)	
Antidepressant/Anxiolytic	04 (19.0)	08 (38.1)	09 (42.9)	
Multivitamin	01 (33.3)	01 (33.3)	01 (33.3)	0.730
Anti-inflammatory	0 (0)	0 (0)	01 (100.0)	
Anticoagulant	01 (100.0)	0 (0)	0 (0)	

Abbreviations: SD= standard deviation, Med= median, Min= Minimum, Max= Maximum. Data to p<0.05.
Source: Silva PHA, et al., 2024.

Table 2 compares CVH and health indicators. Among the components of CVH, the metric with the lowest prevalence of ideal levels was diet (14.0%), while smoking (93.4%), PAL (47.1%), blood glucose (91.7%), and total cholesterol (66.1%) had higher percentages. When analyzed by sex, women had a higher prevalence of ideal levels for BMI (49.3%) and systemic BP (46.5%), while PAL (42.3%) was lower compared to men.

Table 2- Behavioral and biological parameters, anthropometrics measures, biochemical, cardiorespiratory fitness and quality of life factors according to sex (n=121).

Parameters	Total (n=121)	Female (n=71)	Male (n=50)	Δ	
	Mean (SD)	Mean (SD)	Mean (SD)	p	
Behavioral					
Diet (points)	27.9±5.7	28.8±05.8	26.6±5.4		0.457
PAL (min/dia)	35.1±29.1	27.3±19.2	46.2±36.5	18.9	0.009
BMI (kg/m2)	25.9±5.1	25.5±4.7	26.7±5.5		0.131
Biological					
Blood glucose (mg/dL)	86.4±20.2	85.8±25.1	87.2±9.9	1.4	0.021

TC (mg/dL)	181.9±40.4	182.2±35.9	181.6±46.4		0.063
SBP (mmHg)	123.4±15.3	119.3±15.7	129.1±12.7	9.8	<0.001
DBP (mmHg)	80.7±11.0	79.3±11.6	82.8±9.8		0.257
Anthropometric					
WC (cm)	85.1±12.9	81.8±12.1	89.8±12.6	8.0	<0.001
WHR	0.9±0.1	0.8±0.1	0.9±0.1	0.1	<0.001
Biochemicals					
HDL-c (mg/dL)	53.2±8.6	53.8±9.5	52.2±7.1		0.431
LDL-c (mg/dL)	107.4±37.5	106.6±32.7	118.6±43.7		0.059
Triglycerides (mg/dL)	103.7±49.5	108.9±54.9	96.4±39.8		0.280
Cardiovascular health					
CVH score	9.9 (2.1)	10.1±2.1	9.5 (2.2)		0.134
Cardiorespiratory fitness					
$VO_{2máx}$ (mL/kg/min)	31.7±5.3	28.5±2.4	35.2±5.8	6.7	<0.001
Quality of life					
Physical component	49.2±6.7	48.0±6.9	50.7±6.0	2.7	0.022
Mental component	46.3±11.7	43.6±11.9	50.1±10.5	6.5	0.002

Abbreviations: SD: standard deviation, BMI: body mass index, PA: physical activity, SBP: systolic blood pressure, DBP: diastolic blood pressure, WC: waist circumference, WHR: waist-hip ratio, TC: total cholesterol, CVH: cardiovascular health. Data to p<0.05.
Source: Silva PHA, et al., 2024.

The comparison of anthropometric and biochemical variables, CRF, HRQoL and working hours according to CVH groups is shown in (**Table 3**). WC (Δ= 13.7 cm, p <0.001), WHR (Δ= 0.1, d= 0.88, p <0.001), LDL (Δ= 26.2, d= 0.69, p= 0.004), and triglycerides (Δ= 34.2, p= 0.002) showed lower values in the ideal CVH group compared to the poor CVH group. Regarding the CRF, the highest values of VO2max were found in the group of employees with ideal CVH (Δ= 2.8 ml/kg/min, d= 0.54, p= 0.041) compared to the group of employees with poor CVH. For the physical component of HRQoL, lower values were found in the group of employees with poor CVH compared to the groups of employees with intermediate (Δ= 4.0, p= 0.036) and ideal (Δ= 3.8, p= 0.002) CVH. Workload was higher in those with poor CVH compared to those with intermediate (Δ= 0.5 h/day, p= 0.039) and ideal (Δ= 0.5 h/day, p= 0.027) CVH.

Table 3- Comparison of anthropometric and biochemical variables, cardiorespiratory fitness, quality of life and working hours between cardiovascular health groups (n=121).

Cardiovascular Health				
Variables	**Poor (n=31)**	**Intermediate (n= 33)**	**Ideal (n=57)**	**p**
	Mean (SD)	**Mean (SD)**	**Mean (SD)**	
Anthropometric				
WC (cm)	93.9 (14.9)	85.3 (10.6)	80.2 (10.3)	<0.001
WHR	0.9 (0.1)	0.7 (0.1)	0.8 (0.1)	<0.001
Biochemical				
LDL-c (mg/dL)	124.4 (43.4)	107.4 (37.8)	98.2 (30.6)	0.006
HDL-c (mg/dL)	51.7 (9.1)	55.6 (8.6)	52.6 (8.1)	0.150
Triglycerides (mg/dL)	125.3 (64.7)	104.9 (41.1)	91.1 (40.3)	0.002
Cardiorespiratory fitness				
VO2máx (mL/kg/min)	29.6 (4.2)	30.9 (4.4)	32.4(5.98)	0.046
Quality of life				
Physical Component	46.3 (6.9)	50.3 (6.5)	50.1 (6.2)	<0.001
Mental Component	44.8 (11.9)	46.7 (12.9)	46.8 (11.1)	0.751
Working hours				
Hours/day	8.9 (1.2)	8.4 (0.9)	8.4 (1.4)	0.05

Abbreviations: SD: standard deviation, WC: waist circumference, WHR: waist-hip ratio. Data tor p<0.05.
Source: Silva PHA, et al., 2024.

Table 4 shows a multiple linear regression between the CVH score and CRF, anthropometric measurements, and HRQoL. CVH showed a positive relationship with VO_{2max} (p= 0.001) and the physical component of HRQoL (p= 0.020), while the relationship was inverse for WC (p<0.001), WHR (p<0.001), LDL-c (p<0.001), and triglycerides (p<0.001), with data adjusted for sex and age.

Table 4- Multiple linear regression between the cardiovascular health score and the variables of cardiorespiratory fitness, anthropometric measures, quality of life, biochemistry and working hours (n= 121).

Cardiovascular health score			
Variables	**β (CI95%)**	**Adjusted R2 (%)**	**p**
Model 1			
VO2máx (mL/kg; min)	0.153 (0.075. 0.239)	12.8	0.001
Model 2			
Waist circumference (cm)	- 0.089 (- 0.117. - 0.061)	26.8	<0.001
Model 3			
waist-hip ratio	- 10.582 (- 14.841. - 6.322)	18.5	<0.001
Model 4			
Physical component	0.068 (0.011. 0.126)	6.10	0.020
Model 5			
mental component	0.010 (- 0.024. 0.045)	2.00	0.556
Model 6			
LDL-c (mg/dL)	- 0.18 (- 0.028. - 0.008)	11.5	<0.001
Model 7			
Triglycerides (mg/dL)	- 0.014 (- 0.022. - 0.006)	11.6	<0.001
Model 8			
Working hours (h/day)	-0.01(-0.169. 0.153)	1.4	0.920

Abbreviations: CI= Confidence interval. Adjustment variables: Age and gender. Data for p<0.05.
Source: Silva PHA, et al., 2024.

DISCUSSION

The main findings were that education level was associated with CVH. Men had higher values for blood glucose, SBP, WC, WHR and PAL. Regarding the parameters of CVH, according to sex, a lower percentage of women reported ideal PAL, whereas women stood out with a higher percentage of ideal systemic BP and BMI. WC and WHR were lower in the group with ideal CVH, and this group had higher levels of VO_{2max} and the physical component of HRQoL. Workload was higher in workers with poor CVH. Finally, CVH score was directly related to VO_{2max} and PCS of HRQoL, and inversely related to WC, WHR, LDL, and triglycerides.

Some studies show that the level of education levels are associated with CVH, and indicating that the higher the level of education, the more ideal factors will be present in the majority of the individuals evaluated, being categorized as having intermediate and ideal CVH (GONZÁLEZ-RIVAS JP, et al., 2019; SERON P, et al., 2018), as found in the present study. Workers with higher levels of education often perform optimal health behaviors, such as the consumption of fruits, vegetables, and grains (HIZA HAB, et al., 2013), foods considered healthy for the CVH of Brazilians (MINISTÉRIO DA SAÚDE, 2018).

Gender influenced in significant differences between biochemical, anthropometric, and hemodynamic variables (GONZÁLEZ-RIVAS JP, et al., 2019; MACHADO LBM, et al., 2017). Men had higher values for WC, PAL, triglycerides, blood glucose, and diastolic and systolic blood pressure (GARCA-HERMOSO A, et al., 2017). These aspects are similar to the majority of those reported in the present study, what differs in not having found significant differences in DBP and in the serum concentration of triglycerides.

On the other hand, it is known that these biochemical, anthropometric, and hemodynamic parameters, when high, are factors associated with a higher incidence of CVDs over time. When testing the association with sex and categorized metrics, only BMI and systemic BP were significant, with women having a higher percentage of ideal CVH for systemic BP and BMI. The literature supports this fiding in relation to women for

BMI (GARCA-HERMOSO A, et al., 2017; BENZIGER CP, et al., 2018), but this relationship is not well understood for systemic BP (GARCA-HERMOSO A, et al., 2017; SERON P, et al., 2018; BENZIGER CP, et al., 2018).

It is worth mentioning that high levels of WC and WHR can detect the development of future cardiovascular or cardiometabolic diseases that become established in the body (PASDAR Y, et al., 2020). Diabetes mellitus, dyslipidemia, and arterial hypertension are examples that are associated with increased abdominal fat (LO K, et al., 2021). In addition, increased WHR is one of the risk factors for acute myocardial infarction and other clinical events (CAO Q, et al., 2018).

These elevated factors are found in individuals with impaired physical and mental QoL (POOL LR, et al., 2019) and in CRF (GOROSTEGI-ANDUAGA I, et al., 2018). Thus, the group with poor CVH is more likely to develop cardiovascular comorbidities, as they have higher values for WC and WHR, and lower values for CRF and the physical component of HRQoL.

Overweight and obesity have become a major public health problem and are associated with chronic and cardiovascular diseases. However, one of the most appropriate and effective ways to more accurately describe the distribution of body fat is to measure WC and WHR measurements (WHO, 2008). When there is an excess of fat present in the abdomen and hips, fat cells (triglycerides and LDL-c) are transferred to the vascular system and can accumulate in the coronary arteries, kidneys, liver and, especially, in the heart (NISHI H, et al., 2019).

On the other hand, to maintain these anthropometric measures at appropriate levels, they must be associated with better behavioral patterns, such as adequate nutrition and regular practice of activity and physical exercise, which are fundamental to improve CVH metrics (KALRA R, et al., 2019).

This explains the inverse relationship that was found between the CVH score and WC, WHR, triglycerides, and LDL-c is explained. However, this is the first study to report these findings and to be focus on the CVH of workers during the pandemic period. Because of the implications of these findings for health promotion, more evidence is needed to encourage educational institutions to implement prevention and health promotion programs.

CVH at optimal levels protects human health against cardiovascular pathologies, chronic non-communicable diseases, and cancer, and increases life expectancy (GAO B, et al., 2020). Therefore, it is imperative to promote CVH, especially behavioral factors, such as encouraging active transportation and consumption of natural products, which are key points to improve CVH factors (GONZÁLEZ-RIVAS JP, et al., 2019).

Furthermore, researchers POOL LR, et al. (2019) emphasize that in order to maintain CVH at an adequate level of health, it is important to have a good physical and mental QoL, especially in relation to physical aspects, as they are the greatest predictors of cardiovascular risk. These aspects were similar to those in the current study, as only the physical component showed a direct relationship with the CVH score, that is, directly associated. Regarding the mental component, this is not well explained in the literature, while the physical component, as it is associated with the time spent in activity or systematic exercises and active practice of routine activities, collaborates with the CVH metrics (POOL LR, et al., 2019).

There is evidence that workload and the work environment affect people's health, both physical and mental, and are associated with the development of cardiovascular disease (CALITZ C, et al., 2021). Workload was higher in the group with poor CVH.

As most of the population of each country works, the workplace is ideal for implementing programs, policies, and practices to promote health, specifically CVH, as CVDs is the leading cause of death worldwide. Working more than 10 hours per day and 55 hours per week is directly associated with the development of coronary heart disease, stroke, and an increased risk of cardiovascular disease (LEE D, et al., 2019; VIRTANEN M, KIVIMKI M, 2018). Increased CRF may provide better physiological, biochemical, and hemodynamic control, which is responsible for the prevention of CVD and the reduction of associated risk factors (TIKKANEN E, et al., 2018). From this perspective, increasing VO2max improves cardiac function by significantly reducing

cardiac stiffness and making blood distribution more efficient (STRASSER B, BURTSCHER M, 2018). It is also considered a health biomarker for the delivery of oxygen to the entire human body, maximizing the mitochondrial respiratory capacity of tissues (STRASSER B, BURTSCHER M, 2018).

Furthermore, it was found that a good exercise tolerance (VO2max) is a predictor and a key point to promote and maintain CVH at ideal levels. Although this result showed that CRF is directly related to CVH, further studies are needed because this is the first time in the literature that the relationship between the CVH score and VO2max has been presented. However, it has already been confirmed that good CRF helps to control of blood glucose, total cholesterol (triglycerides, LDL-c and HDL), systemic BP, and BMI, in addition to being associated with healthier habits (PEREIRA DE LIMA M, et al., 2020). Therefore, these measures should be considered in the primary prevention of CVH (LLOYD-JONES DM, et al., 2010).

The strengths of this study were the inclusion of a greater number of variables related to cardiovascular risk (triglycerides, LDL, WC, WHR, HRQoL, and VO2max), and it is the first to include a cardiorespiratory test and study in the relation to CVH. The CVH metrics were standardized according to the AHA recommendations, and the dietary intake was adequate for the Brazilian population according to the assessment performed (Supplementary Material 2).

The results of the present study should be considered with the following limitations: First, although the sample had the power to be generalized to this population, the pandemic period that which is in, caused by COVID-19, led to difficulties in recruitment, mainly in the application of the cardiorespiratory test, since it had to be performed without personal protective equipment.

The eight-hour workday of most workers prevented them from participating and completing all stages of the project due to lack of time. Second, due to the sampling method chosen (i.e., convenience sampling), the possibility of a selection bias is plausible and work responsibilities differ among cleaners, administrative staff and professors.

Third, due to the cross-sectional design, causal inferences could not be made. Fourth, because the estimates were not adjusted for potential confounders, the possibility of residual confounding affecting the results is likely. The results indicate the importance of institutions becoming aware of the need for internal policies focused on the prevention and promotion of the CVH among their workers. This is justified by the fact that workers spend most of their time in the institution, which makes it difficult to maintain a healthy diet and regular physical activity.

CONCLUSION

The study found that a quarter of the workers had poor CVH. The results suggest that when workers maintain ideal CVH, they have better results for anthropometric (WC and WHR) and biochemical (HDL-c, LDL-c and triglycerides) measures related to CVD, in addition to improved CRF. With regard to working hours, better distribution of work and rest time, the implementation of educational practices, encouragement of physical activity, adequate dietary intake, and other lifestyle habits help to improve CVH and the physical component of HRQoL.

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