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Original article

Risk of suicide in patients with cancer aged 75 years or more – Follow-up of over 400,000 individuals

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ABSTRACT

Background: It is well established that older patients with cancer have a significantly higher risk of suicide. However, a comprehensive understanding of the risk factors is lacking. In this study, we aimed to identify groups at an increased risk of suicide among patients aged ≥75 years with a previous cancer diagnosis.

Material and methods: All Polish individuals diagnosed with cancer at the age of ≥75 years between 1 January 2009 and 31 December 2019 were included in this study. Standardized mortality ratios (SMRs) and 95 % confidence intervals (CIs) were calculated.

Results: A total of 410,440 patients (211,730 men and 198,710 women) were included in this study. SMR for both sexes was 1.64 (95 % CI 1.43–1.87). When analyzed by sex, a significantly higher risk was observed only in men (SMR 1.70, 95 % CI 1.47–1.95). Among them, the risk of suicide was observed after the diagnosis of lymphoma (2.83, 1.14–5.82), lung cancer (2.63, 1.70–3.89), kidney cancer (2.16, 1.03–3.96), colorectal cancer (1.96, 1.41–2.65), urinary tract cancer (1.86, 1.22–2.70), and prostate cancer (1.40, 1.07–1.82). The highest risk of suicide in men was observed within 6 months of diagnosis (2.83, 2.11–3.71).

Conclusions: Men diagnosed with cancer at ≥75 years of age are at a higher risk of suicide than men of the same age in the general population. The observations from this study suggest which are the most vulnerable groups of elderly patients with cancer, and the time at which they should be given special support.

1. Introduction

It is well established that patients with cancer have a higher risk of suicide than the general population. A meta-analysis of data from over 22 million oncological patients estimated this risk to be 85 % higher than that of the general population [1]. The risk is higher in men than in women, and within the first year after diagnosis [1]. According to another literature review, risk is also affected by the patient's age at the time of cancer diagnosis [2]. Patients under the age of 39 years are at the lowest risk, although still higher than the general population, while those older than 80 years are at the highest risk [2].

Although, in 2020, older patients accounted for one-third of all new cancer cases globally (≥70 years of age 6,410,524 new diagnoses vs. 18,094,716 new diagnoses overall) [3], the literature on the risk of suicide after a cancer diagnosis in this age group is poor.

The most extensive available study, by Choi and Park, comes from South Korea and is based on a randomly sampled group of 259,688 older adults, who, according to the authors, constitute a representative portion of the older adult Korean population [4]. The investigation focused on exploring the association between cancer and suicide risk in this age group within one year after cancer diagnosis. The study showed that older patients with cancer displayed a higher suicide risk compared to non-cancer individuals, emphasizing the need for early mental health support, particularly in those with pre-existing mental disorders. The study also highlighted varying suicide risks among older patients with specific cancer types, such as bladder, head and neck, liver, lung, and stomach cancers, underscoring the importance of targeted interventions for these individuals.

Other previously published studies have referred to the risk of suicide after cancer diagnosis by age group, without more detailed analyses [2]. To our knowledge, no study based on the entire national population has determined the risk of suicide in this age group by sex, cancer site,

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and time since diagnosis. Moreover, the previously published results cannot be generalized in the context of patients from Central and Eastern Europe, which are characterized by different cultural factors that ultimately affect both the provision of medical services and attitudes towards cancer patients.

This study aimed to identify groups at increased risk of suicide among Polish patients aged ≥75 years with a previous cancer diagnosis.

2. Materials and methods

2.1. Study design

This research is part of the Polish Suicidality in Cancer Patients (PolSCa) study, a population-based retrospective cohort study based on data from all Polish patients diagnosed with cancer between the 1st of January 2009 and the 31st of December 2019.

The reason for selecting the time frame was to ensure an adequate and recent representation of the Polish population diagnosed with cancer. This period allowed for a comprehensive analysis of the data while considering both the availability and reliability of the cancer registry records. By including data from this period, we aimed to capture a substantial number of cancer cases and provide a robust analysis of the relationship between cancer and suicide risk among the Polish population. Furthermore, this timeframe enabled us to account for potential changes in diagnostic practices, advancements in treatment modalities, and variations in cancer epidemiology over the specified period.

2.2. Cohort selection and source of data

The included cases encompassed all primary malignant neoplasms, except non-melanoma skin cancers (C00-C43, C45-C76, and C80-C96, according to the ICD-10) registered by the Polish National Cancer Registry (PLCR). The PLCR system is based on a unique Polish personal identification number (PESEL) and avoids double coding of the same patient. The operating principles of PLCRs have been thoroughly described elsewhere [5].

Only the most recent diagnosis of a primary malignant neoplasm was included in the analysis of patients with two or more independent coexisting malignant neoplasms. By including only the most recent diagnosis, we can ensure clinical relevance. Considering only the most recent cancer diagnosis aligns with the clinical reality that patients and healthcare providers primarily focus on managing the most current cancer diagnosis. Focusing on the most recent diagnosis can provide insights directly applicable to clinical practice and interventions to reduce suicide risk in older patients with cancer. Other rationales for including only the most recent diagnosis were: reducing confounding variables, enhancing internal validity, and addressing practical considerations like changes in sample size requirements.

Definitions of age groups used for health metrics reporting vary greatly [6], as it is challenging to establish standards that could be applied regardless of geographical location and the research question under consideration [7]. In the analyses presented in this sub-study, we included all individuals who were at least 75 years old on the day of cancer diagnosis, sometimes referred to in geriatric studies as “middle-old” and “oldest-old” [7]. In the Polish healthcare system, old age is defined by proxy as a group of people aged ≥75 years. The lawmakers decided that this group was so vulnerable that some unique benefits would cover it. First, free medicines for treating common conditions in older patients are available to all patients aged ≥75 years. According to Polish Ministry of Health data, in 2021, approximately 2.5 million patients benefited from this program [8]. In addition, all persons entitled to an old-age or disability pension in Poland aged ≥75 years receive an additional care allowance regardless of their health condition.

The endpoints of follow-up were established as suicide, death due to other causes, or the 31st of December 2019, whichever occurred first. Data on deaths due to suicide in the general Polish population, used to calculate the expected number of suicides, were obtained from Statistics Poland.

2.3. Statistical analyses

The normality of continuous variables (age at diagnosis/suicide) was assessed using the Shapiro-Wilk test of normality. For numeric variables, descriptive statistics were presented as mean and standard deviation (SD).

The ratios of the observed to the expected number of deaths due to suicide, denoted as standardized mortality ratios (SMRs), were calculated for all cancers overall and for specific cancer sites. Person counts in five-year age groups (15–19, 20–24, …, and 75+ years) at the time of death due to suicide were used as weights for age standardization. The reference was age-period-sex-specific Polish national suicide incidence rates in the same five-year age groups. The 95 % confidence intervals (CIs) were calculated assuming a Poisson distribution. R software (version 4.1.2) was used for the statistical analysis.

2.4. Compliance with ethical standards

Individual-level data from the PLCR can be used for statistics in aggregate form and for scientific purposes, according to Polish legislation. The PLCR adheres to stringent regulations to ensure individual confidentiality and protection.

The guidelines for Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) were followed [9].

3. Results

Between 2009 and 2019, there were 410,440 cancer cases in Polish individuals aged ≥75 years (211,730 men and 198,710 women). This group included 69,772 cases of colorectal cancer, 57,895 of prostate cancer, 49,290 of breast cancer, and 30,289 of urinary system cancer (Table 1). In this study population, 218 suicide deaths were recorded (195 men and 23 women). The deaths included 58 patients with prostate cancer, 49 with colorectal cancer, 27 with urinary system cancer, 26 with lung cancer, and 11 with kidney cancer (Table 1). The mean age at the time of committing suicide was 80.7 years (SD 4.6 years; men 80.5 years, SD 4.4; women 82.8 years, SD 5.3).

The risk of suicide after cancer diagnosis was 64 % higher than that in the general elderly population (SMR 1.64, 95 % CI 1.43 to 1.87; Table 2). When analyzed by sex, a significantly higher risk was observed only in men (1.70, 95 % CI 1.47 to 1.95). There were no significant differences between the risk of suicide in women with a cancer diagnosis and the general elderly female population (1.28, 95 % CI 0.81 to 1.93).

Among men, the highest risk of suicide compared to the general male population was observed after the diagnosis of lymphoma (SMR 2.83, 95 % CI 1.14 to 5.82, Table 2). An increased risk was also observed in patients with lung cancer (2.63, 95 % CI 1.70 to 3.89), kidney cancer (2.16, 95 % CI 1.03 to 3.96), colorectal cancer (1.96, 95 % CI 1.41 to 2.65), urinary tract cancer (1.86, 95 % CI 1.22 to 2.70), and prostate cancer (1.40, 95 % CI 1.07 to 1.82). In women, the risk of suicide did not increase at any cancer site.

In a detailed analysis that considered sex, cancer site, and time since diagnosis, the risk of suicide varied significantly only in men and only in some cancers (Table 3). Within the first six months after cancer diagnosis, the risk increased for anal cancer, lymphomas, lung cancer, colorectal cancer, and prostate cancer. For prostate cancer, the second peak of increased suicide risk was observed between the 12th and 24th month after diagnosis. In the case of urinary tract cancer, the risk of suicide increased with time from diagnosis and was higher than that in the general male population at 3rd-5th year after diagnosis and 5th–10th year after diagnosis. For multiple myeloma, the risk increased in the 5th–10th year after diagnosis.

Table 1
Characteristics of the study population.

ICD-10	Site	Number of persons under follow-up			Person-years under risk of suicide			Number of suicides		
		Overall	Men	Women	Overall	Men	Women	Overall	Men	Women
	All cancers[a]	410,440	211,730	198,710	803,993	403,954	400,039	218	195	23
C00-C14 + C30	Head and neck	8131	4716	3415	16,693	9605	7088	3	3	–
C15	Esophagus	2668	1756	912	2226	1379	847	1	1	–
C16	Stomach	18,181	10,505	7676	21,848	11,891	9957	3	3	–
C17	Small intestine	853	378	475	1639	758	881	–	–	–
C18-C20	Colorectum	69,772	35,757	34,015	149,415	74,710	74,705	49	42	7
C21	Anus	835	217	618	1624	395	1229	1	1	–
C22–24	Liver and gallbladder	9629	3496	6133	9107	3451	5656	3	2	1
C25	Pancreas	9377	3396	5981	6156	2117	4039	1	1	–
C32	Larynx	4188	3642	546	8829	7642	1187	4	4	–
C33	Trachea	60	39	21	75	45	30	–	–	–
C34	Lung	49,290	33,453	15,837	513,20	33,226	18,094	26	25	1
C37	Thymus	113	48	65	234	87	147	–	–	–
C38	Heart and pleura	424	213	211	505	202	303	–	–	–
C40	Bone – limbs	192	76	116	391	165	226	–	–	–
C41	Bone – axial skeleton	328	147	181	591	249	342	–	–	–
C43	Melanoma	9796	4434	5362	23,184	9935	13,249	3	2	1
C45-C49	Soft tissues	3317	1662	1655	5660	2754	2906	1	1	–
C50	Breast	42,723	459	42,264	110,364	1086	109,278	7	1	6
C51-C52	Vulva and vagina	3253	–	3253	6051	–	6051	1	–	1
C53	Cervix uteri	4420	–	4420	8832	–	8832	2	–	2
C54-C55	Corpus uteri	17,000	–	17,000	43,060	–	43,060	1	–	1
C56	Ovary	7509	–	7509	12,187	–	12,187	1	–	1
C60	Penis	793	793	–	1740	1740	–	–	–	–
C61	Prostate	57,895	57,895	–	146,606	146,606	–	58	58	–
C62	Testis	187	187	–	475	475	–	–	–	–
C64	Kidney	14,155	7186	6969	34,213	16,463	17,750	11	10	1
C65-C67	Urinary system	30,289	22,837	7452	66,642	50,086	16,555	27	27	–
C69-C72	Central nervous system	6303	2422	3881	7566	2613	4954	2	2	–
C73	Thyroid gland	3341	637	2704	8086	1371	6715	–	–	–
C74	Adrenal gland	217	83	134	406	142	264	–	–	–
C76, C80	Unspecified site	6227	2348	3879	4613	1706	2907	1	1	–
C81-C88	Lymphoma	10,378	4597	5781	20,385	8664	11,721	8	7	1
C90	Multiple myeloma	5407	2245	3162	9168	3693	5475	3	3	–
C91-C96	Leukemia	11,395	5489	5906	21,776	9845	11,931	1	1	–

[a] All primary malignant neoplasms except non-melanoma skin cancers (C00-C43, C45-C76, C80-C96 according to the ICD-10).

4. Discussion

4.1. Main findings

We present a large cohort study, part of the PolSCa study, assessing the risk of suicide among cancer patients aged ≥75 years, who are considered especially vulnerable among oncological patients [10]. It is well known that non-skin cancer diagnosis in the elderly is associated with increased levels of disability, geriatric syndromes, vulnerability, and frailty [11,12]. Furthermore, despite significant improvements in cancer survival over the last two decades [13], seniors with cancer are a rapidly expanding population [5] with poorer outcomes than younger individuals. Additionally, cancer management in these patients can be difficult because of comorbidities and age-related circumstances, which can affect the choice of therapies and influence treatment outcomes [14,15].

To our knowledge, this is the most thorough examination of suicides after a cancer diagnosis in the elderly in Central Europe, with estimates of over 400 thousand patients with cancer. This study improves on earlier research on this topic in terms of scale (study population), method (SMR-type epidemiological model that uses age-period-sex-specific national suicide incidence rates as a reference), and generalizability (since it deploys the entire national population).

The most important clinically relevant finding was that the risk of suicide after a cancer diagnosis in patients aged ≥75 years was 64 % higher than that in the general elderly population. This study supports evidence from the previous observations [2]. Key American and English studies on the topic of suicide after cancer diagnosis, for patients aged 70–79 years reported SMR at 2.75 (95 % CI 2.62 to 2.90) and 1.29 (95 % CI 1.19 to 1.39), respectively [16,17]. The observed discrepancy between countries might be the result of differences in health coverage, social relations, cancer stigma, and burden related to disease. The generally reported increase in risk of suicidality in older oncological patients may be related to ageism in healthcare, which is demonstrated in age-based bias in cancer detection and treatment, likely to result in disparities in care that are not merited [18,19]. There is also evidence that vulnerable older patients with cancer are underrepresented in oncology clinical trials [20].

Although, in our study, we did not directly measure disability, it is worth considering its impact on suicide risk among older cancer patients. The findings from Conwell et al. indicate that functional limitations and associated impairments in instrumental activities of daily living (IADL) independently contribute to suicide risk in the second half of life [21]. Drawing from their study, it is plausible to suggest that older cancer patients experiencing disability, functional impairments, and limitations in daily activities may face increased psychological distress and reduced quality of life. These factors could potentially contribute to an elevated risk of suicide among this population. To improve our understanding of the association between disability and suicide risk in older cancer patients, future research could specifically investigate the impact of functional limitations, IADL impairments, and the need for home care services on psychological well-being and suicide risk.

In our study, we observed that the risk of suicide increased only among men aged ≥75 years. No increase in suicide risk was observed in women in the same age group. This finding is consistent with the risk of suicide in the general Polish population, which is higher in men than in women [22]. This is also consistent with previous literature on suicide risk in patients with cancer [17,23]. Our study's observation of increased suicide risk only among men aged ≥75 years aligns also with the findings from Waern et al., who reported that serious physical illness

Table 2
Deaths due to suicide among patients with cancer – standardized mortality ratios (SMR) and 95 % confidence intervals (95 % CI) by cancer site and sex.

ICD-10	Site	Overall			Men			Women		
		Observed	Expected	SMR (95 % CI)	Observed	Expected	SMR (95 % CI)	Observed	Expected	SMR (95 % CI)
	All cancers[a]	218	133	**1.64 (1.43–1.87)**	195	115	**1.70 (1.47–1.95)**	23	18	1.28 (0.81–1.93)
C00-C14 + C30	Head and neck	3	3	0.96 (0.20–2.82)	3	3	1.08 (0.22–3.14)	0	0	0.00 (0.00–11.50)
C15	Esophagus	1	0	2.29 (0.06–12.77)	1	0	2.52 (0.06–14.03)	0	0	0.00 (0.00–93.81)
C16	Stomach	3	4	0.77 (0.16–2.25)	3	3	0.87 (0.18–2.54)	0	0	0.00 (0.00–8.11)
C17	Small intestine	0	0	0.00 (0.00–14.44)	0	0	0.00 (0.00–17.07)	0	0	0.00 (0.00–93.75)
C18-C20	Colorectum	49	25	**1.97 (1.46–2.61)**	42	21	**1.96 (1.41–2.65)**	7	3	2.08 (0.84–4.29)
C21	Anus	1	0	5.89 (0.15–32.81)	1	0	8.75 (0.22–48.77)	0	0	0.00 (0.00–66.42)
C22–24	Liver and gallbladder	3	1	2.38 (0.49–6.95)	2	1	2.00 (0.24–7.23)	1	0	3.83 (0.10–21.36)
C25	Pancreas	1	1	1.25 (0.03–6.94)	1	1	1.62 (0.04–9.05)	0	0	0.00 (0.00–19.68)
C32	Larynx	4	2	1.80 (0.49–4.62)	4	2	1.85 (0.50–4.73)	0	0	0.00 (0.00–69.55)
C34	Lung	26	10	**2.52 (1.65–3.69)**	25	9	**2.63 (1.70–3.89)**	1	1	1.21 (0.03–6.77)
C38	Heart and pleura	0	0	0.00 (0.00–49.64)	0	0	0.00 (0.00–60.87)	0	0	0.00 (0.00–269.18)
C41	Bone - axial skeleton	0	0	0.00 (0.00–43.28)	0	0	0.00 (0.00–52.77)	0	0	0.00 (0.00–240.70)
C43	Melanoma	3	3	0.87 (0.18–2.54)	2	3	0.70 (0.08–2.52)	1	1	1.68 (0.04–9.38)
C45-C49	Soft tissues	1	1	1.07 (0.03–5.97)	1	1	1.25 (0.03–6.95)	0	0	0.00 (0.00–28.19)
C50	Breast	7	5	1.35 (0.54–2.77)	1	0	3.17 (0.08–17.69)	6	5	1.23 (0.45–2.67)
C51-C52	Vulva and vagina	1	0	3.65 (0.09–20.32)	–	–	–	1	0	3.65 (0.09–20.32)
C53	Cervix uteri	2	0	5.00 (0.61–18.07)	–	–	–	2	0	5.00 (0.61–18.07)
C54-C55	Corpus uteri	1	2	0.52 (0.01–2.90)	–	–	–	1	2	0.52 (0.01–2.90)
C56	Ovary	1	1	1.82 (0.05–10.12)	–	–	–	1	1	1.82 (0.05–10.12)
C60	Penis	0	1	0.00 (0.00–7.30)	0	1	0.00 (0.00–7.30)	–	–	–
C61	Prostate	58	41	**1.40 (1.07–1.82)**	58	41	**1.40 (1.07–1.82)**	–	–	–
C62	Testis	0	0	0.00 (0.00–26.72)	0	0	0.00 (0.00–26.72)	–	–	–
C64	Kidney	11	5	**2.02 (1.01–3.62)**	10	5	**2.16 (1.03–3.96)**	1	1	1.25 (0.03–6.99)
C65-C67	Urinary system	27	15	**1.77 (1.16–2.57)**	27	15	**1.86 (1.22–2.70)**	0	1	0.00 (0.00–4.95)
C69-C72	Central nervous system	2	1	2.05 (0.25–7.41)	2	1	2.67 (0.32–9.64)	0	0	0.00 (0.00–16.35)
C73	Thyroid	0	1	0.00 (0.00–5.48)	0	0	0.00 (0.00–9.76)	0	0	0.00 (0.00–12.48)
C76, C80	Unspecified site	1	1	1.55 (0.04–8.61)	1	1	1.96 (0.05–10.92)	0	0	0.00 (0.00–26.99)
C81-C88	Lymphoma	8	3	**2.66 (1.15–5.25)**	7	2	**2.83 (1.14–5.82)**	1	1	1.89 (0.05–10.56)
C90	Multiple myeloma	3	1	2.29 (0.47–6.70)	3	1	2.83 (0.58–8.27)	0	0	0.00 (0.00–14.83)
C91-C96	Leukemia	1	3	0.29 (0.01–1.64)	1	3	0.35 (0.01–1.95)	0	1	0.00 (0.00–6.82)

Bold values denote statistical significance at the **$p < 0.05$ level**.

[a] All primary malignant neoplasms except non-melanoma skin cancers (C00-C43, C45-C76, C80-C96 according to the ICD-10).

Table 3
Deaths due to suicide among male patients with cancer – standardized mortality ratios (SMR) and 95 % confidence intervals (95 % CI) by cancer site and time since diagnosis.

ICD	Site	Time since diagnosis [years]	Observed	Expected	SMR (95 % CI)
	All cancers[a]	[0.0, 0.5)	52	18	**2.83 (2.11–3.71)**
		[0.5, 1.0)	18	14	1.29 (0.76–2.04)
		[1.0, 2.0)	42	22	**1.93 (1.39–2.61)**
		[2.0, 3.0)	15	17	0.90 (0.50–1.48)
		[3.0, 5.0)	41	24	**1.74 (1.25–2.35)**
		[5.0,10.0]	27	21	1.32 (0.87–1.92)
C18-C20	Colorectum	[0.0, 0.5)	11	3	**3.40 (1.70–6.08)**
		[0.5, 1.0)	3	3	1.15 (0.24–3.36)
		[1.0, 2.0)	8	4	1.90 (0.82–3.75)
		[2.0, 3.0)	8	3	**2.47 (1.07–4.87)**
		[3.0, 5.0)	9	4	2.03 (0.93–3.86)
		[5.0,10.0]	3	4	0.80 (0.17–2.35)
C21	Anus	[0.0, 0.5)	1	0	**49.71 (1.26–276.96)**
		[0.5, 1.0)	0	0	0.00 (0.00–250.15)
		[1.0, 2.0)	0	0	0.00 (0.00–169.55)
		[2.0, 3.0)	0	0	0.00 (0.00–259.68)
		[3.0, 5.0)	0	0	0.00 (0.00–180.25)
		[5.0,10.0]	0	0	0.00 (0.00–160.68)
C34	Lung	[0.0, 0.5)	10	3	**3.45 (1.66–6.35)**
		[0.5, 1.0)	3	2	1.85 (0.38–5.41)
		[1.0, 2.0)	4	2	2.22 (0.60–5.68)
		[2.0, 3.0)	1	1	0.98 (0.02–5.47)
		[3.0, 5.0)	4	1	3.32 (0.90–8.50)
		[5.0,10.0]	3	1	3.16 (0.65–9.25)
C61	Prostate	[0.0, 0.5)	12	5	**2.53 (1.31–4.42)**
		[0.5, 1.0)	6	4	1.39 (0.51–3.03)
		[1.0, 2.0)	18	8	**2.38 (1.41–3.76)**
		[2.0, 3.0)	1	6	**0.16 (0.00–0.88)**
		[3.0, 5.0)	15	10	1.57 (0.88–2.59)
		[5.0,10.0]	6	9	0.68 (0.25–1.49)
C65-C67	Urinary system	[0.0, 0.5)	3	2	1.38 (0.28–4.02)
		[0.5, 1.0)	0	2	0.00 (0.00–2.08)
		[1.0, 2.0)	6	3	2.11 (0.78–4.60)
		[2.0, 3.0)	3	2	1.36 (0.28–3.98)
		[3.0, 5.0)	8	3	**2.62 (1.13–5.16)**
		[5.0,10.0]	7	3	**2.80 (1.12–5.76)**
C81-C88	Lymphoma	[0.0, 0.5)	4	0	**9.94 (2.71–25.44)**
		[0.5, 1.0)	0	0	0.00 (0.00–12.17)
		[1.0, 2.0)	1	0	2.11 (0.05–11.73)
		[2.0, 3.0)	1	0	2.71 (0.07–15.12)
		[3.0, 5.0)	0	1	0.00 (0.00–7.14)
		[5.0,10.0]	1	0	2.43 (0.06–13.54)
C90	Multiple myeloma	[0.0, 0.5)	0	0	0.00 (0.00–18.46)
		[0.5, 1.0)	0	0	0.00 (0.00–24.30)
		[1.0, 2.0)	1	0	4.39 (0.11–24.45)
		[2.0, 3.0)	0	0	0.00 (0.00–23.30)
		[3.0, 5.0)	0	0	0.00 (0.00–19.23)
		[5.0,10.0]	2	0	**15.33 (1.86–55.37)**

[a] All primary malignant neoplasms except non-melanoma skin cancers (C00-C43, C45-C76, C80-C96 according to the ICD-10).

was associated with an increased risk of suicide in elderly men but not in women [24]. These consistent findings across studies suggest that the association between serious medical illness and suicide risk may exhibit sex differences in older populations, highlighting the importance of considering gender-specific factors when evaluating suicide risk among older adults with cancer or other significant health conditions.

Our analyses assessing the association between cancer site and risk of suicide show that elderly men diagnosed with lymphoma, lung cancer, kidney cancer, colorectal cancer, urinary tract cancer, and prostate cancer are at a higher risk than the general population of elderly men. A possible explanation for these observations might be the overall survival prognosis of these cancer sites. Apart from prostate cancer, the rest of these tumors can be classified as having an intermediate prognosis (lymphoma, kidney cancer, colorectal cancer, and urinary tract cancer) or poor prognosis (lung cancer) [1]. Another factor related to the increased risk of these cancer sites might be stoma-related body image concerns (for example, after radical cystectomy or colectomy) [25–27]. Additionally, smoking tobacco, which is considered an independent risk factor for suicide [28], is also a risk factor for all six cancers identified in this study with increased suicide risk after diagnosis. Also, while we did not directly measure pain as a factor, it is reasonable to consider that cancer-related pain could potentially contribute to the observed increased suicide risk among these cancer sites. A study by Juurlink et al. suggests that presence of pain, may exacerbate psychological distress, decrease quality of life, and potentially increase suicide risk in older individuals [29]. Therefore, considering pain management strategies and assessing its impact on psychological well-being should be an integral part of comprehensive care for older cancer patients.

Another important finding is that a bimodal distribution of suicide risk was observed after prostate cancer diagnosis. Notably, a significant increase in suicide risk was observed within the first six months after diagnosis, followed by a second peak occurring between the 12th and 24th month post-diagnosis. This temporal pattern suggests a potential association between the adverse effects of prostate cancer treatment, such as impotence and incontinence, which may manifest in the later stages of treatment. These treatment-related complications could significantly impact patients' psychological well-being and quality of life [30], potentially contributing to the observed bimodal distribution

of suicide risk in this population. Further research examining the specific influence of prostate cancer treatments and associated complications on psychological distress and suicidal ideation during different time intervals post-diagnosis is warranted.

4.2. Implications of the study

At the time of writing this article, there were no strategies at the national level in Poland that would concern suicide prevention or support the mental health of Polish patients diagnosed with cancer. There is an urgent need to create and validate an inexpensive and effective tool for screening for symptoms of depression and suicide risk in oncology patients, which would be adapted to Polish reality and widely available.

Currently, in Poland, patient associations or non-governmental organizations acting for their benefit help them face cancer-related difficulties, including mental challenges. However, information on these organizations' activities is available mainly via the Internet. According to the Polish Center for Public Opinion Research, in 2022, the percentage of individuals aged ≥75 years using the internet was 22 % [31]. Therefore, there is a need to direct the assistance provided so far also to digitally excluded patients by developing printed or multimedia materials that are available in healthcare facilities or conventional media.

4.3. Strengths and limitations

This is the first national population-level study on the risk of suicide after a cancer diagnosis in elderly patients. The significant strength of this study was the large population, which was fully covered by universal access to healthcare, data linkage based on unique personal identity codes, an extended follow-up period, and SMR-type calculations. In addition, the analyses encompassed the entire national population, allowing for generalizability of the results.

This analysis may be somewhat limited by underreporting suicide as a cause of death. Such underreporting may have affected the data on patients with cancer more than the general population; hence, the overall risk of suicide among patients with cancer could have been somewhat underestimated. Another limitation is the lack of information on mental disorders, information on other suicide risk factors, including a history of substance abuse, recent death of a family member or a close friend, or a history of disability other than cancer [32]. We highlight that the lack of information mentioned above could be a potential confounding factor and may impact the observed association between cancer diagnosis and suicide risk. Future research on the topic should incorporate such information to provide a more comprehensive understanding of the relationship between cancer diagnosis, mental health, and suicide risk.

4.4. Conclusions

An increased risk of suicide characterizes Polish men aged ≥75 years with cancer compared to general elderly male population. The risk varies depending on the cancer site and time since diagnosis. The highest risk concerns patients diagnosed with lymphoma, lung cancer, or kidney cancer. The observations from this study suggest the most vulnerable groups of elderly patients with cancer and the time at which they should be given special support, such as increased access to mental health services, regular check-ins by healthcare professionals, and tailored psychosocial interventions. Further research should focus on identifying socioeconomic factors that may influence suicide risk in this group.

Contributors

Irmina Maria Michalek contributed to study concept and design, acquisition, analysis, and interpretation of data, statistical analysis and drafting of the manuscript.

Florentino Luciano Caetano dos Santos contributed to acquisition, analysis, and interpretation of data, and statistical analysis.

Urszula Wojciechowska contributed to acquisition, analysis, and interpretation of data.

Joanna Didkowska contributed to acquisition, analysis, and interpretation of data.

All authors had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.All authors contributed to critical revision of the manuscript for intellectual content.

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Ethical approval

We complied with all relevant ethical regulations. Following national regulations, these data were exempt from institutional review board reviews because there were no participants in the study. Detailed legislative aspects of the National Polish Cancer Registry are regulated by Polish Law (Dz.U. 2018 poz. 1197).

Provenance and peer review

This article was not commissioned and was externally peer reviewed.

Research data (data sharing and collaboration)

There are no linked research data sets for this paper. The data analyzed in this study were obtained from the PLCR and are available upon reasonable request by contacting the PLCR at krn@pib-nio.pl and subject to ethical approvals in place and material transfer agreements.

Declaration of competing interest

The authors declare that they have no competing interest.

References

[1] M. Heinrich, L. Hofmann, H. Baurecht, et al., Suicide risk and mortality among patients with cancer, Nat. Med. 28 (4) (2022) 852–859.
[2] L. Du, H.Y. Shi, H.R. Yu, et al., Incidence of suicide death in patients with cancer: a systematic review and meta-analysis, J. Affect. Disord. 276 (2020) 711–719.
[3] H. Sung, J. Ferlay, R.L. Siegel, et al., Global Cancer Statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries, CA Cancer J. Clin. 71 (3) (2021) 209–249.
[4] J.W. Choi, E.C. Park, Suicide risk after cancer diagnosis among older adults: a nationwide retrospective cohort study, J. Geriatr. Oncol. 11 (5) (2020) 814–819.
[5] J. Didkowska, U. Wojciechowska, I.M. Michalek, F.L. Caetano Dos Santos, Cancer incidence and mortality in Poland in 2019, Sci. Rep. 12(1):10875 (2022).
[6] T. Diaz, K.L. Strong, B. Cao, et al., A call for standardised age-disaggregated health data, Lancet Healthy Longev. 2 (7) (2021) e436–e443.
[7] N. Geifman, R. Cohen, E. Rubin, Redefining meaningful age groups in the context of disease, Age (Dordr.) 35 (6) (2013) 2357–2366.
[8] Ministerstwo Zdrowia, Leki 75+. https://75plus.mz.gov.pl (Accessed 2022-11-27).
[9] J.P. Vandenbroucke, E. von Elm, D.G. Altman, et al., Strengthening the reporting of observational studies in epidemiology (STROBE): explanation and elaboration, PLoS Med. 4 (10) (2007), e297.
[10] O.J. Ding, G.J. Kennedy, Understanding vulnerability to late-life suicide, Curr. Psychiatry Rep. 23 (9) (2021) 58.
[11] S.G. Mohile, Y. Xian, W. Dale, et al., Association of a cancer diagnosis with vulnerability and frailty in older Medicare beneficiaries, J. Natl. Cancer Inst. 101 (17) (2009) 1206–1215.
[12] S.G. Mohile, L. Fan, E. Reeve, et al., Association of cancer with geriatric syndromes in older Medicare beneficiaries, J. Clin. Oncol. 29 (11) (2011) 1458–1464.
[13] F.L. Caetano Dos Santos, U. Wojciechowska, I.M. Michalek, J. Didkowska, Progress in cancer survival across last two decades: a nationwide study of over 1.2 million Polish patients diagnosed with the most common cancers, Cancer Epidemiol. 78 (2022), 102147.

[14] S. Kadambi, K.P. Loh, R. Dunne, et al., Older adults with cancer and their caregivers - current landscape and future directions for clinical care, Nat. Rev. Clin. Oncol. 17 (12) (2020) 742–755.
[15] K.P. Loh, S.G. Mohile, J.L. Lund, et al., Beliefs about advanced cancer curability in older patients, their caregivers, and oncologists, Oncologist. 24 (6) (2019) e292–e302.
[16] N.G. Zaorsky, Y. Zhang, L. Tuanquin, S.M. Bluethmann, H.S. Park, V.M. Chinchilli, Suicide among cancer patients, Nat. Commun. 10 (1) (2019) 207.
[17] K.E. Henson, R. Brock, J. Charnock, B. Wickramasinghe, O. Will, A. Pitman, Risk of suicide after cancer diagnosis in England, JAMA Psychiatry 76 (1) (2019) 51–60.
[18] S. Schroyen, S. Adam, G. Jerusalem, P. Missotten, Ageism and its clinical impact in oncogeriatry: state of knowledge and therapeutic leads, Clin. Interv. Aging 10 (2015) 117–125.
[19] D.W. Shin, K. Park, A. Jeong, et al., Experience with age discrimination and attitudes toward ageism in older patients with cancer and their caregivers: a nationwide Korean survey, J. Geriatr. Oncol. 10 (3) (2019) 459–464.
[20] L. Tack, T. Lefebvre, M. Lycke, et al., Underrepresentation of vulnerable older patients with cancer in phase II and III oncology registration trials: a case-control study, J. Geriatr. Oncol. 11 (2) (2020) 320–326.
[21] Y. Conwell, P.R. Duberstein, J.K. Hirsch, K.R. Conner, S. Eberly, E.D. Caine, Health status and suicide in the second half of life, Int. J. Geriatr. Psychiatry 25 (4) (2010) 371–379.
[22] A. Gawliński, I. Sołtyszewski, M. Wiergowski, Epidemiology of suicides in Poland in 1990-2018 - changes and new trends, Arch. Med. Sadowej Kryminol. 70 (4) (2020) 222–234.
[23] S. Misono, N.S. Weiss, J.R. Fann, M. Redman, B. Yueh, Incidence of suicide in persons with cancer, J. Clin. Oncol. 26 (29) (2008) 4731–4738.
[24] M. Waern, E. Rubenowitz, B. Runeson, I. Skoog, K. Wilhelmson, P. Allebeck, Burden of illness and suicide in elderly people: case-control study, BMJ. 324 (7350) (2002) 1355.
[25] C. Taylor, Body image concerns after colorectal cancer surgery, Br. J. Nurs. 24 (10) (2015) (S8, s10–12, s14).
[26] C.J. Han, B. Gigic, M. Schneider, et al., Risk factors for cancer-related distress in colorectal cancer survivors: one year post surgery, J. Cancer Surviv. 14 (3) (2020) 305–315.
[27] B.K. Somani, D. Gimlin, P. Fayers, J. N'Dow, Quality of life and body image for bladder cancer patients undergoing radical cystectomy and urinary diversion-a prospective cohort study with a systematic review of literature, Urology. 74 (5) (2009) 1138–1143.
[28] J. Poorolajal, N. Darvishi, Smoking and suicide: a meta-analysis, PLoS One 11 (7) (2016), e0156348.
[29] D.N. Juurlink, N. Herrmann, J.P. Szalai, A. Kopp, D.A. Redelmeier, Medical illness and the risk of suicide in the elderly, Arch. Intern. Med. 164 (11) (2004) 1179–1184.
[30] B.N. Breyer, S.A. Kenfield, S.D. Blaschko, B.A. Erickson, The association of lower urinary tract symptoms, depression and suicidal ideation: data from the 2005–2006 and 2007–2008 National Health and utrition xamination urvey, J. Urol. 191 (5) (2014) 1333–1339.
[31] CBOS, Korzystanie z internetu 2022. https://www.cbos.pl/SPISKOM.POL/2022/K_077_22.PDF, 2022. Published. (Accessed 2022-11-27).
[32] T.B. Cole, J.M. Bowling, M.J. Patetta, D.G. Blazer, Risk factors for suicide among older adults with cancer, Aging Ment. Health 18 (7) (2014) 854–860.