METABOLIC DISORDERS IN WOMEN AT PROCREATIVE AGE LIVING IN WARSAW

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ABSTRACT

Background. Abnormal body mass and related metabolic disorders may affect female reproductive health.

Objectives. To determine the prevalence of under- and overweight, and also related metabolic disorders, among women at procreative age in Warsaw.

Materials and Methods. 164 non-pregnant women at procreative age (20-49 years) living in Warsaw, who in 2011-2012 participated in the WAW-KARD cross-sectional study of the Warsaw population, assigned to 3 age groups: 20-29 years (n=17), 30-39 years (n=78) and 40-49 years (n=69).

Results. Under- and overweight, obesity and abdominal obesity was found in respectively 1.2%, 25%, 12.2% and 37.2% of the participants. Prevalence of excessive body mass tended to increase with age. Hypercholesterolemia was shown in 42.7% of the whole group and was particularly widespread in the oldest females (56.5%). Prevalence of low serum HDL-cholesterol levels (found in 13.4% of the whole group) tended to increase with age, on the borderline of statistical significance. The mean fasting glucose level was 5.0 ± 0.4 mmol/l and tended to increase with age. Impaired fasting glucose concerned 7.7% and 10.6% of females in age groups of 30-39 and 40-49 years respectively, and diabetes 4.4% of females 40-49 years old. Prevalence of arterial hypertension and metabolic syndrome (MS) in the whole group was 10.4% and 7.3% respectively; prevalence of MS tended to increase with age, on the borderline of statistical significance.

Conclusions. Overweight and obesity, especially of abdominal type, are prevalent in women at procreative age in Warsaw. Disturbances of lipid and glucose metabolism, as well as arterial hypertension and MS, are also frequent. Prevalence of many of them tended to increase with age. Some of the women exhibited diabetes.

Key words: *females at procreative age, body mass, lipid disturbances, glucose metabolism, metabolic syndrome*

STRESZCZENIE

Wprowadzenie. Nieprawidłowa masa ciała kobiety i wiążące się z nią zaburzenia metaboliczne mogą niekorzystnie wpływać na zdrowie prokreacyjne.

Cel. Zbadanie częstości występowania niedowagi i nadmiernej masy ciała, a także zaburzeń metabolicznych u kobiet w wieku rozrodczym mieszkających w Warszawie.

Materiał i metody. 164 nieciężarne kobiety w wieku rozrodczym (20-49 lat) zamieszkałe w Warszawie, które w latach 2011-2012 wzięły udział w przekrojowym badaniu populacji Warszawy WAW-KARD, podzielone na 3 grupy wiekowe: 20-29 lat (n=17), 30-39 lat (n=78) oraz 40-49 lat (n=69).

Wyniki. Niedowaga, nadwaga, otyłość i otyłość brzuszna dotyczyły odpowiednio 1,2%, 25%, 12,2% i 37,2% badanych. Występowanie nadmiernej masy ciała wykazywało tendencję wzrostową wraz z wiekiem. Hipercholesterolemia występowała u 42,7% ogółu kobiet i była szczególnie częsta w najstarszej grupie wiekowej (56,5%). Rozpowszechnienie niskich stężeń HDL-chol w surowicy (obecne u 13,4% ogółu badanych), wykazywało tendencję wzrostową wraz z wiekiem, na pograniczu znamienności statystycznej. Średnie stężenie glukozy na czczo wynosiło $5,0 \pm 0,4$ mmol/l i wykazywało tendencję wzrostową wraz z wiekiem. Nieprawidłowa glikemia na czczo występowała u 7,7% i 10,6% kobiet odpowiednio w wieku 30-39 i 40-49 lat, natomiast cukrzyca u 4,4% kobiet w wieku 40-49 lat. Występowanie nadciśnienia tętniczego i zespołu metabolicznego (ZM) w całej grupie wynosiło odpowiednio 10,4% i 7,3%, przy czym rozpowszechnienie ZM wykazywało tendencję wzrostową wraz z wiekiem, na pograniczu znamienności statystycznej.

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Wnioski. Nadwaga i otyłość, zwłaszcza brzuszna, są częste u kobiet w wieku rozrodczym w Warszawie. Częste są również zaburzenia metabolizmu lipidów i glukozy, nadciśnienie tętnicze i zespół metaboliczny. Rozpowszechnienie wielu z tych zaburzeń wykazuje tendencję wzrostową wraz z wiekiem. U części kobiet stwierdzono już występowanie cukrzycy.

Słowa kluczowe: *kobiety w wieku rozrodczym, masa ciała, zaburzenia lipidowe, metabolizm glukozy, zespół metaboliczny*

INTRODUCTION

Abnormal body mass in women and resulting metabolic disorders may adversely affect procreative health. Overweight and obesity may cause ovulatory disorders and thus lead to decreased chance of pregnancy [22]. Both deficient and excessive maternal body mass before pregnancy may result in abnormal foetal development. Underweight is associated with increased risk of intrauterine growth retardation (IUGR) [12, 17], whereas overweight and obesity is linked to macrosomia [14]. Both these conditions may lead to many obstetric complications. They may also increase the likelihood of metabolic disorders in the child's later adult life leading to type 2 diabetes, arterial hypertension, lipid disorders and cardiovascular diseases [21]. Macrosomia is a risk factor for obesity [14, 21].

It should be underlined that maternal overweight and obesity may be responsible for such conditions as gestational diabetes [25] and hypertensive disorders of pregnancy i.e. pregnancy induced hypertension and pre-eclampsia [1, 5, 6] which often result in disturbances of foetal development. Gestational diabetes may lead to micro- or macrosomia in the child, whilst hypertensive disorders to IUGR. It is also worth noting that these aforementioned pregnancy complications are recognised risk factors for maternal cardiovascular diseases [16].

The study aim was to determine the rates of underweight and excessive body mass together with metabolic disorders in women at procreative age living in Warsaw.

MATERIAL AND METHODS

The study group consisted of 164 non-pregnant women of childbearing age (20-49 years) resident in Warsaw, who in 2011-12 took part in the Polish section of the European Health Examination Survey–Joint Action (EHES JA) and the Warsaw Population Health Status Study (WAW-KARD); the latter being a continuation of the EHES. Both projects were undertaken by the Department of Epidemiology, Cardiovascular Disease Prevention and Health Promotion of the Institute of Cardiology for assessing health status of the Warsaw population. The studies included random representative samples of adult inhabitants of the city.

The risk factor profile for lifestyle diseases was evaluated for each subject based on survey outcomes, laboratory tests, anthropometric and blood pressure measurements, and dietary assessment. Aims, project methods and random sampling schemes were fully described in the detailed reports of the aforementioned studies [8, 13, 23]. Measurements of serum lipid and glucose concentrations were performed at the central 'Diagnostica' laboratory that participated in the standardisation programmes conducted by the CDC (Atlanta) and European RANDOX programmes.

Subjects were assigned to 3 age groups as follows: 20-29 years (n=17), 30-39 years (n=78) and 40-49 years (n=69). The analysis included demographic characteristics (marital status, education, employment and the net household income per person), body mass, waist circumference, lipid and glucose concentrations, blood pressure and presence of metabolic syndrome. Means, standard deviations and medians were determined for the Body Mass Index (BMI), waist circumference, and serum concentrations of total cholesterol (TC), LDL-cholesterol, HDL-cholesterol and triglycerides (TG) along with systolic and diastolic blood pressure (respectively SBP and DBP). Underweight, overweight and obesity were defined according to WHO criteria [24], excessive waist circumference was defined according to both ATP III [11] and IDF [5] criteria. Hypercholerolaemia, hypertriglceridaemia (HTG) and low HDL-cholesterol levels were recognised using criteria adopted by the European Society of Cardiology [10]. Low HDL-cholesterol concentrations were defined also according to the IDF criteria [5]. Abnormal fasting glucose levels were recognised according to the recommendations of the Polish Diabetic Society [25], arterial hypertension according to the ESH/ESC recommendations from 2013, and metabolic syndrome (MS) using harmonized criteria established by IDF/ NHLBI/ AHA/ WHF/ IAS/ IASO in 2009 [4].

Significant differences between age groups were determined by the *Kruskal-Wallis* and *Chi*-square tests. The significance of trends was assessed by the *Chi*-square test for trend. These statistical methods enabled assessment of diversity of different women's groups of varied numbers.

RESULTS

Table 1 presents data on marital status, education, employment and net household income per person for

Table 1. Marital status, education, occupational activity, and net household income per person in the women under study

Parameter	All n=164	Age (years)			P value
		20-29 n=17	30-39 n=78	40-49 n=69	
Marital status:					ns
Married (%)	57.9	41.2	59.0	60.9	
Education:					
Primary (%)	4.9	5.9	2.6	7.3	ns
Secondary (%)	21.9	17.6	17.9	27.5	
Higher (%)	73.2	76.5	79.5	65.2	
Occupational activity (%)					
Yes	85.4	88.2	83.3	87.0	ns
No	14.6	11.8	16.7	13	
Net household income per person (%)*					
≤ 500 PLN	1.4	0	1.5	1.9	
501-1000 PLN	11.8	0	8.7	18.9	
1001-2000 PLN	28.7	21.4	21.7	39.6	<0.05
2001-3000 PLN	30.9	57.1	31.9	22.6	
>3000 PLN	27.2	21.5	36.2	17.0	

* included only those who answered the question, i.e. 136 subjects

the subjects under study. No statistically significant differences concerning these characteristics, except of income, were found.

Mean BMI and waist circumference values and percentages of women with abnormal body mass and high waist circumference are shown in Table 2, with the first two variables being significantly higher in the oldest age group. Likewise, rates of overweight, obesity and abdominal obesity were the highest in women aged 40-49 years. Underweight (BMI<18.5 kg/m^2) was observed only in a few participants in the group aged 30-39 years.

The lipid profile data and rates of lipid abnormalities are shown in Table 3. LDL-cholesterol and triglyceride concentrations were significantly the highest, whereas HDL-cholesterol level was the lowest in the oldest age group (at the borderline level of significance). Prevalence of hypercholesterolemia (defined as LDL-cholesterol ≥3.0 mmol/l), was significantly the highest in the oldest age group. There were no significant differences in the rates of hypertriglyceridaemia or low HDL-cholesterol level. The latter, defined according to IDF criteria, tended to rise with age, at the level of borderline significance.

Rates of carbohydrate metabolism disorders, as well as arterial hypertension, and MS are presented in Table 4. Glucose concentrations tended to rise with age significantly. Prevalence of impaired fasting glucose levels

Table 2. Mean values and medians of BMI and waist circumferences, and percentages of women with abnormal body mass and high waist circumference

Parameter	All n=164	Age (years)			P value
		20-29 n=17	30-39 n=78	40-49 n=69	
BMI (kg/m^2)					
x ± SD	24.5 ± 4.5	22.3 ± 2.5	23.4± 3.6	26.4 ± 5.1	<0.0001
Median	23.5	21.69	22.72	25.22	
BMI (%)					
<18.5 kg/m^2	1.2	0	2.6	0	
18.5-24.9 kg/m^2	61.6	76.5	70.4	47.9	<0.05
25-29.9 kg/m^2	25.0	23.5	18.0	33.3	
≥30 kg/m^2	12.2	0	9.0	18.8	
Waist (cm)					
x ± SD	78.2 ± 10.8	72.5 ± 6.2	75.4 ± 8.4	82.8 ± 12.3	<0.0001
Median	76.0	72	74	81	
Waist (%)[a]					
<80 cm	62.8	82.3	74.4	44.9	<0.001
≥ 80 cm	37.2	17.7	25.6	55.1	
Waist (%)[b]					
<88 cm	81.7	100	89.7	68.1	<0.001
≥ 88 cm	18.3	0	10.3	31.9	

[a] according to the IDF criteria, [b] according to the ATP III criteria

Table 3.   Mean values and medians of lipid parameters, and percentages of women with lipid disorders

Parameter	All n=164	Age (years)			P value
		20-29 n=17	30-39 n=78	40-49 n=69	
TC (mmol/l) x ± SD Median	5.14 ± 0.78 5.18	4.97 ± 0.60 5.09	5.00 ± 0.71 5.03	5.36 ± 0.84 5.27	ns
LDL-chol (mmol/l) x ± SD Median	2.90 ± 0.70 2.87	2.76 ± 0.58 2.83	2.74 ± 0.65 2.65	3.15 ± 0.70 3.06	<0.001
TG (mmol/l) x ± SD Median	0.92 ± 0.50 0.75	0.95 ± 0.50 0.75	0.82 ± 0.42 0.69	1.02 ± 0.57 0.86	<0.05
HDL-chol (mmol/l) x ± SD Median	1.82 ± 0.43 1.81	1.77 ± 0.32 1.80	1.90 ± 0.44 1.91	1.74 ± 0.43 1.72	0.0715
TC (%) TC < 4.9 mmol/l TC ≥ 4.9 mmol/l	39.6 60.4	35.3 64.7	47.4 52.6	31.9 68.1	ns
LDL-chol (%) LDL-chol <3.00 mmol/l LDL-chol ≥3.00 mmol/l	57.3 42.7	58.8 41.2	69.2 30.8	43.5 56.5	<0.01
TG (%) < 1.7 mmol/l ≥ 1.7 mmol/l	93.3 6.7	88.2 11.8	97.4 2.6	89.9 10.1	ns
HDL-chol (%)[a] HDL-chol <1.16 mmol/l HDL-chol ≥1.16 mmol/l	6.7 93.3	5.9 94.1	5.1 94.9	8.7 91.3	ns
HDL-chol (%)[b] HDL-chol <1.3 mmol/l HDL-chol ≥1.3 mmol/l	13.4 86.6	5.9 94.1	10.3 89.7	18.8 81.2	ns P value for trend: 0.077

[a] according to the criteria of the European Society of Cardiology, [b] according to the IDF criteria

was also higher in the older subject groups, however without reaching statistical significance. Diabetes was present only in women aged 40-49 years.

SBP and DBP values and arterial hypertension rates did not differ significantly between the age groups. MS rates tended to rise with age, at borderline significance.

DISCUSSION

Overweight and obesity, especially of abdominal type, and also hypercholesterolemia occurred often in the studied women of reproductive age. Some of participants had also disorders of carbohydrate metabolism, arterial hypertension and MS. Rates of many of these disorders tended to rise with age and were particularly frequent in subjects aged above 40 years.

The overall mean BMI value was 24.5 kg/m^2 and increased with age, starting at 22.3 kg/m^2 in the youngest group and rising to 26.4 kg/m^2 in the oldest. In comparison, the WOBASZ study [20], the nationwide study of the Polish population conducted in 2003-5, showed similar results. The mean BMI was 22.62 kg/m^2 among women aged 20-34 years and 25.36 kg/m^2 in those 35-44 years old. In turn, an American study, the National Health and Nutrition Examination Survey (NHANES), performed in 1999-2008, showed higher mean BMI values in USA women aged 16-49 years, equal to 27.7 kg/m^2 [3].

Only 1.2% of the subjects who participated in our study were underweight, however 1 in 4 were overweight and 12% were obese. In comparison, in the WOBASZ study underweight occurred in women aged 20-45 years more often (4%), whilst overweight and obesity rates were respectively 19% and 9.6%. According to the ATP III criteria, prevalence of abdominal obesity in our study was similar to that in the WOBASZ study [20], where it also tended to rise with age. Presence of this type of obesity characterized over the half of our subjects aged 40-49 years. Thus, excessive body mass, including abdominal obesity, is in young Warsaw women unequivocally more frequent than underweight.

Lipid disorders were common in participants of our study. Hypercholesterolemia (defined by LDL-cholesterol ≥3.0 mmol/L) was found in about 43% of subjects, somewhat more frequently than in the WOBASZ study in which it was shown in 37% of women aged 20-44 years [20]. In our study this condition occurred in 56% of women aged 40-49 years. Prevalence of low HDL-cholesterol levels (<1.3 mmol/L) tended to increase with age, at borderline significance. It was probably related to the parallel increase in frequency of excessive body mass, and particularly abdominal obesity, with age.

Table 4.   Prevalence of glucose metabolism disorders, arterial hypertension, and metabolic syndrome in the women under study.

Parameter	All n=164	Age (years)			P value
		20-29 n=17	30-39 n=78	40-49 n=69	
Fasting glucose (mmol/l)					
x ± SD	5.0 ± 0.4	4.8 ± 0.4	4.9 ± 0.4	5.1 ± 0.5	<0.05
Median	4.9	4.9	4.9	5.1	
Fasting glucose (%)					
Normal (<5.6 mmol/l)	90.1	100	92.3	85.0	
Impaired fasting glucose (5,6-6,9 mmol/l)	8.1	0	7.7	10.6	ns
Diabetes (diagnosed or fasting glucose ≥ 7 mmol/l)	1.8	0	0	4.4	
Diabetes (%)					
Yes (diagnosed or fasting glucose ≥ 7 mmol/l)	1.8	0	0	4.4	ns
No	98.2	100	100	95.6	
SBP (mm Hg)					
x ± SD	114.4 ± 12.1	116.7 ± 10.4	112.0 ± 11.8	116.4 ± 12.4	ns
Median	112.8	115	111.25	114	
DBP (mm Hg)					
x ± SD	71.3 ± 9.4	71.8 ± 9.9	69.6 ± 9.0	73.1 ± 9.6	ns
Median	69.5	68.5	68.25	70.5	
BP (%)					
< 140/90 mm Hg	89.6	88.2	94.9	84.1	ns
≥ 140/90 mm Hg	10.4	11.8	5.1	15.9	
MS (%) when waist >80 cm					ns
Yes	7.3	0	5.1	11.6	P value for
No	92.7	100	94.9	88.4	trend: 0.0533
MS (%) when waist >88cm					ns
Yes	6.1	0	3.9	10.1	P value for
No	93.9	100	96.1	89.9	trend: 0.0549

SBP- systolic blood pressure; DBP- diastolic blood pressure; BP- blood pressure; MS- metabolic syndrome

In the females under our study the mean serum glucose level was somewhat higher than that in the WOBASZ study, where in women aged 20-34 and 35-44 years its values were respectively 4,4 mmol/L and 4,7 mmol/L [20]. It should be noted that in our subjects glucose concentrations tended to increase with age. Besides, in older females impaired fasting glucose levels were found more often. Diabetes was present only in participants above 40 years of age. However, these differences were not statistically significant. Hypertension rate was 10,4%. There were no statistically significant differences between age groups. Prevalence of metabolic syndrome tended to increase with age, at borderline of statistical significance.

As it was mentioned in the introduction, excessive body mass and related metabolic disturbances are a great threat to procreative health. They may impair fertility, and also foster development of such pregnancy complications as hypertensive disorders of pregnancy and gestational diabetes. Besides, they may contribute to foetal macrosomia and increased risk of diabetes, arterial hypertension, lipid disorders and cardiovascular diseases in the child in adulthood.

The trends for increased rates of many of the described disorders with age is worrying in the light of the recently observed tendency of postponing decision about pregnancy that caused the mean age at childbirth to rise from 26.0 to 28.5 years in Polish mothers between 1980 and 2009. In this timespan the age of giving birth to the first child increased from 23.4 to 26.3 years [26]. Such tendency may result in increase in reproductive disorders. It seems that infertility is more prevalent now than it was several decades ago. However, there is no data available concerning this phenomenon. It is estimated that over a million of couples in Poland may be affected by this problem [18]. Similarly, there is no reliable data about prevalence of pregnancy complications, such as gestational diabetes and hypertensive disorders of pregnancy in Poland. It is assessed that gestational diabetes in various populations occur in 1-14% pregnancies [2]. Hypertensive disorders of pregnancy in the United States is observed in 12% pregnancies [7]. For the latter, such high rates may be related to the great prevalence of overweight and obesity in the population of American women.

Macrosomia in the newborn is one of the complications observed in obese mothers. Between 1992 and 2012, percentage of newborns with high body mass (i.e. ≥4000 g) increased from 7.7% to 10.8% [19]. However, these data should be taken with caution, as the definition of a live birth was altered in 1994. Nonetheless, high body mass in newborns is common in Poland what gives

cause of concern about the risk of complications in later adult life, such as type 2 diabetes, arterial hypertension and cardiovascular diseases.

It should be emphasised that the epidemic of overweight and obesity, that is observed in the last decades, is a rising phenomenon on the global scale [9]. One of its causes may be intrauterine programming of the risk of metabolic disorders through epigenetic mechanisms that pass on a predisposition for obesity to subsequent generations. The study thereby demonstrates the need for monitoring overweight in women of childbearing age.

CONCLUSIONS

1. Overweight and obesity, especially of abdominal type, are common in women at procreative age living in Warsaw.
2. Prevalence of disorders of lipid and glucose metabolism, and also arterial hypertension and MS is also high in this population.
3. Many of these disorders tend to increase with age, so there is a need for their monitoring in women of childbearing age.

Conflict of interest
The authors declare no conflict of interest.

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