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Short Communication

Comparison of Incidence of Cardiovascular Risk Factors and Selected Indices of Vascular Endothelium Status in Women Aged 40-60

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Abstract

The aim of our study was to compare cardiovascular risk factors and selected indices of vascular endothelium status in women aged 40-60, inhabiting urban (86 women) and rural (72 women) areas. In women inhabiting rural regions compared with urban dwellers, a significantly lower incidence of metabolic syndrome was found (31.7% vs. 66.7%) as well as higher waist circumference (92.65±13.56 vs. 86.25±13.56 cm), lower values of rest heart rate (60.8±8.2/min. vs. 64.5±9.3/min.), less frequent occurrence of increased values of diastolic blood pressure (14.8% vs. 24.4%), raised peptide C serum levels (48.5% vs. 57.1%), and higher IGF BP1 serum values (7.94±6.84 vs. 6.97±8.41 ng/ml). Despite the differences in distribution of metabolic syndrome and obesity in postmenopausal women inhabiting rural and urban areas in the Lublin region, there were no significant differences in selected indices of vascular endothelial status.

Keywords: cardiovascular risk factors, C-reactive protein, metalloproteinase-8, -9, tissue inhibitor of metalloproteinase-1, tumor necrosis factor, insulin, growth-factor–binding-protein, adiponectin, intercellular adhesive molecule-1, sex hormone binding globulin

Introduction

Cardiovascular diseases are a threat to women's health and life (similarly to men's), as they are still the main reason of deaths both in the USA and developed European countries. About 55% of all women's deaths are for cardiovascular reasons, which may result from the aging of societies [1, 2].

In Poland, age-adjusted indices of mortality because of cardiovascular disease are lower than those in highly developed countries where they range from 400 to 500/100,000 people. In Poland the indices are lower in women than in men of the same age. In 1998-2003 they were 121.8-450.8/100,000 for men aged 45-64. For women, however, only in the next decade (i.e. between 66-74 years of age) did they reach a similar value to that in men – 282-386.2/100,000. In the period between 1998 and 2003 a general downward trend was observed in Poland and other countries both for men and women, except for 2003, when a break in the downward trend line was observed [3, 4]. Menopause is a recognized cardiovascular disease risk factor. In postmenopausal women, regardless of age, the incidence of cardiac infarcts is three times higher [1].

Risk factors of cardiovascular system diseases such as arterial hypertension, dyslipidemias, obesity, insulin resistance, and metabolic syndrome are much more frequent and intensified in the perimenopausal period, which determines a greater risk of cardiovascular disease development in women at that stage of life [5].

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From epidemiological studies in Ford's meta-analysis [6] it appears that the presence of metabolic syndrome increases the death risk for cardiovascular reasons by 12-17%, and for general reasons by 6-7%; with concomitant diabetes the death risk is increased by 30-52% [6]. The progressing growth in metabolic syndrome incidence in Poland and other countries can be a reason for the higher incidence of cardiovascular disease. In the metabolic syndrome, visceral fatty tissue plays an important role. It is the source of many active substances, e.g. adiponectin, TNF-α, and leptin. The substances secreted by fatty tissue – atherogenic lipidemia, arterial hypertension, and glucose intolerance – can participate in vascular endothelium metabolism, leading to early atherosclerotic changes [7-9].

The incidence of risk factors and indices of inflammatory process intensification in the course of atherosclerosis can be different in various age and professional groups, and one determinant of these differences can be the dwelling and work place defining the life environment of the patient.

Progressive civilization, changes in living conditions in the city and in the country, changes in dietary habits, and level of education can contribute to the frequency of occurrence of cardiovascular disease risk factors in urban and rural areas [10-12].

Efficient prophylactic activities should be directed at the elimination of risk factors such as hypertension, obesity, and lipid and carbohydrate disorders although it seems essential to find the factors that would predict the future possibility of cardiovascular episode occurrence. Such a role could be played by the markers of atherosclerotic process intensification.

The aim of our work was to compare the incidence of cardiovascular risk factors among women of 40-60 years old – city dwellers with the inhabitants of rural areas situated around a big city. Simultaneously, the influence of cardiovascular risk factors on the condition of vascular endothelium was assessed on the basis of determining in blood the factors participating in the inflammatory atherosclerotic process.

Experimental Procedures

A group of 158 women aged 40-60, including 86 (54.1%) women (group 1) from the city of Lublin (population nearly 500,000) and 72 (45.9%) women (group 2) from rural areas situated within a 50-kilometre radius of Lublin. The average age of group 1 women was 51.4±4.9 and group 2 women – 52.8±4.8 years; the differences were statistically insignificant. We separated these groups during the population research from rural areas of Lubelszczyzna (Lublin Region) in Poland from 758 patients participating in the population examination – chosen at random.

The criteria of exclusion from the studies were the following: acute cardiovascular episodes in history, organic heart diseases, diagnosed diabetes, other systemic organic diseases.

In the studied women, a physical examination was carried out and the data were registered in a questionnaire. The questionnaire contained information about current ailments and earlier diagnosed diseases, earlier and current treatment, and gynecological history (last menstruation date; menopause duration was established), plus bad habit data: cigarette smoking (habit duration, number of cigarettes smoked per day; if the patient did not smoke – since when), and alcohol consumption (amount and kind of alcohol). A physical examination was carried out and the results were also registered in the questionnaire. During two visits to a doctor, systolic pressure (RRs) and diastolic pressure (RRd) were taken twice each time. The levels of pressure were classified as average. Hypertension was diagnosed for RRs≥140 mm Hg and/or RRd≥90 mm Hg or earlier diagnosed.

In all investigated patients, 24-hour blood pressure monitoring by the Holter method was performed. Measurements of systolic and diastolic blood pressure during the day were performed 3 times per hour and at night twice per hour. During the day the values of RRs≥135 mm Hg, RRd≥85mm Hg, at night: RRs≥120 mm Hg, RRd≥70 mm Hg were assumed as elevated [13]. The obtained study results were worked out by the OXFORD computer program. Body mass index (BMI) and waist-hips ratio (WHR) were calculated. Lipidograms (LDL: cholesterol-LDL, HDL: cholesterol-HDL, TG: triglycerides) were performed on the basis of enzymatic method using bioMerieux tests, taking fasting blood. Glucose levels in blood in the fasting state were determined using the enzymatic method with glucose oxidase. The fibrinogen level in blood was marked using the coagulation metod and SYS-MEX-CA560. The C-reactive protein (CRP) in blood was examined by employing the turbidimetric quantitative method (highly sensitive) and using Konelab 301. The levels of metalloproteinase 8, 9 (MMPs-8, MMPs-9), tissue inhibitor of metalloproteinase 1 (TIMP-1) and the tumor necrosis factor –TNFα, adiponectin, growth factor binding protein-1 (IGFBP-1), and C-peptide were determined using the immunological test and the ELISA method. Sex hormone binding globulin (SHBG) levels in blood were determined using the IRMA method by means of gamma radiation meter Berthold Technologies LBIS 50. The levels of insulin were determined using the immunological test and the ELISA method. The plate is first read at 450 nm against a reference filter set at 650 nm (or 630 nm). Insulin resistance (IR) was calculated according to HOMA: IR = {fasting insulin level (μIU/ml) x fasting glycaemia level (mmol/l)}/22.5 [14]. The index IR>2.7 was assumed as insulin resistance. Metabolic syndrome was diagnosed on the basis of the following criteria: waistline≥80cm and additionally two out of four cardiovascular risk factors – the concentration of fasting glucose in the blood >100 mg/dl, arterial pressure RR>135/80 mm Hg (an average measurement was registered both times, arterial blood pressure after rest was taken) or hypertension diagnosed earlier, HDL-cholesterol concentration in blood (HDL)<50 mg/dl, triglycerides (TG) concentration >150 mg/dl (International Diabetes Federation) [14, 15].

Table 1. A comparison of mean lipid concentrations, adiponectin, insulin-like growth factor, sex hormone binding globulin, and obesity indices and insulin resistance in groups 1 and 2.

Parameter	group 1	group 2	A		B	
	Mean±SD	Mean±SD	Wald's χ^{23}	OR 95% CI	Wald's χ^2	OR 95% CI
LDL-cholesterol (mg/dl)	141.62±39.99	142.19±39.16	0.09	1.00 0.99-0.09	0.09	1.00 0.99-1.01
HDL-cholestrol (mg/dl)	62.26±16.25	59.65±12.55	1.16	0.99 0.97-1.01	1.033	0.99 0.97-1.01
Triglycerides (mg/dl)	119.20±73.40	121.66±61.40	1.25	0.99 0.99-1.01	1.64	0.60 0.27-1.32
Fgl (mmol/l)	4.89±15.20	4.65±28.16	1.73	1.36 0.86-2.16	2.33	1.46 0.90-2.37
BMI (kg/m2)	26.71±4.55	28.62±5.87	4.49*	1.08 1.01-1.15	4.37	1.08 1.00-1.15
Waistline (cm)	86.25±13.56	92.65±13.56	2.09*	1.03 1.00-1.05	4.31*	1.03 1.00-1.05
WHR	0.828±0.065	0.831±0.067	0.30	2.19 0.01-413.14	0.17	2.99 0.01-622.93
Insulin µIU/ml (450/630)	17.75±8.97	17.62±12.61	0.003	0.99 0.96-1.04	0.001	1.00 0.96-1.05
Insulin µIU/ml (490/630)	16.50±8.55	16.80±13.00	0.12	0.02 0.90-1.00	0.04	1.01 0.96-1.05
HOMA (450/630)	3.71±1.75	3.64±2.53	0.05	1.03 0.83-1.29	0.05 0.21	1.03 0.82-1.29
HOMA (490/630)	3.44±1.66	4.14±3.75	0.17	1.05 0.84-1.31	0.14 0.37	1.04 0.83-1.31
SHBG nmol/l	56.30±36.29	56.71±34.99	0.18	1.00 0.99-1.01	0.30	1.00 0.99-1.01
Adiponectin µg/ml	7.19±3.22	7.87±5.80	0.53	1.0 0.94-1.12	0.92	1.06 0.94-1.21
IGF BP 1 ng/ml	6.97±8.41	7.94±6.84	2.22	1.09 0.97-1.23	1.85	1.08 0.97-1.21

group 1 – urban inhabitants, group 2 – rural inhabitants
A – Comparison of studied groups regardless of age, B – Age-adjusted comparison of studied
*p<0.05, OR – odds ratio, 95 % CI-95% confidence intervals
BMI – body mass index (kg/m^2), Fgl- Fasting blood glucose, WHR – waist/hips ratio, HOMA – IR–Insulin resistance={fasting insulin level (µIU/ml) x fasting glycemia level (mmol/l)}/ 22.5, (450/630) (490/630) insulin level – read at 450 nm or 630 nm a reference filter, SHBG – sex hormone binding globulin, IGF BP 1 – growth factor binding protein-1.

Statistical Analysis

The data are presented as mean±SD, unless stated otherwise. Results were subject to statistical analysis using the Statistica 5.0 computer program. To compare mean values the parametric Student t-test and ANOVA test were used. Nonparametric data were compared using χ^2 test. The studied groups were compared using logistic regression method, calculating Wald's χ^2, odds ratio – OR and 95% confidence intervals (95% CI). In the statistical workout of the material factors influencing the compared parameters such as age, medication, menopause, and cigarette smoking were taken into account.

Results

The studied groups of women inhabiting urban areas (group 1) and rural areas (group 2) significantly differed in education level (OR=2.45 [95 % CI 1.67-4.38], p<0.01). In group 1, 26.8% of the women had a higher education, 58.2% secondary education, and 14.9% a primary education. However, in women from rural areas 11.1% had a higher education, 48.2% secondary education, and primary education 38.8%.

Group 1 had 22 smokers and 32 ex-smokers (17 women had stopped smoking longer than 5 years before), the others never smoked. Group 2 included 17 smokers and 20 ex-

Table 2. Comparison of mean values of systolic and diastolic blood pressure, pulse pressure, percentage of raised values of systolic and diastolic blood pressure, and heart rates in groups 1 and 2.

Parameters	group 1	group 2	A		B	
	Mean±SD	Mean±SD	Wald's χ^2 p	OR 95% CI	Wald's χ^2 p	OR 95% CI
DRRs (mm Hg)	124.7±12.7	124.0±13.1	0.15	0.60 0.99-1.03	0.05	1.00 0.97-1.03
DRRd (mm Hg)	77.3±9.7	75.6±9.2	0.72	0.98 0.94-1.02	0.26	0.99 0.95-1.03
NRRs (mm Hg)	109.2±17.8	109.0±14.2	0.12	1.00 0.98-1.03	0.03	1.00 0.98-1.02
NRRd (mm Hg)	67.9±8.8	65.2±10.2	1.04	0.98 0.94-1.02	0.87	0.98 0.94-1.02
DPP (mm Hg)	46.7±7.2	48.3±7.6	0.92	1.03 0.97-1.09	0.55	1.02 0.96-1.08
NPP (mm Hg)	42.8±6.5	44.0±7.4	1.75	1.04 0.98-1.10	1.16	1.03 0.97-1.10
DHR	73.9±10.3	72.4±11.2	0.09	0.99 0.96-1.03	-0.07	1.00 0.96-1.04
NHR	64.5±9.3	60.8±8.2*	3.74 p=0.05	0.95 0.97-1.00	2.70	0.957 0.91-1.01
%DRRs	22.0±21.1	16.7±21.8	2.58	0.98 0.96-1.00	2.76 p=0.09	0.98 0.96-1.00
%DRRd	24.4±25.2	14.8±20.3	4.19 p=0.04	0.98 0.96-1.00	3.56 p=0.05	0.98 0.96-1.00
%NRRs	32.0±30.3	23.5±30.0	0.92	0.99 0.98-1.01	2.76 p=0.09	0.98 0.96-1.00
%NRRd	20.8±24.3	15.4±25.6	0.74	0.99 0.98-1.01	3.57 p=0.05	0.98 0.96-1.0

group 1 – urban inhabitants, group 2 – rural inhabitants
A – Comparison of studied group regardless of age, B – Age-adjusted comparison of studied groups
OR – odds ratio, 95% CI-95% confidence intervals
DRRs – daytime systolic blood pressure, DRRd – daytime diastolic blood pressure, NRRs – systolic blood pressure at night, NRRd – diastolic blood pressure at night, DPP – daytime pulse pressure, NPP – pulse pressure at night, DHR – daytime heart rate, NHR – heart rate at night, %DRRs – percentage of increased values of daytime systolic pressure (≥135 mm Hg), %DRRd – percentage of increased values of daytime diastolic pressure (≥85 mm Hg), %NRRs – percentage of increased values of systolic pressure at night (≥120 mm Hg), %NRRd – percentage of increased values of diastolic pressure at night (≥70 mm Hg).

smokers (18 women had stopped smoking longer than 5 years before): the others had never smoked. Differences between the groups were statistically insignificant. In group 1 average numbers of cigarettes smoked per day (12.07±9.56) and habit duration (19.87±7.43 years) did not differ compared with group 2 (number of cigarettes smoked per day 13.82±10.20, habit duration – 17.29±9.41 years). No statistically significant differences were found.

Metabolic syndrome was more frequent in a statistically significant way in group 1 (66.7%) compared with group 2 (31.7% women) (OR=2.94 [95% CI 1.27-6.80], p=0.01). Odds ratio is similar after considering the influence of age and cigarette smoking (OR=2.98 [95% CI 1.26-7.05], p=0.01).

A comparison of lipid concentrations in blood serum, obesity indices and insulin resistance in goups 1 and 2 is presented in Table 1.

The age-adjusted incidence of metabolic disorders was similar in both groups: LDL>130mg/dl in group 1 – 56.8%, group 2 – 56.7% (OR=0.87 [95%CI 0.44-1.73]), HDL<50 mg/dl in group 1 – 28.4% , group 2 – 24.2% (OR=1.47 [95% CI 0.68-3.17]), triglycerides >150 mg/dl in group 1 – 29.6%, group 2 – 23.9% (OR=0.64 [95% CI 0.29-1.38]). Four women from group 1 were taking statins. Group 2 did not include patients taking statins.

When comparing groups 1 and 2, the levels of LDL cholesterol and MMP-8 levels are taken into consideration, the odds ratio of both raised (>130 mg/dl) LDL cholesterol level (OR=0.98 [95% CI 0.96-1.00]) and of MMP-8 level (OR=1.06 [95% CI 0.99-1.13]) will be close to 1; the differences between the groups will not be statistically significant. The odds ratio does not change and is also close to 1 when we consider the influence of age and cigarette smok-

Table 3. Comparison of the activity of extracellular matrix enzymes, cytokines system, and indices of vascular endothelium inflammation in blood serum in groups 1 and 2.

Parameters	group 1	group 2	A		B	
	Mean±SD	Mean±SD	Wald's χ^2	OR 95% CI	Wald's χ^2	OR 95% CI
TNF-α (pg/ml)	8.55±17.78	5.43±3.08	0.47	0.97 0.89-1.06	0.51	0.96 0.85-1.08
MMP-8 (ng/ml)	11.38±6.22	14.74±8.15	3.29 p=0.06	1.06 0.99-1.13	3.04 p=0.08	1.06 0.99-1.13
CRP (mg/l)	2.03±1.93	1.84±1.53	0.42	0.94 0.76-0.15	0.79	0.91 0.74-1.12

group 1 – urban inhabitants, group 2 – rural inhabitants
A – Comparison of studied groups regardless of age, B – Age-adjusted comparison of studied groups
OR – odds ratio, 95% CI-95% confidence intervals
TNF-α – Tumor Necrosis Factor –α, MMP-8 – Metalloproteinase-8, CRP – C-Reactive Protein

ing (for LDL (OR=0.98, 95% [CI 0.96-0.99], for MMP-8 level: (OR=1.06 [95 % CI 0.99-1.13]).

The studied groups did not, however, differ in terms of the incidence of waistline>80 cm (in group 1 – 64.9%, group 2 – 74.99%) (OR=1.44 [95% CI 0.71- 2.95]). The odds ratio also does not change when age-adjusted (OR=1.36, [95 % CI 0.65-2.83]).

The studied groups did not statistically differ in terms of obesity and overweight incidence, estimated on the basis of BMI. 45% of group 1 were overweight (BMI 25-29.9 kg/m^2) 13.6% were obese (BMI ≥30 kg/m^2). 41.5 of group 2 were overweight, whereas 25% were obese (OR=1.47 [95 % CI 0.88-2.45]).

Fasting glucose concentration in blood>100 mg/dl was found in 20.24% women in group 1 and in 24.64% of group 2; the differences were not statistically significant (OR=1.98 [95% CI 0.80-4.91], p=0.138). When age adjusted, the odds ratio was slightly greater and the differences were close to statistical significance (OR=2.31 [95 % CI 0.90-5.96] p=0.07).

Among country women compared with those living in a big city, there were no statistically significant differences in the incidence of being raised above 12.0 µIU/ml fasting insulin level (39.4% vs. 63%) (OR=0.59 [95% CI 0.23-1.53]). The odds ratio did not significantly change when adjusted for age (OR=0.63 [95% CI 0.24-1.64]).

In the studied groups the percentage of patients with insulin resistance calculated using HOMA index was similar (in group 1 – 60.9%, group 2 – 51.5%). The odds ratio did not change after considering the influence of age (OR=1.82 [95% CI 0.67-4.73]).

When comparing group 1 and 2, the age-adjusted incidence of raised levels of fasting glucose>100 mg/dl and IGF BP1 level, the statistically significant differences between the groups will concern the incidence of glucose level >100 mg/dl (OR=8.21 [95% CI 1.43-47.04], p=0.02), for IGF BP 1. However, the odds ratio will be about 1. The differences between group 1 and group 2 in the incidence of BMI groups, HOMA index and IGFP1 level, when age adjusted, will be statistically significant to the similar extent both for BMI (OR=3.23 [95% CI 1.31-7.95], p=0.0094) and for IGF BP1 in blood serum (OR=1.28 [95% CI 1.060-1.54], p=0.009). If instead of the BMI group the waistline will be the studied parameter, the odds ratio for waistline will be about 1 (OR=1.08 [95% CI 1.02-1.015], p=0.01), the odds ratio for IGF BP1 level will be slightly greater (OR=1.27 [95% CI 1.06-1.53], p=0.01).

C-peptide level in blood serum was 942.82±668.19 pmol/l in group 1, 803.82±846.72 pmol/l in group 2; the differences were not statistically significant.

The studied groups did not differ in the incidence of C-peptide concentration in blood serum above 600pmol/l (in group 1 – 57.1%, group 2 – 48.5%) (OR=1.73 [95% CI 0.68-4.42]). When age-adjusted, the odds ratio remained the same (OR=1.72 [95 % CI 0.67-4.40]).

Comparing the incidence of raised C-peptide levels and percentage of daytime raised systolic pressure values, statistically significant differences were found between the studied groups for the raised values of C-peptide (OR=4.21 [95% CI 1.04-17.04], p=0.04). The age-adjusted odds ratio is not changed (OR=4.12 [95% CL 1.01-16.88], p=0.04).

The occurrence of adiponectin in blood below 7µg/ml was 63.2% in group 1, 45.7% in group 2. When age adjusted, the odds ratio is close to 1 (OR=0.97 [95% CI 0.36-2.63]); the differences are statistically insignificant.

Table 2 contains the comparison of systolic and diastolic blood pressure, pulse pressure, and heart rate in groups 1 and 2.

The incidence of hypertension was high in both groups (in 58.3% group 1, in 65.2% group 2) (OR=1.67 [95% CI 0.73-3.82], p=0.22).

Having taken into account the influence of age and cigarette smoking, the differences in the incidence of arterial hypertension were close to statistical significance (OR=2.19 [95% CI 0.86-5.53], p=0.09).

In group 1, 19 patients were taking medication for hypertension (16, blockers of converting enzyme; angiotensin II receptor type 1 (AT1) antagonist, 16, beta blockers), in group 2, 14 patients were treated for hypertension (12 with converting enzyme blocker, angiotensin II receptor type 1 (AT1) antagonist, 8 with beta blocker). The differences between studied groups in the incidence of hypertension medication use were not statistically significant (OR=1.28 [95% CI 0.59 - 2.77]).

The comparison of activity of TNF-α, MMP-8, and CRP in blood serum in groups 1 and 2 are shown in Table 3.

In group 1, CRP>5mg/l was found in 8.2%, in group 2, 14.3%. These differences did not reach the level of statistical significance when age and cigarette smoking was considered (OR=0.93 [95 % CI 0.75-1.16]).

In group 1, MMP-9 level (ng/ml) was 168.70±129.52; in group 2, 155.22±136.20. TIMP-1 level (ng/ml) in group 1 was 219.45±67.03, in group 2, 225.37±76.00. sICAM-1 level (ng/ml) in group 1 was 339.71±108.98, in group 2, 325.56±88.32. The differences in the parameters between the groups were not statistically significant. Fibrinogen level (mg/dl) in group 1 was 328.23±151.25; in group 2, 421.25±89.15, p=0.044. The comparison in groups 1 and 2 of MMP-9, TIMP-1, sICAM-1, and fibrinogen level in the logistic regression equation was impossible due to uncertain estimations.

Among country women compared with those living in a city, we found a statistically insignificantly less frequent occurrence of elevated values of diastolic pressure (14.8% vs. 24.4%), the odds ratio is close to 1 (OR=0.98 [95% CI 0.96-0.99]), also when age and cigarette smoking were taken into account (OR=0.98 [95 % CI 0.96-1.00]).

Among country women compared with those living in a city, we found statistically significantly lower values of heart rate at rest (60.8±8.2/min vs. 64.5±9.3/min) (OR=0.90 [95%CI 0.83-0.99], p=0.02). When we considered age and cigarette smoking, the odds ratio was unchanged (OR=0.90 [95 % CI: 0.82-0.99], p=0.03).

Discussion of Results

The incidence of risk factors of ischaemic disease is still very high in Polish society, although in the last few years the tendency for growth in mortality and morbidity because of acute coronary episodes was inhibited [3]. Many population studies showed that abdominal obesity, insulin resistance, and metabolic syndrome are among the classic cardiovascular risk factors [16, 17]. One of the factors that could influence their incidence is the dwelling and work place, determining the lifestyle, dietary habits, or type of employment. The groups of women from urban and rural areas that we studied differed in terms of employment, as the percentage of women with higher or secondary education was considerably lower in the group of women living in the country. This fact can significantly influence differences in life- and workstyle in the studied groups, and, in consequence, the presence of cardiovascular risk factors. The argument for the existence of such differences can be the statistically significant differences that we found in the average heart rate at rest and behaviour of arterial blood pressure in the Holter study in both groups. In the studied population, average values of diastolic blood pressure and heart rate at night were significantly higher in city inhabitants, which may be connected with higher activity of the adrenergic nervous system, being a response to industrialization, stress, pace of life, and sedentary position.

The group of women aged 40-60 that was the subject of our studies is special, because at that stage of life hormonal changes occur that are evidence for or the cause of considerable metabolic disorders, hiperlipidemia, obesity and, as a result of these changes, the incidence of cardiovascular episodes is increased [18, 19].

In our studied population of women aged 40-60 the incidence of classic risk factors (obesity, overweight, hypertension, metabolic syndrome) is very high, higher than that observed in Lublin in the WOBASZ study [20, 21]. About 60% of women in both studied groups have arterial hypertension. Over half of them have lipid disorders, and more than 60% are obesite or overweight. The incidence of abdominal obesity is particularly high in women living in the city, as it concerns almost 70% of the studied women; a slightly lower percentage (although the differences are not statistically significant) occurs in rural areas. Overweight, obesity, or atherogenic lipid profile incidences are not, as could be expected, significantly lower among the women from the country in our study.

The assessment of metabolic syndrome incidence among women from rural and urban areas of the Lublin Region resulted in completely different findings. Their discussion seems to require some methodological comments. In epidemiological studies three definitions of the metabolic syndrome exist. They are: the definition worked out by Cholesterol Education Program (NCEP) ATPIII, the altered NCEP definition, and the definition of the International Diabetes Federation (IDF), developed in 2005.

Li et al. [22], when studying hypertensive patients, found that it is just the presence of a metabolic syndrome defined in accordance with the IDF crtiteria that shows the strongest connection with ischaemic heart disease.

Each of the consecutively developed definitions is more sensitive and, simultaneously, more specific, although their changes and consequent changes in the diagnostic criteria for the metabolic syndrome prove the necessity of improving the notion and a better understanding of metabolic disorders [21, 22]. Changes in the criteria of metabolic sydrome diagnosis cause difficulties in comparing the incidence of metabolic syndrome in various populations. In addition, the incidence of metabolic syndrome depends on the age of the studied patients [23, 24].

In our studied group of women aged 40-60, metabolic syndrome, diagnosed on the basis of the IDF definition (2005) occurred less frequently among women from rural areas compared with women from a city. In the urban population the mentioned criteria for metabolic syndrome diagnosis were fulfilled by a significantly larger number of people (over 66%) compared with people from the country (about 31%).

Similar differences in the incidence of metabolic syndrome in cites and in the country have been presented by other authors [24-26]. Das et al. [27] observed a higher incidence of metabolic syndrome among studied women from India over 30 years of age in cities (56.2%) compared with a rural population (36.4%) [28]. In the studies of Ramirez-Vargas [25] including people aged 35-65, the metabolic syndrome diagnosed on the basis of the same criteria as ours, occurred twice as often in the city (45.4%) compared with the country (27%).

From the definition of the metabolic syndrome, it appears that insulin resistance determination is not necessary to diagnose it, although in many papers such verification is reported. Fasting insulin concentrations in blood serum over 12 μIU/ml among women from the country were observed less often (about 40%) compared with the city women (63%). However, the incidence of insulin resistance calculated on the basis of HOMA (HOMA index >2.7) was high among city women and country women and concerned over half of them. Statistically significant differences in the incidence of insulin resistance, depending on the place of life and work of the studied women, were not found. Similarly, no significant differences were found in the incidence of high values (over 600 pmol/l) of C-peptide in blood, although in city and country women this index of insulin resistance and hyperinsulinemia also concerned about half of the studied women (57.1% vs. 48.5%). The role of C-peptide was described by Haban et al. [29] in the study of postmenopausal women with type 2 diabetes. The authors observed the relationship of the elevated concentration of C-peptide in blood with the atherogenic lipid image and obesity, suggesting that C-peptide level is a clinically important marker of cardiovascular complications and early diabetes diagnosis.

The reverse influence that diminishes insulin resistance and, at the same time, has a beneficial antiatherogenic effect and a protective one against cardiovascular diseases, are produced by an increase in the concentration of endogenous adiponectin, whose source is mainly fatty tissue, and also higher concentrations of SHBG and IGFBP-1. The cooperation of these compounds depends on the volume of the fatty tissue, especially abdominal, which is metabolically active (more so than subcutaneous fatty tissue) [30, 31]. In our studies we observed a lower incidence of the reduced adiponectin concentration (below 7 μg/ml) in the rural population (about 46%) compared with the urban population (over 63%), although the differences were statistically insignificant. Wang et al. [32] studied the relationship between blood serum adiponectin and metabolic syndrome in the Chinese population of men and women from the city and the country. The blood serum adiponectin level was higher among women compared with men from rural areas, and also with city inhabitants. The incidence of metabolic syndrome increased together with the decrease in adiponectin level. The protective effect of adiponectin against insulin resistance has recently been described in many studies [31, 33].

Endogenous indices of insulin resistance are also SHBG and IGF-BP-1 levels [10, 34, 35], whose average levels were similar in the studied groups of women from the city and the country. There is a significant relationship of lipid levels and SHBG level in blood serum. Low SHBG levels correlate with visceral obesity and atherogenic lipid profile, which we observed in our earlier studies of patients with metabolic syndrome [36]. Similar results are reported by other authors [10, 28]. In the studies of Kaiaj et al. [19], insulin-resistant women showed a higher BMI, higher free androgen index, and lower values of SHBG and HDL, which suggests that SHBG can be an insulin resistance marker in obese women.

The excess of visceral fat leading to insulin resistance, lipid metabolism disorders, and atherogenic lipidogram profile, also induces the weakening of coagulation and fibrinolysis processes. Metabolically active abdominal fatty tissue is the source of a number of compounds of significant importance to the cardiovascular risk. Proinflammatory substances can be the indices of a chronic atherosclerotic process [37, 38]. In our studies we observed a similar activity of proinflammatory compounds (TNF-α, MMP-9, TIMP-1, ICAM-1, CRP) in the group of women from the city and the country. Only the average MMP-8 level was higher in patients from rural areas and close to statistical significance. Similar population studies concerning a comparison of the endothelium function on the basis of those markers in women from urban and rural areas were not found in literature. Only studies of men, carried out by Yajnik et al. (Coronary Risk of Insulin Sensivity in Indian Subjects Study – CRISIS) [39] were aimed at the comparison of the incidence of insulin resistance, obesity, glucose tolerance disorders, beta cells activity, and inflammatory factors in the urban and rural populations. They showed the prevalence of insulin resistance indices and a greater activity of inflammatory factors (interleukin-6 and CRP) among the studied city inhabitants. The TNF-α activity was similar in all the studied groups, as in our population of women [39].

The results of our studies are in accordance with those obtained by other authors in relation to lower incidences of metabolic syndrome in the population of country women. Other authors have found the presence of higher adiponectin concentrations in country women [32, 38]. Despite those differences, the index of insulin resistance, adiponectin and C-peptide concentration in blood, incidence of obesity, and atherogenic lipid profile did not significantly differ in both studied groups. Unlike other authors, we did not observe lower concentrations of TNF-α and CRP in the rural population, or significant changes in the activity of metalloproteinases, their tissue inhibitor, adhesive molecule, or the SHBG content in blood.

The results of our studies point to a complex and diverse image of cardiovascular risk factors in urban and rural areas which, despite existing differences, do not seem to cause fundamental, essential changes in the indices of intensification of destructive processes in the vascular wall.

Conclusions

1. The incidence of metabolic syndrome, insulin resistance factors such as the incidence of increased levels of fasting C peptide, higher average levels of IGF BP1, and significantly lower average heart rate and percentage of increased values of diastolic blood pressure at

night were among women from rural areas compared with the inhabitants of a big city, which suggests a lower adrenergic system activity in rural women compared with those from a city. The observed differences appear to be connected with the lifestyle resulting from industrialization.

2. The incidence of atherogenic lipid profile (LDL>130 mg/dl, HDL<50 mg/dl, triglycerides >150 mg/dl), abdominal obesity, insulin resistance (HOMA>2.7), and hypertension did not significantly differ among inhabitants from the country or the city.
3. Serum concentrations of factors participating in the active inflammatory atherosclerotic process of vascular endothelium (TNF-α, MMP-9, TIMP-1, ICAM-1, CRP) in women without clinically manifested atherosclerotic symptoms (except for MMP-8, whose concentration in blood was significantly higher among rural women) did not significantly differ in the studied groups of women from the country and the city.

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References

1. AMERICAN HEART ASSOCIATION. HEART Disease and Stroke Statistics – 2003 Update. Dallas, T.X.: American Heart Association, **2002**. (http://www.americanheart.org/downloadable/heart/10590179711482003HDSStatsBookREV7-03.pdf)
2. KROMHOUT D. Epidemiology of cardiovascular diseases in Europe. Public Health Nutr. **4**, 441, **2001**.
3. JASIŃSKI B. Cardiovascular mortality in Poland in 1997 – 2003. Department of Epidemiology, Cardiovascular Disease Prevention and Health Promotion, Institute of Cardiology, Warsaw **2005**.
4. RYWIK S.L., PIOTROWSKI W., RYWIK T.M., BRODA G., SZCZEŚNIEWSKA D. Is the decrease of cardiovascular mortality in Poland associated with the reduction of global cardiovascular risk related to changes in life style? Kardiol Pol. **58**, 344, **2003**.
5. MATTHEWS K.A., CRAWFORD S.L., CHAE C.U., EVERSON-ROSE S.A., SOWERS M.F., STERNFELD B., SUTTON-TYRRELL K. Are changes in cardiovascular disease risk factors in midlife women due to chronological aging or to the menopausal transition? J Am Coll Cardiol. **54**, 2366, **2009**.
6. FORD E. S. Risk for all-cause mortality, cardiovascular disease, and diabetes associated with the metabolic syndrome. A summary of the evidence. Diabetes Care, **28**, 1769, **2005**.
7. LIANG K.W., SHEU W.H., LEE W.L., LIU T.J., TING C.T., HSIEH Y.C., WANG K.Y., CHEN Y.T., LEE W.J. Decreased circulating protective adiponectin level is associated with angiographic coronary disease progression in patients with angina pectoris. Int J Cardiol. **129**, 76, **2008**.
8. BASTARD J.P., MAACHI M., LAGATHU C., KIM M.J., CARON M., VIDAL H., CAPEAU J., FEVE B. Recent advances in the relationship between obesity, inflammation, and insulin resistance. Eur Cytokine Netw. **17**, 4, **2006**.
9. BENTLEY-LEWIS R., KORUDA K., SEELY E.W. The metabolic syndrome in women. Nat Clin Pract Endocrinol Metab. **3**, 696, **2007**.
10. PUGEAT M., MOULIN P., COUSIN P., FIMBEL S., NICOLAS M.H., CRAVE J.C., LEJEUNE H. Interrelations between sex hormone-binding globulin (SHBG), plasma lipoproteins and cardiovascular risk. J Steroid Biochem Mol Biol. **53**, 567, **1995**.
11. KUMAR R., SINGH M.C., SINGH M.C., AHLAWAT S.K., THAKUR J.S., SRIVASTAVA A., SHARMA M.K., MALHOTRA P., BALI H.K., KUMARI S. Urbanization and coronary heart disease: a study of urban-rural differences in northern India. Indian Heart J. **58**, 126, **2006**.
12. OĞUZ A., TEMIZHAN A., ABACI A., KOZAN O., EROL C., ONGEN Z., CELIK S. Obesity and abdominal obesity; an alarming challenge for cardio-metabolic risk in Turkish adults. Anadolu Kardiyol Derg., **8**, 401, **2008**.
13. O'BRIEN E., ASMAR R., BEILIN L., IMAI Y., MALLION J.M., MANCIA G., MENGDEN T., MYERS M., PADFIELD P., PALATINI P., PARATI G., PICKERING T., REDON J., STAESSEN J., STERGIOU G., VERDECCHIA P. (European Society of Hypertension Working Group on Blood Pressure Monitoring). European Society of Hypertension recommendations for conventional, ambulatory and home blood pressure measurement. J Hypertens. **21**, 821, **2003**.
14. MUNIYAPPA R., LEE S., CHEN H., QUON M.J. Current approaches for assessing insulin sensitivity and resistance in vivo: advantages, limitations, and appropriate usage. Am J Physiol Endocrinol Metab. **294**, E15, **2008**.
15. ALBERTI K.G., ZIMMET P., SHAW J. The metabolic syndrome-a new worldwide definition. IDF Epidemiology Task Force Consensus Group. Lancet. **366**, 1059, **2005**.
16. GAMI A.S., WITT B.J., HOWARD D.E., ERWIN P.J., GAMI L.A., SOMERS V.K., MONTORI V.M. Metabolic syndrome and risk of incident cardiovascular events and death: A systematic review and meta-analysis of longitudinal studies. J Am Coll Cardiol. **49**, 403, **2007**.
17. SMITH S.C. JR, HASLAM D. Abdominal obesity, waist circumference and cardio-metabolic risk: awareness among primary care physicians, the general population and patients at risk – the Shape of the Nations survey. Curr Med Res Opin. **23**, 29, **2007**.
18. DAVIS C.E., PAJAK A., RYWIK S., WILLIAMS D.H., BRODA G., PAZUCHA T., EPHROSS S. Natural menopause and cardiovascular disease risk factors. The Poland and US Collaborative Study on Cardiovascular Disease Epidemiology. Ann Epidemiol. **4**, 445, **1994**.
19. KAJAIA N., BINDER H., DITTRICH R., OPPELT P.G., FLOR B., CUPISTI S., BECKMANN M.W., MUELLER A. Low sex hormone-binding globulin as a predictive marker for insulin resistance in women with hyperandrogenic syndrome. Eur J Endocrinol. **157**, 499, **2007**.
20. BIELA U., PAJĄK A., KACZMARCZYK-CHAŁAS K., GŁUSZEK J., TENDERA M., WAŚKIEWICZ A., KURJATA P., WYRZYKOWSKI B. Incidence of overweight and obesity in men and women aged 20-74. The results of WOBASZ Programme.. Kardiol. Pol., **63**, 6 S, 632, **2005** [In Polish].

21. WYRZYKOWSKI B., ZDROJEWSKI T., SYGNOWSKA E., BIELA U., DRYGAS W., TYKARSKI A., TENDERA M., BRODA G. Epidemiology of metabolic syndrome in Poland. The results of WOBASZ Programme). Kardiol. Pol. **63**, 6 S, 641, **2005** [In Polish].
22. LI W.J., XUE H., SUN K., SONG X.D., WANG Y.B., ZHEN Y.S., HAN Y.F., HUI R.T. Cardiovascular risk and prevalence of metabolic syndrome by differing criteria. Chin Med J. **121**, 1532, **2008**.
23. JANUS E.D., LAATIKAINEN T., DUNBAR J.A., KILKKINEN A., BUNKER S.J., PHILPOT B., TIDEMAN P.A., TIRIMACCO R., HEISTARO S. Overweight, obesity and metabolic syndrome in rural southeastern Australia. Med J Aust. **187**, 147, **2007**.
24. KOZAN O., OGUZ A., ABACI A., EROL C., ONGEN Z., TEMIZHAN A., CELIK S. Metabolic syndrome and associated lifestyles in adult males from Oaxaca, Mexico. Salud Publica Mex, **49**, 94, **2007**.
25. WENG X., LIU Y., MA J., WANG W., YANG G., CABALLERO B. An urban-rural comparison of the prevalence of the metabolic syndrome in Eastern China. Public Health Nutr. **10**, 131, **2007**.
26. DAS M., PAL S., GHOSH A. Rural urban differences of cardiovascular disease risk factors in adult Asian Indians. Am J Hum Biol. **20**, 440, **2008**.
27. RAMIREZ-VARGAS E., ARNAUD-VINAS MDEL R., DELISLE H. Prevalence of the metabolic syndrome and associated lifestyles in adult males from Oaxaca, Mexico. Salud Publica Mex, **49**, 94, **2007**.
28. LUKANOVA A., LUNDIN E., ZELENIUCH-JACQUOTTE A., MUTI P., MURE A., RINALDI S., DOSSUS L., MICHELI A., ARSLAN A., LENNER P., SHORE RE., KROGH V., KOENIG K.L., RIBOLI E., BERRINO F., HALLMANS G., STATTIN P., TONIOLO P., KAAKS R. Body mass index, circulating levels of sex-steroid hormones, IGF-I and IGF-binding protein-3: a cross-sectional study in healthy women. Eur J Endocrinol. **150**, 161, **2004**.
29. HABAN P., SIMONCIC R., ZIDEKOVA E., OZDIN L. Role of fasting serum C-peptide as a predictor of cardiovascular risk associated with the metabolic X-syndrome. Med Sci Monit. **8**, CR175, **2002**.
30. BURCHARDT P., GOŹDZICKA-JÓZEFIAK A., SIMINIAK T. IGF-1 a new risk factor for coronary atherosclerosis. Kardiol Pol. **64**, 1297, **2006** [In Polish].
31. LU J.Y., HUANG K.C., CHANG L.C., HUANG Y.S., CHI Y.C., SU T.C., CHEN C.L., YANG W.S. Adiponectin: a biomarker of obesity-induced insulin resistance in adipose tissue and beyond. J Biomed Sci. **15**, 565, **2008**.
32. WANG J., LI H., FRANCO O.H., YU Z., LIU Y., LIN X. Adiponectin and metabolic syndrome in middle-aged and elderly Chinese. Obesity. **16**, 172, **2008**.
33. ONAT A., HERGENC G., DURSUNOGLU D., KUCUKDURMAZ Z., BULUR S., CAN G. Relatively high levels of serum adiponectin in obese women, a potential indicator of anti-inflammatory dysfunction: relation to sex hormone-binding globulin. Int J Biol Sci. **4**, 208, **2008**.
34. GALLOWAY P.J., DONALDSON M.D., WALLACE A.M. Sex hormone binding globulin concentration as a prepubertal marker for hyperinsulinaemia in obesity. Arch Dis Child. **85**, 489, **2001**.
35. PETERSSON U., OSTGREN C.J., BRUDIN L., BRISMAR K., NILSSON P.M. Low levels of insulin-like growth-factor-binding protein-1 (IGFBP-1) are prospectively associated with the incidence of type 2 diabetes and impaired glucose tolerance (IGT): The Söderåkra Cardiovascular Risk Factor Study. Diabetes Metab. **35**, 198, **2009**.
36. MIECZKOWSKA J., BARUD W., KWAŚNIEWSKI W. The metabolic syndrome during the climacteric period. Obesity and Metabolism. **4**, 149, **2008**.
37. HSU L.A., KO Y.L., WU S., TENG M.S., CHOU H.H., CHANG C.J., CHANG P.Y. Association of soluble intercellular adhesion molecule-1 with insulin resistance and metabolic syndrome in Taiwanese. Metabolism. Metabolizm. **58**, 983. **2009**.
38. SZMITKO P.E. Adiponectin and cardiovascular disease: state of the art? Am J Physiol Heart Circ Physiol. **292**, H1655, **2007**.
39. YAJNIK C.S., JOGLEKAR C.V., LUBREE H.G., REGE S.S., NAIK S.S., BHAT D.S., URADEY B., RAUT K.N., SHETTY P., YUDKIN J.S. Adiposity, inflammation and hyperglycaemia in rural and urban Indian men: Coronary Risk of Insulin Sensitivity in Indian Subject (CRISIS) Study. Diabetologia. **51**, 39E, **2008**.