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Circunferência do pescoço como ferramenta antropométrica em pacientes com esteatose hepática não alcoolica

Neck circumference as an anthropometric tool for patients with non-alcoholic fatty liver disease

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ABSTRACT

Background: Non-alcoholic hepatic steatosis is characterized by the buildup of triglycerides in hepatocytes, surpassing 5 to 10% of the total weight of the organ. Excess abdominal fat is related to excess fat in the neck region, which is responsible for a greater systemic release of free fatty acids in comparison to the visceral region. However, although the measurement of neck circumference is used for the evaluation of excess body fat and is an efficient manner for identifying obese individuals.

Objective: Evaluate the usefulness of the use of neck circumference as an anthropometric tool for the nutritional assessment of individuals with Non-alcoholic hepatic steatosis.

Methods: A cross-sectional study was conducted at a university hospital in the city of Brazil, between July-December 2016. 49 male and female patient were analyzed. Sociodemographic, behavioral, clinical and nutritional data were collected. The statistical analysis was performed with the aid of the Statistical Package for Social Sciences.

Results: The group of patients with larger neck circumference values had larger mean values for waist-to-height ratio (p<0.01), body mass index (p<0.001), waist circumference (p<0.001) and arm circumference (p<0.01). Neck circumference was also correlated with waist circumference (p<0.001), body mass index (p<0.001), waist-to-hip ratio (p=0.003) and arm circumference (p<0.001).

Discussion: Based on the neck circumference, 51% of the sample was classified as obese, which is in agreement with findings described by Frizon and Boscain who evaluated 155 healthy individuals in the state of Rio Grande do Sul and found that 55% had an increased NC (p< 0.001).

Conclusion: Neck circumference is a simple, reliable, low-cost tool that can be easily used in clinical practice and is associated with abdominal obesity, proving to be a good method of anthropometric evaluation for patients with Non-alcoholic hepatic steatosis.

KEY WORDS

Fatty liver, obesity, nutritional assessment, neck.

INTRODUCTION

Non-alcoholic hepatic steatosis (NAHS) is an initial, relatively benign phase of non-alcoholic fatty liver disease and is characterized by the buildup of triglycerides in the cytoplasm of hepatocytes[1]. Due to the harm caused to liver cells, NAHS is considered one of the most common causes of chronic liver disease in developed nations as well as emerging countries, as rapid economic development leads to an epidemiological transition associated with chronic non-communicable diseases[2]. The development of this NAHS is related to lifestyle,

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especially physical inactivity and unhealthy eating habits, which are factors associated with the development of metabolic syndrome[3].

It is estimated that 10 to 24% of the adult population has NAHS and this figure rises to 57 to 74% among obese individuals[4]. Bellentani and colleagues (2000)[5] report an increase in the prevalence of steatosis in obese individuals who do not consume alcohol (75.8%) in comparison to individuals in the ideal weight range (16.4%). Moreover, the increase in the incidence of NAHS is an emerging clinical problem among obese individuals, even children and adolescents, and can lead to cirrhosis of the liver[6,7].

According to Day and James (1998)[8], NAHS occurs in two steps. Peripheral insulin resistance increases lipolysis and the release of free fatty acids to the liver, triggering an increase in the cascade of beta oxidation reactions, which is one of the predisposing factors for the development of steatosis and also causes oxidative stress in the organ due to the increase in the release of free radicals. Concomitantly, a specific intra-hepatic change occurs in the mitochondria, making liver cells more susceptible to the harm caused by free radicals.

Increased concentrations of fatty acids in the intracellular environment are either directly toxic to hepatocytes or can cause oxidative stress, which leads to inflammation and the process of fibrogenesis[9]. The main causes of the induction of non-alcoholic hepatitis are lipid peroxidation and oxidative stress, which also seem to cause the second trigger in the pathogenesis of NAHS[8].

The distribution of body fat can be evaluated using different methods, such as imaging techniques and anthropometrics (measures of circumferences of body segments and skinfold thickness). The advantages of anthropometrics are the relatively simple use, low cost, absence of risk and absence of discomfort as well as the good performance in the prediction of visceral fat and cardiovascular risk[10].

The most widely used anthropometric indicator is body mass index (BMI), however, the BMI is an indicator of generalized obesity and cannot be used for the evaluation of fat built up in the abdominal region[11]. Thus, for clinical practice, neck circumference (NC) has recently been used as an anthropometric indicator of cardiovascular risk. This simple method offers greater ease to both the examiner and patient and is more socially acceptable, especially for adolescents with overweight and obesity. However, there are no international reference values for this measure yet[12].

Moreover, it has been demonstrated that the neck region is responsible for a greater release of systemic free fatty acids than the visceral region, especially in obese individuals[13], which is associated with type 2 diabetes mellitus, central obesity, overweight and metabolic syndrome[14]. NC is easy to measure, can be routinely used in clinical practice[15-16] and has been reported to be a more sensitive indicator than traditional methods[17].

According to Tibana et al. (2012)[18], NC is a more reliable indicator of cardiovascular risk in comparison to fat deposited in the visceral region. Souza et al. (2013)[19] state that NC is strongly correlated with BMI, blood pressure and biochemical indicators of both insulin resistance and cardiometabolic risk and can be used as a screening tool in the identification of early disturbances in metabolism.

In an article published in 2006, Ben-Noun[20] concluded that there is a positive relationship between changes in NC and risk factors for cardiovascular disease, such as changes the levels of insulin, glucose, triglycerides, uric acid and low-density lipoprotein (cholesterol). Other studies report that NC can serve as a new marker for metabolic syndrome, overweight and obesity[14].

Considering the fact that the neck region is responsible for the release of free fatty acids, especially in obese individuals, and that obesity is one of the main causes of hepatic steatosis, the aim of the present study was to evaluate the usefulness of NC, which is a little employed anthropometric indicator in clinical practice and research, as a screening tool regarding the need for early nutritional intervention in individuals with NAHS and metabolic disease.

METHODS

A cross-sectional study was conducted involving male and female adults and older adults recruited from the Liver Disease Nutrition Clinic of the Oswaldo Cruz University Hospital (University of Pernambuco) between July and December 2016. This study received approval from the human research ethics committee for the hospital complex under process number 56102216.1.0000.5192 and was conducted in compliance with the norms governing research involving human subjects stipulated in Resolution 466/12 of the Brazilian National Board of Health. The researchers signed a statement of confidentiality. After receiving clarifications regarding the objectives, risks, benefits and procedures of the study, the volunteers agreed to participate in the study by signing a statement of informed consent.

The inclusion criteria were age 20 years or older and a diagnosis of NAHS confirmed by an imaging exam (computed tomography, magnetic resonance or ultrasound). The following were the exclusion criteria: psychiatric or cognitive problem that impeded answering the questionnaire; signs of peripheral edema, ascitis or anasarca; enlarged liver or spleen; currently pregnant; inability to stand; amputated limb; and deformity in the neck region (goiter, parotid hypertrophy, etc.).

Data were collected on demographic characteristics (age and sex), level of physical activity[21] and clinical characteristics (type 2 diabetes mellitus, systemic arterial hypertension and dyslipidemia). The following anthropometric measures were determined: weight, height, BMI, waist circumference (WC), NC, arm circumference (AC), hip circumference, waist-to-hip ratio (WHR) and waist-to-height ratio (WHtR).

Weight was determined using a scale (FILIZOLA™) with a 150-kg capacity and precision of 100 g. The patient was positioned erect in the center of the scale, barefoot, with feet together and arms alongside the body, wearing light clothing, with no objects in the hands or pockets and no adornments. Height was determined using a stadiometer coupled to the scale with a 2-m capacity and precision of 1 mm. The patient was positioned erect, barefoot, with feet together and arms alongside the body, gazing forward, with the heels, back and head touching the stadiometer. For older patients, height was determined based on the height of the knee using the formula proposed by Chumlea (1985)[22] and an anthropometric ruler with a millimeter scale. For such, the patient was positioned lying down with the legs flexed forming a 90° angle and the measurement was taken from the heel to the distal part of the thigh near the patella. The BMI was calculated by weight in kilograms divided by height in meters squared (kg/m²). BMI was classified using the criteria established by the World Health Organization (WHO, 1997)[23] for adults and the Pan American Health Organization (2002)[24] for older adults.

WC was measured using a non-elastic metric tape at the midpoint between the last rib and iliac crest and the reading was made at the end of exhalation. Abdominal obesity was classified based on the criteria proposed by the WHO (1997)[23]. Hip circumference was measured with the metric tape positioned in the area of greatest protuberance of the hips. WHR was determined by the quotient between WC and hip circumference in cm and the cutoff points proposed by the WHO (2000)[25] and the *Associação Brasileira para o Estudo da Obesidade e da Síndrome Metabólica* (ABESO [Brazilian Association for the Study of Obesity and Metabolic Syndrome], 2009)[26] were used for the determination of obesity (WHR ≥ 0.90 and WHR ≥ 0.85 for men and women, respectively). WHtR was determined in cm using the cutoff points proposed in a Brazilian study by Pitanga & Lessa (2005)[27] for the definition of abdominal obesity (WHtR ≥ 0.52 for men and ≥ 0.53 for women).

NC was measured using a metric tape (Sanny®). The patient stood erect with the head positioned on the horizontal Frankfort plane and the measurement was made at the midpoint of the cervical spine and middle of the throat. In men, NC was measured below the laryngeal prominence and the reference values proposed by Ben-Noun et al.[15] were used.

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS, version 13.0, SPSS Inc., Chicago, IL, USA). The Kolmogorov-Smirnov test was used to determine the distribution (normal or non-normal) of the continuous variables. Parametric data were expressed as mean and standard deviation. Qualitative variables were evaluated using Pearson's chi-squared test. The Student's t-test for independent samples was used for the comparisons of mean values. Pearson's correlation coefficients were calculated to determine the strength of correlations between NC and the other nutritional assessment indicators. A p-value < 0.05 was considered indicative of statistical significance.

RESULTS

The sample was composed of 49 individuals, 37 of whom (75%) were women. Age ranged from 25 to 79 years (mean: 54.3 ± 10.7 years). Table 1 lists the sociodemographic, clinical and anthropometric characteristics of the sample and data regarding physical activity. Half of the patients (50.2%) took blood pressure medication, 36.7% took anti-diabetic medication and 28.6% took lipid-lowering agents.

In the group of patients classified with obesity (n = 25), NC was significantly associated with WHtR, BMI, WC, AC and age. No significant association was found between NC and chronic non-communicable diseases (Table 2). Correlations were found between NC and the following anthropometric variables: WC, BMI, WHR and AC. No correlation was found with WHtR (Table 3).

DISCUSSION

According to the Brazilian Hepatology Society, other factors besides obesity contribute to the development of liver disease, such as the regional distribution of fat and inflammation of adipose tissue[28], as the physiopathology involves peripheral insulin resistance, which determines greater transport of free fatty acids from adipose tissue to the liver, leading to hepatic steatosis. The great discovery was that fat deposition in the neck region also contributes to the risk of cardiovascular disease, as abdominal/visceral fat is not the main source of circulating concentrations of free fatty acids[16].

Although many issues on the relationship between obesity and chronic liver disease are discussed in the literature, no studies have investigated NC values in individuals with NAHS, which impedes the comparison of the present findings.

With regard to demographic characteristics, it has been established that women use health services more, whereas the male demand for such services is most often linked to work (obligatory checkup prior to employment) or the need for an official medical diagnosis in order to receive a pension[29], which may explain the greater frequency of female patients in the present study. Few investigations on NAHS address schooling in the characterization of the sample. In the present study, the largest portion of the patients had a complete high school education (40.8%), which differs from findings described in a study by Frizon and Boscain (2013)[30], in which the largest portion of patients had an incomplete elementary school education (36.8%).

Table 1. Sociodemographic, clinical and anthropometric variables and level of physical activity among patients with non-alcoholic hepatic steatosis recruited from nutrition clinic of university hospital; Recife, Brazil, 2016.

CHARACTERISTICS OF SAMPLE		N	(%)
SEX	Female	37	75.5
	Male	12	24.5
AGE GROUP	Adult	33	67.3
	Older adult	16	32.7
HYPERTENSION	No	18	36.7
	Yes	31	63.3
TYPE 2 DIABETES	No	33	67.3
	Yes	16	32.7
DYSLIPIDEMIA	No	28	57.1
	Yes	21	42.9
BMI	Underweight	1	2
	Ideal range	5	10.2
	Overweight	43	87.8
NC	Without obesity	24	49
	With obesity	25	51
WC	With risk	44	89.8
	Without risk	5	10.2
WHR	With risk	47	95.9
	Without risk	2	4.1
WHtR	With risk	49	100
	Without risk	-	-
PHYSICAL ACTIVITY	Does not practice ≥ 6 months	28	57.1
	Practices 1-2x per week	9	18.4
	Practices ≥ 3x per week	12	24.5
SCHOOLING	Illiterate	4	8.2
	Incomplete primary 1	9	18.4
	Complete primary 1/Incomplete primary 2	8	16.3
	Complete primary 2/Incomplete high school	5	10.2
	Complete high school/Incomplete university	20	40.8
	Complete university	3	6.1

BMI: body mass index; NC: neck circumference; WC: waist circumference; AC: arm circumference; WHR: waist-to-hip ratio; WHtR: waist-to-height ratio.

NAHS is commonly associated with obesity, type 2 diabetes, dyslipidemia and insulin resistance. According to ABESO[26], obesity is increasing in Brazil. Some surveys suggest that more than 50% of the population is overweight, which is in agreement with the rate found in the present sample.

Lifestyle is a significant factor for the development of NAHS, as poor eating habits can favor an increase in weight. Excess weight leads to an increase in inflammatory cytokines and insulin resistance, which can cause the inflammation of visceral fat, thereby increasing the accumulation of fat in the liver[8]. According to the Brazilian Hepatology Society[28], obesity is the main risk factor for the development of NAHS, as the prevalence in the obese population is estimated to be between 75 and 80%. In individuals with severe obesity (BMI > 35kg/m²), the prevalence is estimated to be between 90 and 100% and this condition is often associated with metabolic syndrome and a greater risk of cardiovascular disease.

Based on the NC, 51% of the sample was classified as obese, which is in agreement with findings described by Frizon and Boscain (2013)[30], who evaluated 155 healthy individuals in the state of Rio Grande do Sul (southern Brazil) and found that 54.8% had an increased NC ($p < 0.001$). In a cross-sectional study involving 69 postmenopausal women, Tibana et al. (2012)[18] found that 55% had an increased NC. All other anthropometric variables analyzed in the present study (WC, AC, WHR and WHtR) were predominantly higher than the range of normality.

In a cross-sectional study involving 702 university students in the city of Fortaleza (northeastern Brazil), Pereira et al. (2014) found that a decrease in NC was associated with an improvement in blood pressure ($p < 0.001$). In the study by Frizon and Boscain (2013)[30], an increased NC was associated with systemic arterial hypertension, type 2 diabetes mellitus and dyslipidemia. Other authors describe similar findings. Tibana et al. (2012)[18] report an association between an increased NC and hypertension; Ben-Noun and Laor (2001)[20] report an association with dyslipidemia and obesity; Preis et al. (2010)[16] report an association with type 2 diabetes

Table 2. Characteristics of sample according to neck circumference among patients with non-alcoholic hepatic steatosis recruited from nutrition clinic of university hospital; Recife, Brazil, 2016.

Variables	Neck circumference (cm)		p-value*
	Without obesity	With obesity	
WHtR (cm)	0.62 ± 0.68	0.66 ± 0.43	0.01*
WHR (cm)	0.94 ± 0.06	0.96 ± 0.07	0.259
BMI (Kg/m²)	29.25 ± 4.18	34.27 ± 3.04	< 0.001*
WC (cm)	96.82 ± 9.04	107.17 ± 4.88	< 0.001*
AC (cm)	31.21 ± 2.54	35.08 ± 3.35	< 0.01*
Age (years)	57.52 ± 9.26	51.46 ± 11.32	0.048*
Height (cm)	1.55 ± 0.08	1.60 ± 0.096	0.066
PHYSICAL ACTIVITY			
Does not practice ≥ 6 months	12 (42.9%)	16 (57.1%)	0.659**
Practices 1-2x per week	4 (44.4%)	5 (55.6%)	
Practices ≥ 3x per week	7 (58.3%)	5 (41.7%)	

WHtR: waist-to-height ratio; WHR: waist-to-hip ratio; BMI: body mass index; WC: waist circumference; AC: arm circumference; without obesity: NC < 39.5 for men and < 36.5 women; with obesity: NC > 39.5 for men and < 36.5 for women; *Student's t-test; ** Pearson's chi-square test; *p < 0.05.

Table 3. Correlation coefficients for neck circumference in relation to other anthropometric variables among patients with non-alcoholic hepatic steatosis recruited from nutrition clinic of university hospital; Recife, Brazil, 2016.

Variables	Correlation coefficient	
	r	p-value
WC (cm)	0.606	p < 0.001*
BMI (kg/m²)	0.459	p = 0.001*
WHR (cm)	0.414	p = 0.003*
WHtR (cm)	0.275	p = 0.056
AC (cm)	0.464	p = 0.001*

WHtR: waist-to-height ratio; WHR: waist-to-hip ratio; BMI: body mass index; WC: waist circumference; AC: arm circumference; without obesity: NC < 39.5 for men and < 36.5 women; with obesity: NC > 39.5 for men and < 36.5 for women; *Student's t-test; ** Pearson's chi-square test; *p < 0.05.

and associations with insulin resistance, hypertension and dyslipidemia. In contrast, no association was found between NC and chronic non-communicable diseases in the present study, which was an unexpected finding.

The group classified with obesity based on NC had significantly higher mean values for WHtR, BMI, WC, AC and age. Likewise, Gonçalves et al. (2014) evaluated 260 adolescents between 10 and 14 years of age in a cross-sectional study and found that NC was correlated with body fat, WC, HC, weight, height, BMI and WHtR. Mean NC was lower in the group of older patients, which differs from all references cited and may be explained by the narrow age range in the sample, as mean age was 54.3 ± 10.7 years of age.

An increase in NC was correlated with an increase in BMI, which is in agreement with data reported in a previous study[20]. Investigating women in the Federal District of Brazil, Tibana et al. (2012)[18] describe the usefulness of NC as a measure of excess fat in the upper region of the body due to its ease of use and the fact that it does not excessively expose the patient to embarrassment, as occurs with the measurement of WC.

WC and WHR were also positively correlated with NC. The moderate, statistically significant correlation with WC is in agreement with findings described by Tibana et al. (2012)[18], who found a strong correlation between these variables. Yang et al. (2010)[14] and Ben-Noun and Laor (2001)[20] all found that individuals with an increased WC also had an increased NC.

The present study has limitations that should be considered when interpreting the results. The sample size was small and the female sex predominated, which impedes the determination of greater associations regarding the sexes separately. Moreover, there is no international standard for the classification of NC. No control group without NAHS was used, which would have enriched the analyses in terms of correlations and comparisons. Finally, there is little data in the literature on the variables analyzed.

CONCLUSION

In the present study, neck circumference was associated with general and abdominal obesity and proved to be a good anthropometric tool for the physical evaluation of patients with non-alcoholic hepatic steatosis. Moreover, neck circumference was positively correlated with arm circumference, waist circumference, body mass index and waist-to-hip ratio. The determination of neck circumference is a simple, reliable, low-cost method that causes less embarrassment in comparison to other methods and can be easily applied in clinical practice by any health professional in primary care as a screening tool for nutritional status in large and different contingents of the population.

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