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Association Of Cardiovascular Health With Health Indicators And Quality Of Life In Adults: Cross-Sectional Study

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Abstract:
***Background**: Maintaining ideal cardiovascular health is associated with improved health indicators and a reduced risk of cardiovascular disease (CVDs) mortality in adults. Objective: To associate cardiovascular health (CVH) with cardiorespiratory fitness (CRF), obesity markers and quality of life (QoL) in adults.*
***Materials and Methods**: Cross-sectional study, carried out with 121 individuals who worked at a higher education institution. CVH was assessed by seven metrics [smoking status, body mass index (BMI), physical activity level (PAL), diet, systolic blood pressure (SBP), glucose, and total cholesterol]. The obesity markers considered were anthropometric measurements [waist circumference (WC) and waist-to-hip ratio (WHR)] and biochemical variables (LDL-c and triglycerides). CRF was assessed by the shuttle run test and QoL by the Short Form-36 questionnaire.*
***Results:** 52.9% of participants had a non-ideal CVH. Participants with ideal CVH had lower values of LDL-c (P=0.009), triglycerides (P = 0.009), WC (P<0.001) and WHR (P<0.001), with higher VO2max (P=0.022) and physical component (P=0.008) of QoL. CVH was directly related to VO2max, while it was inversely related to WC (P<0.001), WHR (P=0.005), triglycerides (P=0.025) and LDL-c (P=0.035).*
***Conclusion:** For an ideal CVH, a reduction in LDL-c, triglycerides, WC, and WHR is suggested, as well as elevated VO2max values. These recommendations can be achieved through the acquisition of healthy lifestyle habits, including regular physical exercise and an appropriate diet.*
***Key Word:** Cardiovascular health; Cardiovascular metrics; Obesity indices; Biochemistry markers; Exercise tolerance.*

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I. Introduction

Chronic noncommunicable diseases (CNCDs) represent the primary cause of mortality globally.[1] These comorbidities encompass a wide range of diseases, including but not limited to cardiovascular disease, cancer, diabetes, and chronic respiratory diseases. In 2017, it was determined that 38 million individuals worldwide succumbed to CNCDs.[2] In Brazil, in 2021, approximately 72% of the population died of CNCDs.[3] Furthermore, in Brazil in the same year, the number of deaths and hospitalizations resulting from cardiovascular disease (CVDs) reached 142 thousand and 1,336,472, respectively, with a significant proportion of these individuals experiencing long-term complications.[4]

The rise in mortality from CVDs in 2010 prompted the American Heart Association (AHA) to define seven metrics as markers of cardiovascular health (CVH) for use in interventions, with the objective of reducing these deaths by 20% by 2020.[5] A decade later, the CVH construct was updated with the inclusion of a new metric, namely sleep health.[6] Consequently, CVH is currently evaluated using eight metrics (Life's Simple 8), although the continued use of Life's Simple 7 is crucial for intervening and reducing cardiovascular risks, particularly in adult.[6,7] Moreover, it is widely acknowledged that, in addition to mortality, comorbidities resulting from CVDs are prevalent in adults and are associated with stress, a sedentary lifestyle, obesity, alcoholism, hypertension, and high cholesterol.[8]

The literature provides evidence that elevated levels of anthropometric (waist circumference and waist-to-hip ratio) and biochemical measures (low-density lipoprotein cholesterol and triglycerides) associated with obesity are risk factors for CVDs and cardiometabolic disorders.[9] Conversely, good cardiorespiratory fitness

(CRF)[10] and a favorable quality of life (QoL) are protective factors.[11] The relationship between these parameters and CVH in adults still unclear.[12] However, numerous population-based studies have documented the prevalence of ideal, intermediate, and poor metrics.[13–15] The maintenance of an ideal CVH has been demonstrated to prevent the development of non-alcoholic liver disease,[16] as well as the onset of CVDs in both healthy individuals[17] and those with pre-diabetes or diabetes.[18] The results on CVH remain estimates and further research is required.

The analysis of CVH in the adult population provides a basis for the development of new, assertive health policies that aim at promoting health and preventing CVDs. Furthermore, it provides a foundation for developing educational initiatives that encourage healthy behaviors, such as physical activity and healthy eating. Thus, the objective of this study was to assess cardiovascular health and associate it with cardiorespiratory fitness, obesity markers, and quality of life in adults.

II. Material And Methods

Sample

This study employed a cross-sectional design and focused on the examination of a specific population of workers at a higher education institution. The institution had approximately 1,726 employees, of whom 302 were selected for participation in the study. Of these, 133 agreed to take part. The participants were between the ages of 18 and 59 and had been employed at the institution for a minimum of six months. Individuals who did not complete all research procedures, those with physical limitations that prevented them from performing the cardiorespiratory test, and participants with heart, chronic lung, and/or cardiometabolic diseases were excluded. Consequently, of the 133 participants, 12 were excluded due to their diabetic or hypertensive status, resulting in a final sample size of 121 participants (41.3% male and 58.7% female).

Study Design

The study was conducted between January and July 2021. The scheduling of procedures was conducted in accordance with the availability of each participant. The data were collected in the following sequence: 1) The identification form and the QoL, Mediterranean diet, and physical activity level (PAL) questionnaires were administered; 2) Anthropometric measurements and the cardiorespiratory test were conducted; 3) Blood samples were only collected in the morning by a specialized laboratory. All procedures were conducted individually in the Cardiorespiratory and Metabolic Health Studies Laboratory and in the institution's multi-sports gymnasium.

The project was approved by the Ethics and Research Committee of the Evangelical University of Goiás – Uni EVANGÉLICA under number 4.512.382/2021. All participants signed an informed consent in accordance with National Health Council Resolution 466/12 and Helsinki Declaration. Reliability and anonymity were guaranteed. The assessments were conducted in a private setting, with participants identified by numerical codes to ensure confidentiality. Access to the data was restricted to the researchers, and it will be stored for five years before being discarded (with the physical materials being incinerated and the digital materials being deleted). The results of all variables analyzed in the study were provided individually to each participant. Participants who identified as having non-ideal CVH were advised to seek consultation with a specialist in the field (i.e., a physician).

Assessment Protocols

Sociodemographic Data

An identification record was completed, providing data on gender, age, level of education (elementary school, secondary school, incomplete secondary school, complete undergraduate, incomplete undergraduate, and graduate studies), monthly income (up to two minimum wages, two to three minimum wages, three to four minimum wages, over four minimum wages), continuous use of medication (yes or no), existing comorbidities (yes or no), and job position.

Cardiovascular Health

The assessment of cardiovascular health was conducted according to the recommendations by the AHA. Seven health metrics were established, comprising four behavioral metrics (diet, PAL, Body mass index, and smoking) and three biological metrics (total cholesterol, glycemia, and systolic blood pressure).[5] The metrics were categorized as poor (0 point), intermediate (1 point), and ideal (2 points). The total number of points was used to categorize the participants' CVH as either ideal (11 to 14 points) or non-ideal (0 to 10 points) (Table 1). The adaptation of the classification was consistent with that of previous research conducted in the United States of America,[19] Spain,[20] and Brazil.[21] Table 1 illustrates the manner in which the seven CVH metrics were classified as either ideal or non-ideal.

Table 1: Classification of cardiovascular health metrics according to the American Heart Association, following the adaptation by Nriagu *et al.*,[19] for adults.

Cardiovascular health	Non-ideal (0-10 points)	Ideal (11-14 points)
Smoking	Current smoker or ex-smoker who quit less than 12 months ago	Never smoked or quit more than 12 months ago
Diet	Questionnaire score between 00-34	Questionnaire score between 35-55
BMI	≥ 25 Kg/m^2	< 25 Kg/m^2
PAL	Perform no or < 149 min PA per week with MI or < 74 min with VI or 1-49 min MI + VI	Perform ≥ 150 min of weekly PA with MI or ≥ 75 min with VI or ≥ 150 min of MI +VI
Glucose	≥ 100 mg/dL	< 100 mg/dL
Total cholesterol	≥ 200 mg/dL	< 200 mg/dl
SBP	≥ 120/80 mmHg	< 120/< 80 mmHg

BMI, Body mass index; PAL, Physical activity level; SBP, Systemic blood pressure; PA, Physical activity; MI, Moderate intensity; VI, vigorous intensity.

The dietary assessment tool was adapted from the Cardioprotective Food Manual, which was developed by the Ministry of Health in collaboration with the Heart Hospital for use with the Brazilian population.[22] In this manual, the foods deemed to be cardioprotective are identical to those included in the Mediterranean Diet Questionnaire utilized in the aforementioned study.[23] The questionnaire comprises 11 items that assess the frequency of consumption of specific foods over the course of a typical week.[23] The instrument exhibits a degree of adherence, with a score range of 0 to 55 points, wherein higher values indicate a diet that is more cardioprotective.[23]

The International Physical Activity Questionnaire - short version (IPAQ-short version), validated for use with the Brazilian population, was employed to assess the PAL.[24] The instrument comprises eight questions regarding the frequency and duration of physical activities undertaken during the day and week.[24] Smoking history was evaluated through a self-report questionnaire, whereas the body mass index (BMI) was calculated by dividing weight (kg) by height squared (m²). The lipid profile (LDL-c, HDL-c, and triglycerides) and blood glucose levels were determined from the blood samples using the enzymatic colorimetric method, which required the participants to have fasted for a period of 8 to 12 hours. Systolic and diastolic blood pressures were obtained using a semi-automatic device (OMRON model HEM 705CP, Kyoto, Japan).[25]

Quality of Life

The evaluation was conducted using the Short Form-36 (SF-36) questionnaire, which has been validated for use with the Brazilian population.[26] The instrument comprises 11 questions pertaining to the preceding four weeks.[26] Eight domains are evaluated and utilized to calculate the physical component score (PCS) and the mental component score (MCS). The PCS encompasses domains pertaining to physical aspects, pain, and activities of daily living, whereas the MCS incorporates social, emotional/mental, and vitality aspects.[27] The SF-36 items are scored on a scale of 0 to 100, with lower values indicating a less favorable quality of life.[26]

Anthropometric Measurements

Waist circumference (WC) and hip circumference (HC) were measured using an inextensible measuring tape (Cescorf, model Trena, São Paulo, Brazil). WC was measured with the tape positioned at the midpoint between the superior iliac crest and the last palpable rib. HC was measured in the hip region and the tape was placed in the area of greatest protuberance.[28] Consequently, the waist-to-hip ratio (WHR) was calculated by dividing the WC/HC. [28] The reference values for WHR in women were < 0.76 cm and in men < 0.91 cm, which are considered normal values.[28] WC values ≥ 88 cm for women and ≥ 102 cm for men was considered with abdominal adiposity.[28]

Cardiorespiratory Fitness

The shuttle run test has been validated for use with the Brazilian population.[29] The 20-stage test is designed to identify the subject's maximum aerobic power. It requires the use of a 20-meter flat track and a metronome to complete the run.[29] The metronome emitted sequences of beeps with increasing intensity, commencing at 8.5 km/h. Two subsequent stages were not completed, the test was terminated, and the velocity attained in the final stage was employed to estimate VO2max via the following formula: [29]

$$VO2max = -24.4 + 6 \times (Speed)\ ml/kg/min \qquad \text{Equation (1)}$$

Data Analysis

The data were expressed as means, standard deviations, frequencies, percentages, and tables. The Kolmogorov-Smirnov test was employed to ascertain the normality of the data. The Student's T-test for independent samples (for data with a symmetrical distribution) and the Mann-Whitney U-test for independent samples (for data with an asymmetrical distribution) were employed to compare the two groups (ideal CVH and non-ideal CVH). Furthermore, the chi-square test was employed to ascertain the frequencies. Binary logistic regression was conducted between the CVH groups with independent variables (VO2max, WC, WHR, LDL-c, triglycerides, HDL-c, and QoL). The effect size was calculated and classified according to Cohen.[30] The p-value considered was < 0.05, and the Statistical Package for the Social Sciences (SPSS, IBM, version 23.0, Armont, NY) was utilized for the analysis.

III. Result

A total of 121 adults participated in the study, of whom 47.1% exhibited ideal CVH and 52.9% demonstrated non-ideal CVH. The mean body mass was found to be higher in participants with non-ideal CVH (p = 0.005). With regard to gender, smoking history, and level of education, 56.3% of women, 89.1% of non-smokers, and 32.8% of participants with complete high school education exhibited a non-ideal CVH, respectively. With regard to the use of medication, 21 individuals (17.4%) used anxiolytics or antidepressants, three individuals (2.5%) multivitamins, one individual (4.8%) anti-inflammatories, one individual (4.8%) anticoagulants, and ten women (8.3%) contraceptives (Table 2).

Table 2 - Sociodemographic and clinical characteristics of the sample (n=121).

Variables	Cardiovascular health			p*
	Total (n=121)	**Ideal (n=57)**	**Non-ideal (n=64)**	
	Mean ± SD	**Mean ± SD**	**Mean ± SD**	
Age (years)	35.9 ± 10.1	33.8 ± 9.7	37.9 ± 10.2	0.054
Height (cm)	166.9 ± 10.3	167.8 ± 9.9	166.2 ± 10.7	0.372
Body mass (kg)	72.8 ± 17.9	67.8 ± 14.3	77.2 ± 19.6	0.005
	n (%)	**n (%)**	**n (%)**	**p****
Sex				0.566
Male	50 (41.3)	22 (38.6)	28 (43.8)	
Female	71 (58.7)	35 (61.4)	36 (56.2)	
Smoking				0.060
Former or current smoker	08 (6.7)	01 (1.8)	07 (10.9)	
Never smoked	113 (93.3)	56 (98.2)	57 (89.1)	
Education				0.023
Elementary school	04 (3.3)	02 (3.5)	02 (3.1)	
High school	20 (16.5)	05 (8.8)	15 (23.4)	
High school: incomplete	29 (24)	19 (33.3)	10 (15.6)	
Higher education: complete	32 (26.4)	11 (19.3)	21 (32.8)	
Graduate degree	36 (29.8)	20 (35.1)	16 (25.1)	
Job title				0.064
Teachers	12 (9.9)	07 (12.3)	05 (7.8)	
Administrative	91 (75.2)	46 (80.7)	45 (70.3)	
General services	18 (14.9)	04 (7.0)	14 (21.9)	
Monthly income (minimum wages)				0.468
One to two	50 (41.3)	21 (36.8)	29 (45.3)	
Two to three	41 (33.9)	23 (40.4)	18 (28.1)	
Three to four	09 (7.4)	03 (5.3)	06 (9.4)	
> than four	21 (17.4)	10 (17.5)	11 (17.2)	
Comorbidity				0.997
Yes	20 (16,5)	10 (17.5)	10 (15.6)	
No	101 (83,5)	47 (82.5)	54 (84.4)	
Medication				0.414
Yes	36 (29.8)	15 (26.3)	21 (32.8)	
No	85 (70.2)	42 (73.7)	43 (67.2)	

SD, Standard deviation; p*, Student's t-test or Mann-Whitney test; p**, Chi-squared test for independence. Data for p < 0.05.

Participants with non-ideal CVH had higher values for BMI (Δ = 3.9 kg/m2, p < 0.001), total cholesterol (Δ = 21.8 mg/dL, p = 0.002), systolic blood pressure (Δ = 13.6 mmHg, p < 0. 001), diastolic blood pressure (Δ = 9.9 mmHg, p < 0.001), LDL-c (Δ = 17.4 mg/dL, p = 0.009), triglycerides (Δ = 23.5 mg/dL, p = 0.009), WC (Δ = 9.2 cm, p < 0.001) and WHR (Δ = 0.1, p < 0.001). However, diet (Δ = 3.1, p = 0.003), PAL (Δ = 118.2 min/wk, p = 0.001), VO_{2max} (Δ = 2.1 mL/kg; min, p = 0.022), PCS (Δ = 1.8, p = 0.008) QoL and CVH score (Δ = 3.4, p < 0.001) were lower (Table 3).

Table 3 - Comparison of cardiovascular health metrics, biochemical and anthropometric measurements, cardiorespiratory fitness and quality of life between the groups with ideal and non-ideal cardiovascular health (n=121).

Parameters	Cardiovascular Health				
	Total (n=121)	**Ideal (n=57)**	**Non-ideal (n=64)**	**ES**	**p**
	Mean ± SD	**Mean ± SD**	**Mean ± SD**		
Behavioral					
Diet (points)	27.9 ± 5.7	29.5 ± 5.0	26.4 ± 5.9	0.27	0.003
PAL (min/sem)	245.9 ± 203.5	308.4 ± 216.1	190.2 ±174.9	0.29	0.001
BMI (kg/m^2)	25.9 ± 5.1	23.9 ± 3.3	27.8 ± 5.7	0.84	<0.001
Biological					
Glucose (mg/dL)	86.4 ± 20.2	82.8 ± 7.9	89.5 ± 26.5	0.17	0.069
TC (mg/dL)	181.9 ± 40.4	170.4 ± 31.8	192.2 ± 44.5	0.56	0.002
Systolic BP (mmHg)	123.4 ± 15.3	116.2 ± 10.9	129.8 ± 15.8	0.97	<0.001
Diastolic BP (mmHg)	80.8 ± 11.0	75.5 ± 8.4	85.4 ± 11.01	1.01	<0.001
Biochemical					
LDL-c (mg/dL)	107.4 ± 37.5	98.2 ± 30.6	115.6 ± 41.2	0.48	0.009
HDL-c (mg/dL)	53.1 ± 5.6	52.7 ± 8.1	53.7 ± 8.9	0.12	0.492
TG (mg/dL)	103.7 ± 49.5	91.3 ± 40.3	114.8 ± 54.4	0.24	0.009
Anthropometric					
WC (cm)	85.1 ± 12.9	80.2 ± 10.2	89.4 ± 13.5	0.77	<0.001
WHR	0.8 ± 0.1	0.8 ± 0.1	0.9 ± 0.10	0.45	<0.001
CRF					
VO_{2max} (mL/kg; min)	28.3 ± 5.3	29.4 ± 5.9	27.3 ± 4.4	0.20	0.022
CVH					
CVH score	9.9 ± 2.1	11.7 ± 0.8	8.3 ± 1.6	0.80	<0.001
Quality of life					
Physical component	49.2 ± 6.7	50.1 ± 6.2	48.3 ± 7.0	0.13	0.008
Mental component	46.3 ± 11.7	46.8 ± 11.1	45.8 ± 12.4	0.04	0.932
QoL score	69.6 ± 18.4	71.5 ± 17.1	67.9 ± 19.6	0.10	0.932

PAL. Physical activity level; BMI. Body mass index; TC. Total cholesterol; Sistólic BP. blood pressure; Diastólic BP. Diastolic blood pressure; LDL-c. Low-density lipoprotein cholesterol; HDL-c. High-density lipoprotein cholesterol; TG. Triglycerides; WC. Waist circumference; WHR. Waist-to-hip ratio; CRF. Cardiorespiratory fitness; VO_{2max}. Maximum oxygen consumption; CVH. Cardiovascular health. ES. Effect size; QoL. Quality of life; SD. Standard deviation.

The binary logistic regression identified that, after adjusting for age and gender, high WC ($p < 0.001$) was a significant predictor. An increase in WHR ($p = 0.005$), triglycerides ($p = 0.025$), and LDL-c ($p = 0.035$) was associated with an elevated likelihood of non-ideal CVH. Similarly, a reduction in VO_{2max} ($p = 0.002$) was also linked to a higher risk of non-ideal CVH (Table 4).

Table 4: Binary logistic regression models of the predictive capacity of VO_{2max}, obesity markers and quality of life to identify non-ideal and ideal CVH (n=121).

	Cardiovascular health								
	Non adjusted model			**Adjusted model ^{a*}**			**Adjusted model ^{a**}**		
	β (EP)	**OR (IC95%)**	**p**	**β (SE)**	**OR (IC95%)**	**p**	**β (SE)**	**OR (IC95%)**	**P**
Model 1									
VO_{2max} (mL/kg; min)	0.09 (0.04)	1.09 (0.01/1.17)	0.028	0.08 (0.04)	1.08 (0.99/1.17)	0.053	0.18 (0.06)	1.19 (1.07/1.35)	0.002
Model 2									
WC (cm)	-0.07 (0.02)	0.94 (0.90/0.97)	<0.001	-0.07 (0.02)	0.94 (0.90/0.97)	0.001	-0.07 (0.02)	0.94 (0.90/0.97)	<0.001
Model 3									
WHR	-8.00 (2.41)	0.00 (0.00/0.04)	0.001	-7.24 (2.45)	0.00 (0.00/0.09)	0.003	-8.15 (2.89)	0.00 (0.00/0.08)	0.005
Model 4									
Triglycerides (mg/dL)	-0.01 (0.01)	0.99 (0.99/0.99)	0.012	-0.01 (0.01)	0.99 (0.98/0.99)	0.030	-0.01 (0.01)	0.98 (0.98/0.99)	0.025
Model 5									
LDL-c (mg/dL)	-0.01 (0.01)	0.99 (0.98/0.99)	0.013	-0.01 (0.01)	0.99 (0.98/0.99)	0.032	-0.01 (0.01)	0.99 (0.98/0.99)	0.035
Model 6									
HDL-c (mg/dL)	-0.02 (0.02)	0.99 (0.94/1.03)	0.489	-0.01 (0.02)	0.99 (0.95/1.04)	0.710	-0.10 (0.02)	0.99 (0.95/1.04)	0.661
Model 7									

Physical component	0.04 (0.03)	1.04 (0.98/1.10)	0.159	0.04 (0.03)	1.04 (0.98/1.09)	0.229	0.04 (0.03)	1.04 (0.99/1.11)	0.163
Model 8									
Mental component	0.01 (0.02)	1.01 (0.98/1.04)	0.629	0.01 (0.02)	1.01 (0.98/1.05)	0.454	0.02 (0.02)	1.02 (0.99/1.05)	0.272

WC. Waist circumference; WHR: Waist-to-hip ratio; LDL-c. Low-density lipoprotein cholesterol; HDL-c. High-density lipoprotein cholesterol. β: Regression coefficient; CI: Confidence interval; OR: Odds ratio; SE: Standard error; * Models adjusted by age; ** Models adjusted by age and sex; Data for P < 0.05.

When the mean probabilities from the BLR were compared between the CVH groups, it was observed that the group with ideal CVH had higher probabilities for VO_{2max} ($p < 0.001$), WC ($p < 0.001$), WHR ($p < 0.001$), triglycerides ($p < 0.001$), LDL-c ($p < 0.001$), HDL-c ($p = 0.012$), physical component ($p = 0.004$), and mental component ($p = 0.007$) (Figure 1).

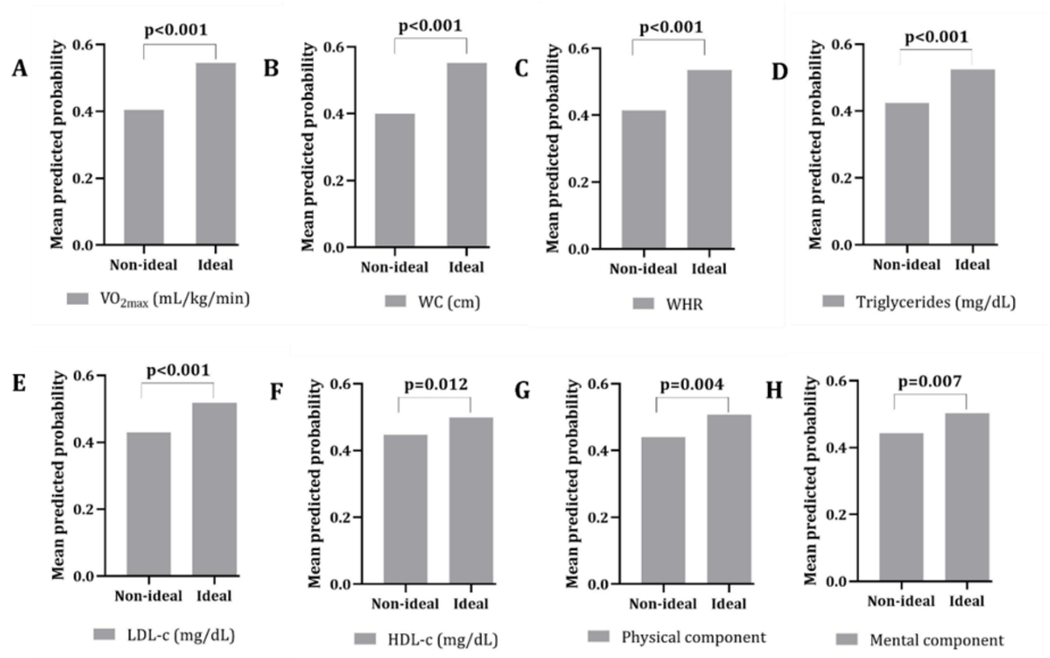

Figure 1 - Comparison graph of probability means according to the predictor variable (A to H). Student's t-test for independent samples was used to compare the probability between groups (data for p<0.005). **A**. Maximum oxygen consumption. **B**. Waist circumference. **C**. Waist-to-hip ratio. **D**. Triglycerides. **E**. LDL-c. **F**. HDL-c. **G**. Mental component. **H**. Physical component.

IV. Discussion

This study identified an association between CVH and CRF, as well as obesity markers and QoL in adults. The study yielded three primary findings. First, participants with non-ideal CVH exhibited lower values for VO_{2max} and PCS of QoL. Second, the results demonstrated that LDL-c, triglycerides, WC and WHR were higher in participants with non-ideal CVH. Furthermore, the binary logistic regression models identified that participants with high levels of WC, WHR, LDL-c, and triglycerides were more likely to have non-ideal CVH, while increased VO_{2max} contributed to better CVH.

CVH has been shown to be an effective strategy for reducing the incidence and prevalence of CVDs, as well as associated risk factors.[31] Furthermore, the CVH score is directly correlated with the PCS[32] and the MCS of QoL in adults.[27] The relationship of CVH with MCS remains unclear.[32] Regarding overall QoL, this appears to exert a direct influence on CVH in healthy adults[27] and in patients with chronic kidney disease.[33] Although this study did not show associations between CVH status and overall QoL or MCS, the lack of significance may suggest that mental aspects of QoL are less sensitive to variations in CVH in this population, or that other psychosocial and behavioral factors exert a stronger influence on MCS. Nevertheless, the PCS of QoL and VO_{2max} were lower in participants with non-ideal CVH. The results of this study indicate that suboptimal CVH is associated with decreased performance, functionality, and vitality, particularly in activities of daily living.

The findings of this study suggest that ideal and non-ideal CVH status were inversely associated with LDL-c and triglyceride levels. Elevated values of these biochemical parameters have been demonstrated to be directly related to cardiovascular risk.[33] This relationship can be attributed to the accumulation of lipids in circulation, which has been shown to damage the arterial endothelium, promote cholesterol deposition, and accelerate the formation of atheromatous plaques. This process has been shown to increase the likelihood of obstructions in coronary blood flow, which can culminate in acute myocardial infarction.[34] Consequently, individuals with no ideal CVH are more susceptible to developing atherosclerotic complications. Although HDL-C did not demonstrate a significant association with CVH status in this study, its protective function is recognized, as it exerts antiatherogenic, anti-inflammatory, and antioxidant effects that contribute to the reduction of adverse cardiovascular outcomes. It is important to note that regular physical exercise is an essential strategy for reducing these risk factors, improving the lipid profile, preventing disability, and reducing all-cause mortality.[35] The following essay will provide a comprehensive overview of the relevant literature on the subject.

In addition, it was observed that no ideal CVH was associated with higher WC and WHR values, which are important markers of abdominal adiposity. The accumulation of visceral and ectopic adipose tissue has been demonstrated to promote insulin resistance, alter lipid metabolism, and contribute to increased circulating levels of LDL-c and triglycerides.[36] This redistribution of fat, particularly in the abdominal region, has been shown to intensify the risk of metabolic and cardiovascular dysfunction, thereby reinforcing the role of central obesity as a determinant of risk profile. Consequently, the reduction of these anthropometric markers is associated with a greater chance of achieving a healthier cardiovascular profile.[32] It is important to note that WC and WHR have been shown to be cost-effective and can be utilized as follow-up markers in lifestyle change programs.

The present study found that ideal CVH status is directly associated with CRF. Participants with lower VO_{2max} levels exhibited a substantially diminished probability of attaining ideal CVH, thereby reinforcing the pivotal role of CRF as a determinate of CVH. In addition to aerobic capacity, evidence suggests that flexibility[20] and PCS of HRQoL[27] are positively associated with CVH in adults. It is widely accepted that CRF is a robust biomarker of health. Higher levels of this marker are associated with maximum mitochondrial respiration, improved endothelial function, reduced cardiac stiffness, and greater autonomic balance.[36] These physiological adaptations contribute to more efficient oxygen utilization, improved glucose and lipid metabolism, and decreased systemic inflammation, thereby reducing the incidence of CVDs and their associated risk factors.[36, 37] In this regard, the promotion of regular physical activity and the adoption of healthy dietary habits by public and private policies in the workplace is of paramount importance in favoring CVH metrics. This approach not only serves to prevent CVDs but also to enhance occupational health in this demographic.

The present study was limited in the following ways: 1) The lack of compliance was attributed to participants' workload and the restrictions imposed by the COVID-19 pandemic, both of which contributed to the low adherence observed; 2) Since this was a cross-sectional study, it was not possible to establish a cause–effect relationship. Potential biases included measurement errors and recall bias, however, the researchers responsible for data collection were previously trained to minimize these issues; 3) The measurement of maximum aerobic power was performed using an indirect test, as this is a low-cost method with a high relationship with the cardiopulmonary exercise test. Conversely, the study's key strengths lie in its ability to evaluate a range of variables at a relatively low cost, including obesity markers, CRF, QoL and CVH factors. These objective assessments provide valuable insights into the overall SCV. Furthermore, it can assist public and private organizations in formulating institutional policies aimed at enhancing the quality and direction of educational initiatives.

V. Conclusion

In conclusion, the prevalence of non-ideal CVH was high among participants. The results indicate that individuals who maintain an ideal CVH profile may demonstrate a reduction in obesity-related markers, including LDL-c, triglycerides, WC, and WHR. CRF and PCS of QoL exhibited superior outcomes, which, in turn, indicated a reduced ratio of CVDs. These findings highlight important implications for workplace health, since non-ideal CVH can negatively impact employees' productivity, increase absenteeism, and raise long-term healthcare costs. Therefore, it is recommended that workplace-based educational practices be implemented, with incentives for healthy eating and regular exercise, as these behavioral factors directly influence the biological determinants of CVH and overall occupational well-being.

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