ORIGINAL ARTICLE

Ten-year changes in adherence to a healthy lifestyle: the results of the WOBASZ surveys

Magdalena Kwaśniewska[1], Małgorzata Pikala[2], Anita Aranowska[3],
Wojciech Bielecki[4], Krystyna Kozakiewicz[5], Andrzej Pająk[6], Andrzej Tykarski[7],
Tomasz Zdrojewski[8], Paweł Nadrowski[5], Jerzy Piwoński[3], Wojciech Drygas[1,3]

1   Department of Preventive Medicine, Medical University of Lodz, Łódź, Poland
2   Department of Epidemiology and Biostatistics, Medical University of Lodz, Łódź, Poland
3   Department of Cardiovascular Disease Prevention and Health Promotion, Cardinal Stefan Wyszyński University, Institute of Cardiology, Warsaw, Poland
4   Department of Social Pathologies, Medical University of Lodz, Łódź, Poland
5   Department and Clinic of Cardiology, Medical University of Silesia, Katowice, Poland
6   Department of Epidemiology and Population Studies, Institute of Public Health, Jagiellonian University, Kraków, Poland
7   Department of Epidemiology, Department and Clinic of Hypertension, Angiology and Internal Medicine, Poznan University of Medical Sciences, Poznań, Poland
8   Department and Clinic of Hypertension and Diabetology, Medical University of Gdansk, Gdańsk, Poland

ABSTRACT

BACKGROUND   The evidence on the beneficial role of low-risk characteristics is well established. However, data on trends in lifestyle patterns in Central Europe are limited.

OBJECTIVES   The aim of this report was to determine changes in lifestyle patterns among adults in Poland between 2003 and 2014.

PATIENTS AND METHODS   The study sample comprised 12 857 adults aged 20 to 74 years (5986 men and 6871 women) participating in 2 nationwide representative surveys, the WOBASZ (2003–2005) and WOBASZ II (2013–2014). Low-risk characteristics included: nonsmoking, nonobese waist circumference, satisfactory physical activity, good-quality diet, and low saturated fat intake. The 5 characteristics created a lifestyle index ranging from 0 to 5. A poor lifestyle was defined as the lifestyle index from 0 to 1.

RESULTS   About 2% of the participants followed a healthy lifestyle, and 25%, a poor lifestyle in both surveys. The proportion of nonsmokers significantly increased (from 57.8% to 66.9% for men and from 72.6% to 77.1% for women). There was a significant decrease in the prevalence of nonobese waist circumference (from 75.4% to 71.3% among men and from 61.2% to 57.9% among women), adequate physical activity (from 37.5% to 27.5% among men and from 31.5% to 29% among women), and low saturated fat consumption (from 23.4% to 20.2% among men and from 26.1% to 23.7% among women). Lower educational attainment was the strongest sociodemographic factor contributing to a poor lifestyle ($P < 0.001$).

CONCLUSIONS   The ultimate goal for the healthcare system should be to implement more effective interventions focused on promoting healthy lifestyle as a whole.

INTRODUCTION   The evidence supporting the importance of a healthy lifestyle in prevention of noncommunicable diseases is well established and continuously growing. Since the initial study of Belloc and Breslow,[1] a number of researchers have demonstrated the combined effects of different sets of healthy behaviors and lifestyle patterns on specific health outcomes including life expectancy, all-cause mortality as well as mortality due to cardiovascular diseases, metabolic disorders, cancers, and disability.[1-10] Li et al[2] revealed a strong impact of 5 low-risk lifestyle factors on premature mortality and life expectancy in a large sample of the United States adults followed over 34 years. According to these data, refraining from smoking, having adequate body mass index, following high-quality diet, and being physically active can substantially reduce the risk of premature death.[2] Importantly, adherence to a healthy lifestyle at midlife is associated with

longer life expectancy free of cancer, cardiovascular disease, and type 2 diabetes.[3]

Whereas much is known about trends in lifestyle patterns of Western societies, data from Central and Eastern European countries are scarce. The WOBASZ (Multicenter National Population Health Examination Survey; Polish, Wieloośrodkowe Ogólnopolskie Badanie Stanu Zdrowia Ludności) is the largest and the most comprehensive Polish epidemiological project. Two editions of the project performed in 2003 to 2005 and 2013 to 2014 provide representative national data on changes of several aspects of noncommunicable diseases using standardized methods. Several studies published to date presenting the results of these projects focused separately on selected risk factors and behaviors.[11-18]

The aim of this report was to determine 10-year changes in the prevalence of health behaviors and lifestyle patterns among adult residents of Poland. Special attention was paid to potential determinants of poor lifestyle patterns which could be fundamental for an effective national health policy and preventive care.

PATIENTS AND METHODS   The Ethical Committee of the Institute of Cardiology in Warsaw approved the study protocol. All participants provided informed written consent.

Study population and data selection   A detailed description of the WOBASZ surveys was published in previous publications.[11,19] For the purpose of this study, we used datasets taken from 2 nationwide representative cross-sectional surveys WOBASZ (2003–2005) and WOBASZ II (2013–2014). The methodology of the surveys has been kept as similar as possible in order to enable a relevant monitoring of changes in risk factors. For both surveys, an independent random sample was drawn from the national population register. The sampling scheme covered the whole territory of Poland and was stratified according to administrative units, type of urbanization, and gender. Personal invitations to participation in the study were sent to all chosen individuals. Both WOBASZ surveys enrolled a total of 20 939 adults aged 20 years and older (14 769 participants in the WOBASZ and 6170 participants in the WOBASZ II).

The study protocol comprised a questionnaire interview, blood pressure, heart rate, anthropometric measurements, and a blood sample collection. The WOBASZ questionnaire included detailed questions on medical history, sociodemographic and economic factors, health knowledge, attitudes, lifestyle, nutrition, social support, and depression. In the first edition of the WOBASZ survey (2003–2005), questionnaire on dietary habits was carried out in the 50% randomly selected subsample of the whole population, and in the second survey, in all participants.

All procedures were carried out by nurses and trained interviewers in the participants' houses or in selected outpatient clinics and were comparable in both WOBASZ surveys. Fieldwork supervisors conducted controls in selected samples of interviewers.

After excluding subjects with incomplete data for study variables, the final sample comprised 5986 men (3604 in WOBASZ and 2382 in WOBASZ II) and 6871 women (4024 in WOBASZ and 2847 in WOBASZ II) aged 20 to 74 years.

Assessment of lifestyle factors   Lifestyle was assessed based on the prevalence of 5 factors: smoking, waist circumference, physical activity (PA), percentage of calories consumed from saturated fat, and adherence to the Mediterranean diet. The selected characteristics are among the fundamental factors that were shown to have substantial influence on morbidity and mortality due to chronic diseases. A similar set of lifestyle characteristics has already been used by other authors.[20-22]

Apart from anthropometric measurements, the analysis of other lifestyle characteristics was based on self-reported data. People who had never smoked and exsmokers were included in the nonsmokers group. Waist circumference was measured in the middle of the distance between the lowest rib and the iliac crest (in underwear, standing position) and rounded to the nearest 0.5 cm. The nonobese waist circumference was defined as less than 102 cm in men and less than 88 cm in women. For the assessment of PA, participants were asked whether they took part in any regular physical activities (walking, jogging, swimming, bicycling, gardening, etc) accumulating at least 30 minutes per session. Those who did were asked to recall the frequency of such activities. Satisfactory PA was defined as performing exercises for minimum 30 minutes at least 5 days per week.

In both WOBASZ surveys, dietary habits were assessed by a 24-hour dietary recall. Of all nutritional patterns, the traditional Mediterranean diet has the strongest evidence on beneficial effects on health and survival.[21,22] This type of diet was beneficial also in the inhabitants of countries other than Mediterranean, including Poland.[23] In the present analysis, adherence to the Mediterranean diet was assessed by using a historic tool created by Trichopoulou et al[21] with some modifications in order to better apply to Polish nutrition habits. Therefore, for each participant, daily intakes (in grams) of vegetables, legumes, fruits and nuts, cereals, fish and seafood, dairy

TABLE 1 Sociodemographic characteristics of the participants of the WOBASZ (2003–2005) and WOBASZ II (2013–2014) surveys, by gender

Characteristics		Men (n = 5986)			Women (n = 6871)		
		WOBASZ (n = 3604)	WOBASZ II (n = 2382)	P value	WOBASZ (n = 4024)	WOBASZ II (n = 2847)	P value
Age, y	18–34	974 (27.03)	574 (24.1)	0.04	1130 (28.08)	635 (22.3)	<0.001
	35–64	2142 (59.43)	1489 (62.51)		2362 (58.7)	1836 (64.49)	
	>64	488 (13.54)	319 (13.39)		532 (13.22)	376 (13.21)	
Place of residence	Rural	1159 (32.16)	782 (32.83)	0.89	1342 (33.35)	1010 (35.48)	0.76
	Small urban	1138 (31.58)	734 (30.81)		1272 (31.61)	869 (30.52)	
	Large urban	1307 (36.27)	866 (36.36)		1410 (35.04)	968 (34)	
Educational level	Elementary	772 (21.42)	281 (11.8)	<0.001	982 (24.4)	394 (13.84)	<0.001
	Secondary	2349 (65.18)	1571 (65.95)		2282 (56.71)	1432 (50.3)	
	University	483 (13.4)	530 (22.25)		760 (18.89)	1021 (35.86)	
Marital status	Single	812 (22.53)	550 (23.09)	0.003	588 (14.61)	409 (14.37)	<0.001
	Married	2593 (71.95)	1666 (69.94)		2798 (69.53)	1928 (67.72)	
	Divorced	114 (3.16)	115 (4.83)		182 (4.52)	209 (7.34)	
	Widowed	85 (2.36)	51 (2.14)		456 (11.33)	301 (10.57)	

Data are presented as number (percentage) of participants.

TABLE 2 Changes in the distribution of healthy lifestyle characteristics in participants of the WOBASZ (2003–2005) and WOBASZ II (2013–2014) surveys, by gender

Healthy lifestyle behaviors and factors	Men (N = 5986)			Women (N = 6871)		
	WOBASZ	WOBASZ II	P value	WOBASZ	WOBASZ II	P value
Nonsmoking	57.8	66.9	<0.001	72.6	77.1	<0.001
Nonobese waist circumference	75.4	71.3	<0.001	61.2	57.9	0.01
Adequate physical activity	37.5	27.5	<0.001	31.5	29.0	0.03
Low saturated fat intake	23.4	20.2	0.004	26.1	23.7	0.02
The highest tertile of the Mediterranean diet score	26.5	28.3	0.03	24.6	26.4	0.03

Data are presented as percentage.

products, meat and meat products (including red meat, poultry, and processed meat), and alcohol were estimated. Using median consumption as the cutoff, a value of 0 or 1 was assigned to each of the mentioned components as suggested previously.[22] Medians were elaborated separately for the WOBASZ and WOBASZ II study. Those who consumed above the median of the beneficial food type (ie, vegetables, legumes, fruits and nuts, cereals, fish, the ratio of monounsaturated lipids to saturated lipids) were assigned a value of 1, while those who consumed the median or less were given a value of 0. Not beneficial food (mainly due to its excessive consumption or high fat content) comprised: meat (both red and poultry, processed meat), dairy products (including eggs), and alcohol. Those whose consumption was above the median were assigned a value of 0, and those who consumed the median or less were given a value of 1. Therefore, the total Mediterranean diet score could range from 0 to 9. Tertiles were created using the distribution of the score and the highest tertile indicated greater adherence to the Mediterranean diet. According to the recommendation of the European Society of Cardiology, low saturated fat

intake was defined as less than 10% of total energy intake.[24]

Low-risk characteristics analyzed in this study included: nonsmoking, nonobese waist circumference, satisfactory PA, the Mediterranean diet score in the highest tertile (good-quality diet), and low saturated fat intake. The 5 mentioned characteristics were summed to develop a lifestyle index which could range from 0 (unhealthy lifestyle) to 5 (healthy lifestyle). A poor lifestyle was defined as the lifestyle index from 0 to 1.

Statistical analysis In order to compare the frequency and assess statistical significance of the categories of qualitative characteristics, the χ² test was implemented. Given that the potential correlates may differ between genders, the analyses were performed separately for men and women. In TABLE 1, the χ² test was used and in the TABLES 2 and 3, the 2-proportions Z test. Logistic regression analysis was performed to identify sociodemographic factors (age, place of residence, educational level) that can contribute to a poor lifestyle. The results were shown as odds ratios (ORs) with 95% CIs for following a poor lifestyle. Individuals younger than 35 years, residents

TABLE 3 Changes in daily consumption of selected dietary products included in the Mediterranean diet score in participants of the WOBASZ (2003–2005) and WOBASZ II (2013–2014) surveys, by gender

Dietary variable	≤Median				>Median				P value	
	WOBASZ		WOBASZ II		WOBASZ		WOBASZ II			
	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men
Vegetables	2155 (53.55)	1661 (46.09)	1481 (52.02)	1134 (47.61)	1869 (46.4)	1943 (53.91)	1366 (47.9)	1248 (52.4)	0.21	0.25
Legumes	3713 (92.27)	3246 (90.07)	2636 (92.59)	2220 (93.2)	311 (7.7)	358 (9.93)	211 (7.4)	162 (6.8)	0.62	<0.001
Fruits and nuts	2099 (52.16)	2211 (61.35)	1346 (47.28)	1368 (57.43)	1925 (47.8)	1393 (38.65)	1501 (52.7)	1014 (42.6)	<0.001	0.002
Fish and seafood	3605 (89.59)	3217 (89.26)	2543 (89.32)	2075 (87.11)	419 (10.4)	387 (10.74)	304 (10.7)	307 (12.9)	0.72	0.01
Cereals	2681 (66.63)	1133 (31.44)	1810 (63.58)	806 (33.84)	1343 (33.4)	2471 (68.56)	1037 (36.4)	1576 (66.2)	0.01	0.052
MUFA/SFA	2180 (54.17)	1634 (45.34)	1552 (54.51)	1062 (44.58)	1844 (45.8)	1970 (54.66)	1295 (45.49)	1320 (55.4)	0.78	0.57
Dairy products	1993 (49.53)	1831 (50.8)	1384 (48.61)	1232 (51.72)	2031 (50.47)	1773 (49.2)	1463 (51.39)	1150 (48.3)	0.45	0.49
Meat and meat products	2558 (63.57)	1263 (35.04)	1815 (63.75)	800 (33.59)	1466 (36.43)	2341 (64.96)	1032 (36.25)	1582 (66.41)	0.88	0.25
Alcohol	3903 (96.99)	3086 (85.63)	2832 (99.47)	2342 (98.32)	121 (3.01)	518 (14.37)	15 (0.53)	40 (1.68)	<0.001	<0.001

Data are presented as number (percentage) of participants.

Abbreviations: MUFA, monounsaturated fatty acids; SFA, saturated fatty acids

of large urban settings, and those with university education were used as a reference, being assigned an OR value of 1. The multivariable logistic regression analyses were adjusted for age, education, and place of residence. P values in logistic regression were 2-tailed and a P value of less 0.05 was considered statistically significant. Statistical analyses were performed using STATISTICA for Windows XP, version 12 (StatSoft Polska, Kraków).

RESULTS Data of 12 857 participants of both WOBASZ surveys (5986 men and 6871 women) were included in the present analysis. Descriptive statistics on the sociodemographic characteristics of the study samples are presented in TABLE 1. In both studies, majority of participants were middle aged, married, with secondary educational level.

Ten-year changes in the distribution of healthy behaviors and characteristics revealed substantial changes in the years 2003 to 2014 (TABLE 2). Among men, the percentage of nonsmokers and persons following a good-quality diet (the Mediterranean diet score in the highest tertile) increased significantly (P <0.001 and P = 0.03, respectively) while the percentage of persons with nonobese waist circumference, adequate PA level, and low saturated fat consumption decreased (P <0.001, P <0.001, and P = 0.004, respectively) between the years 2003 and 2014. Similar direction of changes was observed in women. The prevalence of nonsmoking and good-quality diet significantly increased (P <0.001 and P = 0.03, respectively) while the percentage of women with

nonobese waist circumference, adequate PA level, and low saturated fat consumption decreased (P = 0.01, P = 0.03, and P = 0.02, respectively) between the surveys.

The analysis of the nutrition habits revealed that most of the participants had 3 to 5 scores of all 9 points of the Mediterranean diet score (67.1% and 66.2%, respectively in the WOBASZ and WOBASZ II surveys). Only 0.36% of all participants achieved a score of 8 to 9. No differences were found in the distribution of the Mediterranean diet score between genders in both surveys.

Table 3 presents changes in the intake of studied dietary products included in the Mediterranean diet score. In women, there was a statistically significant increase in the consumption of fruits and nuts (P <0.001) and cereals (P = 0.01) while consumption of alcohol significantly decreased (P <0.001). In men, there was a significant decrease in the intake of legumes (P <0.001) and an increase in the consumption of fruits and nuts as well as fish and seafood in the analyzed period (P = 0.002 and P = 0.01, respectively). Moreover, the significant fall in the percentage of men drinking alcohol above the median was noted (P <0.001; TABLE 3).

The number of healthy lifestyle factors in the study samples is shown in FIGURE 1. In both surveys, the majority of participants had 1, 2, or 3 of all 5 analyzed low-risk characteristics. In the WOBASZ II survey, about 12.5% of the participants had 4 or 5 characteristics, while only 1.9% had all 5 of the analyzed lifestyle factors. About 25% of the study sample had poor lifestyle index, that is, 0 to 1 of all healthy lifestyle factors.

FIGURE 1 The number of healthy lifestyle factors observed in participants of the WOBASZ (2003–2005) and WOBASZ II (2013–2014) surveys
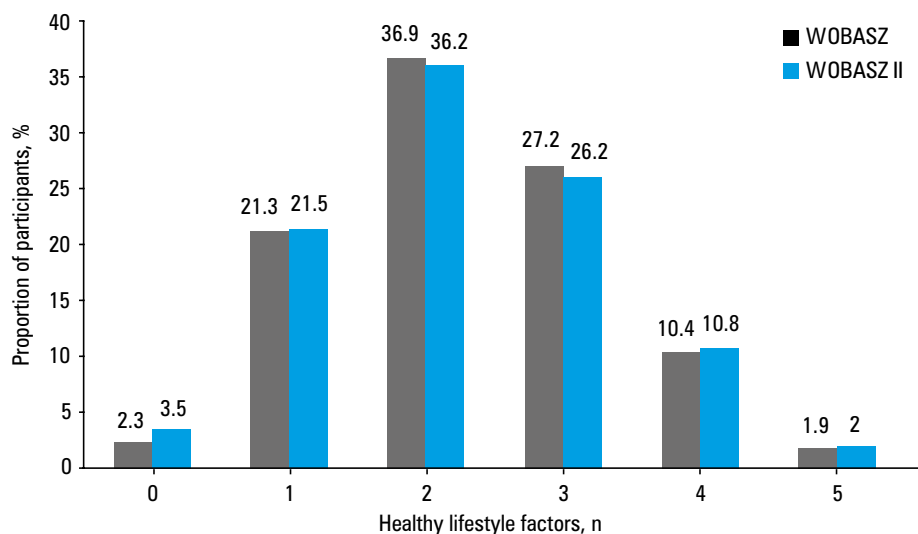
TABLE 4 Odds ratios and 95% CIs for the poor lifestyle index (0–1 factors) according to selected sociodemographic characteristics in participants of the WOBASZ (2003–2005) and WOBASZ II (2013–2014) surveys

Characteristics		Men				Women			
		WOBASZ		WOBASZ II		WOBASZ		WOBASZ II	
		OR (95% CI)	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value
Age, y	<35 (referent)	1	–	1	–	1	–	1	–
	35–64	1.18 (0.98–1.42)	0.08	1.11 (0.88–1.4)	0.37	1.54 (1.28–1.86)	<0.001	1.27 (1.01–1.61)	0.04
	>64	1.12 (0.85–1.47)	0.42	0.81 (0.57–1.14)	0.22	1.24 (0.95–1.62)	0.11	1.47 (1.06–2.02)	0.02
Educational level	Elementary	1.28 (0.96–1.72)	0.09	2.01 (1.39–2.91)	<0.001	2.29 (1.79–2.94)	<0.001	2.12 (1.57–2.84)	<0.001
	Secondary	1.25 (0.98–1.59)	0.07	1.69 (1.30–2.18)	<0.001	1.4 (1.13–1.73)	0.002	1.76 (1.43–2.15)	<0.001
	University (referent)	1	–	1	–	1	–	1	–
Place of residence	Rural	0.84 (0.69–1.01)	0.07	0.89 (0.7–1.13)	0.33	0.72 (0.6–0.87)	<0.001	0.92 (0.75–1.14)	0.47
	Small urban	0.99 (0.85–1.17)	0.96	1.1 (0.87–1.38)	0.44	0.88 (0.73–1.04)	0.12	1.01 (0.82–1.25)	0.89
	Large urban (referent)	1	–	1	–	1	–	1	–

Abbreviations: OR, odds ratio

Similar distribution of the number of lifestyle factors was noticed in both genders.

Due to the high prevalence of persons having 0 to 1 of all 5 healthy factors, we investigated the potential sociodemographic contributors of poor lifestyle index (TABLE 4). In women, the higher age and the lower educational attainment, the higher probability of poor lifestyle index was found in both surveys. In men, educational level was the most significant sociodemographic contributor of the index (TABLE 4).

DISCUSSION The current analysis provides the insight to the 10-year changes in lifestyle patterns of the nationwide sample of Polish adults. To our knowledge, this is the first study presenting trends in the prevalence of combined risk factors and behaviors in this region of Europe.

A majority of various lifestyle scores or indexes used in assessing peoples lifestyle worldwide include similar characteristics, such as smoking status, dietary patterns, weight, and PA level. No matter which specific criteria were used, the studies investigating the impact of the combined low-risk factors on different clinical outcomes provided evidence on strong preventive role of sustaining healthy lifestyle.[1-9] There is also a growing body of evidence showing that even a small shift in lifestyle behaviors has the potential to reduce burden of chronic diseases and prolong life expectancy.[2,3,20,25] A decline in cardiovascular diseases and total mortality in Poland in the recent decades did not coincident with similar, dynamic favorable changes in the prevalence and treatment of hypercholesterolemia, hypertension, and smoking.[12,18,26] In the intervention study of primary,

secondary, and tertiary prevention, a decrease in mortality reflected less the use of cardioprotective medications than lifestyle changes, mainly in PA and diet.[26]

In the present analysis, we confirmed favorable changes in the prevalence of smoking, and to some extent, in nutrition habits that were described above. No substantial positive changes were observed in other analyzed lifestyle characteristics in the study period. Consequently, the cluster of risk factors combined with the lifestyle index has not changed since 2003. About 12.5% of the study participants were characterized by 4 or 5 low-risk factors while twice more had poor lifestyle (0–1 healthy characteristics) in both surveys. Although the percentage of persons declaring good-quality diet increased, the specific Mediterranean diet score was fairly stable and remained far from the recommendations.

The results achieved in other countries did not reveal much better results. In a 10-year prospective study of 0.5 million Chinese adults, Zhu et al[4] revealed that only 2.1% were characterized by all 5 healthy behaviors. Another large study conducted among more than 111 000 Americans participating in the Nurses' Health Study and the Health Professionals Follow-Up Study showed that following healthy lifestyle is also not common. Li et al[3] reported that only about 5.9% of the study group had 4 or 5 low-risk factors. Observation of 10-year trends in lifestyle patterns of the United States adults who participated in the Behavioral Risk Factor Surveillance System surveys did not show beneficial changes in the study period. Ford et al[5] created a lifestyle index including 4 characteristics, that is, not currently smoking, any exercise during the past 30 days, consuming fruits and vegetables 5 times or more per day, and body mass index of less than 25 kg/m^2. The age-adjusted percentage of adults meeting all 4 low-risk lifestyle factors decreased from 8.5% to 7.7% (P for linear trend <0.001). Similar lifestyle index was used among German participants of the EPIC (European Prospective Investigation Into Cancer and Nutrition-Potsdam) study. Fewer than 4% of participants had 0 healthy factors, most had 1 to 3 healthy factors, and approximately 9% had 4 factors.[6]

The strong relationship between the low-risk factors and all-cause mortality imposes a particular focus on these healthy behaviors. Although a spectacular progress in reducing prevalence of unhealthy lifestyle was observed in Polish society during the political and economic transformation, the favorable trends seem to have slowed down in the last decades.

According to the national statistics, smoking rates in Poland have declined over the past decade. The percentage of never smoking men has risen substantially since the 1990s. The average number of cigarettes smoked daily per smoker significantly decreased among men (from 17.9 to 15.8 cigarettes/day) and women (from 13.7 to 12.1 cigarettes/day).[12] However, as it was shown in the present analysis, regular smoking is still common in both genders. What is worse, the proportion of never smoking women has not changed since 2003. It seems that smoking shall remain one of the most challenging problems of public health. The WOBASZ studies demonstrated a limited efficiency of promotional and educational activities, fiscal policy, price control, counselling, and tobacco addiction treatment in reducing tobacco use. It is necessary to implement novel strategies in order to intensify tobacco control in Poland with a particular focus on the most vulnerable sociodemographic groups.

Although obesity became an explicit public health concern in most developed countries, general trends have remained unfavorable worldwide.[27,28] According to the prognosis performed by Ward et al,[29] the prevalence of adult obesity and severe obesity in the United States will continue to increase nationwide. The authors predict that by 2030, nearly 1 in 2 adults will have obesity and the prevalence will be higher than 50% in 29 states and not below 35% in any state. In Europe, the calculations provide less pessimistic prognosis, but they are still not favorable. By 2025, obesity is projected to increase in most European countries. If present trends continue, 33 of the 53 countries are projected to have an obesity prevalence of 20% or more.[30]

Data collected in Poland show that the age-standardized prevalence of obesity (BMI ≥30 kg/m^2) increased in the last decades reaching about 24.2% in men and 23.4% in women and this change was more pronounced in men (P <0.05). Between the years 2003 to 2005 and 2013 to 2014, the distribution of abdominal fat categories clearly shifted to higher values (45.7% in women and 32.2% in men) with more dynamic increase in waist circumference among men (P <0.05).[17] These findings are of special importance as excess of abdominal fat is particularly dangerous due low-grade inflammation, abnormal hormone secretion, metabolic disturbances, cardiovascular diseases, and cancers.[31]

In the present analysis, the percentage of persons with nonobese waist circumference decreased substantially between the surveys. It is not easy to find an evident reason of such unfavorable trend, especially in the context of several programs elaborated and implemented in recent years. In 2006, European countries adopted the European Charter on Counteracting Obesity in order to address the growing challenge posed by the epidemic of obesity.[32] However, the undertaken interventions have not been efficient enough to stop or slow down this trend in most countries.[33,34] It seems that preventive interventions should comprise wider spectrum of important contemporary factors such as chronic use of electronic devices (televisions, smartphones, laptops, computer games), sleep disorders, long-term stress at school or at work, highly processed food, and so on.

Changes in the PA level in Poland were particularly beneficial during the socioeconomic transformation 3 decades ago. According to the report of Bandosz et al,[35] over half of the decline in mortality from coronary heart disease in Poland could be attributed to changes in major risk factors, mainly reducing total cholesterol concentration and increasing leisure-time PA. An increased PA level explained about 10% of the decrease in mortality rates in Poland and resulted in about 2500 fewer coronary deaths between 1991 and 2005. The results obtained in the WOBASZ projects suggest that these remarkable trends in the PA level seem to have weakened in the recent years. As we reported in our previous studies, unfavorable changes were observed in all domains of PA. The percentages of subjects physically active at least 5 days per week fell substantially between the surveys in both genders. Unfavorable changes occurred also in work-related and commuting activity.[36] The most striking results concern the significant increase of physical inactivity among middle-aged men. These findings are of particular importance due to still high premature mortality among men in our country.[37] There are several potential reasons of decreasing PA in leisure time. It is partly due to increasing sedentarism during leisure time. Inactive individuals, especially middle-aged, revealed that the most frequent reason for not exercising is lack of time. This could be, to some extent, associated with a number of hours spent at work which is one of the highest in Europe. In the meantime, there is an increase in "passive" commuting which also contributes to insufficient PA. In order to counteract sedentary lifestyle, new more effective strategies should be encouraged and facilitated including engagement of family practitioners, trained nurses, health educators, occupational health specialists, media, and so on.

The Mediterranean diet has well established evidence on beneficial effects on various health outcomes also in societies other than Mediterranean. Grosso et al[23] evaluated the relationship between adherence to a Mediterranean-type diet and metabolic syndrome in the Polish arm of the HAPIEE (Health, Alcohol and Psychosocial factors in Eastern Europe) cohort study.[23,38] The authors demonstrated that individuals with the highest quality of diet had significantly lower risk of metabolic disorders. In another study, Witkowska et al[14] showed that nut consumption, which is an important element of the Mediterranean diet, is strongly correlated with better lifestyle choices.

Although some positive changes were observed in our study (a decrease of alcohol drinking above the median and an increase in the intake of fruits and nuts), the specific Mediterranean diet score remained far from the recommendations relevant for prevention.

These findings are in line with previous analyses of dietary habits of Polish adults.[14-16,36,37] Waśkiewicz et al[39] reported that a significant percentage of Poles had unhealthy dietary habits and the consumption of several macro- and micronutrients was found not to be balanced. Excessive total fat and saturated fatty acid intake was declared by about 80% of the study participants.[36] In the present study, the percentage of individuals declaring low consumption of saturated fatty acids significantly decreased, especially in men. Among other disturbing changes, consumption of meat and meat products did not decrease in the analyzed period. In spite of relatively large availability of vegetables, legumes and fish, the consumption of these products remained unchanged or even significantly decreased. The most probable reasons for continually inappropriate food choices of Polish adults seem poor dietary education at school, at work, in media, aggressive advertisement of highly processed food, higher prices of healthy products. Additionally, the process of food reformulation in order to reduce the content of calories, sugars, salt, or unhealthy fats is too slow.

Adherence to healthy behavior recommendations was related to some sociodemographic characteristics in the study population. As expected, poor lifestyle index rates were significantly higher among persons with lower educational attainment. This finding is in line with the results presented by other authors suggesting that those with elementary or less than college degrees exhibit unhealthy behavior profiles.[40-42] Zujko et al[13] showed that higher socioeconomic status was significantly associated with a more favorable lifestyle, better objective health outcomes and better dietary habits (including a higher intake of dietary antioxidants). Also, a recent report by Zagozdzon et al[41] revealed substantial differences regarding socioeconomic characteristics between smokers and nonsmokers in Poland. There was a statistically significant inverse relationship between income and smoking, and persons living in towns were more likely to smoke than those living in rural areas.[41] Education exerts a positive effect on health knowledge levels which results in better lifestyle choices.[42,43] The analysis of Hoffman and Lutz[39] revealed that an additional year of schooling increases the probability of having a healthy lifestyle by about 3.5%. In order to assess the awareness of risk factors and health behaviors, Piwońska et al[44] evaluated the cardiovascular health knowledge of the adult Polish population in the years 2003 to 2014. They found that younger and better educated persons had greater health knowledge. In the present analysis, age was also a significant determinant of lifestyle, especially in women. Women older than 64 years had significantly higher probability of poor lifestyle as compared with younger female respondents mainly due to the lower PA level and lower quality of diet (data not shown). Although there were substantial differences in lifestyle characteristics between genders (especially in smoking and waist circumference), the direction of changes was similar. Therefore, more

specific approach is required for middle-aged and older persons as well as those with lower educational attainment.

Our study has some limitations. The main disadvantage was the cross-sectional design which limits the causal inferences. A well-known limitation is also the possibility of recall bias due to self-reported data on smoking, nutrition, and PA level. Moreover, a single 24-hour recall method was applied, which may not reflect a typical diet. The use of several 24-hour recalls or multiday recalls would certainly increase the quality of the collected data, but it would be much more complicated in such a large study as WOBASZ and could result in an increase of drop-out rates. In order to make the dietary recall more precise, the participants of the WOBASZ studies were asked whether their diet on a given day was typical of their usual nutrition. Moreover, we did not analyze the effect of the season of the year on the Mediterranean diet score.

However, this study has important strengths. This analysis provides insight into trends in the prevalence of combined risk factors and behaviors over time in a large national representative sample of adults in Poland. Of note, both WOBASZ surveys adopted consistent methodology to ensure comparable data on trends in the study characteristics.

In conclusion, the results obtained in this analysis illustrate very low prevalence of healthy lifestyle as less than 2% of the study population followed a combination of all 5 low-risk factors. Importantly, no changes were observed in the distribution of lifestyle index between the surveys. The obtained results raise particular concerns in the context of a low PA level, inappropriate dietary choices and rising prevalence of obesity. However, the ultimate goal for healthcare experts and practitioners should be implementing more effective interventions focused not only on prevention of single risk factors, but rather on promoting a healthy lifestyle as a whole. Specific policies to promote a healthy lifestyle should engage relevant sectors like healthcare centers, also mass-media, food industry, workplace, legislation, local authorities, and so on. Health education focused on smoking, nutrition, and PA, labor and workplace policies promoting appropriate behaviors, creating attractive infrastructure for safe forms of active transportation, and better access to healthy food are among the most important issues.

ARTICLE INFORMATION

REFERENCES

1 Belloc NB, Breslow L. Relationship of physical health status and health practices. Prev Med. 1972; 1: 409-421.

2 Li Y, Pan A, Wang DD, et al. Impact of healthy lifestyle factors on life expectancies in the US population. Circulation. 2018; 138: 345-355.

3 Li Y, Schoufour J, Wang DD, et al. Healthy lifestyle and life expectancy free of cancer, cardiovascular disease, and type 2 diabetes: prospective cohort study. BMJ. 2020; 68: l6669.

4 Zhu N, Yu C, Guo Y, et al. Adherence to a healthy lifestyle and all-cause and cause-specific mortality in Chinese adults: a 10-year prospective study of 0.5 million people. Int J Behav Nutr Phys Act. 2019; 16: 98.

5 Ford ES, Li C, Zhao G, et al. Trends in low-risk lifestyle factors among adults in the United States: findings from the Behavioral Risk Factor Surveillance System 1996-2007. Prev Med. 2010; 51: 403-407.

6 Ford ES, Bergmann MM, Kroger J, et al. Healthy living is the best revenge: findings from the European Prospective Investigation Into Cancer and Nutrition-Potsdam Study. Arch Intern Med. 2009; 169: 1355-1362.

7 Loef M, Walach H. The combined effects of healthy lifestyle behaviors on all cause mortality: a systematic review and meta-analysis. Prev Med. 2012; 55: 163-170.

8 Stampfer MJ, Hu FB, Manson JE, et al. Primary prevention of coronary heart disease in women through diet and lifestyle. N Engl J Med. 2000; 343: 16-22.

9 Tamakoshi A, Tamakoshi K, Lin Y, et al. JACC Study Group. Healthy lifestyle and preventable death: findings from the Japan Collaborative Cohort (JACC) Study. Prev Med. 2009; 48: 486-92.

10 Manuel DG, Perez R, Sanmartin C, et al. Measuring burden of unhealthy behaviours using a multivariable predictive approach: life expectancy lost in Canada attributable to smoking, alcohol, physical inactivity and diet. PLoS Med. 2016; 13: e1002082.

11 Piwońska A, Piotrowski W, Kozela M, et al. Cardiovascular diseases prevention in Poland: results of WOBASZ and WOBASZ II studies. Kardiol Pol. 2018; 76: 1534-1541.

12 Polakowska M, Kaleta D, Piotrowski W, et al. Tobacco smoking in Poland in the years from 2003 to 2014. Multi-centre National Population Health Examination Survey (WOBASZ). Pol Arch Intern Med. 2017; 127: 91-99.

13 Zujko ME, Waśkiewicz A, Drygas W, et al. Dietary habits and dietary antioxidant intake are related to socioeconomic status in Polish adults: a nationwide study. Nutrients. 2020; 12: 518.

14 Witkowska AM, Waśkiewicz A, Zujko ME, et al. The consumption of nuts is associated with better dietary and lifestyle patterns in Polish adults: results of WOBASZ and WOBASZ II surveys. Nutrients. 2019; 11: 1410.

15 Różańska D, Waśkiewicz A, Regulska-Ilow B et al. Relationship between the dietary glycemic load of the adult Polish population and socio-demographic and lifestyle factors - results of the WOBASZ II study. Adv Clin Exp Med. 2019; 28: 891-897.

16 Pająk A, Szafraniec K, Polak M, et al. Changes in the prevalence, treatment, and control of hypercholesterolemia and other dyslipidemias over 10 years in Poland: the WOBASZ study. Pol Arch Med Wewn. 2016; 126: 642-652.

17 Stepaniak U, Micek A, Waśkiewicz A, et al. Prevalence of general and abdominal obesity and overweight among adults in Poland. Results of the WOBASZ II study (2013-2014) and comparison with the WOBASZ study (2003-2005). Pol Arch Med Wewn. 2016; 126: 662-671.

18 Niklas A, Flotyńska A, Puch-Walczak A, et al. Prevalence, awareness, treatment and control of hypertension in the adult Polish population - Multi-center National Population Health Examination Surveys – WOBASZ studies. Arch Med Sci. 2018; 14: 951-961.

19 Drygas W, Niklas AA, Piwońska A, et al. Multi-centre National Population Health Examination Survey (WOBASZ II study): assumptions, methods, and implementation. Kardiol Pol. 2016; 74: 681-690.

20 Booth JN 3rd, Colantonio DL, Howard G, et al. Healthy lifestyle factors and incident heart disease and mortality in candidates for primary prevention with statin therapy. Int J Cardiol. 2016; 207: 196-202.

21 Trichopoulou A, Kouris-Blazos A, Wahlqvist ML, et al. Diet and overall survival in elderly people. BMJ. 1995; 311: 1457-1460.

22 Trichopoulou A, Costacou T, Bamia C, Trichopoulos D. Adherence to a Mediterranean diet and survival in a Greek population. N Engl J Med. 2003; 348: 2599-2608.

23 Grosso G, Stepaniak U, Micek A, et al. A Mediterranean-type diet is associated with better metabolic profile in urban Polish adults: results from the HAPIEE study. Metabolism. 2015; 64: 738-746.

24 Piepoli MF, Hoes AW, Agewall S, et al. 2016 European Guidelines on cardiovascular disease prevention in clinical practice: the Sixth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of 10 societies and by invited experts). Developed with the special contribution of the European Association for Cardiovascular Prevention & Rehabilitation (EACPR). Eur Heart J. 2016; 37: 2315-2381.

25 Feldman AL, Long GH, Johansson I, et al. Change in lifestyle behaviors and diabetes risk: evidence from a population-based cohort study with 10 year follow-up. Int J Behav Nutr Phys Act. 2017; 14: 39.

26 Pająk A, Wolfshaut-Wolak R, Doryńska A, et al. Longitudinal effects of a nurse-managed comprehensive cardiovascular disease prevention program for hospitalized coronary heart disease patients and primary care high-risk patients. Kardiol Pol. 2020; 78: 429-437.

27 NCD Risk Factor Collaboration (NCD-RisC). Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19.2 million participants. Lancet. 2016; 387: 1377-1396.

28 Ford ES, Li C, Zhao G, Tsai J. Trends in obesity and abdominal obesity among adults in the United States from 1999-2008. Int J Obes (Lond). 2011; 35: 736-743.

29 Ward ZJ, Bleich SN, Cradock AL, et al. Projected US state-level prevalence of adult obesity and severe obesity. N Engl J Med. 2019; 381: 2440-2450.

30 Pineda E, Sanchez-Romero LM, Brown M, et al. Forecasting future trends in obesity across Europe: the value of improving surveillance. Obes Facts. 2018; 11: 360-371.

31 Tchernof A, Després JP. Pathophysiology of human visceral obesity: an update. Physiol Rev. 2013; 93: 359-404.

32 Brug J. The European charter for counteracting obesity: a late but important step towards action. Observations on the WHO-Europe ministerial conference, Istanbul, November 15-17, 2006. Int J Behav Nutr Phys Act. 2007; 4: 11.

33 Ezzati M, Riboli E. Can noncommunicable diseases be prevented? Lessons from studies of populations and individuals. Science. 2012; 337: 1482-1487.

34 Roberto CA, Swinburn B, Hawkes C, et al. Patchy progress on obesity prevention: emerging examples, entrenched barriers, and new thinking. Lancet. 2015; 385: 2400-2409.

35 Bandosz P, O'Flaherty M, Drygas W, et al. Decline in mortality from coronary heart disease in Poland after socioeconomic transformation: modelling study. BMJ. 2012; 344: d8136.

36 Kwaśniewska M, Pikala M, Bielecki W, et al. Ten-year changes in the prevalence and socio-demographic determinants of physical activity among Polish adults aged 20 to 74 years. results of the National Multicenter Health Surveys WOBASZ (2003–2005) and WOBASZ II (2013–2014). PLoS One. 2016; 11: e0156766.

37 Maniecka-Bryla I, Bryla M, Bryla P, Pikala M. The burden of premature mortality in Poland analysed with the use of standard expected years of life lost. BMC Public Health. 2015; 15: 101.

38 Boylan S, Welch A, Pikhart H, et al. Dietary habits in three Central and Eastern European countries: the HAPIEE study. BMC Public Health. 2009; 9: 439.

39 Waśkiewicz A, Szcześniewska D, Szostak-Węgierek D, et al. Are dietary habits of the Polish population consistent with the recommendations for prevention of cardiovascular disease? – WOBASZ II project. Kardiol Pol. 2016; 74: 969-977.

40 Skalamera J, Hummer RA. Educational attainment and the clustering of health-related behavior among U.S. young adults. Prev Med. 2016; 84: 83-89.

41 Zagozdzon P, Zarzeczna-Baran M, Jędrusik P, et al. Socioeconomic correlates and biochemical profiles of smokers in Poland: cross-sectional study. Pol Arch Intern Med. 2020; 130: 967-974.

42 Hoffmann R, Lutz SU. The health knowledge mechanism: evidence on the link between education and health lifestyle in the Philippines. Eur J Health Econ. 2019; 20: 27-43.

43 Pikala M, Burzyńska M, Pikala R, et al. Educational inequalities in premature mortality in Poland, 2002-2011: a population-based cross-sectional study. BMJ Open, 2016; 6: e011501.

44 Piwońska A, Piotrowski W, Piwoński J, et al. Cardiovascular health knowledge of the Polish population. Comparison of two national multi-centre health surveys: WOBASZ and WOBASZ II. Kardiol Pol. 2017; 75: 711-719.