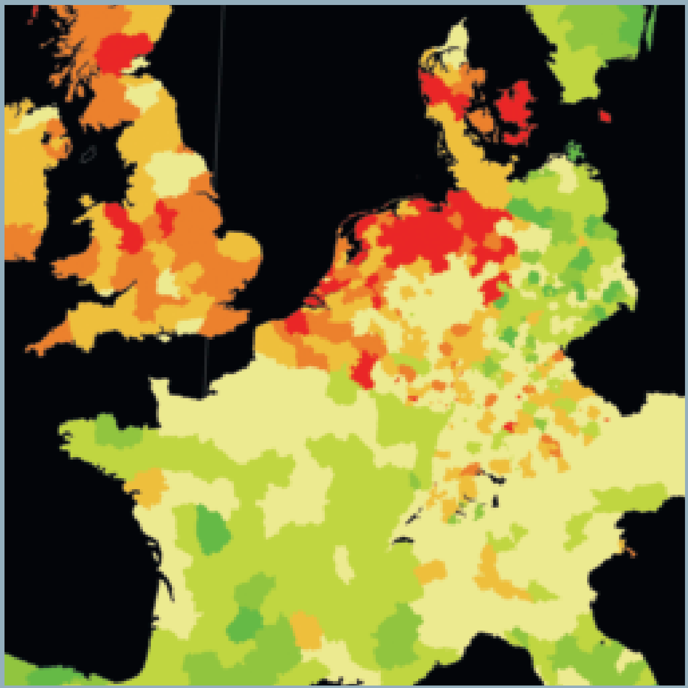
The global burden of cancer

Cancer is a major disease burden worldwide but there are marked geographical variations in incidence overall and at specific organ sites. Reliable estimation of the number of new cases (incidence) requires population-based cancer registration. Compilation of worldwide age-standardized cancer rates allows the identification of countries and regions where particular tumour types are most common. Such differences usually reflect exposure to distinct causative environmental factors. In addition to providing data on the distribution of neoplastic disease, descriptive epidemiology provides the basis for prevention, health service planning and resource allocation.



THE GLOBAL BURDEN OF CANCER

SUMMARY

> Worldwide, approximately 10 million people are diagnosed with cancer annually and more than 6 million die of the disease every year; currently, over 22 million people in the world are cancer patients.

> All communities are burdened with cancer, but there are marked regional differences. The total cancer burden is highest in affluent societies, mainly due to a high incidence of tumours associated with smoking and Western lifestyle, i.e. tumours of the lung, colorectum, breast and prostate.

> In developing countries, up to 25% of tumours are associated with chronic infections, e.g. hepatitis B virus (liver cancer), human papillomaviruses (cervical cancer), and *Helicobacter pylori* (stomach cancer).

> Differences in the regional distribution of cancer and its outcome, as documented by a worldwide network of population-based cancer registries, help to identify causative factors and those influencing survival.

> In some Western countries, cancer mortality rates have recently started to decline, due to a reduction in smoking prevalence, improved early detection and advances in cancer therapy.

Cancer afflicts all communities. Worldwide, the burden of disease impinges on the lives of tens of millions annually. Based on the most recent incidence and mortality data available, there were 10.1 million new cases, 6.2 million deaths and 22.4 million persons living with cancer in the year 2000 [1]. This represents an increase of around 19% in incidence and 18% in mortality since 1990.

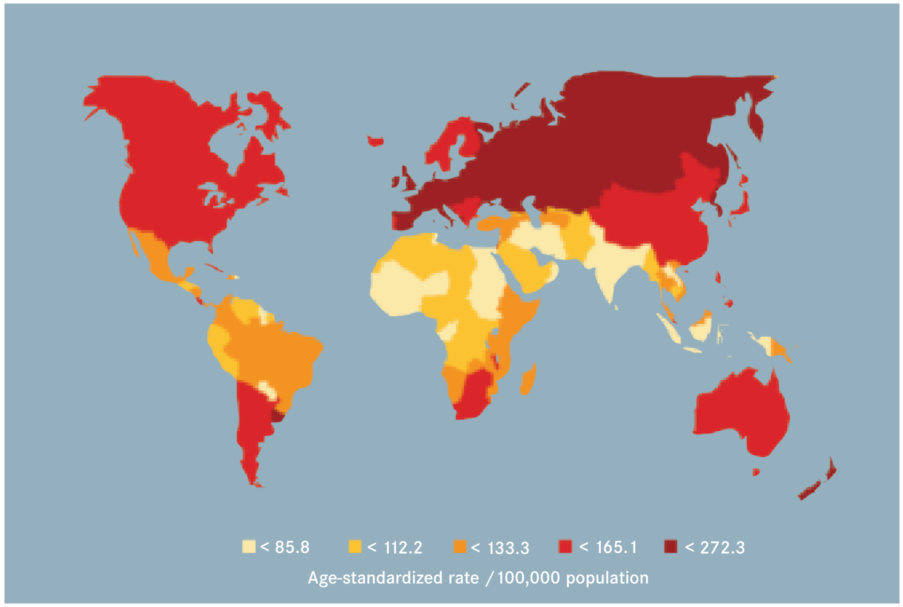


Fig. 1.1 Mortality rates in men for all cancer sites combined, excluding non-melanoma skin cancer. The highest rates are recorded in affluent countries.

Cancer involves a pathological breakdown in the processes which control cell proliferation, differentiation and death of particular cells. Most commonly, the malignant cells which form a tumour arise from epithelial tissue (i.e. tissue which has a secretory or lining function) and are termed “carcinoma”. In many organs (breast, lung, bowel, etc.), most cancers are carcinomas. While having certain characteristics in common, different types of cancer have very different causes and show widely differing response to treatment. The biological basis of malignant transformation, the influence of environmental factors and options for prevention, screening and treatment are addressed in this Report. This chapter delineates the burden of cancer in numerical terms by reference to incidence, mortality and prevalence (Box: *Terms used in cancer epidemiology*, p18) on the basis of data generated through cancer registries and vital statistics systems (death registration).

The major cancer types

In terms of incidence, the most common cancers worldwide (excluding non-melanoma skin cancers) (Fig. 1.2) are lung (12.3% of all cancers), breast (10.4%) and colorectum (9.4%). For any disease, the relationship of incidence to mortality is an indication of prognosis, similar incidence and mortality rates being indicative of an essentially fatal condition. Thus, lung cancer is the largest single cause of deaths from cancer in the world (1.1 million annually), since it is almost invariably associated with poor prognosis. On the other hand, appropriate intervention is often effective in avoiding a fatal outcome following diagnosis of breast cancer. Hence this particular cancer, which ranks second in terms of incidence, is not among the top three causes of death from cancer, which are respectively cancers of the lung (17.8% of all cancer deaths), stomach (10.4%) and liver (8.8%).

The most conspicuous feature of the distribution of cancer between the sexes is

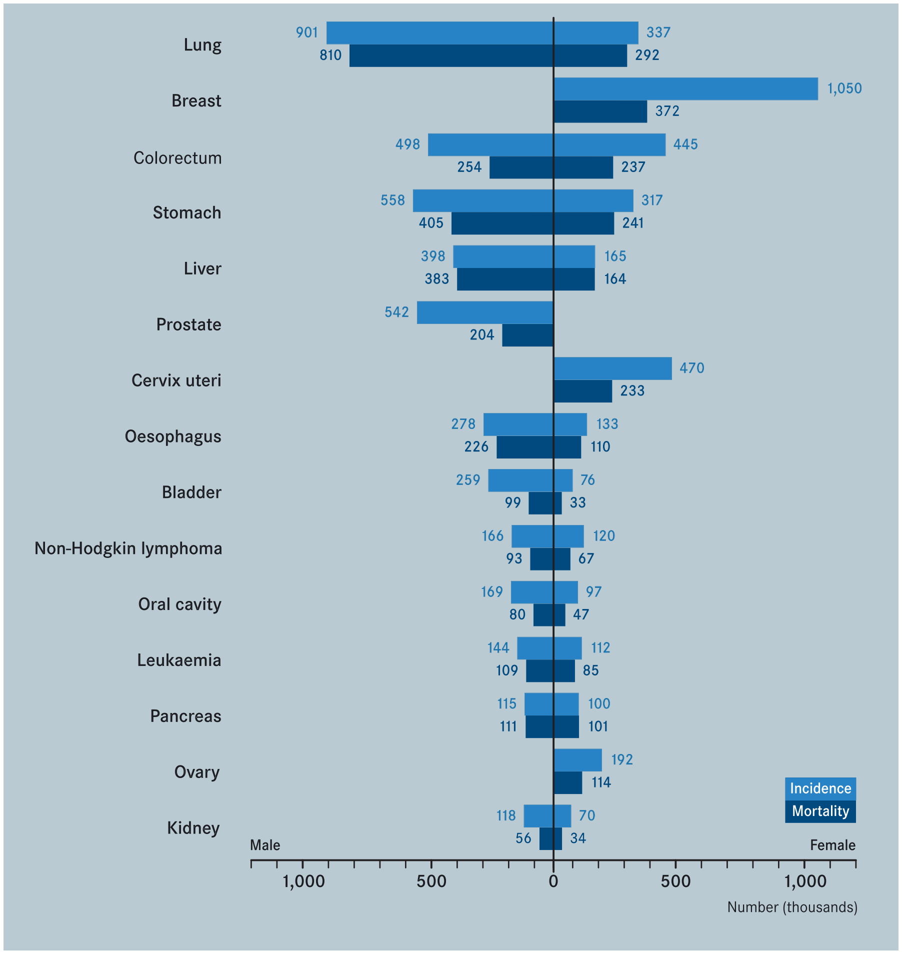


Fig. 1.2 Incidence and mortality of the most common cancers worldwide.

the male predominance of lung cancer (Fig. 1.2). Stomach, oesophageal and bladder cancer are also much more common in males. For the most part, differences in distribution between the sexes are attributable to differences in exposure to causative agents rather than to variations in susceptibility. For other tumour types, including cancers of the colorectum and pancreas, there is little difference in the sex distribution. Generally speaking, the relationship of incidence to mortality is not affected by sex. Thus, for example, the prognosis following diagnosis of liver or pancreatic cancer is dismal for both males and females. Many other tumour types are more responsive to therapy, so that cancers of breast, prostate and uterine cervix, for example, are the cause of death in only a minority of patients diagnosed.

The burden of cancer is distributed unequally between the developing and developed world, with particular cancer types exhibiting different patterns of distribution (Fig. 1.7). All of Europe, Japan, Australia, New Zealand and North America are classified here as more developed regions, whilst Africa, Latin America and the Caribbean, Asia (excluding Japan), Micronesia, Polynesia and Melanesia are classified as developing or less developed regions.

As discussed in later chapters, many differences in the distribution of cancer between regions are explicable with reference to etiological factors. For example, populations in developing countries are vulnerable to cancers in which infectious agents (and associated non-malignant diseases) play a significant role [2] (*Chronic infections*, p56). These include cancers of the stomach, uterine cervix, liver and possibly oesophagus. Conversely, there are other cancers – exemplified by cancers of the colorectum and prostate – where the burden of disease falls disproportionately on the developed world. These observations seem to be largely attributable to differences in lifestyle, with dietary factors believed to be of major significance.

Monitoring

The extent of variation in the impact of cancer between different regions of the world has been studied for more than 50 years. Data permitting such comparisons come from cancer registries and from local and national health statistics, with respect to deaths from cancer. The completeness and accuracy of data accumulated by cancer registries has progressively increased, as has the proportion of the

Fig. 1.3 In some regions, waters are the source of chronic *Schistosoma haematobium* infection which may cause bladder cancer.

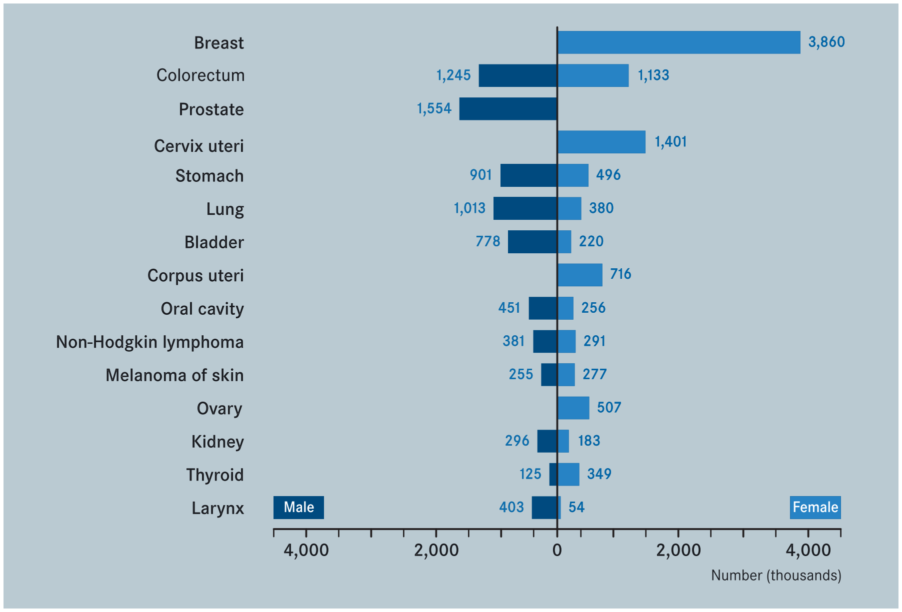


Fig. 1.4 The most prevalent cancers worldwide in 2000, expressed as thousands of persons diagnosed with cancer within the previous five years.

world's population included in such databases.

The International Agency for Research on Cancer has played a primary role in the establishment of cancer registries, the accreditation of data collection procedures and the integration and reporting of findings [3]. An aspect of this work has been publication of the volumes *Cancer Incidence in Five Continents* [4].

Incidence data are available from cancer registries. For this Report, incidence rates for a country were obtained whenever possible from cancer registries serving the whole population, or a representative sample of it. The number of cancer registries has increased steadily over the years. Registries cover entire national populations, selected regions or sub-samples of selected regions. Registries also provide statistics on cancer survival. With data on incidence and on survival, the prevalence of cancer (number of persons living with cancer that was diagnosed within the preceding five years) can be estimated. Mortality data by cause are available for many countries because of registration of vital events (birth and death), although the degree of detail and quality of the data (both in terms of the accuracy of the recorded cause of death and the completeness of registration) vary considerably.

The most recent national mortality data from the WHO mortality data bank were used to obtain information on cancer deaths. For some countries a correction factor was applied to account for known and quantified under-reporting of mortality.

In the absence of either of these data sources, an estimate of cancer incidence was built up from available information on the relative frequency of different cancers (by age-group and sex), applied to an overall "all sites" incidence figure for the corresponding area. These "all sites" figures were derived from such data as could be found for the corresponding geographic area.

For some countries, data on mortality could be found, but nothing on incidence. In this case, incidence was estimated using sets of regression models which, for a given area, cancer, sex and age group, predict incidence from mortality, based on cancer registry data from the same area. Conversely, incidence rates were available for some countries where there were no data on mortality. For these countries, information on cancer survival was used to obtain estimates of mortality. Prevalence was estimated from incidence and survival. Three sources of data on population-based survival were used: the *Cancer Survival in Developing Countries* project by IARC [5], which provides cancer survival data for populations of China, the Philippines, Thailand, India and Cuba for all of the sites considered; the SEER programme covering 10% of the US population [6] and the *EUROCARE II* project providing figures from several European cancer registries [7]. Estimates of the population of countries (by age and sex) for the year 2000 were taken from the 1998 UN population projections [8].

By these methods, comprehensive databases have been generated including information on the incidence, mortality, prevalence and age distribution of cancer for many countries and in some cases for local areas (or sub-populations) within countries. Additional information and the methods used to produce estimates of incidence, mortality, and prevalence are summarized elsewhere [9, 10]. Only a partial overview of the total available data is presented here.

Regional distribution of cancer

The incidence of cancer for 12 broad "regions" is shown in Figure 1.8. Even when considered in relation to such broad geographical areas, marked differences are apparent in terms of the sites of the most common tumours in a region, and the ranking of those cancer sites. Equally important, some similarities are evident.

The validity of contrasting cancer incidence in more and less developed countries (Fig. 1.7) is supported, at least in part, by the similar patterns of cancer incidence recorded for North America, Northern Europe, Western Europe and Oceania (predominantly Australia and New Zealand). In all these regions the predominant cancers are those of colorectum, lung, breast and prostate, the only deviation from this pattern being the emergence of melanoma as a major cancer in Australia and New Zealand. Both

Central and Southern Europe differ marginally from this pattern as a result of the relatively high incidence of stomach cancer. Bladder cancer occupies the fifth or sixth position in all these regions (except Oceania).

East Asia, which includes Japan and regions of China, comprises nations and communities divided between the “more developed” and “less developed” categories. Accordingly, the distribution of cancer is evocative of that in more developed regions with regard to lung, colorectal and breast cancer, but different insofar as cancers of the stomach, oesophagus and liver are of major concern. In the less developed world, there is no single grouping of cancers constituting a clear pattern; rather particular patterns are specific to broad regions.

Breast cancer is of importance to communities in both more and less developed countries. In contrast, cervical cancer is a particularly serious problem for much of the developing world including South Central Asia, sub-Saharan Africa and South America. Otherwise, there are cancers that are of singular significance to certain regions. Thus cancer of the oral cavity ranks high in South Central Asia, liver cancer is of particular relevance to sub-Saharan Africa and parts of Asia, while bladder cancer is a major problem for Northern Africa and Western Asia.

Possibilities for cancer prevention and treatment

As previously indicated, the overview of cancer in the world presented here represents a superficial examination of the comprehensive data that are available concerning the distribution of cancer. Despite the limitations of the present assessment, certain principles are clearly evident. The burden of cancer in the world varies according to the community. The extent of variation when subcontinental regions are compared is equally apparent at a national level and may be clear even at the local district level. As this Report describes, variation in cancer incidence is primarily explicable in terms of, and indicative of, the influence of particular risk factors. Many established risk factors operate as causes of disease, for which the relevant biological mechanisms are being progressively clarified. For the most part, understanding the causes of cancer

Fig. 1.5 Traffic emissions and other sources of atmospheric, soil and water pollution may account for as many as 4% of all cancers.

Fig. 1.6 A young mother from Senegal holding her son wearing a sweatshirt with cigarette industry logo.

provides an opportunity for cancer prevention or early detection. This transition

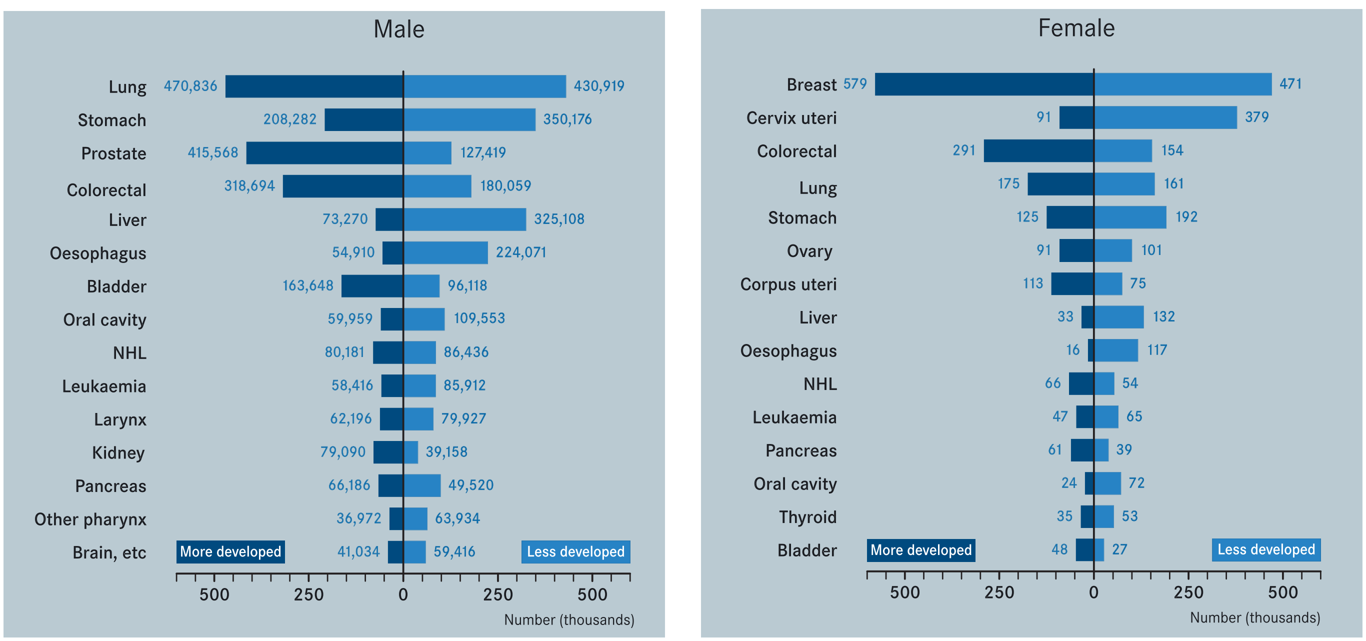
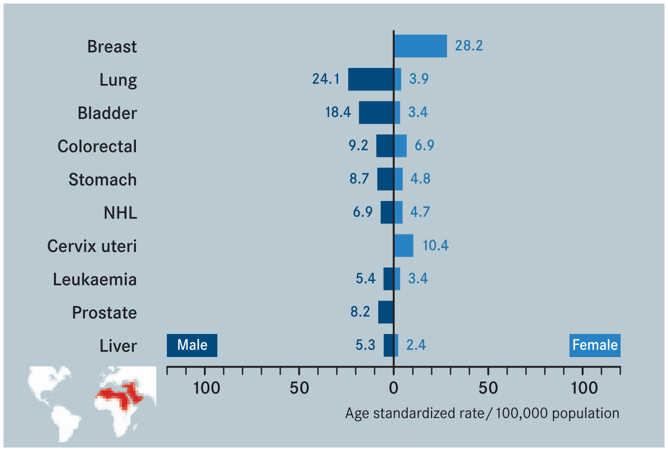
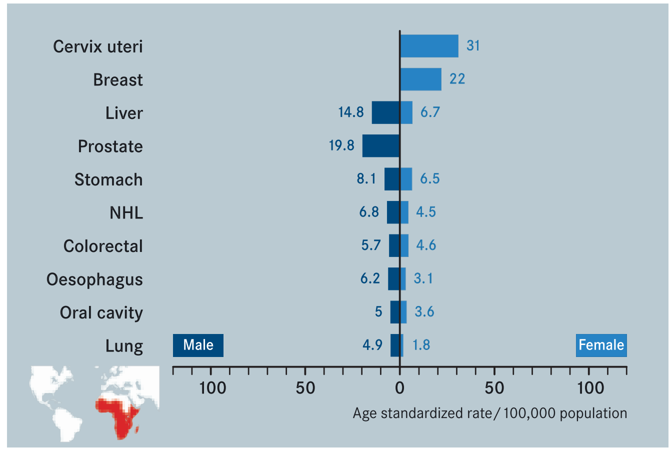


Fig. 1.7 Comparison of the most common cancers in more and less developed countries in 2000. NHL = Non-Hodgkin lymphoma.

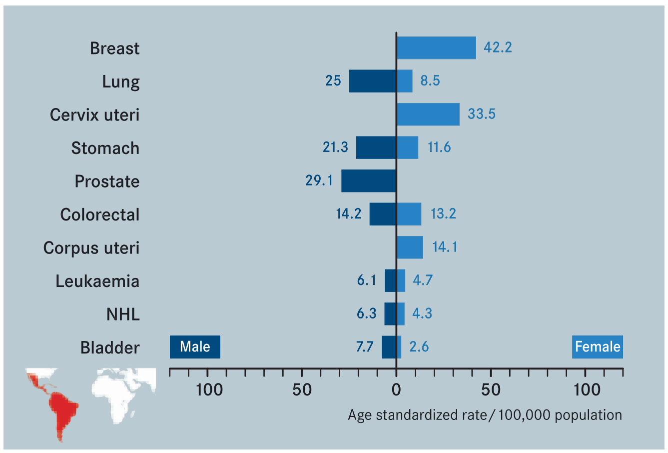
Fig. 1.8 Incidence of cancer in twelve world regions.



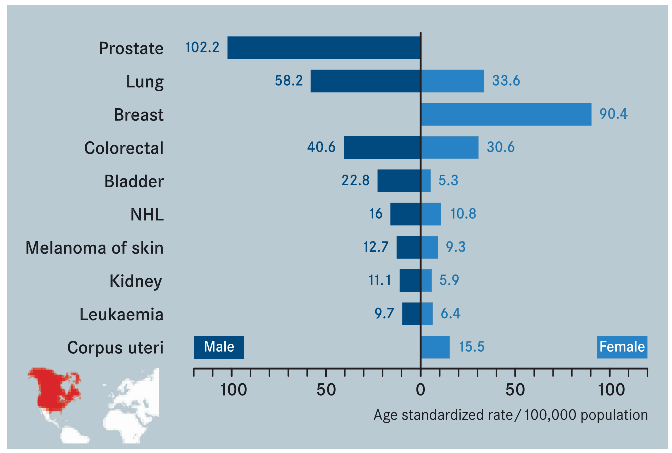
Incidence of cancer in North Africa and Western Asia.



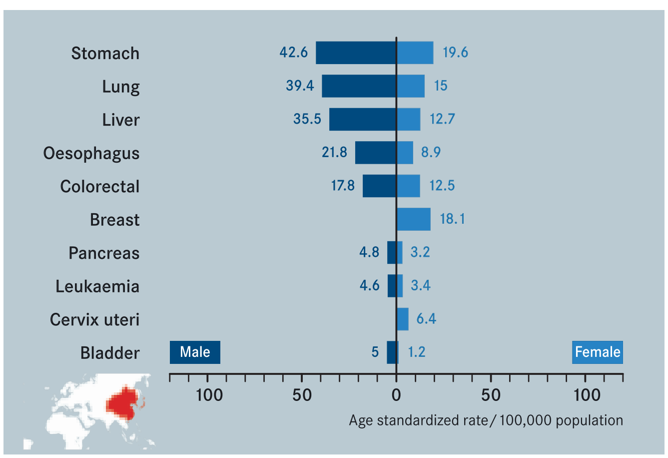
Incidence of cancer in sub-Saharan Africa.



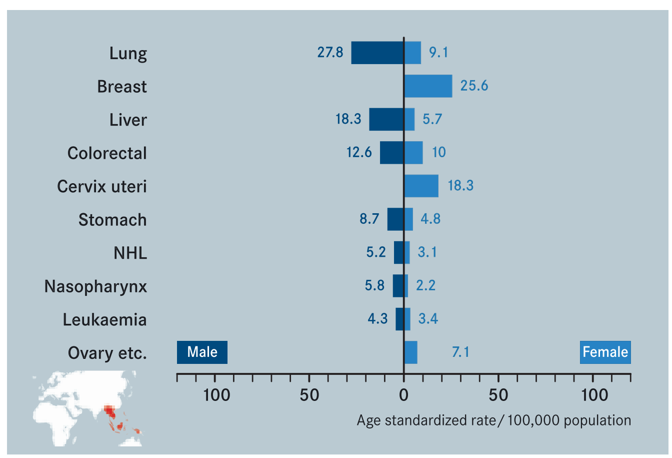
Incidence of cancer in South and Central America and the Caribbean.



Incidence of cancer in North America.

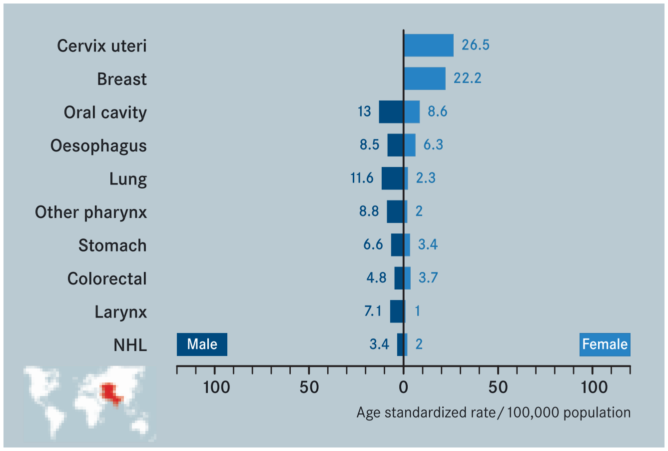


Incidence of cancer in Eastern Asia.

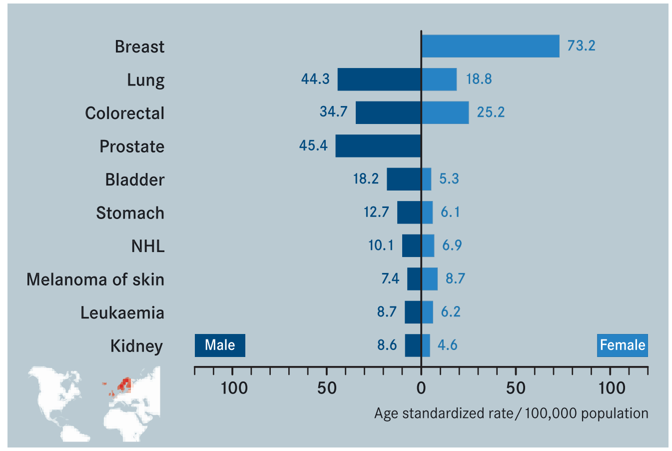


Incidence of cancer in South-Eastern Asia.

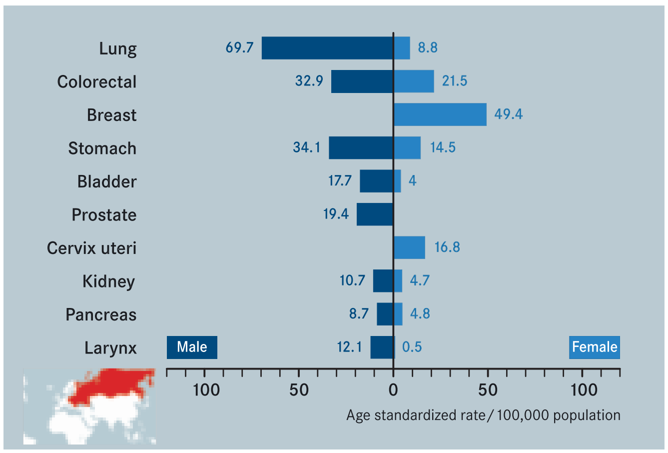
Fig. 1.8 Incidence of cancer in twelve world regions (continued).



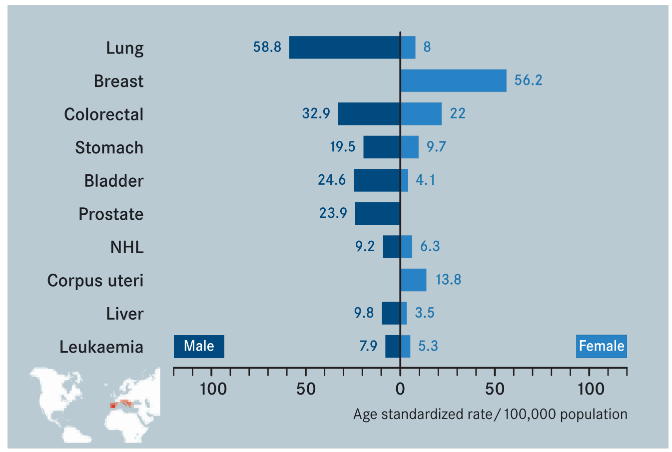
Incidence of cancer in South Central Asia.



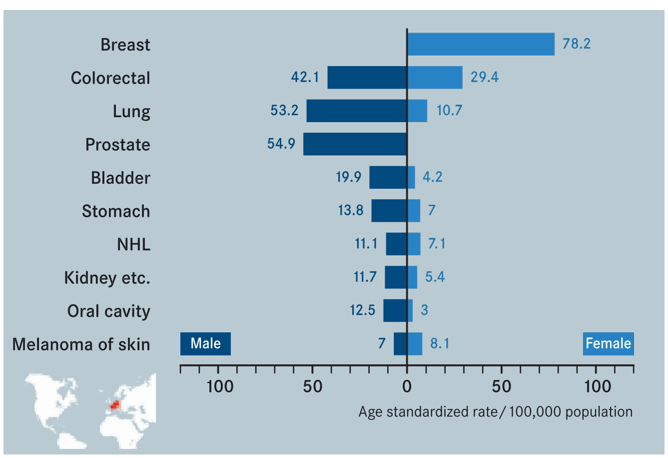
Incidence of cancer in Northern Europe.



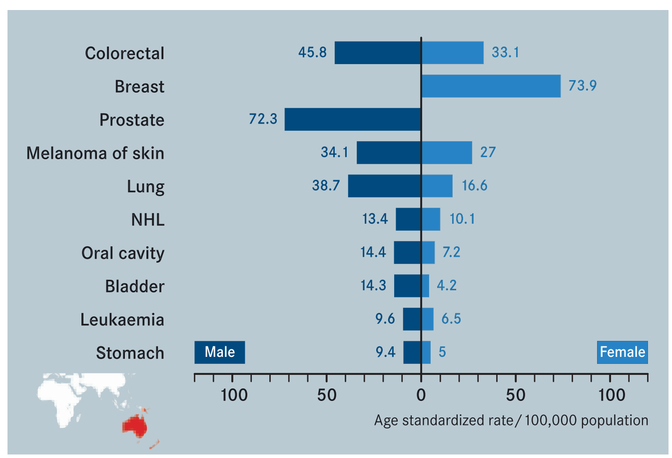
Incidence of cancer in Eastern Europe.



Incidence of cancer in Southern Europe.



Incidence of cancer in Western Europe.



Incidence of cancer in Oceania.

TERMS USED IN CANCER EPIDEMIOLOGY

There are several statistics that may be used to measure the burden of cancer in a given community. The following discussion is presented specifically in relation to cancer, though in most instances the terms discussed have general application.

Incidence is the number of new cases which occur. It can be expressed as an absolute number of cases per year or as a rate per 100,000 persons per year. The latter provides an approximation of the average risk of developing a cancer, which is useful in making comparisons between populations (countries, ethnic groups, or different time periods within a country for example).

Mortality is the number of deaths occurring, and the mortality rate is the number of deaths per 100,000 persons per year. The number of deaths provides one measure of the outcome, or impact, of cancer. It represents the product of the incidence and the fatality of a given cancer. "Fatality", the inverse of survival, is the proportion of cancer patients who die. Mortality rates therefore measure the average risk to the population of dying from a specific cancer, while fatality (1 minus survival) represents the probability that an individual diagnosed with cancer will die from it.

Rate Incidence, mortality and other data may be presented as rates, most often in relation to populations of 100,000.

Age-standardized rates (ASR) take into account differences in the age structure of the populations being compared. This is necessary because the risk of cancer is very powerfully determined by age; a population containing a high proportion of old people will generally have a higher incidence of cancer than one in which young people predominate. Standardization is a set of techniques used to remove the effects of differences in age when comparing two or more rates. Thus, standardization may be undertaken to allow comparison on the basis of populations having the same age structure for which a "world standard population" is commonly used.

Prevalence of cancer indicates the number of persons in whom the disease has been diagnosed and who are alive at a particular point in time. Thus prevalence may be characterized as the number of people living with cancer, although a precise meaning of this term is not agreed. Some authors understand "living with cancer" to refer to ever having been diagnosed, even if this was many years ago, and the disease no longer has any impact on the individual. The latter circumstances may be equated with cure. Probably what is sought from prevalence in most instances is the number of people being treated for cancer (or, at least, still needing some sort of medical supervision). Such data are not only difficult to obtain, but would certainly vary from one place to another, depending on medical practice. However, since cure is often but arbitrarily taken to equate with survival beyond five years, a useful compromise is to estimate prevalence as the number of people alive who have had a cancer diagnosed within the last five years.

Several other measures are used to assess the impact of disease, and that of cancer specifically. These include *person-years of life lost* (how many years of normal life span are lost due to deaths from cancer). Economists often refine this measurement, by giving different values to life-years at different ages, so that a year saved at, for example, age 20, is more "valuable" than one at age 60. A further refinement is to calculate *quality-* or *disability-adjusted life-years lost (DALY)*, by giving a numerical score to the years lived with a reduced quality of life between diagnosis and death (where quality = 0) or cure (quality = 1). Such estimates require comprehensive data on incidence and survival as well as approximations about quality of life in different circumstances and cultures.

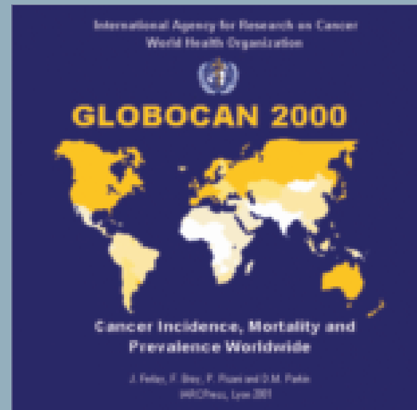


Fig. 1.9 The Globocan 2000 database is published as a CD by IARC*Press*.

Fig. 1.10 A cancer registration team in Ho Chi Minh City, Viet Nam.

from documentation of disease to a basis for action may also be pursued in relation to treatment. Thus incidence, mortality and other data offer insight into prognosis and efficacy of treatment for particular cancer types.

The distribution of cancer changes with time, and specific assessments generally relate to a particular period. Irrespective of change in distribution, the burden of cancer remains. This burden involves the disruption, by suffering, of the lives of hundreds of millions of the world's population. As will be indicated throughout this volume, that burden may be progressively lessened by appropriate intervention.

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WEBSITES

IARC cancer epidemiology databases, including GLOBOCAN 2000 and the WHO Cancer Mortality Database:
http://www-dep.iarc.fr/

ICD9 classification of diseases:
http://www.cdc.gov/nchs/about/major/dvs/icd9des.htm