


# Socioeconomic factors and suicide risk in Polish cancer patients – a population-based cohort study exploring associations and implications

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**Introduction.** This study aimed to explore socioeconomic factors influencing the suicide rate in Polish cancer patients.

**Material and methods.** Data on cancer cases and socioeconomic covariates were obtained from the Polish National Cancer Registry and Statistics Poland. Suicide rates were calculated for each year. Multivariable linear regression analyses explored associations between unemployment, income, university education, access to physicians overall and to psychiatry hospitals, and suicide incidence.

**Results.** The study included 1.43 million cancer patients diagnosed between 2009 and 2019. Among them, 830 suicides were identified, with higher rates among men. Income *per capita* and higher education degrees were significant predictors of suicide among male cancer patients ( $p = 0.05$  and  $0.01$ , respectively). However, no significant associations were found for female cancer patients. The regression models explained 13% of the variation in male suicide incidence.

**Conclusions.** Lower income and higher education levels increase suicide risk in male cancer patients, highlighting the need for targeted interventions.

**Key words:** cancer, suicide, risk, epidemiology, cohort study

## Introduction

Extensive evidence suggests that various socioeconomic factors significantly influence suicide rates in the general population. Protective factors such as marriage, parenting, and religiosity play a role in preventing suicides, although their impact varies by gender. Economic factors, including unemployment and low socioeconomic status, strongly predict suicide risk at an individual level [1].

A study examining gender-specific suicide rates across 35 countries found that higher suicide rates among both males and females were associated with increased female labor

force participation, unemployment, and a larger proportion of elderly individuals. However, increased health spending *per capita* was linked to lower suicide rates for both genders. The study highlighted the influence of labor market and economic factors on suicide rates, surpassing the significance of population-level indicators of interpersonal relationships. Additionally, males exhibited greater sensitivity to changes in the social environment compared to females [2, 3].

Furthermore, evidence indicates that environmental factors can impact suicide rates among cancer patients. A study utilizing the American Surveillance, Epidemiology, and End

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Results Program (SEER) database investigated sociological risk factors for suicide death in leukemia patients and revealed a significantly higher death rate in areas with a high proportion of individuals holding at least a bachelor's degree [4].

However, there remains a gap in our knowledge regarding the socioeconomic factors associated with suicide incidence among cancer patients in the Polish population. Thus, this study aims to fill this gap and provide insights into the specific factors influencing suicide risk in this population.

## Material and methods

### Data source for cancer patient suicides

The data for this study were derived from the Polish Suicidality in Cancer Patients study (PoISCa), which is a cohort study previously described in the literature [5, 6]. Information on cancer cases was obtained from the Polish National Cancer Registry (PLCR), a non-profit national institution responsible for statistical and epidemiological cancer research in Poland. The PLCR encompasses all newly diagnosed cancer cases in the country and requires mandatory reporting. Rigorous validation processes, including verification by trained PLCR coders and adherence to recommendations from the European Network of Cancer Registries, ensure data accuracy. The unique Polish personal identification number (PESEL) is utilized within the PLCR system to prevent duplicate coding for the same patient. Detailed information regarding the operational principles of the PLCR can be found elsewhere [7].

The study population comprised individuals aged 15 years or older diagnosed with primary malignant neoplasms, excluding non-melanoma skin cancers (ICD-10 codes: C00–C43, C45–C76, C80–C96). In cases where patients had multiple independent coexisting neoplasms, only the most recent diagnosis was considered. All eligible cases diagnosed between January 1, 2009, and December 31, 2019, were included in the study. The follow-up period extended until the occurrence of suicide (ICD-10 codes: X60–X84), death from other causes, or December 31, 2019, whichever came first.

### Data source for covariates

Based on existing literature [2, 3], several variables were identified as potential covariates influencing the suicide rate among patients diagnosed with cancer. These covariates included the unemployment rate, income *per capita*, the proportion of individuals holding at least a bachelor's degree (referred to as the higher education degree rate), overall access to physicians (referred to as the physician access index), and access to psychiatric services (referred to as the psychiatry access index). Data for all these variables were obtained from Statistics Poland, spanning the years 2009 to 2019 and encompassing 16 of the highest level administrative regions (voivodships).

The unemployment rate was defined as the registered unemployment rate, representing the ratio of registered unemployed individuals to the active civilian population. This rate in-

cludes individuals employed in individual farming households, considered as part of the active civilian workforce.

Income *per capita* was defined as the average monthly gross remuneration, including income tax advances and mandatory social security contributions (pension, disability, and sickness) paid by the insured employee. The data pertained to entities within the national economy with a workforce of 10 or more individuals, as well as budgetary entities regardless of the workforce size.

The higher education degree rate was defined as the number of university graduates with at least a bachelor's degree per 10,000 population. The physician access index was defined as the number of physicians working at their primary workplace per 10,000 population. The psychiatry access index was defined as the number of psychiatric hospital beds per 10,000 population.

### Statistical analysis

Initially, we calculated the suicide rate per 1,000 previously diagnosed cancer patients. The numerator consisted of the number of suicides that occurred within a given year among patients previously diagnosed with cancer. The denominator included the mid-year population of cancer patients, representing the number of individuals living with a malignant tumor diagnosis on June 30th of the respective year. We calculated this rate for each calendar year, stratified by patient gender and region (voivodship).

To explore the association between suicide incidence (dependent variable) in patients with cancer and several independent variables (unemployment rate, income *per capita*, higher education degree rate, the physician access index, and psychiatry access index), separate multivariable linear regression analyses were conducted for males and females.

To examine the correlation between the physician access index and psychiatry access index, we calculated the correlation coefficient, which measures the strength and direction of the linear relationship between the two variables. The resulting correlation coefficient was 0.30, indicating a positive but weak correlation. Considering the comprehensive evaluation of healthcare resource impact on suicide incidence among patients with cancer, we decided to include both variables in the analysis.

The regression model was constructed using the formula "suicide incidence ~ unemployment rate + income *per capita* + education degree rate + physician access index + psychiatry access index". The model was summarized by presenting coefficient estimates, standard errors, t-values, and associated p-values for each independent variable. All statistical analyses were conducted using R software (version 2023.06.0+421).

### Compliance with ethical standards

The utilization of individual-level data from the Polish National Cancer Registry (PLCR) for statistical and scientific purposes

complies with Polish legislation. The PLCR adheres to stringent regulations to ensure the confidentiality and protection of individuals. This study was conducted in accordance with the guidelines provided by Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) [8].

## Results

### Study population characteristics

The study encompassed a total of 1.43 million individuals (717,144 men and 709,517 women) who were diagnosed with cancer between January 1, 2009, and December 31, 2019. Over the course of the follow-up period, a total of 830 suicide cases were identified among the patients diagnosed with primary cancer, with 683 cases occurring in men and 147 cases in women. Throughout the study period spanning from 2009 to 2019, the incidence rate of suicide per 1,000 patients with cancer ranged from 0.0 to 2.9, depending on voivodship, gender, and year.

### Socioeconomic factors and risk of suicide in patients with cancer

A multiple linear regression analysis was performed to investigate the association between socioeconomic factors and suicide incidence among cancer patients in the Polish population (tab. I).

Among male cancer patients, the regression analysis revealed that income *per capita* ( $p = 0.05$ ) and the rate of higher education degrees ( $p = 0.01$ ) were statistically significant predictors of suicide incidence (tab. I). The results indicated that a decrease in income and an increase in educational attainment were associated with a higher incidence of suicide. Additionally, the psychiatry access index ( $p = 0.03$ ) demonstrated a statistically significant positive association with suicide incidence among male cancer patients. However, the unemployment rate ( $p = 0.44$ ) and the physician access index ( $p = 0.34$ ) did not exhibit statistically significant associations with suicide incidence among male cancer patients. The multiple R-squared value for the model was 0.13, suggesting that approximately

13% of the variability in suicide incidence among male cancer patients was explained by the included independent variables. The adjusted R-squared value, accounting for predictors and degrees of freedom, was 0.10. The F-statistic (4.516) with a p-value of  $<0.01$  indicated that the overall regression model was statistically significant, demonstrating a significant combined effect of the independent variables on suicide incidence among male cancer patients.

In contrast, none of the independent variables reached statistical significance in predicting suicide incidence among female cancer patients (tab. I). The estimates for unemployment rate ( $p = 0.60$ ), income *per capita* ( $p = 0.08$ ), educational attainment ( $p = 0.15$ ), psychiatry access index ( $p = 0.80$ ), and physician access index ( $p = 0.13$ ) did not show statistically significant associations with suicide incidence among female cancer patients.

The multiple R-squared value for the model was 0.06, and the adjusted R-squared value was 0.03. The F-statistic (1.958) with a p-value of 0.09 indicated that the overall regression model did not reach statistical significance, suggesting that the combined effect of the independent variables did not significantly impact suicide incidence among female cancer patients in the Polish population.

## Discussion

### Added value of the study in the context of the literature

The literature on population-based studies examining the association between socioeconomic factors and the risk of suicide in cancer patients is limited. To date, only two relevant studies have been conducted, both in the United States, and focused on factors such as urbanization, financial status, and university education [4, 9]. However, there is a lack of research exploring the impact of access to healthcare resources on suicide risk in the oncological patient population. To the best of our knowledge, our study is the first to comprehensively analyze the influence of healthcare resource access, including physicians and psychiatry services, on the risk of suicide among cancer patients.

**Table I.** Linear regression results for suicide incidence among male and female cancer patients

Variable	Men †				Women ‡			
	estimate	std. error	t-value	p-value	estimate	std. error	t-value	p-value
(intercept)	0.47	0.30	1.55	0.12	0.11	0.11	1.02	0.31
unemployment rate	-0.01	0.01	-0.77	0.44	-0.00	0.00	-0.53	0.60
income <i>per capita</i>	-0.00	0.00	-2.02	0.05	-0.00	0.00	-1.79	0.08
the higher education degree rate	0.00	0.00	2.60	0.01	0.00	0.00	1.46	0.15
the physician access index	0.01	0.01	0.96	0.34	0.00	0.00	1.51	0.13
the psychiatry access index	0.08	0.03	2.22	0.03	-0.00	0.01	-0.25	0.80

† – multiple R-squared: 0.13, adjusted R-squared: 0.10, F-statistic: 4.52, p-value:  $<0.01$ ; ‡ – multiple R-squared: 0.06, adjusted R-squared: 0.03, F-statistic: 1.96, p-value: 0.09; intercept – a mathematical constant, no clinical interpretation

This study adds to the growing body of evidence on the association between socioeconomic factors and suicide incidence in cancer patients. By specifically examining variables such as income *per capita* and the higher education degree rate, the study identifies these factors as significant predictors of suicide incidence among male cancer patients. These findings align with a study conducted in the United States, which also highlights the importance of addressing economic disparities and educational attainment in understanding suicide risk among individuals with cancer [9].

Moreover, this study explores the impact of healthcare resource access on suicide risk in cancer patients. The inclusion of the physician access index and psychiatry access index provides insights into the relationship between the availability of medical professionals and suicide incidence. The finding of a positive association between the number of psychiatric beds and suicide incidence among male cancer patients may initially seem counterintuitive. Several potential explanations can shed light on this result. Reverse causality suggests that areas with higher suicide rates allocate more resources, including psychiatric beds, to address increased mental health needs. Improved accessibility and identification may lead to higher detection rates in areas with more psychiatric beds. The complexity of cases or regional differences in mental health infrastructure, policies, or cultural factors could also play a role. The multifactorial nature of suicide and potential confounding variables should be considered.

Furthermore, this study adds value by considering gender-specific differences in the associations between socioeconomic factors and suicide incidence. While the study identifies significant predictors of suicide among male cancer patients, none of the independent variables reached statistical significance for female cancer patients. This finding highlights the need for further investigation into gender-specific factors and the complex interplay between socioeconomic variables and suicide risk in female cancer patients.

Overall, this study's added value lies in its comprehensive examination of socioeconomic factors and healthcare resource access as potential determinants of suicide incidence in cancer patients. By identifying significant predictors and exploring gender differences, the study contributes to a deeper understanding of the complex relationships between these factors and suicide risk, which can inform targeted interventions and support strategies to mitigate suicide risk in this vulnerable population.

### **Implications for the field of the study**

The findings of this study have important implications for the field of suicide prevention and cancer care. The identification of socioeconomic factors associated with suicide risk in cancer patients provides valuable insights for targeted interventions and support programs. Specifically, the significant associations observed between income *per capita* and higher

education degree rate with suicide incidence among male cancer patients highlight the importance of addressing economic disparities and promoting educational opportunities to mitigate suicide risk. These findings emphasize the importance of implementing comprehensive and tailored strategies to address the multifaceted challenges faced by cancer patients at risk of suicide, ultimately improving their overall well-being and quality of life.

### **Strengths and limitations of the study**

The present study has several strengths. First, the data were derived from the PolSCa, a cohort study with a comprehensive design that provides a reliable and representative sample of cancer patients in Poland. The use of the PLCR data ensured the inclusion of all newly diagnosed cancer cases in the country, while strict validation processes guaranteed data accuracy. Furthermore, the study considered a wide range of potential covariates, including socioeconomic factors and access to healthcare resources, to explore their association with suicide incidence among cancer patients.

However, certain limitations must be acknowledged. Firstly, although the study covered a substantial period from 2009 to 2019, the follow-up period was limited, and longer-term outcomes could not be assessed. Moreover, the study focused on the Polish population, which may limit the generalizability of the findings to other populations or settings. Lastly, while multiple socioeconomic factors were considered, the inclusion of additional variables, such as social support or mental health status, could have provided a more comprehensive understanding of the factors influencing suicide incidence among cancer patients.

### **Conclusions**

In this study examining the association between socioeconomic factors and suicide incidence among cancer patients in the Polish population, several key findings emerged. Among male cancer patients, income *per capita* and a higher education degree rate were significant predictors of suicide incidence, indicating that lower income and higher university-level education rate were associated with an increased risk of suicide. However, the unemployment rate and the physician access index did not show significant associations. In contrast, none of the independent variables reached statistical significance in predicting suicide incidence among female cancer patients. These findings emphasize the need for targeted interventions and support for at-risk subgroups in cancer patients to mitigate the risk of suicide.

### **Article information and declarations**

#### **Data availability**

We complied with all relevant ethical regulations. The data analyzed in this study were obtained from the PLCR and are available upon reasonable request by contacting the PLCR

at krn@nio.gov.pl and subject to ethical approvals in place and material transfer agreements. Following national regulations, these data were exempt from institutional review board reviews. There were no participants in the study; thus, there was no consent form. Detailed legislative aspects of the National Polish Cancer Registry are regulated by Polish Law (Dz.U. 2018 poz. 1197). Waiver of ethics approval was deemed unnecessary according to national legislation (reference to the relevant legislation <https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20180001197>).

### **Ethics statement**

The utilization of individual-level data from the Polish National Cancer Registry (PLCR) for statistical and scientific purposes complies with Polish legislation. The PLCR adheres to stringent regulations to ensure the confidentiality and protection of individuals. This study was conducted in accordance with the guidelines provided by Strengthening the Reporting of Observational Studies in Epidemiology (STROBE).

### **Author contributions**

All the authors had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Irmina M. Michalek – study concept and design, acquisition, analysis, and interpretation of data, drafting of the manuscript, critical revision of the manuscript for important intellectual content, statistical analysis, obtained funding.

Florentino L. Caetano dos Santos – acquisition, analysis, and interpretation of data, critical revision of the manuscript for important intellectual content, statistical analysis, obtained funding.

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### **Conflict of interest**

None declared

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