BIOLOGICAL SYMPTOMS OF AGING IN WOMEN REGARDING PHYSICAL ACTIVITY AND LIFESTYLE

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ABSTRACT

Purpose. Menopause in many women is related to worse health conditions, increased diseases incidence and body mass. The purpose of this research was to investigate whether the differentiation of the involutional changes related to the climacteric period depends on women's physical activity and selected aspects of lifestyle. The following aging indices were analyzed: age of menopause, value of blood parameters, disease incidence, BMI. **Basic procedures.** The research, conducted in the health care units, was based on the survey approved by the Bioethical Committee at the Jagiellonian University. The data of 896 women above the age of 40 were used in the research. Basic statistics were calculated and tests of significance of differences and correlation were applied. **Main findings.** There is no significant relationship between the level of physical activity, the type of work performed and the age of menopause. However, women performing white-collar work and practicing sports enter menopause last. In smokers the age of menopause lowered. Women using vegetarian diets and women with high BMI values go through menopause later. High BMI values and nicotine addiction are significantly related to the increased level of blood sugar, diabetes incidence and high blood pressure. The cholesterol level is significantly related to the age of the subjects. The percentage of increased cholesterol level is smaller in women practicing sports who have also significantly lower BMI values than those who do not go in for any sports. **Conclusions.** The analysis of health and aging indices confirms the highest correlation between BMI and the external factors. Moreover, regarding the specificity of hormonal changes during climacterium, overweight and obese women go through menopause later.

Key words: aging, menopause, physical activity, lifestyle

Introduction

Aging is a natural result of development and reached maturity. In recent years, due to the observed increase in life expectancy in modern societies the interest in the subject of late adulthood has increased. Many publications on aging indicate genetical and physiological conditioning of this phenomenon, yet they do not exclude the influence of general lifestyle frequently resulting from the educational level [1–3]. In various research on different aspects of aging, including the influence of external factors on the involutional changes, ambiguities which raise questions can be observed. It means that the level of knowledge on aging processes is still insufficient.

Different assessment methods of the involutional processes and the human's biological age can be distinguished (e.g. based on the osteological changes, the biochemical composition of cells, intensity of metabolism and many others). In women's case also age at menopause is thought to be a symptom of aging and health.

This research reveals that entering the menopause period is related to worse health conditions, increased incidence of vascular diseases, osteoporosis and body mass increment. Mondul et al. [4] report that menopause in older age is related to the increased risk of breast and uterine cervix cancer. On the other hand, it has been implied that women going through menopause earlier live shorter than those going through it later [5].

The purpose of this research was to investigate whether the differentiation of the involutional changes related to the climacteric period depends on women's physical activity and selected aspects of lifestyle (type of work, nicotine addiction, diets). The analyzed aging and health indices were: age at menopause, values of physiological and biochemical parameters (blood glucose and total cholesterol, blood pressure), incidence of cardiovascular diseases and osteoporosis, body mass index (BMI) values.

The obtained results may be useful to create health oriented programs for women. The increased health care of mature women is more noticeable now, since a vast majority of Polish female population born in the post-war baby boom is currently passing this onto-genesis period. Moreover, due to the fast lifestyle and

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women's prolonged social activity, this type of care is required.

Material and methods

The research was based on the author's survey approved by the Jagiellonian University Bioethical Committee. Anonymous questionnaire was to be completed due to the personal specificity of some questions. The research carried out in the years 2005–2007 was conducted among women living in the southern provinces of Poland. Data was collected in the health care units during prophylactic cytological and mammographic screening. Women answered more than 40 questions concerning their social status, life style, reproductive period and health. The data of 896 women above the age of 40 were used in the analysis.

The age distribution in the sample varies from the Polish women's age structure based on demographic data of General Statistical Office [6]. Due to the research specificity and selected method most women in the course of the survey were 45–55. The numbers of women born in a big city, small town and in the country were approximately equal. However, while the research was being done, most women lived in big cities in the south of Poland – Wrocław, Katowice, Kraków, and Rzeszów. The subjects' education level and marital status were varied, but a vast majority of women were married.

In order to compare the results with those obtained in the national and international research, terminology related to the climacteric period was based on that commonly used and suggested by The World Health Organization [7, 8]. The categories of BMI were taken from the WHO guidelines [9], while glycemia and cholesterolemia threshold values and blood pressure derive from the national data [10].

Basic statistics were calculated. Tests of significance of differences and tests of correlation were applied. Statistica PL 7.0 and 8.0 were used for statistical calculations.

To confirm the hypothesis that climacteric period is related to the health deterioration, the results of two groups of women (before and after menopause) were compared. Mean values of menopausal age were computed on the basis of declared birth and last menstruation dates. Declared body mass and body height were used to calculate the mean BMI values.

The diversity of menopausal age and BMI values were examined by t-Student test (for the groups of equal and unequal variances), ANOVA, Scheffe's test and also multivariate tests.

Chi-squared test was applied to determine the correlation between the level of physiological and biochemical blood parameters and physical activity and other elements of lifestyle. Values of physiological parameters were categorized since few subjects knew the exact results of their research. However, most of them were able to determine whether their results were correct or not.

Due to the survey specificity, the reliability of the research was evaluated by the *test-retest* method [11]. This method is based on the research repetition with the time interval. Hence, the selected group of women filled in the questionnaire again. Its aim was to estimate the consistency of the given answers and their reliability. Based on the collected data the difference between the answers was determined. The significance of differences was examined by the usage of suitable statistical tests.

Due to women's reliable answers, it was observed that the first and second surveys tallied considerably with each other. The rate of memory mistake is not high and does not decrease the cognitive value of the research.

Results

A comparison of menstruating women with post-menopause women

To assess changes of women's body during climacterium, two groups of women: before and after menopause were compared. The difference in the mean age between the groups was obvious – post-menopause women were nearly 10 years older than menstruating women (Tab. 1).

In post-menopause women a greater number suffered from high blood pressure, elevated level of blood glucose and total cholesterol than in pre-menopause women (Tab. 1). Increased values of blood physiological

Table 1. Comparison of two groups of women: pre- and post-menopause

Characteristic	Percentages of women	
	pre-menopause	post-menopause
Hypertension	9.8%	29.3%
Increased blood cholesterol	27.6%	51.3%
Increased blood glucose	4.1%	10.6%
Cardiovascular diseases	17.7%	21.2%
Diabetes	2.5%	4.8%
Overweight/obesity	50.6%	61.8%
Osteoporosis	2.8%	13%
Bad self-rating of health	1.1%	4.8%
Mean		
Age of women	47.37 years	58.92 years
BMI	25.12 kg/m²	26.75 kg/m²

parameters in the post-menopause group of women, in comparison to those still menstruating, were connected with higher incidence of heart diseases, diabetes, osteoporosis, and occurence of overweight and obesity among women (Tab. 1). As a consequence of deteriorating health conditions after menopause a greater number of women considering their health conditions as poor was observed among non-menstruating women (Tab. 1).

Age at menopause

Only women going through natural menopause were considered in the analysis of diversification of menopausal age (women undergoing supplementary hormonal therapy and those who went through artificial menopause were excluded), since the manner of retaining of ovarian function causes significant differences in the age of menopause [8, 12]. Mean age of natural menopause was approximately 50 years (Tab. 2).

The level of physical activity and the type of performed work were not significantly related to the age at menopause. However, it is worth indicating that women who are white-collar or freelance workers and those going in for sports enter menopause later (Tab. 3). After the analysis of all physical activities resulting from the type of job and sports done it was stated that women doing both white-collar work and sports went through menopause last.

Smoking cigarettes lowered the age of menopause in the subjects, while a vegetarian diet delayed climacterium (Tab. 3). In this case, the conclusions ought to be formed carefully since only few women admitted they were vegetarian. Women smoking over 20 cigarettes per day go through menopause first (48.4 years).

Table 2. Characteristics of menopausal age

Natural menopause	N	$\bar{x}$	SD	min	max
Basic statistics	247	50.2	3.44	40.20	58.94

It is surprising that women smoking for the longest period of time went through menopause later than those who smoked shorter (50.3 in comparison to 49.5 years).

Women's relative body mass is influenced by the lifestyle, diets and the level of physical activity. The higher body mass is related to the greater content of fat tissue, responsible for aromatization of sex hormones in the climacteric period and after menopause. The women examined showed a tendency to the increase of menopausal age with the growth of BMI values before menopause (Tab. 4).

Canonical analysis confirmed that none of the analyzed variables is significantly related to age at menopause ($p = 0.940$).

Blood sugar level

High body mass index values of the subjects significantly increase the risk of hyperglycemia and diabetes (Tab. 5). Statistically significant relationship was observed between smoking cigarettes and blood sugar level ($p = 0.0281$). A percentage of women with diabetes was lower among smoking than non-smoking women (2.6% and 5.2%, respectively). A low percentage of women with hyperglycemia and diabetes practised sport (8.3% in comparison to 16.8% among healthy women). No relationship between glycemia level and following low fat or vegetarian diets was observed (respectively $p = 0.6003$; $p = 0.7939$).

Table 3. Characteristics of menopausal age in relation to social features

Features		Menopausal age					
		N	$\bar{x}$	SD	min	max	Significance*
Type of job	manual	55	49.93	3.79	41.74	57.98	
	white-collar	179	50.21	3.37	40.20	58.94	$p = 0.8712$
	self-employed	10	50.26	1.94	47.96	53.89	
Sport	professional	8	50.82	1.99	48.41	54.00	
	amateurish	35	50.68	3.49	40.36	58.94	$p = 0.5500$
	no	204	50.07	3.48	40.20	57.98	
Smoking	yes	129	49.83	3.22	40.20	57.29	$p = 0.2483$
	no	118	50.57	3.64	40.45	58.94	
Vegetarian diet	yes	8	51.58	2.88	48.41	56.50	$p = 0.8310$
	no	239	50.14	3.45	40.20	58.94	
Slimming diet	yes	41	50.25	2.82	40.45	53.89	$p = 0.9834$
	no	198	50.18	3.49	40.20	57.98	

* t-Student test/ANOVA

Table 4. Characteristics of menopausal age in relation to BMI values (kg/m^2)

BMI	Menopausal age					
	N	$\bar{x}$	SD	min	max	ANOVA
18.50–24.99	52	49.7	3.15	43.16	58.94	
25.00–29.99	176	50.2	3.49	40.20	57.98	$p = 0.1450$
> 29.99	6	51.1	3.09	47.72	54.68	

Table 5. Characteristics of BMI (kg/m^2) in relation to values of blood parameters

Blood parameters		BMI					
		N	$\bar{x}$	SD	min	max	Significance*
Glycemia	normal	405	26.3	4.43	17.99	44.95	$p = 0.0000$
	above normal	42	30.0	5.43	20.45	63.95	
Cholesterolemia	below normal	13	26.8	3.11	20.43	30.85	$p = 0.8914$
	normal	246	26.7	4.93	19.00	63.95	
	above normal	180	26.5	3.59	17.99	36.86	
Blood pressure	normal	579	26.0	3.88	17.99	42.44	$p = 0.0000$
	hypertension	111	28.2	5.79	19.05	63.95	

* t-Student test/ANOVA

Table 6. Characteristic of women's age (years) in relation to values of blood cholesterol

Cholesterolemia	Women's age					
	N	$\bar{x}$	SD	min	max	Significance
Below normal	13	54.6	8.44	44.71	73.56	$p* = 0.0048$
Normal	251	53.2	7.47	35.62	78.80	
Above normal	183	55.5	7.26	42.78	88.90	$p** = 0.0049$

* ANOVA, ** Scheffe's test (significant difference between normal and increased cholesterolemia)

Blood cholesterol level

No relationship between the blood cholesterol, low-fat ($p = 0.1902$) and vegetarian diets ($p = 0.6137$), smoking cigarettes ($p = 0.6834$) and physical activity ($p = 0.2365$) and BMI values (Tab. 5) was observed. Still, the percentage of increased cholesterol level is lower in women practicing sports than in those who do not go in for any sports (31.8% and 42.9%, respectively). The cholesterol level is significantly related to the age of the subjects (Tab. 6).

BMI

Women practicing sports as amateurs have significantly lower BMI values than those who do not practise any sports (24.8 kg/m^2 in comparison to 26.4 kg/m^2; $p = 0.0004$). The similar tendency was observed by Suchomel et al. [13]. While following low-fat diets is significantly related to the higher BMI values (27.7 kg/m^2 in women following diets and 25.6 kg/m^2 in the other

women; $p = 0.0000$). Body mass index was not related to nicotine addiction; however, it significantly influenced the value of blood pressure. Women with high blood pressure as a rule had higher BMI values (Tab. 5).

High blood pressure

High blood pressure in women was not related to their physical activity ($p = 0.3976$), nicotynism ($p = 0.9159$) and use of low fat or vegetarian diets ($p = 0.3615$).

Osteoporosis

Osteoporosis incidence was not significantly related to any of the analyzed factors.

Discussion

Correct functioning of the organism is controlled by the neurohormonal system which coordinates all the systems and organs and maintains homeostasis. The

organism's homeostasis ability weakens with age, thus many illnesses and incorrectness in organs' functioning can be observed. The period of time when health condition is worsening is more visible in women than in men. This period (climacterium) is strictly related to worsening of ovarian function. What characterizes it are changes in the physiological parameters values and in women's body build (fatness).

The characteristic feature of the female menopause hormon profile is the lower level of estrogen with increased level of FSH secretion. Disturbances in lipid metabolism are caused by hipoestrogenism. The increasing content of certain lipids fraction in plasma increases the risk of cardiovascular diseases development. An increase in fatness in post-menopausal women is also related to the change of hormone profile. Estradiol (the main estrogen of the reproductive period) is replaced by estrone, a hormone secreted by adrenal cortex and aromatized in the fat tissue cells.

Blood pressure, blood sugar and total blood cholesterol levels increase with age and change of menopausal status [14]. The results of this research are consistent with the above observations. The increased blood pressure values, total cholesterol and glucose were observed more frequently in post-menopausal women. That was related to the overweightness and obesity, cardiovascular diseases as well as diabetes and osteoporosis in post-menopausal women. Skrzypczak and Szwed noticed that the number of overweight and obese women increases with their age and after menopause [15].

Involutional processes influence the change of women's body shape; menopausal changes are mainly related to the way of fat tissue distribution. The BMI values change due to the alternations in body height and mass with age [16]. In post-menopausal women body proportions change due to fat tissue concentration in the waist area, unlike in younger women – on tights and hips [17].

Considering all this, the age of ovarians' function termination comes into prominence. Kaczmarek [18], applying Kaplan-Meier's method, assessed the age of early (below 46.6 years) and late menopause (over 55.0 years) in Polish women population. Based on the comparison conducted by the author, menopause in women from different countries of the world occurs approximately between 48 and 52. The difference between industrial regions, where women pass menopause after 51, and poor regions, where women stop menstruating approximately 5 years earlier, is also important [8]. It is supposed that in poor countries, due to the common malnutrition, the lower amount of oocytes is created in the foetal period.

Based on the analyses conducted, the computed mean menopausal age in the examined subjects was 50.2 years. The obtained results are similar to those published in the literature [19, 20]. Other authors obtained lower or higher mean age of menopause [12, 21, 22]. Those differences may result from different methodology of the survey and data analysis and from the diverse socio-economic conditions. Data of women after natural menopause, artificial menopause and those after hormonal treatment obtained in the earlier research were examined concurrently. That might have disturbed the average climacteric age. The menopausal age is a quantitative feature, whose final value depends on genetic predispositions and influence of the environment. The environmental factors influence, directly or indirectly, different biological properties of women's organism related to the climacterium.

Many published data indicate that inveterate smokers go through menopause earlier than non-smoking women [2, 23]. This is due to the toxic effect of cigarette smoke compounds on the ovarian follicle which causes oocytes degradation. Moreover, nicotine decreases the estrogen's level and accelerates tissues and organs aging, including ovaries, by oxidizing cell membranes. Despite the fact that smoking cigarettes and the number of cigarettes smoked per day did not significantly differentiate mean age of menopause in subjects, it is significant that non-smoking women go through menopause two years later than women who are habitual smokers. The period of smoking addiction was not significantly related to the age of menopause. However, it is surprising that in the sample analyzed the women smoking for the longest period go through menopause later (women smoking for less than 20 years did not significantly differ in their age from those smoking for over 20 years). In many women the nicontynism period was shorter since they gave up smoking due to their poor health conditions. It is likely that women who have been smoking for 20 years but in good health were not forced to quit smoking. Their genetical predispositions were related to the later menopausal age.

No relationship between menopausal age and use of vegetarian diets was proven (however, it is worth mentioning that in the sample, women following a vegetarian diet entered menopause 1 year later). A diligent comparison of these two groups is difficult since the groups were not equal in number. Baird et al. [24] observed earlier menopausal age in vegetarians, while Torgerson et al. [25] revealed the relationship between the amount of meat eaten and age at menopause.

The level of physical activity did not significantly influence the mean age of menopause among the sub-

jects, which was consistent with Parazzini et al.'s results [26]. It was observed that the mean menopausal age increases with the level of declared physical activity (described as: no sports practice, frequent sports training as amateur, professional sports training). Waszak et al. [27] noticed that moderate physical activity eases symptoms of menopause.

It was suspected that constitutional indicators, whose value is frequently connected to the lifestyle, may be related to the menopausal age. Despite that, the statistical significance was not proven, an increase of menopausal age can be observed with increasing BMI in women. The results of the research conducted on different populations are varied. The age at menopause increases with women's BMI [28]. In overweight women it may be related to the higher estrogen level. However, Beşer et al. [29] report that the risk of earlier menopause is increased by too high a BMI level. Kirchengast et al. [30] imply the lack of relationship between BMI and climacteric age.

High values of the body mass index significantly increase the risk of hyperglycemia and diabetes. It was proven that doing sport lowers BMI and protects against hyperglycemia and high blood pressure. Still, the percentage of increased cholesterol level is lower in women practicing sports. It is interesting to note that the use of low fat diets was related to the higher BMI values. The diets were probably used by the overweight women.

The results obtained during the analysis of smoking factor, commonly perceived as aging accelerator (damaged cells), were surprising. A percentage of women with diabetes was lower among smoking than non-smoking women (2.6% and 5.2%, respectively). Perhaps, smoking affects diet selection and consumption of carbohydrate. Nicotynism does not influence the BMI values, total blood cholesterol level and blood pressure.

Using low-fat diets was not related to the glycemia level, cholesterolemia and osteoporosis incidence in the subjects. The cholesterol level is significantly related to the age of the subjects. In comparison with younger women, older women have higher cholesterolemia values. This may be related to the higher percentage of overweight women and postmenopausal obesity.

Although osteoporosis incidence was not significantly related to any of the factors analyzed, it is commonly known that due to changes in the hormon profile, osteoporosis incidence is higher in older and in postmenopausal women [31], whereas bone mineral density is higher in physically active women [32].

As to the factors related to the climacterium and women's biological condition, the conclusions concerning the factors responsible for involutionary changes in acceleratation are to be formulated cautiously. Moreover, no factor acts independently so the influences of many modificators are aggregated. Their actions are either reinforced or weakened, hence it makes the assessment more difficult.

Conclusions

Summing up, the analysis of health and aging indices confirms a very high correlation between the relative body mass index and the external factors.

BMI diversification is significantly related to the intensity of the physical activity, diets used, high blood pressure and blood sugar level. Due to the specificity of hormone changes during climacterium, overweight and obese women go through menopause later.

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