PART 1.

EVIDENCE OF SOCIAL INEQUALITIES IN CANCER

CHAPTER 5.

Social inequalities in cancer between countries

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Introduction

Omran's theory of epidemiological transition focused on how changing health and disease patterns interact with societal, economic, and demographic factors (Omran, 1971). In particular, in the third stage of the transition, the model describes how chronic diseases increase as life expectancy rises beyond age 70 years and mortality from degenerative diseases is postponed to older ages. This late-stage transition is analogous to the rising prominence of noncommunicable diseases (NCDs), which in the past decades have surpassed communicable diseases as the leading cause of death worldwide (WHO, 2016).

Cancer has emerged as an important NCD. The growing elderly population and continuing declines in deaths from cardiovascular disease are steadily increasing the relative share of cancer mortality, heightening the influence of cancer on future mortality patterns and making the disease the main obstacle to continued improvements in life expectancy. With an estimated 14 million new cancer cases and 8 million cancer-related deaths occurring in 2012 worldwide (Ferlay et al., 2015), a growing recognition of cancer as a public health priority is exemplified by the adoption of a new cancer resolution by governments from around the world at the Seventieth World Health Assembly, in 2017 (WHA, 2017a, b).

Although once considered the preserve of the rich and of the inhabitants of the countries of highest income, cancer is a global problem that affects all nations; two thirds of cancer deaths occur in countries transitioning socially and economically to higher levels of the Human Development Index (HDI) (referred to here as "transitioning countries") (Bray et al., 2012; Ferlay et al., 2015).

The increasing magnitude of cancer is partly a consequence of declining fertility and increasing longevity (leading to population growth and ageing), but it is also the result of societal, economic, and lifestyle changes associated with globalization. In this chapter we present a global framework of the impact of cancer transitions on cancer occurrence worldwide. We

illustrate the profound effects on the patterns and trends in cancer that will lead to projected increases in the magnitude of the disease, and show how they can be linked to changing levels of human development.

We comment on inequalities between countries as a result of such transitions in terms of cancer incidence and mortality, using either the numbers of new cancer cases (or deaths) or incidence (or mortality) rates. An exploration of inequalities in cancer outcomes between countries, in terms of benchmarking cancer survival in transitioning countries, is provided in Focus 3.

Finally, it is important to note that the national measures examined in this chapter do not consider inequalities within countries; this topic is covered in Chapter 6.

The Human Development Index

As described in Chapter 4, HDI is a summary indicator of national average achievement in terms of three areas of human development: a long and healthy life (based on life expectancy at birth), knowledge (based on mean and expected years of schooling), and a decent standard of living (based on gross national income per capita) (UNDP, 2015, 2018). The composite measure ranges from 0 to 1, with lower values indicating the least developed nations in terms of human development and higher values representing the most developed nations. It is commonly presented according to the predefined cut-off points of the United Nations Development Programme, representing four tiers of HDI: low, medium, high, and very high.

As shown in Fig. 5.1a, low-HDI countries are largely concentrated in sub-Saharan Africa, although several countries in this region have now transitioned to the group of medium-HDI countries, which are geographically diverse. High-HDI countries comprise the largest group, including many in Asia and South America. The group with very high HDI is closest to the traditional view of developed countries; it includes Australia, Europe, Japan, New Zealand, and North America as well as several countries in Asia, the Eastern Mediterranean, and South America.

Cancer burden and profile by HDI category in 2012

When HDI values are compared with the GLOBOCAN 2012 estimates of country-specific all-cancer incidence rates at the national level for 2012 (Ferlay et al., 2013), a strong link between HDI and incidence is observed; in particular, national incidence rates are increasing rapidly with increasing HDI levels (Figs. 5.1b and 5.2a). To illustrate, 41% of the total number of

Fig. 5.1. Global maps of: (a) Human Development Index, 2012; (b) all-cancer age-standardized incidence rates per 100 000 people; and (c) all-cancer age-standardized mortality rates per 100 000 people. Source: reproduced from Ferlay et al. (2013).

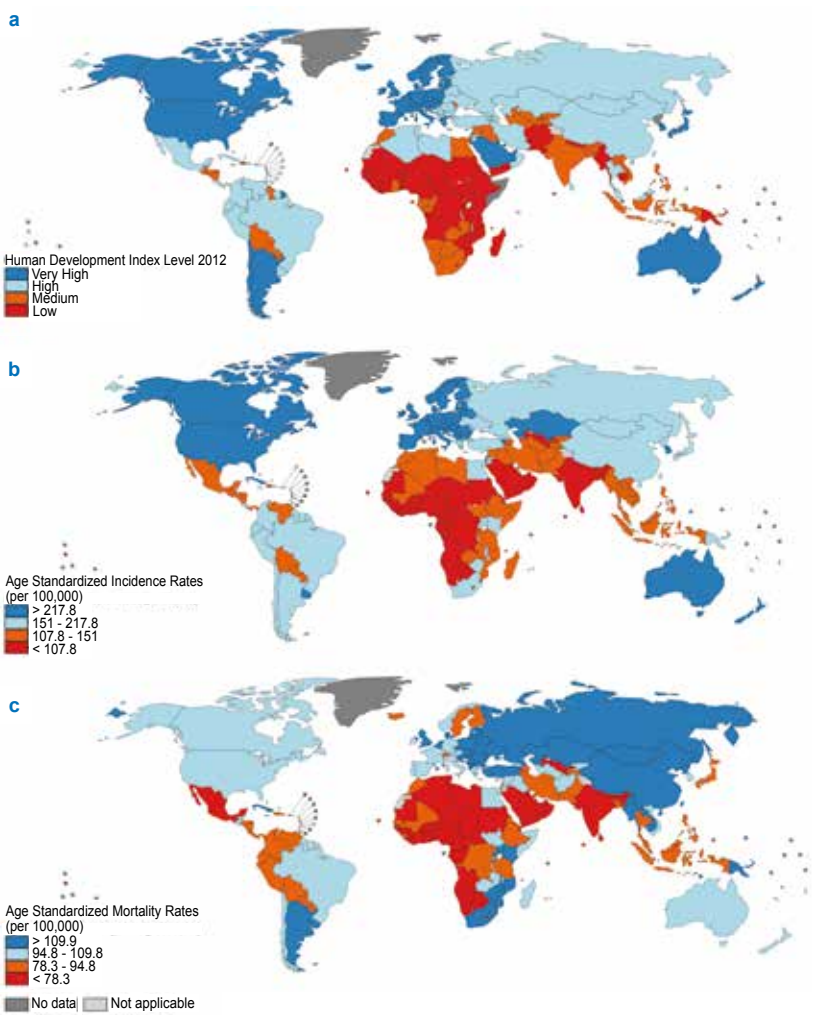


Fig. 5.2. Country-specific age-standardized all-cancer (a) incidence and (b) mortality rates by Human Development Index. Source: reproduced from Ferlay et al. (2013).

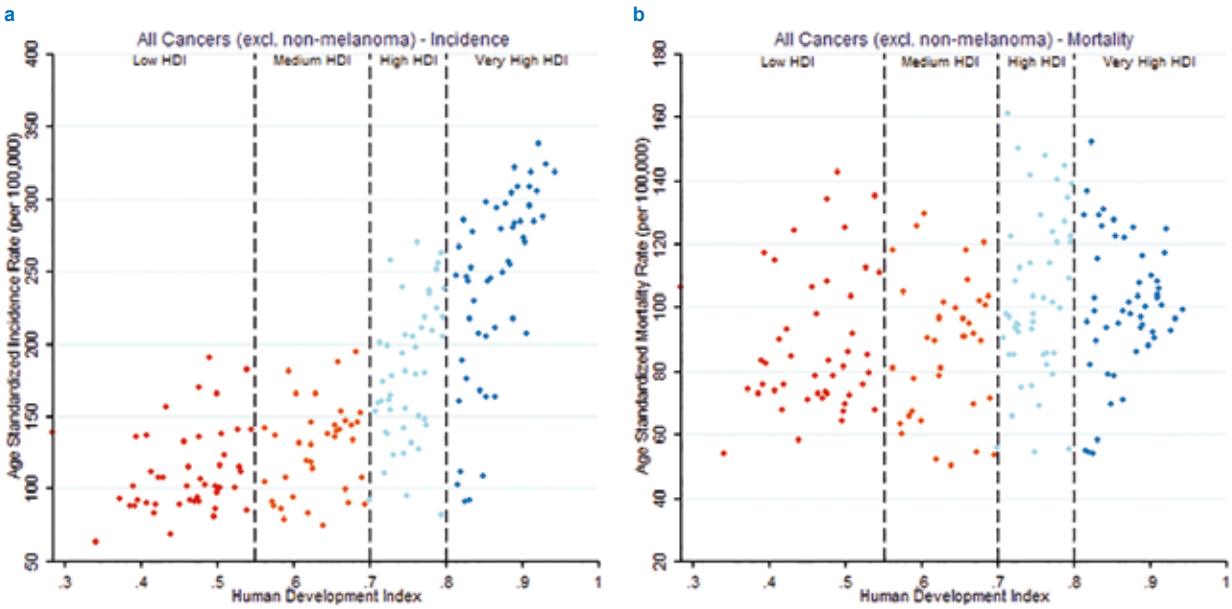
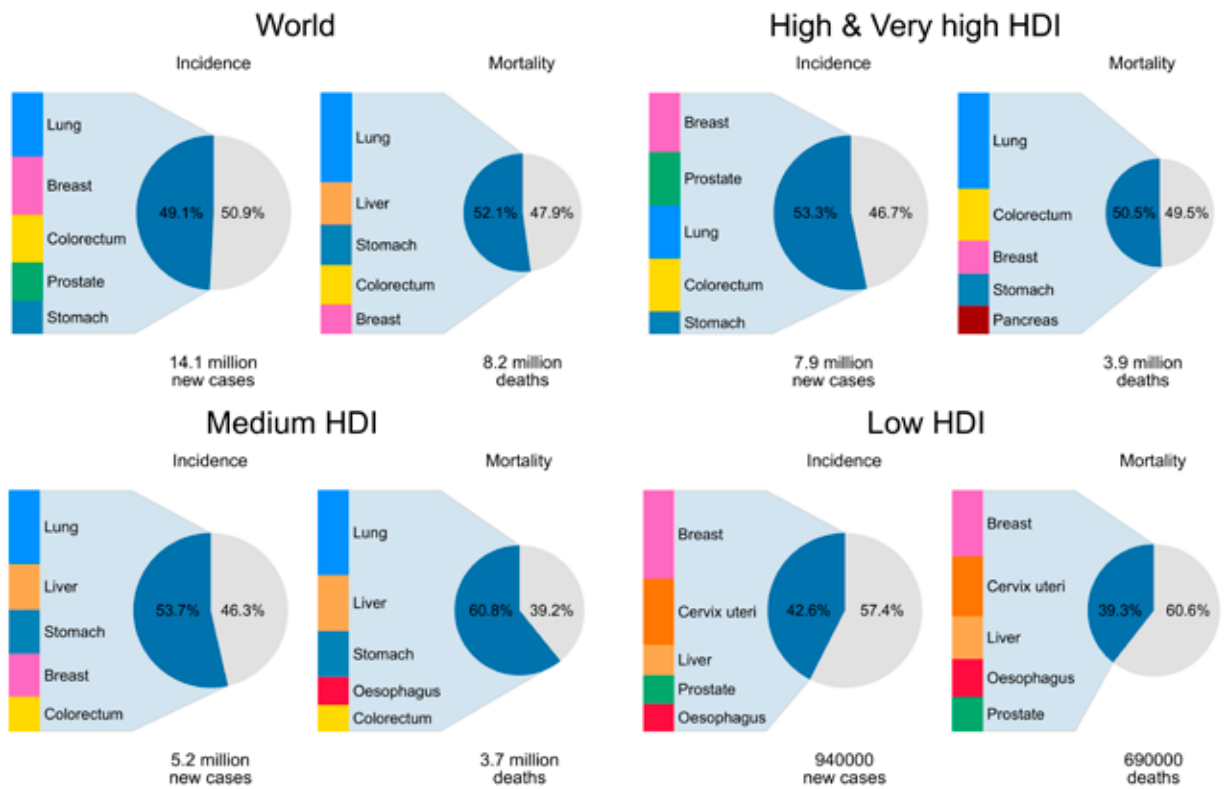


Fig. 5.3. The five most frequent cancer types in terms of incident cases and deaths, globally and by Human Development Index. Source: reproduced from Ferlay et al. (2013).



new cancer cases in 2012 occurred in countries with very high HDI, compared with 28%, 16%, and 6% in countries with high, medium, and low HDI, respectively (Ferlay et al., 2013). There is little correlation between the cancer mortality rates and the HDI level of any country, however, as illustrated in Figs. 5.1c and 5.2b.

The cancer profile of a country, that is, the five most common types of cancer in terms of both new cases and deaths, is dependent upon the HDI level (Fig. 5.3). The difference between countries with low HDI and high HDI is stark; a high residual burden of infection- and poverty-related cancers is observed in countries with low HDI, where cancers of the cervix, liver, and oesophagus are leading cancers, compared with countries with high or very high HDI, where the most frequent cancers are those of the prostate, breast, colorectum, and lung (Bray et al., 2004, 2010; Fidler et al., 2016). In countries with medium HDI, there is still a large burden of infection-related cancers, including cancers of the stomach, liver, and oesophagus. The increasing incidence burden of infection-related cancers with decreasing HDI level is highlighted when quantifying the population-attributable fractions by HDI level; in 2012, the proportion of new cancer cases attributable to infectious agents was 25.3%, 21.5%, 13.2%, and 7.6% in countries with low, medium, high, and very high HDI, respectively (Plummer et al., 2016).

Evidence of cancer transitions linked to HDI

Colorectal cancer rates can be considered a marker of human development; national incidence increases with some consistency with increasing HDI level; rates in countries with very high HDI are many times higher than those in countries with low HDI in both sexes (Bray, 2014). Trends in age-standardized incidence rates of colorectal cancer in men are plotted against trends in national HDI in selected countries (those with high-quality population-based cancer registries) in Fig. 5.4, in which is it evident that colorectal cancer incidence increases in parallel with increasing HDI in most countries (Arnold et al., 2016; Fidler et al., 2017). It also appears that colorectal cancer incidence rates have stabilized or declined quite recently in several countries that have attained very high HDI levels, including Australia, Japan, and the USA; this may be due to multiple factors, including colorectal cancer screening and a changing prevalence of the

Fig. 5.4. Temporal trends in age-standardized incidence rates (ASR) of colorectal cancer in men and in Human Development Index (HDI) for selected countries. *, countries without a national cancer registry, but combined regional registries. Source: reproduced from Forman et al. (2013).

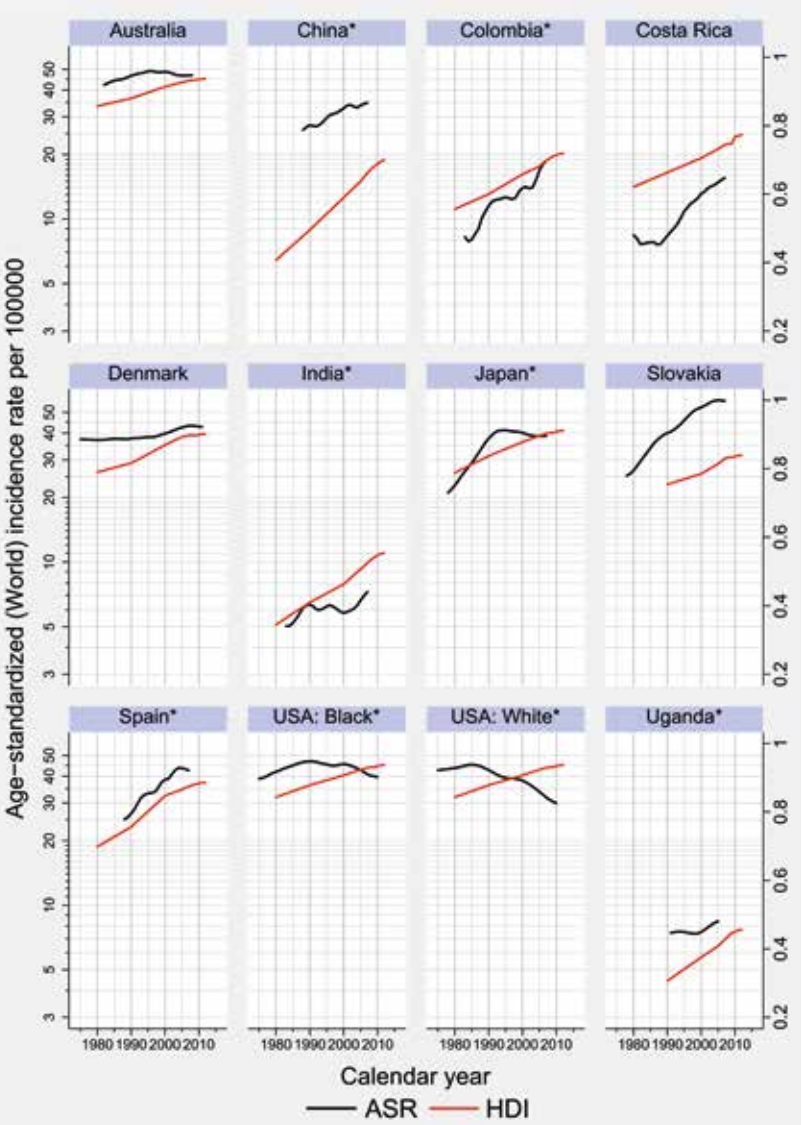
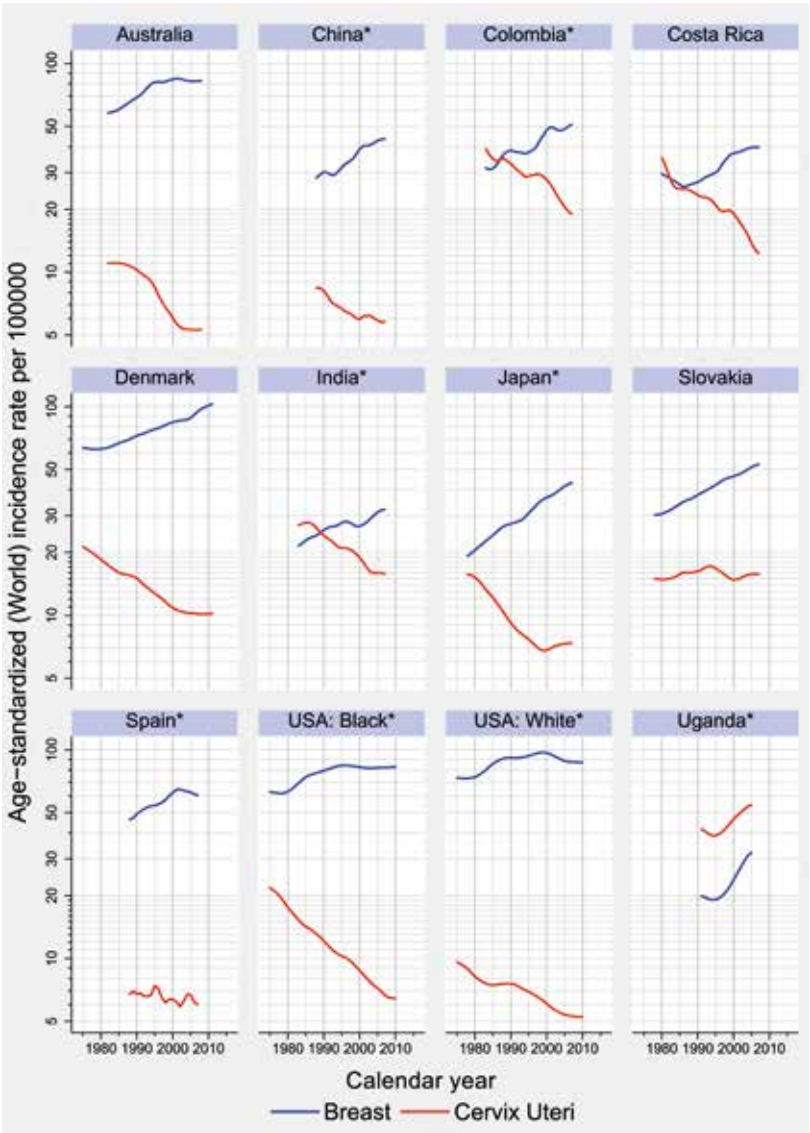


Fig. 5.5. Temporal trends in age-standardized incidence rates of breast cancer and cervical cancer for selected countries. *, countries without a national cancer registry, but combined regional registries. Source: reproduced from Forman et al. (2013).



putative risk factors, protecting against the disease (Arnold et al., 2016). The corresponding decline in mortality rates is a direct result of falling incidence, but also a result of a number of improvements in treatment and cancer care.

The evolution of breast cancer and cervical cancer in women (Fig. 5.5) is another example of how HDI levels can be linked to changing risks of specific cancers. Cervical cancer accounts for up to one third of all neoplasms diagnosed in both sexes in some countries with low HDI, particularly in sub-Saharan Africa, and breast cancer incidence rates in countries with very high HDI are approximately 3 times those in countries with low HDI. In contrast, mortality rates for breast cancer vary much less than incidence rates with HDI level; the much higher incidence-to-mortality ratio in countries with high and very high HDI compared with countries with low HDI most likely reflects the inequalities in survival and prognosis between countries of different socioeconomic development.

Breast cancer is a highly frequent cancer across countries of all HDI levels (Fidler et al., 2016; Ginsburg et al., 2017), and a general observation has been one of rising incidence. This has been offset by declining incidence rates of cervical cancer in more developed and transitioning countries, the year in which the two cancers are equally common, with one trending up and other down, being a marker of the extent of transition in a given country (Stewart and Wild, 2014). Fig. 5.5 demonstrates that this convergence must have occurred in the distant past in countries with very high HDI (e.g. Australia, Denmark, and the USA), but occurred more recently for countries with medium or high HDI (e.g. Colombia, Costa Rica, and India).

On the basis of the trends from the high-quality cancer registry in Kampala in Uganda, a low-HDI country, this transition has yet to occur (Wabinga et al., 2014), with the incidence rate of cervical cancer remaining twice that of breast cancer. Trends are similar in the Barshi population in rural India (Badwe et al., 2014). The large differences in rates and the direction of trends are an indication of barriers to cervical cancer control in countries with lower HDI, where preventive and screening programmes have been largely absent. Conversely, the increasing burden of breast cancer is related to changes in reproductive and hormonal factors (some of which are considered protective for cervical cancer) and an increased prevalence of obesity

at postmenopausal ages, as well as mammographic screening in countries with higher HDI (Bleyer and Welch, 2012).

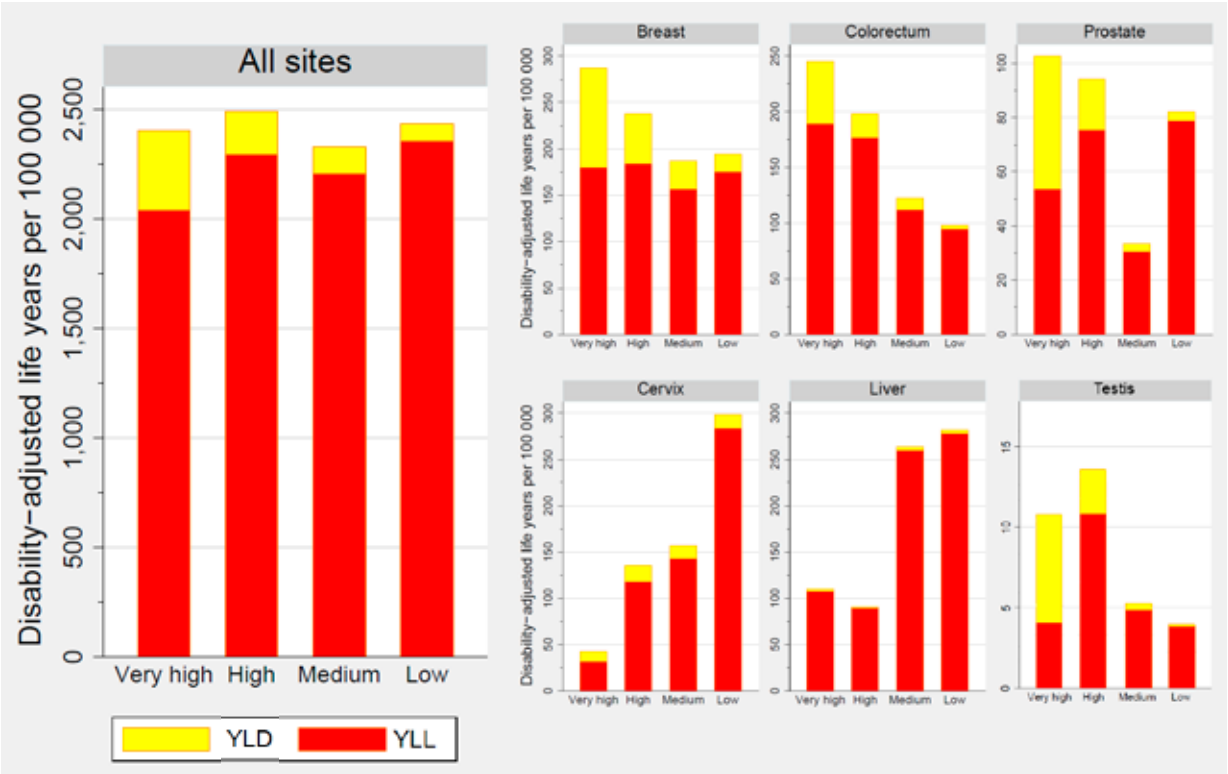
Inequalities in cancer between countries with different HDI levels

Although countries with higher HDI have a greater share of the overall cancer incidence burden, mortality rates are disproportionately higher in countries with lower HDI, as are the inequalities related to premature mortality and life expectancy gains. Projections of cancer rates also indicate that the greatest proportional increases in the number of cancer diagnoses will occur in countries with lower HDI. Some examples of inequality are illustrated in the following.

Disability-adjusted life years

Disability-adjusted life years (DALYs) is a measure that combines the degree of illness and disability in patients and long-term survivors in terms of years lost because of disability (YLD) and the burden of cancer mortality in terms of years of life lost (YLL) to quantify the number of years of healthy life lost. When assessed at the global level for all cancers, measures of DALYs are actually rather similar across the four tiers of HDI (Fig. 5.6) (Soerjomataram et al., 2012a). However, inequalities in the contribution of YLL and YLD to total DALYs are evident between countries with different HDI levels. In general, individuals in countries with higher HDI were observed to live a greater number of years with disability, whereas individuals in countries with lower HDI were observed to have a greater burden of premature mortality. When assessed by specific types of cancers, YLL was observed to be the main contributor to DALYs overall. YLD contributed to a greater proportion of DALYs in higher-HDI countries compared with lower-HDI countries, whereas YLL contributed to a greater proportion of DALYs in lower-HDI countries compared with higher-HDI countries, although the extent of these relationships varied with cancer site. The fact that the fraction of DALYs due to YLL was consistently greater in lower-HDI countries is an indication of the poor prognosis for cancer patients in developing countries, and highlights the need for prevention and treatment programmes in these countries

Fig. 5.6. Age-adjusted disability-adjusted life years per 100 000 people by cancer site and Human Development Index level. YLD, years lost because of disability; YLL, years of life lost. Source: reproduced from Soerjomataram et al. (2012b), copyright 2012, with permission from Elsevier.



to reduce inequalities in non-fatal and fatal cancer-related outcomes worldwide.

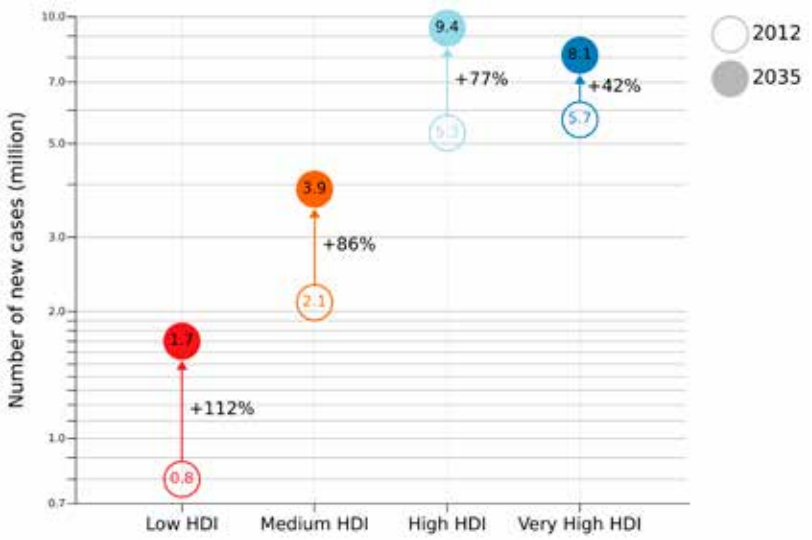
Gains in life expectancy

In a study assessing the impact of all-cancer mortality trends on overall life expectancy over the period 1981–2010, countries with very high HDI were found to make larger gains in life expectancy relative to countries with medium and high HDI (Cao et al., 2017). More specifically, reductions in cancer mortality were responsible for improving life expectancy by 0.8 years for men and 0.5 years for women, respectively, for individuals aged 40–84 years in countries with very high HDI, whereas the corresponding gain was 0.2 years for both men and women in countries with medium and high HDI. Similar inequalities in life expectancy gains would have been observed in the hypothetical situation that all cancer deaths were eliminated: for the period 2006–2010, life expectancy gains were estimated to be 2.5 years for men and 1.9 years for women for individuals aged 40–84 years in countries with very high HDI, compared with 1.6 years for men and 1.5 years for women in countries with medium and high HDI. These results provide evidence of disproportional improvements in cancer rates according to HDI level, leading to widening gaps in life expectancy between more and less developed nations.

Future burden

The projections of future cancer burden depicted in Fig. 5.7 show how the increase in numbers of new cancer cases will be proportionally greatest in countries with lower HDI; it has been estimated that countries with low and medium HDI will experience a 112% and 86% increase, respectively, in the incidence of cancer from 2012 to 2035. Because these countries are the least equipped to deal with such a pending increase in cancer patients, the projections highlight the necessity for investment in targeted, resource-dependent, effective, and cost-effective interventions that will reduce the burden of and suffering from the disease.

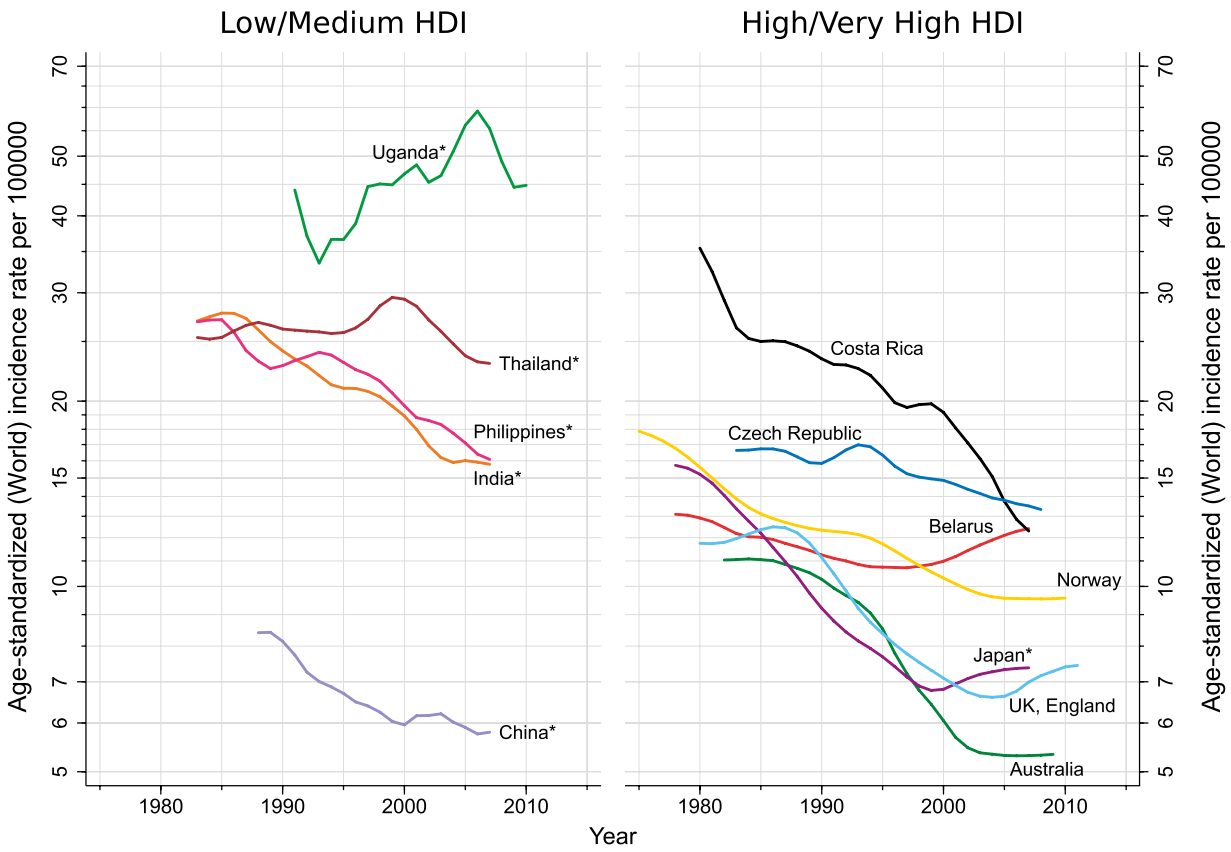
Fig. 5.7. Projections of future cancer burden by Human Development Index (HDI) level. Source: reproduced from Ferlay et al. (2013).



Evidence of regional diversity

Increasing average levels of societal and economic indicators are linked to a changing scale and profile of cancer at the individual and grouped HDI levels. However, this serves only to identify that a myriad of factors – some risk-related (reproductive, dietary, metabolic, and hormonal) and some systems-related (including the extent of cancer plans and the population-wide implementation of effective interventions) – can increase (or fail to reduce) the risk of developing or dying from certain (preventable or treatable) cancers. Fig. 5.3 also captures the complexity and diversity of cancer patterns and trends. For example, breast cancer has the leading incidence rates worldwide irrespective of HDI level, yet stomach cancer remains a common cancer even within several countries with high and very HDI, and ranks as the fifth and fourth most common cancer in this tier in terms of incidence and mortality, respectively. The temporal development of cervical cancer is another example of a complex and diverse trend between countries. Although there have been systematic reductions in cervical cancer incidence in countries with medium and high HDI, the 40-year trends in incidence rates depicted in Fig. 5.8 highlight the recent increases in countries with high HDI (e.g. Belarus) and very high HDI (e.g. Japan). These increases can be linked to several factors, including changing sexual behaviours (increasing the risk of persistent infections by high-risk human papillomavirus subtypes), the continued absence of organized screening programmes (Vaccarella et al., 2013, 2016), and the low, or

Fig. 5.8. Age-standardized (World) cervical cancer incidence rates per 100 000 by calendar year for selected populations, 1975–2012. Source: reproduced from Forman et al. (2013).



*: China (Hong Kong and Shanghai), India (Chennai and Mumbai), Japan (Miyagi, Nagasaki and Osaka), Philippines (Manila), Thailand (Chiang Mai), Uganda (Kampala).

diminishing, compliance in countries where screening programmes exist. As a consequence, the incidence of cervical cancer in these countries is increasing, particularly among recent generations of women.

Conclusions

That heterogeneity in the magnitude of cancer incidence within HDI levels remains is not surprising given the extent to which local risk factors, alongside the presence or absence of medical intervention, serve to modulate the national cancer burden. However, HDI level does provide a useful framework to map the continuing transitions in cancer and highlight the stark reality of the increasing burden in countries with lower HDI compared with countries with higher HDI. Although the cancer incidence rates are higher in countries with very high HDI, those living in countries with low HDI experience disproportionately higher mortality, and are projected to be most affected by the disease in the near future. These inequalities can only be expected to increase unless established effective and cost-effective interventions (WHA, 2017a, b; WHO, 2017) are urgently implemented.

Finally, with cancer projected to become the leading cause of mortality worldwide in the coming decades as deaths from cardiovascular diseases decline, it is increasingly evident that cancer control initiatives will also play an important role in decreasing inequalities in all-cause mortality. The development and implementation of effective, affordable, feasible, and sustainable cancer control measures in transitioning countries can therefore be seen as an effort to not only decrease inequalities in cancer but also decrease inequalities across the spectrum of causes.

Key points

- Major inequalities in cancer outcomes exist between countries. Assigned values of the Human Development Index (HDI), a proxy for the socioeconomic development of a country, can be linked to the corresponding cancer magnitude and profile to explain cancer transitions at the national level.
- The rapid rise in all-cancer incidence rates with increasing levels of HDI contrasts with the lack of a clear correlation between all-cancer mortality rates and HDI levels. A high residual burden of infection- and poverty-related cancers is observed in low-HDI countries. In several medium- and high-HDI countries, often those undergoing major social and economic transitions, marked declines in rates of these cancer types are offset by increasing rates of cancers more frequently observed in transitioned (very high HDI) countries.
- Premature cancer mortality in terms of years of life lost is highest in low-HDI countries and declines with increasing HDI. Conversely, for treatable cancers associated with major sequelae after diagnosis, the number of years of disability increases as HDI increases and is highest in countries with very high HDI.
- The global cancer burden is predicted to exceed 20 million new cancer cases annually by 2025, compared with an estimated 14.1 million new cancer cases in 2012; relative increases are greatest in lower-HDI countries.
- Although evident, the role of human development in global cancer transitions cannot be overgeneralized, given the complexity of the disease. There are clear examples of national and regional cancer diversity that depart from this model.

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