Kardiologia Polska 2012; 70, 7: 718–727 ISSN 0022–9032

ORIGINAL ARTICLE

Socioeconomic factors and the risk of metabolic syndrome in the adult Polish population: the WOBASZ study

Elżbieta Sygnowska, Aleksandra Piwońska, Anna Waśkiewicz, Grażyna Broda

Department of Epidemiology, Cardiovascular Disease Prevention and Health Promotion, Institute of Cardiology, Warsaw, Poland

Abstract

Background: Metabolic syndrome (MetS) increases the risk of cardiovascular disease and its development is determined by certain socioeconomic and lifestyle factors.

Aim: To investigate the impact of socioeconomic and lifestyle factors on the risk of MetS and the underlying contributing factors in the Polish population aged 20–74 years.

Methods: Between 2003 and 2005, as part of the National Multicentre Health Survey (WOBASZ, *Wieloośrodkowe Badanie Stanu Zdrowia Ludności*), a random sample of Polish residents aged 20 to 74 years was investigated. Data on sociodemographic and anthropometric parameters, blood pressure, lipid and glucose levels and medical history were collected. MetS was defined according to the criteria proposed by the American Heart Association/National Heart, Lung, and Blood Institute (AHA/NHLBI) and by the International Diabetes Federation (IDF) in 2005. Data necessary to evaluate MetS and the socioeconomic characteristics were obtained for 5940 men and 6627 women.

Results: MetS was identified in 26.0% of men and 23.9% of women according to the AHA/NHLBI definition, and in 30.7% of men and 26.8% of women according to the IDF definition. In both genders older age, higher body mass index and current smoking increased the risk of developing MetS, whereas higher physical activity and good self-rated health decreased the risk. Moreover, women with higher education and in the higher quartile of alcohol intake were associated with a lower risk of having MetS. Household per-capita income did not affect the risk of having MetS in either gender.

Conclusions: A relatively high percentage of individuals with MetS was observed in the Polish population aged 20 to 74 years. In both sexes, the risk of MetS and its contributing factors was significantly associated with age and the following lifestyle factors: body mass index, smoking, self-rated health and, additionally for women, higher education and alcohol intake.

Key words: metabolic syndrome, socioeconomic factors, lifestyle factors

Kardiol Pol 2012; 70, 7: 718–727

INTRODUCTION

Metabolic syndrome (MetS) is defined as a coexistence of interrelated metabolic risk factors, such as visceral obesity, high blood pressure and carbohydrate and lipid metabolism abnormalities. MetS increases the risk of cardiovascular disease, which continue to be the most common cause of death in industrialised countries, including Poland. Metaanalyses of prospective studies [1, 2] have shown that the risk of cardiovascular morbidity and mortality is 78–140% higher in patients with MetS compared to individuals without MetS.

The presence of MetS may be determined by many factors, including socioeconomic and lifestyle factors, which are usually interrelated. Individuals with a low level of education and of low socioeconomic status have been shown to be at a higher risk of MetS. They are usually characterised by incorrect dietary habits, low physical activity and a high rate of harmful habits, which all of which affect the higher risk of metabolic abnormalities [3–5].

Address for correspondence:
Elżbieta Sygnowska, MD, PhD, Institute of Cardiology, ul. Alpejska 42, 04–628 Warszawa, Poland, e-mail: esygnowska@ikard.pl
Received: 19.10.2010 **Accepted:** 21.12.2011

The aim of the study was to evaluate the impact of selected socioeconomic and lifestyle factors on the likelihood of developing MetS and its components in the Polish population aged 20 to 74 years.

METHODS

Study population

Between 2003 and 2005, as part of the National Multicentre Health Survey (WOBASZ, *Wieloośrodkowe Badanie Stanu Zdrowia Ludności*), a random sample of Polish residents aged 20 to 74 years was investigated. The details of the selection of the sample have been published previously [6]. Briefly, a sample of 19,200 people was randomly drawn, 17,622 people were available for the study (change of address, death of the respondent) and 13,545 people reported for the study (6,392 men and 7,153 women). Evaluable data were available in the case of 5,940 men and 6,627 women, from whom all the information necessary to assess the risk of MetS and all the information about sociodemographic and health-related factors had been obtained. The study was approved by the relevant bioethics committee and all the subjects provided informed consent to participate in the study. Using a structured questionnaire data on sociodemographic factors (age, marital status, level of education), economic factors (household per-capita income), health-related behaviour (habits, physical activity) and self-rated health were collected. In addition, each subject underwent measurements of height, body mass, waist circumference, blood pressure and blood sampling for determination of total cholesterol, HDL-cholesterol, triglycerides and fasting glucose. MetS was diagnosed on the basis of two most commonly employed definitions: the American Heart Association/National Heart, Lung, and Blood Institute (AHA/NHLBI) definition proposed in 2005 [7] and the International Diabetes Federation (IDF) definition proposed in 2005 [8]. According to the AHA/NHLBI definition, MetS is diagnosed if at least three of the following criteria are met: waist circumference ≥ 102 cm in men or ≥ 88 cm in women, triglycerides ≥ 1.7 mmol/L, HDL-cholesterol ≤ 1.03 mmol/L in men or ≤ 1.30 mmol/L in women or lipid-lowering treatment, glucose ≥ 5.6 mmol/L or antidiabetic treatment, systolic blood pressure ≥ 130 mm Hg or diastolic blood pressure ≥ 85 mm Hg or antihypertensive treatment. The essential element of the IDF definition is waist circumference ≥ 94 cm in men or ≥ 80 cm in women (for Europe) plus at least two factors out of the factors identical to those in the AHA/NHLBI definition.

The level of education was grouped into three classes: less than secondary (incomplete primary, primary, vocational, incomplete secondary), secondary (secondary, post-secondary, incomplete college or university), higher (completed college or university). Leisure-time physical activity was classified as low (if the frequency of continuous physical exercise of at least 30 minutes' duration was less than once a week), moderate (if the frequency was 1 to 3 times a week) and high (if the frequency was at least 4 times a week). Alcohol consumption was evaluated using a structured standardised questionnaire concerning the consumption of beer, wine and vodka within the year preceding the study. Depending on the frequency and amount consumed on a single occasion, alcoholic beverages (beer, wine and vodka) were converted into consumption of pure ethanol. The subjects, men and women separately, were divided into alcohol consumption quartile groups.

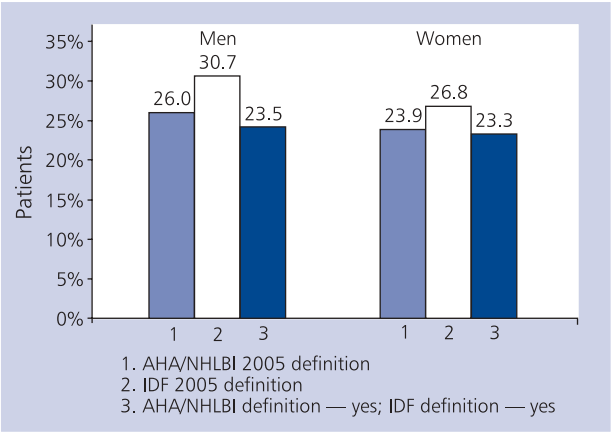

Figure 1. Percentage of patients with metabolic syndrome diagnosed according to the AHA/NHLBI and IDF definitions

Statistical analysis

The statistical analyses were performed with SAS version 9.2 using a covariance method (proc GLM) to compare mean values of the analysed factors and a multivariate regression model (proc LOGISTIC) to assess the likelihood of MetS and meeting the criteria of its components for various levels of the analysed factors.

RESULTS

In the study population, MetS was present in 26.0% of men and 23.9% of women according to the AHA/NHLBI definition and in 30.7% of men and 26.8% of women according to the IDF definition (Fig. 1). A total of 1,393 (23.3%) men and 1,547 (23.3%) women met both definitions of MetS. Men and women with MetS were characterised by significantly higher mean values of the analysed cardiovascular risk factors compared to the subjects without MetS (Table 1).

The likelihood of MetS diagnosed according to the AHA/NHLBI and IDF definitions, after adjustment for the remaining analysed factors, in both genders, was higher in subjects in the older age groups (Table 2). Both in men and women, the risk of MetS increased with body mass index (BMI), was higher in current smokers, and in the group of ex-smokers compared to non-smokers. A lower risk of MetS was identi-

Table 1. Study population characteristics depending on the presence of metabolic syndrome according to the AHA/NHLBI and IDF definition

Factors	Metabolic syndrome					
	According to the AHA/NHLBI definition			According to the IDF definition		
	Present	Absent	P	Present	Absent	P
Men						
Number of subjects	1545	4395		1821	4119	
Age [years]	51.5	43.8	0.0001	51.5	43.3	< 0.0001
Body mass index [kg/m^2]	30.6	25.3	0.0001	30.3	25.1	< 0.0001
Waist circumference [cm]	106.7	91.4	0.0001	106.0	90.6	< 0.0001
Systolic blood pressure [mm Hg]	147.4	134.2	0.0001	146.8	133.6	< 0.0001
Diastolic blood pressure [mm Hg]	90.3	81.6	0.0001	89.9	81.2	< 0.0001
Total cholesterol [mmol/L]	5.8	5.2	0.0001	5.8	5.2	< 0.0001
LDL-cholesterol [mmol/L]	3.56	3.20	0.0001	3.58	3.16	< 0.0001
HDL-cholesterol [mmol/L]	1.09	1.46	0.0001	1.12	1.47	< 0.0001
Triglycerides [mmol/L]	2.78	1.30	0.0001	2.59	1.29	< 0.0001
Glucose [mmol/L]	6.04	4.80	0.0001	5.9	4.8	< 0.0001
Women						
Number of subjects	1582	5045		1775	4852	
Age [years]	55.8	41.9	0.0001	55.2	41.5	< 0.0001
Body mass index [kg/m^2]	31.6	24.4	0.0001	31.0	24.4	< 0.0001
Waist circumference [cm]	100.9	81.2	0.0001	99.1	81.0	< 0.0001
Systolic blood pressure [mm Hg]	146.3	125.2	0.0001	145.4	124.7	< 0.0001
Diastolic blood pressure [mm Hg]	89.5	79.0	0.0001	89.0	78.8	< 0.0001
Total cholesterol [mmol/L]	5.9	5.2	0.0001	5.9	5.2	< 0.0001
LDL-cholesterol [mmol/L]	3.70	3.08	0.0001	3.69	3.06	< 0.0001
HDL-cholesterol [mmol/L]	1.24	1.63	0.0001	1.26	1.64	< 0.0001
Triglycerides [mmol/L]	2.11	1.07	0.0001	2.06	1.05	< 0.0001
Glucose [mmol/L]	5.82	4.58	0.0001	5.72	4.56	< 0.0001

Table 2. Odds ratio (OR) for the occurrence of metabolic syndrome according to the AHA/NHLBI and IDF definitions depending on the level of selected sociodemographic factors*

Factors	Metabolic syndrome according to the AHA/NHLBI definition			Metabolic syndrome according to the IDF definition		
	OR	95% CI	P	OR	95% CI	P
Men						
Place of residence						
District of up to 8 thousand inhabitants	1.00			1.00		
District of 8 to 40 thousand inhabitants	1.28	1.09–1.51	0.0030	1.15	0.98–1.34	0.0843
District of more than 40 thousand inhabitants	1.29	1.08–1.55	0.0051	1.14	0.96–1.35	0.1422
Age						
20–40 years	1.00			1.00		
41–60 years	1.70	1.42–2.03	0.0001	1.91	1.61–2.26	0.0001
≥ 61 years	1.60	1.27–2.01	0.0001	1.86	1.49–2.31	0.0001
Marital status						
Married	1.00			1.00		
Single	0.88	0.73–1.06	0.1662	0.82	0.68–0.97	0.0253
Education						
Below-secondary	1.00			1.00		
Secondary	0.99	0.84–1.17	0.9220	0.94	0.80–1.11	0.4691
Higher	1.25	0.96–1.62	0.0930	1.06	0.82–1.36	0.6681

→

Table 2. Continued. Odds ratio (OR) for the occurrence of metabolic syndrome according to the AHA/NHLBI and IDF definitions depending on the level of selected sociodemographic factors*

Factors	Metabolic syndrome according to the AHA/NHLBI definition			Metabolic syndrome according to the IDF definition		
	OR	95% CI	P	OR	95% CI	P
Per-capita income						
Below 501 PLN	1.00			1.00		
501–1000 PLN	1.07	0.91–1.26	0.4287	1.13	0.96–1.32	0.1321
Over 1000 PLN	1.14	0.88–1.46	0.3277	1.21	0.95–1.55	0.1262
Don't know, refusal	0.86	0.67–1.11	0.2564	0.87	0.69–1.11	0.2587
Body mass index						
Up to 25.0 kg/m^2	1.00			1.00		
25.0–29.9 kg/m^2	5.46	4.43–6.73	0.0001	8.83	7.19–10.85	0.0001
Over 29.9 kg/m^2	29.03	23.20–36.33	0.0001	32.98	26.33–41.30	0.0001
Smoking status						
Non-smoker	1.00			1.00		
Ex-smoker	1.39	1.17–1.66	0.0002	1.26	1.07–1.50	0.0061
Current smoker	1.25	1.05–1.50	0.0124	1.20	1.01–1.42	0.0364
Physical activity						
Low	1.00			1.00		
Moderate	0.94	0.78–1.13	0.5041	0.92	0.77–1.09	0.3239
High	0.76	0.65–0.89	0.0006	0.79	0.68–0.92	0.0022
Alcohol consumption						
1st quartile (≤ 1.20 g)	1.00			1.00		
2nd quartile (1.25–4.45 g)	1.03	0.85–1.25	0.7680	0.90	0.75–1.09	0.2945
3rd quartile (4.55–11.05 g)	0.79	0.64–0.97	0.0217	0.72	0.60–0.88	0.0012
4th quartile (> 11.05 g)	1.15	0.94–1.41	0.1628	1.14	0.94–1.39	0.1833
Self-rated health						
Poor, moderate	1.00			1.00		
Good, very good	0.66	0.57–0.78	0.0001	0.73	0.62–0.85	0.0001
Women						
Place of residence						
District of up to 8 thousand inhabitants	1.00			1.00		
District of 8 to 40 thousand inhabitants	1.00	0.85–1.18	0.9660	1.03	0.88–1.21	0.6729
District of more than 40 thousand inhabitants	0.99	0.82–1.19	0.8911	1.07	0.90–1.27	0.4564
Age						
20–40 years	1.00			1.00		
41–60 years	2.50	2.03–3.08	0.0001	2.50	2.08–3.02	0.0001
≥ 61 years	4.73	3.68–6.08	0.0001	4.63	3.68–5.84	0.0001
Marital status						
Married	1.00			1.00		
Single	0.89	0.75–1.05	0.1546	0.89	0.76–1.04	0.1471
Education						
Below-secondary	1.00			1.00		
Secondary	0.8	0.74–1.03	0.1033	0.92	0.79–1.07	0.2671
Higher	0.72	0.54–0.98	0.0340	0.72	0.55–0.95	0.0218
Per-capita income						
Below 501 PLN	1.00			1.00		
501–1000 PLN	1.08	0.91–1.27	0.3828	1.08	0.92–1.26	0.3357
Over 1000 PLN	1.22	0.90–1.64	0.1950	1.23	0.93–1.62	0.1527
Don't know, refusal	0.83	0.64–1.08	0.1616	0.86	0.68–1.10	0.2288
Body mass index						
Up to 25.0 kg/m^2	1.00			1.00		
25.0–29.9 kg/m^2	6.62	5.37–8.18	0.0001	5.09	4.26–6.09	0.0001
Over 29.9 kg/m^2	23.92	19.27–26.68	0.0001	14.15	11.74–17.05	0.0001
Smoking status						
Non-smoker	1.00			1.00		
Ex-smoker	1.19	0.98–1.44	0.0813	1.11	0.92–1.33	0.2673
Current smoker	1.54	1.28–1.86	0.0001	1.37	1.15–1.63	0.0004
Physical activity						
Low	1.00			1.00		
Moderate	0.87	0.72–1.05	0.1516	0.94	0.79–1.12	0.4953
High	0.82	0.70–0.96	0.0148	0.83	0.71–0.96	0.0130
Alcohol consumption						
1st quartile (= 0 g)	1.00			1.00		
2nd quartile (0.05–0.35 g)	0.70	0.58–0.85	0.0002	0.80	0.67–0.96	0.0156
3rd quartile (0.40–1.05 g)	0.68	0.56–0.83	0.0001	0.74	0.61–0.88	0.0011
4th quartile (> 1.05 g)	0.63	0.51–0.78	0.0001	0.68	0.56–0.83	0.0002
Self-rated health						
Poor, moderate	1.00			1.00		
Good, very good	0.74	0.64–0.87	0.0001	0.76	0.66–0.88	0.0002

*Each variable adjusted for the remaining variables listed in the table; CI — confidence interval

Table 3. Odds ratio (OR) for the occurrence of exceeded components of metabolic syndrome depending on the level of selected sociodemographic factors*

Factor	Waist circumference ≥ 94 cm	Waist circumference ≥ 102 cm	Triglycerides ≥ 1.7 mmol/L#	HDL-cholesterol < 1.03 mmol/L#	Glucose ≥ 5.6 mmol/L#	SBP ≥ 130 mm Hg DBP ≥ 85 mm Hg#
Men						
Place of residence						
District of up to 8 thousand inhabitants	1.00	1.00	1.00	1.00	1.00	1.00
District of 8 to 40 thousand inhabitants	1.17 (0.98–1.39)	1.29 (1.06–1.57)	1.11 (0.96–1.27)	1.10 (0.94–1.30)	1.04 (0.88–1.22)	1.05 (0.92–1.21)
District of more than 40 thousand inhabitants	1.16 (0.96–1.41)	1.20 (0.97–1.49)	1.12 (0.96–1.30)	1.27 (1.07–1.51)	0.93 (0.78–1.12)	1.02 (0.87–1.19)
Age						
20–40 years	1.00	1.00	1.00	1.00	1.00	1.00
41–60 years	2.44 (2.05–2.92)	2.09 (1.69–2.59)	1.26 (1.09–1.45)	0.84 (0.71–0.99)	2.99 (2.45–3.64)	2.18 (1.89–2.51)
≥ 61 years	3.92 (3.04–5.05)	3.91 (2.98–5.13)	0.76 (0.62–0.93)	0.57 (0.45–0.72)	4.17 (3.29–5.29)	3.52 (2.84–4.36)
Marital status						
Married	1.00	1.00	1.00	1.00	1.00	1.00
Single	0.64 (0.53–0.77)	0.78 (0.62–0.98)	0.91 (0.78–1.05)	0.85 (0.71–1.02)	1.12 (0.93–1.34)	1.09 (0.95–1.26)
Education						
Below-secondary	1.00	1.00	1.00	1.00	1.00	1.00
Secondary	0.85 (0.71–1.02)	0.83 (0.68–1.01)	1.03 (0.90–1.18)	1.18 (1.00–1.38)	0.91 (0.77–1.08)	0.78 (0.67–0.89)
Higher	0.87 (0.65–1.15)	0.99 (0.73–1.34)	1.07 (0.86–1.34)	1.62 (1.27–2.06)	0.96 (0.73–1.25)	0.70 (0.56–0.88)
Per-capita income						
Below 501 PLN	1.00	1.00	1.00	1.00	1.00	1.00
501–1000 PLN	1.18 (0.99–1.41)	1.07 (0.88–1.30)	1.15 (1.00–1.32)	1.09 (0.93–1.28)	1.04 (0.88–1.22)	1.18 (1.02–1.36)
Over 1000 PLN	1.22 (0.92–1.62)	1.37 (1.02–1.85)	0.98 (0.79–1.23)	1.04 (0.81–1.33)	1.16 (0.89–1.49)	1.14 (0.91–1.44)
Don't know, refusal	1.02 (0.79–1.30)	1.08 (0.80–1.45)	0.96 (0.79–1.17)	0.88 (0.69–1.12)	1.06 (0.83–1.35)	1.10 (0.91–1.33)
Body mass index						
Up to 25.0 kg/m^2	1.00	1.00	1.00	1.00	1.00	1.00
25.0–29.9 kg/m^2	15.7 (13.4–18.5)	21.1 (14.6–30.5)	2.60 (2.26–2.99)	2.75 (2.30–3.28)	1.72 (1.44–2.04)	1.87 (1.65–2.13)
Over 29.9 kg/m^2	259 (174–387)	386 (260–571)	5.62 (4.76–6.63)	5.85 (4.82–7.10)	3.62 (3.00–4.36)	4.00 (3.31–4.84)
Smoking status						
Non-smoker	1.00	1.00	1.00	1.00	1.00	1.00
Ex-smoker	1.15 (0.94–1.40)	1.33 (1.09–1.64)	1.35 (1.16–1.57)	1.13 (0.95–1.34)	1.25 (1.04–1.49)	1.13 (0.96–1.32)
Current smoker	0.91 (0.76–1.10)	1.05 (0.85–1.30)	1.34 (1.16–1.55)	1.26 (1.07–1.49)	1.23 (1.03–1.47)	1.02 (0.88–1.18)
Physical activity						
Low	1.00	1.00	1.00	1.00	1.00	1.00
Moderate	0.83 (0.68–1.01)	0.76 (0.61–0.94)	0.87 (0.75–1.01)	0.88 (0.74–1.05)	0.78 (0.65–0.94)	0.93 (0.80–1.08)
High	0.75 (0.63–0.88)	0.83 (0.69–1.00)	0.78 (0.68–0.89)	0.81 (0.69–0.94)	0.80 (0.69–0.93)	1.10 (0.96–1.27)
Alcohol consumption						
1st quartile (≤ 1.20 g)	1.00	1.00	1.00	1.00	1.00	1.00
2nd quartile (1.25–4.45 g)	0.95 (0.77–1.18)	1.17 (0.92–1.47)	1.07 (0.91–1.27)	0.83 (0.69–0.99)	1.09 (0.90–1.32)	1.04 (0.88–1.24)
3rd quartile (4.55–11.05 g)	0.97 (0.78–1.22)	0.98 (0.77–1.25)	0.89 (0.75–1.06)	0.59 (0.49–0.72)	1.05 (0.86–1.29)	1.08 (0.91–1.29)
4th quartile (>11.05 g)	1.08 (0.86–1.34)	1.35 (1.06–1.72)	1.28 (1.08–1.51)	0.51 (0.41–0.62)	1.36 (1.11–1.66)	1.55 (1.29–1.85)
Self-rated health						
Poor, moderate	1.00	1.00	1.00	1.00	1.00	1.00
Good, very good	0.76 (0.64–0.92)	0.60 (0.50–0.72)	0.99 (0.86–1.14)	0.69 (0.59–0.81)	0.72 (0.62–0.84)	0.87 (0.75–1.01)

→

Table 3. Continued. Odds ratio (OR) for the occurrence of exceeded components of metabolic syndrome depending on the level of selected sociodemographic factors*

Factor	Waist circumference ≥ 94 cm	Waist circumference ≥ 102 cm	Triglycerides ≥ 1.7 mmol/L#	HDL-cholesterol < 1.03 mmol/L#	Glucose ≥ 5.6 mmol/L#	SBP ≥ 130 mm Hg DBP ≥ 85 mm Hg#
Women						
Place of residence						
District of up to 8 thousand inhabitants	1.00	1.00	1.00	1.00	1.00	1.00
District of 8 to 40 thousand inhabitants	1.29 (1.05–1.50)	1.06 (0.88–1.28)	1.11 (0.95–1.29)	1.07 (0.93–1.22)	0.97 (0.80–1.17)	0.95 (0.83–1.09)
District of more than 40 thousand inhabitants	0.97 (0.80–1.18)	0.87 (0.70–1.07)	1.05 (0.88–1.24)	1.17 (1.00–1.35)	0.90 (0.73–1.12)	0.99 (0.85–1.16)
Age						
20–40 years	1.00	1.00	1.00	1.00	1.00	1.00
41–60 years	2.38 (2.01–2.82)	1.93 (1.59–2.35)	1.74 (1.46–2.07)	0.77 (0.67–0.90)	3.16 (2.39–4.18)	4.14 (3.60–4.76)
≥ 61 years	6.60 (4.97–8.77)	4.31 (3.29–5.66)	2.46 (1.97–3.07)	0.70 (0.57–0.85)	6.49 (4.73–8.91)	13.1 (10.5–16.4)
Marital status						
Married	1.00	1.00	1.00	1.00	1.00	1.00
Single	0.70 (0.59–0.83)	1.00 (0.83–1.20)	0.85 (0.74–0.99)	0.88 (0.77–1.01)	0.85 (0.71–1.03)	1.08 (0.94–1.23)
Education						
Below-secondary	1.00	1.00	1.00	1.00	1.00	1.00
Secondary	0.75 (0.64–0.89)	0.67 (0.56–0.80)	1.06 (0.91–1.23)	0.93 (0.81–1.06)	0.96 (0.79–1.16)	0.77 (0.67–0.88)
Higher	0.57 (0.43–0.74)	0.49 (0.36–0.67)	0.96 (0.74–1.24)	1.00 (0.80–1.24)	0.67 (0.47–0.97)	0.60 (0.48–0.75)
Per-capita income						
Below 501 PLN	1.00	1.00	1.00	1.00	1.00	1.00
501–1000 PLN	1.15 (0.95–1.38)	0.98 (0.81–1.19)	1.08 (0.93–1.26)	0.99 (0.87–1.14)	1.10 (0.92–1.33)	1.01 (0.87–1.16)
Over 1000 PLN	1.08 (0.77–1.50)	1.09 (0.78–1.52)	1.15 (0.88–1.50)	1.09 (0.85–1.39)	1.08 (0.77–1.53)	1.33 (1.03–1.72)
Don't know, refusal	1.03 (0.80–1.31)	1.00 (0.76–1.31)	0.91 (0.72–1.14)	0.97 (0.80–1.18)	0.71 (0.52–0.98)	0.88 (0.72–1.07)
Body mass index						
Up to 25.0 kg/m^2	1.00	1.00	1.00	1.00	1.00	1.00
25.0–29.9 kg/m^2	21.4 (17.8–25.7)	18.3 (15.2–22.1)	2.38 (2.02–2.82)	2.37 (2.04–2.74)	1.89 (1.50–2.38)	1.99 (1.74–2.29)
Over 29.9 kg/m^2	656 (245–999)	314 (229–431)	4.74 (3.99–5.63)	4.41 (3.76–5.16)	4.88 (3.91–6.08)	5.16 (4.36–6.11)
Smoking status						
Non-smoker	1.00	1.00	1.00	1.00	1.00	1.00
Ex-smoker	1.09 (0.88–1.35)	1.00 (0.80–1.25)	1.15 (0.96–1.37)	0.93 (0.84–1.17)	1.28 (1.02–1.59)	0.96 (0.81–1.13)
Current smoker	0.72 (0.60–0.86)	0.86 (0.70–1.05)	1.56 (1.32–1.84)	1.63 (1.41–1.88)	1.43 (1.15–1.78)	0.95 (0.82–1.10)
Physical activity						
Low	1.00	1.00	1.00	1.00	1.00	1.00
Moderate	0.76 (0.62–0.92)	0.78 (0.63–0.96)	1.08 (0.91–1.27)	1.08 (0.93–1.25)	0.85 (0.69–1.06)	0.91 (0.78–1.06)
High	0.76 (0.64–0.91)	0.83 (0.69–0.99)	0.90 (0.78–1.04)	0.98 (0.86–1.11)	0.77 (0.64–0.92)	0.99 (0.87–1.14)
Alcohol consumption						
1st quartile (= 0 g)	1.00	1.00	1.00	1.00	1.00	1.00
2nd quartile (0.05–0.35 g)	1.09 (0.87–1.37)	0.81 (0.64–1.01)	0.82 (0.69–0.97)	0.74 (0.63–0.87)	0.71 (0.57–0.88)	0.97 (0.81–1.15)
3rd quartile (0.40–1.05 g)	1.03 (0.83–1.28)	0.76 (0.61–0.95)	0.74 (0.62–0.88)	0.71 (0.60–0.83)	0.71 (0.57–0.89)	0.92 (0.78–1.09)
4th quartile (> 1.05 g)	1.12 (0.90–1.40)	0.89 (0.70–1.13)	0.75 (0.62–0.91)	0.55 (0.46–0.66)	0.75 (0.59–0.96)	0.98 (0.82–1.17)
Self-rated health						
Poor, moderate	1.00	1.00	1.00	1.00	1.00	1.00
Good, very good	0.82 (0.68–0.99)	0.80 (0.66–0.96)	0.82 (0.71–0.95)	0.73 (0.64–0.84)	0.74 (0.62–0.88)	0.85 (0.74–0.98)

*Each variable adjusted for the remaining variables listed in the table; #Or relevant treatment; SBP — systolic blood pressure; DBP — diastolic blood pressure

fied in men and women declaring high physical activity compared to groups declaring low physical activity and in subjects self-rating their health as being good compared to subjects self-rating their health as being poor. Only in men and only in the case of the AHA/NHLBI definition the risk of MetS increased with the population of the administrative district they inhabited, while only in women higher education and high alcohol consumption decreased the risk of MetS.

The risk of meeting the criteria for most components of MetS was higher in subjects who were older, had a higher BMI and were current smokers, and lower in subjects who self-rated their health as being good (Table 3). Furthermore, women with secondary or higher education were characterised by a lower likelihood of meeting the criteria of most components of MetS compared to women with below-secondary education. In men, the increase in the level of education was associated with the increased risk of low HDL-cholesterol and a lower risk of high blood pressure.

DISCUSSION

In the study sample of the Polish population, a higher rate of MetS (by 4.7% in men and by 2.9% in women) was observed employing the IDF definition compared to the AHA/NHLBI definition. It should, however, be emphasised that 90% of men and 98% of women with MetS according to the AHA/NHLBI definition also met the IDF criteria, and 77% of men and 87% of women with MetS according to the IDF definition also met the AHA/NHLBI criteria. When the NCEP-ATP 2001 definition was employed MetS was identified in 19.5% of men and 18.6% of women [9]. Other studies in Poland showed similar rates of subjects with MetS to our rates. MetS was observed in 18.0% of men and 22.6% of women in the NATPOL PLUS study (2001–2002) [10, 11], and in 20% of men and 19% of women in the Pol-MONICA Warszawa study conducted in 2001 [12]. In Europe, the prevalence of MetS varied with the diagnostic criteria being met by 14.8% of men and 15.3% of women in Sweden [13], 15.9% of men and 23.9% of women in Slovakia [14] and 27.6% of men and 22.6% of women in Spain [15]. Outside Europe, a relatively high prevalence of MetS has been observed in the US population (29.9% of men and 28.4% of women) [16] and in South Korea (31.0% of men and 27.6% of women) [17]. Although the comparison of data is complicated by the fact of using different definitions of MetS and the varied age of the subjects, the percentage of individuals with MetS in developed countries most often ranged from 15% to 30% of the study populations.

Both the presence of MetS and the meeting of the criteria of MetS components have been associated, in both sexes, with the following factors: age, BMI, smoking, physical activity and self-rated health. Additionally in women an association between the level of education and alcohol consumption has been observed. It should, however, be emphasised that the association between the analysed factors and the likelihood of MetS did not differ considerably for the assessment methods employed. Differences were, however, noted between men and women in the magnitude of association between the above factors and the risk of MetS. The stronger factors in men included BMI, physical activity and self-rated health and age in women. Both in our and in other studies [15, 18], age was a significant factor increasing the risk of MetS and the risk of exceeding the criteria for the majority of MetS components. Ageing increases the risk of obesity, especially visceral obesity, abnormalities of lipid metabolism, abnormalities of carbohydrate metabolism and high blood pressure. Additionally, hormonal changes in women may be responsible for the greater increase of the risk of MetS in women *versus* men [19, 20]. In our study, the severity of obesity was a factor strongly affecting the occurrence of MetS with the risk of MetS in obese subjects being 29 times (AHA/NHLBI definition) and 33 times (IDF definition) higher in men and 24 and 14 times higher in women, respectively, compared to subjects with normal BMI values. With the increase of BMI there was a strong increase of the likelihood of meeting the criteria of all the MetS components. A French study (involving a 6-year follow-up of nearly 4 thousand subjects) showed that the risk of MetS increased by 22% per each kilogram of body mass increase [21].

Smoking was also associated with a higher risk of MetS and with meeting the criteria of most of MetS components in both sexes compared to non-smokers. The results varied with the studies. In adult Americans [18], the risk of MetS was significantly higher among female and male smokers and female ex-smokers, while a Portuguese study [22] did not demonstrate an association between smoking and MetS in men and most women. Nicotine has an anti-estrogenic effect: it induces lipolysis through stimulation of the sympathetic nervous system, which results in increased plasma levels of free fatty acids [23, 24].

High leisure-time physical activity decreased the likelihood of MetS in women and men alike. Similar results were obtained in Spain [15], while in the NHANES III study [18] and in Portugal [22], a lower level of physical activity was associated with a higher risk of MetS in men only. Studies [25, 26] show that physical activity affects lipid profile (particularly HDL-cholesterol [increase] and triglycerides [decrease]), reduces BMI, reduces blood pressure, improves glucose tolerance and increases insulin sensitivity.

Only in the group of women there was a significant reduction in the risk of MetS with increased level of education, which may result from the fact that in women, the likelihood of meeting 3 out of 5 criteria of MetS decreased with increasing level of education and the remaining 2 criteria were statistically non-significant. Among men, on the other hand, a significant effect of education was observed for 2 components of MetS with the likelihood of meeting the criteria of

one component increasing and of the other decreasing with increased level of education. In both the American [27] and the Korean [17] studies, only in women, the risk of MetS decreased with increasing level of education, while in the French [28] and Swedish [29] studies there was a significantly lower likelihood of MetS in both sexes with higher levels of education compared to primary education.

Only in the group of women was a decrease in the risk of MetS observed with the increased alcohol consumption. It should, however, be emphasised that the declared consumption of alcohol by Polish women was low and did not exceed 3 g ethanol/day for 90% of the women. In the NHANES III study [26], moderate consumption of alcohol was associated with a lower risk of MetS also only in women. Moderate alcohol consumption may increase HDL-cholesterol levels, inhibit oxidation of LDL-cholesterol, reduce insulin levels and increase insulin sensitivity, therefore improving the factors associated with MetS. At the same time, high alcohol consumption may increase triglyceride levels and blood pressure. In our study, in both sexes, a reduced likelihood of low HDL-cholesterol was showed with increasing alcohol consumption and among women additionally a reduced likelihood of elevated triglycerides and glucose.

We did not observe any association between household per-capita income and the risk of MetS, and the association between household per-capita income and the risk of meeting MetS criteria in men and women was low and most likely accidental. In addition, the level of income is usually correlated with the level of education (the coefficient of correlation in our study was 0.35, $p < 0.001$) and with such lifestyle factors as physical activity, smoking and the incidence of overweight and obesity. For this reason the lack of association between the level of income and the risk of MetS may result from the interaction between these two factors. In other studies, the results varied. Among American [27] and French [28] women with low household income the likelihood of MetS was higher than among women with high income, while among men income did not affect the risk of MetS.

Limitations of the study

The main limitation of the study is its cross-sectional design, in which data are based on single measurements, which is why the relationship between the analysed socioeconomic factors and MetS cannot be unequivocally considered causal and should be confirmed in prospective and, possible, interventional studies. In addition, similarly to most epidemiological studies, there is a probability of not including all the confounders, which may also affect the results of the analyses.

CONCLUSIONS

A relatively high percentage of individuals with MetS was observed in the Polish population aged 20 to 74 years. In both sexes, the risk of MetS and its contributing factors was significantly associated with age and the following lifestyle factors: BMI, smoking, self-rated health and, additionally for women, higher education and alcohol intake.

We observed differences between men and women in the strength of association between the above factors and the risk of MetS. Factors that exerted a stronger effect included BMI, physical activity and self-rated health in men and age in women.

The knowledge of factors affecting the risk of MetS in Poles is necessary for undertaking correct prophylactic activities and providing medical care to persons at an increased metabolic risk may contribute to further reduction of cardiovascular morbidity and mortality.

Conflict of interest: *none declared*

References

1. Gami AS, Witt BJ, Howard DE et al. Metabolic syndrome and risk of incident cardiovascular events and death. A systematic review and meta-analysis of longitudinal studies. J Am Coll Cardiol, 2007; 49:403–414.
2. Mottillo S, Filion KB, Genest J et al. The metabolic syndrome and cardiovascular risk. A systematic review and meta-analysis. J Am Coll Cardiol, 2010; 56:1113–1132.
3. Martin AR, Nieto JMM, Ruiz JPN, Jimenez LE. Overweight and obesity: The role of education, employment and income in Spanish adults. Appetite, 2008; 51: 266–272.
4. Nocon M, Keil T, Willich SN. Education, income, occupational status and health risk behaviour. J Public Health, 2007; 15: 401–405.
5. Skrzypczak M, Szwed A, Pawińska-Chmara R, Skrzypulec V. Body mass index, waist to hip ratio and waist/height in adult Polish women in relation to their education, place of residence, smoking and alcohol consumption. J Comp Hum Biol, 2008; 59: 329–342.
6. Rywik S, Kupść W, Piotrowski W et al. Wieloośrodkowe ogólnopolskie badanie stanu zdrowia ludności — projekt WOBASZ. Założenia metodyczne oraz logistyka. Kardiol Pol, 2005; 63: (supl. 4): s605–s613.
7. Grundy SM, Cleeman JI, Daniels SR et al. Diagnosis and management of the metabolic syndrome. An American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement. Circulation, 2005; 112: 2735–2752.
8. International Diabetes Federation. The IDF consensus worldwide definition of the metabolic syndrome. http://www.idf.org/webdata/docs/IDF_Meta_def_final.pdf.
9. Wyrzykowski B, Zdrojewski T, Sygnowska E et al. Epidemiologia zespołu metabolicznego w Polsce. Wyniki programu WOBASZ. Kardiol Pol, 2005; 63: 6 (supl.4): s641–s644.
10. Zdrojewski T, Bandosz P, Szpakowski P et al. Rozpowszechnienie głównych czynników ryzyka chorób układu sercowo-naczyniowego w Polsce. Wyniki badania NATPOL PLUS. Kardiol Pol, 2004; 61 (supl.4): IV5–IV26.
11. Wyrzykowski B, Zdrojewski T, Bandosz P. Zespół metaboliczny w Polsce. Kardiol Pol, 2005, 62 (supl.2): II30–II35.
12. Broda G, Szcześniewska D, Rywik S. Częstość występowania zespołu metabolicznego w populacji osób dorosłych Warszawy. Med Metab, 2003; 7: 225–229.
13. Hollman G, Kristenson M. The prevalence of the metabolic syndrome and its risk factors in a middle-aged Swedish population — Mainly a function of overweight? Eur J Cardiovasc Nursing, 2008; 7: 21–26.

14. Mokan M, Galajda P, Pridavkova D et al. Prevalence of diabetes mellitus and metabolic syndrome in Slovakia. Diabetes Res Clin Pract, 2008; 81: 238–242.
15. Buckland G, Salas-Salvado J, Roure E et al. Sociodemographic risk factors associated with metabolic syndrome in a Mediterranean population. Public Health Nutr, 2008; 11: 1372–1378.
16. Loucks EB, Rehkopf DH, Thurston RC, Kawachi I. Socioeconomic disparities in metabolic syndrome differ by gender: evidence from NHANES III. Ann Epidemiol, 2007; 17: 19–26.
17. Park MJ, Yun KE, Lee GE et al. A cross-sectional study of socioeconomic status and the metabolic syndrome in Korean adults. Ann Epidemiol, 2007; 17: 320–326.
18. Park YW, Zhu S, Palaniappan L et al. The metabolic syndrome. Prevalence and associated risk factor findings in the US population from the Third National Health and Nutrition Examination Survey, 1988–1994. Arch Intern Med, 2003; 163: 427–436.
19. Kim HM, Park J, Ryu SY, Kim J. The effect of menopause on the metabolic syndrome among Korean women. The Korean National Health an Nutrition Examination Survey, 2001. Diabetes Care, 2007; 30: 701–705.
20. Lobo RA. Metabolic syndrome after menopause and the role of hormones. Eur Menopause J, 2008; 60:10–18.
21. Hillier TA, Fagot-Campagna A, Eschwege E et al. Weight change and changes in the metabolic syndrome as the French population moves towards overweight: the D.E.S.I.R. Cohort. Int J Epidemiol, 2006; 35: 190–196.
22. Santos AC, Ebrahim S, Barros H. Alcohol intake, smoking, sleeping hours, physical activity and the metabolic syndrome. Prev Med, 2007; 44: 328–334.
23. Andersson K, Arner P. Systemic nicotine stimulates human adipose tissue lipolysis through local cholinergic and catecholaminergic receptors. Int J Obes, 2001; 25: 1225–1232.
24. Corella D, Guillen M, Saiz C et al. Association of LPL and APOC3 gene polymorphisms on plasma lipids in a Mediterranean population: interaction with tobacco smoking and the APOE locus. J Lipid Res, 2002; 43: 416–427.
25. Brouwer BG, Visseren FLJ, van der Graff Y. The effect of leisure-time physical activity on the presence of metabolic syndrome in patients with manifest arterial disease. The SMART study. Am Heart J, 2007; 154: 1146–1152.
26. Zhu S, St-Onge M-P, Heshka S, Heymsfield SB. Lifestyle behaviors associated with lower risk of having the metabolic syndrome. Metabolism, 2004; 53: 1503–1511.
27. Salsberry PJ, Corwin E, Reagan PB. A complex web of risks for metabolic syndrome. Race/ethnicity, economics, and gender. Am J Prev Med, 2007; 33: 114–120.
28. Dallongeville J, Cottel D, Ferrieres J et al. Household income is associated with the risk of metabolic syndrome in a sex-specific manner. Diabetes Care, 2005; 28: 409–415.
29. Silventoinen K, Pankow J, Jousilahti P et al. Educational inequalities in the metabolic syndrome and coronary heart disease among middle-aged men and women. Int J Epidemiol, 2005; 34: 327–334.

Czynniki socjoekonomiczne a ryzyko wystąpienia zespołu metabolicznego w dorosłej populacji polskiej: badanie WOBASZ

Elżbieta Sygnowska, Aleksandra Piwońska, Anna Waśkiewicz, Grażyna Broda

Zakład Epidemiologii, Prewencji Chorób Układu Krążenia i Promocji Zdrowia, Instytut Kardiologii, Warszawa

Streszczenie

Wstęp: Zespół metaboliczny zwiększa ryzyko chorób sercowo-naczyniowych, a jego występowanie jest determinowane przez wiele czynników socjoekonomicznych i związanych ze stylem życia.

Cel: Celem pracy była ocena wpływu wybranych czynników socjoekonomicznych i stylu życia na ryzyko wystąpienia zespołu metabolicznego i spełnienia kryteriów jego składowych w populacji Polski w wieku 20–74 lat.

Metody: W latach 2003–2005 w ramach Wieloośrodkowego Badania Stanu Zdrowia Ludności (WOBASZ) przebadano losową próbę mieszkańców Polski w wieku 20–74 lat. Zebrano informacje dotyczące cech socjoekonomicznych, a ponadto wykonano pomiary antropometryczne, pomiary ciśnienia tętniczego, oznaczono lipidy i glukozę. Występowanie zespołu metabolicznego określono na podstawie kryteriów *American Heart Association/National Heart, Lung, and Blood Institute* (AHA/NHLBI) z 2005 r. oraz *International Diabetes Federation* (IDF) z 2005 r. Dane niezbędne do oceny wystąpienia zespołu metabolicznego i charakterystyki socjoekonomicznej uzyskano dla 5940 mężczyzn i 6627 kobiet.

Wyniki: Zespół metaboliczny wg AHA/NHLBI zdiagnozowano u 26,0% mężczyzn i 23,9% kobiet, natomiast wg IDF odpowiednio u 30,7% i 26,8%. U obu płci starszy wiek, wyższy wskaźnik masy ciała i palenie tytoniu zwiększały prawdopodobieństwo wystąpienia zespołu metabolicznego, natomiast wysoka aktywność fizyczna i dobra samoocena zdrowia zmniejszały to ryzyko. Ponadto wśród kobiet wykształcenie wyższe i wyższy kwartyl spożycia alkoholu wiązały się z niższym prawdopodobieństwem wystąpienia zespołu metabolicznego. Zarówno wśród mężczyzn, jak i kobiet wysokość dochodu na osobę w rodzinie nie wpływała na ryzyko zespołu metabolicznego.

Wnioski: W polskiej populacji w wieku 20–74 lata zanotowano relatywnie wysoki udział osób z zespołem metabolicznym. U obu płci istotny związek z ryzykiem wystąpienia zespołu metabolicznego i spełnienia kryteriów jego składowych miały wiek badanych oraz czynniki związane ze stylem życia: wskaźnik masy ciała, palenie tytoniu, samoocena stanu zdrowia, a wśród kobiet dodatkowo poziom wykształcenia i spożycie alkoholu.

Słowa kluczowe: zespół metaboliczny, czynniki socjoekonomiczne, czynniki dotyczące stylu życia

Kardiol Pol 2012; 70, 7: 718–727

Adres do korespondencji:
dr n. med. Elżbieta Sygnowska, Instytut Kardiologii, ul. Alpejska 42, 04–628 Warszawa, e-mail: esygnowska@ikard.pl
Praca wpłynęła: 19.10.2010 r. **Zaakceptowana do druku:** 21.12.2011 r.