Chapter 6. Social inequalities in cancer within countries

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Summary of key points

- Stark and consistent inequalities in cancer exist between groups and individuals living within the same country. Socioeconomic inequalities in cancer incidence, survival, and mortality have been reported from all high-income countries as well as low- and middle-income countries in which information on education level, occupational class, income, or other indicators of socioeconomic status (SES) is available and has been investigated in relation to cancer.
- Disadvantaged individuals and groups tend to have a different spectrum of cancers compared with people with higher SES, notably an excess of tobacco-related and infection-related cancers.
- Despite the substantial variability in the magnitude and direction of the association between SES and the outcomes of specific cancer types, for the large majority of cancer types groups with lower SES systematically have substantially higher mortality rates and lower survival rates than their more affluent fellow citizens.
- These remarkable inequalities are the result of major trends over time. Evidence from high-income countries has shown that cancer mortality rates among individuals with high SES have almost universally declined; over the past decades, however, trends have generally been more favourable among groups with high SES than among those with low SES, for which cancer mortality rates have often remained stable or even increased.
- The variability of inequalities in cancer incidence and mortality, both between countries and over time, is a major public health challenge. This variability clearly suggests that these inequalities are not based on immutable laws of nature but are potentially modifiable.

Introduction

As well as the large variations in cancer incidence, survival, and mortality that are observed between countries (see Chapter 5), stark and consistent inequalities in cancer also exist between groups and individuals living within the same country. Socioeconomic inequalities in cancer incidence, survival, and mortality have been reported from all high-income countries (HICs) in which information on education level, occupational class, income, or other indicators of socioeconomic status (SES) is available and has been investigated in relation to cancer, as recorded in cancer or cause-of-death registries. These associations are subject to substantial variability, not only across the different cancer types but also between countries and over time.

In this chapter, these issues are illustrated by reviewing and analysing a unique collection of data on inequalities in cancer mortality rates by education level in 17 European countries over the period 1980–2015. In addition, a summary overview was undertaken of the literature currently available on socioeconomic inequalities in cancer in HICs and low- and middle-income countries (LMICs).

Cancer mortality data in European populations

Cancer mortality data by education level in 17 European countries were collected and harmonized within the framework of two European collaborative studies: Developing Methodologies to Reduce Inequalities in the Determinants of Health (DEMETRIQ; Gregoraci et al., 2017) and Lifepath (Stringhini et al., 2017; Vineis et al., 2017). A key feature of these data is that information on cancer mortality by education level is available for the entire population in most of the study countries. Social inequalities in cancer mortality and the corresponding 95% confidence intervals (CIs) were quantified by calculating the ratio of the age-standardized rates for individuals with a low education level (LEL) to those for individuals with a high education level (HEL) in each country. Country-specific and pooled estimates were estimated for 18 cancer types (see Box 6.1).

Box 6.1. On the mortality data (DEMETRIQ/Lifepath)

Data were mostly derived from census-based mortality follow-up studies, but data from a few countries were derived from cross-sectional unlinked studies. Although data covered complete national populations for most of the studied countries, for England and Wales and France a 1% sample was used. For Italy and Spain, national data were available for the most recent time periods only; time trends for these countries were based on data from the regions of Turin and Barcelona, respectively. In addition to inequalities in mortality from all cancers combined, inequalities in mortality from 18 specific cancer types are shown (Fig. 6.2). Causes of death were coded according to the 10th revision of the International Statistical Classification of Diseases and Related Health Problems and previous editions for data from previous time periods. Mortality inequalities are shown by education level, with low education level (LEL) being defined as International Standard Classification of Education levels 1–2 (primary and lower secondary education) and high education level (HEL) being defined as levels 5–6 (tertiary education). Mortality rates per 100 000 person-years, age-standardized by the European Standard Population (Doll, 1976), were computed for each education level in each country. Inequalities were quantified by calculating the ratio of the age-standardized rates for LEL groups to that for HEL groups in each country. The corresponding rate ratios for middle versus high education level were computed but are not included or discussed in this chapter. To summarize inequalities in cancer mortality between countries, a random effects meta-analysis was conducted and pooled estimates of the rate ratios were computed. In a graphical representation of the results for overall cancer (Fig. 6.1), rate ratios for each country are plotted as grey squares of size inversely proportional to the variance of the logarithm of the rate ratio. Diamonds represent summary rate ratios for the pooled data. Heterogeneity of the rate ratios between countries was also assessed. Time trends of overall cancer mortality by education level were computed and plotted for the available time points in each country. Finally, the estimated annual percentage change was computed for all-cancer mortality (Fig. 6.1) and for selected cancer types (Fig. 6.2) for each education level.

Evidence of social inequalities for all cancers combined

Among men, mortality from all cancers combined was higher among LEL groups than among HEL groups in all study countries, with a pooled rate ratio of 1.75 (95% CI, 1.61–1.89). However, there was some variability between countries; relative inequalities in mortality were consistently larger in central and eastern Europe than in other European countries. Rate ratios ranged from a little below 1.4 in Spain and Sweden to almost 2.2 in Hungary and Estonia (Fig. 6.1). Relative inequalities were almost always smaller among women than among men (with the exception of Sweden, where inequalities were slightly higher among women); the pooled rate ratio for cancer mortality in LEL women versus HEL women was 1.34 (95% CI, 1.23–1.46). The pattern of variation between countries is also somewhat different for women than for men: among women, the relative inequalities in mortality were largest in northern Europe and central and eastern Europe, and smallest or almost absent in southern Europe. Rate ratios ranged from 1.0 in Italy, Slovenia, and Spain to about 1.6 in Norway and Denmark (Fig. 6.1).

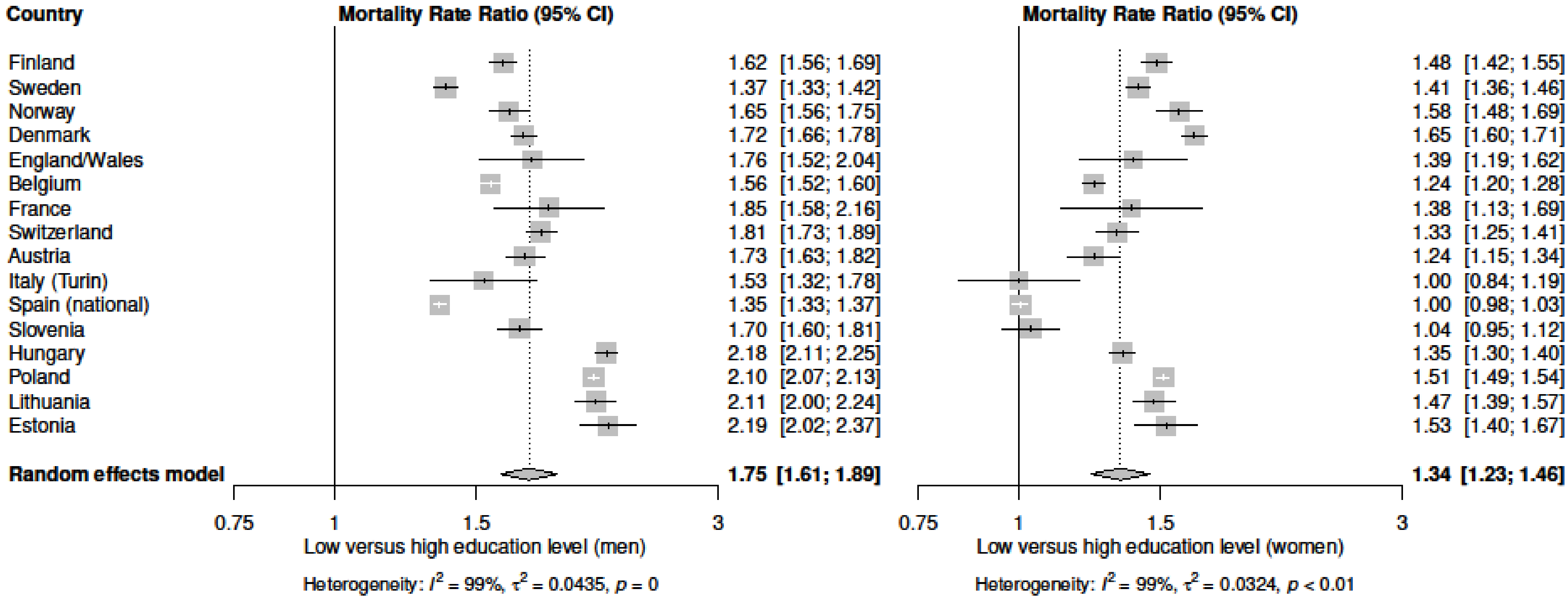

Fig. 6.1. Relative social inequalities in cancer mortality by education level in 17 European countries, by country, for the most recent data available for each country (from 2004 to 2013). The charts show rate ratios and corresponding 95% confidence intervals of mortality from all cancers combined for men (left) and women (right) with a low versus high education level, and a pooled rate ratio estimate obtained from a random effects meta-analysis.

Similar patterns, although with more pronounced contrasts between countries, were found for absolute inequalities in cancer mortality. Rate differences of cancer mortality varied by more than 4-fold among men (from ~80 per 100 000 in Sweden to ~360 per 100 000 in Hungary) and by even more among women (from ~0 in Italy, Slovenia, and Spain to ≥ 120 per 100 000 in Denmark and Norway; results not shown).

Evidence of social inequalities for specific cancer types

Cancer mortality rates were greater for LEL groups than for HEL groups for most cancer types, although substantial variability was found in the magnitude of the association for specific cancer types (Fig. 6.2). The largest inequalities were found for mortality rates of smoking- and alcohol-related cancers, including cancers of the larynx; buccal cavity and pharynx; oesophagus; and trachea, bronchus, and lung. These data suggest that the social patterning of smoking and excessive alcohol consumption plays an important role in generating inequalities in cancer mortality. Compared with HEL individuals, LEL individuals had mortality rates that were 2–3 times as high for cancers of the lung and oesophagus, 2–4 times as high for cancers of the buccal cavity and pharynx, and 3–5 times as high for cancer of the larynx.

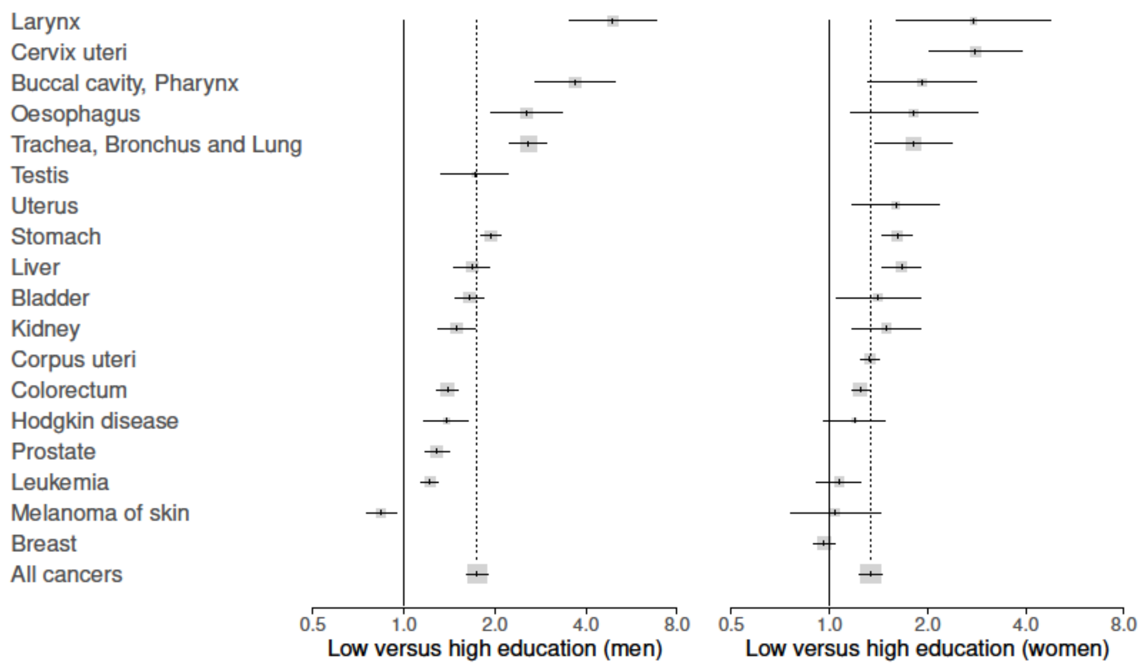

Fig. 6.2. Relative inequalities in mortality from 18 specific cancer types in 17 European countries, according to the most recent data available for each country (from 2004 to 2013). The graphs show pooled rate ratio estimates and corresponding 95% confidence intervals of mortality for men (left) and women (right) with a low versus high education level, obtained from a random effects meta-analysis.

Lung cancer was the main contributor to the differences between European countries in the magnitude of inequalities in cancer mortality shown in Fig. 6.1. This is unsurprising because lung cancer is a very common cancer and tobacco smoking, its main risk factor, is strongly associated with SES. In Europe, absolute inequalities in lung cancer mortality rates in men were largest in central and eastern Europe, followed by Belgium and Norway, whereas inequalities in women were largest in Denmark and Norway and very small in Italy and Spain (results not shown).

Large inequalities in cancer mortality rates were also observed for infection-related cancers, that is, cervical cancer (by a factor of 3 for LEL vs HEL), and stomach cancer and liver cancer (by a factor of 2 for LEL vs HEL) in both sexes. No differences in mortality rates were observed for breast cancer, and the only cancer for which mortality rates were higher among HEL men than among LEL men was cutaneous melanoma (Fig. 6.2).

Time trends

The remarkable inequalities described above are the result of major trends over time. Cancer mortality among HEL groups of men and women has almost universally declined, but trends in cancer mortality over the past decades have generally been more favourable among HEL groups than among LEL groups, for which cancer mortality rates have often remained stable or even increased (Fig. 6.3). For all cancers combined, annual percentage declines as well as absolute declines (not shown) were considerably larger among HEL individuals versus LEL individuals, particularly among women (Fig. 6.4), meaning that both relative and absolute inequalities in cancer mortality have risen in many countries. However, inequalities in cancer mortality have reversed in some countries, for example Estonia and Hungary, from higher mortality among HEL groups in the early 1990s to higher mortality among LEL groups in the early 2010s (Fig. 6.3). Because cardiovascular disease mortality has declined at a greater rate and more uniformly than cancer mortality has (Bray et al., 2012; Torre et al., 2015; Townsend et al., 2016), among both HEL men and women and LEL men and women, inequalities in cardiovascular disease mortality have declined in many countries. Cancer has therefore become relatively more important as a cause of inequalities in total mortality in several populations, for example, among men in Austria, Belgium, England

and Wales, Italy, Spain, and Switzerland, and among women in England and Wales, Italy, and Norway (results not shown).

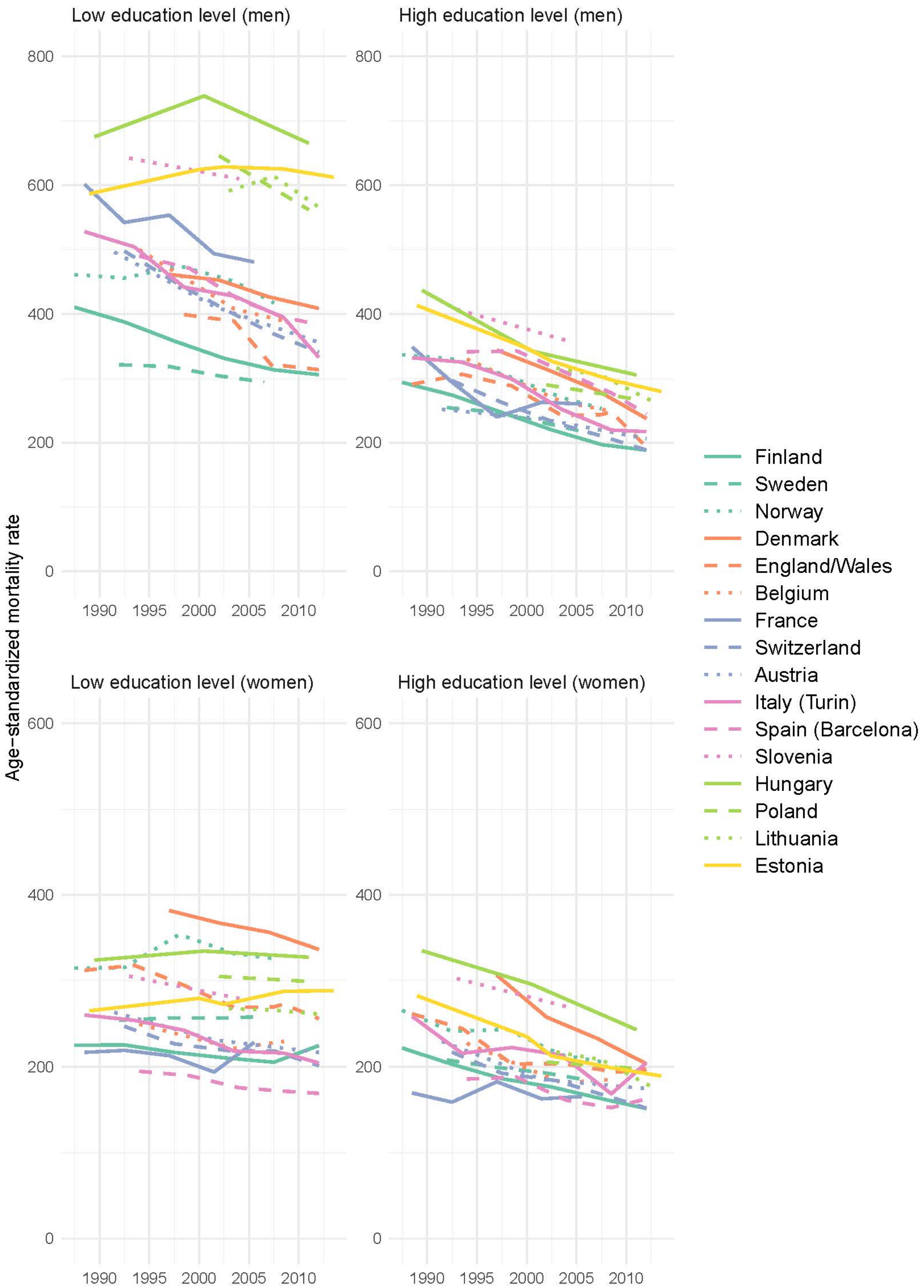

Fig. 6.3. Trends of age-standardized all-cancer mortality rates (European Standard Population) in deaths per 100 000 person-years in 17 European countries, using data from 1990–2012. The graphs show mortality rates for men (upper) and women (lower) with a low (left) and high (right) education level.

The magnitude and even the direction of temporal trends for groups with different education levels differ by cancer type, however. Declines were observed in most countries for several cancer types in both HEL and LEL groups, but were often greater in HEL groups, for example, cancer of the breast in women and cancers of the prostate, colorectum, and lung in men. Cervical cancer mortality rates decreased in both HEL and LEL groups in certain countries, but also increased in LEL groups in other countries. General declines were also observed for stomach cancer mortality rates, often more favourable to LEL groups versus HEL groups in some countries, but increases were also observed in HEL groups in other countries. Mixed trends in liver cancer mortality rates were observed, with increases for both HEL and LEL groups in several countries. Lung cancer mortality has generally increased among women, but more so among LEL groups versus HEL groups. The patterns described above are quite general, however; it is important to acknowledge that trends in specific cancer types may vary in magnitude and sometimes even in direction across different countries (Fig. 6.4).

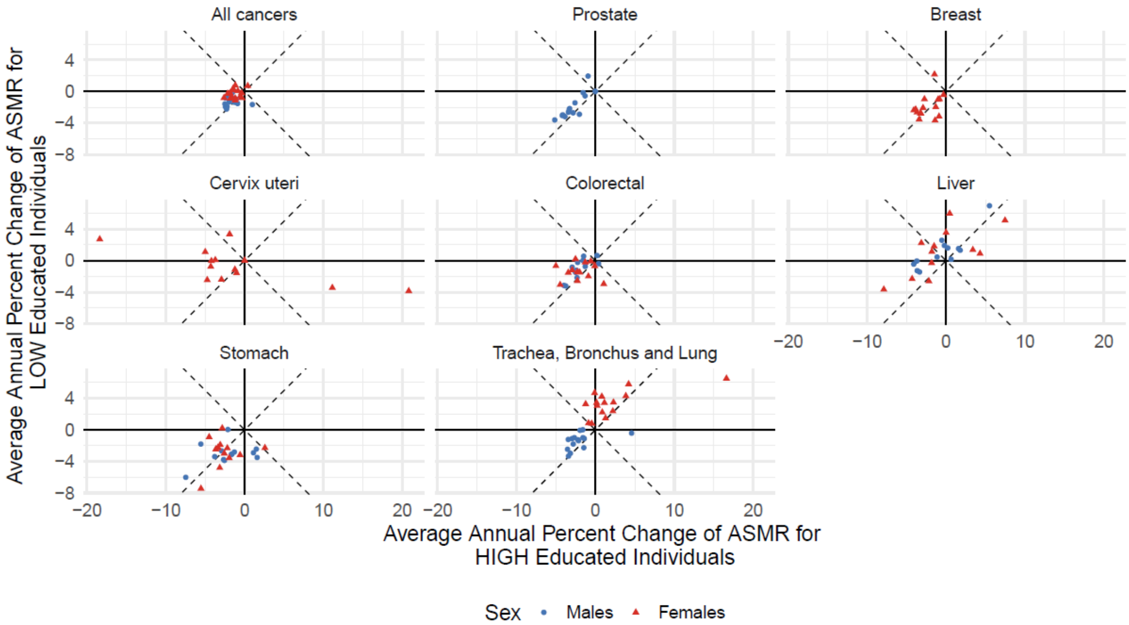

Fig. 6.4. Annual percentage change in age-standardized mortality rates from all cancers and specific cancer types in 17 European countries for men (blue) and women (red) with a low education level (vertical axis) plotted against those with a high education level (horizontal axis), using data from 1980 to 2015. A comparison of the magnitude of same-direction changes (decreases or increases) between the groups of different education level is provided by the dashed lines. For example, a blue dot in the lower-left quadrant indicates that, in that specific country, cancer mortality rates decreased over time for men with both a low and high education level; if the dot lies above the dashed line, then the decrease is greater for those with a high education level.

Evidence of social inequalities in cancer within HICs

This section integrates the information provided above on social inequalities in cancer mortality in Europe with the most recent and highest-quality available evidence on social inequalities in cancer incidence in countries classified as HICs by the World Bank (2018a). Several searches were undertaken in PubMed to identify key systematic reviews, meta-analyses, or significant cohort studies (published in the past 10 years) that focused on cancer incidence in relation to SES. Articles were reviewed, and data in relation to HICs or HIC groupings were abstracted.

Four cohort studies that investigated associations between SES and risk of cancer incidence (in all sites and across subsites) were identified: one in North America and three in European countries. Table 6.1 presents the data from these cohort studies on the risk associations by sex of LEL versus HEL groups (note that all cohort studies investigated multiple measures of SES; only education level is reported here). Despite the different definitions of cancer used and differences in modelling approaches, the four cohort studies observed increased risks of cancer incidence for both sexes for LEL groups relative to HEL groups (Dalton et al., 2008; Mouw et al., 2008; Spadea et al., 2010; Sharpe et al., 2014). Across all cohort studies, those with the lowest levels of education had higher risks of cancers of the lung, upper aerodigestive tract, stomach, and cervix uteri relative to those with the highest levels of education. In contrast, LEL groups generally had a lower risk of cancers of the skin, prostate, and breast.

Table 6.1. Summary of results from selected cohort studies from high-income countries: relative risk of incidence of specific cancer types for those with a low education level compared with those with a high education level

Cancer site	Relative risk (low vs high education level)							
	Mouw et al. (2008), USA (1995–2004)[a]		Dalton et al. (2008), Denmark (1994–2003)[b]		Spadea et al. (2010), Turin, Italy (1985–1999)[b]		Sharpe et al. (2014), Scotland (1991–2006)[b]	
	Men	Women	Men	Women	Men	Women	Men	Women
Mouth and pharynx			1.43[c]	1.25				
Larynx			1.67[c]	3.23[c]				
Head and neck	1.29	1.21						
Upper aerodigestive tract					1.96[c]	1.10	1.82[c]	1.42[c]
Thyroid		1.01						
Oesophagus	2.00[c]		1.30[c]	0.87				
Stomach	1.67[c]	0.92	1.37[c]	1.23[c]	2.19[c]	1.48		
Pancreas		0.74	1.20[c]	1.22[c]				
Colorectal					0.89[c]	0.9		
Colon	1.10	1.37[c]	0.93	1.02				
Rectum	1.50	1.05	1.02	1.12				
Liver	1.28				1.05	1.09		
Lung	1.95[c]	1.43[c]	1.53[c]	1.85[c]	1.68[c]	0.59[c]	3.05[c]	1.94[c]
Pleura	4.56[c]							
Breast		0.83[c]		0.80[c]		0.66[c]		
Cervix		1.20		1.33[c]		2.13[c]		
Corpus/endometrium		0.65[c]		0.98				
Ovary		1.08		0.97				
Prostate			0.81[c]					
Prostate (localized)	0.85[c]							
Prostate (advanced)	0.89							
Testis			1.00					
Kidney	0.97	1.29	1.22[c]	1.54[c]				
Bladder	1.20[c]	0.67	1.15[c]	1.37[c]				
Malignant melanoma	0.53[c]	0.40[c]	0.65[c]	0.69[c]	0.34[c]	0.41[c]		
Brain and central nervous system	0.82		1.04	0.92				
Lymphoma	0.76[c]	0.99						
Non-Hodgkin lymphoma			1.10	1.14				
Hodgkin lymphoma			1.05	1.16				
Leukaemias	1.11	1.14	0.96	1.10				
All cancers	1.03	0.84[c]	1.10[c]	1.02	1.17[c]	0.78[c]	1.17[c]	0.99

[a] Data adjusted for age, sex, ethnicity, smoking, alcohol consumption, energy intake, BMI, physical activity, marital history, and family history of cancer.
[b] Data adjusted for age, period, and multiple SES variables.
[c] Data for which the 95% confidence interval excludes unity.

In addition to the four large cohort studies described above, there is a large body of evidence (usually in the form of case–control studies) from HICs investigating the relationship between SES and cancer incidence by cancer site. These studies are often collated within systematic reviews and are usually combined with meta-analyses, or in pooled data consortia. Data were abstracted from these studies by cancer type for HICs (Table 6.2). Unadjusted (or minimally adjusted) pooled estimates of the risk associations for LEL groups relative to HEL groups, or other SES measure where education level was not available, are shown (note again that some of these studies reported multiple measures of SES, although only data on education level are included here). In agreement with the results from the four cohort studies described above, the incidence of cancers of the lung, head and neck, stomach, and cervix was increased for groups with lower SES relative to groups with higher SES. There was no clear relationship for cancers of the colon and rectum, and an inverse relationship was observed for breast cancer incidence (Table 6.2).

Table 6.2. Systematic reviews and meta-analyses of associations between socioeconomic status and risk of cancer incidence by site for high-income countries

Reference	Cancer site	Setting	No. of studies	Unadjusted pooled OR (95% CI) for groups with different levels of SES
Lundqvist et al. (2016)	Breast	Europe	8	All SES measures combined; high vs low SES: 1.25 (1.17–1.32)
Parikh et al. (2003)	Cervix	North America	10	Low vs high education level: 2.30 (2.01–2.65)
		Europe	8	Low vs high SES: 1.28 (1.10–1.49)
Uthman et al. (2013)	Stomach	HICs	19	Low vs high education level: 2.65 (1.64–4.30)
		North America	4	Low vs high education level: 2.37 (0.99–5.69)
		Europe	11	Low vs high education level: 2.92 (1.37–6.19)
Manser and Bauerfeind (2014)	Colon	North America	5	Low vs high education level: 1.03 (1.00–1.06)
	Rectum	Europe	9	Low vs high education level: 0.90 (0.76–1.07)
Conway et al. (2008)	Oral cavity	HICs	37	Low vs high education level: 1.85 (1.60–2.15)
Conway et al. (2015)	Head and neck	North America	15	Low vs high education level: 3.00 (2.05–4.39)
	Head and neck	Europe	11	Low vs high education level: 2.20 (1.55–3.11)
	Oral cavity			Low vs high education level: 2.06 (1.64–2.58)
	Oropharynx			Low vs high education level: 2.34 (1.66–3.31)
	Larynx			Low vs high education level: 2.99 (2.19–4.07)
Sidorchuk et al. (2009)	Lung	HICs	11	Low vs high education level (adjusted for smoking): 1.66 (1.10–2.51)
		North America	6	Low vs high education level: 2.13 (1.45–3.13)
		Europe	6	Low vs high education level: 1.61 (1.26–2.05)

Table 6.2. Systematic reviews and meta-analyses of associations between socioeconomic status and risk of cancer incidence by site for high-income countries

Reference	Cancer site	Setting	No. of studies	Unadjusted pooled OR (95% CI) for groups with different levels of SES
Hovanec et al. (2018)	Lung	North America	2	Low vs high occupational SES (adjusted for smoking, exposures): 1.54 (1.61–2.09)
		Europe	10	Low vs high education level: 1.84 (1.61–2.09)

CI, confidence interval; HICs, high-income countries; OR, odds ratio; SES, socioeconomic status; vs, versus

Evidence of social inequalities in cancer within LMICs

A literature review on social inequalities in cancer incidence and mortality in LMICs was conducted using PubMed, Scielo, and Bireme, and the reference lists from retrieved reports were reviewed to identify other sources. Keywords included inequalities, cancer, Latin America, Africa, Asia, and LMIC. Both ecological and individual-level indicators of inequality in cancer incidence and mortality for countries classified as LMICs by the World Bank (2018b) were included. When several studies of inequalities were reported for certain cancer types within a particular country, the most recent and/or those reporting the broadest age groups were used. Of note, most studies on social inequalities in cancer in LMICs reported only cancer mortality data; the very few publications that included individual-level data by education level almost exclusively reported mortality data (Attar et al., 2010; Dey et al., 2010a; Dikshit et al., 2012; de Vries et al., 2015, 2016, 2018; Tarupi et al., 2018). Published results are mostly limited to some countries in Latin America and a few countries in Africa and Asia, and the majority are ecological studies, comparing regions or states with different SES indicators, such as percentage of illiteracy and mortality of children younger than 5 years.

Despite these limitations (see Box 6.2), studies in LMICs combining all-cancer incidence or mortality usually show inequalities, with generally higher rates among people with lower SES (Diez Roux et al., 2007; Cavalini and de Leon, 2008; Chiavegatto Filho et al., 2012; Dikshit et al., 2012; Oguntoke, 2014; de Vries et al., 2016; Wang and Jiao, 2016). These general patterns conceal large differences in the magnitude and even the direction of inequalities by cancer type, but are consistent with those observed in HICs, described above. In general, studies based on individual SES data report the largest inequalities for smoking-related cancers and for infection-related cancers, such as those of the stomach, liver, and cervix. In contrast, breast cancer and colorectal cancer do not show a clear and consistent association with SES in LMICs (Dikshit et al., 2012; de Vries et al., 2015, 2018) (Table 6.3).

Table 6.3. Evidence of associations between socioeconomic status and risk of cancer incidence or mortality by cancer site for low- and middle-income countries

Reference	Individual or ecological studies	Incidence or mortality	Setting	SES indicator	Measure	Results (95% CI or *P* value)
Cancer of the cervix						
de Vries et al. (2018)	Individual	Mortality	Colombia	Education level	RII	6.8 (6.2–7.5)
				Education level	MRR (low vs high)	4.7 (4.6–4.7)
Dikshit et al. (2012)	Individual	Mortality	India	Education level (illiterate vs senior secondary)	MRR	3.5
				Rural vs urban	MRR	1.13
Dey et al. (2010a)	Individual	Incidence	Egypt	Urban vs rural	IRR	3.1 (2.1–4.6)
Martínez and Guevel (2013)	Ecological	Mortality	Buenos Aires, Argentina	Worst vs best areas	Standardized MRR	1.75
Girianelli et al. (2014)	Ecological	Mortality	Brasilia, Brazil	HDI	Correlation	−0.38 (0.050)
				% individuals of age ≤ 25 yr with > 11 yr schooling	Correlation	−0.57 (0.002)
				% young population illiterate	Correlation	0.18 (0.3588)
				% living below poverty line	Correlation	0.45 (0.020)
Oguntoke (2014)	Ecological	Incidence	Nigeria	% illiteracy	Correlation	0.16 (NS)
				% urbanization	Correlation	0.61 (< 0.05)
Palacio Mejía et al. (2003)	Ecological	Mortality	Mexico	Urban vs rural	MRR	3.07
Sánchez-Barriga (2012)	Ecological	Mortality	Mexico	Regional SES (low vs high, 2007)	MRR	1.38 (1.20–1.58)
Drumond and Barros (1999)	Ecological	Mortality	São Paolo, Brazil	Regional SES (low vs high)	MRR	1.92
Cancer of the stomach						
de Vries et al. (2015)	Individual	Mortality	Colombia	Education level (low vs high)	RII	M, 3.21 (2.48–4.17); F, 2.05 (1.48–2.83)

Table 6.3. Evidence of associations between socioeconomic status and risk of cancer incidence or mortality by cancer site for low- and middle-income countries

Reference	Individual or ecological studies	Incidence or mortality	Setting	SES indicator	Measure	Results (95% CI or *P* value)
					MRR	M, 2.56 (2.29–2.86); F, 1.98 (1.75–2.24)
Dikshit et al. (2012)	Individual	Mortality	India	Education level (illiterate vs senior secondary)	MRR	M, 4.32; F, 4.97
				Urban vs rural	MRR	M, 1.60; F, 1.25
Drumond and Barros (1999)	Ecological	Mortality	São Paolo, Brazil	Regional SES (low vs high)	MRR	M, 1.30; F, 2.18
Sánchez-Barriga (2016)	Ecological	Mortality	Mexico	Regional SES (low vs high)	MRR	1.06 (NS)
Cancer of the lung						
de Vries et al. (2015)	Individual	Mortality	Colombia	Education level (low vs high)	RII	M, 2.24 (1.65–3.04); F, 1.35 (0.90–2.03)
					MRR	M, 1.64 (1.47–1.82); F, 1.32 (1.16–1.50)
Dikshit et al. (2012)	Individual	Mortality	India	Education level (illiterate vs senior secondary)	MRR	M, 1.83
				Rural vs urban	MRR	M, 0.78; F, 0.95
Antunes et al. (2008)	Ecological	Mortality	São Paolo, Brazil	HDI of city areas	MRR (high vs medium)	M, 1.08 (1.00–1.16); F, 1.27 (1.11–1.45)
					MRR (low vs medium)	M, 0.74 (0.67–0.83); F, 1.01 (0.90–1.13)
Drumond and Barros (1999)	Ecological	Mortality	São Paolo, Brazil	SES condition region (low vs high)	MRR	M, 0.70; F, 0.88
Cancer of the breast						
de Vries et al. (2015)	Individual	Mortality	Colombia	Education level (low vs high)	RII	0.71 (0.58–0.89)
					MRR	0.93 (0.87–0.99)
Dikshit et al. (2012)	Individual	Mortality	India	Education level (illiterate vs senior secondary)	MRR	1.48
				Rural vs urban	MRR	0.94

Table 6.3. Evidence of associations between socioeconomic status and risk of cancer incidence or mortality by cancer site for low- and middle-income countries

Reference	Individual or ecological studies	Incidence or mortality	Setting	SES indicator	Measure	Results (95% CI or *P* value)
Dey et al. (2010b)	Individual	Incidence	Egypt	Urban vs rural	IRR	3.73 (3.30–4.22)
Sánchez-Barriga (2015)	Individual	Mortality	Mexico	Education level (college vs no education)	MRR	1.28 (1.23–1.33)
Girianelli et al. (2014)	Ecological	Mortality	Brasilia, Brazil	% individuals ≤ 25 yr with > 11 yr schooling	Correlation	0.51 (0.006)
				% young population illiterate	Correlation	−0.22 (0.27)
				HDI	Correlation	0.32 (0.099)
				% living below poverty line	Correlation	−0.26 (0.188)
Oguntoke (2014)	Ecological	Incidence	Nigeria	% urbanization	Correlation	0.64 (< 0.05)
				% illiteracy	Correlation	0.22 (> 0.05)
Tumas et al. (2017)	Ecological	Incidence	Córdoba, Argentina	% households in neighbourhoods with unmet basic needs	IRR	1.128 (1.076–1.183)
Fei et al. (2015)	Individual	Incidence	China	Urban vs rural	IRR	1.86 (< 0.001)
	Ecological	Incidence	China	% illiteracy	Correlation	−0.288 (NS)
	Ecological	Incidence	China	Years of education	Correlation	0.640 (< 0.01)
Girianelli et al. (2014)	Ecological	Mortality	Brasilia, Brazil	HDI	Correlation	0.32 (0.099)
				% aged < 25 yr with > 11 yr or schooling	Correlation	0.51 (0.0063)
				% aged < 25 yr illiterate	Correlation	−0.22 (0.2764)
				% below poverty line	Correlation	−0.26 (0.1878)
Drumond and Barros (1999)	Ecological	Mortality	São Paolo, Brazil	Regional SES (low vs high)	MRR	0.75
Cancer of the prostate						
de Vries et al. (2015)	Individual	Mortality	Colombia	Education level (low vs high)	RII	1.38 (0.83–2.32)
					MRR	1.04 (0.92–1.19)
Oguntoke (2014)	Ecological	Mortality	Nigeria	% urbanization	Correlation	0.51 (< 0.05)
				% illiteracy	Correlation	0.15 (NS)

Table 6.3. Evidence of associations between socioeconomic status and risk of cancer incidence or mortality by cancer site for low- and middle-income countries

Reference	Individual or ecological studies	Incidence or mortality	Setting	SES indicator	Measure	Results (95% CI or *P* value)
Cancer of the colon and rectum						
de Vries et al. (2015)	Individual	Mortality	Colombia	Education level (low vs high)	RII	M, 0.99 (0.67–1.47); F, 0.94 (0.65–1.36)
					MRR	M, 0.91 (0.82–1.01); F, 1.01 (0.90–1.13)
Dikshit et al. (2012)	Individual	Mortality	India	Rural vs urban	MRR	M, 1.04; F, 1.12
Drumond and Barros (1999)	Ecological	Mortality	São Paolo, Brazil	Regional SES (low vs high)	MRR (colon)	M, 0.40; F, 0.62
Sánchez-Barriga (2017)	Individual	Mortality	Mexico	Regional SES (low vs high)	MRR	0.62 (< 0.05)
Cancer of the oral cavity and pharynx						
Dikshit et al. (2012)	Individual	Mortality	India	Education level (illiterate vs senior secondary)	MRR	M, 2.74; F, 5.60
				Rural vs urban	MRR	M, 0.96; F, 1.29
Attar et al. (2010)	Individual	Incidence	Egypt	Urban vs rural (head and neck)	IRR	M, 2.59 (2.26–2.97); F, 2.00 (1.64–2.43)
Oguntoke (2014)	Ecological	Incidence	Nigeria	% urbanization	Correlation	0.52 (< 0.05)
				% illiteracy	Correlation	0.10 (> 0.05)
Antunes et al. (2008)	Ecological	Mortality	São Paolo, Brazil	% low instruction	Correlation	0.308 (0.001)
				% academic degree	Correlation	−0.472 (< 0.001)
				HDI	Correlation	−0.348 (< 0.001)
Borges et al. (2009)	Ecological	Mortality	Brazil	Education	Correlation	0.569 (0.002)
				Unit increase per capita income	Correlation	0.734 (< 0.001)
Ferreira et al. (2012)	Ecological	Incidence	São Paolo, Brazil	HDI	MI	0.226 (0.01)
		Mortality		HDI	MI	0.337 (0.01)

CI, confidence interval; F, female; HDI, Human Development Index; IRR, incidence rate ratio; M, male; MI, Moran index; MRR, mortality rate ratio; NS, not significant; RR, relative risk; RII, relative index of inequality; SES, socioeconomic status; vs, versus; yr, year(s)

Note: RII is a regression-based index that summarizes the magnitude of SES as a source of inequalities in health (see Chapter 4).

Box 6.2. Limitations in studies of social inequalities in cancer within countries

Several limitations need to be acknowledged in studies of social inequalities in cancer within countries, and this is particularly true in LMICs. To produce individual-level comparisons of cancer burden according to SES, both the numerators (numbers of new cases or cancer deaths) and population data on the SES indicator (e.g. income, education level, place of residence, profession) of interest must be available. In some settings, it is difficult to obtain information on patient's SES or abstract this information from death certificates, and it is often even more difficult to obtain reliable information on the population distribution of SES indicators (the denominators) to be able to calculate rates and indices of inequality. It is probably because of this lack of data, as well as a lack of research based on cancer registry data in many LMICs, that published information on inequalities in cancer incidence and mortality with individual-level data is very scarce (see Focus 2). Comparing cancer incidence or mortality rates between regions within a country may also be challenging; SES indicators may differ substantially between different areas because of the presence of individual- and area-level effects and because of a possible ecological fallacy (in which all individuals in an area are assigned a SES on the basis of their area of residence). A caveat should also be added when interpreting education level for different birth cohorts, because the meaning of this variable and the consequent features of the SES associated with it may vary between generations.

Discussion

In summary, major social inequalities in cancer exist within countries, with consistent evidence from HICs and LMICs. Disadvantaged individuals and groups tend to have a different spectrum of cancers compared with people with higher socioeconomic status (SES), notably an excess of tobacco-related and infection-related cancers. Compared with groups with high SES, lower cancer incidence rates are observed in certain anatomical sites than in groups with lower SES. However, disadvantaged individuals systematically suffer from substantially higher mortality rates and lower survival rates than groups with higher SES for the large majority of cancer types. This is clearly evident in HICs where a substantial amount of data is available. Data from LMICs are more sparse, but the available evidence on social inequalities in cancer within such populations points to similar conclusions as for HICs.

Despite the many tobacco control measures and prevention campaigns, lung cancer is still among the most frequently diagnosed cancer types in most countries (Ferlay et al., 2018). On a global scale, lung cancer is mostly caused by cigarette smoke and environmental contamination, factors that are strongly related to SES; the associations observed vary by country, however, probably as a result of the varying characteristics of the smoking epidemic. A lower education level is related to higher incidence and mortality rates of lung cancer and oral cancer (Conway et al., 2008; Dikshit et al., 2012; de Vries et al., 2015); exceptions have been observed in some rural areas in LMICs where low SES has been linked to a lower incidence of lung cancer, presumably because of a lower uptake of smoking among the most deprived groups of individuals in these areas (Dikshit et al., 2012). It is important to note that in some LMIC settings the types of housing and cooking methods, which are also associated with SES, are also important contributors to lung cancer risk (Hosgood et al., 2011; Jia et al., 2018).

About 85% of the global burden of cervical cancer occurs in LMICs, where it accounts for almost 12% of all cancers in women. In addition to LMICs having a higher burden of cancer incidence, survival, and mortality compared with HICs, large inequalities are also observed for cervical cancer within both HICs and LMICs; LEL women (Martínez and Guevel, 2013; Girianelli et al., 2014; Oguntoke, 2014; de Vries et al., 2018) living in rural areas (Antunes et al., 2008; Cavalini and de Leon, 2008; Ferreira et al., 2012) and in areas of lower SES (Drumond and Barros, 1999; Sánchez-Barriga, 2012; Girianelli et al., 2014) have the highest cervical cancer incidence and mortality rates. These observations are probably explained by the lack or limited availability of and limited access to well-organized cervical cancer screening programmes (Murillo et al., 2012), and by the limited access to screening for disadvantaged individuals even in HICs (see Example 2). The large variation in the relative and absolute differences in mortality (by up to a factor of 7) represents an enormous potential for reduction of this disease, even among the groups with the lowest SES (Hall et al., 2019), particularly because of the availability of the highly effective human papillomavirus (HPV) vaccine and of HPV-based screening tests.

Incidence and mortality rates of stomach and liver cancer have been declining in many HICs but are still high in LMICs (Colquhoun et al., 2015; Petrick et al., 2016; Sierra et al., 2016), where the burden of the disease is highest (Ferlay et al., 2018). Stomach and liver cancer are also diseases of the groups of lower SES within both HICs and LMICs, with clearly increased rates among LEL groups and in rural populations (Drumond and Barros, 1999; Belon and Barros, 2011; Dikshit et al., 2012; Ferreira et al., 2012; de Vries et al., 2015; Sánchez-Barriga, 2016). The evidence of a social gradient for the infectious agents causally linked with stomach cancer (*Helicobacter pylori*) and liver cancer (hepatitis B and C viruses) is discussed in Chapter 7.

No clear social gradient is observed for breast cancer. Although incidence is much higher in HICs than in LMICs (see Chapter 5) and breast cancer is often considered a disease of the affluent, data from both HICs and LMICs do not show clear associations between breast cancer mortality rates and SES (Dikshit et al., 2012; de Vries et al., 2015; Sánchez-Barriga, 2015). In HICs, breast cancer mortality rates used to be higher among HEL women, but they are now equally high among both LEL and HEL women. This could be explained by (i) strong declines in breast cancer mortality among HEL women, as a result of improvements in screening and treatment in this group, and (ii) slower declines (or even increases in some countries) in breast cancer mortality among LEL women, which may be due to an increased incidence as a consequence of a progressive transition towards delayed childbearing in this group of women, an established risk factor for breast cancer (Logan, 1953). In LMICs, living in rural areas seems to be consistently related to lower breast cancer risk (Dey et al., 2010b; Dikshit et al., 2012; Oguntoke, 2014; Fei et al., 2015); this is probably a result of childbearing-related factors, but also lower participation in screening (see Chapters 14 and 15). Although women with lower SES in LMICs may have a lower breast cancer risk, they also have a lower breast cancer survival rate, causing their mortality rates to be similar to those of women with higher SES.

In HICs, a social gradient was also observed with colorectal cancer, which is among the most frequently diagnosed cancer types in HICs and is also increasingly common in LMICs and emerging economies (Li et al., 1997; Ferlay et al., 2018). Screening and early detection combined with timely and effective treatment can greatly improve prognosis, but 5-year survival has stagnated at about 65% in HICs and is only 30–45% in many LMICs (Allemani et al., 2015). Within LMICs, the association between colorectal cancer mortality and education level is unclear (Dikshit et al., 2012; de Vries et al., 2015; Sánchez-Barriga, 2017).

The only cancer for which mortality was higher among HEL men compared with LEL men in HICs was cutaneous melanoma, perhaps as a result of more intermittent sunlight exposure among HEL men (Fig. 6.2). For some specific cancer types, such as cancers of the thyroid, breast, and prostate, incidence was higher among people with high SES, even though mortality was not (or only to a lesser extent). The large discrepancy between incidence and mortality observed for certain cancers in HICs or emerging economies could be predominantly explained by the availability of and access to effective treatments and by the increased detection of clinically irrelevant cancers in individuals with better access to a health-care system (see Chapter 18). However, the discrepancy between incidence and mortality is smaller in LMICs than in HICs, predominantly because of lower survival rates in LMICs as a result of later diagnosis and poorer access to treatment.

Three potentially relevant arguments related to the observed patterns are proposed.

First, social inequalities in cancer mortality reflect social inequalities both in incidence and in survival. Socioeconomic inequalities in mortality from cancer types for which the effectiveness of life-prolonging treatment is still relatively low, such as lung cancer, are likely to be based on socioeconomic inequalities in incidence. However, for other cancers, such as breast cancer, the balance may be different; socioeconomic inequalities in access to care and treatment may have a larger weight.

Second, social inequalities in incidence and survival must be based on inequalities in exposure to a large array of specific determinants of incidence and survival. On the basis of the literature, it is clear that health-related behaviours (such as smoking, excessive alcohol consumption, dietary factors, unprotected sex, and delayed childbearing), occupational and other environmental factors, and access to screening and treatment all play a role (see Chapter 7). Tobacco use is certainly one of the most important factors underlying socioeconomic inequalities in cancer: the remarkably large inequalities in cancer mortality among both Danish and Norwegian women (Fig. 6.1) would not exist without the large inequalities in smoking-related cancers that have emerged within these countries, which are otherwise characterized by egalitarian social and health-care policies. It is therefore important to control the smoking epidemic (also focusing on targeting the underlying socioeconomic determinants of smoking), especially in some emerging economies and LMICs, such as in sub-Saharan Africa and Asia, where the epidemic is currently expanding (see Chapter 11 and Example 1).

Third, current inequalities in cancer mortality rates are the result of striking differences between socioeconomic groups in cancer mortality trends. For most cancer types, the trends of the past decades have been more favourable for groups with higher SES, who have apparently benefited more from advances in prevention and treatment of cancer. This confirms the central idea of the so-called fundamental causes theory, which stipulates that, whenever opportunities for health improvement arise, groups with higher SES are in a better position to benefit, because they have greater access to an array of material and non-material resources, greater health literacy, and fewer financial barriers to health care. This suggests that redistributing specific risk factors for cancer is insufficient to eliminate inequalities in cancer, and that policies should also tackle the underlying inequality in social and economic resources.

Conclusions

The variability of inequalities in cancer incidence and mortality, both between countries and over time, is a major public health challenge. This variability clearly suggests that these inequalities are not based on immutable laws of nature but are potentially modifiable. The fact that cancer is gradually replacing cardiovascular disease as the main cause of inequalities in total mortality highlights the urgency for a stronger focus on equality in cancer prevention and treatment policies.

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