Relationship between BMI and Skinfold Thicknesses to Risk Factors in Premenopausal and Postmenopausal Women

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A B S T R A C T

Studies conducted on children and adults have pointed to the correlation of BMI (kg/m²) with risk factors for certain diseases. Other studies have stressed a more intense correlation between the risk factors and indicators of subcutaneous fat obtained in other ways. The aim of the study was to compare the intensity of correlation between the risk factors and triceps and subscapular skinfold thickness in relation to BMI. The study included 53 postmenopausal and 107 premenopausal women, the risk factors were assessed upon systolic and diastolic blood pressure, glucose concentration, triglyceride and cholesterol levels. Statistically significant differences were established in almost all variables referring to premenopausal and postmenopausal women, except in body height, subscapular skinfold thickness and triglyceride concentration. Significant correlation with the risk factors was detected in BMI and both skinfold thicknesses, while the subscapular thickness correlates more intensively with the risk factors than it is the case with the triceps thickness. The results indicate that BMI equally correlates with risk factors as well as skinfold thickness.

Key words: BMI, skinfold thickness, risk factors, premenopause, postmenopause

Introduction

According to the World Health Organization (WHO) data chronic non-communicable diseases are leading causes of death worldwide. In the period ahead further rise of mortality attributable to these diseases is expected, and the most of deaths will take place in underdeveloped and developing countries[1]. Changing lifestyles due to growing urbanization are associated with adverse cardiovascular risk factors irrespective of habitat (rural *vs.* urban)[2]. In 2007, chronic non-communicable diseases accounted for 85% of all causes of death in Serbia, as well as in countries of the European Region[3]. Serbia witnesses a falling trend of cardiovascular mortality, but its proportion in all causes of death still remains on top. The standardized diabetes mortality rates were almost two times higher than in the EU countries[4]. The leading risk factors for development of chronic non-communicable diseases are smoking, hypertension, hypercholesterol-

emia, alcohol, obesity, improper diet and physical inactivity[5]. The 2006 health survey of the population of Serbia showed that 33.6% of the population are smokers, 46.7% have hypertension, 40.3% drink alcohol every day or occasionally, 18.3% are obese and 74.3% suffer from lack of exercise[6].

According to WHO[7] overweight and obesity have been found to be major risk factors for chronic diseases, including cardiovascular diseases, diabetes, some forms of cancer and musculoskeletal disorders. Serbian Institute for Health Care reports that more than a half of adult population (54%) have a weight problem – overweight or obesity (36.7% and 17.3%, respectively)[8].The highest prevalence has been reported in the region of Vojvodina where the latest studies[9] indicate that excessive weight problem is recorded in 58.47% of individuals of both sexes, with 38.52% of them being overweight and 19.48% obese.

The determination of the quantity and the distribution of excess fat are important and can be quantitated in many ways[10]. New and reliable methods for assessing body composition are hydrodensitometry, dual energy X-ray absorptiometry (DEXA) or bioelectrical impedance. These methods are costly and not widely available. Therefore anthropometric measures and indices are now widely used, as they have shown to be surrogate measures of body fat.

Body mass index BMI (kg/m²) has been widely used for assessing nutritional status and health risks caused by weight problems. Studies conducted on both children and adults have confirmed that high BMI correlates with health risks of various cardiovascular diseases (CVD), atherosclerosis, as well as with morbidity and mortality rates[11,12]. Research has also shown that in general BMI and body fat (BF) are highly correlated, especially in the underweight and obese BMI groups[13]. In addition to this, BMI has been reported to relate to other factors, such as fat and fat-free mass, sex and age[14,15], ethnic group[16,17], socio-economic factors[18] and marital status[19]. This is the reason why a number of authors point out that relation between BMI and risk factors has a limiting effect[20].

Although it is an indirect indicator of the body fat amount, BMI does not offer enough information on the fat distribution. Adipose tissue distribution, i.e. intra-abdominal fat accumulation is another factor that can indicate predisposition for cardiovascular or metabolic diseases[21]. Measures of central obesity like, waist circumference (WC), waist-to-hip ratio (WHR) and waist-to-height ratio (WHtR) also give an important insight and provide information on the risk of CVD[22].

Additional anthropometric assessments such as skin-fold-thickness measurements may complement other established measurements for predicting risk factors[23]. Some investigations show[24] that truncal skinfold thickness may be a stronger predictor of insulin sensitivity than is abdominal visceral fat as measured by magnetic resonance imaging. Some other studies[25,26] also show that skinfold-thickness measurements are strong predictors of morbidity. Recent studies of both children and adults[27,28] show that BMI correlates with the level of lipids, insuline, and blood pressure as strongly as it is the case with skinfold thickness.

Postmenopausal women are at an age when the incidence of the chronic health conditions associated with obesity become more prevalent. They have an increased tendency for gaining weight[29]. Estrogen withdrawal during menopause has a detrimental effect on metabolism and body fat distribution to an android pattern. Therefore, in postmenopausal women is often increased rates of hypertension, diabetes mellitus, coronary artery disease and mortality[30].

Bearing this in mind, the aim of the present study is to investigate the relationship between BMI and skinfold thickness to risk factors in pre and postmenopausal women as well as to determine if skinfold thickness is more associated with risk factors than it is the case with BMI.

Material and Methods

In 2011 and 2012 a cross sectional investigation was conducted in the city of Novi Sad. Novi Sad is the second largest city in Serbia, the seat of administrative organs of the northern Serbian Province of Vojvodina and the administrative center of the South Bačka District. The study included 53 postmenopausal and 107 premenopausal women who took part in the project »The influence of physical activity on risk factors in the working population«. The project is funded by the Provincial Secretariat for Science and Tehnological Development. The subjects were continually engaged in a program of physical activities including free exercises and breathing technique exercises. The aim of the program was to develope and improve morphofunctional and motor skills, as well as to increase the potential of the organism – specific adaptation to the adverse effects of emotional stress. The body height and body weight measurements were used for assessing BMI of the subjects (kg/m²), while subscapular and triceps skinfold thickness measures served as indicators of body fat. The risk factor assessment was done on the basis of systolic (SBP) and diastolic blood pressure (DBP) measures and the level of glucose, triglycerides and total cholesterol.

Body height was measured with an anthropometer in the standing erect position, to the nearest 1 mm. Body weight was measured on an electronic digital scale with an accuracy of up to 0.1 kg. The triceps and subscapular skinfolds were each measured three times to the nearest 1.0 mm using Lange skinfold caliper. We used the mean of each skinfold thickness in the analyses. Systolic blood presure (SBP) and diastolic blood presure (DBP) were measured on the right arm, in sitting position using a sphygmomanometer. Biochemical blood parameters were measured by means of a biochemical analyzer (Olympus AU 400) applying spectrophotometric analysis of the level of glucose, triglycerides and cholesterol concentrations in the serum.

Cut-off values for hypertension (>140/>90 mmHg) were taken on the recommendations of European Society of Hypertension/European Society of Cardiology[31]. According to the recommendations of the National Health and Medical Research Council (NHMRC)[32] threshold for risk of diabetes are 5.5–6.9 mmol and for high risk ≥7 mmol. Complying with the National Guide for Primary Health Care Providers[33], the total cholesterol levels of 5.20–6.18 mmol/l and ≥6.20 mmol/l were set as borderline high and high values, respectively. As for triglyceride level in the serum, the borderline high value ranged from 1.70 to 2.29 mmol/l while high risk value was set at ≥2.30 mmol/l.

Statistical data processing was conducted by SPSS 20.0 version. Prior to the data processing, the analysis of variance (ANOVA) was applied for obtaining descriptive statistical results and significant differences between premenopausal and postmenopausal women. The factor analysis (principal–components analysis) was applied for determining the structure of the first principal compo-

TABLE 1
DESCRIPTIVE STATISTICS OF VARIOUS CHARACTERISTICS IN RELATION TO MENOPAUSAL STATUS

Variable	Premenopausal	Postmenopausal	F	p
Age (years)	38.87±9.81	58.42±1.01	163.45	0.00
Body height (cm)	164.39±5.69	162.85±5.78	2.56	0.11
Body weight (kg)	64.86±10.82	69.75±11.96	6.65	0.01
BMI (kg/m²)	24.03±4.10	26.26±4.15	10.20	0.00
Subscapular skinfold thickness (mm)	18.98±7.94	19.96±7.63	0.36	0.54
Triceps skinfold thickness (mm)	20.14±6.11	23.03±5.09	11.59	0.00
SBP (mmHg)	109.14±12.29	118.77±20.45	10.99	0.00
DBP (mmHg)	70.60±8.02	75.66±11.10	8.72	0.00
nowidctlparGlucose (mmol/l)	4.61±0.43	4.83±0.52	8.11	0.00
Triglycerides (mmol/l)	1.20±1.22	1.46±0.67	2.08	0.15
Total cholesterol (mmol/l)	5.55±1.17	6.23±1.19	12.13	0.00

nent of risk factors (general risk factor) in both groups of subjects.

The level of correlation between BMI, skinfold thickness and risk factors was assessed by Pearson's coefficient, the level of significance being $p<0.05$.

All applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during this research.

Results

The mean age of postmenopausal women equals 58.42 ± 1.01, and in premenopausal women it is 38.87 ± 9.81 (Table 1). Statistically significant differences are established for all variables referring to premenopausal and postmenopausal women, except for the body height, subscapular thickness and triglyceride concentration. According to the mean of BMI values, most of menopausal women are overweight, while the majority of younger women are with normal body weight. Although women in menopause have higher skinfold thickness values, significant differences are observed only in triceps skinfold thickness. Mean values of risk factors are also significantly higher in older women. Mean values of blood pressure and biochemical parameters indicate that most women have normal values of these characteristics. The total cholesterol values, however, indicate that a large percentage of premenopausal women are with borderline high values, while in considerable number of menopausal subjects high-risk values are observed.

Considering the established differences between the two groups of subjects, in further data processing the two groups were treated as two independent subsamples.

The factor analysis was employed to identify the structure of general risk factor in both groups (Table 2). In women that have not entered the menopause, the general risk factor was most observable in systolic and diastolic pressure and triglyceride variables. Contrary to these subjects, in postmenopausal women the general risk factor was manifested through systolic and diastolic

pressure variables along with total cholesterol and triglycerides variables. The structure of general risk factor in posmenopausal women was better explained (41.47 % of variance).

Accordingly, most information considering the risk factors in pre and postmenopausal women can be obtained from the variables that highly manifested the risk factors.

TABLE 2
STRUCTURE OF GENERAL RISK FACTORS OF PREMENOPAUSAL AND POSTMENOPAUSAL WOMEN

Variable	Premenopausal	Postmenopausal
	H1	H1
SBP	0.90	0.89
DBP	0.79	0.87
Glucose	0.16	0.35
Triglycerides	0.69	0.42
Total cholesterol	0.19	0.46
% of Variance	39.50	41.47

Table 3 shows Pearson correlation between risk factors and BMI and skinfold thicknesses. In both groups BMI significantly correlates with almost all variables and general risk factors, except for the glucose level in premenopausal and total cholesterol in postmenopausal women. Similarly, subscapular thickness more correlates with risk factors than it is the case with the triceps thickness. Differences in correlation between obesity indicators (BMI and skinfold thicknesses) and risk factors are detected in the glucose level as it shows more significant correlation in postmenopausal women, while in premenopausal subjects the differences are observable in total cholesterol and diastolic pressure, as these show more intense correlation with obesity indicators.

The general risk factor and sistolic pressure show a high statistically significant correlation with the obesity indicators in both groups of subjects.

TABLE 3

PEARSON CORRELATION BETWEEN RISK FACTORS AND BMI AND SKINFOLD THICKNESSES IN PREMENOPAUSAL AND POSTMENOPAUSAL WOMEN

Variable	Premenopausal			Postmenopausal		
	BMI	Triceps skinfold thicknesss (mm)	Subscapular skinfold thickness (mm)	BMI	Triceps skinfold thickness (mm)	Subscapular skinfold thickness (mm)
SBP (mmHg)	0.44[a]	0.37[a]	0.37[a]	0.41[a]	0.22[b]	0.26[a]
DBP (mmHg)	0.37[a]	0.41[a]	0.40[a]	0.33[a]	0.15	0.20
Glucose (mmol/l)	0.17	–0.07	0.20	0.30[a]	0.12	0.19[b]
Triglycerides (mmol/l)	0.37[a]	0.21	0.40[a]	0.39[a]	0.29[a]	0.33[a]
Total cholesterol (mmol/l)	0.34[a]	0.28	0.29[b]	0.11	0.12	0.07
General risk factor	0.52[a]	0.47[a]	0.52[a]	0.48[a]	0.26[b]	0.33[a]

[a] Significant value $p < 0.01$, [b] Significant value $p < 0.05$

Discussion

The study included the subjects that had been actively involved in a program of physical exercises and assessment of health status. In Serbia, cardiovascular diseases appeared as the most common cause of death among women in the period 1997–2007[4]. Women's health is particularly important considering the fact that the promotion of their health and quality of life has a beneficial impact on the whole family. This study attempted to determine the relationship between BMI and skinfold thickness to risk factors in premenopausal and post-menopausal women. Although some authors state that skinfold thickness measurement may complement other established measurements for predicting metabolic abnormalities[23], this survey reveals that BMI and skinfold thickness at triceps and subscapuli are equally well connected with various risk factors. Significant correlation is detected between adiposity measures and risk factors. A slightly higher correlation with risk factors is observable in BMI than it is the case with the skinfold thicknesses, with subscapular thickness showing somewhat higher correlation with the risk factors than the triceps thickness. A number of studies indicate that adverse levels of cardiovascular disease (CVD) risk factors are associated with estimates of body fatness obtained in different ways[28]. Some investigators claim that various estimates of body fatness are more strongly associated with risk-factor levels than BMI[34]. Other investigations report on small or no difference in the magnitudes of the associations[35,36]. Recent studies in elderly Taiwanese[37] show that mid-arm and calf circumferences are better than body mass index in predicting health status and mortality risk. Other studies[38] suggest that WC and WHR have a stronger correlation with cardiovascular risk factors than BMI and percentage body fat (PBF). Authors also suggest that although PBF has an important association with some cardiovascular risk factors, it is not a better predictor of hypertension, plasma glucose, insulin and lipid abnormalities than BMI. Recent studies on a large number of subjects[39] report that BMI is strongly associated with hypertension, while waist circumference is strongly associated with type 2 diabetes and dyslipidemia.

Investigations on relation of BMI and skinfold thicknesses to risk factors[28] are in agreement with our studies. The authors conclude that BMI appears to be as accurate as skinfold thicknesses in identifying metabolic risk among adults. The results indicate that levels of various risk factors are as strongly related to BMI as to the triceps and subscapular skinfold thicknesses. Some other studies also show that BMI and skinfold measures are both strongly predictive of non-fatal and fatal coronary heart disease[40] and ischaemic heart disease[41].

It is widely known that continual and organized physical activity decreases subcutaneous fat and at the same time improves the body co-ordination[42]. In the same way phylates exercises, have shown to decrease obesity, modify the body composition and increase the flexibility[43,44]. Although the subjects of this study were actively involved in a three-times-a-week physical education program, significantly higher means of anthropometric indicators and risk factors are observed in postmenopausal women. These differences can be explained by biological aging of the organism. The appearance of an increased proportion of fatty tissue under the skin in body composition is caused by decreased production of estrogen and progesterone, especially in women entering the menopause. In women after menopause insufficiencies of estrogens play a significant role in the change of body composition and changes of adipose tissue[45]. Onset of menopause plays a vital role to alter body composition and in turn CVD risk factors[46,47].

Although skinfold thickness is generally accepted as a better indicator for determining the body fat amount

than it is the case with BMI, it should be stated that skinfold thickness values can considerably vary since the measurements largely depend on the examiner's skills and as adiposity is greater, an error is more likely to appear.

The study presents the results of a preliminary investigation conducted as a part of the project »The Influence of Physical Activity on Risk Factors in Working Population«. The limiting effect of the study can be attributed to a relatively small sample of subjects including only females and the fact that this is a cross sectional investigation. Therefore more researches are needed to investigate possible relationship between risk factors and other adiposity measures, like waist circumference, waist-hip ratio, percentage body fat, etc. in both sexes, to obtain

more reliable data on the relationship of these variables. Nevertheless, despite the limiting effects, the results indicate that it is not only skinfold thickness, but also BMI that can be well correlated with SBP, DBP, glucose, triglyceride contents and total cholesterole. This finding is in line with the reports of recent studies.

Acknowledgements

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POVEZANOST BMI I DEBLJINE KOŽNIH NABORA SA RIZIČNIM FAKTORIMA KOD PREMENOPAUZALNIH I POSTMENOPAUZALNIH ŽENA

S A Ž E T A K

Istraživanja djece i odraslih su ukazala na povezanost BMI (kg/m^2) sa faktorima rizika za određene bolesti. Druga istraživanja su ukazala na jaču povezanost između rizičnih faktora i pokazatelja potkožnog masnog tkiva koji su dobiveni na drugi način. Cilj rada je bio da se ispita da li je debljina kožnih nabora na tricepsu i subskapuli više povezana sa faktorima rizika u odnosu na BMI kod premenopauzalnih i postmenopauzalnih žena. Ukupno je ispitano 53 postmenopauzalnih i 107 premenopauzalnih žena, koje su bile uključene u program znanstveno-istraživačkog projekta Fakulteta sporta i fizičkog vaspitanja Univerziteta u Novom Sadu pod nazivom „Utjecaj fizičke aktivnosti na rizične faktore kod radno aktivnog stanovništva«. Rizični faktori procijenjeni su temeljem vrijednosti sistoličkog i dijastoličkog krvnog tlaka, koncentracije glukoze, triglicerida i ukupnog kolesterola. Uočene su statistički značajne razlike u gotovo svim varijablama između premenopauzalnih i postmenopauzalnih žena, izuzev tijelesne visine, subskapularnog kožnog nabora i koncentracije triglicerida. Utvrđena je značajna korelacija faktora rizika sa BMI, kao i kožnim naborima pojedinačno. Nešto veća korelacija sa rizičnim faktorima je utvrđena za BMI u odnosu na oba kožna nabora, a nabor lopatice pokazuje jaču povezanost sa rizičnim faktorima u odnosu na nabor tricepsa. Rezultati ukazuju da BMI podjednako značajno korelira sa rizičnim faktorima, kao i debljina kožnih nabora.