Assessment of Neck Circumference Measurement among Type 2 Diabetic Patients in Identifying: Obesity and the Likelihood of Developing Metabolic syndrome.

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Abstract

Background: Obesity is an evolving major health problem in both developed and developing countries. Traditional obesity indices as body mass index, waist circumference, waist-hip-ratio are well known measures to identify obese subjects, however, neck circumference as an index of upper-body obesity was found to be a simple and time-saving screening measure that can be used to identify obesity and the likelihood of developing metabolic syndrome in type 2 diabetic patients.

Aim: to investigate the relationship of neck circumference (NC) to obesity and metabolic syndrome in Iraqi subjects with type 2 diabetes.

Methods: The study group included 90 type 2 diabetic subjects (48 men and 42 women) aged 30-68 years. The subjects were those who attending The Specialized Center for Endocrinology and Diabetes/Baghdad. Main indicators studied included Neck Circumference (NC), waist circumference (WC), waist-to-hip ratio (WHR), body mass index (BMI), blood pressure, fasting blood glucose, and lipoprotein levels.

Results: Pearson's correlation coefficients indicated a significant association between NC and body mass index, waist circumference, and waist-hip-ratio ($p < 0.0001$ in men and from 0.014 to less than 0.0001 in women). Also NC is positively correlated with systolic blood pressure (SBP), diastolic blood pressure (DBP), triglycerides (TGA), fasting blood glucose level (p value from 0.092 to less than 0.0001). Cross tabulation between NC and BMI indicated that NC identified obese persons with 100% sensitivity in men and 90% in women, also a cross tabulation between NC and metabolic syndrome indicated that NC can identify metabolic syndrome with 100% sensitivity in both men and women. Metabolic syndrome was identified according to a modified criteria proposed by the National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATPIII).

Conclusion: Neck circumference is positively correlated with BMI, waist circumference, waist-hip-ratio, and positively correlated with components of metabolic syndrome in Iraqi individuals with type 2 diabetes. Accordingly, the measurement of neck circumference could be useful in clinical screening for obese persons and for persons who are at risk of developing metabolic syndrome.

Keywords: neck circumference, obesity, metabolic syndrome.

Al – Kindy Col Med J 2012; Vol. 8 No. 1 P:

Introduction

Obesity is one of the component of metabolic syndrome, in addition to the other components such as elevated blood pressure, elevated fasting glucose level (equal or greater than100 mg/dL), elevated triglycerides (equal or greater than 150 mg/dL) and reduced high density lipoprotein (HDL-cholesterol, in men less than 40 mg/dL, in women less than 50 mg/dL). Accordingly, metabolic syndrome is identified as the presence of three or more of these components in one person. People with metabolic syndrome are at increased risk of coronary heart disease and other diseases related to plaque buildups in artery walls (e.g. stroke and peripheral vascular disease) and type 2 diabetes.[1] Body mass index and waist hip ratio have been suggested as the best anthropometric indices of obesity and the related cardiovascular risk in both men and women.[2]

Neck circumference (NC) as an index of upper-body obesity was found to be a simple and time-saving screening measure that can be used to identify obese individuals. It has been shown that men with NC less than 37cm and women with NC less than 34cm probably have a low body mass index (BMI). Furthermore, patients above these levels require a more comprehensive evaluation of their overweight and obesity status.[3]

A high correlation between NC and cardiovascular risk factors has been reported in obese patients.[4] Recently, the association between NC and the individual components of metabolic syndrome has also been studied.[5] So the aim of the present study was to investigate whether can NC be an additional tool for identifying obese patients by studying the correlation between NC with the traditional indices of obesity and to test the association NC with components of metabolic syndrome.

Methods:

Ninety eight subjects aged 30 years and older (up to 68 years), were recruited from The SpecializeCenter for Endocrinology and Diabetes/Baghdad. Subjects with any pathology in the neck region were excluded (8 patients), the remaining was ninety (48 men and 42women), NC was measured in addition

to the traditional anthropometric measures (height, weight, waist circumference and hip circumference), NC was measured at mid-neck height, between the

mid-cervical spine to mid-anterior neck, to within 1mm. In men with a laryngeal prominence (Adam's apple), it was measured just below the prominence. Blood pressure was recorded in the sitting position after 5 minutes of rest.[6] Fasting blood samples were sent for analyses of blood glucose, triglycerides and high density lipoprotein (HDL-cholesterol). We counted participants who reported currently using antihypertensive medication as participants with high blood pressure.[7]

Obesity was identified as BMI ≥ 30 Kg/m² [8], while metabolic syndrome was identified according to recommendation of The American Heart Association and the National Heart, Lung, and Blood Institute, based on a modified criteria proposed by the National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATPIII).[1]

Pearson correlation coefficients were used to test the correlation between NC and anthropometric indices. *p* value was considered to be significant at $p < 0.05$. The significance of difference in the means between NC and both patients with and patients without metabolic syndrome was assessed using Student's *t* test (2 sample test). Data were analyzed using MINITAB Release 13.20 of MINITAB statistical software.

Results:

The clinical characteristics of study subjects are summarized in table 1. the table illustrates non significant differences between men and women in the mean age, BMI, waist circumference, hip circumference, waist-hip-ratio, and triglycerides, HDL-cholesterol, and glucose levels. At the same time men were heavier, taller than women, however, women had higher blood pressure levels than men.

In both sexes, NC correlated positively with all of the traditional obesity indices; BMI, Waist circumference, and waist-hip-ratio. (see Table 2)

Table 3 illustrates significant difference in the means of BMI in both NC above and NC below 37 cm in men, and significant difference in the means of BMI above and below 34 cm in women. ($p<0.0001$)

NC correlated positively with all of the components of metabolic syndrome; systolic and diastolic blood pressure, triglycerides, and glucose levels except with HDL. (see Table- 4)

Table 5 shows a cross tabulation between two categories of BMI as obese and non obese with NC of two categories as; NC above and below 37 cm in men, and NC above and below 34 cm in women as the subjects that were below this level might probably have low BMI, and those who were above this level require a more comprehensive evaluation regarding their obesity status, the table shows significant difference between the different groups in men as p-value =0.018, while in women p-value is incalculable due to data shortage in women with NC below 34 cm. although, p-value < 0.0001 if men and women is calculated together. (see table 5) Table 6 shows a cross tabulation between two categories of subjects with metabolic syndrome and subject without metabolic syndrome tabulated with two categories of subjects with NC above and below 37 cm in men and subjects with NC above and below 34 cm in women, showing a significant difference in men (p-value = 0.018), however, in women p-value is incalculable due to shortage of data, while p-value < 0.0001 for men and women if calculated together).(Table 6).

Discussion:

Obesity is an evolving major health problem in both developed and developing countries. Traditional obesity indices as body mass index (BMI), waist circumference (WC), waist-hip-ratio (WHR) are well known measures to identify obese subjects; however, in the present study we tested the application of NC measurement as an additional tool for identifying obese people and to investigate NC correlation with metabolic syndrome in patients with type 2 diabetes.

Previous studies have demonstrated the association of NC with insulin resistance-related factors.[9] Also, another study had demonstrated the relationship of NC to cardiovascular risk factors among healthy people.[10] However, in our study we considered type 2 diabetic patients, the study indicated strong correlation between NC and BMI, as well as between NC and other obesity indices as; WC and waist-to-hip ratio. Similar findings were reported by previous study in china.[11]

NC was also positively correlated with SBP, DBP, TGA, and fasting glucose level. No significant correlation was found between NC and HDL-cholesterol level, and we conclude that this parameter is not affected by NC. Our findings are very consistent with findings reported by Onat *et al*.[12]

The Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) highlights the importance of treating patients with the metabolic syndrome to prevent cardiovascular diseases. The elements of the current definition of the metabolic syndrome include WC, fasting glucose, blood pressure, triglycerides, and HDL- cholesterol.[1] Therefore, the contribution of the present report lies in the indication of the association between NC and the factors of the metabolic syndrome.

BMI is a reasonable index of fatness because it is simple, easy to determine, inexpensive, safe, and practical. It has shown reasonably good correlation with the direct measures of fatness.[13] BMI should be used to assess overweight and obesity and to monitor changes in body weight.[14] Therefore, in this study NC measures were compared primarily with BMI values.

In the present study, mean BMI of men with NC of equal or above 37 cm is significantly higher than mean BMI of men with NC of below 37 cm; again women with NC equal or above 34 cm have a higher mean BMI significantly than women with NC below 34 cm. These findings agreed with findings reported by

previous study.[3] They also indicate that NC can be used as a simple, easy to perform, quick test that can be used to identify obese patients.

Neck circumference 37 cm or above for men and 34cm or above for women identified subjects with BMI of 30 Kg/m² with 100% sensitivity for men and 90% for women. In addition, NC 37 cm or above for men and 34cm or above for women identified subjects with metabolic syndrome with 100% sensitivity for both women and men.

Accordingly, we can consider NC as a marker for obesity and for some of the components of metabolic syndrome; this is agreed with previous study. [12] [15]

Some researchers think patients would understand that having a large neck size is an indication of potential health problems more readily than considering BMI that may be meaningless to most people.[16]

In conclusion, NC is strongly correlated with the anthropometric measures of obesity, and it is also strongly correlated with the components of metabolic syndrome in Iraqi individuals with type 2 diabetes, and therefore, is correlated with risk of cardiovascular disease.

The measurement of neck circumference could be useful in clinical screening for obese persons and for persons who are at risk of developing metabolic syndrome. It is simple and easier to perform than the measurement of waist circumference, which may vary during the day. However, the results should be confirmed in other studies with larger sample size for proper calculation of sensitivity and specificity and to overcome short data problem.

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Table 1: The characteristics of study subjects.

Variable	Men (n=48) (mean ± SD)	Women(n=42) (mean ± SD)	p-value
Age (years)	51.8 ± 10.0	54.2 ± 10.8	0.27
NC (cm)	39.9 ± 3.2	35.9 ± 1.3	0.0001
Height(cm)	172.0 ± 4.6	156.8 ± 6.1	0.0001
Weight (Kg)	83.8 ± 16.2	74.5 ± 10.6	0.002
BMI (Kg/m²)	28.1 ± 4.4	30.3 ± 4.4	0.02
Waist (cm)	100.7 ± 12.7	99.9 ± 8.4	0.72
Hip (cm)	105.3 ± 6.4	103.4 ± 8.1	0.23
WHR	0.95 ± 0.07	0.96 ± 0.06	0.39
f-HDL (mg/dl)	39.3 ± 4.3	41.62 ± 10.5	0.19
f-TGA (mg/dl)	121.2 ± 31.6	128.85 ± 51.7	0.41
Systolic BP (mmHg)	129.1 ± 8.0	139.1 ± 12.7	0.0001
Diastolic BP(mmHg)	81.3 ± 8.1	86.7 ± 6.7	0.001
f-Glucose (mg/dl)	127.6 ± 16.7	128.1 ± 16.4	0.89

f=fasting

Table 2: correlation of NC with other anthropometric indices.

	Neck circumference (NC)			
Variable	**Men (n=48)**		**Women(n=42)**	
P-value	***R***	***P***	***r***	***P***
BMI	0.92	0.0001	0.37	0.014
Waist circumference	0.93	0.0001	0.52	0.0001
WHR	0.86	0.0001	0.47	0.002

Table 3: Comparison of mean BMI according to NC level.

Men			
NC (cm)	< 37	≥ 37	p-value
mean BMI	23.0 ± 0.76	29.9 ± 3.78	0.0001
Women			
NC (cm)	< 34	≥ 34	p-value
mean BMI	27.2 ± 0.07	30.51 ± 4.5	0.0001

Table 4: correlation of NC with components of metabolic syndrome.

	Neck circumference (NC)			
Variable	**Men (n=48)**		**Women(n=42)**	
P-value	***r***	***P***	***r***	***P***
SBP (mm Hg)	0.72	0.0001	0.65	0.0001
DBP (mm Hg)	0.63	0.0001	0.71	0.0001
f-Glucose (m/d)	0.98	0.0001	0.96	0.0001
Triglycerides (m/d)	0.56	0.001	0.26	0.092
HDL-cholesterol (m/d)	-0.01	0.92	-0.18	0.23

Table 5: Cross tabulation between NC and BMI.

BMI (kg/m²)	NC (cm)					P-value
Men	**<37**	**%**	**≥37**	**%**	**Total**	
≥30	0	0%	16	100%	16	
<30	12	37%	20	62%	32	0.018
Total	12	25%	36	75%	48	
Women	**<34**	**%**	**≥34**	**%**	**Total**	
≥30	2	10%	20	90%	22	
<30	0	0%	20	100%	20	*
Total	2	5%	40	95%	42	
Total (men and women)	14	15%	76	85%	90	0.0001

*incalculable

Table 6: Cross tabulation between NC and metabolic syndrome.

Metabolic syndrome	NC (cm)					P-value
Men	**<37**	**%**	**≥37**	**%**	**Total**	
+ve	0	0%	16	100%	16	
-ve	12	37.5%	20	62.5%	32	0.018
Total	12	25%	36	75%	48	
Women	**<34**	**%**	**≥34**	**%**	**Total**	
+ve	0	0%	30	100%	30	
-ve	2	16.7%	10	83.3%	12	**
Total	2	4.7%	40	95.3%	42	
Total (men and women)	14	15.5%	76	84.5%	90	0.0001

**incalculable

Al – Kindy Col Med J 2012 Vol. 8 No. 1 P:

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