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Cardiovascular Risk of Community-Dwelling Elderly from a City in Northeastern Brazil: Correlations with Vitamin D and Parathormone

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Abstract

We investigated the cardiovascular disease (CVD) risk of the elderly in a city in northeastern Brazil, and the correlation of this risk with vitamin D and PTH status. We studied 359 elderly, both genders, from Piauí-Teresina-Brazil. Variables investigated: body mass index, waist circumference, systolic and diastolic blood pressure. A subsample (n = 100) was investigated for biochemical analyses: PTH and 25(OH)-vitamin D levels; total, HDL and LDL-cholesterol; and fasting glucose. High blood pressure, abdominal obesity, sedentarism, high total cholesterol, high triacylglycerol levels, as well as low vitamin D levels, were, among the investigated variables, the most prevalent. Visceral adiposity and low vitamin D were found to be more prevalent in women than in men, whilst alcohol intake and smoking were more prevalent in men. The correlation between vitamin D, PTH and the investigated risk variables, under our study conditions, were not significant.

Keywords

Cardiovascular Diseases, Risk Factors, Elderly, Vitamin D, PTH

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1. Introduction

Aging processes enhance the risk to chronic diseases, such as obesity, hypertension, type II diabetes mellitus, dyslipidemias, and cardiovascular diseases. In this way, we can find a number of published articles investigating risk factors and different strategies to manage the associated diseases [1]-[3].

Recent researches have shown an important role of vitamin D in the development of many chronic diseases. This vitamin binds to its receptors (vitamin D receptors-VDR), constituting a complex capable of modifying pathways of gene expression, or other non-genomic pathways, in a number of tissues [4]-[6]. Several systems, directly or indirectly related to cardiovascular function seem to be influenced by the binding of vitamin D to its receptors. For instance, we can count effects on the renin-angiotensin-aldosterone system; effects on vascular endothelial growth factor and cytokine production; effects on endothelial cell function and myocyte calcium influx [7]-[14]. In addition, low vitamin D levels are associated with high parathormone (PTH) levels, which in turn are associated with left ventricular hypertrophy and heart failure [15].

With regard to nutritional deficiencies that are typical of aging, many studies have shown low levels of vitamin D in elderly people. Classic studies have suggested the prevalence of vitamin D deficiency in these individuals to be close to 40% [16]-[18]. Brazilian studies have shown a prevalence varying from 5% to 25% [17]. Taking into account the institutionalized elderly, this prevalence can reach 71.2% [11]. Therefore, the aging process can result in a combination of some risk factors for CVD.

Despite the importance of investigating vitamin D and associated diseases, there are still few regional studies in Brazil, particularly in some cities of northeastern of the country. As such, the aim of this study was to investigate the CVD risk in elderly from Teresina-PI-Brazil, and the correlation of this risk with vitamin D and PTH status. Considering the fast population aging [19], this kind of study may contribute to the management of the high cost of diseases associated with this population's group.

2. Material and Methods

2.1. Subjects

This is an observational, descriptive, and cross-sectional study. The participants were elderly (above 60-years old), of both genders, and were community-dwelling in Teresina, Piauí-Brazil. Subjects were selected using data from a Brazilian Ministry Health Program (Health Family Strategy). The sample size was calculated from the standard deviation estimative of 28.5 ng/mL of 25(OH)-D [11], with a confidence level of 95% and sample error of 5.6 ng/mL. We excluded subjects that were bedridden, those that used a wheelchair, those with hearing or talking impairments, those who were taking vitamin D or calcium supplements and those with diseases related to vitamin D metabolism (for instance, kidney or liver diseases). The guidelines for human studies were followed according to the Declaration of Helsinki. The volunteers elected to the study signed their informed consent, and the project was approved by the Ethics Committee of the Federal University of Piauí, protocol number 0386.0.045.000-10.

2.2. Assessments

Data were obtained during a house interview, adopting a questionnaire that had been pre-tested in a previous pilot experiment. Data were collected from February to June, 2011. The anthropometric measurements were: body weight (Plenna scale, 150 Kg), knee height-measured with a caliper consisting of an adjustable measuring stick with a blade attached to each end, at a 90˚ angle [20] [21]—and waist circumference (WC), measured with an inelastic fiberglass tape. From the measurements, we estimated the height [20], and calculated the body mass index [BMI = weight/(height)^2]. To classify the nutritional status according to BMI, we adopted the recommendation of the Pan-American Health Organization; normality when BMI was between 23 - 28 kg/m^2, overweight when 28 kg/m^2 ≤ BMI < 30 kg/m^2 and obesity when BMI ≥ 30 Kg/m^2 [22]. To identify cardiovascular risk from the waist circumference, we adopted standards proposed by the WHO [23], where waist circumference ≥ 102 cm for men and ≥ 88 cm for women constituted cardiovascular risk.

Blood pressure was measured following the VI Brazilian Guidelines for Hypertension (BD sphygmomanometer). According to these guidelines, hypertension was defined as systolic blood pressure (SBP) ≥ 140 mm/hg and/or diastolic blood pressure (DBP) ≥ 90 mm/Hg. The values were obtained by calculating the average of two measurements [24]. For participants with diabetes, hypertension was defined when SBP was ≥ 130 and/or DBP

80 ≥ mmHg. In addition, participants who referred to taking medicines for hypertension were also considered as having high blood pressure [25].

2.3. Biochemistry

For blood sample collection, the participants were required to attend the Health Unit on a scheduled day, during the morning, after fasting and rest of between 8 - 12 hours. In case of any difficulty, the researcher went to the participant's house to carry out blood withdrawal. The blood was centrifuged and the plasma was frozen until analysis. Biochemical analyses were performed at the *Hospital Med Imagem*, Teresina, Piauí, Brazil. PTH and 25(OH)-D levels were analyzed by chemiluminescence method (IMMULITE 200 and Diasorin LIAISON™, USA, respectively). The reference range for PTH was 12 to 72 pg/mL, and the classification of vitamin D levels followed that proposed by Holick *et al.* [26]: ≤ 20 ng/mL-vitamin D deficiency; 21 to 29.9 ng/mL-insufficient level; ≥ 30 ng/mL to 100 ng/mL-adequate levels. Plasma lipids were analyzed by automation (ViteK Systems Clinline 150-Biomerieux). HDL-cholesterol and triacylglycerol were measured by enzymatic colorimetry, and LDL-cholesterol was calculated according to the Friedwald equation [27]. We adopted reference values according to the IV Brazilian Guidelines on dyslipidemia and arterosclerosis prevention [28]. Fasting blood glucose was measured by enzymatic colorimetric method, and the reference values followed those of the Brazilian Society of Diabetes [29]. Participants with blood glucose values ≥ 126 mg/dL and those with normal values, but under pharmacological treatment, were considered as diabetic.

2.4. Data Analysis and Statistical Methods

Numeric data were presented as mean and standard deviation. The categorical variables were presented as percentages. The Kolmogorov-Smirnov test revealed that none of the investigated variables presented normal distribution. Therefore, we adopted non-parametric tests (Mann-Whitney test and Kruskal-Wallis test). The association between categorical variables was investigated by the Chi-square test (χ^2), and cases where more than 25% of the cells presented $n < 5$ we adopted the Fisher exact-test. Some data were correlated by Spearman test. We considered a p-value < 0.05 as significant for all analyses and the analyses were performed with the Statistical Package for Social Sciences (SPSS®), version 18.0.

3. Results

3.1. Sociodemographic and Clinical Aspects

Table 1 depicts the variables investigated and **Table 2** presents the prevalence of cardiovascular risk, for both genders. With regard to demographic data, the majority of the participants declared living with a partner; most of them reported low schooling and low income.

Both men and women presented a low prevalence of total obesity, as evaluated by BMI values. However, abdominal obesity, evaluated by WC, suggested that the majority of women presented CVD risk, but not the majority of men. Both genders presented an elevated prevalence of high blood pressure.

Biochemical analysis suggested low levels of 25(OH)-D for both genders, but women presented lower values than men. PTH values were between normality ranges for the majority of both men and women. High fasting glucose was relatively low in prevalence both in men and women, although the mean values were higher in men. The prevalence of high total cholesterol and triacylglycerol was elevated in both genders, without any difference between genders. In turn, the prevalence of both high LDL-cholesterol and low HDL-cholesterol was lower than other markers of blood lipids, although women showed a higher prevalence than men. Alcohol intake and smoking were referred by a small percentage of the participants; men reported these habits more than women. In addition, a sedentary lifestyle was referred by the majority of participants, of both genders.

In order to turn our study broader, we investigated cardiovascular risk by taking into account other independent variables. With regard to schooling, total obesity was higher in the subjects with higher schooling level. In contrast, a sedentary lifestyle was more common in subjects with lower schooling (illiterate = 7.2% and 81.3% for total obesity and sedentary lifestyle, respectively; fundamental level = 12.4% and 73.3% respectively; intermediate level and above: 16.9% and 55.9% respectively; $p < 0.05$ for all the comparisons). Biochemical variables and blood pressure values did not present any significant association with regard to schooling. Considering marital status, high blood pressure, abdominal obesity and low HDL-cholesterol were more prevalent in the

Table 1. Distribution of the variables investigated, according to gender*.

Demographic variables	Male (n = 138) N (%)	Female (n = 221) N (%)		Total (n = 359) N (%)
Age group				
60 - 69 y	66 (47.8)	117 (52.9)	$\chi^2 = 0.98$	183 (51.0)
70 - 79 y	49 (35.5)	73 (33.0)	p = 0.61	122 (34.0)
≥80 y	23 (16.7)	31 (14.0)		54 (15.0)
Marital status				
Without partner	20 (14.5)	114 (51.6)	$\chi^2 = 49.96$	134 (37.3)
With partner	118 (85.5)	107 (48.4)	p < 0.001	225 (62.7)
Schooling				
Illiterate	52 (37.7)	87 (39.4)		139 (38.7)
Fundamental level[1]	65 (47.1)	96 (43.3)	$\chi^2 = 0.52$ p = 0.77	161 (44.8)
Intermediate level or above[1]	21 (15.2)	38 (17.2)		59 (16.4)
Family Income				
<2 MS[2]	71 (51.4)	142 (64.2)	$\chi^2 = 10.42$	213 (59.3)
2 - 5 MS	44 (31.9)	64 (29.0)	p = 0.005	108 (30.1)
>5 MS	23 (16.7)	15 (6.8)		38 (10.6)
Anthopometric and BP variables	Male (n = 138) Mean (SD)	Female (n = 221) Mean (SD)	p-value*	Total (n = 359) Mean (SD)
BMI[3] (kg/m^2)	24.6 (3.8)	25.2 (4.4)	0.065	25.0 (4.2)
WC (cm)	96.8 (10.3)	98.2 (12.5)	0.072	97.7 (11.7)
SBP[4] (mmHg)	131.7 (19.0)	131.6 (22.2)	0.679	131.6 (21.0)
DBP[5] (mmHg)	78.3 (11.0)	77.6 (11.7)	0.391	77.9 (11.5)
Biochemical Variables	Male (n = 42) Mean (SD)	Female (n = 38) Mean (SD)	p-value*	Total (n = 100) Mean (SD)
25(OH)-D (ng/mL)	25.7 (9.2)	20.2 (6.2)	0.001	22.5 (8.0)
PTH (pg/mL)	42.0 (22.5)	39.3 (19.7)	0.555	40.7 (20.9)
Fasting Glucose (mg/dL)	108.0 (23.6)	98.4 (22.7)	0.024	102.4 (23.4)
Total Cholesterol (mg/dL)	239.2 (36.8)	251.8 (55.8)	0.346	246.5 (48.9)
LDL-Cholesterol (mg/dL)	145.0 (25.7)	158.6 (50.9)	0.335	152.9 (75.6)
HDL-Cholesterol (mg/dL)	51.6 (9.4)	51.1 (6.9)	0.922	51.3 (8.0)
Triacylglycerol (mg/dL)	231.1 (95.9)	210.3 (57.4)	0.444	211.5 (75.6)

*Category variables were compared by Chi-squared test (χ^2), and numeric variables were compared by Mann-Whitney Test. [1]Complete or incomplete; [2]MS = Minimal salary; [3]BMI = body mass index; [4]SBP = systolic blood pressure; [5]DBP = diastolic blood pressure.

Table 2. Prevalence of cardiovascular risk, according to the investigated parameters.

Anthropometric and BP parameters	Total n = 359	Male n = 138	Female n = 221	p
	%	%	%	
High blood pressure	71.3	66.7	74.2	0.124
Total obesity	11.1	9.4	12.2	0.688
Abdominal obesity	65.2	30.4	86.9	<0.001
Alcohol intake	22.6	34.8	14.9	<0.001
Smoking	11.7	15.2	9.5	<0.001
Sedentary	73.5	74.6	72.9	0.709
Biochemical parameters	n = 100	n = 42	n = 58	p
	%	%	%	
Low vitamin D	82.0	66.7	93.1	0.001
Low PTH	4.0	4.8	3.4	0.355
High fasting glucose	22.0	28.6	17.2	0.177
High total cholesterol	88.0	85.7	89.7	0.549
High LDL-c	34.0	23.8	41.4	0.067
Low HDL-c	30.0	11.9	43.1	0.001
Hypertriacylglycerol	88.0	88.1	87.9	0.980

participants living without a partner (with partner = 65.3%, 56.9% and 23.2%, respectively; $p < 0.05$ for all comparisons; without partner = 81.3%, 79.1% and 45.2%, respectively). In turn, alcohol intake was higher in participants living with a partner (27.1%, versus 14.9%; $p < 0.05$). There were no differences in any of the risk factors when stratified for income. When grouping the participants according to age intervals (60 - 69, 70 - 79 and above 80 years), the only variable that was significantly different in the groups was alcohol intake (29.5%, 15.6% and 14.8% respectively, $p < 0.05$).

3.2. Correlation between Vitamin D and Parathormone with Cardiovascular Risk

Table 3 shows the correlation between vitamin D and variables related to cardiovascular risk, and **Table 4** shows the correlation between PTH and the same variables. We did not observe any significant correlation of vitamin D levels and any of the variables. With regard to PTH, only DBP presented significant correlation with this factor.

4. Discussion

We investigated some variables related to CVD risk of elderly individuals in a city in the northeastern Brazil, and the correlation between those variables and vitamin D and PTH status. We observed that the most prevalent risk factors were: high blood pressure, abdominal obesity, sedentarism, high total cholesterol, high triacylglycerol, and low vitamin D. We also found that abdominal adiposity and low vitamin D were variables that were more prevalent in women than in men, whilst alcohol intake and smoking were more prevalent in men. However, we did not find significant correlation between vitamin D, PTH and any risk variables investigated.

The correlation investigated in the present study show divergences in literature. With regard to adiposity, Kimmons *et al.* [30], in agreement with the present study, found no significant correlation between PTH and BMI, while Ahlström *et al.* [31] and Premaor & Furnanetto [17] found positive and significant correlations between these variables. The authors attributed these significant results to the ability of adipocytes to store vitamin

Table 3. Correlation (spearman) between variables related to cardiovascular risk and 25(OH)-vitamin D levels.

Variables	r-value	p-value
SBP with use of medicine	0.009	0.948
DBP with medicine	−0.057	0.673
SBP without use of medicine	−0.152	0.337
DBP without medicine	−0.105	0.509
Fasting blood glucose	−0.042	0.680
Body mass index	−0.144	0.154
Waist Circumference	−0.173	0.085
Total-Cholesterol	−0.126	0.210
LDL-Cholesterol	−0.114	0.261
HDL-Cholesterol	−0.017	0.863
Triacylglycerol	−0.120	0.234

Table 4. Correlation (spearman) between variables related to cardiovascular risk and PTH levels.

Variables	r-value	p-value
SBP (mmHg)	−0.124	0.218
DBP (mmHg)	−0.201	0.045
Fasting blood glucose (ml/dL)	−0.078	0.443
Body Mass Index (kg/m²)	0.023	0.818
Waist Circumference (cm)	0.027	0.787
Total Cholesterol (ml/dL)	−0.175	0.081
LDL-Cholesterol (ml/dL)	−0.145	0.149
HDL-Cholesterol (ml/dL)	−0.010	0.918
Triacylglycerol (ml/dL)	−0.137	0.175

D, which makes this vitamin biologically unavailable [10] [32]-[34]. As such, low levels of vitamin D and consequently high levels of PTH contribute to the elevation of intracellular calcium in adipocytes, stimulating lipogenesis.

Data from 15 088 individuals from a study by NHANES III showed an inverse association between obesity and vitamin D [10]. Studies have found a significant association between vitamin D and visceral obesity [34] [35], whilst others have not [8] [36]. Cigolini *et al.* [8], in a case-control study, did not find differences in body fat, when comparing individuals with or without vitamin D deficiency.

Regarding blood pressure, data from NHANES III (USA) showed an inverse correlation between SBP and vitamin D [12], and other studies have shown similar associations [37] [38]. The role of vitamin D in the renin-angiotensin-aldosterone system is the most plausible explanation for the results [13]. However, other authors, similarly to us, failed to find significant correlations between SBP and DBP with vitamin D [35] [36].

In agreement with our study, neither Ahlström *et al.* [30] nor Hjelmesaeth *et al.* [38] found any significant correlation between PTH and blood glucose, or between PTH and LDL-cholesterol. However, Ahlström *et al.* [31], as well as Hjelmesaeth *et al.* [39] found a negative and significant correlation between PTH and HDL-cholesterol, and also a positive and significant correlation between PTH and triacylglycerol.

Ponda *et al.* [40] showed an inverse correlation between vitamin D and total cholesterol and LDL-cholesterol, and others with triacylglycerol [8] [10] [36] [40] [41]. Some studies have also suggested a positive association between vitamin D and HDL-cholesterol [40] [41], but other studies did not find any significant association with HDL-c, LDL-c and total cholesterol [8] [10] [36]. As vitamin D contributes to vascular endothelial growth factor and cytokine production, understanding the role of this vitamin in CVD risk remains important [13].

Studies have found an inverse correlation between vitamin D and blood glucose, in both genders [42] or only in men [36]. Animal studies showed that low levels of vitamin D lead to low insulin synthesis by pancreatic tissues. It has been postulated that the binding of vitamin D and VDR present in pancreatic islets triggers a genomic pathway related to insulin secretion [43] [44]. Despite those findings in literature, we did not find significant correlation between blood glucose and vitamin D.

It is important to highlight some limitations of the present study. It should be pointed out that there exist a number of potential confounding factors in observational studies on vitamin D, and some of these confounder were present in our study; age, obesity, smoking, sedentary lifestyle, chronic inflammation, medication, genetics, or even assay heterogeneity [7]. In addition, any disease state makes the individual more sedentary, with less exposure to sunlight, signifying reverse causality [10]. Additionally, the investigation of inflammation markers, and also genetic polymorphisms of vitamin D receptor, could allow a better understanding of our results. It's also important to highlight the regional feature of our work. Although it's important to understand Brazilian specificity, our results could not be extrapolated to other locations.

5. Conclusion

Under our study conditions, we found low levels of vitamin D, and the prevalence of a number of risk factors for CVD. Associations between vitamin D, PTH and CVD risk did not present significance, probably due to the numerous confounders existing in elderly studies. Vitamin D may constitute an additional risk factor for CVD, but not necessarily an independent factor.

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