

Is neck circumference measurement an indicator for abdominal obesity? A pilot study on Turkish Adults

*Mendane Saka, Perim Türker, Aydan Ercan, Gül Kızıltan, Murat Baş

Başkent University, Health Science Faculty, Department of Nutrition and Dietetics, Ankara, Turkey

Abstract

Background: Neck circumference (NC) measurement is one of the simple screening measurements which can be used as an index of upper body fat distribution to identify obesity.

Objectives: The aim of this study was to determine the relationship between neck circumferences and obesity.

Methods: A total 411 volunteer adults participated in this study (174 men, 237 women). A questionnaire which consisted of anthropometric measurements and demographic features was used. Patients with NC ≥ 37 cm for men and ≥ 34 cm for women require evaluation of overweight status.

Results: The percentages of the men and women with BMI ≥ 25 kg/m² were 55.2% and 27.0% respectively and with high neck circumferences were 85.1% and 38.8%, respectively. The percentages of the men and women with high waist circumference were 31.6% and 79.3%, respectively. In both gender there were positive significant correlations between neck circumference, body weight (men, $r=0.576$; women, $r=0.702$; $p=0.000$), waist circumferences (men, $r=0.593$; women $r=0.667$; $p=0.000$), hip circumferences (men, $r=0.568$; women, $r=0.617$; $p=0.000$) and BMI (men, $r=0.587$; women, $r=0.688$; $p=0.000$).

Conclusions: This study indicates that NC was associated with body weight, BMI, waist and hip circumferences and waist/hip ratio for men and women. A significant association was found between NC and conventional overweight and obesity indexes. NC was associated with waist/hip ratio for men and women.

Key words: Neck circumference, obesity.

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Introduction

Obesity is associated with several risk factors for later cardiovascular and metabolic disturbances. These disorders require close monitoring to prevent long-term effects. Obesity, particularly when it occurs in upper part of body, is a major health problem. ^[1-3] Overweight is defined as a body mass index (BMI) between 25.0 and 29.9 kg/m² and obesity is defined as a BMI of 30.0 kg/m² or higher. There are numerous methods of assessing overweight and obesity. Some techniques are applicable, such as measurement of weight, height, abdominal and hip circumferences, waist/hip ratio and BMI. ^[5] Body mass index (BMI) is the most used marker of both adult and childhood obesity, but not a good indicator of body fat. ^[4] Other procedures, such as ultrasound,

computed tomography, and magnetic resonance imaging are expensive and are primarily used for research purposes. ^[5]

In the assessment of central obesity, various techniques are used: waist circumference, waist/hip ratio, mid-upper arm circumference, subscapular/triceps ratio and neck circumference. ^[1] The neck circumference is more accurate than BMI because of the strong correlation between high neck circumference measurements and central adiposity (fat around the abdomen). The technique was also more convenient than waist circumference. ^[4] Neck circumference (NC) measurement is a simple screening measure, as an index of upper body fat distribution that can be used to identify overweight and obese people. ^[5,6] NC, also a time saving anthropometric measurement, is identified as an index of central obesity. Framingham heart study demonstrated that NC was independently associated with visceral adipose and BMI. NC plays an independent contribution to predicting the metabolic abnormalities beyond the classical anthropometric indices of BMI, WC and waist to hip ratio (WHpR) and may be used as an optimal screening other obesity related chronic diseases. ^[7,8]

* Corresponding Author

Başkent University, Health Science Faculty,
Department of Nutrition and Dietetics,
Baglica Kampusu, Eskişehir Yolu, 20.km
Etimesgut, Ankara/ TURKEY
Phone: +90 312 2461609
E-mail: saka@baskent.edu.tr

Various methods are available to measure fat mass, such as magnetic resonance imaging (MRI) and computed tomography (CT), although they are unsuitable for studies requiring large populations. Dual energy absorptiometry (DXA) scanning is an accurate alternative measure of fat mass that is well suited for studies in clinical settings due to its relatively lower associated costs, training expertise, and radiation exposure. It remains unknown whether DXA-measured regional fat can predict better than traditional anthropometric measures.^[9]

Neck circumference is significantly associated with cardiovascular disease (CVD) risk factors such as elevated insulin, high-density lipoprotein (HDL) cholesterol, and homeostasis model assessment (HOMA-IR). The neck circumference is positively associated with insulin and HOMA-IR, and negatively associated with HDL cholesterol, and fasting glucose to insulin ratio (FGIR). All anthropometric indices are positively associated with systolic blood pressure and triglycerides, while neck circumference, WC, HC, and WHpR are associated with diastolic blood pressure.^[10]

Therefore, the objective of this study was to determine the relationship between neck circumferences and obesity.

Methods

Subjects

A total of 411 volunteer adults (age between 20-60 years) participated in this study (174 men, 237 women).

Questionnaire

A questionnaire, which consisted of demographic features, was administered by face to face interview.

Anthropometric Measurements

Body weight, height, neck circumference (NC), waist and hip circumferences were measured and Body Mass Index was calculated [(BMI=weight (kg) /height (m)²]. BMI was categorized according to WHO classifications. The patients were grouped into four categories; underweight, normal-weight, overweight and obese in

accordance with the cut-off points of <18.5 kg/m², 18.5 to 24.9 kg/m², 25.0 to 29.9 kg/m² and >30kg/m² respectively^[11]. Circumferences were measured using an inelastic tape with one millimetre precision. Waist circumference was measured at the midpoint between the inferior costal margin and the upper iliac crest. The hip circumference was obtained at the level of the femoral trochanters and the neck circumference was measured below the cricoid cartilage, and afterwards, at the level of the mid cervical spine.^[12] WHO waist circumferences (>102cm for men, >88cm for women) and waist/hip ratio cut-off points (>1 for men, >0.85 for women) were used.^[13] Patients with NC ≥37 cm for men and ≥34 cm for women require evaluation of overweight status.^[5]

Data analysis

The results were expressed as the mean ±, standard deviation (± SD) and percentages. Correlation test was used to compare the percentage of risk factors among men and women. Multi variate regression models were estimated to determine the independent relationship of each variable with the outcome variable (NC). The statistical analyses were performed with SPSS version 13.0 for Windows. Differences were considered significant with a probability value of $p < 0.05$.

Results

The mean age of the participants was 32.4±12.03 years. The 59.5% of them were women, 40.5% of them were men. The mean BMI was 22.9±4.34kg/m² for women, 25.7±3.92kg/m² for men. The 55.2% of the men and 27.0 % of the women were overweight and obese (BMI ≥25kg/m²). The mean waist and hip circumferences of the women and the men were 77.7±12.82cm, 95.8±12.14cm and 99.2±10.17cm, 105.3±9.71cm, respectively. The waist/hip ratio was 0.78±0.08 in women, 0.91±0.07 in men. The percentages of the men and women with high waist circumference were 31.6% and 79.3%, respectively. The mean NC of men and women were 40.27±3.41 cm, 33.43±3.17 cm, respectively. The 85.1% of men and 38.8% of women's neck circumference measurements were higher than the standards.

Table1. Anthropometric measurements of participants

Anthropometric measurements	Men (n=174)		Women (n=237)	
	X	SS	X	SS
Weight, kg	80.7	14.23	61.2	11.19
Height, cm	176.9	6.89	163.3	6.37
BMI, kg/m ²	25.7	3.89	22.9	4.34
Waist circumference, cm	95.8	12.14	77.7	12.82
Hip circumference, cm	105.3	9.71	99.2	10.17
Neck circumference, cm	40.27	3.41	33.43	3.17
Waist/hip ratio	0.91	0.07	0.78	0.08
	n	%	n	%
BMI, ≥25kg/m ²	96	55.2	64	27
Waist circumference, cm ≥102 male, ≥88 female	55	31.6	188	79.3
Neck circumference, cm ≥37male, ≥34 female	148	85.1	92	38.8

In both gender, neck circumference correlated positively with body weight (men, $r=0.576$; women, $r=0.702$; each $p=0.000$), waist circumferences (men, $r=0.593$; women $r=0.667$; each $p=0.000$), hip circumferences (men, $r=0.568$; women, $r=0.617$; each $p=0.000$), waist-hip ratio (men, $r=0.273$; women, $r=0.450$; each $p=0.000$) and BMI (men, $r=0.587$; women, $r=0.688$; each $p=0.000$).

In the regression analysis, we examined the relative importance of NC with the BMI, body weight, waist and hip circumferences. The multiple regression

models showed a significant relationship between NC and BMI, body weight, waist and hip circumferences. R² statistics for the models were 0.425 in men and 0.535 in women.

According to the kappa statistics, we determined the fair agreement between BMI ($\kappa=0.306$) ($p<0.000$), slight agreement waist circumferences ($\kappa=0.14$) ($p<0.000$) and poor agreement waist to hip ratio ($\kappa=0.004$) ($p=0.825$) and NC in men. In the kappa statistics, we found the moderate agreement between BMI ($\kappa=0.511$) ($p<0.000$), waist circumferences ($\kappa=0.524$) ($p<0.000$) and examined fair agreement waist

Table 2. The correlation between anthropometric measurements and neck circumference of participants to hip ratio ($r=0.341$) ($p<0.000$) NC in women.

Anthropometric measurements	Neck circumference(cm)			
	Men (n=174)		Women (n=237)	
	r	p	r	p
Weight, kg	0.576	0.000	0.702	0.000
BMI, kg/m ²	0.587	0.000	0.688	0.000
Waist circumference, cm	0.593	0.000	0.667	0.000
Hip circumference, cm	0.568	0.000	0.617	0.000
Waist/hip ratio	0.273	0.000	0.450	0.000

Discussion

Overweight and obesity are defined as excessive body fat accumulation that it may have an adverse effect on health, leading to reduced life expectancy and increased health problems. WHO defines people as overweight if their BMI is between 25 and 30 kg/m², and obese when it is greater than 30 kg/m². Over weight and obesity are major risk factors for a number of chronic diseases, including diabetes, cardiovascular diseases and cancer. [14,15,16,17]

Before the 20th century, obesity was rare; [18] in 1997 the WHO formally recognized obesity as a global epidemic. [19] According to WHO report 65% of the world's population live in countries where overweight and obesity kills more people than underweight. [20]

The prevalence of obesity in Europe is estimated to be 10% to 20% of adult men and 15% to 25% of adult women. [21] In the United States, the prevalence of overweight and obesity was 59.4% for men, 50.7% for women, between 1988 and 1994. [22] In Turkey, according to Turkish Adult Risk Factor Study (TEKHARF), the prevalence of overweight and obesity were 44.2% for women, 25.2% for men. [23]

There are numerous methods of assessing overweight and obesity. [5] The most common criteria to determine overweight and obesity is BMI. However, to define fat distribution, BMI is a less suitable to assess body fat distribution. In the assessment of central obesity, various techniques are used: waist circumference, waist/hip ratio, and neck circumference. Waist circumference was defined as an index to reveal central obesity and could be used identify overweight and obesity. [1]

In this study, the mean BMI was 22.9±4.34 kg/m² for women 25.7±3.92kg/m² for men. The 55.2% of the men and 27.0 % of the women were overweight and

obese (BMI ≥25kg/m²). According to WHO standards, 31.6% of men and 79.3% of women 8.6% of men and 20.3% of women had high waist circumference and waist/hip ratio values respectively.

Additionally, anthropometric indices, like neck circumferences (NC), other than waist circumferences can be used in determining body fat distribution. NC, as an index of upper-body subcutaneous adipose tissue distribution and reliable, simple, quick method for assessment of overweight and obesity [1,5] However, a standard doesn't exist for neck circumference. Jean Vague was the first researcher to use a neck skinfold to assess upper-body fat distribution. [24] The cut off of level is the NC determined by Liubov and et al [5] and NC≥37 cm for men and ≥34 cm for women were the best cut off levels for determining the subject with BMI ≥25 kg/m².

In present study, the mean NC of the men and women were 40.27±3.41 cm, 33.43±3.17 cm respectively. The 85.1% of men and 38.8% of women had NC ≥37cm and ≥34 cm respectively. In gender, neck circumference correlated positively with body weight, waist circumferences, hip circumferences, waist/hip ratio and BMI ($p<0.05$).

Simpson concluded that lean tissue is a substantial contributor to neck circumference in men. In women, an increased neck circumference appears to be more likely to be associated with a disproportionate increase in fat, despite the tendency of women to accumulate fat more peripherally, as compared with men. [9]

There is a strong positive correlation of NC with BMI and WC in both male and female subjects. Several studies have examined the association of conventional anthropometric measures of obesity with NC. [25,26]

Neck circumference is a valid marker for identifying obese individuals and correlated well with other anthropometric measurements. Neck circumference has also been shown to correlate positively with insulin resistance and biochemical components of the metabolic syndrome.^[27,28,29]

Neck circumference was correlated with visceral adipose tissue (VAT) [$r = 0.63$ (men); $r = 0.74$ (women); $P < 0.001$] and BMI [$r = 0.79$ (men); $r = 0.80$ (women); $P < 0.001$]. After further adjustment for VAT, neck circumference was positively associated with systolic blood pressure, diastolic blood pressure in men only, triglycerides, fasting plasma glucose in women only, insulin, proinsulin, and homeostasis model assessment of insulin resistance and was inversely associated with high-density lipoprotein (all P values < 0.01).^[8]

In the other study, there was a significant association between changes in NC and changes in body mass index (men, $r=0.67$; women, $r=0.69$; each, $P<0.0001$), waist circumference (men, $r=0.69$; women, $r=0.56$; each, $P<0.0001$), waist-to-hip ratio (men, $r=0.27$; women, $r=0.33$; each, $P<0.0001$), total cholesterol (men, $r=0.68$; women, $r=0.64$; each, $P<0.0001$), low density lipoprotein cholesterol (men, $r=0.58$; women, $r=0.59$; each, $P<0.0001$), triglyceride (men, $r=0.48$; women, $r=0.44$; each, $P<0.0001$), glucose (men, $r=0.51$; women, $r=0.44$; each, $P<0.0001$) and uric acid (men, $r=0.42$; women, $r=0.47$; each, $P<0.0001$) levels. The relative changes in NC contributed to independent significant changes in total cholesterol (8% for men and 1% for women), low density lipoprotein cholesterol (1% for men and 1% for women) and triglycerides (23% for men); it did not significantly contribute to changes in high density lipoprotein cholesterol, glucose or uric acid levels.^[9]

Neck circumference, as an index for upper-body obesity index has been evaluated in relation to cardiovascular risk factors, insulin resistance and biochemical components of metabolic syndrome.^[30,31,32,33] Furthermore, the free fatty acid release from upper body subcutaneous fat was found to be larger than from lower-body subcutaneous fat. NC is also related to cardiovascular risk factors in severely obese men and women. It seems, therefore, that with an increase in NC, the likelihood of risk factors for cardiovascular disease also increases.^[5]

The participants with high NC were more likely to have hypertension, cardiovascular diseases and diabetes mellitus. The participants with high NC were more likely to have hypertension (13,8%), cardiovascular

diseases (2.1%) and diabetes mellitus (4.2%) (data not shown)

In the population-based evaluation among middle-aged and elderly Turkish adults, NC contributes to MetS likelihood beyond waist circumference and the MetS components.^[28] In the community diabetic population based study, NC is related with BMI, waist circumference and metabolic syndrome (MS) in Chinese subjects with type 2 diabetes.^[34]

Conclusion

At the end of this study, in both gender there was a significant correlation between neck circumferences and other some anthropometric measurements. So, it may use as a simple screening measure to identify overweight and obese people, especially for clinical practices and epidemiological survey.

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