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# Socioeconomic predictors of suicide risk among cancer patients in the United States: A population-based study

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ABSTRACT

*Objective:* To assess the socioeconomic predictors of suicide risk among cancer patients in the United States.
*Methods:* Cancer patients available within Surveillance, Epidemiology and End Results (SEER) database who were diagnosed between 2000–2010 have been reviewed. Linkage analysis to Census 2000 SF files was conducted to determine area-based socioeconomic attributes. Observed/ Expected ratios were calculated for the overall cohort as well as for clinically and socioeconomically defined subgroups. "Observed" is the number of observed completed suicide cases in the studied cohort; while "Expected" is the number of completed suicide cases in a demographically similar cohort within the United States and within the same period of time.
*Results:* The current study reviews a total of 3,149,235 cancer patients (diagnosed 2000–2010) within the SEER database. Regarding socioeconomic county attributes, higher risk of suicide seems to be associated with lower educational attainment (O/E for counties with > 20% individuals with less than high school education: 1.41; 95% CI: 1.35–1.47), poverty rates (O/E for counties with > 5% individuals below poverty line: 1.39; 95% CI: 1.34–1.43), unemployment rates (O/E for counties with > 5% families below poverty line: 1.36; 95% CI: 1.31–1.41) and less people living in urban areas (O/E for counties with $\leq$ 50% individuals living in urban areas: 1.63; 95% CI: 1.50–1.77). On the other hand, risk of suicide seems to be inversely related to a higher representation of foreign-born individuals (O/E for counties with $\leq$ 5% foreign-born individuals: 1.56; 95% CI: 1.47–1.65); and inversely related to a higher representation with recent immigrants to the US (O/E for counties with $\leq$ 5% recent immigrants: 1.33; 95% CI: 1.29–1.38).
*Conclusions:* Cancer patients living in a socioeconomically vulnerable environment (lower educational status, poverty, and unemployment) seem to have higher suicide risk compared to other cancer patients.

## 1. Introduction

Socioeconomic status (e.g. employment, poverty, and educational attainment) has been extensively evaluated as a predictor of cancer-specific outcomes among cancer patients; but the relationship between socioeconomic status and non-cancer outcomes has been rarely evaluated [1–8].

Previous population-based analyses from North America examining the risk of suicide among cancer patients have focused on clinicopathological characteristics most likely associated with suicide risk [9,10]. While we know from analyzing suicide rates in the general population that socioeconomic conditions play a very important role in predicting such a risk [11]; this piece of information is still missing among cancer patients.

Currently, available cancer registries in North America provide very little information about personalized socioeconomic information. It is still possible, however, to provide area-based estimates of socioeconomic conditions among cancer patients in the US based on linkage analysis between Surveillance, Epidemiology and End Results (SEER) database and other national databases of socioeconomic attributes of different areas in the US.

Providing a relationship between suicide risk in cancer patients and area-based socioeconomic attributes would potentially highlight the populations at the most need for social and psychological support programs.

## 2. Objective

To assess the socioeconomic predictors of suicide risk among cancer patients in the United States.

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## 3. Methods

### 3.1. Data sources

This study is based on the SEER 18 registries (2017 submission) which are linked to 2000 county attributes (calculated using census 2000 SF files) [12]. Detailed methodological considerations for the census 2000 files were described elsewhere [13]. In order to include patients into the current study, cancer diagnosis should have occurred between 2000–2010 (in order to be covered by the country attributes of 2000 as 2000 county attributes do not cover patients diagnosed beyond 2010). Moreover, inclusion of patients diagnosed at 2010 (with survival follow-up till 2015) would allow enough time to assess the risks of suicide following cancer diagnosis.

For the sake of the current study, the following definitions of county socioeconomic attributes were utilized:

- Educational attainment: percentage of county residents with less than high school education.
- Poverty: percentage of families below the poverty line.
- Employment: percentage of individuals $\geq$ 16 years who are unemployed.
- Immigration status: percentage of individuals moved from outside the United States in the past 5 years.
- Foreign-born status: percentage of individuals who were foreign-born.
- Urban: Percentage of individuals living in urban areas.

### 3.2. Study end points

The primary endpoint of the current study is the Observed/Expected (O/E) ratio for suicide among cancer patients. Where “Observed” is the number of observed completed suicide cases in the studied cohort; while “Expected" is the number of completed suicide cases in a demographically similar cohort within the US and within the same period of time. Mortality statistics of the general US population were based on the National Center for Health Statistics mortality database which was accessed by the SEER database [14].

### 3.3. Statistical analysis

Using SEER*stat software (version 8.3.5), standardized mortality (O/E) ratios (with corresponding 95% confidence intervals) were calculated for the whole cohort of patients as well as for clinically defined subgroups of patients according to clinicopathological characteristics (age, sex, race, ethnicity, primary tumor location and SEER summary stage). Moreover, O/E ratios were also calculated for distinct socioeconomic county attributes including educational attainment, poverty level, unemployment, the percentage of foreign-born individuals and percentage of recent immigrants at the time of 2000 census ($\leq$ 5 years).

## 4. Results

### 4.1. Patients’ characteristics

The current study reviews a total of 3,149,235 cancer patients (diagnosed 2000–2010) within the SEER database. Among those patients, 4382 patients (0.13%) have suicide as their cause of death (survival follow-up continued till December 2015). Other causes of death for the study cohort were detailed in supplemental Table 1. Baseline clinicopathological characteristics of included patients were described in Table 1; the majority of included patients were males (51.8%), aged 40–69 years of age (57.4%), have a white race (82.8%). A total of 47.9% of patients have localized disease at presentation and 17.7% of patients have prostate cancer.

**Table 1**
Suicide risk according to clinicopathological characteristics in the studied cohort.

| Parameters | Number of reviewed cancer patients | Number of observed suicide cases among cancer patients | Observed/ Expected (95% CI) |
|---|---|---|---|
| All patients | 3,149,235 | 4,382 | 1.29 (1.25-1.33) |
| Age | | | |
| < 40 years | 223,695 | 269 | 1.18 (1.04-1.33) |
| 40-69 years | 1,809,397 | 2,587 | 1.27 (1.22-1.32) |
| $\geq$ 70 years | 1,116,143 | 1,526 | 1.35 (1.28-1.42) |
| Sex | | | |
| Male | 1,633,932 | 3,673 | 1.31 (1.27- 1.35) |
| Female | 1,515,303 | 709 | 1.19 (1.10-1.28) |
| Race | | | |
| White | 2,609,993 | 4,027 | 1.26 (1.22-1.30) |
| Black | 334,156 | 167 | 1.48 (1.27-1.73) |
| Asian-Pacific Islander | 192,256 | 167 | 1.74 (1.49-2.03) |
| American Indian | 12,830 | 21 | 3.50 (2.17-5.35) |
| Ethnicity | | | |
| Hispanic | 287,313 | 185 | 0.59 (0.51-0.68) |
| Non-Hispanic | 2,861,922 | 4197 | 1.36 (1.32-1.40) |
| Primary tumor location | | | |
| Lung | 348,831 | 387 | 3.13 (2.83-3.46) |
| Prostate | 558,730 | 1,234 | 0.96 (0.91-1.02) |
| Breast | 500,788 | 278 | 1.06 (0.94-1.19) |
| Colorectal | 315,795 | 439 | 1.35 (1.22-1.48) |
| Pancreas | 62,080 | 45 | 3.70 (2.70-4.95) |
| Thyroid | 81,448 | 58 | 0.69 (0.53-0.89) |
| Melanoma | 134,918 | 250 | 1.14 (1.00-1.29) |
| Urinary bladder | 130,889 | 282 | 1.31 (1.16- 1.47) |
| Lymphoma | 153,355 | 210 | 1.19 (1.03-1.36) |
| Corpus uteri | 96,850 | 36 | 0.79 (0.55-1.10) |
| SEER stage | | | |
| Localized | 1,509,332 | 2,291 | 1.07 (1.02-1.11) |
| Regional | 665,396 | 853 | 1.44 (1.34-1.54) |
| Distant | 532,836 | 556 | 2.59 (2.38- 2.82) |
| Marital status at diagnosis* | | | |
| Married | 1,784,098 | 2,333 | 1.03 (0.98-1.07) |
| Single | 452,656 | 690 | 1.71 (1.59-1.84) |
| Divorced | 269,977 | 582 | 2.61 (2.41-2.83) |
| Widow | 408,862 | 345 | 1.73 (1.56-1.93) |
| Separated | 28,686 | 41 | 1.80 (1.29-2.44) |

* Marital status was included in this table because it is reported in the SEER database as a personal attribute rather than county attribute.

### 4.2. Suicide risk according to clinicopathological characteristics and socioeconomic county attributes

Risk of suicide seems to be high among older age patients (O/E: 1.35; 95% CI: 1.28–1.42); males (O/E: 1.31; 95% 1.27–1.35); racial minorities (O/E for African American: 1.48, 95% CI: 1.27–1.73; O/E for Asian-pacific Islander: 1.74, 95% CI: 1.49–2.03; O/E for American Indians: 3.50, 95% CI: 2.17–5.35); Non-Hispanic ethnicity (O/E: 1.36; 95% CI: 1.32–1.40); Pancreatic and lung primaries (O/E for pancreatic cancer: 3.70, 95% CI: 2.70–4.95; O/E for lung cancer: 3.13; 95% CI: 2.83–3.46); distant SEER stage (O/E: 2.59; 95% CI: 2.38–2.82) and divorced persons (O/E: 2.61; 95% CI: 2.41–2.83) (Table 1).

higher risk of suicide seems to be associated with lower educational attainment (O/E for counties with > 20% individuals with less than high school education: 1.41; 95% CI: 1.35–1.47), poverty rates (O/E for counties with > 5% individuals below poverty line: 1.39; 95% CI: 1.34–1.43), unemployment rates (O/E for counties with > 5% families below poverty line: 1.36; 95% CI: 1.31–1.41) and less people living in urban areas (O/E for counties with $\leq$ 50% individuals living in urban areas: 1.63; 95% CI: 1.50–1.77). On the other hand, risk of suicide seems to be inversely related to a higher representation of foreign-born individuals (O/E for counties with $\leq$ 5% foreign-born individuals: 1.56; 95% CI: 1.47–1.65); and inversely related to a higher

**Table 2**
Suicide risk according to socioeconomic county attributes.

| County attributes | Number of reviewed cancer patients | Number of observed suicide cases among cancer patients | Observed/ Expected (95% CI) |
|---|---|---|---|
| Residents with less than high school educational attainment | | | |
| Counties with ≤ 20% | 1,777,031 | 2,408 | 1.20 (1.16-1.25) |
| Counties with > 20% | 1,371,294 | 1,973 | 1.41 (1.35-1.47) |
| Families below poverty line | | | |
| Counties with ≤ 5% | 703,171 | 791 | 0.97 (0.90-1.04) |
| Counties with > 5% | 2,445,154 | 3,590 | 1.39 (1.34-1.43) |
| Unemployment rates | | | |
| Counties with ≤ 5% | 1,033,128 | 1,374 | 1.16 (1.10-1.22) |
| Counties with > 5% | 2,115,197 | 3,007 | 1.36 (1.31-1.41) |
| Recent immigrants to the US (within the last 5 years) | | | |
| Counties with ≤ 5% | 2,459,804 | 3,580 | 1.33 (1.29-1.38) |
| Counties with > 5% | 688,521 | 801 | 1.12 (1.04-1.20) |
| Foreign-born residents | | | |
| Counties with ≤ 5% | 750,853 | 1,223 | 1.56 (1.47-1.65) |
| Counties with > 5% | 2,397,472 | 3,158 | 1.21 (1.17-1.25) |
| Residents living in urban areas | | | |
| Counties with ≤ 50% | 333,792 | 571 | 1.63 (1.50-1.77) |
| Counties with > 50% | 2,814,533 | 3,810 | 1.25 (1.21-1.29) |

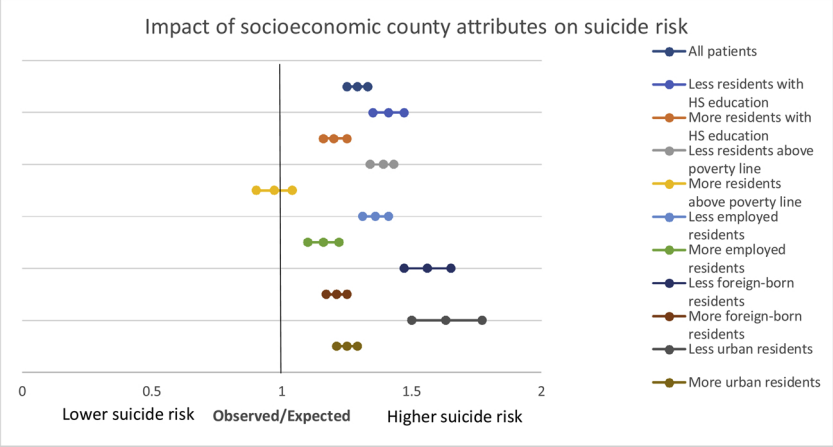


**Fig. 1.** Forest plot for the impact of socioeconomic county attributes on suicide risk.
*HS: High school.

representation with recent immigrants to the US (O/E for counties with ≤ 5% recent immigrants: 1.33; 95% CI: 1.29–1.38) (Table 2) (Fig. 1).

### *4.3. Suicide risk according to specific subgroups of patients combining clinicopathological and socioeconomic features*

Impact of socioeconomic county attributes on clinically defined subgroups of patients was further evaluated. When conducting this analysis according to sex (males versus females), risk of suicide seems to be high among males living in counties with lower educational attainment (O/E: 1.46), males living in counties with a significant burden of poverty line (O/E: 1.42) and males living in counties with higher unemployment rates (O/E: 1.39). The risk is also high among males living in counties with less foreign-born individuals (O/E: 1.61) and males living in counties with less recent immigrants (O/E: 1.36) (Table 3).

When conducting this analysis according to age (< 40 years versus 40–69 years versus ≥ 70 years), risk of suicide seems to be high among older patients living in counties with less education (O/E: 1.52), older patients living in poorer counties (O/E: 1.48) and older patients living in counties with higher rates of unemployment (O/E: 1.46). Likewise, older patients living in counties with less foreign-born individuals and

**Table 3**
Suicide risk according to socioeconomic county attributes among males versus females.

| County attributes | Observed/ expected (95% CI) Males | Observed/ expected (95% CI) Females |
|---|---|---|
| Residents with less than high school educational attainment | | |
| Counties with ≤ 20% | 1.21 (1.15-1.26) | 1.19 (1.08-1.31) |
| Counties with > 20% | 1.46 (1.39-1.53) | 1.18 (1.05-1.32) |
| Families below poverty line | | |
| Counties with ≤ 5% | 0.97 (0.90-1.05) | 0.97 (0.82-1.15) |
| Counties with > 5% | 1.42 (1.37-1.47) | 1.25 (1.15-1.35) |
| Unemployment rates | | |
| Counties with ≤ 5% | 1.16 (1.09-1.23) | 1.18 (1.03- 1.33) |
| Counties with > 5% | 1.39 (1.34-1.45) | 1.19 (1.08-1.30) |
| Recent immigrants to the US (within the last 5 years) | | |
| Counties with ≤ 5% | 1.36 (1.31-1.41) | 1.21 (1.11-1.31) |
| Counties with > 5% | 1.12 (1.04-1.21) | 1.12 (0.94-1.31) |
| Foreign-born residents | | |
| Counties with ≤ 5% | 1.61 (1.51-1.71) | 1.32 (1.13-1.53) |
| Counties with > 5% | 1.22 (1.17-1.27) | 1.15 (1.05-1.25) |

**Table 4**
Suicide risk according to socioeconomic county attributes among younger versus older patients.

| County attributes | Observed/ expected (95% CI) < 40 years | Observed/ expected (95% CI) 40-69 years | Observed/ expected (95% CI) ≥ 70 years |
|---|---|---|---|
| Residents with less than high school educational attainment | | | |
| Counties with ≤ 20% | 1.20 (1.02-1.40) | 1.19 (1.13-1.26) | 1.23 (1.14-1.31) |
| Counties with > 20% | 1.16 (0.96-1.40) | 1.38 (1.30-1.46) | 1.52 (1.41-1.63) |
| Families below poverty line | | | |
| Counties with ≤ 5% | 0.96 (0.71-1.26) | 0.99 (0.91-1.09) | 0.93 (0.82-1.05) |
| Counties with > 5% | 1.25 (1.09-1.43) | 1.35 (1.30-1.41) | 1.48 (1.40-1.56) |
| Unemployment rates | | | |
| Counties with ≤ 5% | 1.24 (1.00-1.51) | 1.17 (1.09-1.25) | 1.13 (1.02-1.24) |
| Counties with > 5% | 1.15 (0.99-1.34) | 1.32 (1.26-1.38) | 1.46 (1.38-1.58) |
| Recent immigrants to the US (within the last 5 years) | | | |
| Counties with ≤ 5% | 1.22 (1.06-1.40) | 1.30 (1.25-1.36) | 1.41 (1.33-1.49) |
| Counties with > 5% | 1.05 (0.79-1.36) | 1.13 (1.03-1.23) | 1.12 (0.99-1.26) |
| Foreign-born residents | | | |
| Counties with ≤ 5% | 1.48 (1.16-1.87) | 1.57 (1.46-1.68) | 1.56 (1.42-1.72) |
| Counties with > 5% | 1.10 (0.95-1.27) | 1.18 (1.12-1.23) | 1.28 (1.21-1.36) |

those living in counties with less recent immigrants seem to be at a higher risk (O/E: 1.41; O/E: 1.56; respectively) (Table 4).

When evaluating suicide risk according to disease stage as well as socioeconomic county attributes, higher suicide risk was observed among patients with distant stage who are living in less-educated counties (O/E: 3.01), living in poorer counties (O/E: 2.82) as well as those living in counties with higher unemployment rates (O/E: 2.83). Higher suicide risk was also observed among distant stage patients who live in counties with less representation of foreign-born individuals (O/E: 3.18) as well as those in less representation of recent immigrants (O/E: 2.66) (Table 5).

Racial differences in suicide risk (white versus African American patients) were further stratified by socioeconomic attributes. Risk of suicide is high among African American patients living in less educated counties (O/E: 1.70), living in poorer counties (O/E: 1.57) as well as those living in counties with higher unemployment rates (O/E: 1.49) (Table 6). Similar analyses were not conducted for Asian American and American Indian patients because of the relatively smaller sample size of these racial groups which might hinder clear demonstration of statistically significant results.

Possible differences in suicide risk among patients with different primary solid tumors (lung cancer, colorectal cancer, pancreatic cancer, and urinary bladder cancer) were further stratified by socioeconomic county attributes. Generally speaking, poorer socioeconomic county attributes (i.e. education, poverty, and employment) seem to correlate with high suicide risks among the evaluated solid tumors (supplementary table-2).

## 5. Discussion

The current study evaluates the impact of different socioeconomic attributes on the risk of suicide among cancer patients. Overall, it indicates that cancer patients living in a socioeconomically vulnerable environment (lower educational status, poverty, and unemployment) seem to have higher suicide risk compared to other cancer patients. Health care providers dealing with cancer patients should identify those higher-risk patients and referral to mental health and psychosocial oncology services should be appropriately arranged.

Interestingly, the current study suggests that cancer patients coming from counties with more foreign-born individuals and recent immigrants have a lower risk of suicide. These findings are consistent with a previous study evaluating suicide risk in the general population in Canada [15]. Possible reasons for this observation might relate to the specific cultural/social fabric of those immigrants which provide stronger support for cancer patients and make suicide a very unpopular idea. An alarming finding in the current study is a higher risk of suicide

**Table 5**
Suicide risk according to socioeconomic county attributes among patients with local/regional disease versus patients with distant disease.

| County attributes | Observed/ expected (95% CI) Local/ regional disease | Observed/ expected (95% CI) Distant disease |
|---|---|---|
| Residents with less than high school educational attainment | | |
| Counties with ≤ 20% | 1.08 (1.03-1.14) | 2.30 (2.04-2.58) |
| Counties with > 20% | 1.24 (1.17-1.30) | 3.01 (2.66-3.39) |
| Families below poverty line | | |
| Counties with ≤ 5% | 0.89 (0.82-0.96) | 1.86 (1.50-2.28) |
| Counties with > 5% | 1.23 (1.18-1.28) | 2.82 (2.56-3.08) |
| Unemployment rates | | |
| Counties with ≤ 5% | 1.05 (0.98-1.11) | 2.14 (1.82-2.50) |
| Counties with > 5% | 1.20 (1.15-1.25) | 2.83 (2.56-3.12) |
| Recent immigrants to the US (within the last 5 years) | | |
| Counties with ≤ 5% | 1.19 (1.15-1.24) | 2.66 (2.42-2.92) |
| Counties with > 5% | 0.97 (0.89-1.05) | 2.36 (1.94-2.85) |
| Foreign-born residents | | |
| Counties with ≤ 5% | 1.36 (1.27-1.45) | 3.18 (2.70-3.72) |
| Counties with > 5% | 1.08 (1.04-1.13) | 2.42 (2.19-2.67) |

**Table 6**
Suicide risk according to socioeconomic county attributes among white patients versus African American patients.

| County attributes | Observed/ expected (95% CI) White patients | Observed/ expected (95% CI) African American patients |
|---|---|---|
| Residents with less than high school educational attainment | | |
| Counties with ≤ 20% | 1.17 (1.13-1.22) | 1.25 (0.97-1.59) |
| Counties with > 20% | 1.39 (1.33-1.46) | 1.70 (1.38-2.06) |
| Families below poverty line | | |
| Counties with ≤ 5% | 0.94 (0.87-1.01) | 1.14 (0.73-1.69) |
| Counties with > 5% | 1.37 (1.32-1.42) | 1.57 (1.32-1.84) |
| Unemployment rates | | |
| Counties with ≤ 5% | 1.13 (1.07-1.19) | 1.46 (1.04-1.97) |
| Counties with > 5% | 1.34 (1.29-1.39) | 1.49 (1.25-1.78) |
| Recent immigrants to the US (within the last 5 years) | | |
| Counties with ≤ 5% | 1.32 (1.27-1.36) | 1.47 (1.23-1.76) |
| Counties with > 5% | 1.06 (0.98-1.14) | 1.52 (1.09-2.05) |
| Foreign-born residents | | |
| Counties with ≤ 5% | 1.56 (1.47-1.65) | 1.52 (1.13-2.01) |
| Counties with > 5% | 1.17 (1.13-1.22) | 1.47 (1.22-1.76) |

among racially marginalized cancer patients in the US. This might be related to the fact that those patients are more likely to have poor socioeconomic conditions, but this might also point to a poor social support system for this subgroup of cancer patients and this might highlight the need to provide further support to those patients. A recent SEER analysis has however suggested that African American patients with cancer might have a lower risk of suicide compared to white patients with cancer [16]. This is not completely in line with the results of the current analysis showing a slightly higher O/E for suicide risk among African American compared to white patients. Possible reasons for this difference might lie in the differences in used statistics between both studies (O/E ratios in the current study versus adjusted rate ratio in the other study) as well as differences in the time period of each of the two studies.

Although the current study is in line with prior SEER analyses suggesting a higher risk of suicide among males, unmarried, nonwhite cancer patients who have lung or pancreatic primaries and who have a distant stage of the disease [17,18], it is unique, however, in providing additional insight into the impact of socioeconomic county attributes on this risk and in evaluating the possible interaction between clinicopathological and socioeconomic factors. A previous SEER analysis evaluating the temporal trends in suicidal death among bladder cancer patients have utilized a SES score to adjust for the risk of suicide [19]. This study is generally different from the current study in terms of the scope (the current study includes all cancer sites) and aim (the current study is mainly focused on impact of different SES parameters on suicide risk). Although the current study is in line with a number of North American population-based studies assessing the risk of completed suicide in the general population (in that it suggests that elderly unmarried males with poor socioeconomic conditions are more likely to commit completed suicide) [20,21], it is, however, unique in focusing on the cancer patients' population. The current study is also different from a previous Korean study suggesting a correlation between suicide among cancer patients with vulnerable socioeconomic conditions (unemployment and poverty) because of larger sample size as well as the focus on North American patients [22].

Suicidal tendencies among cancer patients represent an expression of the numerous underlying stresses these patients unfortunately endure. These stem from possible guilt feeling (particularly for smoking-related malignancies), fear from the consequences of some cancer treatments (e.g. disfigurement with head and neck surgery, chemotherapy side effects…etc.), economic uncertainty associated with potential job losses following cancer diagnosis and concerns about the affordability of health care [23]. The current study suggests that these suicidal tendencies (and possibly the underlying stresses) are exaggerated by poor socioeconomic conditions.

The current study has a number of limitations that need to be considered; first, the socioeconomic part of this study is based on an area-based evaluation (i.e. county-based attributes) rather than personalized socioeconomic information. Ideally, we would like to have a correlation between individualized features and suicide risk; however, this is not feasible within large cancer databases like the SEER database. Second, relevant comorbidities which might have affected a patient's risk to have suicide (e.g. prior diagnosis with a psychiatric condition) are not described in the SEER database. This might also have affected the overall sensitivity of suicide risk analysis. Notably, a recent Canadian study have examined the impact of psychiatric conditions predating cancer diagnosis on the risk of suicide. In the first 50 months after cancer diagnosis, even after adjusting for psychiatric comorbidity, cancer patients were at a 60% increased risk of suicidal death compared to the general population [24]. Third, the current study is based on patients diagnosed and treated within the US. Generalizability of these results to other health care systems in the Western world should be done with caution because of the differences in healthcare coverage and subsequently differences in affordability challenges between the US and many other western countries. These limitations need to be weighed against the obvious strengths of the current analysis; most importantly the large sample size of the study as well as the well-established quality assurance program of both SEER database as well as of the census 2000 SF files.

The current study rings a bell with regards the negative impact of poor socioeconomic status not only on cancer-related outcomes but also on other non-cancer related outcomes among cancer patients. There is a need for a more coordinated effort to provide proper mental health support and psychosocial services to newly diagnosed cancer patients (particularly those with clinicopathological or socioeconomic factors that are high-risk for suicide). Health care providers dealing with cancer patients should be trained in early identification of patients at higher risk of suicide which might facilitate early referral to supportive services. Possible interventions that might be evaluated (within the context of prospective studies) to address the risk of suicide among higher risk patients might include routine administration of a distress screening tool such as that developed by the NCCN [25], more frequent interaction with social services, aggressive and proactive pain management approach, as well as early integration of palliative care services among those patients.

In conclusion, cancer patients living in a socioeconomically vulnerable environment (lower educational status, poverty, and unemployment) seem to have higher suicide risk compared to other cancer patients. Standardized procedures should be available in each cancer care facility in order to support early recognition and referral of those high-risk individuals.

## Funding

This study was not funded.

## Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: as this study is based on a publicly available database without identifying patient information, informed consent was not needed.

## Declaration of Competing Interest

None.

## Acknowledgment

This study is based on the SEER database linked to Census 2000 SF files.

## Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.canep.2019.101601.

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