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ARTYKUŁ ORYGINALNY / *ORIGINAL ARTICLE*

Prevalence of lipid abnormalities in Poland. The NATPOL 2011 survey

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Abstract

Background: Poland represents a country of high cardiovascular (CV) risk. The association between lipid abnormalities and increased CV risk is well established. Therefore, it is important to monitor the prevalence and control of dyslipidaemia.

Aim: To evaluate serum lipids concentrations as well as the prevalence, awareness, and control of lipid abnormalities in a representative sample of adults in Poland.

Methods: In 2011, in a national cross-sectional survey blood samples were collected from 1168 males and 1245 females, aged 18–79 years, for measurement of total cholesterol (TC), high density lipoprotein cholesterol (HDL-C), and triglycerides (TG) in blood serum. Low density lipoprotein cholesterol (LDL-C) was calculated using Friedewald's formula.

Results: Mean serum TC concentration was 197.1 mg/dL (95% CI 193.8–200.4) in males (M) and 198.6 mg/dL (95% CI 195.7–201.5) in females (F). Levels of LDL-C were 123.6 mg/dL (120.9–126.2) and 123.7 mg/dL (121.4–126.1), HDL-C — 45.8 mg/dL (44.7–47.0) and 54.1 mg/dL (53.1–55.1), TG — 140.9 mg/dL (133.0–148.8) and 104.0 mg/dL (99.8–108.2) for males and females, respectively. TC ≥ 190 mg/dL was found in 54.3% subjects (M 54.3%; F 54.4%). After adding patients on lipid-lowering treatment, hypercholesterolaemia was present in 61.1% of adults (M 60.8%; F 61.3%). LDL-C ≥ 115 mg/dL was detected in 57.8% of all subjects (M 58.3%; F 57.3%), while HDL-C < 40 mg/dL in 35.2% of males and < 45 mg/dL in 22% of females TG ≥ 150 mg/dL was found in 21.1% of subjects (M 28.4%; F 14.0%). The highest prevalence of elevated TC and LDL-C levels was present in the age group of 40–59-year-olds. Of those with hypercholesterolaemia 58.7% (M 61.5%, F 56.0%) were not aware of the condition; 22.0% (M 21.0%, F 24.5%) were aware but were not being treated; 8.1% (M 7.7%, F 8.5%) were treated but with TC ≥ 190 mg/dL; and only 10.9% (M 10.7%, F 11.0%) were being treated with TC < 190 mg/dL.

Conclusions: The prevalence of dyslipidaemia in Poland continues to be high — over 60% of adults have hypercholesterolaemia, and control remains poor. The results of the NATPOL 2011 survey call for urgent preventive measures.

Key words: lipids, cross sectional, nationally representative survey, prevalence, awareness, and control of dyslipidaemia

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INTRODUCTION

Lipid disorders have long been considered a major risk factor for cardiovascular diseases (CVD). There is a strong positive association between the development of atherosclerosis and increased levels of total cholesterol (TC) or — more precisely — its main fraction, i.e. low density lipoproteins (LDL-C). This association is evident from prospective observational population studies [1], premature clinical complications of familial hypercholesterolaemia [2], and a reduction in the rate of cardiovascular events, both fatal and non-fatal, as a result of lowering the levels of LDL-C following treatment with statins [3]. This final evidence, which indicates that a decrease in risk is directly proportional to the degree of reduction in LDL-C levels, also leads to the conclusion that the target in primary and secondary prevention should be set at very low LDL-C concentrations [4].

Another CVD risk factor is hypertriglyceridaemia, related to serum retention of very-low-density lipoprotein (VLDL) remnants, chylomicron remnants, and small VLDL particles [5]. These small lipoproteins contribute also to the development of atherosclerosis, under a mechanism similar to LDL. As shown by observational studies, low concentrations of high density lipoprotein cholesterol (HDL-C) increase the CVD risk, and, conversely, high concentrations of HDL-C have a preventive effect. However, these long-established facts are contradicted by the results of clinical trials where treatment leading to an increase in HDL-C concentrations was applied and where, despite the HDL-C increase, no decrease in the rate of cardiovascular episodes was recorded. This 'HDL paradox' was recently described in Polish literature [6, 7].

All this information on the role of lipoproteins as a risk factor provides a solid justification for nationwide population studies with regard to the incidence and management of lipid disorders in Poland, especially in light of changing dietary patterns and increasingly widespread use of statins. This risk factor was already assessed in several studies coded under the following acronyms: NATPOL-PLUS (2002; n = 3051; age 18–95) [8]; WOBASZ (2004–2007; n = 13545; age 20–74) [9]; and POLSENIOR (2007–2010; n = 4949; age 65–100) [10]. This paper is based on the results of the NATPOL 2011 survey (n = 2413; age 18–79) concerning the prevalence of lipid disorders in the adult Polish population, with controls for sex, age, body mass index (BMI), education level, and place of living, and it is also aimed at evaluating the efficiency of hypercholesterolaemia detection and treatment.

METHODS

The NATPOL 2011 survey (Arterial hypertension and other CVD risk factors in Poland; full Polish title: ***Na****dciśnienie* ***T****ętnicze oraz inne czynniki ryzyka chorób serca i naczyń w* ***Pol****sce*) was a cross-sectional observational study aimed at assessing the prevalence and control of CVD risk factors in Poland, taken on a representative sample of Polish men and women aged 18–79 years. The detailed description of a three-stage sample selection procedure, examination methods used for assessment of existing risk factors, and the procedure for blood sample taking, storage, and transport to the central laboratory were all described in detail in an earlier paper [11].

The NATPOL 2011 survey was carried out between January and August 2011. The participation rate was 66.5% of those invited to enter the survey who met the inclusion criteria. As a result, in line with the study design assumptions, the total sample consisted of 2413 participants — 1168 men and 1245 women. Age distribution in the sample was as follows: 974 subjects aged 18–39 years, 879 subjects aged 40–59 years, and 590 subjects aged 60–79 years. The gender and age structure of the sample corresponded to the structure of the Polish population in 2010. Mean age was 44.9 ± 16 for men and 46.7 ± 17.2 for women. 1113 (46.1%) participants were residents of the countryside; 359 (14.9%) lived in towns < 50,000 residents; 410 (17%) — in cities 50,000–200,000 residents; and 531 (22%) — in the largest cities > 200,000 residents. Elementary school, basic (post-primary vocational) education, and unfinished secondary was reported by 956 participants (39.6%); secondary and unfinished university-level — by 948 (39.3%); and university-level education — by 509 (21.1%).

Blood samples were collected at the patient's home, after 10–12 h of fasting. Frozen serum and plasma samples were transported to the central laboratory where analyses were performed. TC, HDL-C, LDL-C, and triglycerides (TG) in serum were analysed with an Architect c8000 clinical chemistry analyser (Abbott Laboratories). Serum TC concentrations were determined by enzymatic method using cholesterol esterase and cholesterol oxidase; HDL-C — by using Accelerator Selective Detergent causing accelerated non-HDL-C oxidation and HDL-C dissolving; LDL-C concentrations were calculated using Friedewald's formula: LDL-C [mg/dL] = TC [mg/dL] – HDL-C [mg/dL] – TG [mg/dL]/5.

Where TG concentrations were greater than 400 mg/dL, Friedewald's formula was not used. TG concentrations were determined by enzymatic method using glycerol kinase and glycerol-3-phosphate oxidase. Serum levels of apolipoprotein A1 and apolipoprotein B (apo B) were determined by immunonephelometry, and the results will be discussed in a separate publication.

Hypercholesterolaemia was defined as either measured TC concentrations ≥ 190 mg/dL (≥ 5.0 mmol/L) or taking statins/fibrates. Increased LDL-C was diagnosed for concentrations ≥ 115 mg/dL (≥ 3.0 mmol/L). Abnormalities in serum levels of HDL-C were defined as concentrations < 45 mg/dL (< 1.2 mmol/L) in women and < 40 mg/dL (< 1.0 mmol/L) in men. Increased TG concentrations were defined at levels ≥ 150 mg/dL (≥ 1.7 mmol/L). The criteria for diagnosing abnormal lipid and lipoprotein concentrations are in line with the guidelines of the European Society of Cardiology [4, 12].

Statistical analyses were carried out using the following software packages: SAS for Windows (ver. 9.1.3.) and R (The R Foundation). Basic statistical analyses involving estimation of the indicators defined in the study objectives were conducted using the procedures of SURVEYFREQ and SURVEYMEANS of the SAS package, taking into account the design effect of the survey.

The NATPOL 2011 survey was approved by the Bioethics Commission of the Medical University of Gdansk.

RESULTS

As shown in Table 1, mean concentrations of TC and LDL-C in men were 197.1 mg/dL (95% CI 193.8–200.4) and 123.6 mg/dL (120.9–126.2), respectively. The corresponding values in women were 198.6 mg/dL (195.7–201.5) and 123.7 mg/dL (121.4–126.1). The highest mean concentrations of TC and LDL-C are found in middle-aged men and women (age group: 40–59 years). In this age range, TC concentration values were as follows: 212.4 mg/dL (208–216.8) for men, and 214.4 mg/dL (210–218.8) for women, but LDL-C concentrations were: 135.1 mg/dL (131.5–138.8) for men and 137.2 mg/dL (133.2–141.1) for women. Mean HDL-C concentrations in men were lower than in women (45.8 mg/dL [44.7–47.0] vs. 54.1 mg/dL [53.1–55.1]), respectively. This was true for all age groups. The difference in concentrations of this lipid between sexes were not dependent on age. Men had higher mean TG concentrations than women — 140.9 mg/dL (133–148.8) vs. 104 mg/dL (99.8–108.2). This difference applied to the 18–39 and 40–59 age groups, whereas TG concentrations in the 60–79 age group were similar for both males and females.

Table 1. Mean values of serum total cholesterol, low density lipoprotein cholesterol (LDL-C), high density lipoprotein cholesterol (HDL-C), and triglycerides

Age intervals [years]	Mean (95% CI)	
	Men (n = 1168)	Women (n = 1245)
Total cholesterol [mg/dL]		
18–39	184.7 (180.1–189.3)	180.5 (177.1–183.9)
40–59	212.4 (208–216.8)	214.4 (210–218.8)
60–79	194.7 (187.9–201.4)	207.4 (202.1–212.7)
All (18–79)	197.1 (193.8–200.4)	198.6 (195.7–201.5)
LDL-C [mg/dL]*		
18–39	113.1 (109.4–116.8)	109.1 (106.1–112.1)
40–59	135.1 (131.5–138.8)	137.2 (133.2–141.1)
60–79	124.8 (119.2–130.4)	129.9 (125–134.7)
All (18–79)	123.6 (120.9–126.2)	123.7 (121.4–126.1)
HDL-C [mg/dL]		
18–39	44.7 (43.2–46.2)	54.3 (53–55.5)
40–59	47.3 (45.4–49.3)	54.7 (52.7–56.6)
60–79	45.3 (43.2–47.3)	52.8 (50.9–54.6)
All (18–79)	45.8 (44.7–47)	54.1 (53.1–55.1)
Triglycerides [mg/dL]		
18–39	136.2 (123.9–148.4)	85.6 (82–89.3)
40–59	154.4 (141.2–167.6)	113 (105.1–121)
60–79	122.3 (112.5–132.1)	125.2 (118.5–132)
All (18–79)	140.9 (133–148.8)	104 (99.8–108.2)

*The results of LDL-C were calculated using Friedewald's formula only when the triglyceride concentration was < 400 mg/dL (< 4.5 mmol/L). The results are given as mean values. In parentheses are 95% confidence intervals (95% CI). The results include the design effect — DEFF. To obtain blood cholesterol and triglycerides in mmol/L divide concentrations in mg/dL by 38.5 and 88.5, respectively.

From Table 2, which shows the percentage distribution of TC concentrations, we can find that TC ≥ 190 mg/dL was found in 54.3% subjects. There is no difference in this respect between male and female subjects (54.3% vs. 54.4%). Severe hypercholesterolaemia (TC ≥ 310 mg/dL) was seen in 0.8% of men and 0.6% of women. Hypercholesterolaemia was most often found in those aged 40–59 years (71.6%). In older subjects (age group: 60–79) increased concentrations of TC were less frequently found (59.3%); and even less often within the oldest sub-group (age: 65–79; 54.3%). Overweight (BMI 25–29.9 kg/m^2) or obese subjects (BMI ≥ 30 kg/m^2) suffered from hypercholesterolaemia more often than those with BMI < 25 kg/m^2. The corresponding percentages are: 61.9%, 61%, and 44.6%. The frequency of increased TC concentrations was higher in those with primary or post-primary vocational education (57.8%), compared to subjects with secondary (52.1%) or higher (53%) education.

When statin/fibrate use was included in the analysis, hypercholesterolaemia was found in 61.1% of subjects (95% CI 58.2–63.9%): in men: 60.8% (95% CI 56.4–65.1%); in women: 61.3% (95% CI 57.4–65.1%); twice as often in the 40–59 and 60–79 age groups (correspondingly: 76.6% and 82.9%) than in the 18–39 age group (38%) (Table 3). If we estimate the population of Poles aged 18–79 years to be about 29,398,000 (based on Central Statistical Office data), we can estimate that the number of patients with hypercholesterolaemia in this broad age range stands at approx. 17,954,000 (95% CI 16,420–19,489 million). The incidence of hypercholesterolaemia is higher in overweight or obese people (69.3% and 74.2%, respectively), compared to those with BMI < 25 kg/m^2 (46.5%). Hypercholesterolaemia was detected in 66.3% of those with elementary or vocational education, 57.5% of people with secondary education, and 59.2% of people with higher education.

Increased serum concentrations of LDL-C (≥ 115 mg/dL) were found in 57.8% of the population under study (Table 4) and the results are similar for men and women (58.3% and 57.3%, respectively). LDL-C < 100 mg/dL (2.5 mmol/L) was found in 25.8% of the population (male [M] 26.3%, female [F] 25.2%). These concentrations of LDL-C are considered

Table 2. The percentage of studied subjects (%) by serum total cholesterol intervals

	< 175 mg/dL	175–189 mg/dL	190–239 mg/dL	240–309 mg/dL	≥ 310 mg/dL
All					
The percentage in each interval	30.7%	14.9%	38.4%	15.2%	0.7%
The cumulated percentage	30.7%	45.7%	84.1%	99.3%	100.0%
By age					
18–39 years	46.0%	16.8%	30.0%	6.9%	0.3%
40–59 years	15.4%	13.0%	47.7%	22.8%	1.1%
60–79 years	26.2%	14.4%	39.3%	19.1%	0.9%
By gender*					
Men	33.1%	12.6%	38.3%	15.2%	0.8%
Women	28.5%	17.1%	38.6%	15.2%	0.6%
By body mass index [kg/m^2]					
< 25.0	38.1%	17.2%	32.7%	11.5%	0.4%
25.0–29.9	26.3%	11.8%	41.6%	19.0%	1.3%
≥ 30.0	25.8%	13.2%	44.1%	16.3%	0.6%
By education					
Primary or basic	28.5%	13.7%	40.0%	16.8%	1.0%
Secondary or incomplete higher	32.6%	15.3%	37.7%	13.8%	0.6%
Higher	30.8%	16.1%	37.3%	15.3%	0.4%
By place of residence					
Village or towns < 50,000	29.3%	13.7%	40.5%	15.6%	0.9%
Towns 50,000–200,000	35.7%	17.7%	30.9%	15.4%	0.2%
Towns > 200,000	30.4%	15.8%	39.1%	13.8%	0.9%

*Mann-Whitney test to compare the differences in distribution between men and women: $p = 0.219$. To obtain blood cholesterol in mmol/L divide concentrations in mg/dL by 38.5.

optimal for healthy people. LDL-C < 70 mg/dL (< 1.8 mmol/L) was found in 4% of the population (M: 5.2%, F: 2.9%) and LDL-C < 55 mg/dL (< 1.4 mmol/L) — in 0.9% of the population (M: 0.9%, F: 0.9%). On the other hand, 3.8% of people had LDL-C levels ≥ 190 mg/dL (M: 3.4%, F: 4.2%). The highest incidence of increased LDL-C levels was found in the 40–59 age group (72.5%), similarly as in the case of increased TC (71.6%). Similarly to TC ≥ 190 mg/dL, the incidence of LDL-C ≥ 115 mg/dL was lower in people 60–79 years old. Overweight and obesity were linked to a higher proportion of people with increased LDL-C (65.4% and 63.7%), compared to those with normal body weight (48.1%). In our survey education had no association with increased LDL-C levels.

Low concentrations of HDL-C (Table 5) were found in 35.2% of men and 22% of women (low HDL-C is diagnosed at < 40 mg/dL in men and < 45 mg/dL in women). High HDL-C concentrations (≥ 60 mg/dL) were found in women more than twice as often as in men (28.0% vs. 13.3%). No significant association of age and hypoalphalipoproteinaemia was detected (neither for HDL-C < 40 mg/dL nor < 45 mg/dL). Low HDL-C was more often found in overweight and obese people, compared to those with BMI < 25 kg/m^2 (respective figures: 27.4%, 31.7%, and 13% for HDL-C < 40 mg/dL; and 43%, 53.2%, and 24.4% for HDL-C < 45 mg/dL). Higher proportions of low HDL-C were observed in people with elementary/vocational or secondary education, compared to those with higher education (respective concentrations: 22.4% and 24.8% vs. 18% for HDL-C < 40 mg/dL; 39.3% and 39.5% vs. 33% for HDL-C < 45 mg/dL).

Hypertriglyceridaemia (TG ≥ 150 mg/dL) was found in 21.1% of the study population (Table 6). Increased TG concentrations were found twice as often in men (28.4%) compared to women (14.0%). Very high TG levels (≥ 400 mg/dL; 4.5 mmol/l) were found in 3.1% of male and 0.2% of female subjects. Hypertriglyceridaemia affected overweight and obese individuals more often (23.9% and 36.2%, respectively) than those with BMI < 25 kg/m^2 (10.4%). Hypertriglyceridaemia occured more often in those with elementary/vocational and secondary education (21.9% and 21.8%), compared to people with higher education (18.1%).

Data on the management of hypercholesterolaemia in Poland in 2011 are shown in Tables 7 and 8). Table 7 shows that among those with hypercholesterolaemia 58.7% were unaware of the condition (M: 61.5%, F: 56%), 22.4% were

Table 3. The prevalence of hypercholesterolaemia (total cholesterol > 190 mg/dL or statins/fibrates use) in Poland by age, gender, body mass index, education, and place of residence

	Subjects with hypercholesterolaemia — prevalence in per cent (95% CI)	Subjects in the NATPOL 2011 sample — number
All	61.1 (58.2–63.9)	1504
By age		
18–39 years	38.0 (33.9–42.2)	385
40–59 years	76.6 (73.2–79.7)	648
60–79 years	82.9 (78.6–86.5)	471
By gender		
Men	60.8 (56.4–65.1)	734
Women	61.3 (57.4–65.1)	770
By body mass index [kg/m^2]		
< 25.0	46.5 (42.4–50.7)	481
25.0–29.9	69.3 (64.6–73.7)	502
≥ 30.0	74.2 (69.6–78.4)	413
By education		
Primary or basic	66.3 (60.9–71.3)	612
Secondary or incomplete higher	57.5 (53.6–61.2)	594
Higher	59.2 (54.2–64.1)	298
By place of residence		
Village or towns < 50,000	63.6 (59.4–67.5)	934
Towns 50,000––200,000	55 (49.1–60.7)	244
Towns > 200,000	59.5 (54.4–64.4)	326

The results after weighing in relation to age and sex structure of the population of adult Poles in 2011. The results include the design effect — DEFF.

aware but not in treatment (M: 20.1%, F: 24.5%), 8.1% were treated but not effectively (TC ≥ 190 mg/dL, M: 7.7%, F: 8.4%), and only 10.9% were treated effectively (TC < 190 mg/dL, M: 10.7%, F: 11%). The largest proportions of patients who are aware of hypercholesterolaemia (57.5%), undergoing treatment for the condition (40.1%), with good control among all individuals with hypercholesterolaemia (28.2%), and with good management of the condition among all people treated (70.3%), were found in individuals aged 60–79 years (Table 8). Those more aware of hypercholesterolaemia were overweight and obese individuals (33.4% and 49.6%, respectively), compared to those with BMI < 25 kg/m^2 (24%). In the group of overweight and obese people there was also a higher proportion of people treated for hypercholesterolaemia (18.7% and 29.8% vs. 8.1%) and a better control of cholesterol concentrations.

Table 9 shows that of the risk factors associated with hypercholesterolaemia, the factor with the greatest impact was age: odds ratio (OR) for people aged 40–59 (vs. 18–39) was 4.76 (3.85–5.87), while OR for those aged 60–79 it was (vs. 18–39) 6.52 (4.87–8.72). There was also an association between hypercholesterolaemia and overweight and obesity: OR 1.75 (1.41–2.17) and 1.86 (1.43–2.42), respectively. Gender had no impact on hypercholesterolaemia.

DISCUSSION

Compared to the 2002 NATPOL PLUS survey [8], mean TC concentrations in the population of Polish adults decreased during nine years, from 205.1 mg/dL to 197.1 mg/dL among men and from 207.2 mg/dL to 198.6 mg/dL among women.

It should be noted that the 2002 survey was conducted on a population sample of 18–94-year-olds, whereas the 2011 sample included respondents aged 18–79 years; however, data collected in 2002 on TC and LDL-C levels are split between sexes and age groups; therefore, it is possible to compare the results of the two surveys. A considerable decrease in TC levels was specifically observed in people aged 60 years or older (M: from 211.6 mg/dL to 194.7 mg/dL; F: from 232.6 mg/dL to 207.4 mg/dL). Similarly, LDL-C levels in this age group have also decreased (M: from 132.8 mg/dL to 124.8 mg/dL; F: from 145.1 mg/dL to 129.9 mg/dL). In the 40–59 age group there has been practically no change in TC and LDL-C concentrations. The likely cause for the decrease in TC and LDL-C levels in subjects aged 60–79 may be the more widespread use of statin therapy in this age group in the years 2002–2011 [13]. Data from Intercontinental Manufacturing Services Health show a large increase in statin sales in the period, but data on specific age groups are lacking. The decrease in TC and LDL-C levels cannot be explained by favourable changes in Polish dietary patterns (a markedly reduced intake of animal fats and an increased consumption of vegetable fats), because these changes occurred primarily in the first decade after 1991 [14] and that was the period when they could have had an impact on population levels of TC and LDL-C. After that period dietary changes were only small. It is a disconcerting finding that the highest TC and LDL-C concentrations are found in the middle-aged group (40–59 years old).

Similar results were obtained in surveys carried out in the United States, Canada, and Germany. In the NHANES survey (National Health and Nutrition Examination Survey), carried out in 1999–2000 on a sample of 4115 adults aged 20 years and older, mean TC levels in the entire population were 205.6 mg/dL (F) and 202.9 mg/dL (M), but they reached the level of 235.2 mg/dL in women aged 55–74 years and 215.6 mg/dL in men aged 45–64 years [15]. In the German DEGS1 survey (German Health Interview and Examination Survey for Adults), taken in 2008–2010 on a sample of about 7000 people aged 18–79 years, the mean TC concentrations

Table 4. The percentage of studied subjects (%) by serum low density lipoprotein cholesterol intervals

	< 70 mg/dL	70–99 mg/dL	100–114 mg/dL	115–154 mg/dL	155–189 mg/dL	≥ 190 mg/dL
All						
The percentage in each interval	4.0%	21.8%	16.4%	40.7%	13.3%	3.8%
The cumulated percentage	4.0%	25.8%	42.2%	82.9%	96.2%	100.0%
By age						
18–39 years	6.3%	30.6%	20.5%	35.9%	5.7%	1.1%
40–59 years	1.3%	12.9%	13.3%	45.7%	20.5%	6.3%
60–79 years	4.3%	19.0%	13.4%	41.6%	16.6%	5.1%
By gender*						
Men	5.2%	21.1%	15.4%	41.1%	13.8%	3.4%
Women	2.9%	22.3%	17.5%	40.4%	12.7%	4.2%
By body mass index [kg/m^2]						
< 25.0	5.3%	28.2%	18.0%	36.0%	9.0%	3.4%
25.0–29.9	2.7%	16.7%	15.0%	43.1%	16.7%	5.6%
≥ 30.0	3.7%	20.0%	12.6%	45.6%	16.1%	2.0%
By education						
Primary or basic	4.5%	21.1%	15.8%	38.5%	16.1%	4.0%
Secondary or incomplete higher	4.3%	21.2%	17.4%	41.9%	12.1%	3.2%
Higher	2.6%	23.9%	15.7%	42.0%	11.0%	4.8%
By place of residence						
Village or towns < 50,000	3.9%	21.8%	15.3%	40.7%	14.5%	3.8%
Towns 50,000–200,000	5.1%	22.2%	18.2%	38.6%	12.4%	3.5%
Towns > 200,000	3.1%	21.4%	17.9%	42.7%	10.9%	4.1%

*Mann-Whitney test to compare the differences in distribution between men and women: p = 0.910. Subjects with serum triglycerides ≥ 400 mg/dL were excluded from the analysis. To obtain blood cholesterol in mmol/L divide concentrations in mg/dL by 38.5.

were 205.1 mg/dL (F) and 200.1 mg/dL (M) [16]. In a study using the data from the Canadian Primary Care Sentinel Surveillance Network for a population of more than 128,000 Canadians aged 20 years and older, the mean level of TC was 191.9 mg/dL, and LDL-C — 112.2 mg/dL [17]. Lower levels of serum cholesterol were detected in a study carried out in Saudi Arabia on a population of about 4500 people, but the study included individuals aged 15 years and older. Mean TC levels were 172.1 mg/dL in females and 173.6 mg/dL in males, and LDL-C — 107.0 mg/dL and 106.3 mg/dL, respectively [18]. The levels of TC found in the NATPOL 2011 survey are close to the levels found in the populations of developed North American and European countries.

Hypercholesterolaemia is the most prevalent risk factor in the Polish population: 61.1% of Polish adults have hypercholesterolaemia (this includes people with TC ≥ 190 mg/dL and those who take hypolipidaemic agents). When hypercholesterolaemia is diagnosed on the basis of serum TC levels only, it is found in 54.3% of Polish adults. This means that the frequency of hypercholesterolaemia defined as TC ≥ 190 mg/dL has decreased over the past nine years: in 2002, when diagnosed on the basis of serum TC levels only, it was found in 60.7% of the study population [8]. The group with the highest incidence rate of hypercholesterolaemia (82.9%) are those aged 60–79 years. This incidence rate covers both those with TC ≥ 190 mg/dL and/or those who take hypolipidaemic drugs (the proportion of people on lipid-lowering drugs is largest in this age group).

The frequency of hypercholesterolaemia (TC ≥ 200 mg/dL) measured in the 1999–2000 NHANES survey was 50.9% in women and 50.4% in men. Hypercholesterolaemia, defined as TC > 200 mg/dL and/or use of hypolipidaemic drugs, was found in 53.5% of women and 55.7% of men, and TC levels for both sexes peaked in the 64–74-year age group [15]. A hypercholesterolaemia frequency similar to Poland was detected in the German DEGS1 survey — TC levels > 190 mg/dL were found in 60.5% of women and in 56.5% of men [16]. The results of the survey taken in Saudi Arabia differ strongly from the results obtained in Poland and Germany. In the Saudi Arabian survey TC levels > 200 mg/dL were found in 19.9% of women and in 18.7% of men [18].

Results of the surveys confirm the established association of HDL-C levels with overweight and obesity. In the 2011

Table 5. The percentage of studied subjects (%) by serum high density lipoprotein cholesterol intervals

	< 40 mg/dL	40–44 mg/dL	45–49 mg/dL	50–59 mg/dL	≥ 60 mg/dL
All					
The percentage in each interval	22.5%	15.6%	15.3%	25.8%	20.8%
The cumulated percentage	22.5%	38.1%	53.4%	79.2%	100.0%
By age					
18–39 years	23.2%	16.4%	14.7%	26.3%	19.3%
40–59 years	21.9%	14.3%	15.1%	25.0%	23.7%
60–79 years	22.1%	16.3%	17.0%	26.1%	18.5%
By gender*					
Men	35.2%	19.6%	14.5%	17.3%	13.3%
Women	10.4%	11.8%	16.1%	33.7%	28.0%
By body mass index [kg/m^2]					
< 25.0	13.0%	11.4%	14.9%	31.0%	29.7%
25.0–29.9	27.4%	15.6%	16.2%	23.3%	17.4%
≥ 30.0	31.7%	21.5%	17.1%	18.3%	11.4%
By education					
Primary or basic	22.4%	16.9%	14.6%	25.1%	21.0%
Secondary or incomplete higher	24.8%	14.7%	15.4%	25.8%	19.3%
Higher	18.0%	15.1%	16.3%	26.9%	23.7%
By place of residence					
Village or towns < 50,000	20.6%	17.0%	14.8%	26.4%	21.2%
Towns 50,000–200,000	27.9%	14.7%	18.4%	21.2%	17.7%
Towns > 200,000	23.1%	12.3%	14.2%	27.8%	22.5%

*Mann-Whitney test to compare the differences in distribution between men and women: $p < 0.001$. To obtain blood cholesterol in mmol/L divide concentrations in mg/dL by 38.5.

NATPOL survey low concentrations of HDL-C were found in 22% of women and in 35.2% of men. This is similar to the results of the 2003–2006 NHANES survey — 23.3% at the same cutoff points [19], but it was much higher than the results of DEGS1. In the German survey HDL-C levels < 40 mg/dL were found in 3.6% of women and in 19.3% of men [16]. When analysing these differences, one should take into account the specific profile of each population and the differences in methods used to measure HDL-C levels.

Hypertriglyceridaemia (TG > 150 mg/dL) is found in 21.7% of the Polish population (M: 28.4%, F: 14%), and more often in people classified as overweight and obese. The frequency of hypertriglyceridaemia in the 2003–2006 NHANES survey was slightly higher — 29.6% [19]. It should be emphasised that mean levels of LDL-C and TG are higher in men and women in the 40–59 age group, compared to other age groups. Considering the high prevalence of lipid disorders in people aged 40–59 years, we conclude that this age group carries the highest risk of CVD. It should be also kept in mind that LDL-C was identified as the primary lipid analysis (Class I of recommendations) for lipid screening and control [4]. Apo B should be considered an alternative risk marker, especially in patients with combined hyperlipidaemia, diabetes, metabolic syndrome, and chronic kidney disease (Class IIa of recommendation with C level of evidence), whereas control of apo B levels is considered to be a secondary treatment target (Class IIa B).

The data concerning control of hypercholesterolaemia in Poland, obtained in the 2011 NATPOL survey, should send a warning message. Almost 60% of patients with hypercholesterolaemia are unaware of their condition, one person in five knows about it but does not take any treatment, 8% of patients take some medication but it is not effective, and only about 11% are on an effective treatment regime. However, the control of dyslipidaemia is not a problem limited just to Poland. Similar data were obtained in surveys carried out in other countries. In the 1999–2000 NHANES survey 65% of subjects with hypercholesterolaemia (the condition was defined as it was in NATPOL) were unaware of their disease, 12% were in treatment, and only 5.4% were on an effective treatment regime [15]. In the DEGS1 survey, it was established that 72.4% of the German population with TC levels > 190 mg/dL are not aware of their hypercholesterolaemia [16].

A telling example for the importance of cholesterol level reduction in the prevention of CVDs is the IMPACT model,

Table 6. The percentage of studied subjects (%) by serum triglycerides intervals

	< 150 mg/dL	150–199 mg/dL	200–399 mg/dL	≥ 400 mg/dL
All				
The percentage in each interval	79.0%	10.4%	9.0%	1.7%
The cumulated percentage	79.0%	89.4%	98.3%	100.0%
By age				
18–39 years	83.6%	8.1%	6.7%	1.6%
40–59 years	74.3%	12.2%	11.4%	2.1%
60–79 years	77.6%	12.2%	9.3%	0.9%
By gender*				
Men	71.5%	12.8%	12.5%	3.1%
Women	86.0%	8.2%	5.6%	0.2%
By body mass index [kg/m^2]				
< 25.0	89.5%	6.1%	4.0%	.3%
25.0–29.9	76.1%	11.3%	10.1%	2.5%
≥ 30.0	63.8%	17.1%	16.1%	3.0%
By education				
Primary or basic	78.1%	10.0%	9.7%	2.2%
Secondary or incomplete higher	78.1%	11.1%	9.6%	1.1%
Higher	82.0%	9.8%	6.5%	1.8%
By place of residence				
Village or towns < 50,000	78.0%	10.7%	9.9%	1.4%
Towns 50,000–200,000	82.1%	7.6%	9.0%	1.4%
Towns > 200,000	78.8%	12.1%	6.6%	2.5%

*Mann-Whitney test to compare the differences in distribution between men and women: $p < 0.001$. To obtain blood triglycerides in mmol/L divide concentrations in mg/dL by 88.5.

Table 7. Awareness, treatment, and control of hypercholesterolaemia in Poland

	The percentage (%) of patients with TC ≥ 190 mg/dL, who are not treated		The percentage (%) of patients on statins or fibrates	
	Unaware of high cholesterol (newly detected)	Aware of high cholesterol but not treated	Treated unsuccessfully: TC ≥ 190 mg/dL	Treated successfully: TC < 190 mg/dL
All (100% patients)	58.7 (54.9–62.4)	22.4 (19.7–25.2)	8.1 (6.2–10.5)	10.9 (8.9–13.2)
By gender				
Men	61.5 (56.7–66.1)	20.1 (16.9–23.6)	7.7 (5.4–10.9)	10.7 (8.4–13.5)
Women	56 (50.6–61.3)	24.5 (20.7–28.7)	8.4 (5.8–12.2)	11 (8.1–14.9)

TC — total cholesterol; Hypercholesterolaemia is defined as serum TC ≥ 190 mg/dL and/or hypolipidaemic medication i.e. statin/fibrate (regardless of the level of TC). The results after weighing in relation to age and sex structure of the population of adult Poles in 2011. The results include the design effect — DEFF. Comparison of the distribution between men and women — χ^2 test: $p = 0.152$.

which shows that the decline in coronary heart disease mortality in Poland over the period of 1991–2005 (reduction by 26,200 coronary deaths) can be credited in 39% to a decrease in TC levels [20]. In the first years following 1991, the decrease in cholesterol levels are probably attributed to considerable favourable changes in the structure of fats consumed by the population [14], but in subsequent years the primary impact resulted probably from an increased use of hypolipidaemic drugs because dietary patterns ceased to change.

CONCLUSIONS

The NATPOL survey is not only a rich source of data concerning the prevalence of CVD risk factors in the population of adult Poles, including lipid disorders, but it also opens an

Table 8. Awareness, treatment, and control of hypercholesterolaemia depending on the age and body mass index

	The percentage of aware among all patients	The percentage of treated among all patients	The percentage of good control: TC < 190 mg/dL among all patients	The percentage of good control: TC < 190 mg/dL among all treated
Age				
18–39 years	11.1 (8.3–14.6)	2.8 (1.4–5.5)	1.8 (0.7–4.6)	65.7 (33.1–88.2)
40–59 years	39.3 (34.4–44.4)	16.6 (12.8–21.3)	6.5 (4.7–9.1)	39.4 (30.5–48.9)
≥ 60 years	57.5 (49.8–64.8)	40.1 (34.8–45.7)	28.2 (22.9–34.2)	70.3 (61.3–78)
P	< 0.001	< 0.001	< 0.001	< 0.001
By body mass index [kg/m^2]				
< 25.0	24 (20.1–28.3)	8.1 (5.8–11.2)	3.9 (2.2–6.7)	47.9 (31.7–64.6)
25.0–29.9	33.4 (28.4–38.9)	18.7 (14.7–23.4)	10.7 (8–14)	57.1 (46.8–66.7)
≥ 30.0	49.6 (43–56.2)	29.8 (23.8–36.6)	17.5 (13.7–22.2)	58.9 (49.9–67.2)
P	< 0.001	< 0.001	< 0.001	0.467

Hypercholesterolaemia is defined as serum total cholesterol ≥ 190 mg/dL and/or hypolipidaemic medication i.e. statin/fibrate (regardless of the level of total cholesterol).

Table 9. Multivariate logistic regression to estimate the odds of hypercholesterolaemia for each of the factors after correction by other variables

Factor	Odds ratio	95% CI
Age the reference group: 18–39 years		
40–59 vs. 18–39 years	4.76	3.85–5.87
60–79 vs. 18–39 years	6.52	4.87–8.72
Gender the reference group: women		
Man vs. woman	0.94	0.77–1.14
BMI the reference group: BMI < 25 kg/m^2		
Overweight (BMI 25–25.99 kg/m^2) vs. subjects with BMI < 25 kg/m^2	1.75	1.41–2.17
Obesity (BMI ≥ 30 kg/m^2) vs. subjects with BMI < 25 kg/m^2	1.86	1.43–2.42
Education the reference group: subjects with higher education		
Primary or basic vs. higher	0.77	0.6–1.01
Secondary vs. higher	0.75	0.59–0.95
R^2	0.240	

Hypercholesterolaemia is defined as serum total cholesterol ≥ 190 mg/dL and/or hypolipidaemic medication i.e. statin/fibrate (regardless of the level of total cholesterol); BMI — body mass index, OR — odds ratio; CI - confidence interval

opportunity to measure and evaluate changes that occurred in this field over the period between 2002 and 2011. The comparison between these two points in time provides valuable information on the effectiveness of preventive actions. Even though the situation concerning the prevalence of lipid disorders has improved, the incidence of these disorders in the population remains high. This indicates that intensive efforts are required to improve the detection and management of these disorders, especially because that is a cost-effective way in which coronary episodes may be prevented. The NATPOL survey could serve as a model base survey to monitor the CVD risk factors, and as such, should be regularly run at predetermined cycles.

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Rozpowszechnienie zaburzeń lipidowych w Polsce. Wyniki badania NATPOL 2011

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Streszczenie

Wstęp: Polska ciągle należy do krajów o wysokim ryzyku sercowo-naczyniowym. Zaburzenia lipidowe należą do głównych czynników ryzyka chorób sercowo-naczyniowych. Dotyczy to przede wszystkim stężenia cholesterolu całkowitego (TC) i cholesterolu frakcji liporotein o niskiej gęstości (LDL-C). Dlatego potrzebna jest okresowa ocena występowania dyslipidemii w populacji, by sprawdzić efektywność podejmowanych działań prewencyjnych i terapii.

Cel: Celem pracy było zbadanie średniego stężenia lipidów w surowicy krwi oraz ocena częstości występowania, wykrywania i kontroli zaburzeń lipidowych w dorosłej populacji Polski.

Metody: Badanie przeprowadzono w reprezentatywnej próbie 1168 mężczyzn (M) i 1245 kobiet (K) w wieku 18–79 lat. W surowicy krwi oznaczono stężenie TC, cholesterolu o wysokiej gęstości (HDL-C) i triglicerydów (TG). Korzystając z formuły Friedewalda, wyliczono stężenie LDL-C.

Wyniki: Średnie stężenie TC u M wynosi 197,1 mg/dl (95% Cl 193,8–200,4), a u K 198,6 mg/dl (195,7–201,5), LDL-C odpowiednio: 123,6 mg/dl (120,9–126,2) i 123,7 mg/dl (121,4–126,1), HDL-C: 45,8 mg/dl (44,7–47,0) i 54,1 mg/dl (53,1–55,1), a TG: 140,9 mg/dl (133,0–148,8) i 104 mg/dl (99,8–108,2). Stężenie TC ≥ 190 mg/dl stwierdzono u 54,3% badanych. Odsetki są podobne dla M (54,3%) i K (54,4%). Biorąc pod uwagę również osoby leczące się z tego powodu, hipercholesterolemia (TC ≥ 190 mg/dl lub terapia statynami) występuje u 61,1% (58,2–63,9%) dorosłych Polaków, w tym u 60,8% M (56,4–65,1%) i 61,3% K (57,4–65,1%). Częstość występowania zwiększonego stężenia LDL-C (≥ 115 mg/dl) wśród wszystkich badanych wynosi 57,8% (M 58,3%; K 57,3%). Stężenie HDL-C < 40 mg/dl zanotowano u 35,2% M, a < 45 mg/dl — u 22,2% K. Hipertriglicerydemia (TG ≥ 150 mg/dl) występuje u 21,1% badanych (M 28,4%; K 14,0%). Nieprawidłowe stężenia TC i LDL-C najczęściej stwierdzano u pacjentów w wieku 40–59 lat. Wśród osób z hipercholesterolemią 58,7% (M 61,5%, K 56,0%) było nieświadomych jej obecności, 22,0% (M 21,0%, K 24,5%) wiedziało o tym, ale się nie leczyło, 8,1% (M 7,7%, K 8,5%) leczyło się, ale nieskutecznie i tylko 10,9% (M 10,7%, K 11,0%) leczyło się skutecznie (TC < 190 mg/dl). Jak wynika z porównań wyników badań NATPOL PLUS (2002) i NATPOL 2011, średnie stężenie TC w populacji zmniejszyło się. Jednak korzystne zmiany stężenia TC i LDL-C dotyczą osób po 60. rż.

Wnioski: Wśród dorosłych Polaków w wieku 18–79 lat aż 61% ma hipercholesterolemię. Niepokojące jest, że nieprawidłowe stężenia TC i LDL-C dotyczą szczególnie często osób w średnim wieku, a poprawa pod tym względem w latach 2002–2011 dotyczy pacjentów > 60. rż. Może to wskazywać i wynikać ze wzrostu przyjmowania statyn przez osoby w tym wieku. Prewencja zaburzeń lipidowych, ich wykrywanie i kontrola w Polsce wymagają radykalnej poprawy.

Słowa kluczowe: lipidy, badanie przekrojowe, metoda reprezentacyjna, rozpowszechnienie, świadomość i kontrola zaburzeń lipidowych

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