

# Survival analysis of patients with acute coronary syndrome receiving comprehensive coordinated care after myocardial infarction (KOS-Zawał)

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## A B S T R A C T

**Background:** This study aimed to analyze survival rates among patients with acute coronary syndrome (ACS) covered and not covered by the National Comprehensive Care after Myocardial Infarction (KOS-Zawał) program.

**Methods:** A total of 179 972 patients after myocardial infarction (MI) were enrolled in KOS-Zawał program between October 2017 and March 2020 and were included in the comparative analysis with survival analysis. A group of 24 496 (13.61%) patients received KOS-Zawał services, while a group of 155 476 (86.39%) were not covered by the KOS-Zawał program. The time points for observation of the incidence of death were set at 30, 180, and 365 days from the end of the first hospitalization.

**Results:** There was a lower incidence of death in favor of the KOS-Zawał group relative to the non-KOS-Zawał group both in hospital and at 30, 180, and 365 days after the end of hospitalization, respectively: 0.19% vs. 6.55%; 0.80% vs. 8.39%; 2.92% vs. 10.74%; and 6.35% vs. 13.40%. Survival analysis revealed a statistically significantly lower ( $P < 0.0001$ ) probability of death in the KOS-Zawał group compared with the non-KOS-Zawał group. Also, logistic regression analysis confirmed that patients in the KOS-Zawał group had a significantly lower risk of death than those in the non-KOS-Zawał group (odds ratio, 0.710; 95% confidence interval, 0.554–0.908;  $P = 0.007$ ).

**Conclusions:** The KOS-Zawał comprehensive care program reduces the risk of death in the first year after MI by 29%. There are indications of a biased interpretation of the data due to the initial better clinical status of post-MI patients covered by the KOS-Zawał program.

**Key words:** acute coronary syndrome, KOS-Zawał limitations, KOS-Zawał program, mortality risk, myocardial infarction

## INTRODUCTION

Acute coronary syndrome (ACS) is a broad term that encompasses ST-elevation myocardial infarction (STEMI), non-ST-elevation myocardial infarction (NSTEMI), and unstable angina (UA). These events are frequent in Poland and worldwide [1]. In 2019, 1 246 700 people with a principal diagnosis of ischemic heart disease (I20-I25 according to the ICD, International Classification of Diseases) were provided with healthcare services in Poland. As many as 228 100 of these patients had

to be hospitalized. Medical care was mainly required for those with chronic ischemic disease. However, it can be noted that between 2014 and 2019, the percentage of patients who received services due to a diagnosed ACS increased. According to the information on publicly funded benefits, 102 700 people with the diagnosis of ACS were hospitalized in 2019 [2].

In 2019, the reimbursement value of health services provided in Poland due to ACS amounted to about 49% of the value

## WHAT'S NEW?

Despite significant advances in the diagnosis and treatment of cardiovascular disease, mortality from myocardial infarction (MI) remains a major challenge for modern cardiology. The implementation of a nationwide program of comprehensive coordinated care after myocardial infarction (KOS-Zawał) was expected to result in a longer life expectancy for patients. Our study showed that patients in the KOS-Zawał group were significantly less likely to die than those in the non-KOS-Zawał group. Promising results were presented, showing that the KOS-Zawał program reduces the risk of death for patients after MI by 29%. A potential limitation of the KOS-Zawał program regarding a biased interpretation of results was also pointed out, due to the possibility that patients in a better clinical condition at baseline, presenting with a more favorable prognosis after MI, may have been eligible for the KOS-Zawał program.

of all services (962.7 million PLN) to treat ischemic heart disease (IHD). Compared to 2014, these benefits increased by approximately 6%. ACS inpatient costs (I20.0, I21 by ICD) accounted for 61.4% of total IHD inpatient costs in 2019. As hospitalization costs amounted to 93% of the funds devoted to IHD, one may conclude that hospital treatment of myocardial infarction (MI) consumes a significant amount of money and shows an upward trend [2].

Special attention should be paid to the unfavorable trend of mortality within 12 months of 10.1% of patients who were discharged from health care facilities after acute coronary syndrome. The reasons for such a significant percentage of out-of-hospital mortality are considered to include patients' failure to make beneficial lifestyle modifications, failure to adhere to therapeutic recommendations, and difficult or insufficient access to specialized cardiac care [3].

Thanks to the development of modern diagnostics and treatment of cardiovascular diseases, including interventional cardiology techniques, a significant decrease in in-hospital mortality has been observed in Poland in recent years. Unfortunately, despite this, annual mortality after MI treated with interventional therapy (i.e. the most effective of all currently used methods) exceeds 12% [4]. This is why it became so important to implement the KOS-Zawał program, which is comprehensive care after myocardial infarction aiming to reduce death and disability due to heart failure and to enable rapid recovery and return to work [5]. Taking into account the causes of morbidity and mortality of patients after MI in Poland, the team of experts from the Polish Cardiac Society and the Agency for Health Technology Assessment and Tariffication developed an innovative concept of organization of post-MI care in Poland [6]. The experts proposed a model of coordinated care under which patients after MI are provided with easier access to cardiac surgical treatment, cardiac rehabilitation, and specialist cardiac care.

The proposed KOS-Zawał concept was eventually included in the regulations of the Minister of Health and Ordinances of the President of the National Health Fund (NFZ) and was implemented in Poland in the fourth quarter of 2017 as coordinated care after MI. The KOS-Zawał program is characterized in the NFZ reporting data by code

03.4100.500.02. Services under this scope started to be reported in October 2017 [7].

The primary objectives of developing and implementing the new healthcare organization were to improve the quality of medical care, increase patient satisfaction, and reduce the risk of subsequent cardiovascular events. A particularly important goal was to prolong the life of patients after MI by increasing the frequency and speed of full myocardial revascularization, increasing the frequency and speed of implantation of implantable devices (if indicated), increasing access to cardiac rehabilitation programs, especially those performed on an outpatient basis, facilitating access to cardiac consultations and reducing delays in the execution of individual procedures [8].

The presented study aimed to compare the survival of patients with acute coronary syndrome included in the comprehensive care after MI (KOS-Zawał) compared with patients not included in this program.

## METHODS

### Study design and participants

The described data were collected and reported by the National Health Fund (NFZ). Data in the comprehensive care after MI (KOS-Zawał) started to be collected and reported from October 2017.

The present study analyzed the data from 2017 to 2020 on 182 526 patients with acute coronary syndrome and other cardiovascular diseases, among whom there were 155 476 (85.18%) patients treated without the KOS benefit and 27 050 (14.82%) patients who were included in the KOS-Zawał program. The control group consisted of patients treated without the KOS-Zawał benefit, among whom there were 99 769 (64.2%) men and 55 707 (35.8%) women. In contrast, the study group consisted of patients covered by the KOS-Zawał program, which included 18 514 (68.4%) men and 8 536 (31.6%) women (Table 1).

The number of patients by year and quarter of initiation of treatment under the KOS-Zawał program is presented in Supplementary material, Table S1. A cross-section of the place of residence of patients who received KOS-Zawał benefits between October 2017 and March 2020 is shown in Supplementary material, Figure S1. The highest

**Table 1.** Demographic characteristics of patients covered by the KOS-Zawał benefits

Sex	N	Age, year, mean (SD)	Age group, years									
			<44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	>85
Male	18 514	64 (10.8)	5%	5%	9%	14%	20%	20%	12%	8%	5%	2%
Female	8 536	69 (10.7)	2%	3%	5%	9%	15%	20%	16%	13%	12%	6%

proportions of patients treated under the KOS-Zawał benefit came from the Silesian, Lower Silesian, and Lublin voivodeships.

### Characteristics of treatment modules

The KOS-Zawał program provides patients with access to comprehensive cardiac rehabilitation, which includes treatment in four treatment modules. Module I is the treatment of the acute phase of MI (invasive treatment of ACS, angioplasty, interventional diagnostics of ACS, arterial bypass grafting, conservative treatment, follow-up visit within 14 days after discharge). Module II includes cardiac rehabilitation in an inpatient setting, in a center or day unit, and telerehabilitation. Module III includes electrotherapy (i.e., implantation of a cardiac assist device), and Module IV includes specialized cardiac care during the 12 months following ACS. Module IV concludes with a balance-of-care approach, which is the performance of laboratory tests and specialized counseling that includes a summary of the patient's clinical condition and/or the issue of a certificate of fitness to work.

### Statistical analysis

Statistical analysis was conducted using R software version 3.6.1 (R Foundation, Vienna, Austria). Descriptive data were presented as the number of observations and percent or means and standard deviations (SD). The distribution of data was analyzed by the Kolmogorov-Smirnov test and the equality of variance by Levene's test. The  $\chi^2$ , Student's t- and t-Welch tests were used for comparison of data. Comparative survival analyzes were performed by the Log-Rank test for two groups and the Log-Rank test for more than two study groups. Survival analyzes were shown using Kaplan-Meier survival curves.

To verify the impact of independent variables (demographic parameters, clinical parameters describing the patients' treatment history, the type of treatment applied, and the completion of cardiac rehabilitation within 60 days from the date of hospitalization, participation in the KOS-Zawał program) on the annual mortality of patients, a statistical model was created. Modeling was carried out in two stages. In the first stage, the propensity score matching (PSM) method was used, in which each patient covered by the KOS-Zawał program was matched with at least one patient not covered by KOS-Zawał but identical in terms of other independent variables. In the second stage, a logistic regression analysis was performed, where the dependent variable was the patient's death within

**Table 2.** Provision of benefits under the different modules of KOS-Zawał

Module	Number of patients, n (%)
Module I	23 724 (99.5)
Module IV	18 523 (77.7)
Module II	17 199 (72.2)
Module III	448 (1.90)
Total	23 837 (100)

365 days from the date of the onset of hospitalization for MI. *P*-values <0.05 were assumed as statistically significant.

## RESULTS

### Clinical characteristics of patients receiving KOS-Zawał benefits

The structure of principal diagnoses at a patient's first KOS-Zawał hospitalization is shown in Supplementary material, *Table S2*, while *Table S3* presents the structure of comorbid diagnoses at the first hospitalization of patients qualified for the KOS-Zawał program.

The highest proportion of patients included those with acute MI (Supplementary material, *Table S2*), and the most common comorbidities were primary hypertension and the presence of other cardiovascular implants and grafts (Supplementary material, *Table S3*).

### Description of the treatment provided to patients receiving KOS-Zawał benefits

The treatment applied to patients covered by the KOS-Zawał program was analyzed based on the treatment modules used. *Table 2* shows data on patients who were treated at least once under a given treatment module (data obtained for  $n = 23\,837$ ). The highest percentage included patients treated under Module I (99.5%), Module IV (77.7%), and Module II (72.2%).

These results are confirmed in *Table 3*, which presents the variants of use of each module by patients covered by the KOS-Zawał benefit. The highest proportion of patients (64.3%) included those treated under Module I, Module IV, and Module II.

### Survival analysis of patients with myocardial infarction

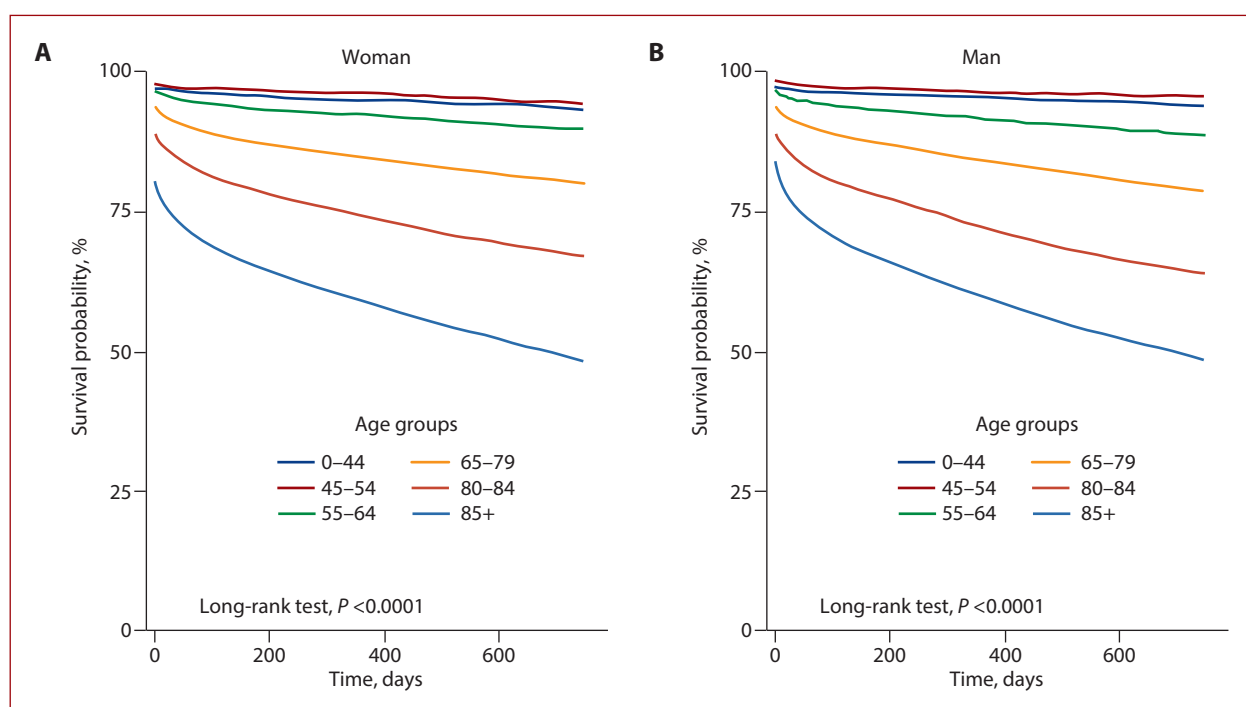
Only patients hospitalized for MI were included in the survival analysis ( $n = 24\,496$ ) and the total number of patients decreased to 179 972 patients (baseline  $n = 182\,526$ ).

**Table 3.** Options for the use of individual modules by patients covered by the KOS-Zawał service

Module I	Module II	Module III	Module IV	Number of patients (n)	Percentage of patients, %	Deaths within 30 days of first contact under KOS, %	Age, years, mean (SD)
1	1	0	1	15 319	64.3	0.0	64 (10.8)
1	0	0	0	3 839	16.1	4.0	68 (11.4)
1	0	0	1	2 684	11.3	0.0	67 (11.1)
1	1	0	0	1 435	6.0	2.0	66 (11.2)
1	1	1	1	373	1.6	0.0	68 (9.3)
0	0	0	1	53	0.2	0.0	69 (13.2)
1	0	1	1	50	0.2	0.0	69 (8.9)
0	1	0	1	44	0.2	0.0	64 (9.4)
0	1	0	0	15	0.0	0.0	67 (13.2)
1	1	1	0	13	0.0	0.0	69 (12.9)
1	0	1	0	11	0.0	0.0	69 (8.7)
0	0	1	0	1	0.0	0.0	55 (0.0)

Uses KOS-Zawał benefits = 1, does not use KOS-Zawał benefits = 0

The results are presented considering the rate of death within the first 30 days of starting the KOS-Zawał benefit and the age of the patients



**Figure 1.** Kaplan-Meier survival curves for the total group of MI patients (n = 179 972) who were divided into two subgroups according to the “sex” parameter and six subgroups according to “age”.

Notes: Comparative analysis was performed by the general Log-Rank test for more than two study groups

Figure 1 shows the survival probabilities calculated for the total group of patients (n = 179 972) hospitalized for MI according to sex and age group. It shows that in both male and female groups, the probability of survival significantly decreases with the increasing age of patients (in both cases  $P < 0.0001$ ).

Table 4 presents the results of comparative analyses for 4 time measurements: death in hospital, death within 30 days after hospitalization, death within six months, and death within one year after hospitalization. There were

statistically significant higher survival rates for patients covered by the KOS-Zawał program compared with patients not covered by the program in all 4-time intervals.

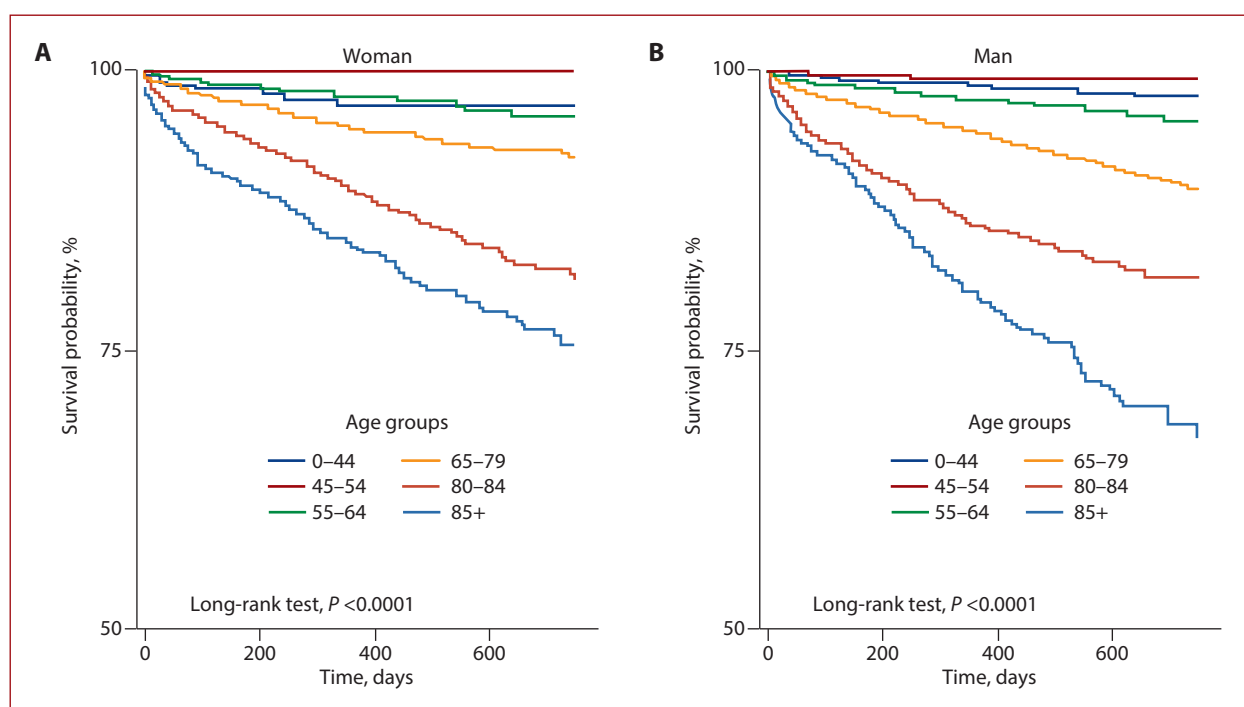
Survival analysis of patients covered by KOS-Zawał (n = 24 496) by sex and age groups was also performed. There was a significant relationship between increasing age and the probability of death for patients, with men over 85 years of age having a 65% probability of survival and women of the same age having a higher 75% probability of survival (Figure 2).

**Table 4.** The incidence of deaths of patients who received a benefit due to myocardial infarction between October 2017 and March 2020 in the group of patients covered by the KOS-Zawał benefit and in the group of patients not covered by the benefit

KOS-Zawał / Time of death	Death at hospital, %	Death within 30 days, %	Death within 180 days, %	Death within 365 days, %
Total	6.74 (n = 179 972)	9.19 (n = 179 972)	13.66 (n = 173 783)	19.75 (n = 143 437)
Patients covered by KOS-Zawał benefits	0.19 (n = 24 496) <sup>a</sup>	0.80 (n = 24 496)	2.92 (n = 23 371)	6.35 (n = 16 889)
Patients not covered by KOS-Zawał benefits	6.55 (n = 155 476)	8.39 (n = 155 476)	10.74 (n = 150 412)	13.40 (n = 126 548)
P-value	<0.0001	<0.0001	<0.0001	<0.0001

Measurements were made at 30 days, 180 days, and 365 days after the end of the first hospitalization. The number of patients against which the death rate was calculated is given in brackets

<sup>a</sup>The number of patients covered by the KOS-Zawał service is slightly lower than in previous statements because not every patient treated under KOS was hospitalized for a heart attack



**Figure 2.** Kaplan-Meier survival curves for MI patients with KOS-Zawał (n = 24 496) by sex who were divided into six subgroups based on age. Notes: Comparative analysis was performed by the general Log-rank test for more than two study groups

### Impact of selected independent variables on the mortality risk within 365 days from the date of the onset of hospitalization due to myocardial infarction

In the performed analyses, the number of patients covered or not by the KOS-Zawał program was reduced because the analyzed patient population was restricted to those who survived 60 days from the date of the onset of hospitalization for MI. This selection of the study samples is because one of the explanatory variables was that the patient's cardiac rehabilitation started within 60 days from the date of hospitalization.

Table 5 presents a comparative analysis of demographic parameters, clinical parameters describing the patients' treatment history, the type of treatment applied, and the

completion of cardiac rehabilitation within 60 days from the date of hospitalization in patients covered by the KOS-Zawał program and those not covered by the program. It was shown that the frequencies of almost all analyzed parameters (except the variables "renal failure", "cancer", and "COPD") were statistically significantly different in the two study groups.

To determine which of the analyzed variables could be significant predictors of the risk of patient death within 365 days from the date of the onset of hospitalization for MI, logistic regression analysis was performed, and the results are shown in Table 6. Most of the variables studied were predictors of the risk of patient death, especially dialysis treatment (odds ratio [OR], 4.049;  $P < 0.001$ ), the presence of cancer as a comorbidity (OR, 2.113;  $P < 0.001$ ), and heart

**Table 5.** Characteristic of selected demographic and clinical variables, and variables describing patient's treatment, type of treatment, and cardiac rehabilitation within 60 days of hospitalization in the model constructed with using propensity score matching (PSM)

Variables	Total population n = 120 974 (100%)	Patients with KOS n = 16 957 (14%)	Patients without KOS n = 104 017 (86%)	P-value
Age, years	68.06 (11.6)	65.49 (10.9)	68.49 (11.6)	<0.001
Sex				<0.001
Male	78 355 (64.77)	11 622 (68.54)	66 748 (64.17)	
Female	42 619 (35.23)	5 335 (31.46)	37 269 (35.83)	
Kidney failure	4 549 (3.76)	639 (3.77)	3 911 (3.76)	0.953
Heart failure	17 408 (14.39)	1 901 (11.21)	15 499 (14.90)	<0.001
Hypertension	68 338 (56.49)	9 272 (54.68)	59 050 (56.77)	<0.001
Stroke	1 307 (1.08)	209 (1.23)	1 103 (1.06)	0.049
COPD	6 932 (5.73)	990 (5.84)	5 939 (5.71)	0.510
Diabetes	28 925 (23.91)	3 822 (22.54)	25 099 (24.13)	<0.001
AF and flutter	9 170 (7.58)	1 078 (6.36)	8 082 (7.77)	<0.001
Cancer	6 956 (5.75)	961 (5.67)	5 991 (5.76)	0.632
CABG	302 (0.25)	78 (0.46)	229 (0.22)	<0.001
PCI	10 440 (8.63)	674 (9.87)	8 769 (8.43)	<0.001
Dialysis	387 (0.32)	76 (0.45)	312 (0.30)	0.002
MI with STEMI	41 797 (34.55)	6 978 (41.15)	34 856 (33.51)	<0.001
PCI during MI hospitalization	91 977 (76.03)	15 292 (90.18)	76 765 (73.80)	<0.001
CABG during MI hospitalization	1 548 (1.28)	304 (1.79)	1 248 (1.20)	<0.001
Cardiac rehabilitation within 60 days of the start of MI hospitalization	39 631 (32.76)	12 984 (76.57)	26 888 (25.85)	<0.001

Descriptive data were presented as mean (SD) or number (%)

Abbreviations: COPD, chronic obstructive pulmonary disease; AF, atrial fibrillation; CABG, coronary artery bypass grafting; PCI, percutaneous coronary interventions; MI, myocardial infarction; STEMI, ST-Elevation Myocardial Infarction; KOS-Zawał, comprehensive coordinated care after myocardial infarction

**Table 6.** Logistic regression analysis of prediction of risk of death in the total population of patients with myocardial infarction (n = 120 974)

Variable	OR (95% CI)	P-value
Age, years	1.058 (1.055–1.059)	<0.001
Male sex	1.217 (1.161–1.276)	<0.001
Kidney failure	1.334 (1.218–1.460)	<0.001
Heart failure	1.974 (1.868–2.084)	<0.001
Hypertension	0.776 (0.738–0.815)	<0.001
Stroke	1.8 (1.515–2.138)	<0.001
COPD	1.492 (1.379–1.612)	<0.001
Diabetes	1.358 (1.293–1.425)	<0.001
AF and flutter	1.052 (0.982–1.127)	0.149
Cancer	2.113 (1.968–2.268)	<0.001
CABG	1.184 (0.766–1.830)	0.447
PCI	0.899 (0.830–0.972)	0.008
Dialysis	4.047 (3.186–5.137)	<0.001
KOS-Zawał	0.710 (0.554–0.908)	0.007
MI with STEMI	1.123 (1.065–1.184)	<0.001
PCI during MI hospitalization	0.587 (0.559–0.616)	<0.001
CABG during MI hospitalization	0.834 (0.659–1.055)	0.131
Cardiac rehabilitation within 60 days of the start of MI hospitalization	0.345 (0.320–0.371)	<0.001

Abbreviations: OR, odds ratio; CI, confidence interval; COPD, chronic obstructive pulmonary disease; AF, atrial fibrillation; CABG, coronary artery bypass grafting; PCI, percutaneous coronary interventions; MI, myocardial infarction; STEMI, ST Elevation Myocardial Infarction; KOS-Zawał, comprehensive coordinated care after myocardial infarction.

failure (OR, 1.974;  $P < 0.001$ ). In contrast, the risk of death within 365 days after MI of patients covered by the KOS-Zawał program was significantly lower than in patients not covered by the program (OR, 0.710;  $P = 0.007$ ). The KOS-Zawał comprehensive care program reduced the risk of death in the first year after MI by 29%.

## DISCUSSION

The results of studies conducted in Poland before the introduction of KOS-Zawał indicated that patients after MI are not always treated optimally [9]. Often the primary goals of secondary prevention were not achieved. It was indicated that, on average, one year after hospitalization for acute coronary syndrome or myocardial revascularization, 20% of patients smoked, 80% were overweight, 47% had too high blood pressure, and 73% had LDL cholesterol  $\geq 1.8$  mmol/l. In addition, one in ten patients did not take any antiplatelet drugs [9].

Among many factors responsible for this situation were insufficient availability of cardiac education and rehabilitation programs and inadequate access to outpatient cardiac care. Coordinated healthcare has become very popular in recent years because it means that healthcare is no longer focused on the provision of individual medical services and procedures but is centered around the patient. Coordinated care providers stop dividing up services and focus on solving a specific health problem. The provider focuses on solving a specific health problem, while the payer finances the whole treatment, rather than its individual stages.

Recently, KOS-Zawał, one of the first and most widely implemented coordinated care frameworks after MI, has also aroused considerable interest in Poland. The results of the program announced in 2020 were very satisfactory: the risk of death from all causes among people receiving care under the program was reduced by around 30%, which can be fully explained by improved access to specialized care, cardiac rehabilitation, as well as other cardiac procedures [10].

A recent study by Jankowski et al. [11] among patients hospitalized for acute MI in Poland between October 1, 2017 and December 31, 2018 shows that the annual all-cause mortality rate was 4.4% among KOS-Zawał participants and 6.0% in the group of patients not participating in the KOS-Zawał program. MI or stroke occurred in 10.6% and 12.0% ( $P < 0.01$ ), while all-cause death or cardiovascular hospitalization occurred in 42.2% and 47.9% ( $P < 0.001$ ) among KOS-Zawał and non-KOS-Zawał participants, respectively.

The results of our study, where a 29% reduction in the risk of death after MI was achieved (OR, 0.710; 95% confidence interval [CI], 0.554–0.908;  $P = 0.007$ ), correspond with the results of the study by Jankowski et al. [10, 11].

It is also important to note that the care provided under the KOS-Zawał program is very well evaluated by patients. According to 96% of participants receiving care under this program, their health has benefited, and 99% thought that the KOS-Zawał program provided them with a sense of security [12]. The system of care for patients after MI, implemented at the end of 2017, ensures continuity of care for 12 months after discharge from the hospital, makes the timing of invasive procedures independent of administrative requirements, reduces delays in procedures, and allows the quality of medical care to be assessed.

### Limitations

The KOS-Zawał program has undeniable clinical benefits for patients after MI, cardiovascular events, and stroke, resulting in a lower risk of death and shorter hospitalization. Despite the promising results of the KOS-Zawał program in Poland, which has been running for 4 years, its limitations, which translate into the presented survival analysis results, should be mentioned. Patients qualified for the KOS-Zawał program are those with a better baseline clinical condition and a more favorable prognosis after MI. This fact may contribute to a biased interpretation of the results. Further research on the effects of the KOS-Zawał program should be conducted taking into account baseline patients' characteristics.

### CONCLUSIONS

The KOS-Zawał comprehensive and multidisciplinary care program reduces the risk of death in patients after MI by 29%. Although the results of the KOS-Zawał program should be treated with caution, it should be emphasized that it has significant clinical benefits for patients after MI.

### Supplementary material

Supplementary material is available at [https://journals.viamedica.pl/kardiologia\\_polska](https://journals.viamedica.pl/kardiologia_polska).

### Article information

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