



# Correlation of Body Mass Index and Waist Hip Ratio with lipid and hormone profile in women in menopausal transition

Lejla Mešalić

Department for health protection of women and pregnant women at the public health institution Health Centre Tuzla, Bosnia and Herzegovina

## ABSTRACT

**Introduction:** Menopausal transition is a period characterised by psychic, somatic changes as well as changes in reproductive capabilities of a woman. It occurs as a consequence of ovarian's function termination, and pertains to the periods of different meanings: perimenopause, menopause and postmenopause. Although there are numerous assessments of behaviour of the lipids and lipoproteins during menopausal transition, their relation to sexual hormones and body mass is still being assessed. The aim of this study is to determine the differences and connections between body mass index (BMI) and waist-hip ratio (WHR) and lipid and hormone profile among the assessees in premenopause, perimenopause and postmenopause.

**Methods:** The assessment was done on 150 assessees divided in three groups of 50, such as: premenopause, perimenopause and postmenopause. The assessment included the following: interview, determination of BMI, WHR, and taking of blood sample and processing of hormone, lipid and lipoprotein concentration.

**Results:** Based on the obtained results, it may not be concluded that BMI has a positive correlation with cholesterol and VLDL concentration in postmenopause, positive correlation with apo A in perimenopause and postmenopause, and positive correlation with Lp (a) and apo B in premenopause and perimenopause, while negative correlation with HDL and estradiol concentrations in premenopause. WHR has negative correlation with HDL concentration in premenopause and perimenopause, and a negative correlation with estradiol concentrations in premenopause.

**Keywords:** menopause, lipids, hormones, body mass index, waist-hip ratio

\*Corresponding author: Lejla Mešalić  
Department for health protection of women and pregnant women, Health Centre Tuzla, Albina Herljevića 1, 75000 Tuzla, Bosnia and Herzegovina; Phone: +387 61 146 698  
E-mail: mesaliclejla@gmail.com

Submitted December 18, 2013/Accepted February 3, 2014

## INTRODUCTION

Menopausal transition is a period in life of a woman, with undefined beginning and duration, but with well-known changes in female organism. Menopausal transition is a period characterized by psychic, somatic and reproductive changes of capabilities at



women (1). Hormonal profile is changing during menopausal transition. Increased level of follicle-stimulating hormone (FSH) stimulates follicles to grow, but those follicles mainly fail to reach the final growth and maturity, which results with frequent anovulation. Progesterone production is 60 % lower than in reproduction period. In menopause, metabolic changes occur in different tissues and organs as a result of changed hormonal profile (2). Fat tissue is not only a passive fat depot reflecting the energy balance and thermo-regulation, but is also a significant endocrine organ (3). The main source of estrogen in menopause is estron generated from androstendion in peripheral tissues. Conversion processes of androgen to estrogens in menopause are not performed in fat tissue only, but also in central nervous system (4, 5). One of the most important fat tissue hormones is leptin. During menopause, not only leptin, but also decreased level of growth hormone, E2 and androgens lead to changes of lipogenesis and lipolysis mechanisms, which lead to characteristic distribution of fat tissue in menopause (centripetal obesity). Lipid profile during menopausal transition changes, but all mechanisms of those changes are not clarified. One of the most important factors in that mechanism is the change of fat tissue distribution in postmenopause. Total cholesterol level increases through menopausal transition, with highest values in menopause. LDL increases during menopausal transition, but it decreases after the menopause. The age is significantly related to the changes in the triglyceride, total cholesterol and LDL level, while body mass index (BMI) is significantly related to the changes of level of triglyceride, LDL, HDL (6). With menopause, HDL concentration decreases and HDL structure changes. HDL concentration is inversely proportional to abdominal obesity level (7). Menopause, age and increased distribution of abdominal fat tissue are three independent and important factors violating the lipoprotein profile from the beginning of menopausal transition (8). Age, BMI and menopausal status are significant indicators of the circulating lipoprotein level during menopausal transition (9). BMI is used to calculate the body surface and estimate the body weight. Doctors use BMI to estimate the risk of body weight and cardiac disease. New analysis of 40 studies, published in the *Lancet* magazine (10), which includes

250 000 patients, shows that the patients with BMI below 20 have higher mortality risk caused by cardiovascular diseases than the obese patients with BMI 30-35. The assesseees who smoke have somewhat lower total cholesterol and significantly lower HDL, although there is no difference in BMI distribution between the assesseees who smoke and those who do not (11). E2 level is much lower at the obese, premenopausal women than at the premenopausal women of normal body weight. FSH level is also lower at the obese postmenopausal women than at the non-obese postmenopausal women (12). BMI impact to E2 and FSH varies in dependence on menopausal profile (13). Waist-hip ratio, WHR is statistically important predictor of LDL concentration and cholesterol in relation to BMI at women in menopause, which confirms the importance of fat tissue distribution as a risk factor for cardiovascular diseases at this group of women (14). Sultan and associates (15) state that waist-hip ratio may be used as screening for identification of postmenopausal women with higher cardiovascular risk.

The aim of this study was to determine the differences and connection of BMI and WHR with lipid and hormonal profile of women in premenopause, perimenopause and postmenopause.

## METHODS

This prospective, comparative study was conducted in period November 2009 – December 2010 and it included a total of 150 assesseees aged 40-55, divided into three groups of 50 assesseees each (premenopause, perimenopause and postmenopause). The assesseees comprised women volunteers who agreed in writing to be included in the study. Each assesseee was introduced with the character of the study implemented according to the generally accepted ethical standards for medical research. Qualification criteria for inclusion into the study were: that the candidates do not take hormonal supplemental therapy, that they do not take medicines which could affect the lipid profile, that they do not consume more than twenty cigarettes a day, that their BMI does not exceed 35kg/m<sup>2</sup>. Processing of assesseees comprised three phases: interview, taking blood sample, measuring BMI and WHR. For the purpose of analysis, the vein blood sample from cubital vein

was taken, after which the blood was centrifuged, and obtained serum divided into two test tubes. The same day, concentration of lipid, lipoprotein, FSH, LH and E2 was determined. Concentration of the total cholesterol, triglyceride, LDL, HDL, VLDL, apo A, apo B and Lp (a) was also determined. Total cholesterol and triglyceride concentration was determined using enzymatic method at SIEMENS «Dimension RxL» machine. HDL and LDL were determined at the same machine utilizing direct „homogenous“ method. VLDL was calculated with formula: VLDL = total cholesterol - HDL - LDL apo A, apo B and Lp (a) values were determined using immunoturbidimetry method at SIEMENS «Dimension RxL» machine, and reagents of the company „SENTINEL“ were used. FSH, LH and E2 values were determined utilizing the hemiluminiscence method. The assessee's body weight and height were measured at the „SECA“ scale with meter. Fattening status was assessed based on the Quee- telet index (Devenport-Kaup modification) or BMI where: BMI= body mass in kg/height in m<sup>2</sup>. Based on the waist measuring at the narrowest place and hip measuring at the widest place, WHR was calculated according to the following formula: WH ratio = waist (cm)/hip (cm).

### Statistical analysis

To compare the numerical variables among the assessee groups we used the variance analysis (ANOVA) or Kruskal-Wallis non-parametric alternative. To analyse relation of BMI, WHR, menarche and reproductive age factors with lipid and hormonal profile, we used linear regression model. Each factor was tested in bivariate model, adjusted to the group of assesseees. Results are presented at regression coefficient with related 95% reliability interval (IP). Statistical significance was confirmed at  $p < 0.05$ . Statistic programme PASW 18 (SPSS Inc., Chicago, Illinois, USA) was used for data processing.

### RESULTS

The assesseees included in the study were aged 40 to 55, with average age  $48.1 \pm 3.9$ . Statistically, the age between the groups differed significantly: the assesseees in perimenopause were 2 years older in average than those in premenopause (95% IP: 0.6-3.5

TABLE 1. Main features of assesseees<sup>1</sup>

	Group I (n=50)	Group II (n=50)	Group III (n=50)	P value
Age	45.4 ± 3.2 (40-52)	47.4 ± 2.6 (41-52)	51.4 ± 3.2 (43-55)	<0.001
Menarche, age	14.2 ± 1.6 (11-18)	13.8 ± 2.0 (10-18)	14.1 ± 1.7 (11-17)	0.574
Age at last menstruation	-	47.2 ± 2.5 (41-52)	47.9 ± 3.3 (39-54)	0.262
Reproductive age	-	33.4 ± 2.7 (26-39)	33.8 (26-42)	0.570
BMI (kg/m <sup>2</sup> )	26.3 ± 3.7 (20.0-36.0)	26.4 ± 3.8 (18.5-37.0)	26.9 ± 3.4 (22.0-36.0)	0.640
WHR	0.81 ± 0.05 (0.70-0.97)	0.79 ± 0.08 (0.43-0.90)	0.81 ± 0.06 (0.67-0.90)	0.076

<sup>1</sup>Values are arithmetic median value ± SD as well as minimum and maximum. Group I= assesseees in premenopause; group II= assesseees in perimenopause; group III= assesseees in postmenopause.

years), and the assesseees in postmenopause were four years older in average than those in perimenopause (95% IP: 2.6-5.4 years) (Table 1). In addition, the assesseees from the second group had somewhat lower WHR than the assesseees from the third group, although the difference was not statistically significant (average difference = 0.03, 95% IP: -0.003-0.06). There is a significant negative relation between BMI and HDL at assesseees in premenopause (Table 2). If the regression coefficient had been standardised to interquartile value of BMI change (IQR=5), the difference of 0.18 mmol/L in medium HDL concentration between low and high BMI would have been suggested. Among the assesseees in postmenopause, there is a significant relation between BMI and cholesterol, as well as between BMI and VLDL. For interquartile value of BMI change, standard regression coefficient shows the increase of 0.67 mmol/L in medium cholesterol concentration and increase of 0.22 mmol/L in medium VLDL concentration. There are no proofs of any relation between other lipid and BMI parameters. Multivariate regression analysis showed that the only important lipid fraction affected by BMI is HDL cholesterol. Considering the BMI value in relation to apo A, results indicate that there is a correlation between the groups of assesseees in perimenopause and post-

TABLE 2. Regression coefficient for lipid profile in relation to BMI.

	Group I			Group II			Group III		
	Regression coefficient	95% IP	P value	Regression coefficient	95% IP	P value	Regression coefficient	95% IP	P value
Cholesterol, mmol/L	-0.029	-0.104, 0.047	0.445	-0.050	-0.135, 0.034	0.236	0.133	0.032, 0.234	0.011
Triglyceride, % increase to BMI unit	3.0	-1.1, 7.2	0.146	2.3	-1.6, 6.4	0.232	0.0	-2.9, 2.8	0.935
HDL, mmol/L	-0.035	-0.057, -0.012	0.004	-0.018	-0.042, 0.006	0.143	0.020	-0.009, 0.050	0.177
LDL, mmol/L	-0.006	-0.065, 0.052	0.834	-0.048	-0.116, 0.019	0.158	0.070	-0.015, 0.154	0.103
VLDL, mmol/L	0.012	-0.022, 0.046	0.482	0.016	-0.025, 0.056	0.436	0.043	0.005, 0.080	0.027
Apo A, g/L	-0.019	-0.048, 0.010	0.191	0.017	-0.014, 0.048	0.283	-0.004	-0.027, 0.020	0.747
Apo B, g/L	-0.010	-0.034, 0.015	0.426	-0.013	-0.033, 0.006	0.170	-0.011	-0.038, 0.016	0.432
Lp (a), % decrease to BMI unit	3.5	-4.3, 11.7	0.376	-0.9	-11.2, 8.2	0.833	0.5	-9.8, 11.7	0.948

<sup>1</sup>Values are arithmetic median value ± SD as well as minimum and maximum. Group I= assesses in premenopause; group II= assesses in perimenopause; group III= assesses in postmenopause.

TABLE 3. Regression coefficient for hormonal profile in relation to BMI.

	Group I			Group II			Group III		
	Regression coefficient	95% IP	P value	Regression coefficient	95% IP	P value	Regression coefficient	95% IP	P value
FSH, IU/L	0.602	-0.768, 1.972	0.381	-0.634	-2.383, 1.116	0.470	0.354	-2.344, 3.053	0.793
LH, IU/L	0.557	-0.383, 1.498	0.239	-0.658	-1.988, 0.673	0.325	0.165	-1.027, 1.358	0.781
Estradiol, % decrease to BMI unit	8.9	2.8, 15.3	0.005	-3.3	-10.7, 3.6	0.358	3.8	-4.9, 13.2	0.399

Group I = assesses in premenopause; group II = assesses in perimenopause; group III = assesses in postmenopause.

TABLE 4. Regression coefficient for lipid profile in relation to WHR, calculated for WHR change of 0.05.

	Group I		Group II		Group III	
	Regression coefficient	P value	Regression coefficient	95% IP	Regression coefficient	95% IP
Cholesterol, mmol/L	0.061	0.645	-0.041	-0.255, 0.173	0.183	-0.119, 0.484
Triglyceride, increase coefficient to WHR increase for 0.05	1.13	0.070	1.06	0.96, 1.17	1.07	0.99, 1.15
HDL, mmol/L	-0.105	0.013	-0.089	-0.144, -0.034	0.017	-0.069, 0.102
LDL, mmol/L	0.074	0.468	0.022	-0.152, 0.195	0.195	-0.044, 0.434
VLDL, mmol/L	0.091	0.119	0.026	-0.075, 0.127	-0.029	-0.140, 0.083
Apo A, g/L	-0.027	0.595	-0.040	-0.117, 0.037	-0.028	-0.094, 0.039
Apo B, g/L	-0.004	0.929	0.006	-0.043, 0.055	0.023	-0.053, 0.100
Lp (a), decrease coefficient to WHR increase for 0.05	1.10	0.474	1.07	0.85, 1.36	1.05	0.78, 1.15

Group I = assesses in premenopause; group II = assesses in perimenopause; group III = assesses in postmenopause.

TABLE 5. Regression coefficient for hormonal profile in relation to WHR.

	Group I		Group II		Group III	
	Regression coefficient	P value	Regression coefficient	95% IP	Regression coefficient	95% IP
FSH, IU/L	1.388	0.566	-3.848	-8.104, 0.408	3.889	-3.653, 11.431
LH, IU/L	0.454	0.786	-2.018	-5.328, 1.292	2.005	-1.315, 5.324
Estradiol, decrease coefficient to WHR increase for 0.05	1.29	0.019	0.93	0.91, 1.29	1.13	0.88, 1.44

Group I = assesses in premenopause; group II = assesses in perimenopause; group III = assesses in postmenopause.

menopause according to the first significance order ( $p < 0.001$ ), while between the assessees in premenopause and postmenopause there is no significant difference ( $p = 0.516$ ). Correlating BMI value in relation to apo B, there was statistically significant difference between the assessees in perimenopause and premenopause ( $p = 0.003$ ), while between the assessees in postmenopause and premenopause there was no statistically significant difference ( $p = 0.367$ ). Obtained results regarding Lp (a) indicate the significant correlation in relation to BMI, only among the assessees in postmenopause and premenopause ( $p < 0.001$ ). Of three analysed hormones, significant relation with BMI is noted only for E2 at women in premenopause (Table 3). For increase of unit in BMI, regression coefficient suggests 8.9-percent decrease in medium E2 concentration. There is a significant negative relation between WHR and HDL at the assessees in premenopause and perimenopause (Table 4). At WHR change of 0.05, regression coefficient shows the difference of 0.11 mmol/L in medium HDL concentration at the assessees in premenopause, and the difference of 0.09 mmol/L in medium HDL concentration at the assessees in perimenopause. The only significant relation between WHR and hormone parameters is proven for E2 at the assessees in premenopause (Table 5). Medium estradiol concentration decreased 1.29 times at WHR increase for 0.05.

## DISCUSSION

Numerous studies addressed the issue of lipid changes during menopausal transition or related to menopausal changes of endogenous hormones. Although the numerous researches have been done on behaviour of lipids and lipoprotein during menopausal transition, their relation with sexual hormones and body mass is still being assessed. The average age in time of the last menstruation among the assessees included in this study is 48. One of the objectives of this study was to determine the relation of BMI and WHR with lipid and hormonal profile of assessees in menopausal transition, and the results show that at the assessees in postmenopause, there is a positive correlation between BMI and total cholesterol, and BMI and VLDL cholesterol, and negative correlation between BMI and HDL in premenopause.

There are no proofs of any relation between other lipid and BMI parameters. Other studies also indicate that women with higher BMI are exposed to the risk of higher lipid level, although skinner women can also have higher hormone-related LDL cholesterol during menopausal transition (16). Duration of postmenopause, as well as BMI in similar studies do not show significant correlation with lipid, lipoprotein and Lp (a) concentration, while WHR shows significant positive correlation with cholesterol, LDL and apo B (14) concentrations. According to Yamamoto and associates (11), there is no significant correlation between BMI and serum Lp (a) value, and medium Lp (a) value shows the possible trend of increase at women over 40. This study showed significant correlation between BMI and Lp (a) at the assessees in postmenopause and premenopause, which is confirmed by contemporary knowledge on impact of higher Lp (a) to the increase of cardiovascular risk. We determined a significant negative relation between WHR and HDL cholesterol at the assessees in premenopause and perimenopause, while in relation to other lipids, there were no correlations. According to Mešalić (14), among women in premenopause, WHR has a significant negative correlation with HDL and Apo lipoprotein A concentration, which, considering the role of these two lipoproteins in occurrence of cardiovascular diseases, confirms that even women with regular menstruations and higher WHR have the risk of cardiovascular diseases. Results of this study indicate negative correlation between WHR and estradiol at the assessees in premenopause and negative correlation between BMI and estradiol in premenopause. However, with increase of WHR and BMI, the estrogen level decreases in premenopause, based on which the women with higher cardiovascular risk may be identified. Assessment results of the comprehensive study conducted by the National Health and Nutrition Examination Survey among the assessees aged 35-60 in period 1999-2002 (17) show that there are no significant differences in total cholesterol, triglyceride, HDL, LDL cholesterol levels adjusted to the age, among menopausal periods at the group of women with normal BMI. The difference in HDL cholesterol values was noticed at the groups with normal and higher BMI. In the groups of assessees with normal BMI, LH and FSH hormones activ-

ity was statistically different than at the assesses in premenopause and perimenopause, and between the assesses in premenopause and postmenopause (17). SO, according to Azizi and Ainy (18) BMI, WHR and triglyceride value in blood does not show the significant differences between the assesses in premenopause, perimenopause and postmenopause. Despite numerous studies, physiological role of Lp (a) has not been determined. Its atherogenic influence is attributed to enormous similarity of Lp(a) and LDL in structure, which are very cholesterol rich. In this study, Lp (a) was the highest at the assesses in premenopause and postmenopause. Somewhat different results are presented by Kim and associates (19), who obtained lower Lp (a) values at perimenopausal assesses than at postmenopausal assesses.

## CONCLUSION

BMI has a positive correlation with cholesterol concentration and VLDLD in postmenopause, positive correlation with apo A in perimenopause and postmenopause, and positive correlation with Lp (a) and apo B in premenopause and perimenopause, while with HDL and estradiol concentration it has a negative correlation in premenopause.

WHR has negative correlation with HDL concentration in premenopause and perimenopause, and negative correlation with estradiol concentrations in premenopause. However, with increase of WHR and BMI, the estrogen level in premenopause decreases, based on which the women with higher cardio-vascular risks may be identified.

## COMPETING INTERESTS

The author declares no conflict of interest.

## REFERENCES

- Petrović L, Korkocić D, Radukanović V, Puslojić J. Menopausal transition and how to live it through in a quality manner. *Medical Gazette of Timocki*, 2006;71-80.
- Dopsaj V, Šumarac Z. Changes of biochemical parameters in menopause. *Pharmacy archives*. 2005;55 (2):76-90.
- Yen SSC, Jaffe RB, Barbieri RL. *Reproductive endocrinology*. Philadelphia: WB Saunders, 1999;191-217.
- Naftolin F. Brain Aromatisation of Androgens. *J of Repr Med*. 1994;39:257-261.
- Vujović S. Central nervous system and sexual steroids. In: Vujović S. *Menopause*. Belgrade: Kosmos. 1998;33-39.
- Torng PL, Su TC, Sung FC, Chien KL, Huang SC, Chow SN, Lee YT. Effects of menopause on intraindividual changes in serum lipids, blood pressure, and body weight—the Chin-Shan Community Cardiovascular Cohort study. *Atherosclerosis*. 2002;161(2):409-15.
- Lamarche B, Moorjani S, Cantin B, Dagenais GR, Lupien PJ, Despres JP. Association of HDL<sub>2</sub> and HDL<sub>3</sub> subfractions with ischemic heart disease in men. Prospective results from the Quebec cardiovascular study. *Arterioscler Thromb Vasc Biol* 1997;17:1098-1105.
- Berg G, Mesh V, Boero L, Sayegh F, Prada M, Royer M, Muzzio ML, Schreier L, Sisele N, Benancia H. Lipid and lipoprotein profile in menopausal transition. Effects of hormones, age and fat distribution. *Horm Metab Res* 2004; 36 (4):215-220.
- Hall G, Collins A, Csemiczky G, Landgren BM. Lipoproteins and BMI: a comparison between women during transition to menopause and regularly menstruating healthy women. *Maturitas* 2002; 41(3):177-185.
- Romero-Corral A, Montori VM, Somers VK, Korinek J, Thomas RJ, Allison TG, Mookadam F, Lopez-Jimenez F. Association of bodyweight with total mortality and with cardiovascular events in coronary artery disease: a systematic review of cohort studies. *The Lancet* 2006;368:666-678.
- Yamamoto A, Horibe H, Mabuchi H, Kita T, Matsuzawa Y, Saito Y, Nakaya N, Fujioka T, Tenba H, Kawaguchi A, Nakamura H, Goto Y. Analysis of serum lipid levels in Japanese men and women according to body mass index. Increase in risk of atherosclerosis in postmenopausal women. *Research Group on Serum Lipid Survey 1990 in Japan*. *Atherosclerosis*. 1999; 144 (1):55-73.
- Freeman EW, Sammel MD, Lin H, Gracia CR. Obesity and reproductive hormone levels in the transition to menopause. *Menopause* 2010;17(4):718-26.
- Randolph JF Jr, Sowers M, Bondarenko I, Gold EB, Greendale GA, Bromberger JT, Brockwell SE, Matthews KA. The relationship of longitudinal change in reproductive hormones and vasomotor symptoms during the menopausal transition. *J Clin Endocrinol Metab* 2005;90(11):6106-6112.
- Mešalić L. Lipid profile of women in menopause. Master study paper. Faculty of medicine, University in Tuzla. 2005;34-58.
- Sultan N, Nawaz M, Sultan A, Fayaz M. Waist hip ratio as an index for identifying women with raised TC/HDL ratios. *J Ayub Med Coll Abbottabad*, 2004;16(1):38-41.
- Derby CA, Crawford SL, Pasternak RC, Sowers M, Sternfeld B, Matthews KA. Lipid Changes During the Menopause Transition in Relation to Age and Weight. *The Study of Women's Health Across the Nation*. *American J of Epidemiol* 2002;169(11):1352-1361.
- Wiacek M, Hagner W, Zubrzycki IZ. Measures of menopause driven differences in levels of blood lipids, follicle-stimulating hormone, and luteinizing hormone in women aged 35 to 60 years: National Health and Nutrition Examination Survey III and National Health and Nutrition Examination Survey 1999-2002 study. *Menopause* 2011;18(1):60-66.
- Azizi F, Ainy E. Coronary heart disease risk factors and menopause: a study in 1980 Tehranian women, the Tehran Lipid and Glucose Study. *Climacteric the journal of the International Menopause Society*. 2003;6(4):330-336.
- Kim CJ, Kim TH, Ryu WS, Ryou UH. Influence of menopause on high density lipoprotein-cholesterol and lipids. *J Korean Med Sci* 2000;15(4):380-6.