

# Risk factors, prognosis, and secondary prevention of myocardial infarction in young adults in Poland

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## INTRODUCTION

Myocardial infarction (MI) is one of the most common causes of death in Europe among individuals below 75 years of age [1]. Young people are also affected: an average of one in ten patients hospitalised for MI is below 45 years of age [2, 3]. Some of the latest studies from Poland are inconsistent with those data. Trzeciak et al. [4] revealed that patients aged less than 40 years represent 1.2% of all patients with MI. However, if the age of 45 years would be established as the cut-off age the percentage of patients would increase to 3.2%, as estimated by Gierlotka et al. [5]. The limitation of the first study is that the data originate from only one administrative region. Compared with other European countries, the situation in Poland is unfavourable because mortality due to cardiovascular diseases among Polish men of working age (25–64 years) is more than 2.5-fold higher than in the founding countries of the European Union. Moreover, the risk factors for MI are much more prevalent in the Polish population than in other European countries [6].

Although MI in young adults affects mostly men, the percentage share of women in this population is increasing, reaching even 25% depending on the cut-off point for young age [7, 8]. Trzeciak et al. [4] reported that in Poland women represent 16.1% of individuals below 40 years of age with MI.

The mechanisms of MI in young individuals may be differentiated into four groups: 1) atherosclerotic coronary heart disease; 2) non-atherosclerotic coronary heart disease; 3) hypercoagulable state; and 4) MI due to chemical substance abuse [9].

The primary cause of MI in both young adults and in older age groups is coronary artery atherosclerosis [2, 10]. Choudhury and Marsh assessed atherosclerosis as the cause of 80% of MI in young individuals [3]. Atherosclerotic lesions are typically observed in one vessel.

Importantly, a higher proportion of young patients with MI is free from significant coronary atherosclerotic lesions (approx. 20%) compared with patients above 45 years of age [3]. This may be due to the fact that atherosclerotic changes progress with age. Moreover, this finding suggests a different mechanism of MI in young patients than due to clogging of the artery lumen with unstable atherosclerotic plaque.

Coronary artery disease due to factors other than atherosclerosis is responsible for a small proportion of MI cases in young patients. MI may be the first manifestation of congenital coronary artery anomalies in young people [9, 11]. One such anomaly is a myocardial bridge, i.e. an interstitial location of a coronary artery that may develop into MI in very rare cases, more commonly in patients with an additional burden such as hypertension and cardiac hypertrophy [12]. Rare cases have been reported where this mechanism was responsible for MI in young adults [13].

Another non-atherosclerotic coronary artery disease that is responsible for MI in young adults is coronary artery

dissection. This phenomenon is twice as common in women than in men and is associated with the perinatal period [9, 14]. A hypercoagulable state is estimated to be responsible for 5% of MI cases in young patients and, similarly to congenital coronary artery anomalies, may be the first manifestation of the underlying abnormality [3, 15].

Another group of mechanisms that can trigger MI in young people is substance abuse. Cocaine-related MI is noticeably represented in literature. However, cases of MI in young adults associated with use of other drugs, including cannabis [16], heroine [17], and so-called “legal highs” [18], have also been reported.

## RISK FACTORS FOR MYOCARDIAL INFARCTION

INTERHEART is one of the largest studies concerning MI carried out in recent years. The study comprised 52 countries from all inhabited continents; the participants included 12,461 patients and 14,637 individuals who were the control group. The study aimed to determine the correlation between risk factors and MI. Nine risk factors were included: cigarette smoking, lipid concentrations, patient-reported hypertension or diabetes, obesity, diet, physical activity, alcohol use, and psychological factors. Smoking, lipid abnormalities, hypertension, and diabetes were shown to be more significant risk factors for MI in younger patients than in older subjects [19]. Smoking is the most prevalent risk factor among young adults. It is also the only factor that is fully modifiable. Tobacco smoking accelerates development of atherosclerosis by causing damage to the vascular endothelium, reducing tissue oxygenation, and increasing activity of the sympathetic nervous system. Additionally, smoking leads to increased aggregatory activity, promoting formation of intravascular clots [20].

The prevalence of smoking among young individuals with MI ranges from 64.5% to 93.7%, depending on the study population [21–25].

As shown by a study carried out by Andrés et al. [22] in over 11,000 individuals with MI, smoking was much more prevalent among patients with premature MI than in individuals who experienced MI above the age of 45 years (76.78% vs. 24.46%, respectively).

Yunyun et al. [24] obtained similar results regarding the much higher prevalence of smoking among young patients with MI than among older patients. As many as 82.56% of individuals with MI aged  $\leq 44$  years and 41.54% of patients aged 60–74 years confirmed that they were smokers. Smoking prevalence among young individuals without coronary heart disease was assessed at 49.37%.

A group of Greek researchers determined the long-term outcomes of patients aged  $\leq 35$  years with MI and found that cigarette smoking was the strongest prognostic factor of secondary cardiovascular events [25]. Out of the 237 patients with a diagnosis of premature ST segment elevation MI, as many as 222 were smokers. Additionally, a long-term

follow-up revealed that 75.8% of those who experienced a secondary cardiovascular event continued to smoke.

Among young Poles with MI smoking was disclosed as the most common risk factor. Trzeciak et al. [4] reported that 60.1% of patients were smokers.

According to the results of WOBASZ [20], a population study carried out in Poland, the proportion of male and female smokers was estimated at 42% and 25%, respectively. The study was performed in 2003–2005 on a representative sample of over 12,000 Poles aged 20–74 years. According to the NATPOL 2011 survey (arterial hypertension and other cardiovascular diseases risk factors in Poland), which involved more than 2000 Poles aged 18–79 years, smoking prevalence was estimated at 26.9% of the general population. These results suggest a significant reduction in smoking prevalence since 2002 when it was assessed at 43.2% among men and 26.7% among women. There are still more male than female smokers, but a significant reduction in smoking prevalence is observed in men, greater than in women. In the youngest study group, i.e. 18–39 years of age, smokers constituted 30.2% of men and 22.4% of women. The highest proportion of smokers was found among both sexes in the 40–59 age group: 37.4% of men and 30.9% of women [26].

According to the 2012 report of the National Institute of Public Health — National Institute of Hygiene, the prevalence of tobacco smoking in Poland was approximately 33% in men and approximately 20% in women. Poland ranks among the ten heaviest smoking European countries [6].

Smoking is highly prevalent among younger adults with MI, as shown above, and is an independent risk factor for MI among young individuals. Therefore, limiting the prevalence of smoking seems to be one of the essential components of both primary and secondary prevention of MI in young adults.

Dyslipidaemia is another risk factor for MI that is highly prevalent among young individuals. According to the results of the INTERHEART study, dyslipidaemia and smoking are the two most important risk factors [19].

A correlation has been found between the blood concentration of lipids and the risk of cardiovascular disease. Studies have shown that a reduction in the total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C) levels of 1% is associated with a reduction in the risk of coronary heart disease by 2%. Moreover, epidemiological data have shown that a reduction in high-density lipoprotein cholesterol (HDL-C) level of 1% is associated with an increase in the risk of coronary heart disease by 2% [20].

Pineda et al. [23] reported hyperlipidaemia in 73.6% of patients with premature MI. This condition was less prevalent in patients who experienced MI after the age of 45 years (59.5%).

In a similar fashion, a higher prevalence of this risk factor in younger patients was observed by Andrés et al. [22]. Here, dyslipidaemia was present in 50.21% of patients with premature MI and 35.79% of patients with MI aged above

46 years. Additionally, among younger patients, this condition was more prevalent in men than in women (52.69% vs. 29.19%, respectively).

The results obtained from the Polish Registry of Acute Coronary Syndromes (PL-ACS) by Trzeciak et al. [4] are conflicting. Hypercholesterolaemia was more prevalent in older patients with MI than in the younger group (47.8% vs. 38.2%, respectively).

In the WOBASZ trial [20], hypercholesterolaemia (defined as TC level  $\geq 5$  mmol/l or LDL-C level  $\geq 3$  mmol/L) was diagnosed in 67% of men and 64% of women. What is most alarming is that in the studied population only 3% of men and 2% of women received effective hypolipemising treatment. Moreover, 76% of men and 69% of women were not even informed of the need for pharmacological treatment of their lipid abnormalities.

The results of NATPOL 2011 [27] assess the prevalence of hypercholesterolaemia in the Polish population at 62%. The prevalence of hypercholesterolaemia varied with sex and age. In individuals aged 18–39 and 40–59 years it was more prevalent in men than in women and affected 42.1% vs. 36.7% and 77.5% vs. 74.4% in the subsequent age groups, respectively. In the oldest group (age 60–79 years) hypercholesterolaemia was more frequent in women than in men (82.6% vs. 76.1%, respectively) [26]. The most intimidating fact is that 58.7% of all patients were unaware of their high cholesterol level. Additionally, only 10.9% of patients were treated successfully [27].

The 3ST-POL study [28–30] revealed a corresponding proportion of patients in whom recommended cholesterol levels were achieved due to hypolipemising treatment. Out of almost 50,000 patients who received statins, 9.5% achieved total cholesterol levels near the upper limit of normal (155–175 mg/dL; 4.0–4.5 mmol/L) and 12.5% achieved LDL-C levels within the 80–100 mg/dL range (2.0–2.5 mmol/L).

Hypertension is less common in young patients with MI than in older patients. Pineda et al. [23] reported hypertension in 28.5% of patients aged  $\leq 45$  years and in 49.5% of patients aged  $> 45$  years with MI. A similar dependency, but with a higher prevalence of hypertension in both age groups, was observed by Yunyun et al. [24]. Hypertension was present in 47.7% of young patients with MI and in 53.9% of older patients. Hypertension in young individuals was also found to be less common in those without coronary heart disease (44.3%). Data obtained from PL-ACS reports hypertension in 42.5% of young patients with MI and in 70.7% of individuals above 40 years [4].

In Poland, the prevalence of hypertension was assessed in the NATPOL 2011 study as 32% of the Polish population; 14.9% of men and 4.8% of women aged 18–39 years were found to be affected. In the 40–59 age group, 44.7% and 30.2%, respectively, were affected. Hypertension control has also improved in Poland, reaching 28.1% in women and 21.1% in men [26].

**Table 1.** Prevalence of risk factors in young Poles

Risk factor	Prevalence (in population aged 18–39 years)	
	Men	Women
Smoking	30.2%	22.4%
Hypercholesterolaemia	42.1%	36.6%
Hypertension	14.9%	4.8%
Diabetes	0.8%	0.9%

Another important risk factor that is less prevalent in young individuals with MI is diabetes. Pineda et al. [23] reported diabetes in 11.5% of young patients with MI and in 24.5% of patients above the age of 45 years. Yunyun et al. [24] reported an even larger proportion of young patients (20.93%), while the prevalence of diabetes among patients with MI above the age of 60 years was 32.3%. Diabetes was reported by Trzeciak et al. [4] to be present in 5.5% of patients with MI younger than 40 years and in 24.7% of those above that age.

Rutkowski et al. [31] estimated that the prevalence of diabetes among Poles aged 18–39 years is 0.8% and 0.9% in men and women, respectively. In the group aged 40–49 years 6.3% of men and 2.4% of women are affected.

According to the INTERHEART study [19], most cases of MI in young adults could be prevented because most risk factors are at least partially modifiable. Therefore, preventive measures should be aimed at limiting the negative impact of these factors (Table 1).

### PROGNOSIS AND SECONDARY PREVENTION

Prognosis after MI is much better in younger patients; in-hospital mortality rates are also lower. In 2012, in-hospital mortality among patients aged 35–49 years was 2.5% and twice as that among patients aged 60–64 years in Poland [1]. Trzeciak et al. [4] obtained even lower results in a young group. In-hospital mortality was 1.5% in young individuals and 5.2% in the older group. Other studies yielded similar results. Das et al. [21] observed in-hospital mortality of 3.2% among young patients and 10.7% among older patients (> 40 years). Andrés et al. [22] reported an even greater disproportion between young (< 46 years) and older patients: 2.77% vs. 13.65%, respectively. At the same time, there is a great risk of cardiovascular rehospitalisation, especially if the patient continues to smoke [32]. The results of studies by Nielsen et al. [33] should therefore come as no surprise, wherein long-term mortality in young patients after MI, albeit low, remains two to four times higher than in the general male population, and even higher in women. Maroszyńska-Dmoch and Woźakowska-Kapłon [34] noted 7.75% mortality during long-term follow-up in young patients with acute coronary syndrome.

Additionally, as shown by Awad-Elkarim et al. [35], who observed patients for 18 years, a good prognosis due to young age becomes worse after nine years. The timing of the study is an important limitation: it was carried out in the 1980s and 1990s when thrombolytic therapy in patients after MI was not common. However, more recent data from such long observation periods are not available.

Secondary prevention in patients after MI includes lifestyle modification, control of risk factors, and pharmacotherapy with proven efficacy. The main interventions that are recommended as part of lifestyle modification include smoking cessation, changing dietary habits and weight control, increasing physical activity to 30 min of moderate-intensity exercises at least five times a week, and arterial pressure control. Unfortunately, compliance with non-pharmacological recommendations is unsatisfactory, primarily with regard to smoking and physical activity [1]. Moreover, changes in diet are usually unsatisfactory among people with cardiovascular diseases [36].

Medications with proven efficacy as part of secondary prevention include acetylsalicylic acid, statins, beta-adrenergolytics, angiotensin converting enzyme inhibitors and angiotensin II receptor blockers, adenosine diphosphate receptor antagonists, and aldosterone antagonists. Unless contraindicated, each patient should be treated at least with the four first groups of medications; the remaining drugs are additionally recommended in particular cases [37, 38].

Despite clear evidence of a positive correlation between pharmacotherapy and reduced risk of cardiovascular events and long-term mortality, adherence remains unsatisfactory. Studies show that adherence decreases during therapy, reaching even below 50% within three years after MI [39].

There are conflicting literature data concerning the impact of age on adherence among cardiovascular patients. Degli Esposti et al. [40] observed that reduced adherence was associated with younger age. Castellano et al. [41] had similar findings. In their study, patients below the age of 50 years displayed significantly lower adherence. Meanwhile, Kassab et al. [42] observed the contrary, i.e. lower adherence among older patients.

Jin et al. [43] aimed to assess the reasons for insufficient use of pharmacotherapy as part of secondary prevention in patients with acute coronary syndrome and to assess the related factors, taking age differences into consideration. Patients below the age of 65 years cited the cost of medicine and fear of adverse reactions as the main causes of non-adherence. Older patients complained about excessive amounts of drugs and considered the drugs insignificant [43]. A limitation of this study is that patients indicated one of five possible reasons given in the survey or chose “other” as the reason for non-adherence and could therefore have been influenced by the available answers.



## CONCLUSIONS

Myocardial infarction in young adults below 45 years of age accounts for approximately 10% of all cases. It affects mostly men, but the proportion of women is steadily increasing. Different mechanisms that lead to MI as well as risk factors may be observed in younger and older individuals. Due to the fact that most risk factors are at least partially modifiable, it is believed that most cases of MI in young age can be prevented.

Additional studies should be carried out to assess adherence among young patients after MI, because this group, if adhering to treatment and lifestyle modification, have favourable long-term prognosis.

**Conflict of interest:** none declared

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Paniom i Panom Profesorom, naszym stałym Recenzentom i Współautorom serdeczne gratulacje i okolicznościowe życzenia składają:  
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