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ORIGINAL ARTICLE

Educational differentials in cancer mortality and avoidable deaths in Lithuania, 2001–2009: a census-linked study

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Abstract
Objectives We investigate relative mortality inequalities by education for detailed cancer sites and provide estimates of deaths which could have been avoided through the elimination of these inequalities.
Methods A census-linked dataset based on a follow-up of all residents registered in the 2001 census was used for the analysis. Mortality rate ratios were estimated by employing multivariate Poisson regression models for count data.
Results An inverse educational gradient was observed for 11 cancer sites among men and for three cancer sites among women. Substantial shares of these cancer deaths would have been avoided if mortality among less educated groups had been the same as mortality among highly educated groups.
Conclusions Cancer control plans must consider socioeconomic inequalities and propose ways to improve prevention measures aimed at disadvantaged groups.

Keywords Cancer · Mortality · Education · Avoidable deaths · Eastern Europe · Lithuania

Introduction

The knowledge of socioeconomic gradients in mortality by detailed cancer sites is far from complete, even for developed countries. One of the first comparative international studies that provided comprehensive evidence of socioeconomic differences in site-specific cancer mortality was conducted by the International Agency for Research on Cancer (IARC) in 1997. The study concluded that with a few exceptions (e.g. breast and prostate cancers) cancers show inverse socioeconomic gradients among men with the highest mortality levels being observed in lower socioeconomic classes (Faggiano et al. 1997). More recent international studies have confirmed that among less educated population groups mortality is systematically higher for lung, upper aero-digestive tract, liver, and stomach cancers among men and for cervical and stomach cancers among women (Menvielle et al. 2008; Ezendam et al. 2008; Stirbu et al. 2010). The patterns and the magnitude of educational differences in site-specific cancer mortality vary across different regions and countries of Europe (Menvielle et al. 2008; Ezendam et al. 2008). At the same time, studies which have examined the relationship between education and less common specific cancers, such as leukaemia and Hodgkin's lymphoma, have generated either inconsistent findings or have found no evidence of a statistically significant link (Faggiano et al. 1995, 1997; Menvielle et al. 2008). Several international studies using data from the 1990s and the early 2000s have found educational inequalities in mortality from certain cancers, such as upper aero-digestive tract, lung, and other smoking-

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related cancers among men, cervical cancer among women, and avoidable cancers among both men and women in a number of Central and Eastern European countries, including Lithuania (Ezendam et al. 2008; Van der Heyden et al. 2009; Kulik et al. 2014). Continuous monitoring of socioeconomic inequalities in cancer mortality is important because the size and even the direction of inequality for some specific cancers have been changing over time. One of the most illustrative examples concerns the disappearance or even the reversal of the positive breast cancer mortality gradient among women (Menvielle et al. 2006; Leinsalu et al. 2009). A few studies have reported substantial increases in educational mortality differentials for all cancer sites and for some broad groups of cancers (e.g. buccal cavity, pharynx, and oesophagus cancer for men and cervical cancer for women) in Lithuania during the 1990s (Kalediene and Petrauskiene 2005; Leinsalu et al. 2009). This evidence may point to growing contributions of certain cancers to the enormous mortality disparities in the country.

However, even the scarce evidence about the magnitude of and changes in educational disparities in mortality from broad groups of cancers in Central and Eastern European countries should be treated with caution. Most of the international studies that included countries from this region were mainly based on census-unlinked cross-sectional data (Menvielle et al. 2008; Ezendam et al. 2008). These data are usually produced by tabulating records of site-specific deaths by age and socioeconomic categories and by producing exactly the same tabulations of (usually) census data. These findings should be interpreted with caution as they may contain substantial distortions in group-specific mortality estimates due to numerator–denominator bias (Valkonen 1993; Kunst et al. 1998; Shkolnikov et al. 2007; Jasilionis et al. 2009, 2012). This bias originates from a discrepancy between the sources of the numerator (death records) and the denominator (census records). The discrepancy occurs because the information provided by the individual himself/herself in the census may differ substantially from the corresponding information provided after his/her death by a proxy informant (e.g. a relative). Determining the exact socioeconomic or sociodemographic status of the deceased can be difficult for a number of reasons, including the fact that relatives are required to answer less detailed questions when completing death certificates than those formulated in a census questionnaire. Moreover, the information provided by relatives of the deceased may also be affected by psychological factors, such as an impulse to "sanctify the memory" or to "promote the dead" (Gordis 1982; Kunst et al. 1998). Studies, which have compared cross-sectional census-unlinked and census-linked mortality estimates (including cancer mortality) in Lithuania, have showed that educational mortality differences are grossly overestimated due to reporting biases in information on education in death records (Shkolnikov et al. 2007; Jasilionis et al. 2009). Research has also shown that group-specific estimates based on such data may fail to report correctly even the direction of inequality (Jasilionis et al. 2012).

The previous study by Smailyte et al. (2012) has produced the first reliable estimates of mortality differences by education in Lithuania using census-linked data. This pilot study covers 3.5 years after the 2001 census and reports findings for only a few major cancer sites. In the present study, which is based on the census-linked dataset covering all cancer deaths during 2001–2009, we report mortality rate ratios by education for a set of detailed cancer sites and provide estimates of avoidable deaths which theoretically could have been avoided or postponed through the elimination of inequalities.

Data and methods

The data used for this study cover all permanent residents of the territory of Lithuania who were aged 30–74 at the official census date of 6 April 2001. Each person was followed from the census date of 6 April 2001 until the date of his or her death or emigration, or until the end of the follow-up period on 31 December 2009. The population exposures required for the calculation of mortality rate ratios were estimated by adding up the number of years survived by each individual.

Linkages between the 2001 census, death, and emigration records were implemented by employees of Statistics Lithuania, who have permission to work with individual-level data. The data for this study were provided in an aggregated multidimensional frequency table format combining deaths and person-years of exposure to risk. The data were then split by sociodemographic and epidemiological variables.

The most frequent cancer sites in Lithuania were selected taking into account the lists of cancer sites used in international studies. The remaining cancer sites are much less frequent and show very small numbers.

Education was used as a single measure of socioeconomic status because of several general methodological limitations related to other socioeconomic variables. This decision was also related to the shortcomings of the information on economic activity status and occupation provided in the census. Information about education was taken from the census records. The educational level of each individual was assigned to one of three broad categories of the highest level of education attained (confirmed by relevant diploma): higher education (at least 14 years of education), secondary education (10–13 years of

education), and lower than secondary education (up to 9 years of education). The percentage of records with missing values on education was fairly small. Following the practice of prior studies, this category was merged to the lowest education category (Shkolnikov et al. 2007).

Mortality rate ratios for each level of education were estimated by means of multivariate Poisson regression models for count data. These models allowed us to run regressions on aggregated data containing numbers of events and person-years (exposures). Following experiences of previous international studies and taking into account specifics of some cancers (prostate and breast cancers), sex-specific models were estimated, with site-specific mortality used as the dependent variable. All models are adjusted only for age, because the inclusion of other potentially important confounding factors would have led to internationally incomparable results. Such confounding effects are an important research issue for future studies.

Our modelling strategy allowed us to calculate relative mortality rate ratios by education using higher education as the reference category. Population-attributable fractions (PAFs) were estimated to estimate the proportions of cancer deaths which hypothetically could have been avoided or postponed if cancer mortality differences by educational level were eliminated assuming that all educational groups have the same mortality rates as those in the highest education group. These PAFs were calculated following a general formula (Anand et al. 2001) which is often applied in studies of health inequalities:

$$\mathrm{PAF} = \frac{\sum_i p_i(MRR_i - 1)}{\sum_i p_i MRR_i}$$

where p_i stands for a share of educational group (i) and MRR_i is the mortality rate ratio for educational group i. A simple method described by Natarajan, Lipsitz, and Rimm (2007) was used for estimating confidence intervals of PAFs.

Results

Sex and education-specific counts of deaths for 20 cancer sites for men and 22 cancer sites for women as well as corresponding counts of person-years of exposure and the total study population observed at the 2001 census baseline are presented in Online Resource 1. Table 1 shows mortality rate ratios for all cancer sites combined and for specific cancer sites. For all cancer sites combined, an inverse educational mortality gradient was observed. Individuals with secondary or lower than secondary education were found to have a significantly higher risk of death than individuals with higher education. These differences were more pronounced among men than among women. The MRRs for the secondary education category ranged from 1.11 times for women to 1.55 times for men, whereas the MRRs for the lower than secondary education category varied from 1.08 times for men to 1.84 times for women.

Among men, a statistically significant inverse educational gradient in cancer mortality was observed for 11 cancer sites (Table 1). Men in the lowest educational category had mortality rates that were at least three times higher than corresponding rates in the higher educational category for cancers of the oral cavity, oesophagus, larynx, and lung. A slightly less notable disadvantage of the lowest educated men was observed for stomach, colorectal, liver, pancreas, prostate, kidney, and bladder cancers. By contrast, a positive relationship was found between mortality and education for skin melanoma and multiple myeloma as highly educated men had the highest mortality levels from these cancers. For the remaining cancers under investigation, no statistically significant mortality differences were observed.

Among women, only three cancer sites were found to have a statistically significant inverse educational mortality gradient. The most striking differences were observed for cervical cancer: the MRRs ranged from 2.43 among women in the secondary education group to 3.37 times among women in the lower than secondary education group. Less educated women had a smaller but statistically still significant disadvantage in mortality from lung and stomach cancers (Table 1). A statistically significant positive mortality gradient was found for four cancer sites: breast cancer, brain cancer, and Hodgkin's and non-Hodgkin's lymphomas. For the remaining cancers, no statistically significant mortality differences were observed.

If men and women with secondary or lower levels of education had experienced the same levels of all-site cancer mortality as their highly educated counterparts, 35 % (around 11,000 cases) of cancer deaths among men and 8 % (around 1700 cases) of cancer deaths among women theoretically would have been avoided or postponed. The public health burden of educational differentials was found to be highly variable across different cancer sites (Table 2). The highest hypothetical share of avoidable deaths was estimated for cancers of the larynx, oral cavity, and oesophagus among men and for cervical cancer among women. Among men, notable effects were also observed for lung, stomach, bladder, and liver cancers.

Discussion

This study provides, for the first time, detailed population-level estimates of site-specific cancer mortality differences

Table 1 Poisson regression mortality rate ratios (MRR), their 95 % confidence intervals (CI), and population-attributable fractions (PAFs) for secondary and lower than secondary educational categories

Cancer site	ICD-10 code	Men		Women	
		Secondary MRR (95 % CI)	Lower than secondary MRR (95 % CI)	Secondary MRR (95 % CI)	Lower than secondary MRR (95 % CI)
All malignant neoplasm's	C00–C96	1.55 (1.49–1.62)	1.84 (1.77–1.92)	1.11 (1.06–1.16)	1.08 (1.03–1.13)
Lip, mouth and pharynx	C00–C14	3.04 (2.43–3.79)	4.41 (3.53–5.52)	1.29 (0.82–2.02)	1.43 (0.89–2.28)
Oesophagus	C15	2.64 (2.03–3.43)	3.86 (2.97–5.02)	0.92 (0.48–1.78)	1.24 (0.66–2.30)
Stomach	C16	1.55 (1.36–1.76)	1.85 (1.64–2.10)	1.17 (1.00–1.36)	1.26 (1.08–1.48)
Colorectal	C18–C21	1.27 (1.13–1.43)	1.13 (1.01–1.27)	1.09 (0.96–1.24)	1.03 (0.90–1.17)
Liver	C22	1.56 (1.19–2.04)	1.51 (1.16–1.96)	1.04 (0.74–1.45)	1.00 (0.72–1.39)
Gallbladder	C23, C24	0.91 (0.55–1.48)	1.17 (0.74–1.86)	1.07 (0.76–1.51)	1.00 (0.71–1.41)
Pancreas	C25	1.30 (1.11–1.52)	1.26 (1.07–1.47)	1.00 (0.83–1.19)	0.84 (0.70–1.00)
Larynx	C32	4.28 (2.96–6.18)	7.49 (5.20–10.77)	1.03 (0.22–4.80)	1.88 (0.41–8.65)
Lung	C33, C34	2.15 (1.96–2.35)	3.15 (2.89–3.43)	1.33 (1.11–1.60)	1.30 (1.08–1.58)
Skin melanoma	C43	0.63 (0.48–0.83)	0.39 (0.28–0.53)	0.90 (0.67–1.22)	0.74 (0.53–1.04)
Skin	C44	1.43 (0.61–3.32)	1.53 (0.69–3.43)	0.59 (0.21–1.68)	0.93 (0.33–2.59)
Breast	C50	–	–	0.97 (0.89–1.06)	0.87 (0.79–0.96)
Cervix uteri	C53	–	–	2.43 (2.01–2.95)	3.37 (2.73–4.16)
Corpus uteri	C54	–	–	1.01 (0.81–1.26)	1.13 (0.90–1.41)
Ovary	C56	–	–	1.03 (0.90–1.19)	1.02 (0.88–1.18)
Prostate	C61	1.20 (1.05–1.36)	1.30 (1.15–1.46)	–	–
Testis	C62	0.46 (0.17–1.19)	0.68 (0.25–1.80)	–	–
Kidney	C64	1.28 (1.07–1.53)	1.27 (1.07–1.52)	1.13 (0.87–1.46)	1.14 (0.89–1.48)
Bladder	C67	1.62 (1.29–2.04)	1.68 (1.35–2.09)	1.03 (0.61–1.72)	1.41 (0.86–2.30)
Brain and nervous system	C70–C72	1.01 (0.83–1.23)	0.84 (0.68–1.03)	0.87 (0.72–1.04)	0.73 (0.60–0.90)
Thyroid	C73	0.87 (0.41–1.81)	1.10 (0.52–2.32	1.18 (0.62–2.25)	1.27 (0.67–2.39)
Hodgkin's lymphoma	C81	0.98 (0.46–2.08)	1.24 (0.55–2.76)	0.56 (0.27–1.17)	0.36 (0.16–0.84)
Non-Hodgkin's lymphoma	C82–C85	1.10 (0.82–1.47)	1.03 (0.77–1.37)	0.85 (0.63–1.14)	0.69 (0.51–0.92)
Multiple myeloma	C90	0.98 (0.71–1.35)	0.71 (0.51–0.97)	0.87 (0.65–1.17)	0.77 (0.57–1.03)
Leukaemia	C91–C95	1.02 (0.83–1.25)	1.02 (0.83–1.24)	1.03 (0.83–1.28)	0.94 (0.76–1.17)

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by socioeconomic status in Lithuania. An important added value of the study is that it uses a dataset, which is unique in the region and which is based on the linkage between death and census records. This approach allowed us to avoid the numerator–denominator bias, often observed in census-unlinked cross-sectional studies and to provide reliable, internationally comparable, and comprehensive data on mortality differentials for an Eastern European country. Following international recommendations, the study also provides quantification of avoidable losses due to observed disparities (Mackenbach et al. 2011).

We have chosen education as the measure of socioeconomic status because it is an internationally comparable and most frequently used socioeconomic dimension. In the absence of detailed data on employment and educational life histories, education has important advantages against other socioeconomic variables such as economic activity status or occupation. Education is usually obtained in early stages of life and remains fixed later in life, whereas occupation or economic activity status has a high probability to change at working ages. Therefore, using the information on occupation or economic activity status fixed at the census baseline may lead to biases in group-specific mortality rates. There are also other methodological issues related to the identification of occupation or economic activity status for some population groups such as older retired people or housewives (Valkonen 1993). Moreover, the Lithuanian censuses report occupation only for the economically active employed population. It has been shown that restricting analyses to the economically active population may lead to biased conclusions about the magnitude of socioeconomic differentials (Kunst et al. 2004b).

Another potentially important methodological issue is related to the success of the linkage between death and census records. The percentage of death records which

Table 2 All cancer and site-specific population-attributable fractions (PAFs) and corresponding numbers of avoidable deaths

Cancer site	ICD-10 code	Men			Women		
		PAF (95 % CI)	Deaths	Avoidable deaths	PAF (95 % CI)	Deaths	Avoidable deaths
All malignant neoplasm's	C00–C96	**0.35** (0.33 to 0.38)	31,545	11,181	**0.08** (0.04 to 0.11)	22,383	1698
Lip, mouth and pharynx	C00–C14	**0.68** (0.60 to 0.74)	1642	1116	0.22 (−0.15 to 0.48)	212	–
Oesophagus	C15	**0.64** (0.53 to 0.72)	1103	701	0.03 (−0.60 to 0.45)	137	–
Stomach	C16	**0.36** (0.28 to 0.43)	3199	1138	**0.14** (0.02 to 0.25)	1868	270
Colorectal	C18–C21	**0.16** (0.07 to 0.24)	3056	481	0.05 (−0.05 to 0.15)	2677	–
Liver	C22	**0.31** (0.13 to 0.46)	634	199	0.02 (−0.29 to 0.26)	392	–
Gallbladder	C23, C24	0.00 (−0.48 to 0.34)	164	–	0.04 (−0.27 to 0.28)	366	–
Pancreas	C25	**0.19** (0.08 to 0.30)	1636	318	−0.05 (−0.22 to 0.09)	1219	–
Larynx	C32	**0.79** (0.70 to 0.85)	953	751	0.22 (−1.43 to 0.81)	45	–
Lung	C33, C34	**0.56** (0.52 to 0.59)	8984	5015	**0.21** (0.08 to 0.33)	1374	288
Skin melanoma	C43	−0.62 (−0.99 to −0.30)	305	–	−0.15 (−0.46 to 0.11)	329	–
Skin	C44	0.28 (−0.44 to 0.67)	88	–	−0.31 (−1.63 to 0.46)	65	–
Breast	C50	–	–	–	−0.06 (−0.14 to 0.02)	3959	–
Cervix uteri	C53	–	–	–	**0.60** (0.51 to 0.67)	1575	939
Corpus uteri	C54	–	–	–	0.04 (−0.15 to 0.21)	839	–
Ovary	C56	–	–	–	0.02 (−0.10 to 0.13)	1853	–
Prostate	C61	**0.17** (0.07 to 0.25)	2804	464	–	–	–
Testis	C62	−0.64 (−2.10 to 0.25)	49	–	–	–	–
Kidney	C64	**0.19** (0.06 to 0.31)	1278	242	0.10 (−0.11 to 0.28)	695	–
Bladder	C67	**0.35** (0.21 to 0.47)	1006	353	0.12 (−0.33 to 0.44)	242	–
Brain and nervous system	C70–C72	−0.04 (−0.23 to 0.12)	816	–	−0.18 (−0.37 to −0.01)	869	–
Thyroid	C73	−0.04 (−0.87 to 0.45)	68	–	0.15 (−0.43 to 0.52)	123	–
Hodgkin's lymphoma	C81	0.06 (−0.75 to 0.53)	74	–	−0.75 (−1.78 to 0.04)	71	–
Non-Hodgkin's lymphoma	C82–C85	0.06 (−0.20 to 0.27)	436	–	−0.21 (−0.52 to 0.05)	416	–
Multiple myeloma	C90	−0.11 (−0.44 to 0.16)	309	–	−0.16 (−0.46 to 0.09)	419	–
Leukaemia	C91–C95	0.02 (−0.17 to 0.17)	862	–	0.00 (−0.19 to 0.17)	850	–

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Number of avoidable deaths are shown only if (1) PAF is statistically significant (95 % confidence interval does not include zero, marked in bold); (2) MRRs show inverse educational gradient

were successfully linked to the 2001 census was high (96.3 %). Systematic checks suggest that excluding the remaining 3.7 % of death records from our analyses did not have a significant influence on aggregated mortality rates and rate ratios. Another potential limitation of the study is the use of a small number of educational categories. Our prior research, however, has shown that the restriction of the analysis to a small number of well-defined education groups (with the highest level of education attained confirmed by a diploma) serves as the best way to avoid potential biases due to misreporting of education in the census (Shkolnikov et al. 2007; Smailyte et al. 2012). In the light of the outcomes of prior sensitivity analyses, we chose to move relatively small shares (3 % of males and 5 % of females) of the study population with unknown education to the lowest education category (Shkolnikov et al. 2007). This was done primarily because for about 80 % of death records with unknown education derived from the census, the information provided in the death records indicated that they should be assigned to the lowest educational category (Shkolnikov et al. 2007; Smailyte et al. 2012). This approach has been used in other studies on educational mortality differentials as well, including several well-known Finnish studies (Valkonen et al. 1993).

While we found marked differences in cancer mortality among men, small or statistically not significant differences were detected for most cancer sites among women. Inequalities in cancer mortality by educational level were particularly large for cancers of the oral cavity, oesophagus, larynx, and lung among men and for cancer of the cervix uteri among women. A hypothetical scenario in which men and women in the lowest education group had the same mortality as their counterparts in the highest education group suggested the greatest potential for the

reduction of overall numbers of deaths due to cancer in Lithuania.

Educational inequalities in mortality reflect combined effects of inequalities in cancer incidence and inequalities in cancer patient survival (Aarts et al. 2013). However, the exact contributions of these two components of mortality disparities may vary substantially depending on the cancer site. It has been suggested that cancer incidence inequalities are closely related to differences in behavioural characteristics—such as smoking, alcohol consumption, and physical activity—and that adjusting for such factors could fully explain the entire educational gradient in cancer incidence (Braaten et al. 2005; Dalton et al. 2008). Much less consistent are the findings on the corresponding inequalities in cancer survival, which are often attributed to the unequal distribution of comorbidities (prevalence of lifestyle-related chronic diseases) (Louwman et al. 2010). Some studies have stressed the importance of other factors, such as inequalities in access to medical treatment (Forrest et al. 2013; Aarts et al. 2013; Treloar et al. 2014). Inequalities in childhood conditions in interaction with current education and socioeconomic status may also contribute to differentials in cancer risk in adult ages (Kelly-Irving et al. 2013).

A large body of literature has attributed educational gradients in cancer mortality to differences in access to health care, timely diagnosis, and screening programs (Hansen et al. 2008; Pokhrel et al. 2010). Some studies have suggested that in Western countries the access to medical care plays only a small role in differences in cancer mortality levels (Menvielle et al. 2008). A previous study on Lithuania has found a reversed educational gradient in the incidence of prostate cancer and has attributed this finding to a PSA testing program (started in 2006) in which a large share of highly educated males participated (Smailyte et al. 2015). People with higher education may have other advantages as well. For example, relative to their less educated counterparts, highly educated people may have higher levels of general and medical knowledge, a greater awareness of health issues, and better skills in approaching and using the health care system (Pokhrel et al. 2010).

Our study found that higher education may be associated with increased mortality risk for some cancers, such as breast cancer. Compared to less educated women, highly educated women in Lithuania displayed a higher prevalence of known risk factors for breast cancer, including having a smaller number of children and having children later in life (Stankuniene 2006). Because breast cancer screening did not start until 2006, this finding indicates that disparities in incidence components (e.g. reproduction factors) may still be much more important than disparities in survival-related factors such as medical treatment and prevention (Menvielle et al. 2006). Similar patterns of breast cancer mortality by educational level have been observed in most developed countries; although no statistically significant differences were found in France, Switzerland, and Turin city (Italy) (Menvielle et al. 2005, 2008). Since the disadvantage of highly educated females identified in our study is fairly small, we may expect that these differences and relationships will start soon gradually changing in Lithuania.

The significant inverse educational gradient in mortality from cancers of the oral cavity, oesophagus, larynx, and lung among men appears to reflect differences between men in past smoking behaviours (Shibuya et al. 2005). Findings based on data from the Finbalt Health Monitor health surveys indicate that Lithuanian lower educated adult men had higher daily smoking rates already in the early 1990s (Grabauskas et al. 2011). The results of our analysis are in line with the international evidence showing notable excess mortality among lower educated males in almost all developed countries and very high mortality disparities attributable to smoking-related causes of death in Central and Eastern Europe (Ezendam et al. 2008; van der Heyden et al. 2009; Kulik et al. 2014).

One of the most striking findings of this study is that lower educated women have extremely high mortality due to cancers of the cervix uteri. The magnitude of this differential is much larger in Lithuania than in most of the other countries, including most countries of Central and Eastern Europe (Ezendam et al. 2008; Leinsalu et al. 2009). Lithuanian women have some of the highest cervical cancer mortality rates in the WHO European Region (World Health Organization Regional Office for Europe 2014). Lower educated Lithuanian women in particular have high rates of sexually transmitted diseases and insufficient access to cancer screening and treatment (Parikh et al. 2003). The first nationwide screening program for cervical pathology in Lithuania did not begin until 2004, and until recently it had opportunistic features (Maver et al. 2013). Finally, our findings confirmed that, in line with the international evidence, there are statistically significant inverse educational differentials in Lithuania in mortality due to stomach cancer (both sexes), pancreas cancer (men), and kidney and bladder cancers (men) (Menvielle et al. 2008; Ezendam et al. 2008). Our findings for other specific and less common cancers—such as leukaemia, Hodgkin's disease, pancreatic cancer, kidney cancer, and bladder cancer—are mostly consistent with findings of previous studies showing that there is no association between education and mortality from these cancers (Menvielle et al. 2008). The exception is a very strong positive gradient for Hodgkin's and Non-Hodgkin's lymphomas among women.

This study suggests directions for health policies in the area of cancer prevention and highlights the potential for

saving lives through the elimination of disparities in mortality from certain types of cancer between educational groups. Cancer control plans in Lithuania should consider both the inverse and the reverse socioeconomic gradients and should propose ways to improve cancer prevention measures and timely access to the medical treatment for the disadvantaged population groups.

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Compliance with ethical standards

Conflict of interest None.

Ethical standard The authors declare that they have no conflict of interest.

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