SANAMED
2013; 8(2): 109–115
ISSN-1452-662X
UDK: 616-008.9-055.1(497.11) ; 572.087-055.1(497.11)
Originalni naučni rad

HEALTH RISK ASSESSMENT BASED ON ANTHROPOMETRIC INDICATORS IN MEN IN NEW BELGRADE

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Primljen/Received 8. 10. 2013. god. Prihvaćen/Accepted 17. 11. 2013. god.

Abstract: **Introduction:** There is little data on the association of metabolic syndrome and health status in Serbian men, so our intention was to investigate the prevalence of the metabolic syndrome in men with no history of diabetes or cardiovascular disease in New Belgrade, Serbia; to determine which of the anthropometric parameters (body mass index — BMI and waist circumference — WC) is best for the evaluation of health risks in primary care, especially the risk factors for metabolic syndrome.

Research Methods and Procedures: The study involved 132 healthy men ages 44.73 ± 9.37 years. Anthropometric values were measured in all the patients. Blood pressure, blood biochemistry (high-density lipoprotein-cholesterol, low-density lipoprotein-cholesterol, triglycerides, blood glucose) and analysis of their medical records were also done. Analysis of consistency has been used in testing hypothesis.

Results: The sample consisted of 132 patients with mean age 44.73 ± 9.37 years. The prevalence of the metabolic syndrome was 44.7%. Analysis of consistence showed differences in the combined predictive ability of anthropometric indicators and other factors of MetS.

Conclusions: BMI and WC are the simple measures of adiposity most strongly associated with metabolic abnormalities. Our findings suggest that WC can not be used as a complementary measurement to identify health risks in any group of men.

Key words: Health Risk, Waist circumference, Body mass index, Metabolic syndrome.

INTRODUCTION

MetS is a group of related risk factors (metabolic factors) that lead to atherosclerotic cardiovascular disease and type 2 diabetes. The dominant risk factors for MetS are abdominal obesity and insulin resistance, other conditions that affect are: physical inactivity, aging, hormonal disorders (1, 2, 3).

It turned out that abdominal obesity accompanying metabolic and cardiovascular disorders in the MetS. This can be explained by varying the magnitude of the enzymes involved in lipolysis, triglyceride synthesis and secretion of adipokines in different parts of the body fat. In addition to fat, triglycerides, ectopic deposition in all tissues, especially the liver, muscle and pancreatic ß-cells, where they can express their lipotoxicity. This effect is manifested as hepatic steatosis, dysfunction and apoptosis of pancreatic ß-cells. Besides lipotoxicity triglycerides lead to insulin resistance in hepato-and myocytes (1, 2, 3).

In recent years, there has been increasing speculation which measure of overweight and obesity is the best to discriminate those individuals who are at increased cardiovascular and metabolic risk. Population-based, cross-sectional, and prospective studies clearly establish that body mass index (BMI) and waist circumference (WC) are predictors of cardiovascular disease and type 2 diabetes (1–5). Body mass index (BMI) is used by the World Health Organization to define severity of overweight and obesity across populations (1, 2, 3). The latter observation is consistent with a large body of evidence implicating abdominal obesity, in particular visceral fat, in the pathogenesis of numerous metabolic risk factors. But increasingly, measure of central adiposity, waist circumference (WC), has been adopted as more accurate predictor of obesity-related cardiovascular risk and have replaced BMI in several definitions for clinical diagnosis of metabolic syndrome (1, 2, 3).

In people who have normal weight (BMI < 25 kg/m^2) and in overweight individuals (BMI = 25.0–29.9 kg/m^2)

prevalence of the metabolic abnormalities increased with increasing waist circumference. If a BMI ≥ 30 kg/m^2, it indicates the presence of central obesity and WC is not need to be measured (5, 6, 7).

There is no data on the prevalence of metabolic syndrome among middle aged Serbian men. It is very important to set up a study on the health men with a risk of metabolic syndrome. The present study aimed to assess the metabolic syndrome among men in New Belgrade, Serbia and to determine which of the anthropometric parameters (body mass index and waist circumference) is best for the evaluation of the risk factors for metabolic syndrome in men in primary care.

The null hypothesis is that the waist circumference is not the best anthropometric predictor of metabolic syndrome in men.

MATERIAL AND METHODS

This cross-sectional study was performed in the Preventive center "New Belgrade", in period September–October 2007. The study was conducted on 132 men, mean age 44.73 ± 9.37 years, who were on a regular systematic review. After the analysis of medical records, we excluded examinees with diabetes and CVD.

The participants gave informed consent before taking part and the authors followed the World Medical Association's Declaration of Helsinki.

In the examined groups clinical examinations were performed including blood pressure measurement, as well as blood biochemistry, and evaluation of anthropometric parameters, nutritional status, and metabolic risk factors.

Anthropometric measurement of waist circumference was taken for each subject as half way between costal arch and iliac crest on the median axillary line. A ribbon made of non-stretching plastic was used, placed parallel to the base, with a patient in an upright position, with arms by the body. The measurements were recorded in centimeters.

Height and weight were measured by anthropometry and medical scales with sliding weight according to standard procedure [8]. From these values, BMI was calculated as recommended by the World Health Organization (WHO). According to the nutritional status the subjects were divided into three groups: group 1 — optimally nourished (BMI = 18.5 to 24.9 kg/m^2), group 2 — overweight (BMI = 25.0 to 29.9 kg/m^2); group 3 — obese (BMI ≥ 30.0 kg/m^2).

Blood pressure was measured in a sitting position on patient's left hand, taking the average of three measurements, according to the standard procedure recommended by the AHA (American Heart Association) (8).

Evaluation of metabolic risk factors included the determination of fasting blood glucose, total cholesterol, LDL-C, HDL-C and triglycerides. A venous blood sample was collected from each respondent who came in the morning after 8 to 12 hours an overnight fasting. Blood glucose concentration was determined by the oxidation of glucose (glucose analyzer Beckman Coulter). Triglycerides, total cholesterol, HDL-C and LDL-C were determined by chromatography (accessories Boeringher Mannheim). Reference values for serum lipid profile and fasting glucose were determined on the basis of IDF diagnostic criteria for MetS (1, 2, 3).

Definition of metabolic syndrome

The International Diabetes Federation (IDF) diagnostic criteria for metabolic syndrome (1, 2, 3) are listed as following:

WC higher than 80 cm in women or WC higher than 94 cm in men plus 2 or more of the following:

a. Low HDL cholesterol with values equaling or lower than 1.03 mmol/L for men and 1.29 mmol/L for women or under treatment;

b. Hypertriglyceridemia with values higher than 1.7 mmol/L or under treatment;

c. Arterial hypertension with values equaling or higher than 130/85 mm Hg, or under treatment;

d. Fasting hyperglycemia with values equaling or higher than 5.6 mmol/L, or under treatment.

All statistical analysis were performed using the Statistical Package for Social Science (SPSS for Windows) and StatCalc of the EPI-INFO software package in version 6.0. All data were expressed as mean value (Xsr), standard deviation (SD), absolute frequencies (n) and the index structure (%). Comparison of mean values of numerical parameters by BMI category was performed by analysis of variance (ANOVA) and Dunnet post hoc test. Comparison of the representation of attribute characteristics between groups was performed Mantel-Haenszel chi square test or Fisher's exact probability test of the null hypothesis (Fisher exact test) when any of the expected frequency characteristics was lower than five. Relationship between the values of different characteristics was evaluated by calculating Pearson linear correlation coefficient (r). Testing the statistical significance of the correlation coefficient was performed using the Student t test. Effect of some factors on the development of metabolic syndrome and assessment of risk for consequences of metabolic syndrome was done by logistic regression analysis. Calculated values are approximate relative risk (odds ratio — OR) and their 95% confidence intervals. Assessment of statistical significance OR values was performed by calculating the Wald values. The factors for the univariate logistic regression analysis, that showed exerts a significant influence on the metabolic syndrome, were included in multivariate regression models. Using the method step by step backwards (Backward Wald) from the multivariate model were excluded all those factors whose impact was not statistically significant.

All factors of the metabolic syndrome may be observed as a dichotomous variable and we can form an additive scale The analysis of the value of this scale can be determined, what factors, in addition to an increased waist circumference, contribute most to the occurrence of metabolic syndrome, based on the calculation of Cronbach's alpha coefficient of internal consistency.

All P values were based on two-sided tests with a significance level of 0.05.

RESULTS

Characteristics of examinees

The study included 132 men, who were on a regular systematic review. The mean age was 44.73 ± 9.37 years (range 35–54 years, median 44.5 years). Basic characteristics of study group and the level of metabolic risk components are shown in Table 1.

The prevalence of the metabolic syndrome in study group, according to the IDF was 44.7%. Of all men, most were overweight; 68.9% had a waist circumference equaling or higher than 94 cm, 67.4% had high blood pressure; 55.3% had high value of triglycerides. Less than 50% of study subjects had abnormal values of another metabolic risk factors (Table 2).

Normal-weight subjects were younger; had significantly lower blood glucose and triglycerides, than overweight and obese men ($p < 0.05$). HDL-C in normal-weight men was higher than in other patients ($p < 0.05$). WC was significantly increased in parallel with increasing BMI ($p < 0.001$) (Table 3).

Among subjects with normal BMI, only 5 men had WC ≥ 94 cm, but 97.1 % obese men had WC ≥ 94 cm. Only one male (4.8%) with normal weight had metabolic syndrome, while the number of people with this syndrome significantly increases with increasing BMI. MetS had 35 (46.1%) overweight and 23 (65.7%) obese subjects. If we look at the prevalence of all components of metabolic syndrome by BMI categories, it is evident that the only statistically significant increase were in WC and triglycerides (Tables 4).

Table 1. *Anthropometric indices, blood pressure, blood glucose and serum lipid levels in study subjects (Mean ± SD)*

Variable	Mean ± SD
Ages (years)	44.73 ± 9.37
Waist circumference (cm)	101.43 ± 12.38
Body mass index (kg/m^2)	27.79 ± 3.63
Sistolic blood pressure (mmHg)	131.25 ± 15.79
Diastolic blood pressure (mmHg)	85.00 ± 11.41
Blood glucosa (mmol/l)	5.64 ± 1.36
HDL cholesterol (mmol/l)	1.40 ± 0.32
Triglycerides (mmol/l)	2.30 ± 1.20

Table 2. *Prevalence of MetS and the components of MetS in study subjects*

Variable	n (%)
BMI < 25 kg/m^2	21 (15.9%)
BMI = 25–29.9 kg/m^2	76 (57.6%)
BMI ≥ 30 kg/m^2	35 (26.5%)
WC ≥ 94 cm	91 (68.9%)
High blood presure ≥ 130/85 mmHg	89 (67.4%)
Blood glucosa ≥ 5.6 mmol/l	43 (32.6%)
HDL cholesterol < 1.04 mmol/l	6 (4.5%)
Triglycerides ≥ 1.7 mmol/l	73 (55.3%)
METABOLIC SYNDROME	59 (44.7%)

Table 3. *Average values of ages, WC, BP, BG, HDL-C and triglycerides of study subjects according to BMI category*

Variable	Normal weight (n = 21)	Overweight (n = 76)	Obesity (n = 35)	ANOVA i Dunnet's test)
Ages (years)	40.95 ± 9.80	45.64 ± 9.41	45.00 ± 8.69	Ns
Waist circumference (cm)	89.33 ± 5.77	98.87 ± 8.41	114.26 ± 11.86	A‡, B‡, C‡
Sistolic blood pressure (mmHg)	127.86 ± 23.00	130.33 ± 13.74	135.29 ± 14.40	Ns
Diastolic blood pressure (mmHg)	82.14 ± 13.47	84.67 ± 10.56	87.43 ± 11.72	Ns
Blood glucosa (mmol/l)	5.14 ± 0.38	5.64 ± 1.32	5.94 ± 1.71	A*, B*
HDL cholesterol (mmol/l)	1.59 ± 0.41	1.39 ± 0.32	1.33 ± 0.23	B*
Triglycerides (mmol/l)	1.65 ± 0.81	2.38 ± 1.20	2.50 ± 1.30	A†, B*

A — optimal weight vs overweight; B — optimal weight vs obese; C — overweight vs obese; * — $p < 0.05$; † — $p < 0.01$; ‡ — $p < 0.001$; ns — no significant difference

Table 4. *Prevalence of MetS and it's individual features stratified by BMI category*

Variable	Normal weight (n = 74)	Overweight (n = 40)	Obesity (n = 18)	Statistical significance (Mantel-Haenszel χ^2 or Fisher's test)
WC ≥ 94 cm	5 (23.8%)	52 (68.4%)	34 (97.1%)	A‡, B‡, C†
High blood pressure ≥ 130/85 mmHg	11 (52.4%)	52 (68.4%)	26 (74.3%)	Ns
Blood glucosa ≥ 5.6 mmol/l	3 (14.3%)	25 (32.9%)	15 (42.9%)	B*
HDL cholesterol < 1.29 (f)	–	5 (6.6%)	1 (2.9%)	Ns
Triglycerides ≥ 1.7mmol/l	4 (19.0%)	49 (64.5%)	20 (57.1%)	A‡, B†
METABOLIC SYNDROME	1 (4.8%)	35 (46.1%)	23 (65.7%)	A†, B‡

A — optimal weight vs overweight; B — optimal weight vs obese; C — overweight vs obese; * — p < 0.05; † — p < 0.01; ‡ — p < 0.001; ns — no significant difference

Table 5. *Correlation coefficients between anthropometric indices and other components for MetS in study subjects*

Variable	Body height	Body mass	WC	BMI	SBP	DBP	Blood glucose	HDL-C	Trigly-cerides
Ages	–0.39†	–0.12	0.17	0.12	0.05	–0.01	0.29†	0.05	0.02
Body height		0.57†	–0.07	0.07	0.08	0.12	0.01	–0.08	0.05
Body mass			0.58†	0.83†	0.19*	0.23*	0.20*	–0.25†	0.24†
WC				0.78†	0.03	0.01	0.11	–0.17	0.13
BMI					0.19*	0.20*	0.26†	–0.25†	0.26†
SBP						0.80†	0.08	–0.05	0.30†
DBP							0.07	–0.13	0.30†
Blood glucose								–0.06	0.09
HDL-C									–0.24†

* — p < 0.05; † — p < 0.01.

Relationship between anthropometric indices and non adipose metabolic risk factors

The linear correlation coefficients were estimated between anthropometric indices and components of MetS according to the criteria of IDF (Table 5). BMI was showed a significant correlation with body weight, blood pressure, blood glucose and triglyceride levels, while negatively correlated with HDL cholesterol. WC values were significantly associated only with the values of body weight (r = 0.58, p < 0.01) and BMI (r = 0.78, p < 0.01) (Table5).

The influence of certain factors on the MetS

Changes in the value of the coefficient Cronbach-α were showen that the most important factors of metabolic syndrome in men were higher levels of triglycerides (from 0.40 to 0.15), the presence of hypertension (form 0.40 to 033) and abnormal glucose regulation (form 0.40 to 033); whereas increased waist circumference and lower levels of HDL cholesterol were of less importance (no changes in the value of the coefficient Cronbach-α) (Table 6).

Univariate logistic regression analysis showed that with each year of age the risk of metabolic syndrome significantly increased by 6% (OR = 1.06, 95% CI). Increasing values of body weight and BMI for one measurement units also lead to increased risk. Other factors did not show a significant influence on the development of the metabolic syndrome in the sample (Table 7).

When in the regression model as independent variables were included all the factors, which in the univariate logistic regression analysis were shown a significant effect on the level of error margin of less than

Table 6. *Analysis of the consistency factor of the metabolic syndrome in study group (Cronbach-α coefficient)*

The steps in the assessment of internal consistency	Average value of the scale	Cronbach α coefficient
All factors included	2.29	0.40
Factors excluded from the scala:		
High blood pressure	1.61	0.33
Impaired glycemic control	1.96	0.33
High levels of triglycerides	1.74	0.15
Low HDL cholesterol	2.24	0.42
High WC	1.60	0.43

***Table** 7. The influence of certain factors on the development of the metabolic syndrome in men (Univariate logistic regression analysis)*

Factors	p	OR	95% CI
Ages	0.002	1.06	1.02–1.10
Body height	ns	1.01	0.96–1.05
Body mass	< 0.001	1.07	1.03–1.11
BMI	< 0.001	1.46	1.25–1.71

Table 8. *The influence of certain factors on the development of the metabolic syndrome in men (Multivariate logistic regression analysis)*

factors	p	OR	95% CI
Ages	0.006	1.07	1.02–1.11
BMI	< 0.001	1.47	1.25–1.73

10% ($p < 0.1$), the risk of metabolic syndrome was increased significantly with each year of age and increasing BMI values of 1. Table 8 shows how to modify the risk of metabolic syndrome with each year of age and increasing BMI values.

DISCUSSION

This study comprising 132 adult men aged 35 years and over aimed prevalence of MetS and to comparative which of the anthropometric parameters (body mass index and/or waist circumference) is best for the evaluation of the risk factors for metabolic syndrome.

Prevalence of MetS

It has been estimated that 20–25% of the world population has MetS (1). In our study, metabolic syndrome was diagnosed in 59 men (44.7%). Ardern et al. showed that 17% of men in Canada have MetS, while the prevalence MetS in the U.S. among men adults is 24,0% (5, 9). The Sofia Metabolic Syndrome (SMS) study reported preliminary data on high prevalence of the components of MetS among the citizens of Sofia in both sexes, and a very high percentage of unknown type 2 diabetes, hypertension and hyperlipidemia, and in some countries, like Greece and USA similar prevalence was also observed for both sexes; in Turkey, India, Iran, African Americans and Mexican Americans women were reported to be much more frequently affected, whereas in France and Australia the MetS was found to be more common among men (10). It was reported that non-diabetic subjects under 40 years of age had an MetS prevalence of 14–41% (11).

Association of MetS components and MetS

Distribution of body fat has a direct impact on the occurrence of metabolic disorders that lead to the metabolic syndrome (1, 2, 3). WC is always the main component of the diagnostic criteria for the metabolic syndrome, and also increasingly being proposed as a better predictor of cardiovascular risk than BMI (1, 5).

In people who are optimally nourished and overweight prevalence of metabolic syndrome increases with increasing waist circumference. If BMI ≥ 30 kg/m^2, it points to the existence of central obesity (3, 5, 6, 7). The prevalence of abdominal obesity in our study was 68.9%. In the group of optimal weight men the prevalence of abdominal obesity was 23.8%. In the obese group, 68.4% of men had increased WC, while the abdominal obesity occurs in 97.1% of men. In a study conducted by Ardren and colleagues 65% of obese men had values greater than the WC limit values; in the group of overweight 13% of men had high levels of WC (5). Janssen et al have obtained similar findings: increased levels of WC in the optimal weight category had 1.0% of men, in the overweight group 27.6% of men, while the prevalence of abdominal obesity in the obese group was 84.8% (12). These data confirm previous studies and show that WC does not need to be measured if BMI ≥ 30 kg/m^2 (5, 6, 7, 13).

The analysis of the frequency of certain components of MetS, according to the degree of obesity in the examined men, found that individuals with normal weight commonly occurring hypertension (52.4%); in the overweight were OS ≥ 94 cm (68.4%), elevated serum triglycerides (64.5%) and high blood pressure (68.4%); while in the group of obese were waist circumference (97.1%), hypertension (74.3%) and elevated serum triglycerides (57.1%). Those results are in agreement with previously reported data (14).

Analysis consistency factor of metabolic syndrome found that different components influence the occurrence of MetS in men: high blood pressure; high triglycerides, high blood glucose, which is consistent with the expected sexual characteristics, and data from the literature (5).

Ardern et al., in their study showed that the most important factors of MetS in men are high levels of triglycerides, high blood pressure and low HDL cholesterol (6). It is now well established that WC remains a ignificant predictor of type 2 diabetes and cardiovascular disease after control for BMI in both men and women. It is often suggested that the ability of WC to predict health risk beyond that predicted by BMI alone is explained by the ability of WC to act as a surrogate for abdominal fat (4). However, it is also observed that the values of WC and BMI as predictors of metabolic abnormalities and clinical manifestations of MetS vary in different populations (ethnic groups) (15).

Correlation between WC, BMI and MetS

In the examined men WC values show a significant correlation with values of body weight and BMI, while BMI was showed a significant correlation with body weight, blood pressure, blood glucose and triglyceride levels, and negatively correlated with HDL. Increasing values of BMI for one measurement units lead to increased risk for MetS and cardiovascular disease. However, studies have shown that both anthropometric factors correlated with all 10 risk factors for cardiovascular disease in young adults of both sexes, and in the elderly men these anthropometric factors are correlated with 8 of 10 risk factors, but whether BMI or WC is a better predictor of cardiovascular (metabolic) risk factors depend on age, as metabolic syndrome depends on the age range as showed in our and other studies (1–3, 5, 11,16).

CONCLUSION

Results of our study show that high WC (68.9%) and MetS (44.7%) are present in a high percentage in the study group. According to the coefficient Cronbach-α, WC is not the best indicator of metabolic health risk in men. But, based on other our results and data from the literature, measurement of waist circumference by BMI categories can point to men with an increased risk of development of metabolic disorder.

List of abbreviations:

BMI — body mass index
CVD — cardio-vascular disease
DM 2 — type 2 diabetes mellitus
IDF — International Diabetes Federation
LDL — low density lipoproteins
HDL — high density lipoproteins
MetS — metabolic syndrome
WC — waist circumferences

Sažetak

PROCENA ZDRAVSTVENOG RIZIKA NA OSNOVU ANTROPOMETRIJSKIH POKAZATELJA KOD MUŠKARACA U NOVOM BEOGRADU

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Uvod: Veoma mali broj istraživanja je rađeno u Srbiji u cilju povezivanja zdravstvenog statusa i metaboličkog sindroma kod muškaraca, tako da je naš cilj bio da se ispita učestalost metaboličkog sindroma kod muškaraca bez istoriju dijabetesa ili kardiovaskularnih bolesti u Novom Beogradu, u Srbiji, da se utvrdi koji od antropometrijskih parametara (indeks telesne mase — ITM i obim struka — OS) je najbolje za procena rizika po zdravlje u primarnoj zdravstvenoj zaštiti, posebno faktora rizika za metabolički sindrom.

Istraživačke metode i postupci : Studija je obuhvatila 132 zdravih muškaraca uzrasta 44,73 ± 9,37 godina. Radjena su antropometrijska merenja, kao i merenja krvnog pritiska, biohemijske analize (HDL, LDL, trigliceridi, šećer u krvi) i analiza njihovih zdravstvenih kartona. Analiza konzistentnosti je korišćena za testiranje hipoteze.

Rezultati: Uzorak su činili 132 ispitanika prosečne starosti 44,73 ± 9,37 godina. Prevalenca metaboličkog sindroma bila je 44,7 %. Analiza konzistentnosti je pokazala razlike u mogućnostima predviđanja na osnovu antropometrijskih pokazatelja i ostalih faktora MetS.

Zaključci: ITM i OS su jednostavne metode za procenu gojaznosti koje su povezane sa metaboličkim poremećajima. rizika. Naši rezultati ukazuju da se OS ne može koristiti kao komplementarno merenje u identifikaciji zdravstvenih za bilo koju grupu muškaraca.

Ključne reči: zdravstveni rizik, obim struka, indeks telesne mase, metabolički sindrom.

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