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Patterns of age-specific socioeconomic inequalities in net survival for common cancers in Taiwan, a country with universal health coverage

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ABSTRACT

Introduction: In high-income countries, advances in early diagnosis and treatment have improved cancer survival. However, socioeconomic inequalities in survival have persisted or increased for some adult cancers.
Materials and methods: We assessed net survival for the 20 most common adult cancers in Taiwan. They were stratified into six age groups and three socioeconomic groups.
Results: Out of 120 cancer site and age group combinations, 49 showed improvements in 5-year net survival from 2000–2004 to 2005–2010. Only cervix uteri cancer in the 35–49-year age group showed a deterioration. During 2000–2010, 13 of the 20 cancer cases experienced socioeconomic inequalities for all age groups combined, and the deprivation gaps varied with cancer site and age at diagnosis. For the five most common cancers – liver, colon and rectum, lung, breast, and oral – there were socioeconomic inequalities, and 5-year net survival improved for most or all of the six age groups from 2000–2004 to 2005–2010.
Conclusion: Reducing socioeconomic inequality in survival may lead to improvements in survival overall. We should focus on the age groups with large deprivation gaps. Our results are useful for prioritizing cancer sites and age groups for in-depth socioeconomic disparity studies and for proposing interventions for health disparity reductions and net cancer survival improvements.

1. Introduction

Socioeconomic inequalities in cancer survival have been observed extensively for more than two decades through studies of many cancers in numerous populations using various methods of determining socioeconomic status (SES) and survival events [1–16]. Although the overwhelming majority of these studies were performed in Western countries, a few were conducted in Asia [17,18]. The goals of these studies were to determine whether there are differences in survival for different socioeconomic groups. Differences in population-based cancer survival between SES groups as well as between countries or regions are increasingly being used to drive improvements in health services [19,20]. Because population-based cancer survival is a key measure of the overall effectiveness of the health system in managing cancer, it is important to examine trends of socioeconomic inequalities in terms of net survival [12,16].

Several studies have suggested that socioeconomic inequalities have persisted and even increased for many common cancers in adults, despite efforts to reduce them. Cancer survival improved significantly for almost all cancers, but patients from lower SES groups may not have benefited as much from advances in early diagnosis and treatment [9,11,12]. Furthermore, a recent study showed that the magnitude and patterns of age-specific socioeconomic inequalities in survival were different for patients diagnosed with lung, breast, and colon cancers. It has therefore been suggested that efforts should be made to ensure the availability of optimal treatment and appropriate management for lung cancer patients in all age groups, and for older patients in deprived groups with breast or colon cancer [21]. Furthermore, it was shown that identifying the age at diagnosis when socioeconomic inequalities in cancer survival are apparent may provide useful information for targeting cancer site-specific interventions and tailoring guidelines for patients at high risk.

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Net cancer survival is the probability of surviving the cancer under study in the absence of other causes of death. Estimates of net survival for a cancer provide useful measures for comparing cancer survival between diagnostic periods, ethnic groups, and registries [22,23]. Net survivals are studied in two frameworks: the relative survival (RS) framework, which does not require knowledge of the cause of death, and the cause-specific survival (CSS) framework, which does. Although estimates in the CSS framework require reliable information regarding the cause of death, which may not be accurately derived from the death certificate [24], for estimates in the RS framework the expected all-cause survival of a comparable group of cancer-free individuals is often derived from life tables of a population, which may cause concern if SES is relevant. For example, in the United States, estimates in the RS framework are often computed using life tables of the general population; they are therefore overestimated for the high-SES group and underestimated for the low-SES group. This causes exaggeration of the SES gradient [25].

To deal with the estimation bias in the RS framework when SES is considered, Howlader and colleagues developed the Surveillance, Epidemiology, End Results program's cause-specific death classification variable (SEERDCV), which utilizes information from the death certificate, the sequence of tumor occurrence, the site of the original cancer diagnosis, and comorbidities to assign the cause of death. They showed that estimates in the CSS framework utilizing SEERDCV provide more accurate estimates of net survival across the SES gradient by addressing differing rates of mortality resulting from other causes of death [25].

In this study, we report the age-group-specific and SES-specific net survival for the 20 most common cancers in Taiwan. We hope our study – which is the first in Taiwan to examine the relationship between age, SES, and net survival – will be useful for prioritizing cancer sites in more thorough and in-depth socioeconomic inequality studies that will eventually contribute to global cancer surveillance. Because lowering cancer mortality has become a priority of the Taiwan government [26], our findings may have a timely impact. To improve the reliability of our results, we also assessed the agreement between estimates in the RS and CSS frameworks based on data for those in Taiwan, and compared the levels of agreement based on data from patients in Taiwan with those based on SEER data.

2. Materials and methods

2.1. Relative survival and cause-specific survival

In this work, estimates of net survival in the RS framework are referred to as RS estimates. The RS estimates we considered were Ederer II estimates and Pohar Perme estimates (PPE) [27–29]. Estimates of net survival in the CSS framework that we used were the actuarial estimates, which are referred to as CSS estimates [30].

Because of the lack of SES-specific life tables in Taiwan, RS estimates using life tables for the general population may cause concern in a study of socioeconomic inequalities in cancer survival. However, because Taiwan's National Health Insurance (NHI) program reduces financial barriers to health care, it is likely that SES-specific RS estimates may not be seriously biased. By using SEERDCV, we examined whether SES-specific RS and CSS estimates in Taiwan were in good agreement. Specifically, we compared RS and CSS estimates of net survival for the 20 most common cancer sites in Taiwan by age at diagnosis, SES, and periods of diagnosis. For each combination of cancer site and age group, we reported the differences between the net survival for high-, medium-, and low-SES groups in terms of CSS estimates.

2.2. Study population

This study used data from the Taiwan Cancer Registry (TCR) during the period 1992–2010, the data from the Taiwan Cause of Death Database (TCOD) during 1992–2011, and the data from the Taiwan National Health Insurance Research Database (NHIRD) during 2000–2012; these data have proved to be valuable resources for health science research [31–33]. The TCR was linked with the NHIRD and TCOD for the current study. For patients in the TCR, the TCOD provided survival information and the NHIRD provided SES information; we also used the NHIRD to confirm the survival information. This study was approved by the institutional review board of the National Health Research Institutes in Taiwan.

The TCR, launched in 1979, is a population-based cancer registry that collects information about newly diagnosed cancer patients at all hospitals with more than 50 beds in Taiwan. The quality of the TCR has been improving and was recently reviewed [32,34]. More detailed description of data linkage and cleaning for the data used in this study is given in the Supplementary material.

Cancer sites were included in this study if the number of patients aged between 50 and 64 years at diagnosis and the number of those aged 65 years or older were > 1000 during 1992–2004; these data were used for comparisons with data from patients in the United States [25]. In addition, these data were used to determine the 20 most common invasive cancer sites. This facilitated the evaluation of the performance of SEERDCV and the agreement of RS and CSS estimates in Taiwan.

Taiwan's National Health Insurance (NHI) program (implemented on March 1, 1995, by the Bureau of National Health Insurance, which is now the National Health Insurance Administration) provides compulsory universal health insurance and covers all healthcare services for more than 99% of Taiwan's population [35].

The TCOD includes cause-of-death information for individuals in Taiwan since 1971. It is maintained by the Department of Statistics of the Ministry of Health and Welfare in Taiwan; its quality has been previously described [31]. Based on the national identification card number, sex, birth date, death date, and cause of death, there are 3,249,784 unique death records for the period between January 1, 1985 and December 31, 2011. The TCOD adopted the national identification card number in 1985. The original TCOD contains 3,255,505 records for this period; < 0.2% of the data were excluded during the data cleaning process.

2.3. Socioeconomic status

The SES of each cancer patient was defined according to insurable monthly income in the NHI registry archives during the year or month of diagnosis, which is the manner in which the NHI administration calculates beneficiary premiums [36]. The Registry for Beneficiaries in the NHIRD provides this information for those who registered in 2000 and after. If the insurable monthly income was unavailable at the time of diagnosis, then the insurable monthly income of the previous year or following year was used.

According to the TCR, a total of 724,992 patients between 15 and 94 years of age were diagnosed with invasive cancers during 2000–2010; among them, 724,770 had survival information recorded in the TCOD and NHIRD. Among the patients having survival information, 723,810 had their SES assigned in this manner. The SES for 93% of these patients was based on the year or month of diagnosis.

All patients were classified into one of the following three categories: low-income (monthly income less than Taiwan's minimum wage level of 15,840 New Taiwan dollars [NTD]; n = 178,083); medium-income (monthly income between 15,840 and 57,779 NTD; n = 500,280); and high-income (monthly income at or above the highest rank of insurable income, 57,800 NTD; n = 45,447) [36]. The exchange rate at the time of this study was approximately 1 United States dollar = 32 NTD. Subjects categorized as poor were classified by the local municipal authority as living below the local lowest living index and receiving social welfare subsidies. The poor category was small and was included in the low-income category.

The number of patients included for the period 2000–2010 in this study by cancer site, age group, and SES are reported in Table 1. More