

The influence of selected factors on the risk of myocardial infarction

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ABSTRACT

The most important risk factors for heart attack are considered to be: lifestyle, smoking, high-calorie diet rich in animal fats, physiological and biochemical factors, elevated levels of cholesterol – especially LDL cholesterol, elevated concentration of triglycerides, hyperglycemia or diabetes, increased levels of homocysteine, elevated thrombotic factors. The aim of the study was to analyze the influence of selected factors on the risk of myocardial infarction. The study was conducted among patients with diagnosed coronary artery disease who reported to the family doctor for a check. The effect of selected variables: age, gender, duration of coronary artery disease, smoking, and LDL cholesterol on the risk of myocardial infarction was studied. The results were statistically analyzed. It was found that the incidence of myocardial infarction is higher in men than in women, especially of premenopausal age. In the age group 35-44 years, the risk of the disease in men is almost nine times higher than in women. The risk of heart attack increases with age in both men and women. Among smokers heart attacks are observed significantly more frequently, and the risk of heart attack in this group is more than 2-fold higher than in non-smokers. The longer the duration of coronary artery disease, the risk of myocardial infarction increases. In patients with elevated LDL cholesterol the risk of heart attack is more than 3-fold higher than in those with normal levels.

Keywords: myocardial infarction, age, gender, duration of coronary artery disease, smoking, LDL cholesterol level

INTRODUCTION

According to the published report of the American College of Cardiology, among all cardiovascular diseases, coronary artery disease (CAD) is the most common cause of death and disability, it affects younger and younger people, especially men [1]. The data presented in the National Registry of Acute Coronary Syndromes PL-ACS shows that in Poland the number of hospitalizations for acute coronary syndrome (ACS) in 2008 amounted to 229,247 people – data from 106 centers [40]. According to the Polish Cardiac Society the most important risk factors for heart attack are: lifestyle, smoking, high-calorie diet rich in animal fats, physiological and biochemical factors, elevated levels of cholesterol, especially LDL cholesterol, elevated triglycerides, hyperglycemia or diabetes, increased levels of homocysteine, elevated thrombotic factors [13].

The aim of this study was to analyze the influence of selected parameters on the risk of myocardial infarction.

MATERIAL AND METHODS

The study was conducted among 299 patients with diagnosed coronary artery disease at the age of 31-77 years, who reported to the family doctor for a check in 5 randomly selected primary care centers in Lublin. Each patient had basic laboratory tests done. The effect of selected variables: age, gender, duration of coronary artery disease, smoking, and LDL cholesterol concentration on the risk of myocardial infarction was studied. The results were statistically analyzed. The values of the analyzed parameters measured in nominal scale were characterized by numbers and percentage. In order to evaluate the existence of the relationship between the analyzed traits χ^2 test of independence and logistic regression analysis were used. There was a 5% error of inference and the associated significance level $p > 0.05$, indicating the existence of significant differences. The analyzed data base and statistical analyzes were performed based on Statistica software 10.0 (StatSoft, Poland).

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Among the respondents, 223 were men (74.6%) aged 32-77 years and 76 women (25.4%) aged 31-69 years. The average age of all patients was 54.6 ± 10.4 years and the average age of men – 55.4 ± 9.7 years and of women – 52.4 ± 12.3 years. The observed differences were statistically significant ($t=2.14$, $p<0.05$). Most of the respondents had secondary education – 156 persons (52.2%), 97 patients (32.4%) – higher education, and 26 respondents (8.7%) – vocational and 20 persons (6.7%) – primary education. In view of the duration of the disease, the investigated individuals were divided into three groups. The first – included individuals in whom coronary artery disease was diagnosed less than two months before, the second – more than two months but not more than one year, the third – persons suffering for over a year.

RESULTS

From among 299 patients suffering from ischemic heart disease, the majority – 212 persons (70.9%) were qualified to the third group – suffering more than one year, 63 patients (21.1%) were qualified into the second group and 24 subjects (8.0 %) – to the first group. The average age of patients with fresh coronary artery disease was 49 ± 8.8 years, mean age of the patients ailing more than for two months but not more than one year was 50.3 ± 10.1 years and the average age of people suffering for more than a year – 56.5 ± 10.1 years. The observed differences were statistically significant (univariate analysis of variance ANOVA ($F = 13.278$, $p<0.05$)) (Fig. 1).

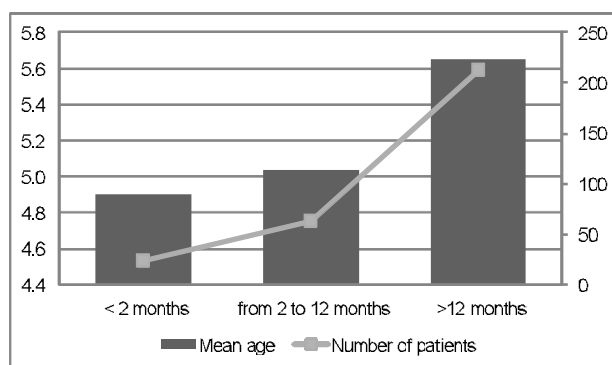


Fig. 1. The average age and the number of patients in each duration category of coronary artery disease (CAD)

Among the patients, myocardial infarction was confirmed in 184 persons (61.5%). Table 1 shows the incidence of myocardial infarction among men and women. Statistically significant relationship was shown between the incidence of myocardial infarction and gender ($\chi^2 = 32.15$, $p<0.05$). Significantly more likely the heart attack affected men than women – 70.9% vs. 34.2%. Based on the collected data the odds ratio (OR) of heart attack in men and women was calculated, which is $OR=4.7$, which

means more than 4-fold higher risk of the occurrence of myocardial infarction in men than in women.

Table 1. The incidence of myocardial infarction by gender

Heart attack	Women	Men	Total
was present	26	158	184
%	34.2	70.85	61.5
was not present	50	65	115
%	65.8	29.1	38.5
Total	76	223	299

In order to determine the effect of age on the occurrence of myocardial infarction, patients were divided into four age groups. The introduction of more categories did not have significant effect on the course of reasoning. Age ranges included persons up to 34 years of age, 35-44 years of age, 45-54 years and above 54 years of age. It was found that with increasing age, the percentage of people with a history of myocardial infarction increases ($\chi^2 = 7.86$, $p<0.05$) (Table 2).

Table 2. Distribution of respondents by age and incidence of myocardial infarction

Age-ranges	Heart attack was not present	Heart attack was present	Total
≤ 34	8	3	11
%	7,0	1,6	3,7
< 35-44 >	12	29	41
%	10,4	15,8	13,7
< 45-54 >	39	72	111
%	33,9	39,1	37,1
> 54	56	80	136
%	48,7	43,5	45,5
Total	115	184	299

The next step consisted in examining the incidence of myocardial infarction in relation to age and gender. It was found that in both men and women, with age the percentage of patients with myocardial infarction increased. By analyzing the incidence of myocardial infarction in different age groups by sex, differences were statistically significant at all ages except for the youngest patients, i.e. up to 34 years of age. The risk of myocardial infarction in each age group was higher in men than in women. With age, these differences decrease from 8.8 in the age group 35-44 years, through 5.8 in the age 45-54 years to 3.1 in the age group above 54 years. This means that in the age group of 35-44 years, the risk of heart attack in men is almost 9-fold higher compared to women in the same age range, and above 54 years of age, the risk of heart attack in men is 3-fold higher than in women (Table 3).

Table 3. The heart attack occurrence by age and gender

Age	Heart attack	Women	Men	
≤ 34 years	yes	2	1	$\chi^2 = 0.64$
	no	7	1	$p > 0.05$
< 35-44 >	yes	4	25	$\chi^2 = 8.58$
	no	7	5	$p < 0.05$
< 45-54 >	yes	7	65	$\chi^2 = 13.15$
	no	15	24	$p < 0.05$
> 54 years	yes	13	67	$\chi^2 = 7.93$
	no	21	35	$p < 0.05$
Total		76	223	299

Logistic regression was used to analyze the impact of some factors on the risk of myocardial infarction. The analysis included the following variables: MI – myocardial infarct (1 – infarct, 0 – no infarct), dichotomy feature, qualitative dependent variable; age – the age of patients, quantitative independent variable; time of coronary heart disease – coronary artery disease duration (1 – below 2 months, 2 – from 2 to 12 months, 3 – over 12 months), discrete feature, qualitative independent variable; smoking cigarettes: 1 – smokes, 0 – does not smoke, dichotomy feature, qualitative independent variable; LDL – LDL levels in serum (1 – to 129 mg/dl, 2 – above 129 mg/dl to 159 mg/dl, 3 – above 159 mg/dl) discrete feature, qualitative independent variable. Estimation of logistic regression equation was performed using a quasi-Newton method. To count loss function the maximum likelihood method was used. The parameters of estimated model are given in Table 4.

1. Smokers and non-smokers, in whom coronary artery disease duration is the same
 $OR = e^{0.4586 * (1-1) + 0.6343 * (1-0)} = 1.886$
 Calculations show that cigarette smoking increases almost 2-fold the risk of heart attack.
2. Smokers with the disease lasting for more than 2 months but less than one year, compared to non-smokers with fresh coronary artery disease – lasting less than 2 months
 $OR = e^{0.4586 * (2-1) + 0.6343 * (1-0)} = 2.983$
 The risk of myocardial infarction in these patients increases almost 3-fold.
3. If the same comparison was carried out after another year of coronary heart disease, we could get
 $OR = e^{0.4586 * (3-1) + 0.6343 * (1-0)} = 4.719$
 The risk of myocardial infarction increases nearly 5-fold.

Table 4. The effect of selected parameters on the risk of myocardial infarction

N=299	Model: Logistic regression (logit) N of 0's:1's: 184 (new data) Dep.var: infarct code Loss: Max likelihood (MS-err. scaled to 1) Final loss: 176.32541436 Chi2 (4)=11.452 p=.02194				
	Const. BO	Age	Duration of CAD	Smoking	LDL categories
Estimate	20.41407	-0.003173778	0.4586274	0.6342919	-0.2055879
Standard Error	19.83833	0.01368111	0.2040062	0.2925457	0.193576
t(294)	1.029022	-0.2319824	2.248105	2.168181	-1.062053
p-value	0.3043152	0.816713	0.02531036	0.03094692	0.2890834
-95%CL	-18.62906	-0.03009911	0.05712978	0.05854276	-0.5865582
+95%CL	59.45721	0.02375155	0.860125	1.210041	0.1753824
Wald's Chi-square	1.058886	0.05381585	5.053977	4.701007	1.127956
p-value	0.3034772	0.8165532	0.02457626	0.03015228	0.2882198
Odds ratio (unit ch)	734039700	0.9968312	1.581901	1.885686	0.8141685
-95% CL	0.00000008118977	0.9703494	1.058793	1.06029	0.5562385
+95% CL		1.024036	2.363456	3.353622	1.191702
Odds ratio (range)		0.8641631	2.502411	1.885686	0.5396882
-95% CL		0.2504342	1.121043	1.06029	0.1721009
+95% CL		2.981932	5.585925	3.353622	1.692399

The analysis included 184 patients who had a myocardial infarction (61.5%) and 115 patients without myocardial infarction (38.5%). Regression coefficients (score) for each variable are statistically significant only for the “duration of coronary heart disease” and “smoking”. This is reflected in the values of statistic test Wald $\chi^2 - p < 0.05$ (the variables – duration of smoking and coronary heart disease – are significant variables explaining the risk of heart attack). The odds ratio indicates that smoking increases the risk of heart attack on average 1.9 times (from 1.1 to 3.4 times with a probability of 95%), while the length of the duration of coronary heart disease on average 2.5 times (from 1.1 to 5, 6 times with 95% probability).

The following formula presents the odds ratio for the considered variables:

$$OR = e^{20.41 + 0.4586 * \text{period of illness} + 0.6343 * \text{smoking}}$$

Feature “smoking” changes abruptly from 0 to 1 and the feature “duration of coronary artery disease” varies from 1 to 3. Based on the obtained formula, we can calculate the odds ratio/ risk of heart attack for example, for:

Since in the analyzed model there was no statistically significant relationship between LDL cholesterol and the risk of heart attack, it was decided to highlight only two categories: 1 – patients whose LDL levels were not higher than 159 mg/dl, and 2 – with high and very high levels of LDL (Table 5). High and very high LDL levels were found in 180 persons (60.2%). The occurrence of heart attacks was observed significantly more frequently among patients with high and very high levels of LDL (73.4% vs. 43.6%) ($\chi^2 = 26.54, p < 0.05$). The odds ratio/risk is 3.6 (2.2 to 5.9 with a 95% likelihood), which means that in people with high and very high cholesterol the risk of infarction is more than 3-fold higher than in patients with LDL below 159 mg/dl.

Table 5. The effect of LDL concentration on myocardial infarction occurrence

Infarct	LDL ≤159 mg/dl	LDL > 159 mg/dl	Total
not present	67	48	115
%	56,4	26,6	38,5
present	52	132	184
%	43,6	73,4	61,5
Total	119	180	299

DISCUSSION

Due to the high prevalence of risk factors for coronary heart disease and aging of the population, coronary heart disease is still the leading cause of death in Poland and around the world. It is estimated that in most European countries, cardiovascular disease is found in 20-40 thousand people per million inhabitants. According to the World Health Organization, the number of deaths from coronary heart disease will increase from 7.1 million in 2002 to 11 million in 2020. The occurrence of angina pectoris in men between 45 and 54 years of age is increased from 2 to 5%, and in 65-74-year-olds it is increased from 11 to 20%. However, coronary heart disease in women occurs in 0.5-1% and 10-14% in the respective age groups. After 75 years of age the incidence of coronary heart disease is comparable in both genders [5]. It is worth noting that in men often the first manifestation of coronary heart disease is acute coronary syndrome (ACS) – 68%, and in women – stable angina (SA) – 56% [11].

ACS is the leading cause of morbidity and mortality in developed countries. The scale of the problem has been confirmed in a number of randomized trials (POLSCREEN, EUROACTION, the National Programme for Prevention and Treatment of Heart Diseases – POLCARD, DART – Diet and Reinfarction Trial, GISSI – *Gruppo Italiano per lo Studio della Sopravvivenza nell'Infarto Miocardico*) [6, 7, 23, 38]. Based on the studies, it seems that the key task in patients with prior myocardial infarction, besides the identification of risk factors, is lifestyle modification and health education. The multiplicity of risk factors and their different effects/different impact levels, make it difficult to make their precise classification. One of the simplest and oldest divisions, taking into account the possibility of effective intervention, distinguishes two groups of factors: modifiable and non-modifiable. The first include, among others, smoking, improper diet, low physical activity, dyslipidemia, including elevated LDL cholesterol and reduced HDL, and co-morbidities such as hypertension, hyperglycemia/diabetes, obesity, vascular disease on the background of atherosclerosis. Non-modifiable factors include: age (men >45 years, women >55 years), male gender, early occurrence of cardiovascular disease on the background of atherosclerosis in the family (men <55 years of age, women <65 years), and genetic predisposition [9]. INTERHEART study published in 2004 was important for determining the significance of specific risk factors for cardiovascular disease and for designation of prevention guidelines. It showed that 6 out of more than 300 modifiable risk factors, and 3 cardio-protective (physical activity, a diet rich in fruits and vegetables, moderate consumption of alcohol) are responsible in 90% of men and 94% of women for the risk of heart attacks. The role of these factors is independent of age, sex and ethnicity. Six key risk factors include hypertension,

dyslipidemia, abdominal obesity, diabetes, smoking, and psychological stress [8, 39, 41]. The research confirms that these risk factors are responsible for more than 90% for the occurrence of coronary heart disease [19, 37].

Our study showed that in men heart attack occurs significantly more often than in women. On average, the risk of myocardial infarction in men is more than 4 times higher than in women. It should be noted, however, that in the age groups specific risk is diversified. In the age range of 35-44 years of life it is almost 9-fold higher, and with increasing age these differences decrease. European Society of Cardiology guidelines emphasize that cardiovascular risk in women is shifted in time by 10 years compared with men. The incidence of coronary artery disease (CAD) in men aged 55 years is similar to that in 65-year-old women [10]. The research of Janion-Sadowska et al. confirms that advanced age is a major risk factor for acute coronary syndrome (ACS), particularly among older women. Therefore, the average life expectancy of women is higher, they form the majority of elderly patients with ACS [15]. The literature shows that women are less often diagnosed, undergo less invasive procedures and are rarely treated according to the standards, as well as they are rarely represented in clinical trials. Of great importance is the understanding of the pathophysiology of coronary artery disease in women. There are differences in the pathophysiology of coronary heart disease between men and women and the differences among women according to age group [32, 33, 34].

While the age and gender cannot be modified - cigarette smoking is a modifiable risk factor. Our study has shown that smoking increases almost 2-fold the risk of developing myocardial infarction. The results of the American Heart Association indicate a 2-4-times increased risk of myocardial infarction among smokers compared to people without the addiction, and that cigarette smoking is an independent predictor of sudden cardiac death in patients with coronary heart disease [31]. According to Narkiewicz, "smokers" increase the risk of heart attack and stroke three times. Smoking of each cigarette is associated with an immediate increase in blood pressure and heart rate acceleration. This effect is especially pronounced when smoking the first cigarette in the morning, when the risk of heart attack and stroke is the greatest [25]. The available studies show that among patients with myocardial infarction with ST-segment elevation (STEMI), men smoked significantly more frequently. Commercial and cultural background meant that for most of the twentieth century mainly men smoked. In recent years, however, a growing percentage of young women-smokers (including young girls) has been observed [2]. Acute coronary syndrome with ST-segment elevation (STEMI) occurs in approximately 20% of Polish women [30]. It should be emphasized that smoking is one of the main factors that

increases 7-fold the risk of coronary heart disease in women below the 55th year of life [4]. In addition, smoking acts synergistically with other factors. In the case of women using hormonal contraceptives, it is one of the major causes of acute myocardial infarction [10]. It is emphasized that the increased risk concerns persons smoking “occasionally” because every single smoked cigarette increases the risk of tobacco-related diseases. The more cigarettes smoked per day, the risk of heart attack, stroke or cancer is greater. It should be noted that the forced exposure to tobacco smoke (i.e. passive smoking) is in terms of population as harmful as active smoking. According to data published by the WHO, every year it contributes to the deaths of 600,000 people around the world [36]. It has been calculated that the relative risk of death from ischemic heart disease for passive tobacco smoker is 1.2-1.7 times higher than those that are not subject to exposure to tobacco smoke [12]. In a paper published in 2004, the findings showed that the 20-year follow-up prospective risk of coronary heart disease in passive smokers is almost the same as in the one smoking 1-9 cigarettes per day [3].

Obesity is a known risk factor for coronary heart disease associated with increased mortality [29]. Although obesity is often inseparable from the co-existence of hypertension, abnormalities in blood lipid concentrations and haemostatic activity of proteins, the research shows that a BMI 25 kg/m² was an independent factor increasing the risk of coronary heart disease by 8%. In addition, the risk of obesity is greater in women than in men – a BMI above 35 kg/m² increases the risk by 42% in men, and as much as 93% in women [14]. As emphasized by Smith et al. metabolic syndrome is an important risk factor for cardiovascular disease and related mortality [20].

Increased cardiovascular risk is confirmed in hypercholesterolemic states, with low concentrations of HDL-cholesterol, and to a lesser degree – with hypertriglyceridemia. Hypercholesterolemia, in addition to smoking, is the most important risk factor for heart attack in both men and women [10, 41]. Lipid disorders in Poland are the most common risk factors for cardiovascular disease, detected in almost 18 million people. The prevalence of hypercholesterolemia in the study was estimated in NATPOL study at 59.5% in men and 62% of women, in the WOBASZ study respectively at 67% and 64%, and in the population over 74 years of age (Senior WOBASZ) – at 43% and 62% [26, 42]. Total cholesterol in women reaches the highest value at approximately 60-year olds, about 10 years later than in men and after 5th decade, total cholesterol is higher in women than in men [10]. The risk of myocardial infarction in patients with high cholesterol is 3-fold higher than in the population with normal lipid profiles [41]. Studies conducted in Polish conditions showed that the risk of coronary heart disease increases

with the concentration of cholesterol in serum. Increased LDL – above 150 mg% is always associated with an increased risk of coronary heart disease [27,28]. It has been shown that the deleterious effects of dyslipidemia are different with regard to age. The meta-analysis of 10 cohort studies indicates that LDL-cholesterol in 50-year-olds decreased by 1mmol/l is associated with a reduced risk of coronary heart disease by 56%, in the group of 60-year-olds – by 41%, and among 70-year-olds – only by 31% [22]. Our own research has shown that on average, the risk of infarction in patients with LDL over 159 mg/dl is almost 4-fold higher. The priority should therefore be to reduce high cholesterol levels in the general population, especially in those at risk. People with hypercholesterolemia and low cardiovascular risk require counseling on changes in diet and lifestyle. For those with hypercholesterolemia and coronary heart disease, diabetes and obesity, in addition to intensive counseling on diet changes and lifestyle, drug therapy should be implemented. Statins used in hypercholesterolemia medication reduce the number of vascular events and total mortality in patients with acute coronary syndromes [16]. Studies have shown that the use of statins in patients with coronary artery disease is an independent risk factor in reducing new myocardial infarction from 10% to 4% during the application [21, 24]. It should be noted that the treatment of hypercholesterolemia, is also important to carry on action aimed at coexisting risk factors (obesity, smoking, diabetes).

Modification of risk factors is based primarily on patient education, which aims to change the lifestyle and follow the doctor’s instructions and drug therapy in accordance with modern standards [2, 17, 35]. Epidemiological studies on the prevalence of cardiovascular factors in different social groups allow prediction of disease risk and optimize preventive measures [2, 18]. Still, the society does not have sufficient knowledge about risk factors for myocardial infarction and ways of modifying them. Health professionals, especially GPs that patients have the most frequent contact with, play the main role of education in healthy lifestyle. Principles of prevention of myocardial infarction should be implemented each time the patients visit a GP clinic, regardless of the type of recommendations and the reasons for the notification of the patient, especially in the prevention study.

CONCLUSIONS

1. Age, gender, duration of coronary artery disease, smoking, and LDL cholesterol levels, are variables that have a statistically significant influence on the risk of myocardial infarction.
2. The risk of myocardial infarction increases with age in both men and women, and is higher in men than in women, especially at premenopausal age. In the age

group 35-44, the risk of the disease in men is almost 9-times higher than in women.

3. Among smokers, infarcts are observed significantly more often. The risk of myocardial infarction is more than 2-fold higher than in non-smokers.
4. The longer the duration of coronary artery disease, the higher the risk of heart attack.
5. The risk of myocardial infarction is more than 3-fold higher in patients with elevated LDL cholesterol.
6. Modification of risk factors for myocardial infarction is a priority element of anti-infarct prevention.

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