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ORIGINAL ARTICLE

BODY COMPOSITION AND FATTY TISSUE DISTRIBUTION IN WOMEN WITH VARIOUS MENSTRUAL STATUS

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ABSTRACT

Background. Menopause, also referred to as climacterium, is a period of multiple changes in the structure and functions of a woman organism.

Objective. Determination of differences in body composition and fatty tissue distribution in women from groups discriminated based on their menstrual status.

Material and Methods. The survey covered 312 women aged 38-75 years. Menstrual status of the surveyed women was established according to WHO guidelines based on answers to a questionnaire, and three groups were discriminated: women in the premenopausal period (group 1), in the perimenopausal period (group 2), and in the postmenopausal period (group 3). The following anthropomological measurements were taken: body height, body mass, waist and hip circumference, and thickness of 6 skinfolds. Their results enabled evaluating the somatic built of women in the separated groups. Fatty tissue distribution was determined based on TER distribution index calculated as a ratio of the sum of trunk skinfolds (TSS) to the sum of extremity skinfolds (ESS). Body composition of the women, including percentage of body fat, lean body mass, soft tissue mass, and total body water, was assessed using an IOI 353 analyzer by JAWON MEDICAL. In addition, percentages of women with underweight, normal content of fatty tissue, and these with overweight and obesity were calculated. The WHR index was computed in the case of obese women.

Results. The highest values of body mass, hip circumference and most of the skinfolds were determined in the perimenopausal group, whereas the postmenopausal women were characterized by the highest percentage of body fat (PBF) and by the lowest contents of lean tissue, soft tissue, and total water content in the body. The highest percentage of obese women was found in the postmenopausal group, including 40% of them having visceral type obesity. The occurrence of the menopause contributed to changes in fatty tissue distribution, causing its shift from extremities toward the trunk.

Conclusions. The study showed differences in the somatic built and body composition in groups of women distinguished based on their menstrual status.

Key words: *menstrual status, body composition, women*

STRESZCZENIE

Wprowadzenie. Menopauza, zwana inaczej przekwitaniem, to okres licznych zmian w budowie i funkcjonowaniu organizmu kobiety.

Cel. Określenie wielkości różnic w składzie ciała i rozmieszczeniu tkanki tłuszczowej u kobiet w grupach wydzielonych na podstawie statusu menstruacyjnego.

Materiał i metody. Badaniom poddano 312 kobiet w wieku 38-75 lat. Na podstawie odpowiedzi udzielonych na pytania ankiety określono status menstruacyjny badanych kobiet zgodnie z zaleceniami WHO. Wydzielono trzy grupy kobiet będących w okresie premenopauzalnym (grupa 1- 69 kobiet), perimenopauzalnym (grupa 2 – 45 kobiet) i postmenopauzalnym (grupa 3- 198 kobiet). Wykonano pomiary antropologiczne: wysokości ciała, masy ciała, obwodu pasa i bioder oraz grubości 6 fałdów skórno-tłuszczowych w celu oceny budowy somatycznej kobiet w wydzielonych grupach. W celu określenia dystrybucji tkanki tłuszczowej obliczono wskaźnik dystrybucji TER, będący stosunkiem

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sumy fałdów skórno-tłuszczowych na tułowiu (TSS) do sumy fałdów skórno-tłuszczowych na kończynach (ESS). Skład ciała oceniono przy pomocy analizatora składu ciała IOI 353 z oprogramowaniem JAWON MEDICAL. Pozwoliło to na określenie m.in. procentowej zawartości tkanki tłuszczowej, beztłuszczowej masy ciała, masy tkanek miękkich oraz całkowitej zawartości wody. Obliczono również odsetek osób z niedowagą, prawidłową zawartością tkanki tłuszczowej oraz z nadwagą i otyłością. U otyłych kobiet obliczono wskaźnik WHR.
Wyniki. Najwyższe wartości masy ciała, obwodu bioder i większości fałdów skórno-tłuszczowych wystąpiły w grupie perimenopauzalnej, a w grupie postmenopauzalnej – najwyższe wartości całkowitej zawartości tkanki tłuszczowej (PBF), przy równoczesnym najniższym poziomie tkanki beztłuszczowej, tkanek miękkich i całkowitej zawartości wody w organizmie. Najwyższy odsetek otyłych kobiet wystąpił w grupie postmenopauzalnej, przy czym u 40% badanych z tej grupy była to otyłość wisceralna. Wystąpienie menopauzy przyczyniło się do zmian w rozmieszczeniu tkanki tłuszczowej, powodując przesunięcie jej z kończyn w kierunku tułowia.
Wnioski. Stwierdzono występowanie różnic w budowie somatycznej i składzie ciała kobiet w grupach wydzielonych na podstawie statusu menstruacyjnego.

Słowa kluczowe: *status menstruacyjny, skład ciała, kobiety*

INTRODUCTION

Menopause is a very important period in every woman's life. First symptoms of reproductive functions ceasing appear on average 5 year beforehand. This period is called the perimenopausal period and is characterized by, e.g., decreased concentrations of estrogens, ovarian androgens, progesterone, and growth hormone [11]. These hormonal changes result in irregular menstrual cycles – initially shortened and then extended with excessive profuse or scanty menstruation [14]. In about 85% of the women being in that period suffer from the so-called climacteric syndrome, symptoms of which include, e.g., heats, night sweats, palpitation, as well as vertigos and headaches. Some psychical disorders like the feeling of fatigue, mood swings, trouble sleeping etc., are likely to appear as well [1, 6, 10].

Lack of menstruation for 12 months is the basic criterion in menopause diagnosis. A study by Kaczmarek [8] indicates the mean age at the natural menopause in Poland determined with the *Kaplan-Meier* method to be 49.5 years. In turn, menopausal age determined with the probit method is at 51.74 years [17]. The age at which the menopause appears is significant for the health of women. The loss of the hormonal activity of ovaries induces many metabolic disorders that may contribute to increased incidence of multiple diseases hazardous to both their health and life. Postmenopausal women face a higher risk of development of osteoporosis, cardiovascular diseases, visceral obesity, and type II diabetes [5, 19].

Changes are also observed in body composition. Hormonal fluctuations in the period of menopause cause an increase in fatty tissue content, induce changes in the ratio between body fat percentage and lean body mass – to the disadvantage of the latter, and contribute to water body loss [13, 17].

This study was aimed at determining differences in body composition and fatty tissue distribution in women from groups discriminated based on their menstrual status.

MATERIAL AND METHODS

Material

The survey included 323 women aged 38-75 years from the Bialski District (Lubelskie Province) attending the Third Age University and from the Siedlecki District (Mazovia Province) attending the so-called bridge studies at the Collegium Mazovia Innovative Higher School in Siedlce, 224 of whom (69.3%) lived in urban areas and the other 99 (30.6%) in rural areas. Participation in the survey was voluntary. Analyzed were results gathered for 312 women. The lower final number of women was due to the appearance of artificial menopause in 11 women (3.52%) as a result of radiotherapy or hysterectomy and/or ovariectomy.

Methods

To collect necessary data, a questionnaire was constructed that comprised two parts. The first part included questions related to, e.g., date of birth and place of residence, whereas the second part included such questions as "do you still menstruate?" or "are your menstrual cycles regular?". The menostatic women were asked to state the date of their last menstruation. Based on the collected answers, the menstrual status of the women was determined following WHO guidelines [22] and respective groups of women were discriminated. The first group included regularly menstruating women (premenopausal women). The second group (perimenopausal period) included women with irregular menstruation and the time from the last menstruation till the day of the survey shorter than 12

months. Women in the case of whom the menostasis was longer than 12 months were classified to the third group (postmenopausal women). Numbers and age of the women were provided in Table 1.

Table 1. Number and age of the surveyed women in groups discriminated based on their menstrual status

Group	Number of women		Age of women		
	n	%	$\bar{x}$	SD	±95% CI
Group 1	69	22.12	44.48	2.22	40.94±46.01
Group 2	45	14.42	48.47	1.75	47.94±48.99
Group 3	198	63.46	66.59	6.69	65.65±67.53

In addition, the women were subjected to measurements of the basic anthropological features, including: body height (BH), body mass (BM), waist circumference (WC), hip circumference (HC), and to measurements of the thickness of left-sided skinfolds: at biceps (BIC), at triceps (TRC), under the scapula (SSC), over the iliac crest (SIC), at the abdomen (ABD), and at the calf (CLF). Body composition including, e.g. percentage of body fat (PBF), lean body mass (LBM), soft tissue mass (SLM), and total body water (TBW), was evaluated using an IOI 353 analyzer by JAWON MEDICAL.

In groups distinguished based on the menstrual status, we also calculated the percentage of women with underweight, with normal body fat percentage, with overweight and obesity. The underweight women were these whose PBF was below 20% acc. to reference values of the IOI 353 analyzer, the group with normal body fat content included women whose PBF ranged from 20 to 30%, whereas the group of overweight and obese women included those whose PBF was: 30-35% and over 35%, respectively. The WHR value being a ratio of waist to hip circumference was additionally calculated for the obese women. It allowed calculating the percentage of women with WHR>0.85, namely these with android obesity, in each analyzed group distinguished based on the menstrual status.

Adipose tissue distribution in extremities and at the trunk was determined by calculating the TER index being a ratio of the sum of skinfolds at the trunk (TSS) and the sum of skinfolds in extremities (ESS).

Differences observed between groups discriminated based on the menstrual status in mean values of somatic traits (BH, BM, WC, HC, BIC, TRC, SSC, SIC, ABD, CLF), percentage of body fat (PBF), lean body mass (LBM), soft tissue mass (SLM), total body water (TBW), fatty tissue distribution index in limbs and trunk (TER), and the sum of skinfolds (TSS and ESS) were evaluated using one-way analysis of variance (ANOVA) and *Newman-Keuls* post-hoc test. The frequency of occurrence of women with various percentage of body fat and obese women with high WHR values (>0.85) in groups discriminated based on the menstrual status was determined with the Chi^2 test. The significance of tests was adopted at $p \leq 0.05$ or higher. Statistical analyses were carried out using Statistica v. 12 PL software.

The study was approved by the Commission of Ethics of Scientific Research at the Academy of Physical Education in Warsaw and conducted followed guidelines of the Helsinki Declaration.

RESULTS

The somatic characteristics of women in groups discriminated based on their menstrual status was presented in Table 2. Data provided in the table show significant differences in body height of the women, i.e. the highest BH value was reached by women in the premenopausal period, and the lowest one by postmenopausal women. Waist circumferences was observed to increase successively, starting from the premenopausal to the postmenopausal group (from 83.58 cm to 88.29 cm), but statistically significant differences were observed only between groups 1 and 3. The analysis of values of body mass, hip circumferences and thickness of skinfolds at: triceps and biceps, under scapula, at the abdomen, and over the iliac crest showed no significant differences between the groups of women. In most cases, the highest values of these traits were found in the perimenopausal women (group 2). An exception was skinfold thickness at the calf: the mean value of which was the highest in women from group 1, and the lowest in these from group 3 (statistically significant differences between groups 1 and 3 as well as 2 and 3). The analysis of the sum of thickness of three skinfolds at the trunk (TSS) and of the sum of thickness of skinfolds at extremities (ESS), and TER distribution index (TSS/ESS) revealed the highest value of TSS in group 2 and of ESS in group 1, as well as successively increasing value of TER in subsequent groups of women discriminated based on their menstrual status.

The anthropometric measurements were completed body composition analysis with the bioelectric impedance method. The analysis of fatty tissue content demonstrated significant differences in body adiposity between women from the studied groups. The highest percentage of body fat (PBF) was determined in the group of postmenopausal women who were additionally characterized by the lowest lean body mass (LBM) and soft tissue mass (SLM). These women had also the lowest content of total body water (TBW). The analysis of variance ANOVA showed the differences observed between the discriminated groups to be statistically significant (Table 3).

Table 2. Somatic characteristics of women in groups discriminated based on their menstrual status

Variables	Group 1			Group 2			Group 3			ANOVA	*Newman-Keuls* test
	$\bar{x}$	SD	±95% CI	$\bar{x}$	SD	±95% CI	$\bar{x}$	SD	±95% CI	F	
BH (cm)	161.71	5.95	160.28±163.14	161.23	5.05	159.71±162.75	157.21	5.82	156.40±158.03	20.409**	1-3; 2-3
BM (kg)	72.35	13.58	69.09±75.61	76.50	22.02	69.89±83.12	72.82	12.21	71.11±74.53	1.389	
WC (cm)	83.58	11.97	80.70±86.45	85.50	14.46	81.15±89.84	88.29	11.20	86.72±89.86	4.362*	1-3
HC (cm)	102.93	9.98	100.53±105.33	105.64	13.32	101.64±109.65	104.89	8.22	103.74±106.04	1.429	
BIC (mm)	11.85	4.64	10.74±12.97	12.02	5.13	10.48±13.56	10.76	3.87	10.21±11.30	2.719	
TRC (mm)	20.48	7.14	18.77±22.20	19.32	5.35	17.71±20.92	19.74	6.28	18.85±20.62	0.530	
CLF (mm)	15.39	5.19	14.14±16.63	14.51	3.32	13.54±15.48	12.46	4.03	11.90±13.03	14.100**	1-3; 2-3
SSC (mm)	21.43	8.72	19.33±23.52	21.91	8.53	19.53±24.47	22.09	7.66	21.01±23.16	0.174	
ABD (mm)	26.77	8.03	24.84±28.70	27.36	7.95	24.97±29.75	26.17	8.02	25.05±27.30	0.462	
SIC (mm)	21.76	8.63	19.69±23.83	21.91	8.83	19.25±24.56	20.30	7.27	19.29±21.32	1.358	
TSS (mm)	69.95	23.70	64.26±75.65	71.18	11.34	64.09±78.27	68.57	20.48	65.69±71.44	0.313	
ESS (mm)	47.71	14.00	44.35±51.08	45.84	11.34	42.44±49.25	42.95	10.69	41.46±44.45	4.718**	1-3
TER (mm)	1.48	0.38	1.39±1.57	1.54	0.31	1.44±1.63	1.63	0.45	1.57±1.69	3.519*	1-3

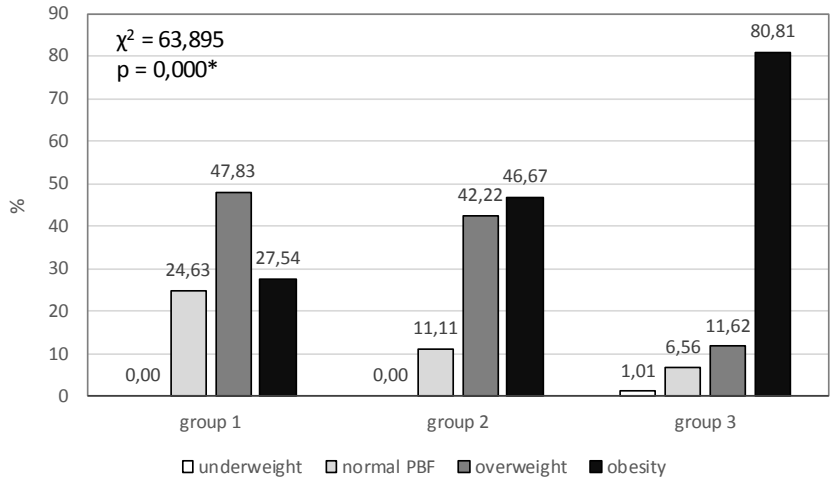
*statistically significant difference at p≤0.05
**statistically significant difference at p≤0.01

Table 3. Analysis of body composition of the surveyed women in groups discriminated based on their menstrual status

Variable	Group 1			Group 2			Group 3			ANOVA	*Newman-Keuls* test
	$\bar{x}$	SD	±95% CI	$\bar{x}$	SD	±95% CI	$\bar{x}$	SD	±95% CI	F	
PBF (%)	33.83	5.70	32.46±35.20	35.53	4.47	34.19±36.87	37.79	4.96	37.09±38.48	16.763**	1-2; 1-3; 2-3
LBM (kg)	47.26	5.83	45.86±48.66	48.51	10.26	45.43±51.59	44.96	6.36	44.07±45.85	6.269**	1-3; 2-3
SLM (kg)	43.17	5.15	41.93±44.41	44.20	9.06	41.48±46.92	40.87	5.78	40.06±41.68	7.193**	1-3; 2-3
TBW (%)	34.02	4.20	33.01±35.03	34.91	7.38	32.71±37.15	32.38	4.59	31.73±33.02	6.248**	1-3; 2-3

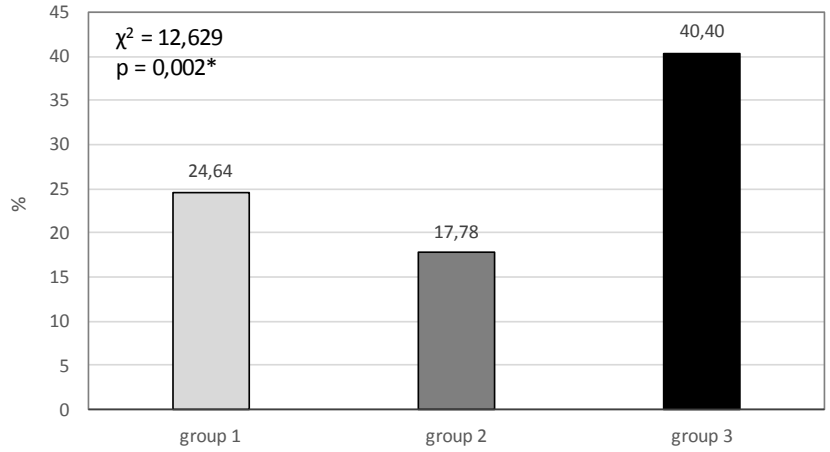
** statistically significant difference at p≤0.01

The boundary PBF values determined based on reference values of the IOI 353 body analyzer allowed discriminating three groups of women: with underweight, with normal PBF values, and with overweight and obesity. The highest percentage of premenopausal women were overweight (47.83% of the surveyed women in this group), whereas in groups 2 and 3 the highest percentage of women were obese, however the percentage of women with obesity in group 3 was significantly higher (by 34.14%) than in group 2 (Figure 1). In each of the discriminated group, the WHR index - being a ratio of waist to hip circumference - was calculated for obese women. The highest percentage of women with WHR>0.85 was observed in group 3 and the lowest one in group 2 (Figure 2).



* statistically significant differences

Figure 1. Percentage of body fat (PBF) in the surveyed women from groups discriminated based on their menstrual status



* statistically significant differences

Figure 2. Percentage of obese women with high WHR values (>0.85) in groups discriminated based on their menstrual status

DISCUSSION

A man's body undergoes successive stages of the physiological development in a strictly defined, irreversible order. Some of the traits of somatic built develop in a progressive way, but once they reach the maximum value they are subject to successive regression. One of such traits is body height which begins to decline at the age of around 40 [7]. This thesis was confirmed in our study. Body height of the women from the oldest age group (postmenopausal group) was on average by 4.5 cm lesser compared to the women from the premenopausal group. A significant regression in body height of women and men over 50 years of life was also observed by *Zając-Gawlak* and *Groffik* [23]. The size of spine intervertebra cartilage decreases as well as tension of abdomen and chest muscles declines with age, which aggravates spinal curvatures and, hence, contributes to body height decrease.

An opposite trend is observed in the case of the fatty tissue, the percentage of which increases successively in the subsequent stages of individual development, and whose rapid increment is observed in women in the peri- and postmenopausal period [17, 20]. Before the menopause, the adipose tissue is deposited most of all subcutaneously, usually in the thigh and gluteal region. In this period, adipocytes may reach significant sizes, while lipogenesis and lipolysis are strongly enhanced [3, 21]. Accumulation of the fatty tissue in the thigh and, gluteal region results from increased secretion of estrogens and the effect of progesterone. These hormones regulate lipolysis and lipogenesis, have a modulating effect upon expression of transcription factors and proliferation of adipocytes, as well as regulate the production of adipokines – leptin, angiotensin, resistin, and adiponectin [16].

In the perimenopausal period, distribution of fatty tissue increases and the tissue begins to accumulate mainly in the trunk and abdominal region. This is due to decreasing concentration of estrogen as a result of declining functionality of the ovaries [12, 19]. It is usually concurrent with increased secretion of androgens [2]. Our study demonstrated the highest percentage of body fat (PBF) in bodies of women classified to the postmenopausal group, and the lowest one in bodies of women who were still regularly menstruating. In turn, the analysis of the percentage of subcutaneous fatty tissue, evaluated based on the thickness of selected skinfolds, revealed the highest content of this tissue in perimenopausal women, except for the skinfolds on triceps and calf, the greatest thickness of which were found in the premenopausal women. In addition, we observed an increased value of TER index in the discriminated groups of women, which was indicative of fatty tissue distribution from extremities towards the trunk. This may confirm the above-described observations related to the preponderance of the subcutaneous fatty tissue in the women before the appearance of menopause symptoms and its migration to the abdominal region (visceral adiposity). Different results were reported by *Ho* et al. [4] in a longitudinal survey carried out among women in China. In the successive periods distinguished based on the menstrual status of the women, they demonstrated no changes in adiposity of extremities, but showed increased adiposity of the trunk already in the perimenopausal period and the highest one in the postmenopausal period, which caused a successive increase in the value of the TER index in the subsequent groups of the women.

Distribution of fatty tissue around waist and on hips is described by the waist-to-heap ratio (WHR). Its high value may be indicative of visceral type obesity being typical of the androgenic type of adiposity. In our survey, over 40% of the obese women from the postmenopausal group were characterized by this type of adiposity. In the two other groups, the percentage of women with WHR>0.85 was significantly lower. Investigations conducted by *Rębacz* et al. [15] demonstrated positive

correlations between WHR value and age of the surveyed women being over 50. In turn, *Skrzypczak* et al. [17] showed statistically significant differences in WHR values between premenopausal and postmenopausal women. These differences were significant regardless of the calendar age of the women. Similar observations were reported by *Kanaley* et al. [9].

CONCLUSIONS

1. The study demonstrated differences in the somatic built and body composition of women from groups discriminated based on their menstrual status. The highest values of body mass, hip circumference, and thickness of most of the analyzed skinfolds were demonstrated in the perimenopausal group. In turn, the postmenopausal women had the highest percentage of body fat (PBF) and the lowest lean body mass, soft tissue percentage, and total body water.
2. The highest percentage of obese women was found in the postmenopausal group, and 40% of these women had visceral type obesity.
3. The appearance of menopause contributed to changes in distribution of fatty tissue, causing its shift from extremities toward the trunk.

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Conflict of interest

The authors declare no conflict of interest.

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