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# CARDIOVASCULAR RISK FACTORS DETERMINED VIA THE INTERNET IN 2 PERIODS OF TIME: 2004–2009 AND 2010–2015 IN POLAND

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**Abstract**

**Objectives:** Web information systems may serve as a diagnostic tool for the Internet users and they also support the epidemiological work of doctors and health care providers. As part of this study, a system has been created for detecting and calculating cardiovascular risk. The aim of this study has been the comparison of cardiovascular risk factors and calculated fatal cardiovascular risk in 2 periods of time: 2004–2009 and 2010–2015 in Poland, as determined via the Internet. **Material and Methods:** The "Ryzyko program" ("Risk program") is available on the website of the Medical University of Gdańsk. To assess the cardiovascular death risk in a 10-year period, the algorithm of the SCORE (Systematic Coronary Risk Evaluation) project was used and 30 402 results of the algorithm have been analyzed. **Results:** Over 30 402 webpage visitors entered the required data and received the outcome. More than 78% of the Internet users who had entered the data, received a recommendation for medical check-up. Significant differences between the data collected in 2004–2009 and 2010–2015 were noticed. Hypercholesterolemia prevalence (67.3% vs. 70.8%; $p < 0.001$), mean total cholesterol concentration in blood (5.60±1.65 mml/l vs. 5.66±1.35 mml/l; $p < 0.001$), prevalence of hypertension (36.6% vs. 35.3%; $p = 0.039$), mean systolic blood pressure (131.5±20.3 mm Hg vs. 132.6±18.0 mm Hg; $p < 0.001$), prevalence of declared smoking (30.7% vs. 26.5%; $p < 0.001$), declared diabetes mellitus (DM) (6.4% vs. 9.7%; $p < 0.001$), and declared coronary artery disease (CAD) (7.2% vs. 14.1%; $p < 0.001$), respectively. **Conclusions:** The prevalence of cardiovascular risk factors has changed during the observed period of time. Online automatic gathering of new data by "Ryzyko program" provides up-to-date observations. Int J Occup Med Environ Health 2017;30(3):499–510

**Key words:**
**Cardiovascular risk factors, SCORE, Diabetes prevalence, Coronary artery disease prevalence, Medical website, Global risk**

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## INTRODUCTION

Diseases of the cardiovascular system still remain the first cause of death in Poland and Europe, despite implementation of large-scale prevention programs [1]. The latest Polish population-based survey, performed in 2013–2014 to evaluate the prevalence, control, treatment and morbidity, is WOBASZ II (Wieloośrodkowe Ogólnopolskie Badanie Stanu Zdrowia Ludności – the Multi-centre National Population Health Examination Survey) [2]. Cardiovascular mortality (according to the International Classification of Diseases 10th Revision (ICD10): I00–I99) reached 45.6% in 2008 in Poland [3,4]. Since then mortality due to cardiovascular diseases has been decreasing. However, the number of deaths due to cardiovascular diseases in Poland is still higher than in most European countries [5]. Lifestyle changes are essential in primary and secondary cardiovascular disease prevention [6–8].

The situation in Polish healthcare is not conducive to providing adequate preventive care in the population. High-risk patients may be unaware of the disease. Prophylactic routine tests are rarely performed at the required intervals of time, or are not executed at all.

What is interesting, in the primarily published results of WOBASZ II, unfavorable changes in the prevalence of cardiovascular risk factors have been observed, as compared to WOBASZ I study [9].

Various techniques are used for the provision of information and education, including the widely available Internet. To achieve this goal a widely available system for automatic assessment of cardiovascular risk seems to be very useful. This system gives an opportunity for people who use medical portals to receive information in that way. Many of them will contact their doctor to verify the acquired information.

Unlimited access to the Internet raises the awareness of the possible threat of disease and its consequences. Educational programs may have a strong influence on primary and secondary prevention. Epidemiological studies are expensive, time consuming and involve a lot of staff. A well-designed Internet system for gathering epidemiological data is a cost-effective, 24 h tool available for anyone. For this purpose, the "Ryzyko program" ("Risk program") has been running since 2004.

### Aim of the study

Comparison of cardiovascular risk factors and calculated fatal cardiovascular risk in 2 periods of time: 2004–2009 and 2010–2015 in Poland determined via the Internet.

## MATERIAL AND METHODS

The "Ryzyko program" is available on the website of the Medical University of Gdańsk [10]. The SCORE (Systematic Coronary Risk Evaluation) algorithm was used for high-risk countries (like Poland) for cardiovascular death risk assessment in a 10-year period, as published in the European Heart Journal [11]. Since the beginning of the program 32 167 results of the algorithm have been registered, and 30 402 – since June 2004. The data was analyzed in 2 periods: June 1, 2004 – December 31, 2009 and January 1, 2010 – April 30, 2015. The following parameters were collected: age, sex, systolic blood pressure, total cholesterol concentration and smoking. The Internet user was able to see the graphic and numerical outcome after entering his or her personal data as required by the program. In the case of results extending beyond the limits recommended by the European Society of Cardiology and Prevention, and/or calculated death risk in the 10-year period being higher or equal 5%, a visit to a physician was recommended [12]. The data obtained from the group of 40–60-year-olds was analyzed in this article. For educational purposes, in the case of participants aged below 40 years old, due to the very low risk calculated by the algorithm regardless of other risk factors, the age was approximated to 60 years old.

**Value ranges in the "Ryzyko program"**

The Internet users were divided by:

- age: young people (18–39 years old) – the group of low risk for cardiovascular disease; middle-aged people (40–65 years old) – the high-risk group; the elderly (66–99 years old) – the very high-risk group,
- sex,
- declared coronary heart disease,
- diabetes mellitus,
- smoking,
- hypertension,
- hypercholesterolemia.

Target values and standards of blood pressure and cholesterol levels were adopted from the European Society of Hypertension and the European Society of Cardiology (ESH/ESC) guidelines [6]. People smoking at least 7 cigarettes a week were classified as cigarette smokers. Declared systolic blood pressure exceeding or equal to 140 mm Hg or higher was assumed as hypertension. The Internet users with total cholesterol concentration equal to or higher than 5 mmol/l were assumed as high cholesterolemic individuals.

To illustrate the scale of the calculated risk, the following risk ranges were determined:

- negligible: < 1%,
- very low: ≥ 1 and < 2%,
- low: ≥ 2 and < 3%,
- average: ≥ 3 and < 5%,
- high: ≥ 5 and < 10%,
- very high: ≥ 10 and < 15%,
- extremely high: > 15%.

All the epidemiological data and the results were gathered on a MySql database on the server of the Medical University of Gdańsk.

Presented results are given as the percentage rate of the total population; numbers were rounded to one decimal place. Elements of descriptive statistics were used. The rationale for this approach is an attempt to determine whether the Internet is a useful tool for achieving the objectives of the work. However, statistically achieved significance in the analysis could be vitiated by errors arising from the open nature of the tool. The selected statistical analysis has been done to illustrate the potential capabilities of the program. The Shapiro-Wilk test, and Kolmogorov-Lilliefors Smirnov and Mann-Whitney U tests were used. In all cases distributions other than normal were obtained.

## RESULTS

Until April 2015 the "Ryzyko program" had shown 90 208 visits on the website; 32 167 (36.1%) of the Internet users had solved the algorithm. The group studied from January 1, 2004 till April 30, 2015 was described, 65.3% (N = 19 851) of the general population were in the age group of 40–65-year-olds.

In the Tables 1–3 the characteristics of the population and the incidence of cardiovascular risk factors have been shown taking into account the distinction between sex and period of data collection.

Comparing data in the Figures 1 and 2, a higher calculated risk was observed in the years from 2004 till 2015 because in the second period (2010–2015) the population was older, the mean cholesterol concentration and mean systolic blood pressure were higher and there were more of the male Internet users in the analysis (Table 2).

The Figures 3–5 illustrate risk factors in the diabetes and coronary artery disease population. All of the Internet users with coronary artery disease (CAD) and diabetes mellitus (DM) have to be allocated to the high-risk group according the SCORE calculations. Neither DM nor CAD have been used in the SCORE risk calculation algorithm of death.

The risk of death in these groups has been calculated solely for the purposes of this study. The calculated high-risk score (≥ 5%) was received by 27.6% of the Internet users with coronary artery disease and 37.9% with diabetes in the age group of 40–65-year-olds.

**Table 1.** Characteristics of the respondents in the "Ryzyko program" ("Risk program") conducted via the Internet [10], Poland, 2004–2015

| Characteristics | Respondents | | | p (males vs. females) |
|---|---|---|---|---|
| | total (N = 30 402) | males (N = 16 803 (55.3%)) | females (N = 13 599 (44.7%)) | |
| Age [years old] (M±SD) | 45.70±12.90 | 45.80±13.10 | 45.50±12.70 | 0.053 |
| Total cholesterol concentration in age-groups [mmol/l] (M±SD) | | | | |
| 18–39 years | 5.04±1.77 | 5.09±1.73 | 4.98±1.81 | < 0.001 |
| 40–65 years | 5.88±1.42 | 5.85±1.47 | 5.90±1.34 | < 0.001 |
| 66–99 years | 5.67±1.52 | 5.54±1.54 | 5.86±1.48 | < 0.001 |
| 40–99 years | 5.86±1.42 | 5.83±1.48 | 5.90±1.35 | < 0.001 |
| total | 5.62±1.58 | 5.61±1.60 | 5.63±1.56 | 0.001 |
| Arterial blood pressure in age-groups [mm Hg] (M±SD) | | | | |
| 18–39 years | 125.20±17.20 | 129.40±16.40 | 119.90±16.60 | < 0.001 |
| 40–65 years | 134.00±219.90 | 136.20±19.20 | 131.30±20.40 | < 0.001 |
| 66–99 years | 141.50±21.70 | 140.80±22.60 | 142.40±20.40 | 0.026 |
| 40–99 years | 134.50±20.10 | 136.60±19.50 | 132.00±20.60 | < 0.001 |
| total | 131.70±19.80 | 134.40±18.90 | 128.50±20.30 | < 0.001 |

M – mean; SD – standard deviation.

**Table 2.** Characteristics of the respondents in the "Ryzyko program" ("Risk program") conducted via the Internet [10], Poland, 2004–2009 and 2010–2015

| Characteristics | Study period | | p |
|---|---|---|---|
| | 2004–2009 | 2010–2015 | |
| Respondents [n (%)] | 23 160 (100.00) | 7 242 (100.00) | |
| females | 10 519 (45.40) | 3 080 (42.50) | < 0.001 |
| males | 12 641 (54.60) | 4 162 (57.50) | < 0.001 |
| > 40 years old | 16 237 (70.10) | 5 112 (70.60) | 0.435 |
| Age [years] (M±SD) | 45.00±12.50 | 47.80±13.80 | < 0.001 |
| Total cholesterol concentration in age-groups [mmol/l] (M±SD) | | | |
| 18–39 years | 5.02±1.85 | 5.11±1.45 | < 0.001 |
| 40–65 years | 5.87±1.47 | 5.90±1.23 | < 0.001 |
| 66–99 years | 5.60±1.65 | 5.78±1.19 | < 0.001 |
| 40–99 years | 5.85±1.48 | 5.89±1.26 | < 0.001 |
| total | 5.60±1.65 | 5.66±1.35 | < 0.001 |

**Table 2.** Characteristics of the respondents in the "Ryzyko program" ("Risk program") conducted via the Internet [10], Poland, 2004–2009 and 2010–2015 – cont.

| Characteristics | Study period | | p |
|---|---|---|---|
| | 2004–2009 | 2010–2015 | |
| Arterial blood pressure in age-groups [mm Hg] (M±SD) | | | |
| 18–39 years | 125.10±17.70 | 125.40±15.30 | 0.600 |
| 40–65 years | 133.70±20.40 | 135.20±18.20 | < 0.001 |
| 66–99 years | 142.70±23.90 | 139.40±17.40 | 0.056 |
| 40–99 years | 134.20±20.70 | 135.60±18.20 | < 0.001 |
| total | 131.50±20.30 | 132.60±18.00 | < 0.001 |

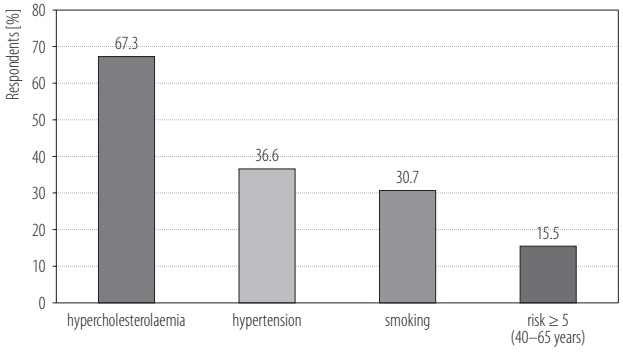
M – mean; SD – standard deviation.

**Table 3.** Risk factors of cardiovascular disease among the respondents in the "Ryzyko program" ("Risk program") conducted via the Internet [10], Poland, 2004–2009 and 2010–2015

| Risk factor | Study period | | p |
|---|---|---|---|
| | 2004–2009 | 2010–2015 | |
| Hypertension | | | |
| respondents [n (%)] | 8 484 (36.6) | 2 556 (35.3) | 0.039 |
| males | 5 269 (41.7) | 1 542 (37.0) | < 0.001 |
| females | 3 215 (30.6) | 1 014 (32.9) | 0.013 |
| Hypercholesterolaemia | | | |
| respondents [n (%)] | 15 589 (67.3) | 5 128 (70.8) | < 0.001 |
| males | 8 397 (66.4) | 2 917 (70.1) | < 0.001 |
| females | 7 192 (68.4) | 2 211 (71.8) | < 0.001 |
| Smoking | | | |
| respondents [n (%)] | 7 099 (30.7) | 1 922 (26.5) | < 0.001 |
| males | 4 133 (32.7) | 1 210 (29.1) | < 0.001 |
| females | 2 966 (28.2) | 712 (23.1) | < 0.001 |

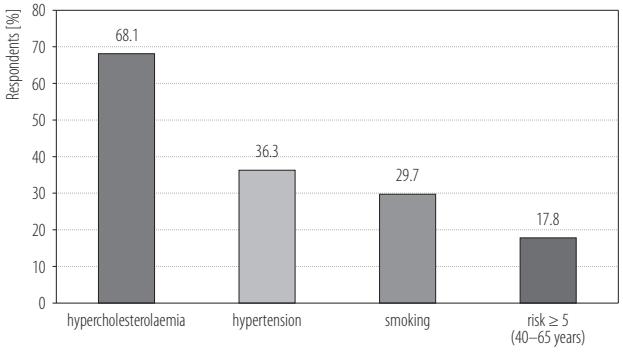
## DISCUSSION

Absolute cardiovascular disease risk is determined by the effect of all cardiovascular risk factors for the patient [13]. The most important risk predictors are age, symptomatic cardiovascular disease, and pathophysiological changes, like left ventricular hypertrophy and renal impairment. Many other factors, such as increased blood pressure and lipids level, smoking and male gender, also influence the risk [14]. Cardiovascular risk prediction and individualized management should be a routine component of clinical practice in middle-aged or older adults. Over the age of 70 years old, the CVD risk is usually greater than 20% over 10 years, especially for men, although the total CVD risk should be calculated using appropriate charts. Doctors should inform their patients about the benefits of cardiovascular risk reduction.



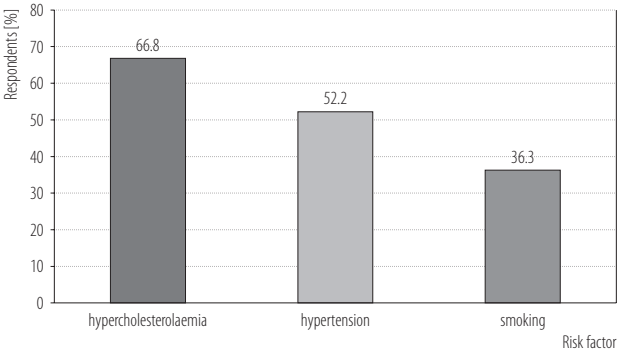

Hypercholesterolemia – total cholesterol concentration ≥ 5 mmol/l; hypertension – systolic blood pressure ≥ 140 mm Hg; smoking – ≥ 7 cigarettes/week; risk ≥ 5 (40–65 years) – calculated high risk (≥ 5) in the group age of 40–65 years.
Data expressed as a percentage of the general study population (N = 23 160).

**Fig. 1.** Risk factors of cardiovascular disease and high risk of death within a period of 10 years among respondents in the "Ryzyko program" ("Risk program") conducted via the Internet [10], Poland, 2004–2009



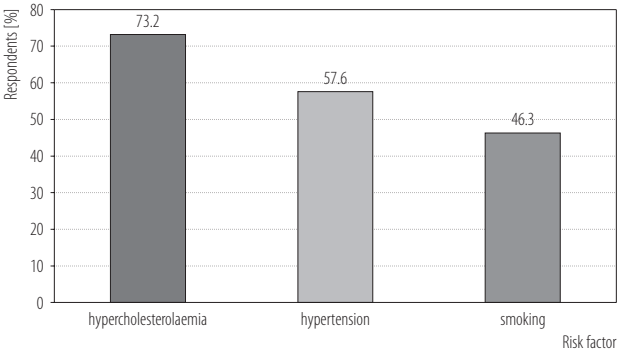

Data expressed as a percentage of the general study population (N = 30 402).
Other explanations as in Figure 1.

**Fig. 2.** Risk factors of cardiovascular disease and high risk of death within a period of 10 years among respondents in the "Ryzyko program" ("Risk program") conducted via the Internet [10], Poland, 2004–2015




Data expressed as a percentage of the coronary artery disease population (N = 3 788).
Other explanations as in Figure 1.

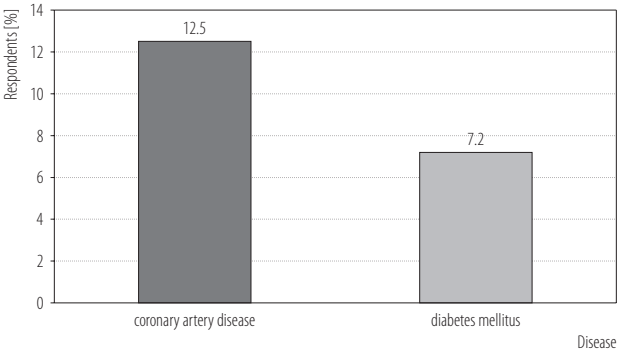
**Fig. 3.** Risk factors of cardiovascular disease among respondents declaring coronary artery disease in the "Ryzyko program" ("Risk program") conducted via the Internet [10], Poland, 2004–2015




Data expressed as a percentage of the diabetes population (N = 2 176).
Other explanations as in Figure 1.

**Fig. 4.** Risk factors of cardiovascular disease among respondents declaring diabetes mellitus in the "Ryzyko program" ("Risk program") conducted via the Internet [10], Poland, 2004–2015

Increasing a patient's knowledge about the possibility of reducing the risk of cardiovascular disease appears to be crucial in the primary and secondary prevention. However, in a small Pomeranian rural population study (469 people), people's knowledge about their blood pressure was high (almost 75% of respondents knew the value of their blood pressure), but 51% of the subjects had elevated blood pressure (≥ 140/90 mm Hg) [15]. In Canada, because of high patients' awareness gained through training and good contact between the patient and the doctor,




Data expressed as a percentage of the general study population (N = 30 402).

**Fig. 5.** Declared coronary artery disease and diabetes in the "Ryzyko program" ("Risk program") conducted via the Internet [10], Poland, 2004–2015

unprecedented worldwide effectiveness of antihypertensive therapy (almost 66%) has been achieved [16–19].

Canadian Recommendations for hypertension treatment do not differ much from European or American guidelines [6,20].

General practitioners need an accurate and reliable tool to help identify patients at high risk of a cardiovascular event. In February 2010 the National Institute for Health and Clinical Excellence withdrew its recommendation that the Framingham risk equation should be used for predicting the risk of cardiovascular disease over the next 10 years [21].

The subject is very interesting. Risk-based management depends on the prediction of cardiovascular disease risk for each individual, which is most accurately done with risk prediction equations (for example with risk charts or the Internet website-based risk calculators). In 2015 a novel risk score to predict cardiovascular disease risk in national populations (Globorisk) was presented [22]. The risk prediction equation for cardiovascular disease is a unified risk score that may be used in different countries. The risk score may be recalibrated and updated for use in different populations and years with routinely available information, and allows for the effects of sex and age on cardiovascular risk to vary between countries. The Globorisk equation helps with the global implementation of risk-based treatment of cardiovascular risk factors, and may be used for measuring progress towards the global non-communicable disease treatment target by estimating the number of people in each country who are at high risk.

Today there is wide access to the Internet. In 2013, 99% of the eastern Polish territory was covered with broadband network access [23]. The Internet seems to be the ideal tool for health promotion, primary and secondary prevention. As the "Ryzyko program" started to run in 2004, it is still gaining new information. The program meets the requirements of modern society. It reaches a wide audience and provides a free-of-charge tool for risk assessment [24–26]. The "Ryzyko program" database highly correlates with the results of large epidemiological studies performed in more customary ways in Poland in recent years in several respects.

The results of the "Ryzyko program" indicate that the study has raised great interest among the Internet users. Since the program was initiated in 2004, 90 208 entries to the main page have been recorded. Over 36% of visitors (32 167) provided the data to assess individual cardiovascular death risk.

In the "Ryzyko program" database, over 65% of the visitors were in the age group of 40–65-year-olds, and approximately 30% visitors were aged 18–39 years old. In Poland the Internet is mainly used by young people [27]. We think that a large number of the Internet users in the middle age group who solved the algorithm were searching for information about the state of their health, due to the presence of first symptoms of the disease, or already developed cardiovascular disease.

A major part of the "Ryzyko program" users were male (55.3% males vs. 44.7% females). It corresponds to the mean numbers of the Internet users in Poland and in Europe [28].

In a pilot study called Lipidogram 2003, 72% of primary care patients had elevated levels of cholesterol concentration [29]. In the evaluation study Lipidogram 2004 there were 69% of hypercholestrolemic patients (female (F): 72%; male (M): 66%) [30]. In the SPES (Southern Poland Epidemiological Survey) study among patients with a negative history of ischemic heart disease, hypercholesterolemia was diagnosed in 55.8% [31]. In the WOBASZ study (16 000 patients involved) more than 65% of participants were hypercholesterolemic (F: 64%, M: 67%) [32]. In the general population in the "Ryzyko program", 68.1% of the Internet study participants reported hypercholesterolemia (total cholesterol level of more than or equal to 5 mmol/l) (F: 69.1%, M: 67.3%).

Total cholesterol levels in the Lipidogram 2004 study amounted to 227 mg% for women (5.9 mmol/l) and to 220 mg% for men (5.72 mmol/l). In the "Ryzyko program" database the Internet users' total cholesterol concentration in blood in the whole group was lower – 5.62 mmol/l. However, given the mean age of the patients in the Lipidogram 2004 study, averaging 55.1±10.6 years old (min. 30 years old, max 98 years old), the more appropriate age group to compare is the group of > 40 years old from the "Ryzyko program", in which the average age is 52.3±8.7 years old. In this group the average total cholesterol concentration is similar to the result of the study Lipidogram 2004 – 5.86±1.42 mmol/l (F: 5.90 mmol/l, M: 5.83 mmol/l).

In the NATPOL PLUS (Nadciśnienie Tętnicze w Polsce Plus Zaburzenia Lipidowe i Cukrzyca – the Arterial Hypertension in Poland Plus Lipid Disorders and Diabetes) study hypertension was diagnosed in 29% of respondents [33]. Prevalence of hypertension was lower than in the Pol-MONICA study (41% and 44%) and the NATPOL II study (44%) [34–36]. In the WOBASZ study, 32.9% females and 42.1% males (36% on average) had elevated blood pressure. Mean arterial pressure was 137.6 mm Hg in men and 129.7 mm Hg among women. In the "Ryzyko program" mean arterial pressure was 131.7 mm Hg (F: 128.5 mm Hg, M: 134.4 mm Hg) and in the group > 40 years of age – 134.5 mm Hg (F: 132 mm Hg, M: 136.6 mm Hg). Prevalence of hypertension in the general population was 36.3% of the Internet users (F: 31.1%, M: 40.5%).

The analysis of the available studies on smoking prevalence in Poland showed that in the 1980's 34% of women and 59% of men were smokers (Pol-MONICA Warsaw 1984), in the 1990's there was a decreasing trend in smoking prevalence among males (51.9%) whereas the prevalence among women was the same (34.6%, Pol-MONICA Warsaw 1993). After the year 2000, the number of smokers has decreased significantly to about 25% among women and 40% among men (NATPOL PLUS 2002, WOBASZ 2003–2005) [37].

In the "Ryzyko program" the average percentage rate of smokers among the Internet users (the group of 18–99 years old) was 29.7% (F: 27%, M: 31.8%) which was lower than in the cited studies, however, comparing the 2 periods of time (2004–2009, 2010–2015) there is clearly a decrease in smoking prevalence (30.7% vs. 26.5%; $p < 0.001$).

The prevalence of diabetes in Poland according to the literature is about 5–7% [32]. An interesting observation is the analysis of risk factors in the group of the Internet users declaring diabetes. In the "Ryzyko program" the percentage rate of the Internet users in the general population with diabetes was 7.2% and the prevalence of diabetes increased with age (3% in the group of 18–39-year-old, 8% in the group of 40–65-year-old and 24.6% in the age group of 66–99-year-olds). This trend, though more pronounced, may also be seen in the group of the Internet users declaring coronary artery disease. The percentage rate of the Internet users with coronary artery disease in the age group of 18–39-year-olds was 3.7%, in the age group of 40–65-year-olds – 14.5% and 38.9% in the age group of 66–99-year-olds, 12.5% in the general population (F: 9.5%, M: 14.8%). An interesting fact is that the Internet users with diabetes and coronary artery disease had higher

absolute values of risk factors (total cholesterol (TC), systolic blood pressure (SBP)) and the percentage rate declaring cigarette smoking among these 2 groups was also higher than in the general population. The obtained data shows that in the group with diabetes, the parameters were even higher than in the group with coronary artery disease.

Comparing the periods 2004–2009 and 2010–2015 there has been an increase in the declared DM (6.4% vs. 9.7%; $p < 0.001$) and a decrease in the declared CAD (14.1% vs. 7.2%; $p < 0.001$).

Decreasing numbers of data collected in 2004–2009 vs. 2010–2015 (23 160 vs. 7242) may be due to fewer promotion actions of the program done in the second period, i.e., courses for nurses.

During that time a shift in the age of the participants towards older age (45.0±12.5 years old in 2004–2009 vs. 47.8±13.8 years old in 2010–2015; $p < 0.001$) and in gender towards higher percentage of men (54.6% vs. 57.5%) has been observed. The results should be considered to have been affected by a possible error of random selection of the test group.

The "Ryzyko program" is a useful epidemiological tool, yet, it has its limitations resulting from the method of gathering the information. There is the possibility of re-entering data into the program in order to obtain a result of the solved algorithm. The Internet user is free to enter data (within the limits specified in the methods of the work). This allows the program to fulfill the educational function but some of the Internet users may enter completely false information. On the other hand, thanks to a large number of entries the extreme values do not distort the mean values in the overall analysis. Because of the large amount of gathered information, the data is comparable with the results from other controlled studies.

Another weak point of the program is that not all the Internet users are aware of the value of their medical parameters. To obtain a result of the calculated risk it is necessary to, *inter alia*, input total cholesterol concentration and systolic blood pressure values. The requirement for entering the total cholesterol concentration and systolic blood pressure values may lead the website visitor to visit his family doctor in order to determine these parameters. The most effective form of therapy appears to be motivation of the patient to adhere to medical recommendations, such as taking the prescribed drugs regularly, or leading a healthy life style.

Attention should be paid to informing patients of their absolute cardiovascular risk and its determinants. The most important consideration in modern clinical practice is to focus on absolute cardiovascular risk treatment, not risk factors. We may assume that the program was used as a diagnostic and decision-making tool in medical facilities. It seems that the "Ryzyko program" may have a significant impact on improving adherence to medical recommendations.

## CONCLUSIONS

The prevalence of cardiovascular risk factors changed during the observed period of time. Thanks to online automatic gathering of new data, the "Ryzyko program" provides up-to-date observations.

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