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CAROTID INTIMA-MEDIA THICKNESS ASSESSMENT AS A PREVENTIVE TOOL IN UNDIAGNOSED BRAZILIAN ADULTS WITH ALTERED TRIGLYCERIDES LEVELS

Regina Célia Vilanova-Campelo[1]

Victor José Campelo-Vilanova[2]

Tara Rendo-Urteaga[3]

Raquel Vilanova Araújo[4]

Mauricio Batista Paes Landim[5]

Abstract

The relationship between the lipid profile, the carotid intima-media thickness (c-IMT) and the subclinical atherosclerosis is not fully elucidated. Currently, c-IMT measurement is not recommended as a screening test to atherosclerosis and cardiovascular disease. A cross-sectional study was conducted addressing the association between the lipid profile and the carotid thickening in undiagnosed adults. Hierarchical analysis was used to examine the association between the lipid profile and c-IMT in each sex. The study included 201 adults without prior diagnosis of atherosclerotic disease or type 2 diabetes (mean age 51±14.6 years; 62.2% female) and selected by simple random probabilistic sampling. The measured outcome was the c-IMT. The independent variables were the low-density lipoprotein, total cholesterol, triglycerides, very low-density lipoproteins and high-density lipoproteins levels. The potential confounders were age, family income, physical activity, smoking, hypertension, obesity and diabetes. The c-IMT was higher (0.92±0.33 µm) when subjects had altered values of triglycerides [men: 0.001 g/L (CI 95%: 0.0002–0.002); and women: 0.0005 g/L (CI 95%: 0.00009–0.001)] in the adjusted analysis. This suggests that triglyceride levels are a simple marker of c-IMT elevation in undiagnosed Brazilian adults. In clinical practice, health care professionals should be encouraged to early measure carotid intima-media thickness in asymptomatic patients with altered triglyceride levels in order to prevent atherosclerosis and cardiovascular disease.

Keywords: Atherosclerosis; Cardiovascular Disease; Carotid Intima-Media Thickness; Triglycerides; Undiagnosed Adults.

Resumo

A relação entre o perfil lipídico, a espessura médio-intimal da carótida (c-IMT) e a aterosclerose subclínica não está totalmente elucidada. Atualmente, a medição da c-IMT não é recomendada como teste de triagem para aterosclerose e doenças cardiovasculares. Foi realizado um estudo transversal abordando a associação entre o perfil lipídico e o espessamento carotídeo em adultos não diagnosticados. A análise hierárquica foi utilizada para examinar a associação entre o perfil lipídico e a c-IMT em cada sexo. O estudo incluiu 201 adultos sem diagnóstico prévio de doença aterosclerótica ou diabetes tipo 2 (idade média 51±14,6 anos; 62,2% mulheres), selecionados por amostragem probabilística aleatória simples. O resultado medido foi o c-IMT. As variáveis independentes foram os níveis de lipoproteína de baixa densidade, colesterol total, triglicerídeos, lipoproteínas de muito baixa densidade e lipoproteínas de alta densidade. Os potenciais confundidores foram idade, renda familiar, atividade física, tabagismo, hipertensão, obesidade e diabetes. A c-IMT foi maior (0,92±0,33 µm) quando os indivíduos apresentaram valores alterados de triglicerídeos [homens: 0,001 g/L (IC 95%: 0,0002–0,002); e mulheres: 0,0005 g/L (IC 95%: 0,00009–0,001)] na análise ajustada. Isto sugere que os níveis de triglicerídeos são um marcador simples de elevação da c-IMT em adultos brasileiros não diagnosticados. Na prática clínica, os profissionais de saúde devem ser incentivados a medir precocemente a espessura médio-intimal da carótida em pacientes assintomáticos com níveis alterados de triglicerídeos, a fim de prevenir a aterosclerose e doenças cardiovasculares.

Palavras-chave: Adultos não Diagnosticados; Aterosclerose; Doença Cardiovascular; Espessura Médio-Intimal da Carótida; Triglicerídeos.

[1] Professor at the State University of Maranhão (UEMA). PhD in Sciences. E-mail: reginacampelo@professor.uema.br

[2] Undergraduate student in Medicine at the State University of Piauí (UFPI). E-mail: vctrcmpl@gmail.com

[3] Professor at Isabel I University. PhD in Food, Physiology and Health. E-mail: tara.rendo.urteaga@gmail.com

[4] Professor at the State University of the Tocantins do Maranhão Region. PhD in Nursing. E-mail: raquel.araujo@uemasul.edu.br

[5] Professor at the Federal University of Piauí (UFPI). PhD in Sciences. E-mail: mauriciolandim@ufpi.edu.br

INTRODUCTION

Atherosclerosis is a dynamic process characterized by the remodeling of the arterial wall, which can go unnoticed for decades without any clinical manifestations. Cardiovascular diseases have a significant economic and social impact and, as such, have been recognized as a public health issue. Atherosclerosis is a chronic disease that affects the body's arteries, involving the accumulation of fat, cholesterol, and other materials on the artery walls. These plaques can become rigid and, over time, narrow the arteries, reducing blood flow.

Evidence indicates that atherosclerosis is one of the leading causes of cardiovascular diseases, such as coronary heart disease, stroke, and peripheral arterial disease. Understanding its risk factors and the ability to assess its progression are crucial for prevention and effective treatment.

Because it is considered a complex process involving a series of interrelated events, the following are listed as risk factors for atherosclerosis: elevated cholesterol levels, high blood pressure, smoking, diabetes, obesity, physical inactivity, age, and gender (the risk of atherosclerosis increases with age and is generally higher in men than in women before menopause).

In this context, in the implementation of primary prevention strategies, it becomes necessary to use reliable tests to identify individuals without established disease who are at high risk of experiencing a future event. Detecting atherosclerosis in asymptomatic individuals using various strategies helps predict and prevent future events.

For this purpose, the measurement of carotid artery wall thickness, known as carotid intima-media thickness (c-IMT), is a non-invasive method used to assess the presence and progression of atherosclerosis. c-IMT assessment is conducted through Doppler ultrasound examinations, which measure the thickness of the intima-media layer of the carotid arteries. c-IMT measurement allows for the identification of atherosclerosis before it causes symptoms or serious complications, enabling targeted interventions and playing a crucial role in early identification and monitoring of atherosclerosis progression, helping to prevent serious cardiovascular events and improve patients' cardiovascular health. In this regard, significant efforts have been made to detect the onset of the disease and establish primary prevention strategies for all individuals, including asymptomatic individuals. However, this examination is not routinely used in clinical practice, especially in public health services. Therefore, this study aimed to evaluate the association between lipid profile and carotid thickness in undiagnosed adults.

The text is divided into the following sections: (1) Introduction, which summarizes the study and is organized to outline the study's theme, its justification, and objectives; (2) Theoretical framework of atherosclerosis and its risk factors, as well as an explanation of c-IMT assessment and its benefits for the diagnosis and monitoring of atherosclerosis progression; (4) Methods with the procedures for data collection and analysis; (5) Discussion that presents evidence from the study showing an association between triglyceride levels (a marker of cardiovascular disease) and c-IMT in asymptomatic patients; (6) Results that present the association between lipid profile and c-IMT by gender.

THEORETICAL FRAMEWORK

Atherosclerosis is a chronic inflammatory disease of multifactorial origin, which occurs in response to endothelial aggression, affecting mainly the intima layer of medium and large calibre arteries (FALUDI *et al*., 2017). Atherosclerosis serves as a substrate for cardiovascular disease (CVD), especially coronary artery disease (FALUDI *et al*., 2017). The intima-media thickness of the common carotid artery (c-IMT) is an established marker of atherosclerosis (STEIN; KORCARZ; POST, 2009; LIU *et al*., 2020) and has been associated with CVD (STEIN *et al*., 2008).

The technique to measure the c-IMT is a non-invasive, inexpensive, and prognostic examination that could be implemented among asymptomatic and diseased patients (MAGNUSSEN, 2017). This marker is used in clinical and epidemiological studies to detect early atherosclerotic lesions, to monitor their progression in the general population (STEIN *et al*., 2008; CHAMBLESS *et al*., 1997; CAO *et al*., 2007; CHAMBLESS *et al*., 2000; LORENZ, 2005; LUDWIG, 2003; GRANÉR, 2006) and to identify atheroma development (LORENZ *et al*., 2012). Monitoring CV risk factors can reduce their incidence, which in turn helps to determine the appropriate treatment for people without clinically established disease (FITCH *et al*, 2011). In this sense, triglyceride levels (TG) represent an important CVD risk biomarker due to its association with remaining atherogenic particles and some apolipoproteins such as apo-CIII (MILLER, 2011; YU *et al*., 2022; SANDESARA *et al*, 2019).

The quantification of carotid intima-media thickness c-IMT is a non-invasive procedure used as a biomarker for early atherosclerosis (LORENZ *et al*., 2012). It is considered a safe and cost-effective method that allows for the direct assessment of all stages of atherosclerosis, being useful both in its diagnosis and in monitoring its progression (SALONEN; SALONEN, 1991; BARTH, 2002). Robinson; Gidding (2014) propose that c-IMT is the best non-invasive measure for assessing atherosclerosis. This imaging method is recognized by the I Brazilian Guideline on Cardiovascular Prevention (SIMÃO *et al*., 2014). Previous studies have shown that c-IMT is associated with the incidence of cardiovascular events and cardiovascular risk factors (POLAK *et al*., 2011; SINNING *et al*., 2011).

The evaluation of c-IMT involves measuring, through ultrasound imaging, the distance between the intima layer of the artery and the media layer of the artery (SHINGHAL *et al*., 2005; KUMAR; SACHDEV; KHALIL, 2004). An increase in this thickness is considered a risk factor for coronary artery disease (KAPUKU *et al*., 2006; LORENZ *et al*., 2012).

Various cardiovascular risk factors have been linked to an increase in c-IMT, including age, male gender, diabetes mellitus, total cholesterol, and smoking (GROBBEE; BOTS 1994; URBINA *et al.*, 2002; SELVIN *et al*., 2005). This increase, in adults, when associated with coronary artery disease, is predictive of future cardiovascular events, including stroke and myocardial infarction (CHAMBLESS *et al*., 1997; O'LEARY *et al*., 1999).

The influence of physical inactivity as a contributor to the increase in c-IMT is already established, Thijssen *et al*., (2012), along with other risk factors, including obesity, Ahmadi *et al*., (2011), hypertension, Palatini *et al*., (2011), visceral adiposity, Maher *et al*., (2009), inflammatory markers, Kozakova *et al*., (2013), and smoking (KATANO; OHNO; YAMADA, 2013).

Scientific evidence, Salonen; Salonon, (1991); Chambless *et al*., (1997), has shown a strong association between c-IMT and the incidence of coronary artery disease, indicating the need for more interventions to reduce risk factors for the progression of this condition (STEIN *et al*., 2008). Robinson; Gidding (2014) propose that c-IMT is the best non-invasive measure for assessing atherosclerosis.

Moreover, the lipid profile has been associated with c-IMT in several studies with subjects with some disease conditions (FEINGOLD; GRUNFELD, 2022; AHMED *et al.*, 2021; NIMKUNTOD; TONGDEE, 2015). The enzymatic technique to determine TG is an easy-to-evaluate, precise and inexpensive method recommended by its cost-effectiveness (XAVIER *et al*, 2013; JELLINGER *et al*., 2017). Hence, to measure TG levels is an important screening test for patients before having an altered c-IMT, which could consequently prevent CVD. In line with this, in clinical practice, the indication for testing c-IMT could be established when TG levels were elevated. To our knowledge, few studies address the association between TG and c-IMT (CHAMBLESS *et al.*, 2002; QIN *et al*., 2017), especially in undiagnosed adults. In this study, we hypothesised that TG levels predicts elevated c-IMT in asymptomatic Brazilian individuals.

METHODS

Study design and data collection

We performed a cross-sectional study involving individuals without previous diagnosis of atherosclerotic disease and aged 20–79 years. The participants attended the Cardiovascular Unit of the

University Hospital of the Federal University of Piauí (CU/UHFUP) in Teresina (Piauí, Brazil), between January and June 2014. The CU/UHFUP offers a medium-to-high complexity services, and there are no urgency or emergency services. However, for being the hospital of reference, the municipal health system (http://www.ebserh.gov.br/web/huufpi/apresentacao) refers patients to outpatient services (such as consultations, tests and procedures). In this sense, the individual identified of CVD or any risk factors for CVD by the primary health care system is referred to CU/UHFUP in order to be examined by specialized care (e.g, cardiologist), which favours an overview of that area. Subjects were selected by simple random probability sampling, a prevalence of CV mortality of 20%, Miller, (2011) and the number of visits performed at the CU/UHFUP during the six-month period (n=701). A margin of error of 2% was adopted with a 95% confidence interval. The result of this calculation determined a minimum sample of 188 subjects. In order to avoid losses and preserve the representativeness of the study, 10% of subjects were added to this sample, resulting in a calculation of 207 subjects. The inclusion criteria for the study were i) adults consulted in the hospital without previous diagnosis of atherosclerotic disease and/or type 2 diabetes, ii) those who did not take continuous medication (e.g, diabetics and hypertensives), iii) those with absence of orthopedic conditions, iv) not pregnant, and v) who properly signed the informed consent form (ICF). The diagnosis of previous CV was identified by the cardiologist by anamnesis, use of medications and / or exams. The valid final sample was 201 subjects (six subjects did not sign the ICF with sufficient information). This study was approved by the Research Ethics Committee of the Federal University of Piauí [process: 19512513.4.0000.5214].

Outcome

A measurement of c-IMT was obtained during ultrasound examination using *Medison-SonoAce* X6 Doppler ultrasound equipment and the software of the equipment itself. The examination was performed by an experienced vascular radiologist, blind to the clinical and laboratory findings of the patients. The exams were performed at the UHFUP Image Diagnostic Unit. Three measurements of the thickness of the right common carotid artery were recorded. The measurements were performed on the posterior wall of the artery, 1 cm proximal to its bifurcation, as the distance between two echogenic lines corresponding to the lumen-intima and media-adventitia interfaces of the arterial wall, Stein *et al.*, (2008), with linear transducer of 7.5 MHz, and with a frequency range of 5–12 MHz. The c-IMT was calculated as the mean of the three values recorded (GEPNER *et al.*, 2006; KANTERS *et al.*, 1997). Subjects were classified according to the VI Brazilian Guideline for Dyslipidemia and Prevention of Atherosclerosis (XAVIER *et al.*, 2013).

Independent variables

The independent variables of this study were the total cholesterol (TC), triglycerides (TG), very low-density lipoproteins (VLDL-c), low-density lipoproteins (LDL-c), and high-density lipoproteins (HDL-c) levels. Blood samples were collected from each subject (5 mL/dL of venous blood) after at least 12 hours of fasting. The serum concentrations of TC, TG, VLDL-c, LDL-c, and HDL-c were analysed by the enzymatic method in the clinical analysis laboratory of the UHFUP. The equipment used to analyse blood samples was the Cobas Integra plus 400 (Roche, Rotkreuz, Switzerland), with specific intra-assay variation coefficients of each chemistry parameter of 2.1% (TC), 1.4% (TG), 1.3% (LDL-c) and 3.5% (HDL-c). The unit of measurement for these biological samples was mg/dL. Abnormal values were defined according to the guidelines for this population (XAVIER *et al*., 2013).

Potential confounders

The potential confounders were age, family income, physical inactivity, cigarette smoking, hypertension, obesity and diabetes. Family income values were used as a categorical variable (no income: 1 wage, 2 wages, 3–5 wages and more than 5 wages) considering the Brazilian Minimum Wage (BMW) of R$678.00. The physical activity level was self-reported using a physical activity questionnaire (MATSUDO *et al*., 2001). Participants who performed less than 60 minutes per day of moderate to vigorous physical activity were considered physically inactive (World Health Organization, 2010). Regarding cigarette smoking, we considered as smokers those participants who consumed one cigarette or more per day in the last 30 days (WANG *et al*., 2017).

Body weight was assessed with participants wearing light clothing and without shoes, using a Welmy scale (São Paulo, SP, Brazil) with a maximum capacity of 150 kg and a precision of 0.1 kg. Height was measured with a stadiometer at a fixed scale (accuracy: 0.01 m). In addition, the body mass index (BMI) was calculated (kg/m^2). These anthropometric measures were taken once by the same trained observer. Abnormal values of BMI were defined according to the NCEP ATP II Final Report (NPEC, 2002). Obesity was classified as BMI ≥30 kg/m^2.

Blood pressure (BP) was recorded by the cardiologist, measured by the auscultatory method with a calibrated and arm-appropriate size aneroid sphygmomanometer and stethoscope (Premium, Duque de Caxias, Rio de Janeiro, Brazil), according to the recommendations (SBC, 2010). Measurements were recorded on the right arm, with the subjects at rest, seated for at least 5 minutes. The BP was measured twice, with an interval of 1 minute and the results recorded in millimetres of mercury (mmHg). We considered subjects with hypertension those participants with a BP ≥180 and ≥110 mmHg for systolic and diastolic pressures, respectively (SBC, 2010).

Plasma glucose levels were analysed by the colourimetric enzymatic method, with specific intra-assay variation coefficient of 1.2%, and evaluated in the clinical analysis laboratory UHFUP, and used to classify diabetic patients, according to the Final Report of the NCEP ATP III (2002) criteria for this population. We considered subjects with diabetes as participants with a fasting blood glucose of ≥126 mg/dL.

Statistical analysis

Descriptive analysis was presented with the mean and the standard deviation (SD) for quantitative variables, and in percentage for categorical variables. Pearson's chi-square (x^2) and linear trend test were performed to check the prevalence of potential confounders. To verify the difference between the means of independent variables according to gender, we performed a Student's *t*-test for unpaired samples. The associations between the outcomes and independent variables were analysed by linear regression. The multiple linear regression was performed according to a hierarchical model at four levels: 1) age; 2) family income; 3) physical activity and smoking; and 4) obesity, hypertension and diabetes. For a variable to be retained in the model, the significance level was set at $p \leq 0.20$. The estimated effects (β) were tested for the outcome (c-IMT) using the null, unadjusted (without potential confounders) and adjusted models (applying hierarchical potential confounders). The Akaike information criterion was used to check the adjustment of the model. The analyses were stratified by gender due to a significant difference between the outcome and gender (p = 0.001). Stata 12 (Stata Corp., College Station, TX, USA) was used for all statistical calculations.

RESULTS

The descriptive analyses are presented in Table 1. In this study, the mean age was 51.0 (sd = 14.2) years, and 62% of them were females.

Table 1 - Characteristics of subjects according to sex

	All (n=201)	Male (n=76)	Female (n=125)	*p-value**
Age, years (SD)	51.0 (14.2)	51.9 (14.6)	50.4 (14.0)	0.44†
Family income, n (%)				
No income	31 (15.4)	6 (7.9)	25 (20.0)	
1 BMW	98 (48.8)	32 (42.1)	66 (52.8)	
2 BMW	41 (20.4)	23 (30.3)	18 (14.4)	0.686**
3–5 BMW	23 (11.4)	11 (14.5)	12 (9.6)	
>5 BMW	8 (4.0)	4 (5.3)	4 (3.2)	
Obesity[1], n (%)	49 (24.4)	19 (25.0)	30 (24.0)	0.333**
Physically inactive[2], n (%)	188 (93.5)	70 (92.1)	118 (94.4)	0.421
Smokers[3], n (%)	19 (9.45)	10 (13.2)	9 (7.2)	0.162
Hypertension, n (%)	89 (44.3)	37 (48.7)	52 (41.6)	0.327
Diabetes, n (%)	28 (13.9)	11 (14.5)	17 (13.6)	0.862
TC, g/L (SD)	209.8 (45.6)	206.4 (46.9)	211 (44.9)	0.419 †
Triglycerides, g/L (SD)	164.6 (104.4)	185.1 (92.8)	152.2 (109.4)	0.030 †
VLDL-c, g/L (SD)	205.4(193.1)	247.8 (234.8)	179.6 (158.3)	0.014 †
LDL-c, g/L (SD)	137.8 (86.8)	134.5 (78.8)	139.8 (91.5)	0.673 †
HDL-c, g/L (SD)	46.0 (14.3)	39.9 (11.4)	49.7 (14.5)	<0.001 †
cIMT, μm (SD)	0.82 (0.33)	0.92 (0.33)	0.76 (0.32)	0.001 †

Source: Own preparation.

**p*-value for Pearson's chi-square test; †*p*-value for Student's *t*-test; ***p*-value for linear trend test; SD: standard deviation; [1]according to cutoff points of BMI (body mass index); [2]less than 60 minutes/day in moderate-to-vigorous physical activity; [3]participants who consumed one cigarette or more per day in the last 30 days; BMW: Brazilian minimum wages; TC: total cholesterol; VLDL-c: Very low-density lipoprotein cholesterol; LDL-c: low-density lipoprotein cholesterol; HDL-c: high-density lipoprotein cholesterol; c-IMT: carotid artery intima-medial thickness.

The associations between the independent variables and c-IMT are presented in Table 2 for men and Table 3 for women. Even after adjustment for the classic factor c-IMT, TG levels appeared associated with c-IMT in men and women (Table 2 and 3). In addition, in women, we found an inverse association between VLDL-c levels and c-IMT (Table 3).

Table 2 - Hierarchical analysis evaluating the association between lipoprotein and lipid concentrations with c-IMT adjusted for potential confounding factors confounders in men

Independent variables	c-IMT		
	Null model (CI 95%)	Unadjusted (CI 95%)	Adjusted[1] (CI 95%)
Constant	0.92 (0.84 to 0.99)	0.90 (0.47 to 1.33)	0.64 (0.25 to 1.02)
TC, g/L		-0.001 (-0.003 to 0.001)	-0.001 (-0.0001 to 0.003)
Triglycerides, g/L		0.001 (-0.0001 to 0.002)	**0.001 (0.0002** to **0.002)**
VLDL-c, g/L		-0.001 (-0.001 to -0.0001)	-0.0003 (-0.001 to 0.0001)
LDL-c, g/L		0.001 (-0.001 to 0.011)	-0.0001 (-0.001 to 0.001)
HDL-c, g/L		0.002 (-0.005 to 0.010)	0.003 (-0.003 to 0.009)
Akaike information criterion	47.52	51.48	29.96

Source: Own preparation.

TC: total cholesterol; VLDL: very low-density lipoprotein cholesterol; LDL: low-density lipoprotein cholesterol; HDL: high-density lipoprotein cholesterol; c-IMT: carotid artery intima-medial thickness; [1]adjusted model (β) for potential confounders (age and hypertension); CI 95%: 95% confidence interval; Significant associations are highlighted in bold.

Table 3 - Hierarchical analysis evaluating the association between lipoprotein and lipid concentrations with c-IMT adjusted for potential confounders in women

Independent variables	c-IMT		
	Null model (CI 95%)	**Unadjusted (CI 95%)**	**Adjusted[1] (CI 95%)**
Constant	0.76 (0.70 to 0.82)	0.20 (-0.11 to 0.51)	0.36 (0.006 to 0.71)
TC, g/L		0.001 (0.0005 to 0.003)	0.0003 (-0.0008 to 0.002)
Triglycerides, g/L		0.0005 (0.00004 to 0.001)	**0.0005 (0.00009 to 0.001)**
VLDL-c, g/L		-0.0005 (-0.0009 to -0.0002)	**-0.0006 (-0.0009 to -0.0002)**
LDL-c, g/L		0.0001 (-0.0004 to 0.0007)	0.0003 (-0.0001 to 0.0009)
HDL-c, g/L		0.004 (0.0004 to 0.008)	0.003 (-0.0008 to 0.006)
Akaike Information Criterion	69.19	52.47	28.47

Source: Own preparation.

TC: total cholesterol; VLDL: very low-density lipoprotein cholesterol; LDL: low-density lipoprotein cholesterol; HDL: high-density lipoprotein cholesterol; c-IMT: carotid artery intimal-medial thickness; [1]adjusted model (β) for potential confounders (age and physical inactivity); CI 95%: 95% confidence interval; significant associations are highlighted in bold.

DISCUSSION

A cross-sectional study was conducted addressing the association between the lipid profile and the carotid thickening in undiagnosed adults. Hierarchical analysis was used to examine the association between the lipid profile and c-IMT in each sex. This study provides evidence that TG levels (marker of CVD) are associated with c-IMT in asymptomatic patients in both sexes. In this sense, in line with the literature, Fitch *et al*., (2011); Chambless *et al*., (2002); Lambrinoudaki *et al*., (2018)**,** our findings suggest that elevated TG levels are a simple marker of c-IMT elevation.

Moreover, it is widely known that c-IMT is also associated with CVD, Perk *et al*., (2012), acting as a well-established marker associated with the diagnosis or severity of this condition and is a predictor of cardiovascular events (COHEN *et al*., 2013; DJABERI *et al*., 2009). In this sense, measuring c-IMT is recommended for disease risk stratification and to make therapeutic decisions, Perk *et al*., (2012); Katakami; Kaneto; Shimomura, (2014), mainly because c-IMT closely reflects the atherosclerotic process and other cardiovascular risk factors (CHAMBLES *et al*., 1997; FOLSOM *et al*., 2003). A possible explanation for our finding is that prolonged exposure to elevated TG levels may alter endothelial metabolism and predispose patients to atherosclerotic changes, Wilhelm; Cooper, (2003), in which case carotid evaluation may be useful for the diagnosis and prognosis of CV. However, to measure c-IMT is not commonly performed in clinical practice, especially in asymptomatic patients (BOQUIST *et al*., 1999; ALSSEMA *et al*., 2008).

Our findings indicate that the sole measure of TG levels may predict an altered c-IMT in undiagnosed individuals, preventing a potential subclinical atherosclerosis, which corroborates with the data available in the literature about adults and the elderly (FITCH *et al*., 2001; CHAMBLESS *et al*., 2002; YANG *et al*., 2014). Even though the lipid profile cannot be discarded as important tool to predict several diseases, measuring TG levels in the clinical practice could be an important tool to prevent atherosclerosis and CV in undiagnosed adults and to reduce cost to the public health system.

After the adjustment for potential confounders, an inverse association between VLDL-c levels and c-IMT was demonstrated among women. A possible explanation for this relationship is that small particles of VLDL-c may enter more easily into the subendothelial space, a formation which is more specifically linked to thrombotic processes than to c-IMT (MASULLI *et al*., 2009). However, a potential treatment bias, where the patients who access the health system tend to improve their lifestyle, should not be discarded (MANSUR; FAVARATO, 2012). This could preferentially be reflected in the lipid profile improvement, such as in the VLDL-c levels, than in the c-IMT.

Evidence of elevated TG levels as an independent risk factor for CVD is increasing; however, the question of causality remains unresolved, Granér (2006), indicating that further research should be performed using larger sample sizes and prospective designs. In this regard, one limitation of our study is the cross-sectional design and non-representative sample of Brazilian adults. Given the nature of our study, associations can be established between the TG levels and the c-IMT. Nonetheless, these associations do not necessarily indicate causality. Another limitation is that the lipid profile was analysed only once. In contrast, the present study has several strengths. This is the first time that the c-IMT has been measured in an undiagnosed Brazilian population. Secondly, the exposure variables and the outcome were assessed by means of objective measures, and thirdly, the carotid measurements were standardised.

Furthermore, the results presented can undoubtedly contribute to a better understanding of screening for the atherosclerotic process in asymptomatic patients, as well as encourage the control of risk factors and the adoption of measures to improve the population's health, such as promoting physical activity. Obesity is one of the risk factors for cardiovascular disease. In this regard, the study conducted by Alecrim (2020) advocates the need for the development of public health policies through sports and leisure to improve the health and quality of life of the population.

FINAL REMARKS

The identification of asymptomatic individuals with a higher predisposition to atherosclerosis is crucial for effective prevention with the correct definition of therapeutic goals for this population. The present study discussed and attested the recommendation of the c-IMT assessment for risk stratification of cardiovascular diseases and for the therapeutic decision-making. However, this type of exam is not frequently utilized in the public health system for cardiovascular risk stratification in asymptomatic patients. Thus, studies of this nature aim to promote the screening of cardiovascular disease to prevent future events and encourage lifestyle changes in the investigated individual.

Therefore, the implementation of healthcare policies, including the promotion of healthy lifestyle habits, access to measures for primary and secondary prevention of cardiovascular disease, combined with the treatment of cardiovascular events, is essential for the control of cardiovascular diseases in all countries, including Brazil.

Based on our findings, we observed that prolonged exposure to high TG levels can alter endothelial metabolism and predispose patients to atherosclerotic changes, in which case carotid assessment can be useful for the diagnosis and prognosis of CVD. Therefore, a single measurement of TG levels can predict altered c-IMT in undiagnosed individuals, preventing potential subclinical atherosclerosis.

In conclusion, triglycerides levels are a simple marker of carotid intima-media thickness in undiagnosed Brazilian adults. In clinical practice, health care professionals should be encouraged to measure carotid intima-media thickness in patients with altered triglyceride levels, which will result in a more accurate diagnosis in order to prevent atherosclerosis and CVD.

This practice could reduce expenses in laboratory tests and accurately identify patients with elevated carotid thickness and at risk of developing atherosclerotic disease. In asymptomatic adults with altered triglyceride levels, early recognition by c-IMT assessment can help in the clinical disease prevention. It is expected that this type of cardiovascular health assessment becomes accessible to a significant portion of people who currently do not have access even to basic and essential healthcare services.

Carotid thickening testing in patients with altered triglycerides is a valuable strategy for assessing cardiovascular risk, identifying atherosclerosis at an early stage and adopting appropriate therapeutic decisions. This test can play an important role in promoting cardiovascular health and preventing serious cardiovascular events such as heart attacks and strokes. It also encourages the control of risk factors and the implementation of measures to improve the health of the population, such as the promotion of physical activity.

This research concludes with a clear certainty that evaluating triglyceride levels and measuring carotid artery wall thickness in public healthcare services play a fundamental role in the prevention, early detection, and treatment of cardiovascular diseases, which can improve the overall health of the population and reduce costs associated with treating serious cardiovascular complications.

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