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Inequalities in childhood cancer mortality according to parental socioeconomic position: A birth cohort study in South Korea

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ABSTRACT

We sought to explore a possible association between higher parental socioeconomic position and lower child cancer mortality. We examined total cancer mortality as well as site-specific cancer mortality. We constructed a retrospective birth cohort by linking South Korean birth records to death records from 1995 to 2004. Parental socioeconomic position and birth characteristics were identified from the birth records. Parental education and occupation were examined as socioeconomic variables while sex, parental age, gestational age, birth weight, multiple birth, birth order, and the death of previous children were included as birth characteristics. Cancer deaths were identified from the death records. In total, 5711,337 births were analyzed, including 30,844,015 total person-years. The total number of deaths was 21,217, including 1102 children who died of cancer. Hazard ratios of cancer mortality according to parental socioeconomic position were calculated using a Cox proportional hazard analysis with adjustment for the birth characteristics. All socioeconomic measures except maternal occupation showed a significant inverse association with cancer mortality after adjusting for the birth characteristics. For paternal education, high school and middle school graduation or lower was associated with an increased hazard ratio of cancer mortality compared to university education or higher: 1.14 (1.00–1.29) and 1.29 (1.02–1.62), respectively. For maternal education, middle school graduation or lower was associated with a hazard ratio of 1.54 (1.21–1.95). For paternal occupation, manual work and economic inactivity were associated with increased hazard ratios as compared to non-manual work: 1.17 (1.02–1.34) and 1.34 (1.04–1.73), respectively. Inequalities were also found for leukemia and central nervous system tumors. The extent of the inequalities decreased after age 5, and only the 1-4-year-old group showed significant associations with parental socioeconomic position. We conclude that there is an inverse relationship between childhood cancer mortality and parental socioeconomic position in Korea.

Introduction

Cancer is a major cause of death among children in Korea and other developed countries (Jemal et al., 2007; Lyons & Brophy, 2005; Vital Statistics Division, 2005) even though the survival rate of childhood cancer has greatly improved during recent decades with the development of effective therapies (Steliarova-Foucher et al., 2004). Compared to patterns of overall mortality, socioeconomic inequalities in childhood cancer have been observed to be smaller in magnitude (Blakely, Atkinson, Kiro, Blaiklock, & D'Souza, 2003; Coleman, Babb, Sloggett, Quinn, & De Stavola, 2001; Schillinger et al., 1999; Shaw, Blakely, Crampton, & Atkinson, 2005; Singh & Kogan, 2007). In the US, Singh et al. reported that childhood cancer mortality did not vary noticeably according to area deprivation, although mortality rates declined more rapidly over time in less-deprived areas (Singh & Kogan, 2007). In England and Wales, Coleman et al. observed no survival differences according to deprivation for eleven common childhood cancers as opposed to most adult cancers (Coleman et al., 2001). Also, survival from lymphocytic leukemia was not affected by deprivation even though the burden of this disease varied by geographic region (Schillinger et al., 1999). It has been suggested that socioeconomic differentials in childhood cancer mortality have narrowed because of the availability of effective chemotherapies, although access to centralized pediatric oncology services might be limited by geographic region in England and Wales (Coleman et al.,

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2001; Schillinger et al., 1999). In New Zealand, mortality from childhood cancer has been shown to be lower among disadvantaged groups (Shaw et al., 2005).

However, too few studies have been conducted to establish that childhood cancer mortality inequalities are not a major problem. Moreover, most studies have focused on inequalities in the incidence of leukemia. These incidence studies showed an inverse relationship when socioeconomic position was measured using parental education or income. However, when parental occupational was included, this association has not been consistently observed (Poole, Greenland, Luetters, Kelsey, & Mezei, 2006). Furthermore, differences in incidence do not necessarily imply the same pattern for mortality. The costs for cancer therapy and non-medical expenditures can also pose an enormous economic burden to the parents (Bodkin, Pigott, & Mann, 1982; Dockerty, Skegg, & Williams, 2003; Lansky et al., 1979). In this regard, socioeconomic inequalities in childhood cancer mortality warrant an in-depth investigation.

In the present study, we investigated the presence and magnitude of inequalities in childhood cancer mortality according to parental socioeconomic position in South Korea based on a retrospective birth cohort. We used individually linked birth and death records between 1995 and 2004 for the entire country.

Methods

Study population

We constructed a retrospective birth cohort for South Korea between 1995 and 2004 and followed it up to the calendar year 2004. First, we obtained 6040,957 records from the Korea National Statistics Office from the birth and death registration records between 1995 and 2004. Second, we linked the death records to the birth records individually via personal identification numbers while excluding those records deemed to be invalid, such as those partially or completely missing personal identification numbers. This procedure generated the 5711,337 records of children as our study population (95% of the birth records included via linkage to death), and then this population was followed up to 2004. All of the registered deaths were successfully linked to this prepared set of birth records. We observed a total of 30,844,015 person-years, during which 21,217 children died, including 1102 from cancer.

Variables

Parental socioeconomic positions (educational attainments and occupation) and birth characteristics were collected from birth registry records based on birth certificates, which are completed by physicians. Parental occupation is included in the birth certificates, while information on parental educational attainment was recorded by local governmental officers during the birth registration procedure. Education was grouped into middle school graduation or lower ($\leq$9 years), high school graduation (10–12 years), and university education or higher ($\geq$13 years). Occupation was grouped into non-manual (e.g., legislators, senior officials and managers, professionals, office workers, service workers, and sale workers), manual (e.g., skilled agricultural, forestry and fishery workers, craft and affiliated craft workers, device and machine operators and assemblers, and laborers), and economically inactive populations (e.g., students, the unemployed, homemakers, and soldiers). Although the economically inactive group contained a heterogeneous population, further categorization was impossible considering the small number of cancer deaths in children. A small portion of the subjects had missing variables for parental socioeconomic position (0.17–0.61%) and were excluded from the analysis, but these are not likely to have made a significant impact on the main results of this study. If subjects with lower socioeconomic positions were overrepresented among those with missing variables, our results might have underestimated the actual extent of the inequalities. As for birth characteristics, sex, parental age, gestational age, birth weight, multiple births, birth order, and the death of previous children were included. Parental age was classified into three groups: $<$25, 25–34, and 35–64 years old. Gestational age was classified into three groups: less than 37 completed weeks (premature), 37–42 weeks, and 42 completed weeks or more (postmature). Birth weight was classified into three groups: $<$2500 g (low birth weight), 2500–4000 g, and $>$4000 g (high birth weight). Multiple births were classified into two groups: 1 and $\geq$2. Birth order was classified into three groups: 1, 2, and $\geq$3. History of death of previous children was dichotomized: yes/no. Ethnicity was not available from our dataset, but Koreans are generally considered ethnically homogenous.

Deaths due to cancers were identified using the ICD 10 codes of C00-C97 on the death registration records based on death certificates completed by physicians. Leukemia was C91-C95, central nervous system tumor was C70-C71, adrenal tumor was C74, non-Hodgkin's lymphoma was C82-C85, and bone and other connective and soft tissue tumor were C40, C41 and C49, respectively.

Statistical methods

The crude death rate was calculated as the number of deaths per 100,000 children. The incidence density of mortality was calculated as the number of deaths per 100,000 person-years, and person-years were calculated by adding up the individual survivals for each year. Because cancer deaths can be considered as rare events, we calculated standard errors under the assumption of a Poisson distribution as the square root of the number of deaths divided by person-years (Rosner, 2006). A 95% confidence interval was calculated as the incidence density $\pm$ 1.96 times standard error multiplied by 100,000 person-years.

Hazard ratios (HR) according to parental socioeconomic positions and birth characteristics were estimated using Cox proportional hazard models. Unadjusted HRs according to each socioeconomic variable were first obtained. Adjusted HRs were then calculated by sequentially adding other variables. In model 1, each parental socioeconomic variable was adjusted for sex and parental age. In model 2, gestational age, birth weight, multiple birth, birth order, and death of previous children were added to model 1. The contributions of leukemia and CNS tumors to the overall inequality in cancer mortality were calculated by the level of inequality from leukemia or CNS tumors divided by the overall cancer inequality. The level of inequality was obtained from the difference in the Cox estimated survival between university or higher and middle school or lower categories of maternal education. Maternal education was selected because this showed the strongest association. To further analyze the combined effects of education and occupation, an interaction analysis of paternal education and paternal occupation was performed, which was insignificant based on the difference in log likelihood ($p > 0.10$) for all cancers (leukemia and central nervous system tumors). Nevertheless, HRs according to paternal education at each level of paternal occupation were calculated. Changes in HRs by age were examined using three age intervals after birth: $<$1, 1–4, and 5–9 years old. A Cox proportional hazard analysis was performed only among singleton births because no cancer death occurred among multiple births in the 5–9-year-old group. HRs were calculated in each age group according to each socioeconomic variable with adjustment for all birth characteristics except multiple births. Cumulative mortality curves were examined for all cancers according to maternal education. Maternal education was chosen because the HR according to maternal education was the largest. All of the results were presented with a 95% confidence interval. R 2.6.1