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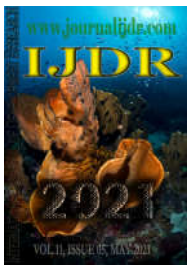

RESEARCH ARTICLE OPEN ACCESS

RELATIONSHIP BETWEEN ABDOMINAL FAT, BLOOD PRESSURE AND HEART RATE VARIABILITY IN THE ELDERLY

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ABSTRACT

Senescence is the sum of changes of normal aging. Taking into account the consequences that the modification of body composition can cause on the nutritional status of the population, evaluating and detecting these as early as possible can contribute to reducing the health problems caused by it. The present study aimed to verify the relationship between abdominal fat and cardiovascular parameters in the elderly, by analyzing their heart rate variability (HRV) and using computed tomography to map the density and thickness of the abdominal wall. The study analyzed the RR interval and the variables SDNN, RMSSD, pNN50, HF, LF and the ratio between LF / HF, within the frequency and time domains, considering that n =48. Heart rate fluctuated noticeably when analyzed in volunteers with a BMI value greater than 26 and an average height of 1.60. The relationship between the indicators of density and thickness of intra-abdominal fat and HRV indicators were statistically significant, resulting in $p<0.05$. Central obesity demonstrated a strong relationship with cardiac autonomicdys function in the elderly. The variables SDNN, pNN50, HF, LF, LF / HF showed a positive association with the indices of thickness and density of intra-abdominal fat.

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INTRODUCTION

Senescence results from the sum of organic, functional and psychological changes in normal aging. One of the most obvious changes that occur is the modification of body dimensions (BRYANT *et al*., 2019). With the aging process, there are changes mainly in height, weight and body composition. The increase in body weight starts around 45 to 50 years, stabilizing at 70 years, and begins to decline until 80 (SASS, MARCON, 2015). Body weight gain and body fat accumulation seem to result from a genetically programmed pattern of changes in diet and level of physical activity, related to age or an interaction between these factors (Frank *et al*., 2018).

The cardiovascular system has its capacity reduced with the Senescence process due to pulmonary, cardiac and vascular alterations (Barroso *et al*., 2017). Cardiac function in the healthy elderly at rest, especially systolic function, does not show a decrease in heart rate, cardiac volume or cardiac debt, and the ejection fraction

is similar to that of young individuals, however, cardiac reserve decreases, which results in two processes linked to aging, the progressive elevation of post-load and the reduction of cardiovascular response to beta-adrenergic stimulation that manifests itself through the cronototropic, inototropic and vasodilator response(SOUZA *et al*., 2014).

According to the World Health Organization (WHO), there is a recent increase in the burden of cardiovascular diseases, especially in low- and low-income countries, reflecting increased life expectancy and, consequently, longer exposure to risk factors for chronic non-communicable diseases (NCDs). The changes in eating habits and lifestyle of recent decades has resulted in an increasingly troubling pattern of body adipose distribution (Kelishadi *et al*., 2016). A higher prevalence of this pattern was observed in female individuals, described as accumulation of fat in the trunk and abdomen region (android pattern) with an increasingly intense exposure to cardiovascular risks (MASSON *et al*., 2017).

Recent studies have highlighted the increase in abdominal obesity in the Brazilian female population in concomitance with cardiovascular diseases (CVD) that represent the greatest cause of morbidity and mortality in Brazil (BARROSO *et al*., 2017). The immoderate concentration of fat in the abdomen and torso has an intimate relationship with several metabolic dysfunctions, and is associated with a higher risk of morbidity and mortality due to athertortotic disease and its consequences, such as Coronary Artery Disease (CAD) (MACEDO, FAERSTAIN, 2017).

Considering the consequences that the modification of body composition can cause on the nutritional status of the population, evaluating and detecting changes in body composition as early as possible can contribute to the reduction of effects resulting from the health problems caused (CESENA *et al*., 2017). Computed tomography (CT) is considered a "gold standard" method for the determination of adipose tissue (PALLADINO, DAMAS, TUCUNDUVA, 2011). Therefore, allowing the precise quantification of visceral or subcutaneous adiposity in anybody region (Palladino, Damas, Tucunduva, 2011). The reasons for these considerations are due to their high reproducibility and correlation coefficients for measures (Palladino, Damas, Tucunduva, 2011). By CT, the visceral fat area is measured in a single tomographic cut at the height of the navel (L3-L4 or L4-L5) showing a strong correlation with the total visceral fat volume (SOUZA *et al*., 2014).

Although several studies have demonstrated the relationship between abdominal fat, heart rate variability and blood pressure, associated with mainly cardiovascular repercussions, few studies bring such a precise evaluation standard as to what CT offers with regard to body composition mapping. In this context, the hypothesis of the present study was that there was a significant correlation from the statistical point of view, between abdominal fat level, blood pressure and heart rate variability in elderly patients, enabling an exploratory analysis for inspection of data distribution, presence of *outliers* and correlation between the variables of heart rate, density and thickness of the abdominal wall.

MATERIALS AND METHODS

Forty-eight elderly people participated in this study. The cooperation took place voluntarily and followed the norms of the Free and Informed Consent Form (TCLE). The inclusion criteria were: being physically independent, previously healthy, being 60 years of age or older, signing the TCLE. Volunteers who presented heart disease or any skeletal muscle disorder were excluded from the study, who were involved in regular systematized physical activity more than once a week over the last six months prior to the beginning of the study, patients with uncontrolled Systemic Arterial Hypertension (SAH), patients with diabetes mellitus and those who were on hormone replacement therapy. This is an applied, descriptive and quantitative analytical study, which used simple and adjusted multiple regression as a method. This project is integrated with the institutional project "Strength training as a strategy in the prevention of falls in the elderly: a randomized clinicaltrial", approved by the Ethics Committee of the Federal University of The São Francisco Valley (CAAE no. 67030617.1.0000.5196). For the calculation of the sample size, an effect size of 0.20, an alpha of 5% and a power of 80% were adopted, obtaining a total sample size of 48 individuals considering a percentage of 10% of possible losses. Heart Rate Variability (HRV) analysis was performed using kubios HRV software, whose information was interpreted based on the time and frequency domains. The parameters of the frequency domain were obtained by the spectral analysis technique by means of the self-regressive and rapid fouriertrans form method. Frequencies between 0.04 and 0.4 Hz were considered physiologically significant, and the low frequency component represented by oscillations between 0.04 and 0.15 Hz and the high frequency component between 0.15 and 0.4 Hz were considered.

The analysis of the parameters of density and thickness of abdominal fat was performed by computed tomography (CT). The calibration of the equipment followed the manufacturer's recommendations. Both calibration and analysis were performed by a responsible physician and a radiology technician with experience in this type of evaluation, through toshiba equipment, model AQUILION CXL (TSX-101A) with 128 channels at the University Hospital – (HU- Univasf). The participants were evaluated wearing light clothes, barefoot and without carrying any metallic object or any other accessory next to the body. They remained lying in supine position and motionless, with their arms beside the body in the supine position. A single scan lasting less than 15 seconds was performed. To measure the surface areas of subcutaneous fat and visceral fat, axial images of the abdomen were evaluated at the level of the lower part of L3 and at the level of L4-L5, adopting the semi-automatic method with manual correction, when necessary. For the identification of adipose tissue will be considered density of -190 to -30 Housnfield Units (HU) and for the identification of skeletal muscles will be considered the density of -29 to +150 HU.

All blood pressure (BP) measurement procedures followed the recommendations of the VIII Brazilian Hypertension Guideline. The volunteers remained seated, for a minimum of 5 minutes, in a calm environment with controlled temperature. Bp was measured in triplicate in both arms by means of a digital monitor. The measurements with a maximum difference of 4 mmHg were considered valid, and the mean of the three measurements of the arm with higher BP value used for the analyses.

Initially, an exploratory analysis was performed to inspect the distribution of data, *presence of outliers* and correlation between the study variables. To examine the association between intra-abdominal fat and heart rate variability parameters, a crude linear regression analysis was performed and adjusted for age, sex and overall body status (BMI). The general characteristics of the participants are presented in average (standard deviation) or percentage (when appropriate). The results of the regression analysis are described using the values of regression coefficient (beta), standard error of estimation and confidence intervals of 95%. All analyses were performed in STATA version 13.0, considering a value of $p<0.05$.

RESULTS

The clinical characteristics and HRV parameters are presented in Table 1. The study analyzed variables of frequency, time, thickness and density with n=48, of which 62.5% were female. The volunteers had a mean age of 67 years, BMI of 26.8 with standard deviation of 4.4 and HR of 68 bpm with standard deviation of 10. HRV was studied using the time variables: SDNN, RMSSD and PNN50 and frequency variables: LH, HF and the ratio between LH/HF, using the multiple regression method adjusted with age, gender and BMI.

Table 1. General characteristics of participants

Variables	n	standard deviation
Sex		
female	30	
male	18	
Age (years)	67	7
Body mass index (kg/m^2)	26,8	4,4
FC rest (bpm)	68	10
RR range (ms)	904,9	141,5
SDNN (ms)	37,4	23,0
RMSSD (ms)	34,3	24,1
pNN50 (%)	22,1	21,9
HF (u.n.)	38,4	16,6
LF (u.n.)	63,1	16,9
LF/HF	20,9	19,1
Density (HU)	-115,8	6,7
Thickness (cm)	2,7	1,6

HR: heart rate, SDNN: standard deviation of all RR intervals, RMSSD: standard deviation of means of normal RR intervals, pNN50: percentage of adjacent R-R intervals with duration differences greater than 50 ms, HF: high frequency band, LF: low frequency band, LF/HF: simpatovagal balance.

Table 2. Result of the association between intra-abdominal fat density and indicators of heart rate variability in the elderly

Variables	beta (EP)	Gross IC95%	P	beta (EP)	Adjusted* IC95%	P
RR range (ms)	0,01 (0,01)	-0,00; 0,03	0,068	0,068	-0,00; 0,03	0,050
SDNN (ms)	-0,11 (0,04)	-0,19; -0,02	0,012	-0,11 (0,04)	-0,19; -0,02	0,013
RMSSD (ms)	0,04 (0,04)	0,04; 0,13	0,295	0,05 (0,04)	0,04; 0,14	0,259
pNN50 (%)	-0,10 (0,05)	-0,19; -0,01	0,032	-0,12 (0,05)	-0,22; -0,02	0,017
HF (u.n.)	-0,12 (0,06)	-0,24; -0,01	0,035	-0,17 (0,06)	-0,29; -0,04	0,011
LF (u.n.)	0,12 (0,06)	0,01; 0,24	0,035	0,18 (0,06)	0,05; 0,30	0,007
LF/HF	0,08 (0,05)	-0,02; 0,19	0,105	0,17 (0,06)	0,01; 0,24	0,033

*Variables analyzed considering age, gender and body mass index; IC95%; 95% confidence intervals; EP- Standard error; P<0.05.

The p, beta and confidence index values of the correlation of intraabdominal fat density and heart rate variability are represented in Table 2. In turn, table 3 shows the correlation of intra-abdominal fat thickness with frequency variability data.

DISCUSSION

The relationship between intra-abdominal fat density and heart rate variability indicators was largely statistically significant, presenting a p<0.05. The LF/HF ratio representing the simpatovagal balance showed a positive correlation with intra-abdominal fat with a beta of 0.08 and p<0.05 in the crude analysis. However, in the adjusted analysis with the data age, gender and BMI, the simpatovagal relationship presented p=0.033 being statistically significant and suggesting that the higher the intra-abdominal density, the greater the simpatovagal activity, indicating negative influence, since sympathetic autonomic modulation is the most observed in individuals with cardiovascular diseases (FARAH, 2020).

The variables SDNN and PNN50 representing the sympathetic balance presented a beta of -0.10, being statistically significant in the crude and adjusted analysis. The variables HF and LF separately also showed a positive correlation and were statistically significant in both analyses, suggesting that higher values of intra-abdominal fat density are related to a higher vagal and sympathetic modulation, respectively. The RR interval, despite having presented a positive correlation with the thickness variable, obtained a p=0.068 in the crude analysis and p=0.050 in the adjusted analysis, thus not being statistically significant. The sympathetic modulation represented by the variable SDNN showed a negative correlation with a beta of -0.10 and was statistically significant in both analyses, crude and adjusted, with p=0.012 and p=0.013, respectively. With the exception of the LF variable that showed a positive correlation with intra-abdominal fat thickness and p<0.05, the other variables pNN50, HF and the LF/HF simpatovagal relationship showed a positive correlation with p<0.05, being statistically significant.

Indicators of central obesity in adolescents, adults and the elderly have been related to simpatovagal cardiac modulation, through areduction in parasympathetic activity, pointing to cardiac autonomic dysfunction (FARAH, 2020).

Studies denote that the evaluation of the results of VCF parameters such as SDNN, RMSSD, LF, HF, LF/HF, are important because they can help in the diagnosis and treatment of complications of the cardiovascular system, as well as contribute to the determination of cardiovascular risk and sudden death (GARCIA, 2012; MONTEZE, 2014).

The adjusted regression analysis showed an association between different indicators of sympathetic modulation and vagal HRV with abdominal fat, suggesting that a worse HRV is related to higher density and thickness of intra-abdominal fat. Obtaining HRV indices is extremely important for clinical understanding of certain physiological variables, because increases in variability indicate good physiological adaptation of the organism and its maintenance, assuming a condition of stability of the biological system, whereas reductions have been pointed out as predictors of diseases or the appearance of adverse events in patients with already known diseases (VANDERLEI *et al*., 2009).

HRV analysis shows peaks in patients with short stature and high BMI without significant changes in blood pressure if considered an isolated group for such results, which may represent difficulty in the correlation of all verified data. After the analysis of body density by the computed tomography method, bp measurement becomes relevant regarding the correlation with the other data. This finding is pertinent, because few studies on HRV have been conducted in patients in which blood pressure did not present significant variability. BP control is more complex because it involves vagal and sympathetic activity for the heart and sympathetic activity for resistance vessels, in addition to the variables of peripheral vascular resistance and mean arterial pressure that demonstrate alternation according to the profile of the patient examined (MALPAS, 2010).

CONCLUSION

Central obesity showed a strong relationship with cardiac autonomic dysfunction in the elderly. The variables SDNN, pNN50, HF, LF, and the relationship between LF and HF, showed a positive association with the thickness and density indices of intra-abdominal fat. In addition, the values of p<0.5 were statistically significant in the correlation of HRV variables.

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