

Mortality analysis of patients with acute coronary syndrome receiving comprehensive cardiac care (KOS-Zawał) during the COVID-19 pandemic period

Keywords

acute coronary syndrome, mortality risk, comprehensive cardiac care, cardiac care

Abstract

Introduction

Due to the SARS-CoV-2 pandemic, there have been fundamental changes to the delivery and operation of healthcare facilities across the world, these changes have significantly impacted how patients with a variety of diseases are treated. We aimed to assess the impact of the COVID-19 pandemic on patient management outcomes among patients with acute coronary syndromes (ACS) and exploring the differences in patients who were treated within and outside the coordinated care programme for patients after ACS (KOS-Zawał).

Material and methods

We analysed 472,996 medical records of patients after ACS from 2017 to 2022. The study examined information on deaths in two groups of patients; those included and those not included in the KOS-Zawał.

Results

Before COVID-19 pandemic higher mortality rate was shown in the group of patients not covered by the KOS-Zawał benefit compared with patients covered by the benefit (25.5% vs. 15.8%; $p < 0.0001$) decreased significantly. During the COVID-19 a significant higher incidence of death was shown in the group of patients not covered by the KOS-Zawał compared with patients covered by the program (18% vs. 7.9%; $p < 0.0001$). Compared to the time before and during COVID-19, the number of deaths among patients not covered (25.5% vs. 18%; $p < 0.0001$) and covered by the KOS-Zawał (15.8% vs. 7.9%, $p < 0.0001$) decreased significantly

Conclusions

Patients not covered by KOS-Zawał had a significantly higher mortality rate compared to those receiving the program during the pandemic. The pandemic significantly affected patients under KOS-Zawał care, with a reduced mortality.

Mortality analysis of patients with acute coronary syndrome receiving comprehensive cardiac care (KOS-Zawal) during the COVID-19 pandemic period

Short title: COVID-19 and ACS Survival Analysis with KOS-Zawal Care

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Conclusions Patients not covered by KOS-Zawal had a significantly higher mortality rate compared to those receiving the program during the pandemic. The pandemic significantly affected patients under KOS-Zawal care, with a reduced mortality.

Key words

acute coronary syndrome; comprehensive cardiac care; mortality risk, cardiac care

1. Introduction

Due to the outbreak of the pandemic caused by the SARS-CoV-2 virus, there have been fundamental changes to the operation of healthcare facilities across the world [1-3]. The rapid and increased patient admissions due to COVID-19 forced a restructuring of hospital services and the redeployment of staff to ensure the delivery of optimal clinical care [4-7]. In many countries, non-urgent elective treatments were been postponed, this has been due to staff and infrastructure constraints, and concerns about exposing potentially vulnerable patients to infection [8]. In Poland, according to the recommendations in force during the COVID-19 pandemic, services in the fields of cardiology, oncology and other clinical areas where the delay of implementation of treatment could have a negative impact on prognosis, should be provided without interruption. In order to minimize the risk of transmission of COVID-19 infection and to provide additional hospital beds for patients requiring urgent hospital admission due to COVID-19 infection, the Polish National Health Fund (NFZ) recommended the limiting of clinical services to the minimum required or the temporary suspension of the provision of planned services.[9,10] Due to concerns about contracting COVID-19 it is noted that in Poland, patients with cardiovascular diseases (CVD), irrespective of their symptoms, often did not call emergency teams and exhibited reduced reporting of symptoms to medical facilities, this was particularly noticeable in the case of myocardial infarction [11].

In 2020, according to the estimates of the Polish Cardiac Society (PTK), only 12-18% of patients with ACS were eligible for the coordinated care programme for patients after ACS (KOS-Zawal), as confirmed by the analyses of the present study. Delivery of treatment and care, including cardiac rehabilitation, under the KOS-Zawal programme has become increasingly difficult as confirmed by the analyses of our own study [12]. KOS-Zawal provides both medical care (diagnostics and interventional treatment) and cardiac rehabilitation for up to 12 months after a ACS. The primary aim of developing and implementing new models of

coordinated medical care was to improve its quality, increase patient satisfaction and reduce the risk of future cardiovascular events. A key objective was to improve mortality and morbidity post myocardial infarction and this was enabled by the increased the frequency and time of complete myocardial revascularisation, improvement in access to services, and where appropriate, to implantable devices, increasing access to cardiac rehabilitation programmes, particularly those performed on an outpatient basis, facilitating access to consultations with a cardiologist and reducing delays in the performance of individual procedures [13,14] Studies conducted in 2017 and 2020, following the introduction of the KOS-Zawal programme, have shown a favourable trend in terms of reduced mortality in this group of patients [13] Kubiela et al. showed that a comprehensive and multidisciplinary KOS-Zawal managed care programme reduces the risk of death in post-ACS patients by approximately 29-30% [13]. In addition, it is important to emphasize that the results of the programme have also increased the sense of safety among patients covered by the KOS-heart attack programme [15]. As a priority action, the NFZ recommends, strengthening preventive measures for modifiable factors of ischaemic heart disease and increasing access to early cardiac rehabilitation [16].

This favourable trend was disrupted by the SARS-CoV-2 virus; therefore, the aim of this study was to assess the impact of the COVID-19 pandemic on patient management and cardiovascular disease outcomes including acute coronary syndrome, for patients treated within the KOS-Zawal programme and the group of patients treated outside of the programme between 2017 and 2022.

2. Material and methods

2.1. Study design and participants

This study analyzed patient data from two distinct periods to assess the impact of the COVID-19 pandemic on outcomes for patients with and without coverage under the KOS-Zawal program. The pre-pandemic period, from October 1, 2017, to March 31, 2020, included

263,619 patients not covered by the KOS-Zawal program and 26,457 patients covered by the program with myocardial infarction. The during-pandemic period, from April 1, 2020, to March 31, 2022, included 155,408 patients not covered and 27,512 patients covered by the KOS-Zawal program. Participants included in this comparative study were diagnosed with Acute Coronary Syndrome (ACS). Eligibility required that participants be adults aged 18 years or older with comprehensive medical records and adequate follow-up data available for the entire study duration. Patients with incomplete medical records or insufficient follow-up data were excluded to ensure the accuracy of mortality rates and the effectiveness assessment of the KOS-Zawal program.

2.2. Ethical Statement

All methods were carried out in accordance with the relevant guidelines and regulations an ethical review and approval for the study were waived for this study because we did not collect personal data and did not involve laboratory tests or medical interviews; therefore, we did not require the consent of a bioethical committee according to Polish national legislation.

2.3. Statistical analysis

Descriptive data were presented as the number of observation and percentage or as mean and standard deviation ($\bar{x} \pm SD$). Chi-square test and Student-t tests were performed for statistical comparisons. Data was analysed using Microsoft Excel Professional 2016 (Microsoft, Redmond, WA, USA), R software version 3.6.1 (R Foundation, Vienna, Austria) and Statistica v.13.3 (Tibco Software Inc., Palo Alto, CA, USA).

3. Results

In the pre-pandemic period (October 2017-March 2020), the mean age in the two groups was between 66 and 68 years, with the majority being male (61.0% and 68.4%, respectively). In the pandemic period (April 2020-March 2022 period), men made up a significant majority

of patients in the two study groups (62.7% and 69.7%, respectively), and the mean age was in the 73-75 years range. The described data was collected and reported by the NFZ. Data in the comprehensive care after MI (KOS-Zawal) was collected and reported from October 2017. Table 1 shows the demographic characteristics of the two groups of patients in the two time periods.

TABLE 1

3.1. Mortality among patients from 1 October 2017 to 31 March 2020

During the pre-pandemic period from October 1, 2017, to March 31, 2020, the mortality rate was observed to be significantly higher in the group of patients not covered by the KOS-Zawal program compared to those covered by the benefit. Specifically, the mortality rate in the non-covered group was 25.5% versus 15.8% in the covered group, reflecting a statistically significant difference ($p < 0.0001$). This disparity highlights the potential impact of the comprehensive care provided under the KOS-Zawal program. Table 2 shows data on patient deaths in the groups of patients covered and not covered by the KOS-Zawal benefit.

TABLE 2

3.2. Mortality among patients from 1 April 2020 to 31 March 2022

During the COVID-19 pandemic, between 2020 and 2022, the number of patients not covered by the KOS-Zawal service decreased to 155,408 people, of whom 28,018 (18.0%) died (Table 3). Over the same period, the number of patients covered by the KOS-Zawal benefit increased to 27,512 people, of whom 2,177 (7.9%) died. Similar to the earlier time interval, a statistically significant higher incidence of death was shown in the group of patients not covered

by the KOS-Zawal service compared with patients covered by the service ($p < 0.0001$). Compared to the earlier time interval of 1st October 2017 to 31st March 2020, in the time interval of 1st April 2020 to 31st March 2022 the number of deaths among patients not covered by the KOS-Zawal benefit decreased significantly by a factor of 0.7, and among patients with KOS-Zawal, the number of deaths decreased significantly by a factor of 0.5 ($p < 0.0001$ for both patient groups). Mortality among patients not covered by the KOS-Zawal benefit was significantly higher than among patients with the KOS-Zawal benefit, in both the male and female subgroups ($p < 0.0001$ for both subgroups) (Table 3).

Table 3

3.3. Comparative analysis of mortality of patients in two time periods: from 1 October 2017 to 31 March 2020 and from 1 April 2020 to 31 March 2022.

The data comparison between the two distinct periods — before and during the COVID-19 pandemic — reveals significant changes in mortality rates across both groups of patients. Specifically, the mortality rate in the group not covered by the KOS-Zawal program showed a reduction from 25.5% in the pre-pandemic period to 18% during the pandemic (table 4). Similarly, the mortality rate for patients covered by the KOS-Zawal program decreased from 15.8% to 7.9% over the same periods (table 5). These changes reflect a reduction in the absolute mortality rates by 7.5% and 7.9% for the non-covered and covered groups respectively, indicating substantial improvements in survival rates during the pandemic period.

The statistical significance of these reductions is profound ($p < 0.0001$ for both comparisons), suggesting that while both groups experienced improvements, the extent of mortality reduction was notably higher in the group receiving coordinated care under the KOS-Zawal program. Data detailing these shifts in mortality rates are comprehensively tabulated in

Tables 4 and 5, which provide a detailed breakdown of the mortality figures for each time frame and patient group.

Table 4

Table 5

4. Discussion

Survival analysis of patients receiving comprehensive cardiac care during the pandemic period is extremely important to assess the effectiveness of interventions and identify potential areas for improvement.

The study focuses on a critically important area of health care delivery during the COVID-19 pandemic—cardiac care for patients with acute coronary syndrome (ACS). Given the substantial restructuring of healthcare services to accommodate COVID-19 patients, understanding the impacts on other urgent medical conditions like ACS is crucial. The research emphasizes the effect of continuous and coordinated cardiac care on mortality rates during such disruptive times^(14,17). The unmet needs in Polish cardiology during the COVID-19 pandemic, especially in its early phase (2020-2021), primarily stem from the patients' fear of contacting the healthcare system due to concerns about becoming infected with SARS-CoV-2. The pandemic necessitated healthcare systems to undertake extensive reorganization, including that of hospital wards, units, and medical staff, as well as reallocating equipment and supplies from other departments to care for COVID-19 patients[1]. Decisions made by patients to delay seeking help or contacting a doctor, particularly in the context of acute coronary syndromes, deprive them of opportunities for a full recovery. The observed trend of a significant decrease in the incidence of acute coronary syndromes during the period 2020-2022 confirms researchers' concerns. An essential factor from the perspective of public health management appears to be the substantial burden on the system due to symptomatic COVID-19 patients

requiring intensive care in anesthesia and intensive care units. The logistical burden, not only on hospital services but also on limited access to primary healthcare and virtually minimal access to ambulatory specialist care, shapes the unmet needs in this area [10,18]. This study distinguishes itself by specifically examining the differences in outcomes between patients enrolled in the KOS-Zawal program and those who are not, during the pandemic. While other studies have generally addressed the broad impacts of COVID-19 on healthcare systems or on cardiac care, this study provides a direct comparison of survival rates within a well-defined patient population before and during the pandemic, offering insights into the effectiveness of the KOS-Zawal care model under crisis conditions. [19–23]. The overwhelming focus on handling COVID-19 cases led to reduced attention and capacity for other essential medical services, including cardiology care [20]. Reports from the USA, China, Spain, Italy, and Germany, indicate that the COVID-19 pandemic has resulted in a substantial decline in the number of interventional cardiology procedures being performed [19,21–23].

Recently published research assessing the impact of pandemic COVID-19 on non-COVID-19 cardiovascular care and outcomes shows a decrease in hospital admissions, a decrease in diagnostic tests and procedures related to cardiovascular disease treatment as confirmed by the results of our own study [24]. As a consequence of these challenges, addressing the unmet needs in Polish cardiology after COVID -19 should be a priority in healthcare planning and resource allocation. This is also consistent with meta-analysis which demonstrated a 20 % decrease in STEMI hospitalisations across the world at the time of the pandemic[25].

The resilience of the KOS-Zawal program during the COVID-19 pandemic highlights its essential role in managing ACS under crisis conditions. The notable decrease in mortality among patients within the program, contrasted with those outside it, underscores the protective impact of structured and continuous care, particularly during health emergencies. These

observations reinforce the value of comprehensive care programs in significantly enhancing patient outcomes.

As global health systems face the dual challenges of ongoing pandemic response and the need for routine medical care, the insights from this study underscore the importance of maintaining and expanding coordinated care frameworks [26-28]. Such systems not only mitigate the immediate impacts of health crises but also strengthen overall healthcare delivery, proving critical in sustaining patient care during and beyond such events.

Study limitation

The analysis relies on the availability and accuracy of the data collected during the pandemic. Any missing or incomplete data could potentially affect the robustness of the findings. The analysis covers a specific period during the COVID-19 pandemic. The findings may not reflect the long-term effects of the pandemic on patients with acute coronary syndrome. The study might be subject to selection bias, as it may only include patients who sought medical attention during the pandemic. Patients who did not seek care or were unable to access healthcare services during this period may not be adequately represented.

Conclusion

The COVID-19 pandemic greatly affected the KOS-Zawal program, resulting in fewer patients being enrolled and higher death rates, which shows serious problems in getting cardiac care. Patients not in the program had even higher death rates, which shows how important the KOS-Zawal program is for protecting them during tough times. Despite these difficulties, the program managed to improve survival rates during the pandemic compared to before, suggesting that the program's improved strategies were effective. These findings highlight how much the pandemic impacted the management and outcomes of heart diseases, proving how

crucial programs like KOS-Zawal are during health crises. This study shows the need for healthcare systems to develop and strengthen such programs to better handle future global health emergencies.

Conflict of interest: The authors declare that they have no competing interests.

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1. Raisi-Estabragh Z, Mamas MA. Cardiovascular Health Care Implications of the COVID-19 pandemic. *Cardiol Clin.* 2022;40(3):389-396. doi:10.1016/j.ccl.2022.03.010

2. Orlewska K, Wierzba W, Śliwczynski A. Cost-effectiveness analysis of COVID-19 vaccination in Poland. *Arch Med Sci.* 2022;18(4):1021-1031. doi:10.5114/aoms/144626
3. Erdem I, Ardic E, Turker E, Kardan ME, Demirkapu MJ. Comparison of antibiotic use in the COVID-19 pandemic with the pre-pandemic period in a university hospital. *Arch Med Sci.* 2022;18(5):1392-1394. doi:10.5114/aoms/152752
4. Nunez-Villaveiran T, González-Castro A, Nevado-Losada E, García-de-Lorenzo A, Garro P. All for One and One for All: Voluntary Physicians in the Intensive Medicine Units During the COVID-19 Outbreak in Spain. *Disaster Med Public Health Prep.* 2022;16(2):612-618. doi:10.1017/dmp.2020.375
5. Melman GJ, Parlikad AK, Cameron EAB. Balancing scarce hospital resources during the COVID-19 pandemic using discrete-event simulation. *Health Care Manag Sci.* 2021;24(2):356-374. doi:10.1007/s10729-021-09548-2
6. Winkelmann J, Webb E, Williams GA, Hernández-Quevedo C, Maier CB, Panteli D. European countries' responses in ensuring sufficient physical infrastructure and workforce capacity during the first COVID-19 wave. *Health Policy Amst Neth.* 2022;126(5):362-372. doi:10.1016/j.healthpol.2021.06.015
7. Artiga-Sainz LM, Sarria-Santamera A, Martínez-Alés G, Quintana-Díaz M. New Approach to Managing the COVID-19 Pandemic in a Complex Tertiary Care Medical Center in Madrid, Spain. *Disaster Med Public Health Prep.*:1-6. doi:10.1017/dmp.2021.63
8. Rosenbäck R, Lantz B, Rosén P. Hospital Staffing during the COVID-19 Pandemic in Sweden. *Healthcare.* 2022;10(10):2116. doi:10.3390/healthcare10102116
9. www.ideo.pl. Provision of health care services in relation to the prevention, counteraction and eradication of COVID-19 - recommendations. National Health Fund (NFZ) - we finance the health of Poles. Accessed April 14, 2024. <https://www.nfz.gov.pl/aktualnosci/aktualnosci-centrali/udzielanie-swiadczen-opieki-zdrowotnej-w-zwiazku-z-zapobieganiem-przeciwdzialaniem-i-zwalczaniem-covid-19-zalecenia,7826.html>
10. Ferraro CF, Findlater L, Morbey R, et al. Describing the indirect impact of COVID-19 on healthcare utilisation using syndromic surveillance systems. *BMC Public Health.* 2021;21(1):2019. doi:10.1186/s12889-021-12117-5
11. Jankowska-Sanetra J, Sanetra K, Synak M, Milewski K, Gerber W, Buszman PP. The impact of the coronavirus pandemic on patients hospitalized due to acute coronary syndrome. *Adv Interv Cardiol W Kardiologii Interwencyjnej.* 2023;19(2):86-98. doi:10.5114/aic.2023.129206
12. Gziut AI. Kompleksowa Opieka Specjalistyczna pacjentów po zawale serca (KOS-Zawal) w czasie pandemii COVID-19 – porównanie doświadczeń ośrodków w zależności od ich trybu pracy. *Kardiologia Inwazyjna.* 2021;16(4):141-143.
13. Kubiela G, Diakowska D, Uchmanowicz I. Survival analysis of patients with acute coronary syndrome receiving comprehensive coordinated care after myocardial infarction

- (KOS-Zawal). *Kardiologia Pol Pol Heart J*. 2022;80(3):315-321.
doi:10.33963/KP.a2022.0035
14. Wita K, Kułach A, Sikora J, et al. Managed Care after Acute Myocardial Infarction (MC-AMI) Reduces Total Mortality in 12-Month Follow-Up-Results from a Poland's National Health Fund Program of Comprehensive Post-MI Care-A Population-Wide Analysis. *J Clin Med*. 2020;9(10):3178. doi:10.3390/jcm9103178
 15. Feusette P, Gierlotka M, Krajewska-Redelbach I, et al. Comprehensive coordinated care after myocardial infarction (KOS-Zawal): a patient's perspective. *Kardiol Pol*. 2019;77(5):568-570. doi:10.5603/KP.a2019.0038
 16. NFZ on health. Ischaemic heart disease - ezdrowie.gov.pl. Accessed April 14, 2024.
<https://ezdrowie.gov.pl/portal/home/badania-i-dane/zdrowe-dane/raporty/nfz-o-zdrowiu-choroba-niedokrwienna-serca>
 17. Wita K, Kułach A, Wita M, et al. Managed Care after Acute Myocardial Infarction (KOS-Zawal) reduces major adverse cardiovascular events by 45% in 3-month follow-up – single-center results of Poland's National Health Fund program of comprehensive post-myocardial infarction care. *Arch Med Sci*. 2020;16(3):551-558.
doi:10.5114/aoms.2019.85649
 18. Miralles O, Sanchez-Rodriguez D, Marco E, et al. Unmet needs, health policies, and actions during the COVID-19 pandemic: a report from six European countries. *Eur Geriatr Med*. 2021;12(1):193-204. doi:10.1007/s41999-020-00415-x
 19. Mengal N, Saghir T, Hassan Rizvi SN, et al. Acute ST-Elevation Myocardial Infarction Before and During the COVID-19 Pandemic: What is the Clinically Significant Difference? *Cureus*. 12(9):e10523. doi:10.7759/cureus.10523
 20. Filip R, Gheorghita Puscaselu R, Anchidin-Norocel L, Dimian M, Savage WK. Global Challenges to Public Health Care Systems during the COVID-19 Pandemic: A Review of Pandemic Measures and Problems. *J Pers Med*. 2022;12(8):1295.
doi:10.3390/jpm12081295
 21. Pessoa-Amorim G, Camm CF, Gajendragadkar P, et al. Admission of patients with STEMI since the outbreak of the COVID-19 pandemic: a survey by the European Society of Cardiology. *Eur Heart J Qual Care Clin Outcomes*. 2020;6(3):210-216.
doi:10.1093/ehjqcco/qcaa046
 22. Tam CCF, Cheung KS, Lam S, et al. Impact of Coronavirus Disease 2019 (COVID-19) Outbreak on ST-Segment-Elevation Myocardial Infarction Care in Hong Kong, China. *Circ Cardiovasc Qual Outcomes*. 2020;13(4):e006631.
doi:10.1161/CIRCOUTCOMES.120.006631
 23. De Filippo O, D'Ascenzo F, Angelini F, et al. Reduced Rate of Hospital Admissions for ACS during Covid-19 Outbreak in Northern Italy. *N Engl J Med*. 2020;383(1):88-89.
doi:10.1056/NEJMc2009166
 24. Nadarajah R, Wu J, Hurdus B, et al. The collateral damage of COVID-19 to cardiovascular services: a meta-analysis. *Eur Heart J*. 2022;43(33):3164-3178.
doi:10.1093/eurheartj/ehac227

25. Sofi F, Dinu M, Reboldi G, et al. Worldwide differences of hospitalization for ST-segment elevation myocardial infarction during COVID-19: A systematic review and meta-analysis. *Int J Cardiol.* 2022;347:89-96. doi:10.1016/j.ijcard.2021.10.156
26. Sarker MNI, Raihan L, Peng Y, et al. COVID-19: access to information, health service, daily life facility and risk perception of foreigners during the coronavirus pandemic in South Korea. *Arch Med Sci.* Published online August 22, 2021. doi:10.5114/aoms/141164
27. Mohammadinia L, Saadatmand V, Khaledi Sardashti H, et al. Hospital response challenges and strategies during COVID-19 pandemic: a qualitative study. *Front Public Health.* 2023;11:1167411. doi:10.3389/fpubh.2023.1167411
28. Antoniewicz AA, Niemczyk W, Regulski PA, Niezgodka M. The impact of the COVID-19 pandemic on urological care in Poland - Post-COVID resilience scenarios and recommendations for healthcare system: A national population-based modelling study. *Arch Med Sci.* Published online December 8, 2021. doi:10.5114/aoms/144310

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Table 1. Characteristic of patients not covered and covered by KOS-Zawal in the following time periods: 1st October 2017 to 31st March 2020 and 1st April 2020 to 31st March 2022.

1 October 2017 to 31 March 2020			
	Patients not covered by the KOS-Zawal programme (N=263 619)	Patients covered by the KOS-Zawal programme (N=26 457)	<i>p</i> -value
Gender:			
men	160 930 (61.0%)	18 090 (68.4%)	<0.0001
women	102 689 (39,0%)	8 367 (31.6%)	
Age (mean \pm SD)	68.5 \pm 10.7	66.5 \pm 10.8	<0.0001
1 April 2020 to 31 March 2022			
	Patients not covered by the KOS-Zawal programme (N=155 408)	Patients covered by the KOS-Zawal programme (N=27 512)	<i>p</i> -value
Gender:			
men	97 428 (62.7%)	19 179 (69.7%)	<0.0001
women	57 980 (37.3%)	8 333 (30.3%)	
Age (mean \pm SD)	74.9 \pm 10.8	73.1 \pm 10.5	<0.0001

Table 2. Number of deaths within 365 days of the first hospitalisation in the patients not covered and covered by KOS-Zawal from 1 October 2017 to 31 March 2020.

	Patients not covered by the KOS-Zawal programme		Patients covered by the KOS-Zawal programme		p-value
	Sample size	Death	Sample size	Death	
	N	N (%)	N	N (%)	
Man	160 930	39 955 (24.8)	18 090	2 770 (15.3)	<0.0001
Woman	102 689	27 358 (26.6)	8 367	1 416 (16.9)	<0.0001
Total	263 619	67 313 (25.5)	26 457	4 186 (15.8)	<0.0001

Table 3. Number of deaths within 365 days of the first hospitalisation in the patients not covered and covered by KOS-Zawal in time period 1 April 2020 to 31 March 2022.

	Patients not covered by the KOS-Zawal programme		Patients covered by the KOS-Zawal programme		p-value
	Sample size	Death	Sample size	Death	
	N	N (%)	N	N (%)	
Man	97 428	16 867 (17.3%)	19 179	1 473 (7.7%)	<0.0001
Woman	57 980	11 151 (19.2%)	8 333	704 (8.4%)	<0.0001
Total	155 408	28 018 (18.0%)	27 512	2 177 (7.9%)	<0.0001

Table 4. Comparative analysis of mortality of patients not covered by KOS-Zawal programme in time periods: 1 October 2017 to 31 March 2020 and 1 April 2020 to 31 March 2022.

Regional Branch of the National Health Fund	Data collected between 1 October 2017 to 31 March 2020		Data collected between 1 April 2020 to 31 March 2022		P-value
	Sample size N	Death N (%)	Sample size N	Death N (%)	
Dolnośląskie	19217	5049 (26.3)	9796	2066 (21.1)	<0.0001
Kujawsko-pomorskie	17918	4667 (26.0)	10889	1845 (16.9)	<0.0001
Lubelskie	20071	4315 (21.5)	13752	1872 (13.6)	<0.0001
Lubuskie	9298	2403 (25.8)	7006	1036 (14.8)	<0.0001
Łódzkie	18432	4970 (27.0)	11218	2173 (19.4)	<0.0001
Małopolskie	19135	4943 (25.8)	10916	2178 (20.0)	<0.0001
Mazowieckie	33639	8469 (25.2)	20025	3497 (17.5)	<0.0001
Opolskie	5312	1341 (25.2)	2826	501 (17.7)	<0.0001
Podkarpackie	14863	3543 (23.8)	8316	1442 (17.3)	<0.0001

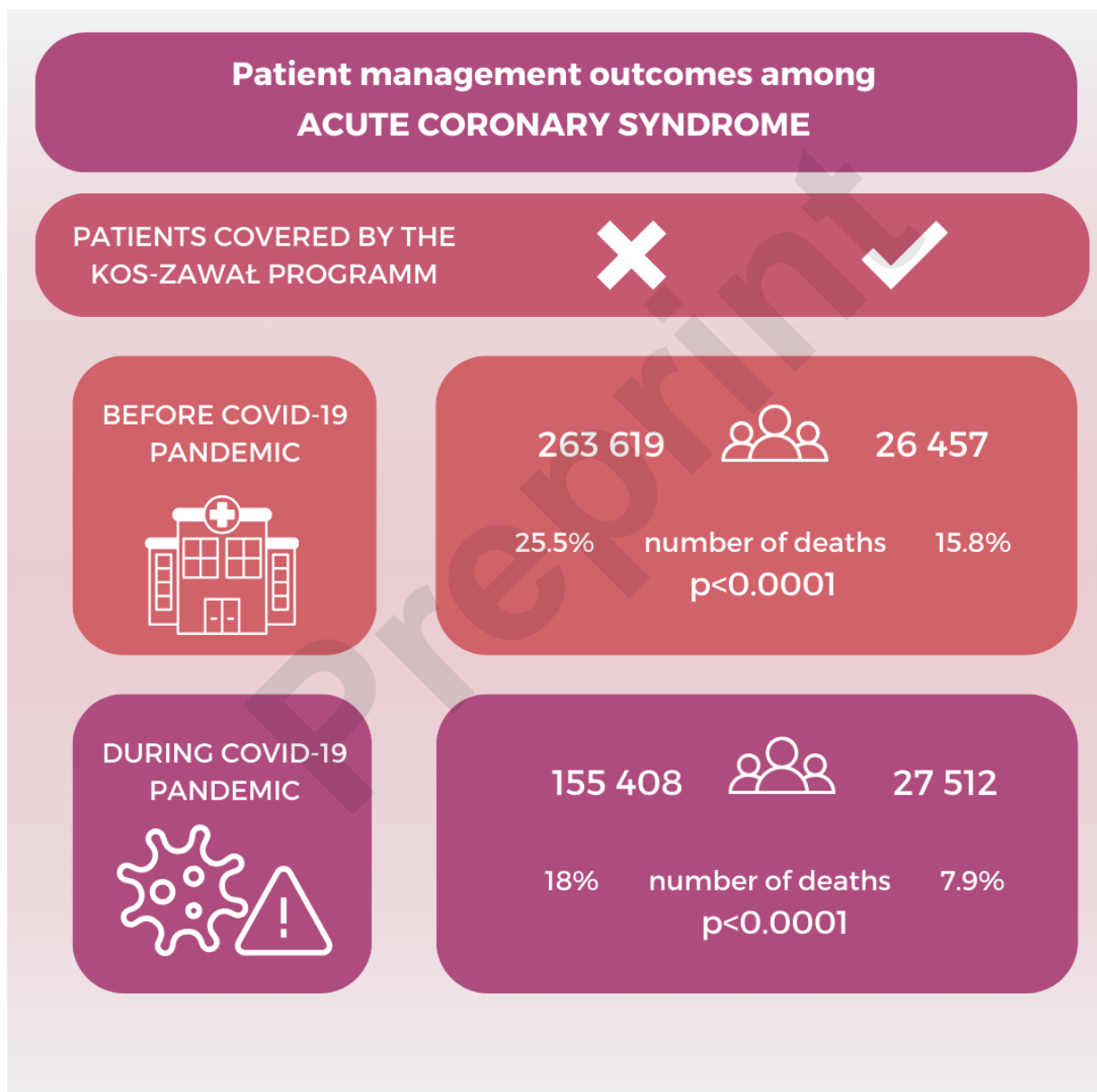
Podlaskie	5516	1550 (28.1)	3707	703 (19.0)	<0.0001
Pomorskie	13629	3598 (26.4)	8126	1529 (18.8)	<0.0001
Śląskie	27701	8415 (30.4)	14413	3203 (22.2)	<0.0001
Świętokrzyskie	8898	2351 (26.4)	5983	1099 (18.4)	<0.0001
Warmińsko-mazurskie	8111	2264 (27.9)	4603	925 (20.1)	<0.0001
Wielkopolskie	33085	6915 (20.9)	18559	2787 (15.0)	<0.0001
Zachodniopomorskie	8794	2520 (28.7)	5273	1162 (22.0)	<0.0001
Total	263619	67313 (25.5)	155408	28018 (18.0)	<0.0001

Table 5. Comparative analysis of mortality of patients covered by KOS-Zawal programme in time periods: 1 October 2017 to 31 March 2020 and 1 April 2020 to 31 March 2022.

Regional Branch of the National Health Fund	Data collected between 1 October 2017 to 31 March 2020		Data collected between 1 April 2020 to 31 March 2022		P-value
	Sample	Death	Sample	Death	
	size N	N (%)	size N	N (%)	
Dolnośląskie	4062	551 (13.6)	4195	272 (6.5)	<0.0001
Kujawsko-pomorskie	112	13 (11.6)	197	8 (4.1)	0.0119
Lubelskie	3611	778 (21.5)	2231	245 (11.0)	<0.0001
Lubuskie	349	46 (13.2)	351	13 (3.7)	<0.0001
Łódzkie	1859	322 (17.3)	1617	157 (9.7)	<0.0001
Małopolskie	1120	133 (11.9)	1715	99 (5.8)	<0.0001
Mazowieckie	1299	96 (7.4)	1268	51 (4.0)	<0.0001
Opolskie	1057	234 (22.1)	670	64 (9.6)	<0.0001
Podkarpackie	298	45 (15.1)	1083	86 (7.9)	<0.0001
Podlaskie	252	22 (8.7)	246	5 (2.0)	0.0009
Pomorskie	182	20 (11.0)	684	45 (6.6)	0.0455
Śląskie	10079	1640 (16.3)	9547	997 (10.4)	<0.0001
Świętokrzyskie	26	8 (30.8)	17	0 (0.0)	0.0112
Warmińsko-mazurskie	43	3 (7.0)	575	12 (2.1)	0.0446
Wielkopolskie	1227	156 (12.7)	2240	90 (4.0)	<0.0001
Zachodniopomorskie	881	119 (13.5)	876	33 (3.8)	<0.0001

Total	26457	4186	27512	2177 (7.9)	<0.0001
		(15.8)			

Figure 1. Graphical abstract



Patient management outcomes among ACUTE CORONARY SYNDROME

PATIENTS COVERED BY THE
KOS-ZAWAŁ PROGRAMM



BEFORE COVID-19
PANDEMIC



263 619



26 457

25.5%

number of deaths

15.8%

$p < 0.0001$

DURING COVID-19
PANDEMIC



155 408



27 512

18%

number of deaths

7.9%

$p < 0.0001$