

The association between neck circumference and cardiovascular risk factors in patients with acute coronary syndrome

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ABSTRACT

Purpose: To investigate the relationship between neck circumferences and cardiovascular risk factors in patients with acute coronary syndrome.

Materials and Methods: In a cross-sectional study, 100 patients with acute coronary syndrome in Kerman hospitals were assessed by measuring their neck circumference and risk factors of cardiovascular disease. The data were analyzed by student *t*-test, Man-Whitney *U* test, χ^2 and Pearson and Spearman correlation tests.

Results: The mean of neck circumference in men with body mass index (BMI) ≥ 25 kg/m² was 39.63 ± 3.02 cm and for women it was 36.47 ± 2.00 cm. The mean of neck circumference in overweight group was 42.70 ± 2.99 cm for men and 38.66 ± 3.28 cm for women. Neck circumference ≥ 41.5 cm for men and ≥ 36.5 cm for women were the best cutoff levels for determining the patients with BMI ≥ 25 kg/m².

Conclusion: There were some associations between some cardiovascular disease risk factors. These risk factors were usually related to increasing weight. Because of fat accumulation in neck during weight gaining, this index can be used as a simple and easy screening way to recognize people with high weights.

Keywords: anthropometry; neck; risk factors; coronary artery disease; metabolic syndrome.

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INTRODUCTION

Coronary artery diseases are the most common cause of cardiovascular diseases and mortality in the world.¹ Just like most countries with rapid economic and demographic transition, cardiovascular diseases are a major cause of mortality and morbidity in Iran.² Obesity, specifically in the upper part of the body, is a major health problem and it is related to cardiovascular diseases and metabolic disorders.³ Overweight is defined as a body mass index

(BMI) between 25 and 29.9 kg/m² and obesity is defined as a BMI of 30 kg/m² or higher. These conditions are associated with various chronic diseases.⁴

Although obesity results in metabolic abnormalities, upper body obesity is more strongly associated with glucose intolerance, hyperinsulinemia, diabetes, hypertriglyceridemia and cardiovascular diseases than lower body obesity.⁵⁻⁷ There are numerous methods of assessing overweight and obesity, such as measurements

of weight, height, abdominal sagittal diameter, abdominal and hip circumferences and calculations of waist to hip ratio and BMI. Jean Vague was the first to show that different body morphologies or types of fat distribution are related to the health risks associated with obesity. He himself used a neck skin fold in his index of masculine differentiation to assess upper body fat distribution.^{5,8}

Some studies have demonstrated that neck circumference is a valid marker for identifying obese individuals and it correlated well with other anthropometric measurements.^{4,5,8} Neck circumference has also been shown to correlate positively with insulin resistance⁷ and biochemical components of the metabolic syndrome, raised insulin and free androgen index.^{6,9} More new works have revealed a relationship between higher neck circumferences with obesity and cardiovascular diseases risk factors.¹⁰⁻¹³ Nasrollah and Jalalmanesh found a significant association between neck circumference and high cholesterol, triglyceride and high blood pressure in women with cardiovascular diseases.¹⁴ However, to the authors' knowledge, the association between neck circumference and cardiovascular risk factors in patients with cardiovascular diseases has been not assessed in the two sexes.

Kerman, a city located in south-east of Iran. The economy of this city is mostly based on agriculture and nut farming. However, new technologies and modern life styles are growing very fast in this community, causing changes in disease epidemiology. The purpose of this study was to assess the association between neck circumferences and cardiovascular risk factors in patients with acute coronary syndrome. Additionally, neck circumference cutoffs for overweight and obesity according to BMI in an Iranian population was calculated.

MATERIALS AND METHODS

Study Subjects

In this cross-sectional study, the association between neck circumferences and cardiovascular risk factors were examined in patients with acute coronary syndrome. The study population consisted of all patients who were admitted to hospitals affiliated to Kerman University of Medical Sciences from January to August 2009. The study participants were selected randomly from patients in coronary care units (CCU) with confirmed diagnose of acute coronary syndrome. The study was approved by the ethics committee of Kerman University of Medical Sciences. The aim of the study was explained to each patient and the confidentiality of information was assured. Written informed consent was waived because there was

no harm to the patients and they could leave the study whenever they wanted.

Measurements

The independent variable was neck circumference. The dependent variables were history of high blood pressure, hyperglycemia, diabetes mellitus, systolic and diastolic blood pressure, fasting blood sugar, high density lipoprotein (HDL), low density lipoprotein (LDL) and cholesterol. Past medical history and demographics data were gathered with a standardized questionnaire. The validity of questionnaire was determined by content validity. Inter-rater reliability was used for reliability. All measurements were made by one investigator using techniques according to Ben-Noun and Laor⁵ as follows: The weight was measured by digital scales (less than 0.1 kg was hospital clothing), height was measured by portable stadiometer up to 0.5 cm, while barefoot; waist and hip circumferences up to 1 mm, with a plastic tape which calibrated weekly, the measurement was on waist in the middle of the lowest rib and the iliac crest, while the patient was standing at the end of gentle expiration and hips at the greater trochanter. The measurement of neck circumference was at mid-neck height, between mid-cervical spine and mid-anterior neck, up to 1 mm, with a plastic tape calibrated every week. In men with a laryngeal prominence (Adam's apple), neck circumference was measured just below the prominence.⁵ The position for measuring all circumferences was standing upright and facing the investigator, with relaxed shoulders.⁵

Blood pressure was measured twice for each subject with a mercury sphygmomanometer (alpk2, Tokyo, 116-0002 Japan), in lying position on the right arm, after 10 min of rest. The mean of two less-than-3-min recordings was recorded.^{6,13} Overweight was defined as $BMI \geq 25 \text{ kg/m}^2$.¹⁵

Statistical Analysis

Data analysis was conducted by the Statistical Package for the Social Sciences (SPSS Inc, Chicago, Illinois, USA) version 18. The data were noted in absolute numbers with percentages, as means with standard deviations. Student *t*-test was used to compare continuous variables, whereas χ^2 test was used to compare proportions. Two continuous variable relationships were assessed by Pearson correlation. The receiver output curve analysis was performed in cutoff points at 0.5 cm neck circumference intervals against two levels of BMI to find the optimal and maximal sensitivity and specificity for neck circumference. In all cases, significance was defined as $P < .05$.

RESULTS

The study consisted of 100 participants (54 women and 46 men) with a mean age of 61.05 ± 11.79 years old. The average of laboratory values were as follows: cholesterol 172.67 ± 48.20 mg/dl, LDL 110.40 ± 45.69 mg/dl, HDL 36.98 ± 12.22 mg/dl, triglyceride 128.10 ± 66.82 mg/dl, fasting blood sugar 133.27 ± 50.79 mg/dl, weight 63.64 ± 12.02 Kg, height 157.29 ± 10.51 cm, waist circumferences 95.80 ± 12.88 cm, hip circumferences 91.87 ± 13.81 cm, BMI 25.76 ± 4.50 kg/m² and waist to hip ratio 1.06 ± 0.26 . Laboratory values and anthropometric data for each gender are shown in Table 1.

The mean of neck circumference was 39.72 ± 3.16 cm. Mean of neck circumference in men (41.30 ± 3.32 cm) was 3.59 cm wider than women (37.71 ± 3.20 cm) and this difference was significant ($P < .001$). The mean of neck circumference in men with BMI ≥ 25 kg/m² was 39.63 ± 3.02 cm and for women it was 36.47 ± 2.00 cm. The mean of neck circumference in overweight group was 42.70 ± 2.99 cm for men and 38.66 ± 3.28 cm for women. Percentile values of 2.5, 25, 50, 75 and 97.5 were 35, 39.75, 42, 43, 52.45 cm in men and 30.40, 35, 37, 40, 46.30 cm in women, respectively. Neck circumference ≥ 41.5 cm for men and ≥ 36.5 cm for women were the

Table 1. Comparison of demographic variables between men and women.

Variables	Men			Women			P (t-Test)
	Mean \pm SD	r	P value	Mean \pm SD	r	P value	
Age (years)	59.09 \pm 12.12	.155	.30	62.72 \pm 11.34	-.074	.59	.12
Cholesterol (mg/dL)	166.29 \pm 44.74	.312	.03	178.07 \pm 50.75	-.094	.50	.23
LDL (mg/dL)	105.72 \pm 41.46	.230	.12	114.37 \pm 49.03	-.053	.70	.35
HDL (mg/dL)	34.52 \pm 13.49	-.169	.26	39.03 \pm 10.76	-.204	.13	.07
Triglyceride (mg/dL)	134.15 \pm 68.84	.503	< .001	122.94 \pm 65.25	.041	.76	.40
Fasting blood sugar (mg/dL)	142.35 \pm 58.85	.191	.23	125.70 \pm 42.10	.392	.006	.12
Weight (kg)	68.28 \pm 10.87	.671	< .001	59.62 \pm 11.59	.539	< .001	< .001
Height (cm)	165.26 \pm 8.25	.173	.25	150.37 \pm 6.68	.191	.17	< .001
Body mass index (kg/m ²)	24.99 \pm 3.38	.649	< .001	26.43 \pm 5.23	.449	.001	.11
Waist circumference (cm)	95.19 \pm 11.51	.556	< .001	96.34 \pm 14.07	.554	< .001	.66
Hip circumference (cm)	92.02 \pm 10.23	.396	.01	91.75 \pm 16.24	.063	.65	.92
Waist-to-hip ratio	1.04 \pm 0.09	.201	.20	1.08 \pm 0.35	.498	< .001	.42

Keys: LDL, low density lipoprotein; HDL, high density lipoprotein; SD, standard deviation.

Table 2. Neck circumference cutoff levels for determining the participants with BMI ≥ 25 kg/m² using receiver output curve analysis.

Cutoff Level (cm)	Men		Women	
	Sensitivity	Specificity	Sensitivity	Specificity
28	—	—	1.00	1.00
31	—	—	1.00	0.95
33.5	—	—	1.00	0.90
34	1.00	1.00	—	—
34.5	—	—	1.00	0.90
35.5	1.00	0.90	0.87	0.80
36.5	1.00	0.81	0.78	0.50
37.5	1.00	0.71	0.51	0.40
38.5	0.95	0.66	0.39	0.35
39.5	0.95	0.52	0.30	0.20
40.5	0.75	0.33	—	—
41	—	—	0.18	0.15
41.5	0.75	0.23	—	—
42	—	—	—	—
42.5	0.54	0.23	0.12	0.05
43.5	0.20	0.09	0.09	0.05
44.5	0.16	0.04	0.06	0.00
46	—	—	0.03	0.00
48	—	—	0.00	0.00
49.5	0.04	0.00	—	—
55	0.00	0.00	—	—

best cutoff levels for determining the participants with $\text{BMI} \geq 25 \text{ kg/m}^2$. Receiver output curve analysis showed 75% sensitivity and 76.2 % specificity for men and 78% sensitivity and 60% specificity for women (Table 2 and Figure 1).

Forty eight participants reported a history of hypertriglyceridemia and 68.75% of them were

receiving medication. There was a significant association between neck circumference categories and the history of hypertriglyceridemia by χ^2 test ($P = .03$). Forty two participants had a history of high blood pressure and all of them were using antihypertensive drugs. The χ^2 test did not show any association between high blood pressure and neck circumference ($P = .15$). A history of diabetes was reported by 39% of the participants which 89.8% of them were type 2. A significant association was found between neck circumference and history of diabetes using χ^2 test ($P = .02$).

There was a significant correlation between neck circumference and HDL levels ($r = -.249$, $P = .04$), triglyceride levels ($r = .272$, $P = .01$), fasting blood sugar levels ($r = .319$, $P = .01$), weight ($r = .665$, $P = .001$), height ($r = .476$, $P = .001$), waist circumference ($r = .454$, $P < .001$), waist to hip ratio ($r = .285$, $P = .01$) and BMI ($r = .345$, $P = .001$) using Pearson correlation test. The association between neck circumference with laboratory values and anthropometric measurements for each gender are shown in Table 3.

DISCUSSION

The results of this study showed that there is an association between higher neck circumference and some of cardiovascular diseases. This association was also shown in previous studies. In 2001, Ben-Noun and colleagues have showed that there is a significant relationship between BMI, waist circumference, waist to hip ratio, higher level of cholesterol, LDL, triglycerides, glucose and higher systolic and diastolic pressures⁴. In another study positive association was found between higher neck circumference and BMI, waist to hip ratio, waist circumference, higher level of LDL, triglycerides, glucose and uric acid⁵. Also a positive association was found with insulin resistance.⁶ In addition, the significant association between neck circumference and level of cholesterol, LDL, triglycerides, glucose and higher systolic and diastolic pressures was found in an Iranian population.¹⁴ Our results are consistent with the results of other similar studies.^{8,12,13,16}

Ben-Noun and Laor have conducted two studies in this regard. In the first study in 2003 they found a significant association between neck circumference and higher BMI, waist circumference, waist to hip ratio, cholesterol, LDL, triglycerides, glucose, systolic and diastolic blood pressure.⁸ In the second study on 2006 they found a significant association between increase of neck circumference with BMI, waist circumference, waist to hip ratio, total cholesterol, triglycerides, glucose and

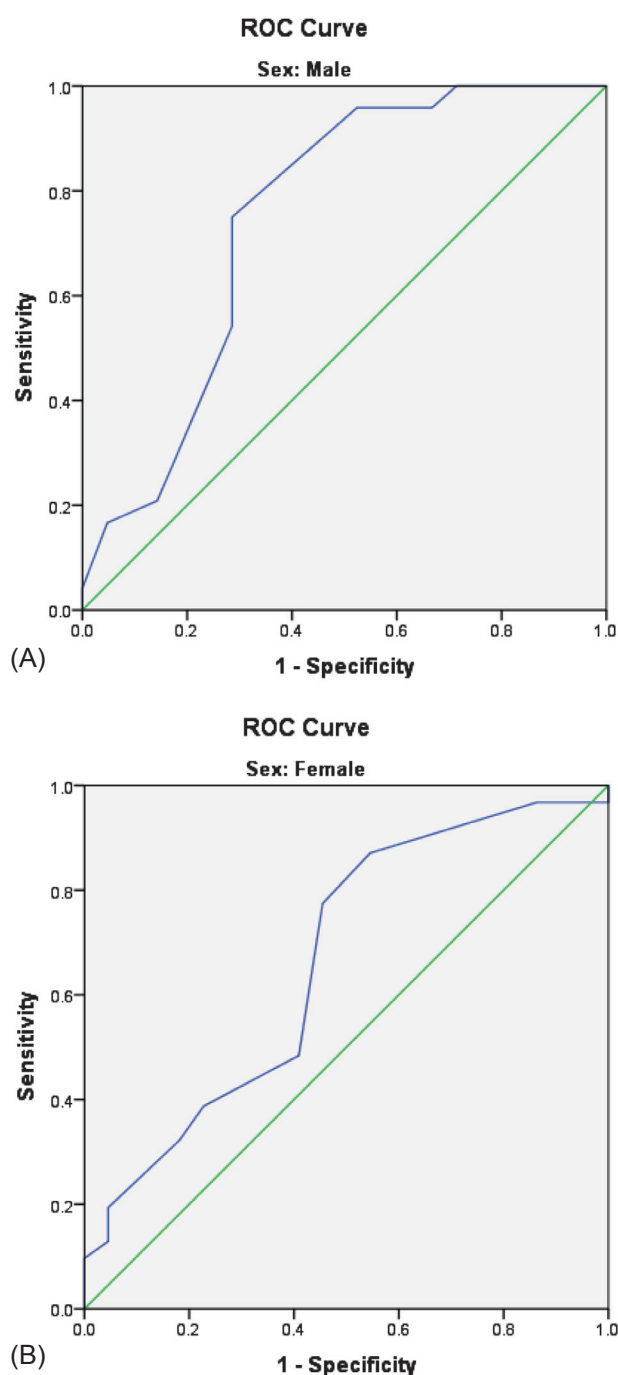


Figure 1. (A) Receiver output curve related to neck circumference and $\text{BMI} \geq 25 \text{ kg/m}^2$ in men; (B) Receiver output curve related to neck circumference and $\text{BMI} \geq 25 \text{ kg/m}^2$ in women.

Table 3. Comparison of cardiovascular disease risk factors between men and women.

Variables	Men			Women		
	NC < 41.5	NC > 41.5	P value	NC < 36.5	NC > 36.5	P value
Age (years)	58.36 ± 13.25	59.75 ± 11.23	.70	63.53 ± 11.73	62.29 ± 11.27	.7
Cholesterol (mg/dL)	149.95 ± 22.81	179.91 ± 53.73	.02	171.21 ± 41.32	182.03 ± 55.68	.4
LDL (mg/dL)	91.34 ± 27.90	118.30 ± 47.51	.02	107.52 ± 35.73	118.20 ± 55.23	.4
HDL (mg/dL)	37.52 ± 16.66	32.04 ± 9.64	.19	40.21 ± 12.74	38.40 ± 9.67	.5
Triglyceride (mg/dL)	159.95 ± 34.46	168.83 ± 67.04	.02	117.31 ± 61.38	126.0 ± 67.94	.6
Fasting blood sugar (mg/dL)	138.65 ± 58.82	146.05 ± 60.16	.69	112.29 ± 31.38	133.06 ± 45.76	.1
Weight (kg)	60.77 ± 7.50	75.16 ± 8.75	< .001	51.84 ± 9.51	63.97 ± 10.40	< .001
Height (cm)	163.81 ± 6.77	166.58 ± 9.36	.26	150.31 ± 6.20	150.41 ± 7.02	.9
Body mass index (kg/m ²)	22.69 ± 2.83	27.09 ± 2.31	< .001	23.01 ± 4.42	28.35 ± 4.68	< .001
Waist circumference (cm)	90.54 ± 11.12	99.45 ± 10.32	.007	86.52 ± 12.92	102.00 ± 11.47	< .001
Hip circumference (cm)	88.89 ± 9.69	94.60 ± 10.14	.07	88.05 ± 15.28	93.87 ± 16.62	.2
Waist-to-hip ratio	1.02 ± 0.13	1.05 ± 0.05	.49	0.98 ± 0.06	1.14 ± 0.43	.1

Keys: NC, neck circumference, LDL, low density lipoprotein; HDL, high density lipoprotein.

uric acid.⁵ These findings are consistent with previous studies on the association between neck circumference and some factors of metabolic syndrome. However, there are differences. For example, lack of correlation between neck circumference and low HDL and high LDL in women in the current study compared to Nasrallah and Jalalmanesh results. Other examples can be lack of correlation between neck circumference and HDL, triglycerides and blood pressure, which was found in the previous studies.

Our results have some differences with previous studies. In studies carried out in other countries on a healthy population, the standard neck circumference was determined using a BMI index. Also, previous studies in Iran have used cutoff points from studies from other countries or simply used correlation between neck circumference and variables of interest.^{14,16,17} However, in this study we first calculated proper neck circumference with receiver output curve and in relation with BMI ≥ 25 as a valid index of overweight. People with cardiovascular risk factors were identified with this calculation. As a result the authors of this study claim that their results are more accurate than similar studies in Iran.

There were some limitations in this study. The first was related to the study design. Using a control group could have lead to accurate results. Second was related to laboratory results, which might have been influenced by patients' condition. Hence, using cholesterol and hemoglobin A1C of the first 12 hours of hospitalization is recommended. However, these conditions were the same for all participants, and can reduce the impact of this limitation.

CONCLUSION

Patients with cardiovascular disease who have higher

neck circumference can probably have more risk factors. Conducting more studies on the Iranian population, especially on healthy people, is recommended. Calculation of neck circumference in specific populations is still an acceptable approach in other countries for children or other diseases. Since this index can be easily used for screening, more studies and adding this anthropometric index to large studies like Tehran glucose and lipid study are recommended.

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CONFLICT OF INTEREST

None Declared.

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