PART 1.

EVIDENCE OF SOCIAL INEQUALITIES IN CANCER

CHAPTER 4.

Measuring socioeconomic status and inequalities

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"The true **measure** of any society can be found in how it treats its most vulnerable members."

Attributed to Mahatma Gandhi (our emphasis)

Introduction

In 2008, the World Health Organization's pioneering Commission on Social Determinants of Health measured the extent of health inequalities in the city of Glasgow, Scotland, as an example. The final report revealed that a boy in the deprived area of Calton had an average life expectancy of 54 years compared with a boy in the affluent suburb of Lenzie, only 12 km away, who could expect to live to an age of 82 years (CSDH, 2008): a gap of 28 years. Michael Marmot, chair of the World Health Organization Commission, later reflected in his book *The Health Gap* that this "was a tale of two cities ... and they are both in Glasgow" (Marmot, 2015). This is a most basic, fundamental, and stark example of measuring health inequalities. The authors of this chapter all work in Glasgow, and are driven by the aim of tackling this inequality.

Measures of health inequality, which are determined by inequalities in income, wealth, and power (WHO, 2010), are a reflection of the levels of justice and fairness in society. The measurement of inequalities in health is essential to define, describe, and understand the nature of the public health problem; it is a crucial first step in the development of strategies and policies to tackle health inequalities, and in the monitoring and evaluation of the effectiveness of approaches.

Socioeconomic inequalities can exist both within and between countries (as detailed in Chapters 5 and 6), and they have an impact across the cancer continuum, from burden and risk, to early detection, diagnosis, and treatment (see Chapter 7), and to outcomes including quality of life, mortality, and survival. Inequalities also exist across other population groups and communities (defined by sex, age, race or ethnicity, geographical area, time periods, and health status, for example), although socioeconomic status (SES) is often a major factor in these differences (United Kingdom Government, 2010; Krieger, 2014). This chapter describes two key aspects of measurement and analysis of SES in relation to cancer: indicators of SES, and metrics of health inequality between socioeconomic strata.

Indicators of SES

SES or socioeconomic position is a theoretical construct of socioeconomic hierarchies with roots in the social theories of Weber and Marx (Lynch and Kaplan, 2000). SES is conceptualized through indicators or measures collected at the individual or area-based level. In social epidemiology, these indicators are used to capture and analyse the impacts of social determinants of health (Glymour et al., 2014). Several comprehensive reviews of SES indicators have discussed in detail the strengths and weaknesses of the different approaches to measurement (e.g. Liberatos et al., 1988; Berkman and Macintyre, 1997; Krieger, 2001; Galobardes et al., 2006a, b; Glymour et al., 2014). Drawing from and expanding on these reviews, we summarize individual indicators of SES, including examples of indicators and notes on their interpretation, in Table 4.1.

Table 4.1. Individual indicators of socioeconomic status: their measurement and interpretation

Indicator	Measurement and examples	Interpretation and comments
Income	Individual or household: monthly or annual; before taxes; equivalized (household income by household size) Government or state welfare benefit support; food stamps Absolute or relative poverty thresholds	Measures access to material resources (food, shelter, and culture) and access to services (health care, leisure or recreation activities, and education) Relates to social standing or prestige Reverse causality: health impacts on level of income Context-specific: country, sex, age
Education	Educational attainment: highest level attained; qualifications; years completed; ISCED	Reflects early-life SES, usually stable across the life-course Strong determinant of employment and income Influences position in society or social networks Affects access to health care or information Determines values, cognitive decision-making, risk taking, behaviours, and life skills Affects exposure to and ability to cope with stressors Reverse causality: childhood poor health impacts on school attendance and attainment Context-specific: country education system, age cohorts
Occupation	Employment or job history: longest, first, last; blue or white collar; manual or non-manual; “head of household”; RGSC; NS-SEC; European Socioeconomic Classification; American Census Classification; Wright’s Social Classification (Wright, 1997); Lombardi et al. Social Classification (Lombardi et al., 1988); Erikson and Goldthorpe Classification (Erikson and Goldthorpe, 1992); country-specific classifications; ISEI; SIOPS Unemployment experience (ever or number of years) Type of contract: salaried or hourly wage; part-time, full-time, or zero-hours; short- or long-term contract; job insecurity	Reflects social standing or prestige, working relations and conditions Strong determinant of income Based on educational attainment Influences social networks, work-based stress, autonomy or control Reflects occupational hazards, exposures, or demands Excludes some groups (e.g. retired people, unpaid home workers or “housewives”, students, some self-employed) Context-specific: country (level of industrialization or deindustrialization), age cohorts Unemployment has particular impacts on social exclusion and income, poverty, and access to health care Reverse causality: health impacts on (un)employment
Wealth	Assets (total or specific): land, property, livestock; housing tenure; ownership of car, refrigerator, television, etc.; DHS; FAS	Reflects material aspect of socioeconomic circumstances Relates to income Context-specific: country, rural or urban Reverse causality: health impacts ability to accumulate wealth
Housing	Housing quality or conditions: overcrowding (number of residents per number of rooms); dampness; housing type; water and sanitation	Direct impact: exposures for specific diseases Relates to material circumstances Context-specific: country development Reverse causality: health impacts on money available to spend on housing

Table 4.1. Individual indicators of socioeconomic status: their measurement and interpretation (continued)

Indicator	Measurement and examples	Interpretation and comments
Compositional	Combinations of SES metrics: education or income (study-specific); income and wealth (FAS); WAMI Historic indicators: Hollingshead index of social position; Duncan index; Nam–Powers socioeconomic status; Warner's index of status characteristics	Attempts to capture multiple dimensions of SES; however, composite indicators perhaps mask specific relationships and mechanisms which individual SES measurements provide
Childhood SES	Parental SES: parental (father's or mother's) occupation; household income or conditions; child-related benefits (e.g. entitlement to free school meals) Educational attainment (end of childhood or early years)	Used in life-course SES analyses to capture childhood socioeconomic circumstances
Subjective SES	Self-identification, comparison, or satisfaction: self-identification as upper, middle, or lower class; comparison of income with others; satisfaction with income; MacArthur Scales of subjective social status	Individual's perception of his or her socioeconomic standing Relates to objective indicators of SES Could be part of psychosocial pathway of health inequalities
Social capital	Social support, inclusion, or exclusion: more than 100 tools identified in recent systematic review (25 with validated psychometric elements; Cordier et al., 2017); CAMSIS	Commonly measures domains of connectedness, community participation, and citizenship; no single instrument measures all aspects within the three domains of social inclusion Hierarchical social interactions reflect social and material advantage; conversely, social exclusion from social and community life can result from economic deprivation and low SES

CAMSIS, Cambridge Social Interaction and Stratification Scale; DHS, Demographic and Health Surveys Wealth Index; FAS, Family Affluence Scale; ISCED, International Standard Classification of Education; ISEI, International Socioeconomic Index; NS-SEC, National Statistics Socioeconomic Classification (UK); RGSC, Registrar General's Social Classification (UK); SES, socioeconomic status; SIOPS, Treiman's Standard International Occupational Prestige Scale; WAMI, water and sanitation, the selected approach to measuring household wealth (assets), maternal education, and income index.

SES indicators have typically included individual measures of income, education, and occupational social class, and these measures have formed the mainstay of cancer socioeconomic analyses in relation to health and disease outcomes. Education level, followed by occupational social class and income, is widely used in analytical epidemiology investigating individual SES risk associations with cancer. Such associations are evident in the systematic reviews and meta-analyses of case–control and/or cohort studies across many cancer sites, including oral cavity (Conway et al., 2008), lung (Sidorchuk et al., 2009), stomach (Uthman et al., 2013), colon and rectum (Manser and Bauerfeind, 2014), head and neck (Conway et al., 2015), and breast (Lundqvist et al., 2016). These analyses sought to both quantify the risk association of SES with cancer, and assess whether such associations are attenuated (explained) by behavioural risk factors. Measures of wealth have increasingly been a focus of health inequality studies, but have received limited attention in relation to cancer (Pollack et al., 2007).

Area-based socioeconomic indicators are summarized in Table 4.2. These indicators are frequently used in descriptive epidemiological analyses of cancer registry data at the state or regional level (Harper and Lynch, 2005) or country level (Purkayastha et al., 2016), often to overcome the lack of individual-level SES data. At the global level, IARC is leading the field in the assessment of the burden of cancer using sophisticated measures that go beyond categorizations of developing versus developed countries, by using more sophisticated measures of development including the Human Development Index (Bray et al., 2012; Arnold et al., 2016). There are concerns that interpretations of the association between area-based indicators and health outcomes are prone to the ecological fallacy, where all individuals living in an area are assigned an SES based on the characteristics of that particular area. However, people living in the same area will share many of the socioeconomic environmental circumstances that have an impact on health apart from (or over and above) individual SES factors (Berkman and Macintyre, 1997).

Within- and between-country inequalities in cancer mortality have also been regularly examined in Europe via educational attainment (Menvielle et al., 2008); see Chapter 6 for further details.

Recent studies have begun to investigate the contribution of multiple measures of SES to inequalities in cancer; this demonstrates the interconnectedness of different SES measures (Spadea et al., 2010; Sharpe et al., 2014). These studies highlight both the independent effects of different SES measures and the further elevated risk associations observed with combinations of SES indicators, for example, low educational attainment or living in a deprived community.

Table 4.2. Area-based socioeconomic indicators: their measurement and interpretation

Indicator	Measurement and examples	Interpretation and comments
Neighbourhood, community (small areas)	Deprivation indices (zip code or postal code) using composite of multiple census or administrative data: Townsend deprivation index (Townsend et al. 1988); Carstairs deprivation index (Carstairs and Morris, 1989); indices of multiple deprivation (e.g. SIMD); European Deprivation Index; single aggregate measure e.g. percentage of population living below the poverty line; urban or rural	Categorizes areas over a continuum from deprived to affluent Usually aggregates individual-level data rather than true area characteristics Infers individual's SES (but ecological fallacy of assigning all individuals in the area the same SES) Infers socioeconomic conditions of an area through the SES characteristics of the people living there, or other dimensions of the social and physical environment increasingly included in indices of multiple deprivation (e.g. access to services)
State, region, county level	Single aggregate measure: income-to-poverty ratio; median income; cost of living; poverty level; rural or urban; HDI (regional level)	Interpreted as per small areas; however, when inferring individual SES, the larger the areas the greater the likelihood of misclassification (underestimation of individual SES)
Country level	Country income or wealth: high-, middle-, or low-income countries; GDP; GDP per capita; GNI per capita Country development: MPI; HDI Country income inequality: Gini index; S80/S20 Country happiness: GNH; WHI	Provides between-country comparisons Country economic measures of national or county income or wealth estimated from economic output (productivity) by population MPI is a composite indicator of poverty (health, living standards) and HDI includes life expectancy, education, GDP; these indicate societal and economic conditions Context-specific: country, underlying demography Country income inequality describes, at the country level, the gap between the rich and poor (i.e. the share of income between higher and lower groups) Impacts on society as a whole, but particularly on those on lower incomes who suffer disproportionate health impacts and are prevented from realizing their human capital potential Happiness indicators are subjective ratings of life (based on small questionnaire sample), weighted by levels of GDP, life expectancy, generosity, social support, freedom, and corruption

GDP, gross domestic product; GNH, gross national happiness; GNI, gross national income; HDI, Human Development Index; MPI, Multidimensional Poverty Index; S20/S80, the ratio of the mean income received by the 20% of the population with the highest income to that received by the 20% of the population with the lowest income; SES, socioeconomic status; SIMD, Scottish Index of Multiple Deprivation; WHI, World Happiness Index.

Sociodemographic factors

In addition to the dominant effect of socioeconomic inequalities, there are also important inequalities related to other population demographic groups. These factors, summarized in Table 4.3, are also known as equality domains and have their origins in human rights (United Nations, 2018). The concept of the interrelationship between these various measures of social stratification and SES was named "intersectionality" by Crenshaw (1991), who proposed a theoretical framework for analysing the combined effects of multiple social categories.

The future of SES measurement

The cancer epidemiology scientific community has been challenged to characterize the exposome, which encompasses individual environmental exposures across the life-course from as early as the prenatal period, using similar conceptual approaches and level of rigour as those taken to map and study the genome (Wild, 2005). The concept has been refined and updated with a general external environment domain that includes SES factors: "social capital, education, financial status, psychological and mental stress, urban–rural environment, [and] climate" (Wild, 2012). More recently, a "socio-exposome" has been proposed to

Table 4.3. Sociodemographic factors: their measurement and interpretation

Indicator	Measurement and examples	Interpretation and comments
Race, ethnicity, caste, immigration	Ethnicity classifications: ESCEG; country-specific (e.g. UK Census, US NIH, or Indian Government Scheduled Castes and Scheduled Tribes) Immigration (legal or illegal): country of birth; time since arrival in new country; degree of acculturation	Difficult to assess (societies are increasingly diverse) Self-reported or self-declared race is superior to name search methods or analyses by country of birth Ethnicity differences reflect multiple factors, including educational, meaning there are different occupational opportunities for minority groups Relates to discrimination Paradox of migrants' health advantage, possibly due to higher SES of those able to migrate relative to health of destination countries; artefactual due to data limitations
Marital status and living arrangements	Living arrangements: with parent(s), child(ren), alone, as a couple, lone parent; residential care (numbers of household residents); prisoners	Marital status can infer social support, but also provides economic or material advantage and access to health care (USA) Adverse impacts on divorced and widowed Healthier selection effects of being married Context-specific: country, culture, age cohort effects Relates to household structure, social relationships, and to SES
Language isolation	For example, the US Census Bureau defines a "limited English speaking household" as one in which no member of age ≥ 14 years (i) speaks only English at home; or (ii) speaks a non-English language at home and speaks English "very well".	Relates to ethnicity, immigration status, and also SES Impacts on abilities to integrate into society and to navigate access to health, care, and public services Impacts on health literacy Context-specific: country, ethnic group
Disability	Self-identified; ICF (e.g. WHODAS, MDS); objective clinical measures (e.g. visual acuity, seizure history)	Includes physical and intellectual disabilities Impact directly on health outcomes, on SES circumstances Impacts on access to health care and participation in society Relates to discrimination Context-specific: country
Religion, faith, belief, religious practices	Assessed along with, but separately from, ethnicity: major, other, or no religion(s)	Impacts on belief system, behaviours (e.g. diet, reproductive health) Reflects SES Relates to ethnicity and identity Relates to discrimination Context-specific: country, age cohorts

Table 4.3. Sociodemographic factors: their measurement and interpretation (continued)

Indicator	Measurement and examples	Interpretation and comments
Sexual identity, sexuality	LGBTQ+ Sexual orientation, behaviour: KSOG; self-assessment; MSS	Can change over lifetime Impacts directly on health, e.g. sexually transmitted diseases Impacts on access to health care Relates to discrimination
Sex, gender	Trans-inclusive measures: two-step measures: (i) birth-assigned sex; and (ii) current gender identity	Women may be performing unpaid work at home in caring roles or be employed in lower-paid jobs, and have different educational and work opportunities Important to consider partner's SES also Relates to discrimination Context-specific: country, ethnic group
Age	Age (years), age groups, life stages (e.g. early years, middle age, older years), birth cohorts	Interactions between age and SES examined in life-course approaches SES fundamentally affects life expectancy Relates to discrimination

ESCEG, European Standard Classification of Cultural and Ethnic Groups; ICF, International Classification of Functioning, Disability and Health; KSOG, Klein Sexual Orientation Grid; LGBTQ+, lesbian, gay, bisexual, transgender, queer (or questioning); MDS, Model Disability Survey; MSS, Multidimensional Scale of Sexuality; NIH, National Institutes of Health; SES, socioeconomic status; UK, United Kingdom; US, United States; WHODAS, World Health Organization Disability Assessment Schedule.

capture the wide range of socioeconomic environments and influences (Senier et al., 2017). Socioeconomic measures and exposures need to be better and more comprehensively captured, so that cancer risks associated with socioeconomic factors and their interactions with physical environmental exposures and genetics can be investigated.

Analysis approaches

Risk association analyses between SES and health or disease (including cancer) are so well accepted that it is very unusual to investigate risk factors without adjusting for SES (Berkman and Macintyre, 1997). However, with the growing discipline of social epidemiology during the past decades, studies have increasingly reversed this logic and focused on socioeconomic factors as risk factors (Kawachi and Subramanian, 2018). Typically, analyses take the highest SES strata as the referent category and quantify the relative risk associations in lower SES strata, quantifying inequalities between groups with different SES. These analyses can be influenced by the number and size of SES strata. Reducing the size (and increasing the number) of strata will increase the extent of inequalities observed between the extreme groups, with smaller strata implying more extreme social groupings. More sophisticated analyses of inequalities that make adjustments for such changes are therefore required (see the section on "Metrics of health inequalities" below).

Life-course analysis takes advantage of the ever-present and potentially changing socioeconomic circumstances at all stages of the life-course from birth (or in utero) to death (Ben Shlomo and Kuh, 2002; see also Chapter 12 for a detailed description); SES is therefore a time-varying exposure, and combinations of SES measures at different times across the life-course can be used. Insights from life-course epidemiology have highlighted the limitation of capturing SES on the basis of data collected at a single time point in terms of investigating socioeconomic risk as well as adjusting for SES confounding in analyses. Although recognition of this limitation represents progress, investigating and disentangling all the processes occurring over a life-course (e.g. critical periods, social mobility, cumulative effects, or combinations of these) is challenging (Hallqvist et al. 2004). Much attention has been given to the effect of adverse SES in childhood and early life on the occurrence of disease in adulthood and later life, independent of adult SES; for example, children who experience conditions of overcrowding or poor hygiene are more likely to become infected with *Helicobacter pylori*, which increases the risk of stomach cancer in later life (Stemmermann and Fenoglio-Preiser, 2002). A few studies have investigated the association between cancer risk and social mobility (Schmeisser et al., 2010; Behrens et al., 2016), and the cumulative effects of SES across the life-course are increasingly recognized as being associated with disease outcomes (Ben-Shlomo and Kuh, 2002).

Multilevel analysis is a form of regression analysis that takes into account the natural clustering of one unit of analysis (such as the individual) within another (such as the area of residence), and can be used to distinguish between contextual (macro) and compositional (micro) influences (Diez Roux, 2002). Even in the absence of any interest in contextual influences, multilevel analysis enables us to correct for the lack of independence between observations at the micro (e.g. individual) level. In assessing inequalities in health, multilevel analysis can be used to estimate a variance indicative of the size of inequality between areas or over time (Leyland, 2004), or to provide an appropriate estimate of a contextual effect, such as an indicator of area deprivation (Krieger et al., 2003).

Metrics of health inequalities

Numerous measures have been proposed as a means of measuring inequalities in health, whether in relation to cancer specifically (Harper and Lynch, 2005) or to health in general (Regidor, 2004a, b; Wagstaff and van Doorslaer, 2004; Blair et al., 2013). Aside from the longstanding debate about whether more emphasis should be placed on absolute or relative measures of inequality (Asada, 2010; King et al., 2012; Mackenbach, 2015), there is a realization that the actual metric chosen can influence the inequality observed and hence the monitoring of changes in inequality; as such, the choice of a measure or measures represents a value judgement (Harper et al., 2010; Kjellsson et al., 2015). For a detailed discussion of interpretation of measures of inequalities, see Chapter 14.

In Table 4.4 we present the definition of some of the most commonly used measures of inequality along with their strengths and limitations; see Munoz-Aroyo and Sutton (2007) for further information on some of these measures. We also present the value and interpretation based on data for cancer mortality of men aged 50–59 years across quintiles of area deprivation in Scotland between 2012 and 2016 (the underlying data are shown in Table 4.5).

The complex methods shown in Table 4.4 have the advantage of taking into account all available information from the different groups and their SES. Although simpler measures do have their place, they do not represent the entire picture (Mackenbach and Kunst, 1997). The slope index of inequality (SII) and relative index of inequality (RII) compare the notionally most deprived individuals with the least deprived individuals in the population on an absolute and relative scale, respectively. Different methods have been proposed for calculation of SII, based on either a linear regression of the age-standardized rates weighted by the size of the socioeconomic groups (Pamuk, 1985) or on an additive Poisson regression of the number of deaths (Moreno-Betancur

Table 4.4. Measures of inequality applied to the example of cancer mortality of men aged 50–59 years in Scotland between 2012 and 2016 across quintiles of area deprivation

Measure	Definition	Advantages	Disadvantages	Interpretation[a]
Simple				
Rate difference (RD)	Absolute measure: difference in health between the most and least deprived group	Easy to calculate and interpret	Insensitive to group size; ignores information in the middle groups	The difference in the cancer mortality rate between the most and least deprived quintiles is 208 per 100 000 population
Rate ratio (RR)	Relative measure: ratio of the rates in the most deprived and least deprived groups	Easy to calculate and interpret	Insensitive to group size; ignores information in the middle groups	The cancer mortality rate in the most deprived quintile is 2.7 times that in the least deprived quintile
Population attributable risk (PAR)	Can be both absolute and relative; shows the improvement in health that would be possible if all groups had the same health as in the highest socioeconomic group	Uses information on all groups; sensitive to group size; can be used for ordered or non-ordered groups	Ignores association between SES and health; PAR is a theoretical figure (e.g. 1393 cancer deaths avoided if everyone reaches the lowest level of deprivation) which may not be achievable in reality	The proportion of cancer deaths attributable to deprivation is 39%; multiplying the PAR by the overall standardized deaths gives a total of 1393 cancer deaths that are attributable to deprivation

Table 4.4. Measures of inequality applied to the example of cancer mortality of men aged 50–59 years in Scotland between 2012 and 2016 across quintiles of area deprivation (continued)

Measure	Definition	Advantages	Disadvantages	Interpretation[a]
Complex				
Health concentration index (HCI)	Relative measure (from –1 to +1) of the extent to which a health outcome is concentrated among the most or least deprived groups; the larger the absolute value of HCI the greater the inequality; strong similarities to the Gini index; Koolman and van Doorslaer (2004) have shown that multiplying the absolute value of HCI by 75 gives the percentage linear redistribution required to arrive at a distribution with an HCI value of 0	Uses information on all groups; graphical representation of the concentration curve	Requires strict ordering of socioeconomic groups from lowest to highest	The HCI of –0.18 reflects higher cancer mortality among the most deprived groups; it is estimated that 13.5% redistribution is required to achieve an equal distribution of cancer mortality across the deprivation groups
Slope index of inequality (SII)	Absolute measure: the slope, obtained by linear or additive Poisson regression, describing the relationship between the mean health rate in a socioeconomic group and the cumulative percentage of the population, ranked by socioeconomic position	Uses information on all groups; sensitive to group size and to the mean health status of the population	Requires socioeconomic groups to be ordered	The cancer mortality rate difference across the population is 238 (linear model) or 203 (additive Poisson model) deaths per 100 000 population
Relative index of inequality – Poisson (RII_P)	Relative measure: the exponential of the slope, obtained by Poisson regression, describing the relationship between the mean health rate in a socioeconomic group and the cumulative percentage of the population, ranked by socioeconomic position	Uses information on all groups; sensitive to group size	Requires socioeconomic groups to be ordered	The RII_P of 3.3 is the relative risk of cancer mortality for the most deprived group compared with the least deprived group, while taking into account the deprivation distribution
Relative index of inequality – linear (RII_L)	Relative measure: SII, obtained by linear regression, divided by the population mean rate of health; an RII_L value of 0 suggests that there is no inequality; a value of 1 suggests that health rates in the most deprived areas are about 50% above average; the maximum value of RII_L is approximately 2	Uses information on all groups; sensitive to group size	Requires socioeconomic groups to be ordered	The RII_L of 1.15 means that the cancer mortality rate in the most deprived group is about 57% higher than the mean cancer mortality rate (and 57% lower than the mean in the least deprived group)

HCI, health concentration index; PAR, population attributable risk; RD, rate difference; RII_L, relative index of inequality – linear; RII_P, relative index of inequality – Poisson; RR, rate ratio; SES, socioeconomic status; SII, slope index of inequality.

[a] Interpretation of each measure is based on the example shown in Table 4.5.

Table 4.5. Number of deaths from all cancers of men aged 50–59 years in Scotland between 2012 and 2016, population estimates (2014), and age-standardized mortality rate by quintile of area deprivation

SIMD quintile[a]	Number of cancer deaths	Population	Age-standardized mortality rate (per 100 000 people)
Most deprived	1043	62 659	334
2	792	65 782	240
3	672	69 945	191
4	604	73 569	163
Least deprived	473	74 440	126
All Scotland	3584	346 395	207

SIMD, Scottish Index of Multiple Deprivation.

[a] Area deprivation assessed using the Scottish Index of Multiple Deprivation (Scottish Government, 2016).

Source: Mortality and population data from National Records of Scotland.

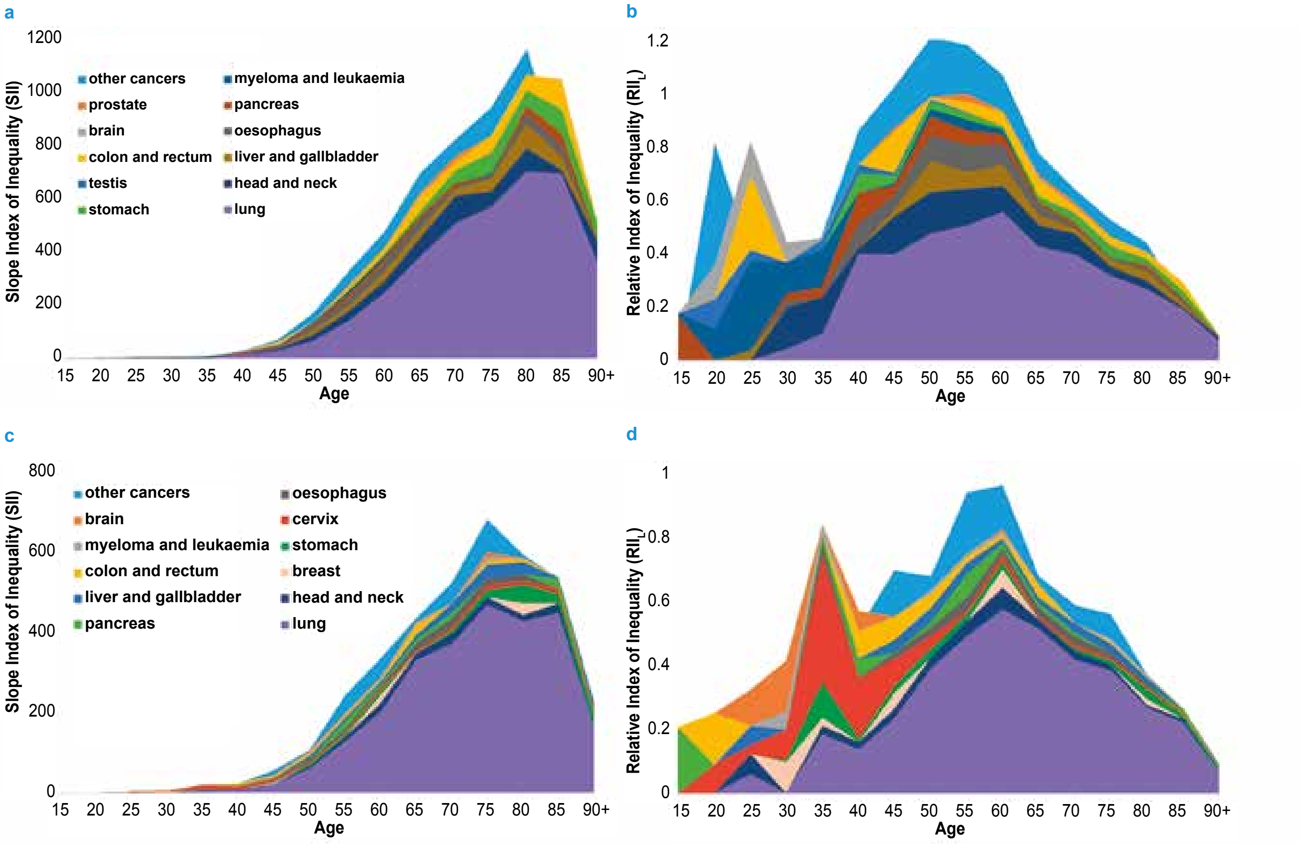
et al., 2015). These different methods produce results of similar magnitude and have the same interpretation; both estimate the absolute difference between the extremes of the distribution. RII can be estimated based on the linear regression model by dividing SII by the population rate (Pamuk, 1985), or through a (standard) multiplicative Poisson regression of the number of deaths (Moreno-Betancur et al., 2015). These methods (denoted RII_L and RII_P, respectively) provide different results with different interpretations as indicated in Table 4.4. The two indices are approximately related by the equation $RII_P \approx (2 + RII_L)/(2 - RII_L)$. When individual time-to-event data are available, SII and RII_P can be calculated using an additive hazards model and a Cox model, respectively (Moreno-Betancur et al., 2015). Despite having different interpretations, the health concentration index (HCI) and SII are approximately equivalent except for the presence of a multiplicative constant (Lumme et al., 2012). The estimate of the required redistribution of mortality across groups is obtained by multiplying the absolute value of HCI by 75 (Koolman and van Doorslaer, 2004).

SII and RII_L are decomposable; as such, they easily lend themselves to visualizations of inequalities and, in particular, to an investigation of the contribution of different causes to socioeconomic inequalities (Leyland et al., 2007). Examples of inequalities in cancer mortality by area-based SES in Scotland are presented in Fig. 4.1. The overall shapes of the graphs illustrate the inequality in all-cancer mortality. The widths of the different bands show the extent to which inequalities in cancer mortality are attributable to specific cancers. SII tends to be lowest for younger ages and increases for older ages, for which death rates are higher. Absolute inequalities are highest at the age of about 80–85 years for men (absolute rate difference of 1166 per 100 000 population between the most and least deprived) and about 75–80 years for women (absolute rate difference of 683 per 100 000 population). The RII_L peaks earlier, at the age of about 50–55 years for men (RII_L, 1.21) and 60–65 years for women (RII_L, 0.96). At younger ages, relative inequalities in cancer mortality tend to be due to causes such as colorectal cancer, brain cancer, myeloma and leukaemia, whereas at ages 40 years and older, the largest contribution to relative inequalities in cancer mortality is from lung cancer.

Conclusions

Measuring SES and social inequalities is essential to understanding the risk, burden, and impact of socioeconomic factors on cancer. Several indicators have been developed to capture SES, and sophisticated analytical methods have been developed to measure inequalities between socioeconomic strata. In line with the Commission on Social Determinants (CSDH, 2008), it is recommended that social inequalities in cancer be measured and monitored using both absolute and relative measures, ideally using both (or multiple) individual and area-based SES indicators. Improvements in data linkage will facilitate the assignment of SES indicators to cancer registry data. Finally, an improved understanding of the effect of socioeconomic factors on the burden of cancer will enable cancer control strategies to be better targeted at populations, communities, and individuals.

Fig. 4.1. Contribution of specific cancers to absolute and relative inequalities in all cancers. (a) SII and (b) RII_L for men aged 15–90 years in Scotland between 2012 and 2016. (c) SII and (d) RII_L for women aged 15–90 years in Scotland between 2012 and 2016. (b, d) Deaths are ordered from bottom to top in terms of contribution to RII_L at peak (50–55 years). The order differs for males and females, but colours have been used consistently for each type of cancer. SII, slope index of inequality. RII_L, relative index of inequality. Area-based Scottish Index of Multiple Deprivation 2016 quintiles.



Key points

- Measuring socioeconomic status and inequalities is essential to understanding the risk, burden, and impact of socioeconomic factors on health, disease, and indeed cancer. It is an important step in developing strategies, policies, and interventions aimed at tackling these inequalities, and in monitoring and evaluating the impact of these interventions.
- Several indicators have been used in epidemiological research to capture socioeconomic status. These are typically education level, occupational social class, and income, but indicators of wealth and of area-based socioeconomic circumstances, as well as wider sociodemographic factors, are increasingly considered to be important.
- In both descriptive and analytical epidemiology studies, the link between socioeconomic status and health inequalities can be measured in absolute or relative terms; these capture different aspects of the inequality burden, and can differ in direction, magnitude, and resulting interpretations.
- It is recommended that social inequalities in cancer be measured and monitored using both absolute and relative measures.

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