Accuracy of Neck Circumference as a Screening Tool in Classifying General and Central Obesity

Zoleika Moazezi[1], Bahar Banasaz[1*], Elham Khanlarzadeh[2], Fatemeh Heidari[3]

1. Department of Internal Medicine, Ayatollah Rouhani Hospital, Clinical Research Development Unit of Rouhani Hospital Babol University of Medical Sciences, Babol, Iran.
2. Department of Community Medicine, School of Medicine, Hamadan University of Medical Sciences, Hamadan, Iran
3. Department of Pediatrics, Health Research center, Golestan University of Medical Sciences, Golestan, Iran.

***Correspondence:**
Bahar Banasaz, Department of Internal Medicine, Ayatollah Rouhani Hospital, Clinical Research Development Unit of Rouhani Hospital Babol University of Medical Sciences, Babol, Iran.
Tel: (98) 113 223 8301
Email: bahar.banasaz@gmail.com

Received: 07 October 2016

Accepted: 25 January 2017

Published in March 2017

Abstract

Objective: the neck circumference (NC) as an index of obesity and upper-body subcutaneous adipose tissue distribution is recently used. This alternative screening tool is reliable, simple, quick and acceptable for assessment of overweight and obesity. the objectives of this study were to examine the correlation between NC measurement and diagnosis of general/visceral obesity and determining the best NC cut point value in a subgroup of Iranian population.

Materials and Methods: About 15000 adult patients (age between 18-75years) participated in this study. At last 8387 patients met the inclusion criteria. A questionnaire which consisted of anthropometric measurements and demographic features was used. The standard criterion to categorization of NC, waist circumference (WC) and body mass index (BMI) identified.

Results: In both gender there were positive significant correlations between neck circumference and: body weight (men, r=0.775; women, r=0.739; *P*=0.000), waist circumferences (men, r=0.77; women r=0.760; *P*=0.000), and BMI (men, r=0.76; women, r=0.738; *P*=0.000). NC ≥38.75 cm for men had sensitivity for overweight/obesity (BMI ≥ 25kg/m2) of 83.5%, a specificity of 77.8% and in women NC ≥34.2 cm had sensitivity for BMI ≥ 25kg/m2 of 79.4%, a specificity of 80.2%. The cutoff values of NC in men and women that identified central obesity (WC ≥95 cm) were ≥39.25 and ≥34.5 cm respectively

Conclusion: This study indicates that NC was associated with body weight, BMI, waist circumferences for men and women. A significant association was found between NC and central obesity for both genders specially men.

Keywords: Neck circumference, General obesity, Visceral obesity, Anthropometric index.

Introduction

Obesity is a growing health concern throughout the world. It is the most serious risk factor for non-communicable chronic disease (NCD) (1). Central fat tissues can predict obesity related complications. Obesity has more adverse consequences on health, leading to reduced life expectancy and increased all-cause mortality (2). Identification of overweight and obese people at earlier stage of life can

[Downloaded from ijdo.ssu.ac.ir on 2026-11-20]

improve health outcome and promote well-being in this population. Therefore choose of a good screening tool could be a first and important step of an overall health screening process toward addressing obese population. There are numerous methods for assessment of overweight and obesity. The most common measure to determine overweight and obesity is body mass index (BMI). The acceptances and popularity of BMI as an anthropometric index make it not a good alternative to assess regional fat distribution (3). In the assessing of visceral obesity, several techniques are used: waist circumference (WC), waist/hip ratio, mid-upper arm circumference, sub scapular/triceps ratio and neck circumference (NC). Although, magnetic resonance imaging (MRI) and computed tomography (CT) and Dual energy absorptiometry (DXA) scanning are using for these purposes but these measures are not appropriate for routine use in clinical settings regarding costs, need to training expertise, and exposure to radiation (4). There is recent interest to use of NC as an index of upper-body subcutaneous adipose tissue distribution. It seems that NC as an alternative screening tool is reliable, simple and quick measure for assessment of overweight and obesity (5,6). However, a standard cutoff value was not identified for NC yet.

Jean Vague was the first researcher to use a neck skin fold to assess upper-body fat distribution (7). A cut off level of NC ≥37 cm for men and ≥34 cm for women has been suggested by Liubov to recognize subjects with BMI ≥25 kg/m2 (2). In subjects of the Framingham heart study high NC was independently associated with visceral obesity and high BMI.

NC plays an independent role to predict metabolic abnormality beyond the routine anthropometric index such as BMI, WC and waist to hip ratio. It can be used as an optimal screening tool for obesity (5).

Several study have indicated that high NC was associated with high body weight, BMI, WC and HC and waist/hip ratio for men and women. They reported a significant association between NC and overweight and obesity indices (4,8,9). The NC has been also used as a potential indicator for visceral obesity and cardiovascular disease in adults (10-12). But this measure is not appropriate in screening tool for classifying childhood overweight/obesity (13). A limitation of past studies is that they only compared NC values with BMI rather than to a more appropriate criteria and gold standard and they had small sample size (14-17). Various study reported different cutoff values in age and sex category of people. Before the NC values can be used in clinical practice, it is essential to validate systematically and to determine an optimum cutoff value. It is important to consider that cutoff values for these anthropometric indices may vary between populations (18). Therefore, the primary objective of this study was to determine correlation between NC and BMI as well as the WC in Iranian adult. The second objective was to determine an optimal cutoff value of NC to identify general and visceral obesity in adults at highest sensitivity and specificity

Materials and Methods

Study population

A total of 15981 adult patients (age between 18-75years) who visited an endocrine clinic in northern Iran Mazandaran province were included in this study. Overall 7594 persons excluded because of thyroid nodule, goiter, hypothyroidism, hyperthyroidism, Cushing syndrome and pregnancy. Eventually 8387 adults were eligible and met the inclusion criteria. The study was approved by the ethics committee of the Babol University of Medical Sciences.

A questionnaire form was prepared which contain the medical history of the study group, included demographic characteristics, past medication, lifestyle behaviors such as cigarette smoking and alcohol use, and medical history of thyroid disease, Cushing disease, pregnancy, corticosteroid and statin

[Downloaded from ijdo.ssu.ac.ir on 2026-11-20]

use, hypophysial and adrenal gland abnormality, and diabetes mellitus.

Measurements

Height was measured to the nearest 0.5 cm by using a wall mounted stadiometer with the patients shoeless and head held in Frankfurt horizontal plane.

Body weight was measured, to the nearest 0.1 kg, by using a calibrated electronic weighing Scale. NC was measured, by using plastic tape ruler at the middle of the neck between mid-cervical spine and mid- anterior neck to 0.5 cm just below the Adam's apple while the patient was sitting ,eyes facing forward and breathing was normal .BMI was calculated by dividing weight in kilograms by the square of height in meters. WC was measured midway between the lowest rib and top of the iliac crest at the end of gentle expiration.

Data processing

WHO definition and The Nafiu age and gender-specific NC cut-offs were applied to categorize BMI and NC values, respectively, as normal weight or overweight/obese. To categorize of high WC indices of ATP III and Iranian obesity committee were used.

Operational Definition of Terms

According to the WHO definition, BMI of 25–29.99 and 30 kg/m2 were taken as cutoff values defining overweight and obesity, respectively. Based on the ATP III definitions, central obesity was defined as WC >102 cm for men and >88 for women and based on the Iranian obesity committee WC >95 in both genders. The NC ≥ 37 cm for men and ≥34 cm for women have been considered as the best cut off levels for determining subjects with BMI ≥25 kg/m2 (3).

Statistical Analysis

All the statistical analyses were conducted by using spss Version 16. Mean, standard deviations (SD), and Min and Max values of the anthropometric variables were calculated. Pearson correlation coefficients along with corresponding two-sided values were obtained among NC, BMI, and WC. A level of significance was set at 0.05. Receiver operating characteristic (ROC) analyses was used to determine an optimal cutoff value for identifying overweight or obese population at highest sensitivity and specificity, Cutoff values and the corroding AUC was calculated.

Results

A total of 8387 adult met the criteria for inclusion in this study, 1937 (23.1%) were men and 6450 (76.9%) women. The mean (± standard deviation) age of participant was 39.36 (14.49) years. The mean BMI (±SD) was 29.26±14.38 kg/m2 for women, 27.14±6.94 kg/m2 for men. About 51.7% of the men and 59.8% of the women were overweight/obese (BMI ≥25kg/m2). Mean WC in women and men were 94.04±14.04 cm and 95.20±12.70 cm respectively. The central obesity frequency in the men and women with central obesity based on the Iranian obesity committee were 48.8% and 47.1% respectively. Frequency of central obesity according to the ATP III definitions was 17.6 % in men and 45.2% in women .The mean NC (±SD) of men and women was 39.56± 3.28 and 35.29 ±2.80cm, respectively. About 57.3% of men and 50.7% of women's NC measurements were higher than the standards (for men≥ 37 cm, for women ≥34 cm).

NC showed a strong positive correlation with BMI, WC, and height and weight in both genders but the correlation coefficients were higher in men (Table 1).

Optimal NC cutoff values for general over weight/obesity in men and women were 38.75cm, 34.2cm respectively. Based on the Iranian obesity committee optimal NC Cutoff Values for central obesity was 39.25ccm for men and 34.5cm for women (Table 2).

Discussion

The aim of our study was to examine the association between NC and other anthropometric indices such as BMI, WC and indicate the usefulness of NC measurement as

[Downloaded from ijdo.ssu.ac.ir on 2026-11-20]

Table 1. The correlation between anthropometric measurements and neck circumference of participants

Variable	Men (n=1937)		Women(n=6450)	
	P	r≠	*P*	r≠
Weight, kg	0.000	0.739	0.000	0.775
Height, cm	0.000	0.09	0.000	0.243
BMI, kg/m2	0.000	0.738	0.000	0.760
Waist circumference, cm	0.000	0.760	0.000	0.770

≠spearman rho for non-parametric variables (height &BMI) and Pearson for parametric variables (Weight& Waist circumference).

Table2. AUCs, Optimal Cutoff Values, Sensitivities, and Specificities for NC Associated with Overweight/Obesity and central obesity

	Variable	Specificity %	Sensitivity%	Cutoff	*P*-value	Se	Auc (95% Ci)
Sex	BMI≥25 (kg/m2)	77.8	83.5	38.75	0.000	0.010	0.869
Men (N=1937)	WC ≥95[≠] (CM)	78.4	83.1	39.25	0.000	0.009	0.878
	WC≥108[#≠] (CM)	0.75	0.82	40.25	0.000	0.011	0.872
Women (N=6450)	BMI≥25 (kg/m2)	80.2	79.4	34.2	0.000	0.006	0.866
	WC ≥95[≠] (CM)	66.3	87	34.5	0.000	0.006	0.858
	WC ≥88[≠#] (CM)	74.0	79.0	34.5	0.000	0.006	0.828

[≠] based on Iranian obesity committee definition of central obesity in both gender
[#،≠#] Based on the ATP III definitions of central obesity for men and women respectively

an alternative screening tool of central and general obesity in a population of adult in north of Iran. BMI is widely used for screening overweight/obesity but has limited value for diagnosing central fat distribution (1). Besides visceral fat, upper-body SC fat has been recently proposed as a separate body fat depot associated with increased production of fatty acids, providing a potential link between obesity, the development of CVD risk factors and metabolic syndrome (5,19,20).

NC can be a tool for measurement of upper-body SC fat. The NC method is a simple, quick, low-cost and requires less effort from both the examiner and the examinee than other anthropometric methods. NC provides good inter- and intra-observer reliability. In addition, the measurement of NC on a body surface is more socially acceptable and cultural tolerable than the surface used for the measurement of WC or HC, thus reducing the probability of false results due to researcher or subjects' (5).

In addition values of WC vary according to the anatomic site and postprandial abdominal distension.

Jean Vague was the first researcher to use NC to assess upper-body fat distribution (7). The NC cut off level is determined by Liubov and et al, they concluded NC≥37 cm for male and ≥34 cm for female were the best cut off levels for determining the subject with BMI ≥25 kg/m2 (2).

In present study, the mean NC of the men and female were 39.56(3.28) cm, 35.29(2.80) cm respectively. The 57.3% of men and 50.7% of female had NC ≥37cm and ≥34 cm respectively. In gender, neck circumference correlated positively with age, body weight, waist circumferences, and BMI (*P*<0.05).

In the other study, Simpson conclude there was a significant association between changes in NC and BMI (men, r=0.67; women, r=0.69; each, *P*<0.0001), WC (male, r=0.69; female, r=0.56; each, *P*<0.0001), W/H (male, r=0.27; female, r=0.33; each *P*<0.0001). (4) Similarly, Ben- Noun and Laor and Onat showed that NC was associated with metabolic syndrome (2). Mendane Saka indicates that NC was associated with body weight, BMI, WC, HC and W/H ratio for men and women in Turkish Adults**.** A significant association was found

[Downloaded from ijdo.ssu.ac.ir on 2026-11-20]

between NC and conventional overweight and obesity index. NC was associated with W/H ratio for men and women. They found positive significant correlations between NC, body weight (male, r=0.576; female, r=0.702; *P*=0.000), WC (male, r=0.593; female r=0.667; *P*=0.000), HC(male, r=0.568; female, r=0.617; *P*=0.000) and BMI (male, r=0.587; female, r=0.688; *P*=0.000) too (4). But in our study observed correlation was stronger.

In study of Olubukola and Nafiu, in 2010 among 1102 children, 52% were male. NC was significantly correlated with age, BMI, and waist circumference in both boys and girls, although the correlation was stronger in older children. Optimal NC cutoff indicative of high BMI in boys ranged from 28.5 to 39.0 cm. Corresponding values in girls ranged from 27.0 to 34.6 cm (8).

Youngwon Kim et al evaluated classification accuracy of NC and compare it with BMI in identifying overweight/obese US children in 2014.

In contrast, the results of that study appear not to strongly support the use of NC measurement as a useful screening tool for classifying childhood overweight/obesity. While NC measurement holds great practicality, its unsatisfactory accuracy in overweight/obesity classification may preclude the widespread use at clinical settings (13).

Some observed discrepancy between our results with other investigation are because of different context (such as genetic variables, race, nutritional status, different Socioeconomic-cultural characteristics and also lifestyle diversity), discordance of sample size, inter and intra subject variability, measurement bias, diversity in method of assessment and references point.

A major strength of the present study is the study large sample of all weight adult Categories and controlling of confounding factors by identify proper exclusion criteria thus result in widening the applicability of the findings. Overweight and obesity levels in our sample were standard and comparable to other study. The limitations of the present study consist non-random study sampling, cross-sectional design and single NC measurement.

Finally, the overall condition prevalence should be considered in interpretation and use of analyses finding that are based on ROC calculations such as predictive value. Nonetheless, our data, the first to show the clinical relevance of NC measurement in a large sample of Iranian healthy adult, further studies are suggested to confirm the current findings in Iranian child population.

Conclusions

The results of this study support the accuracy and widespread use of NC measurement as a useful screening tool for classifying adulthood (central /general) obesity especially for clinical practices and epidemiological survey

Conflict of Interest Statement

The authors have no conflict of interest to declare.

Acknowledgements

We would like to thank all the participants and Babol University of Medical Sciences for financial support of this study. We thank Clinical Research Development unit of Rouhani Hospital, Babol University of Medical Sciences for assistance in discussion of case and editing this article.

References

1. Karakaş P, Gülhal Bozkır M. Anthropometric indices in relation to overweight and obesity among Turkish medical students. Arch Med Sci. 2012;8(2):209-13.

2. Ben-Noun L, Sohar E, Laor A. Neck circumference as a simple screening measure for identifying overweight and obese patients. Obes Res. 2001;9(8):470-7.

3. Grundy SM, Brewer HB, Jr., Cleeman JI, Smith SC, Jr., Lenfant C. Definition of metabolic syndrome: Report of the National Heart, Lung, and Blood Institute/American Heart Association conference on scientific issues related to definition. Circulation. 2004;109(3):433-8.

[Downloaded from ijdo.ssu.ac.ir on 2026-11-20]

4. Saka M, Turker P, Ercan A, Kiziltan G, Bas M. Is neck circumference measurement an indicator for abdominal obesity? A pilot study on Turkish Adults. Afr Health Sci. 2014;14(3):570-5.
5. Preis SR, Massaro JM, Hoffmann U, D'Agostino RB, Levy SD, Robins SJ, et al. Neck Circumference as a Novel Measure of Cardiometabolic Risk: The Framingham Heart Study. J Clin Endocrinol Metab. 2010;95(8):3701–10.
6. Yang GR, Yuan SY, Fu HJ, Wan G, Zhu LX, Bu XL, et al. Neck circumference positively related with central obesity, overweight, and metabolic syndrome in Chinese subjects with type 2 diabetes: Beijing Community Diabetes Study 4. Diabetes Care. 2010;33(11):2465-7.
7. Vague J. The degree of masculine differentiation of obesities: a factor determining predisposition to diabetes, atherosclerosis, gout, and uric calculous disease. Am J Clin Nutr. 1956;4(1):20-34.
8. Nafiu OO, Burke C, Lee J, Voepel-Lewis T, Malviya S, Tremper KK. Neck circumference as a screening measure for identifying children with high body mass index. Pediatrics. 2010;126(2):e306-10.
9. Stabe C, Vasques AC, Lima MM, Tambascia MA, Pareja JC, Yamanaka A, et al. Neck circumference as a simple tool for identifying the metabolic syndrome and insulin resistance: results from the Brazilian Metabolic Syndrome Study. Clin Endocrinol (Oxf). 2013;78(6):874-81.
10. Azizi F, Khalili D, Aghajani H, Esteghamati A, Hosseinpanah F, Delavari A, et al. Appropriate waist circumference cut-off points among Iranian adults: the first report of the Iranian National Committee of Obesity. Archives of Iranian medicine. 2010;13(3):243-4.
11. Onat A, Hergenc G, Yuksel H, Can G, Ayhan E, Kaya Z, et al. Neck circumference as a measure of central obesity: associations with metabolic syndrome and obstructive sleep apnea syndrome beyond waist circumference. Clinical nutrition (Edinburgh, Scotland). 2009;28(1):46-51.
12. Li HX, Zhang† F, Dong D, Xin Z, Qin Guo S, Wang S, et al. Neck circumference as a measure of neck fat and abdominal visceral fat in Chinese adults. BMC public health 2014;14(1):311.
13. Kim Y, Lee JM, Laurson K, Bai Y, Gaesser GA, Welk GJ. Accuracy of Neck Circumference in Classifying Overweight and Obese US Children. ISRN obesity. 2014;2014:781841.
14. Androutsos O, Grammatikaki E, Moschonis G, Roma-Giannikou E, Chrousos GP, Manios Y, et al. Neck circumference: a useful screening tool of cardiovascular risk in children. Pediatric obesity. 2012;7(3):187-95.
15. Hatipoğlu N, Doğan S, Mazıcıoğlu MM, Kurtoğlu S. Relationship between Neck Circumference and Non-Alcoholic Fatty Liver Disease in Childhood Obesity. J Clin Res Pediatr Endocrinol. 2016;8(1):32–9.
16. Zhou JY, Ge H, Zhu M, Wang L, Chen L, Tan J, et al. Neck circumference as an independent predictive contributor to cardio-metabolic syndrome. BMC 2013;12(76).
17. Zen V, Fuchs FD, Wainstein MV, Goncalves SC, Biavatti K, Riedner CE, et al. Neck circumference and central obesity are independent predictors of coronary artery disease in patients undergoing coronary angiography. American journal of cardiovascular disease. 2012;2(4):323-30.
18. Misra A, Wasir JS, Vikram NK. Waist circumference criteria for the diagnosis of abdominal obesity are not applicable uniformly to all populations and ethnic groups. Nutrition (Burbank, Los Angeles County, Calif). 2005;21(9):969-76.
19. Nasrollah S, Jalalmanesh SH, Mohammadzadeh SH, Mahmoodi M. Relationship between higher-standard neck circumference in women and risk factors of coronary artery disease. Journal of Shahid Beheshti School of Nursing & Midwifery 2008;18(60).
20. Moazezi Z, Mahdizadeh H, Pooshani A. Neck Circumference as a Novel Anthropometric Value for Diagnosis of Metabolic Syndrome and Obesity in Patients with Diabetes. Br J Med Med Res. 2016;13(3):1-8.

[Downloaded from ijdo.ssu.ac.ir on 2026-11-20]