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Estimates of worldwide burden of cancer in 2008: GLOBOCAN 2008

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Estimates of the worldwide incidence and mortality from 27 cancers in 2008 have been prepared for 182 countries as part of the GLOBOCAN series published by the International Agency for Research on Cancer. In this article, we present the results for 20 world regions, summarizing the global patterns for the eight most common cancers. Overall, an estimated 12.7 million new cancer cases and 7.6 million cancer deaths occur in 2008, with 56% of new cancer cases and 63% of the cancer deaths occurring in the less developed regions of the world. The most commonly diagnosed cancers worldwide are lung (1.61 million, 12.7% of the total), breast (1.38 million, 10.9%) and colorectal cancers (1.23 million, 9.7%). The most common causes of cancer death are lung cancer (1.38 million, 18.2% of the total), stomach cancer (738,000 deaths, 9.7%) and liver cancer (696,000 deaths, 9.2%). Cancer is neither rare anywhere in the world, nor mainly confined to high-resource countries. Striking differences in the patterns of cancer from region to region are observed.

Accurate statistics on cancer occurrence and outcome are essential, both for the purposes of research and for the planning and evaluation of programs for cancer control.[1,2] For the last 30 years, the International Agency for Research on Cancer (IARC) has published regular estimates of the incidence of, and mortality from cancer worldwide in broad areas of the world,[3–8] and more recently at the country level through its GLOBOCAN series.[9,10] The most recent set of estimates for 2002[10] have now been updated to 2008 using new sources of data and improved methods of estimation. In this article, we provide a summary of the results for 27 major cancers and for all cancers combined, in 20 world regions and for more and less developed regions, as defined by the United Nations.[11] Facilities for the tabulation and visual description analysis of the full dataset of 182 countries and 30 world regions by sex can be accessed *via* the IARC homepage (http://www.iarc.fr).

Data Sources

Incidence

Incidence data derive from population-based cancer registries. These may cover entire national populations but more often cover smaller, subnational areas and, particularly in developing countries, only major cities. In 2006, about 21% of the world population was covered by population-based cancer registries, with sparse registration in Asia (8% of the total population) and in Africa (11%).[1] When considering data of good quality (for example, datasets included in the latest volume (IX) for the Cancer Incidence in Five Continents (CI5) series of the IARC[12]), these percentages are even lower: only 8% of the world population is covered by cancer registries that match the CI5 inclusion criteria, 4% of which are located in Asia with only 1% in Africa. While the information from most of the developing countries might not meet the specific criteria for quality set for inclusion in CI5,[13] this information is still of unique importance as it often remains the only relatively unbiased source of information available on the profile of cancer. Incidence data are generally associated with some delay as they require time to be compiled and published, but recent information can often be found in routine reports from the registries themselves, commonly available *via* their websites.

Population-based cancer registries can also produce survival statistics by following up their vital status of cancer patients. Survival probabilities can be used to estimate mortality from incidence in the absence of mortality data.

Mortality

Mortality statistics are collected and made available by the World Health Organization (WHO).[14] Their advantages are national coverage and long-term availability, although not all datasets are of the same quality. For some countries, coverage of the population is incomplete, so that the mortality rates produced are implausibly low and in others, the quality of cause of death information is poor. By 2005, around one-

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Figure 1. Map showing the 20 world regions.

third of the world population was covered by mortality statistics. While almost all the European and American countries have comprehensive death registration systems, most African and Asian countries (including the populous countries of Nigeria, India and Indonesia) do not. For the GLOBOCAN 2008 estimates, we benefitted from the provisional estimates of the age- and sex-specific deaths from cancer (of all types) for 2008 in each country of the world (Colin Mathers, personal communication, 2009). These preliminary 2008 mortality estimates from WHO are based on 2008 life tables (all-cause mortality) as published in World Health Statistics 2010,[15] and cause-of-death distributions from the Global Burden of Disease study for 2004,[16] projected forward and fitted to the 2008 all-cause mortality estimates.

Population data

National population estimates for 2008 were extracted from the United Nations website.[11] The geographical definition of the regions follows the rules as defined by the UN (Fig. 1), except for Cyprus, which is included in Southern Europe and Chinese Taipei (Taiwan), which is included in Eastern Asia.

Material and Methods

Incidence and mortality estimates in 2008 have been prepared for 27 major cancers (Table 1), by sex and for 10 age groups (0-14, 15-39, 40-44, 45-49,. . ., 75 and over). For the category "all cancers excluding nonmelanoma skin cancer," the number of new cases and deaths were estimated as the sum of the corresponding 27 site-specific numbers plus those that comprise the residual, the "other and unspecified sites." No attempt was made to estimate incidence and mortality from nonmelanoma skin cancer because of the difficulties in collecting (and counting) such tumors and the consequent variability of data available. The categories "Kaposi sarcoma (KS)," "non-Hodgkin lymphoma" and "all cancers excluding nonmelanoma skin cancer" include some disease entities that might have been coded in mortality (but not incidence) statistics to the ICD-10 category B21 (HIV disease resulting in neoplasms).

Prediction of national incidence and mortality to 2008

The methods used to estimate the country-specific burden of cancer are similar to those used in GLOBOCAN 2002[10] and have been described in detail in several reports.[6,7] In summary, the most recent disease rates available were applied to the corresponding population of the country in 2008. For GLOBOCAN 2008, the degree of delay in the available data was taken into account by computing predictions of the national incidence and mortality rates to the year 2008, wherever possible. Although historical trends will not always hold in the future, predictions based on relatively linear trend patterns have been shown empirically to be reasonably accurate, particularly in the short-term. Where the availability of annual data was minimal—commonly between 5 and 10 years—simple time-linear models were fitted to these data to predict incidence and mortality for 2008.[17] Where data series spanning at least 15 years were available, predictions based on age-period-cohort modeling were utilised.[18] An example

Table 1. List of the cancer sites included in GLOBOCAN 2008

Name	ICD-10 code
Lip, oral cavity	C00-08
Nasopharynx	C11
Other pharynx	C09-10, C12-14
Oesophagus	C15
Stomach	C16
Colorectum[1]	C18-21
Liver	C22
Gallbladder	C23-24
Pancreas	C25
Larynx	C32
Trachea, bronchus and lung	C33-34
Melanoma of skin	C43
Kaposi sarcoma[2]	C46+B21.0
Breast[3]	C50
Cervix uteri	C53
Corpus uteri	C54
Ovary	C56
Prostate	C61
Testis	C62
Kidney	C64-66
Bladder	C67
Brain, nervous system	C70-72
Thyroid	C73
Hodgkin lymphoma	C81
Non-Hodgkin lymphoma	C82-85, C96, B21.1-2
Multiple myeloma	C88+C90
Leukemia	C91-95
All cancers excl. nonmelanoma skin cancer	C00-97+B21.3-9 excl. C44

[1]Includes anal cancer. [2]Sub-Saharan Africa only, otherwise included in "other and unspecified cancers." [3]Female only.

of the improvement in methodology and resulting prediction is illustrated in Figure 2 showing predictions of lung cancer mortality in Canadian males using the GLOBOCAN 2002 and 2008 approaches (Fig. 2).

Sex- and cancer-specific predictions of the national incidence and mortality rates were performed when at least 50 cancer cases or cancer deaths (all ages) were recorded per year for short-term predictions, and when at least 100 cancer cases or deaths (all ages) were recorded per 5-year period for NORDPRED.[19] Otherwise, the rates for 2008 were estimated as the annual average for the most recent 5-year period available.

Estimates of cancer incidence by country

The methods to estimate the sex- and age-specific incidence rates of cancer for a specific country are dependant on the availability and the accuracy of data, and fall into one of the following categories, in priority order:

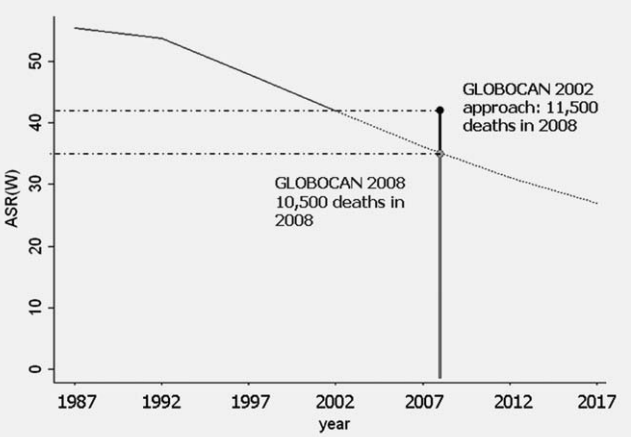

Figure 2. Estimated age-standardized (World) mortality rates (ASR per 100,000) and numbers of deaths from lung cancer in Canadian males in 2008, using the GLOBOCAN 2002 and 2008 approaches.

1. National incidence data: National incidence data were available in 62 countries. For four of these countries, reliable estimates of the national incidence in 2008 were available from local sources and these have been used (1A). When historical data and a sufficient numbers of recorded cases were available (32 countries), incidence rates were projected to 2008 (1B). Otherwise, the incidence rates from the most recent period were applied to the 2008 population (1C, 26 countries).
2. Local incidence data and national mortality data: The method, as used for estimating the national incidence in 52 countries, has been described in detail elsewhere.[20] Estimates of the incidence to mortality ratios (I_R/M_R) were obtained from log-linear models of the numbers of incident cases based on the aggregation of local/regional registries offset by the numbers of deaths in the same registries, adjusted for sex and age. National incidence (I_N) was obtained on applying these fitted ratios to the corresponding national mortality estimates for 2008 (M_N):

$$I_N = M_N * I_R/M_R \quad (1)$$

Before aggregation, each registry dataset was weighted according to the square root of its population to take into account of the relative size of the populations covered. Depending on the accuracy and on the availability of local data, one of two variants of the method was used:

A. A country-specific model was used for 11 countries for which several local cancer registries were in operation with the I_R/M_R ratios obtained from the most recent country-specific data. A correction[20] was applied to the estimation for breast and prostate cancers to take into account the possible screening-

Table 2. Method of estimation of national incidence: population (in millions) and number of countries, by world region (region numbers)

	Population in million (number of countries)				
	Method 1	Method 2	Method 3	Method 4	Method 5
More developed regions	787 (28)	432 (15)			5 (2)
Northern America (9)	339 (2)				
Europe (14-17)	423 (24)	304 (14)			5 (2)
Asia (Japan) (10a)		128 (1)			
Australia/New Zealand (18)	25 (2)				
Less developed regions	225 (34)	2139 (37)	2079 (23)	392 (13)	632 (30)
Africa (1-5)	57 (7)		500 (16)	162 (8)	247 (22)
South America (6-8)	10 (5)	551 (25)	9 (1)		
Asia (excl. Japan) (10b-13)	156 (16)	1588 (12)	1570 (6)	224 (4)	385 (7)
Oceania (19-20)	2 (6)			6 (1)	0 (1)
Total: population	1012 (15%)	2571 (38%)	2079 (31%)	392 (6%)	637 (10%)
Countries	62 (34%)	52 (29%)	23 (13%)	13 (7%)	32 (18%)

related increase in the incidence rates of these two cancers.

B. Regional models were used in the absence of country-specific national or local incidence data, or where they were considered to be of insufficient quality: the I_R/M_R ratios were obtained by the aggregation of cancer registry data in neighboring countries in the same region. Nine models were established, based upon the incidence and mortality data from cancer registries in *Cancer Incidence in Five Continents Vol. IX*[12] or upon more recent data published on the Internet or provided by external collaborators. These comprised four models for the Americas: Temperate South America, Tropical South America, Black Caribbean and Central America/Latin Caribbean; three for Asia: Eastern Asia, South-Central Asia and South-Central/Western Asia; and two for Europe: Central Europe and the Balkans.

3. Local incidence data. No mortality data: For 23 countries, national incidence estimates were derived from data of one or more cancer registries covering a part of the country (city, state, province, etc), with the approach divided into two categories:
   A. A single cancer registry covering part of a country: the cancer registry data is used as representative of the country profile (10 countries).
   B. When more than one local source was available, national incidence rates were estimated as the weighted average of the local rates.

   In both instances, the cancer incidence was scaled using the ratio of the estimated all cancer mortality computed using GDP specific survival data (see later, mortality data) to the WHO all cancer mortality envelope for 2008 (Fig. 4). This correction was performed only if the implied final incidence rates were plausible in relation to the neighboring countries and the local registry was considered sufficiently complete.
4. Frequency data. For 13 countries, neither cancer incidence nor mortality statistics are available, or they are considered to lack sufficient accuracy. In these circumstances, we used a set of age- and sex-specific incidence rates for all cancers combined and partitioned these using data on the relative frequency of different cancers (by age and sex). We used data only from sources likely to provide a relatively unbiased picture of population-based relative frequency of different cancers (and corrected pathology-based series using appropriate biopsy proportions (percentage microscopically verified, %MV) for different cancers). For eight African countries, three sets of age-sex specific incidence rates for all sites combined were used: Eastern, Northern and Western Africa. These rates were produced from the unweighted averages of the observed rates (by sex and age) in registries from Kenya, Malawi, Tanzania, Uganda and Zimbabwe; Algeria, Egypt, Libya and Tunisia; and Cote d'Ivoire, Guinea, Mali, Niger, Nigeria and The Gambia, respectively. For the five remaining countries, the all cancers rates were computed as the population weighted averages of: observed rates in registries in neighboring countries (Bangladesh and Cambodia), or estimated national rates in neighboring countries (Irak, Yemen and Papua New Guinea).
5. No data (32 countries). No useable data could be identified. The country-specific rates therefore represent simply those of neighboring countries in the same region (Table 2).

Estimate of the incidence of KS in sub-Saharan Africa

For the countries with a cancer registry, and incidence rates for years after 2000 with at least 20 cases recorded, the

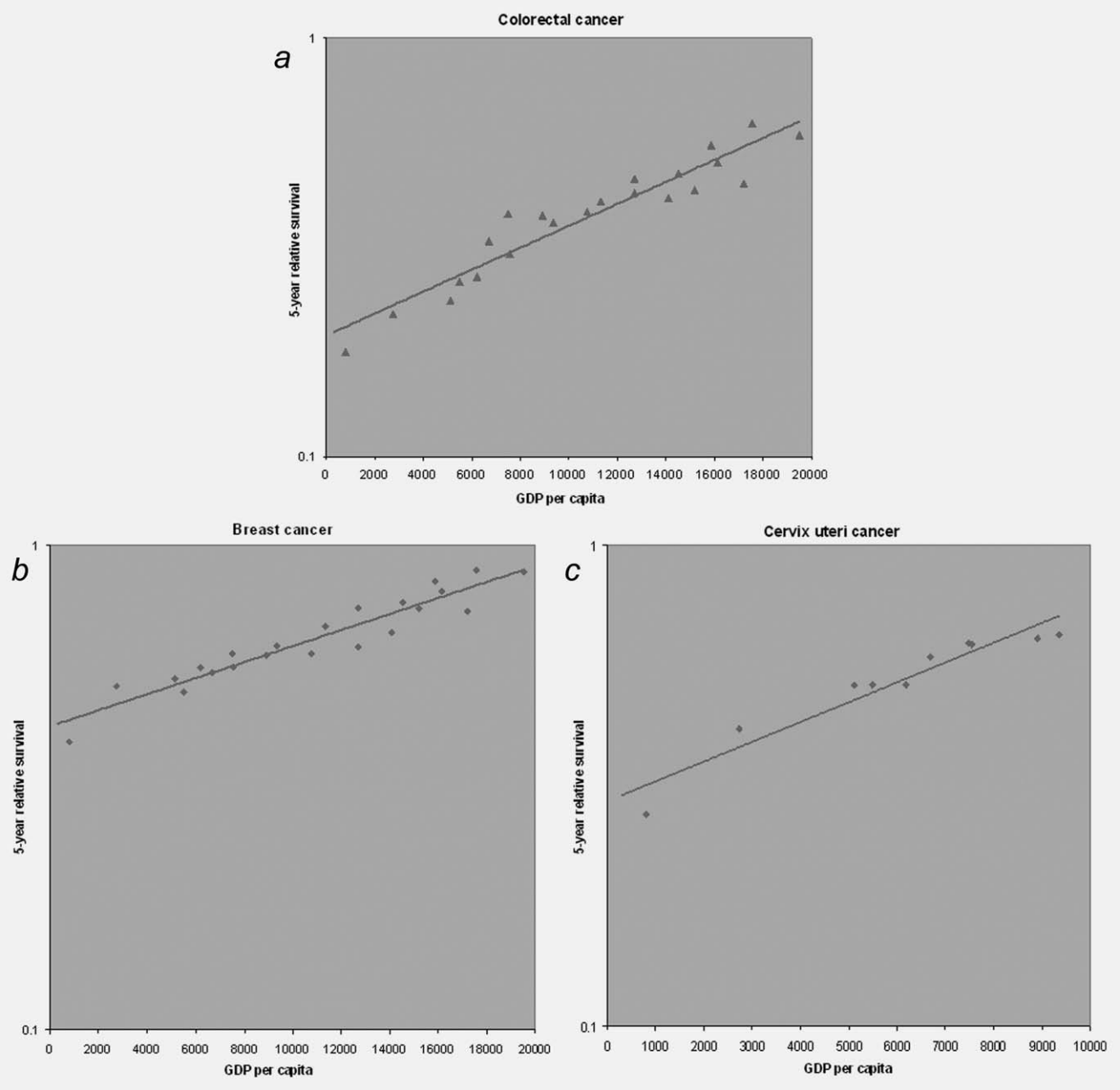

Figure 3. (*a–c*) Relationship between GDP per capita and 5-year relative survival: colorectal (both sexes), breast and cervical cancers. GDP values greater than 5000 are provided by Nordic countries, the two outliers with lower values correspond to Indian (Barshi, Chennai, Karunagappally and Mumbai) and African (The Gambia, Uganda: Kampala and Zimbabwe: Harare) cancer registries.

observed rates were taken to be representative of the country. For all other sub-Saharan African countries, the following method was used:

1. We estimated first the number of endemic (pre-AIDS) KS cases using the percentage frequency of the disease, by sex and age, based on data from Uganda, Kampala (1961–1980) and Nigeria, Ibadan (1971–1990). These percentages were applied to countries in Eastern and Western Africa, respectively. For countries in Middle Africa, we applied a simple average of these frequencies.
2. We calculated the number of epidemic (AIDS-related) KS cases, both sexes, for the year 2008, using estimates of AIDS deaths by country in 2007 (source UNAIDS, http://www.unaids.org/), and an estimate

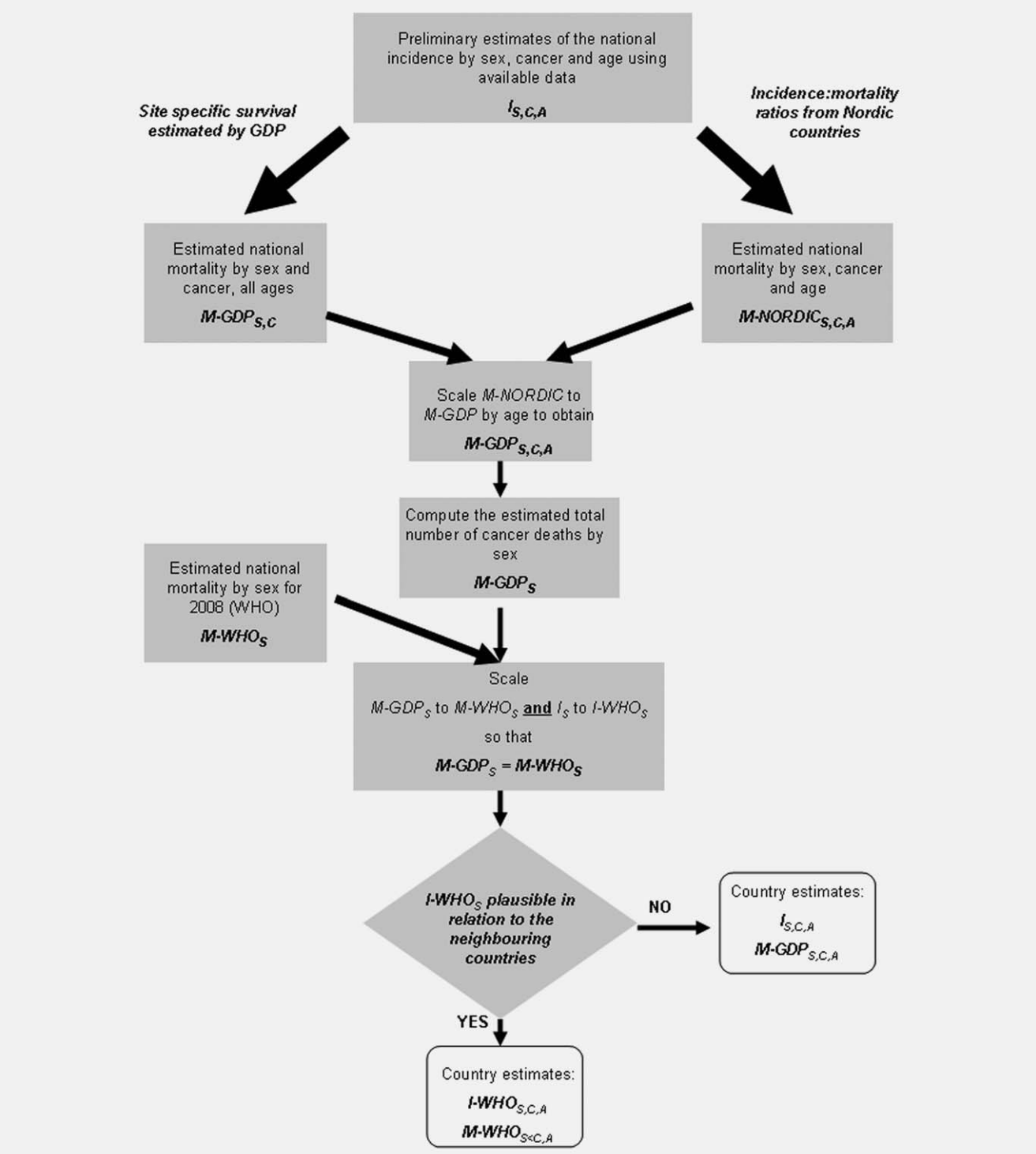

Figure 4. Estimate of cancer mortality: flow chart summarizing method 3 (incidence and survival) process.

of the ratio of deaths from AIDS to incident cases of KS. This ratio was based on observed KS rates in several countries (from the sentinel registries listed later, minus the endemic KS), and was specific by region (varying from 0.4 to 3%). This total number of AIDS-related KS was partitioned by sex and age using sex- and age-specific proportions in the sentinel registries:

- Eastern Africa: Kenya (Eldoret), Malawi (Blantyre), Uganda (Kampala), Zimbabwe (Harare) and Tanzania (Kilimanjaro).
- Middle Africa: Congo (Brazzaville).

Table 3. Method of estimation of national mortality: population (in millions) and number of countries, by world region (region numbers)

	Population in million (number of countries)		
	Method 1	Method 2	Method 3
More developed regions	1216 (42)	3 (1)	5 (2)
Northern America (9)	339 (2)		
Europe (14–17)	724 (37)	3 (1)	5 (2)
Asia (Japan) (10a)	128 (1)		
Australia/New Zealand (18)	25 (2)		
Less developed regions	159 (23)	2077 (30)	3230 (84)
Africa (1–5)	2 (2)		963 (51)
South America (6–8)	63 (10)	490 (19)	17 (2)
Asia (excl. Japan) (10b–13)	94 (9)	1587 (11)	2242 (25)
Oceania (19–20)	0 (2)		8 (6)
Total: population	1375 (21%)	2080 (31%)	3235 (48%)
Countries	65 (36%)	31 (17%)	86 (47%)

- Southern Africa: Botswana, Namibia and Swaziland.
- Western Africa: Guinea (Conakry), Mali (Bamako) and Niger (Niamey).

Estimates of the cancer mortality by country

National statistics are collated and made available by the WHO for countries with vital registration,[14] but, as described already, not all are of the same quality, and some corrections were made before they were used for estimation purposes:

1. Where necessary, the overall number of deaths was corrected for under-reporting or incompleteness using the percentages provided by the WHO.[14]
2. Where the category "ill-defined cause of deaths" (ICD-9 codes 780–799 and ICD-10 codes R00–R99) exceeded 3% of the total deaths, the excess (over 3% which is considered to be the limit as observed in good quality datasets) was partitioned, by sex and age into "cancer deaths" and "other" specific causes of death. The corrected "cancer deaths" category was partitioned into cancer-specific categories using proportions from the uncorrected data. No attempt was made to reallocate ill-defined cancers (ICD-10 C76-C80, C97) into cancer-specific categories.
3. There are large variations in the accuracy of death certificates related to cancer of the uterus, with many deaths recorded as 'uterus cancer, not otherwise specified' (ICD-10 C55). By default, the number of cancer deaths coded as "uterus unspecified" was reallocated to either cervix (C53) or corpus (C54) uterine cancer according to age-specific proportions.[21] For the countries for which country-specific incidence and survival data were available, mortality for cervix uteri (C53) and corpus uteri (C54) cancers was estimated from incidence and 5-year relative survival probabilities.

Depending of the degree of detail and accuracy of the national mortality data, three methods have been utilized in the following order of priority:

1. National mortality data (65 countries): National mortality data is complete for all the cancers. If no historical data were available, the most recent rates were simply applied to the corresponding 2008 population (1A), otherwise the mortality rates were projected to 2008 (1B). When the data were incomplete (available only for major cancer sites), the residual group "other sites" was divided according to age- and sex-specific relative frequencies obtained from local mortality in the country or in the region (1C).
2. Sample mortality data (31 countries): Mortality data are available for a representative sample of the population (or for specific strata within). The age and sex-specific all cancer mortality envelopes for the country in 2008 as provided by the WHO for 2008 were partitioned by site using the sample mortality data. Cancer mortality in China, the most populous country of the world, was estimated using mortality data covering 11% of the Chinese population.[22]
3. No vital statistics available (86 countries): For the countries in developing regions without vital registration, mortality was estimated from incidence by a four step process:
   - We applied sets of cancer-, sex- and age-specific incidence to mortality ratios provided by the national cancer registries in three Nordic countries (Denmark, Finland and Norway) for the period 1953–1957[23] to the estimated national incidence for 2008 [as a reciprocal of formula (1)].
   - We estimated the total number of deaths by cancer (all ages, both sexes combined) using the estimated

Table 4. Estimated new cancer cases (thousands), ASRs (per 100,000) and cumulative risks (percent) by sex and cancer site worldwide, 2008

	Both sexes				Male				Female			
Cancer site	Cases	(%)	ASR (world)	Cum. Risk (0–74)	Cases	(%)	ASR (world)	Cum. Risk (0–74)	Cases	(%)	ASR (world)	Cum. Risk (0–74)
Lip, oral cavity	263	*2.1*	3.9	0.4	170	*2.6*	5.3	0.6	92	*1.5*	2.6	0.3
Nasopharynx	84	*0.7*	1.2	0.1	57	*0.9*	1.7	0.2	26	*0.4*	0.8	0.1
Other pharynx	135	*1.1*	2.0	0.2	107	*1.6*	3.4	0.4	27	*0.4*	0.8	0.1
Oesophagus	482	*3.8*	7.0	0.9	326	*4.9*	10.2	1.3	155	*2.6*	4.2	0.5
Stomach	989	*7.8*	14.1	1.7	640	*9.6*	19.8	2.4	349	*5.8*	9.1	1.0
Colorectum	1233	*9.7*	17.3	2.0	663	*10.0*	20.4	2.3	570	*9.4*	14.6	1.6
Liver	748	*5.9*	10.8	1.2	522	*7.9*	16.0	1.8	225	*3.7*	6.0	0.7
Gallbladder	145	*1.1*	2.0	0.2	58	*0.9*	1.8	0.2	86	*1.4*	2.2	0.3
Pancreas	277	*2.2*	3.9	0.4	144	*2.2*	4.4	0.5	133	*2.2*	3.3	0.4
Larynx	151	*1.2*	2.3	0.3	130	*2.0*	4.1	0.5	21	*0.3*	0.6	0.1
Lung	1608	*12.7*	23.0	2.8	1095	*16.5*	34.0	4.1	513	*8.5*	13.5	1.6
Melanoma of skin	197	*1.6*	2.8	0.3	101	*1.5*	3.1	0.3	96	*1.6*	2.6	0.3
Kaposi sarcoma	34	*0.3*	0.5	0.0	22	*0.3*	0.6	0.1	12	*0.2*	0.3	0.0
Breast	1383	*10.9*	39.0	4.1					1383	*22.9*	39.0	4.1
Cervix uteri	529	*4.2*	15.2	1.6					529	*8.8*	15.2	1.6
Corpus uteri	287	*2.3*	8.2	1.0					287	*4.8*	8.2	1.0
Ovary	225	*1.8*	6.3	0.7					225	*3.7*	6.3	0.7
Prostate	913	*7.2*	28.5	3.5	913	*13.8*	28.5	3.5				
Testis	52	*0.4*	1.5	0.1	52	*0.8*	1.5	0.1				
Kidney	271	*2.1*	3.9	0.5	167	*2.5*	5.2	0.6	103	*1.7*	2.8	0.3
Bladder	386	*3.0*	5.3	0.6	297	*4.5*	9.1	1.0	89	*1.5*	2.2	0.2
Brain, nervous system	238	*1.9*	3.5	0.3	127	*1.9*	3.9	0.4	110	*1.8*	3.2	0.3
Thyroid	212	*1.7*	3.1	0.3	49	*0.7*	1.5	0.2	163	*2.7*	4.7	0.5
Hodgkin lymphoma	67	*0.5*	1.0	0.1	40	*0.6*	1.2	0.1	27	*0.4*	0.8	0.1
Non-Hodgkin lymphoma	355	*2.8*	5.1	0.5	199	*3.0*	6.1	0.6	156	*2.6*	4.2	0.4
Multiple myeloma	102	*0.8*	1.5	0.2	54	*0.8*	1.7	0.2	47	*0.8*	1.3	0.1
Leukemia	351	*2.8*	5.1	0.5	195	*2.9*	5.9	0.6	155	*2.6*	4.3	0.4
All cancers excl. non-melanoma skin cancer	12677	*100.0*	181.8	18.7	6639	*100.0*	204.4	21.2	6038	*100.0*	164.9	16.5

country-specific numbers of new cases for 2008 and country-specific survival data. For a given cancer site, mortality (M) is the product of incidence (I) and the probability of dying from the disease:

$$M = I\,[k - Sj] \qquad (2)$$

where Sj is the relative survival at year j of follow-up and k is a constant depending on j. When 5-year relative survival probabilities are used, the constant k tends to be very close to unity.[7,8] For GLOBOCAN 2008, we applied country-specific survival data to that country and its immediate neighbors: India, Bangladesh, Nepal and Sri Lanka using Indian survival probabilities, and Thailand, Cambodia, Laos and Myanmar using Thai and/or Chinese survival data.[24] For the other countries, we estimated country-specific survival, by cancer, using national macroeconomic data. A study conducted[25] in Europe in elderly patients demonstrated that cancer survival was reasonably correlated with level of Gross Domestic Product (GDP). Based on this assumption we estimated the relationship between cancer-specific 5-year relative survival (both sexes, and all ages) and country-specific GDP per capita.[26]* Models predicting site-specific 5-year relative survival from per capita GDP were established using historical survival probabilities from Denmark (1943–1987, Hans Storm, personal communication) and Finland (1953–1997, Timo Hakulinen, personal

Table 5. Estimated cancer deaths (thousands), ASRs (per 100,000) and cumulative risks (percent) by sex and cancer site worldwide, 2008

	Both sexes				Male				Female			
Cancer site	Deaths	(%)	ASR (world)	Cum. Risk (0–74)	Deaths	(%)	ASR (world)	Cum. Risk (0–74)	Deaths	(%)	ASR (world)	Cum. Risk (0–74)
Lip, oral cavity	127	1.7	1.9	0.2	83	2.0	2.6	0.3	44	1.3	1.2	0.1
Nasopharynx	51	0.7	0.8	0.1	35	0.8	1.1	0.1	15	0.4	0.4	0.1
Other pharynx	95	1.3	1.4	0.2	76	1.8	2.4	0.3	19	0.6	0.5	0.1
Oesophagus	406	5.4	5.8	0.7	276	6.5	8.6	1.0	130	3.9	3.4	0.4
Stomach	738	9.7	10.3	1.2	464	11.0	14.3	1.7	273	8.2	6.9	0.8
Colorectum	608	8.0	8.2	0.9	320	7.6	9.7	1.1	288	8.6	7.0	0.7
Liver	695	9.2	10.0	1.1	478	11.3	14.6	1.7	217	6.5	5.7	0.6
Gallbladder	109	1.4	1.5	0.2	42	1.0	1.3	0.1	66	2.0	1.7	0.2
Pancreas	266	3.5	3.7	0.4	138	3.3	4.2	0.5	127	3.8	3.1	0.3
Larynx	82	1.1	1.2	0.2	70	1.7	2.2	0.3	11	0.3	0.3	0.0
Lung	1378	18.2	19.4	2.3	951	22.5	29.4	3.5	427	12.8	11.0	1.3
Melanoma of skin	46	0.6	0.6	0.1	25	0.6	0.8	0.1	20	0.6	0.5	0.1
Kaposi sarcoma	29	0.4	0.4	0.0	18	0.4	0.5	0.1	10	0.3	0.3	0.0
Breast	458	6.0	12.5	1.3					458	13.7	12.5	1.3
Cervix uteri	274	3.6	7.8	0.9					274	8.2	7.8	0.9
Corpus uteri	74	1.0	2.0	0.2					74	2.2	2.0	0.2
Ovary	140	1.8	3.8	0.4					140	4.2	3.8	0.4
Prostate	258	3.4	7.5	0.6	258	6.1	7.5	0.6				
Testis	9	0.1	0.3	0.0	9	0.2	0.3	0.0				
Kidney	116	1.5	1.6	0.2	72	1.7	2.2	0.2	44	1.3	1.1	0.1
Bladder	150	2.0	2.0	0.2	112	2.6	3.3	0.3	37	1.1	0.9	0.1
Brain, nervous system	174	2.3	2.6	0.3	97	2.3	3.0	0.3	77	2.3	2.2	0.2
Thyroid	35	0.5	0.5	0.1	11	0.3	0.3	0.0	24	0.7	0.6	0.1
Hodgkin lymphoma	30	0.4	0.4	0.0	18	0.4	0.6	0.1	11	0.3	0.3	0.0
Non-Hodgkin lymphoma	191	2.5	2.7	0.3	109	2.6	3.3	0.3	81	2.4	2.1	0.2
Multiple myeloma	72	1.0	1.0	0.1	37	0.9	1.2	0.1	34	1.0	0.9	0.1
Leukemia	257	3.4	3.6	0.3	143	3.4	4.3	0.4	113	3.4	3.1	0.3
All cancers excl. non-melanoma skin cancer	7571	100.0	106.2	11.2	4225	100.0	128.8	13.5	3346	100.0	87.6	9.1

communication), plus 5-year relative survival reported by cancer registries in rural and urban India, and Africa [The Gambia, Uganda (Kampala),[24] and Zimbabwe (Harare, black population)[27]]. For each cancer site, we established a log-linear relation between 5-year relative survival and GDP omitting the data points with high GDP (>10000) from Denmark and Finland for cervical cancer because of the establishment of screening programs in the recent periods. Examples for colorectal (both sexes) breast and cervical cancers are shown in Figures 3*a*–3*c*.

- For each cancer, the sex- and age-specific mortality obtained in 3.1 was scaled using the ratios of the all-ages, both sexes, all cancers combined mortality obtained in 3.2 to that computed in 3.1, to take into account differences in survival.
- Finally, the cancer mortality **and the corresponding incidence** were scaled to the 2008 all cancer mortality envelope provided by the WHO (see incidence data, method 3; Table 3). Figure 4 illustrates this process.

Estimate of mortality from KS in sub-Saharan Africa

Mortality from KS in sub-Saharan Africa was estimated using incidence and 5-year relative survival.

1. For Uganda and Zimbabwe, we used the KS survival from Kampala and Harare (Black population), respectively.[27,28]
2. For all others countries, we estimated mortality using survival based on a pooled average of 5-year relative

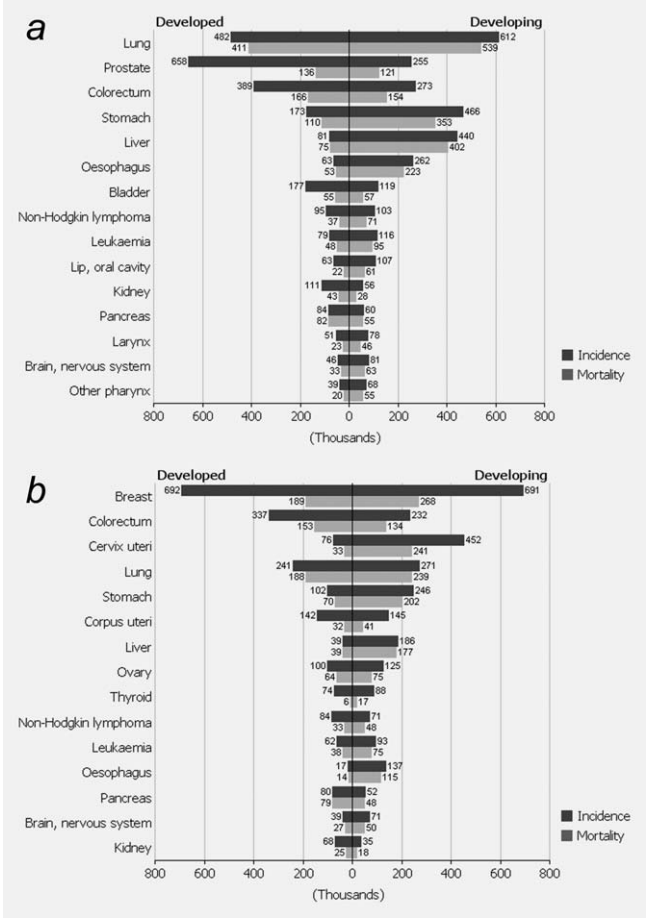

Figure 5. (*a*) Estimated numbers (thousands) of new cancer cases (incidence) and deaths (mortality) in men in developed and developing regions of the world in 2008. (*b*) Estimated numbers (thousands) of new cancer cases (incidence) and deaths (mortality) in women in developed and developing regions of the world in 2008.

survival probabilities from Uganda and Zimbabwe (both sexes combined, by age).

Estimates for the 20 world regions (Fig. 1) were obtained by the population-weighted average of the incidence and mortality rates of the component countries. The rates were age-standardized (ASRs per 100,000 person-years) using the direct method and the World standard population as proposed by Segi[29] and modified by Doll.[30] The cumulative risk of developing or dying from cancer before age 75 was also calculated using the age-specific rates and is expressed as a percentage. The results are presented in terms of global totals and by world regions. In the text that follows, developed countries comprise regions 9, 10b and 14 to 18 (Fig. 1), developing countries the remainder. Incidence and mortality from KS have been estimated separately for sub-Saharan African countries only (regions 1, 2, 4 and 5 of Fig. 1): rates are high in this region because of the high prevalence of HIV infection, while a very low incidence is observed elsewhere (particularly in Asian populations).

The full description of the data and methods used for each country and the detailed set of estimates are available at the GLOBOCAN 2008 web site (http://globocan.iarc.fr).

Results

We estimated that 12.7 million new cancer cases and 7.6 million cancer deaths occurred in 2008 worldwide. Tables 4 and 5 show the estimated number of cases and deaths for 27 cancers in men, women and both sexes combined, together with ASRs and the cumulative risk (to age 74). Lung cancer remains the most common cancer in the world, both in term of cases (1.6 million cases, 12.7% of total) and deaths (1.4 million deaths, 18.2%). Breast cancer is the second most common cancer overall (1.4 million cases, 10.9%) but ranks 5th as cause of death (458,000, 6.1%) followed in terms of incidence by colorectal cancer (1.2 million cases, 608,000 deaths), stomach cancer (990,000 cases, 738,000 deaths), prostate cancer (913,000 cases, 261,000 deaths) and liver cancer (748,000 cases and 695,000 deaths).

Figures 5*a* and 5*b* show the 15 most common cancers for men and women as number of new cases and deaths in the developing and developed regions of the world. Although lung cancer is the most common cancer worldwide among men, it ranks second in developed regions (482,000 cases) after prostate cancer (658,000 cases). In women, cervix cancer, the second most common cancer in developing regions (452,000 cases), is only the 10th most common cancer in developed regions (76,000 cases). Cancers of the lung, stomach and liver predominate among males in developing regions (42% of the new cancer cases, 48% of the total cancer deaths), while breast and cervical cancers represent 33% of the new cancer cases in females, but only 25% of the corresponding cancer deaths.

Tables 6 and 7 show the estimated ASRs (world standard) of incidence and mortality, respectively, by sex and for the eight most common cancer sites, for the 20 regions of the world, and for more developed and less developed regions. Tables 8 and 9 show the estimates of the numbers of cancer cases and deaths, and Tables 10 and 11 the estimates of cumulative risk (0–74, percent) for the same categories. A brief description of the global patterns for the eight most common cancers follows.

All cancers

The number of new cancer cases ranges from 3.7 million in Eastern Asia to about 1800 in Micronesia/Polynesia. In men, the incidence of cancer is high in Northern America (ASR 334 per 100,000), Australia/New Zealand (ASR 356.8) and in Northern and Western Europe (ASRs 303.5 and 337.4, respectively) as a consequence of the high rates of prostate cancer in these regions (ASRs greater than 80 per 100,000 in all). In contrast, the risk of dying from cancer before age 74 for men in the developed regions is higher in Central and

Table 6. Estimated ASRs (World standard) of cancer incidence by sex, cancer site and regions, 2008

	Oesophagus		Stomach		Colorectum		Liver		Lung		Breast	Cervix	Prostate	All sites	
	(C15)		(C16)		(C18-21)		(C22)		(C33-34)		(C50)	(C53)	(C61)	(C00-97/C44)	
	M	F	M	F	M	F	M	F	M	F	F	F	M	M	F
World	10.2	4.2	19.8	9.1	20.4	14.6	16.0	6.0	34.0	13.5	39.0	15.2	28.5	204.4	164.9
More developed regions	6.5	1.3	16.7	7.3	37.6	24.2	8.1	2.7	47.4	18.6	66.4	9.0	63.0	301.1	225.5
Less developed regions	11.9	5.7	21.1	10.0	12.1	9.4	18.9	7.6	27.8	11.1	27.3	17.8	12.0	160.3	138.0
Eastern Africa	14.9	6.4	5.6	4.0	5.8	4.7	7.2	3.6	4.1	1.4	19.3	34.5	14.5	121.3	125.3
Middle Africa	1.5	0.8	5.3	4.7	4.3	3.3	18.9	9.6	2.8	0.9	21.3	23.0	16.4	88.1	96.7
Northern Africa	2.0	1.6	3.9	2.4	7.0	5.8	7.5	2.5	14.9	2.2	32.7	6.6	8.1	109.2	98.9
Southern Africa	22.3	11.7	4.1	2.2	20.4	8.2	13.9	5.1	29.0	8.0	38.1	26.8	53.9	235.9	161.1
Western Africa	1.4	1.0	4.5	3.3	5.6	4.3	16.5	8.1	3.1	1.2	31.8	33.7	22.2	92.0	123.5
Caribbean	5.0	1.4	11.2	6.1	14.4	13.9	6.3	4.4	25.7	12.1	39.1	20.9	71.1	196.3	153.5
Central America	2.1	0.8	12.7	9.3	7.2	6.4	7.3	7.0	12.8	5.5	26.0	22.2	34.8	136.2	134.4
South America	6.2	2.1	17.3	8.4	13.5	11.9	5.3	3.9	20.4	8.4	44.3	23.9	50.2	186.7	162.9
Northern America	5.6	1.2	5.8	2.8	35.3	25.7	6.8	2.2	48.5	35.8	76.7	5.7	85.7	334.0	274.4
Eastern Asia	20.3	8.3	42.4	18.3	21.5	14.8	35.5	12.6	45.0	19.9	25.3	9.6	8.2	222.1	158.1
South-Eastern Asia	3.0	1.4	10.9	6.7	15.2	12.9	21.4	9.0	29.6	11.9	31.0	15.8	8.3	143.9	141.7
South-Central Asia	6.8	4.9	6.7	3.9	4.9	4.1	3.4	1.6	13.1	3.4	24.0	24.6	4.1	99.7	110.8
Western Asia	3.8	2.8	12.6	6.7	13.1	10.1	4.4	2.3	30.7	5.2	32.5	4.5	13.8	152.8	119.5
Central and Eastern Europe	5.6	0.8	22.2	9.7	33.0	21.0	4.6	1.9	57.0	9.6	45.3	14.5	28.5	259.2	184.2
Northern Europe	8.1	2.7	8.6	4.2	36.0	24.6	3.8	1.6	39.3	21.9	84.0	8.3	86.4	303.5	249.4
Southern Europe	4.0	0.7	13.9	6.8	39.3	24.5	9.8	3.2	49.0	10.4	68.9	8.0	50.2	289.9	212.2
Western Europe	6.7	1.6	9.0	4.4	41.2	26.3	7.2	2.1	44.7	16.7	89.9	6.9	94.2	337.4	250.9
Australia/ New Zealand	5.2	1.8	7.4	3.4	45.7	33.0	5.0	2.0	32.4	19.9	85.5	5.0	104.2	356.8	276.4
Melanesia	6.1	2.7	8.8	5.6	10.7	3.7	12.9	5.0	12.4	4.9	22.8	23.7	15.8	146.0	133.4
Micronesia/ Polynesia	5.1	0.6	7.3	6.5	18.8	13.1	9.5	3.3	46.5	15.9	58.0	13.4	39.9	194.1	184.0

Eastern Europe (almost 20%). As in males, the regions with the highest incidence rates in females are Northern America (ASR 274.4 per 100,000), Australia/New Zealand (ASR 276.4) and Northern and Western Europe (ASRs 249.4 and 250.9, respectively) as a consequence of the high rates of breast cancer in these regions (ASRs greater than 75 per 100,000). The lowest cancer incidence rates are in Middle and Western Africa and in South-Central Asia for men and in Middle and Northern Africa for women (ASRs less than 100 per 100,000).

The ratios of ASRs of incidence between developed and developing regions are 1.8 in men and 1.6 in women, while the same ratios for mortality are much lower, 1.2 and almost 1.0 in women. Women living in Eastern, Southern and Western Africa have the same risk of dying from cancer before age 74 as women living in Northern and Central Europe (10%). A number of common cancers in developed countries are associated with reasonably high survival (prostate, breast and colorectal cancers) whereas several common cancers with a poorer prognoses (liver, stomach and oesophageal cancers) are more common in less developed regions (Figs. 5*a* and 5*b*).

Lung cancer

Lung cancer has been the most common cancer in the world for several decades and by 2008, there were an estimated 1.61 million new cases, representing 12.7% of all new cancers (Table 4). It was also the most common cause of death from cancer, with 1.38 million deaths (18.2% of the total). The majority of the cases now occur in the developing countries (55%), a large increase since the estimates in 1980, when it was estimated that only 31% of lung cancer cases occurred in developing countries.[4] Lung cancer is still the most common

Table 7. Estimated ASRs (World standard) of cancer mortality by sex, cancer site and regions, 2008

	Oesophagus (C15)		Stomach (C16)		Colorectum (C18-21)		Liver (C22)		Lung (C33-34)		Breast (C50)	Cervix (C53)	Prostate (C61)	All sites (C00-97/C44)	
	M	F	M	F	M	F	M	F	M	F	F	F	M	M	F
World	8.6	3.4	14.3	6.9	9.7	7.0	14.6	5.7	29.4	11.0	12.5	7.8	7.5	128.8	87.6
More developed regions	5.3	1.0	10.4	4.7	15.1	9.7	7.2	2.5	39.4	13.6	15.3	3.2	10.6	143.9	87.3
Less developed regions	10.1	4.7	16.0	8.1	6.9	5.4	17.4	7.2	24.6	9.7	10.8	9.8	5.6	119.3	85.4
Eastern Africa	14.3	6.2	5.4	3.8	4.7	3.8	7.3	3.8	4.0	1.3	11.4	25.3	11.7	105.4	95.9
Middle Africa	1.4	0.8	5.2	4.6	3.5	2.7	19.2	10.6	2.7	0.9	13.1	17.0	13.4	78.5	75.6
Northern Africa	2.0	1.5	3.7	2.3	5.5	4.5	7.4	2.5	14.0	2.0	17.8	4.0	6.2	89.5	68.2
Southern Africa	21.4	11.1	3.9	2.0	15.8	6.1	13.9	5.0	27.5	7.4	19.3	14.8	19.3	172.1	108.1
Western Africa	1.4	1.0	4.3	3.1	4.6	3.5	16.5	8.3	2.9	1.1	19.0	24.0	18.3	80.1	91.2
Caribbean	4.0	1.2	8.0	4.6	8.8	8.9	6.1	4.4	23.6	11.1	14.2	9.4	26.3	116.6	86.2
Central America	1.8	0.6	10.6	7.9	4.5	3.9	7.3	7.0	12.2	5.3	9.6	11.1	12.6	84.7	80.6
South America	5.6	1.6	14.2	6.9	7.8	6.5	5.4	4.1	18.8	7.5	13.2	10.7	16.2	116.6	88.2
Northern America	4.8	1.0	2.8	1.5	10.4	7.9	5.3	1.9	37.9	24.2	14.8	1.7	9.9	122.4	91.5
Eastern Asia	16.2	6.4	28.1	13.0	9.4	6.7	31.7	11.7	38.1	16.3	6.3	3.9	2.5	155.5	87.3
South-Eastern Asia	2.6	1.3	8.9	5.6	9.9	8.2	19.7	8.3	26.3	10.4	13.4	8.3	5.1	112.3	89.4
South-Central Asia	6.4	4.4	6.3	3.7	3.6	2.9	3.2	1.5	12.0	3.1	12.0	14.1	2.8	78.0	71.7
Western Asia	3.6	2.6	11.1	5.8	8.3	6.2	4.5	2.4	28.4	4.6	14.3	2.1	7.5	113.9	74.3
Central and Eastern Europe	5.1	0.6	19.6	8.1	20.3	12.1	5.6	2.3	51.6	7.9	16.9	6.3	10.9	181.5	94.0
Northern Europe	7.1	2.4	5.7	2.8	14.5	9.7	3.7	1.7	32.2	18.8	17.8	2.4	15.7	134.6	99.7
Southern Europe	3.4	0.6	9.7	4.7	16.3	9.4	8.3	2.9	42.3	8.5	15.3	2.5	10.5	149.9	81.2
Western Europe	5.3	1.1	5.8	2.9	15.1	9.3	6.5	2.0	37.1	12.9	17.5	2.0	12.4	138.4	84.3
Australia/ New Zealand	4.8	1.5	4.3	2.1	16.1	10.3	3.8	1.6	25.6	14.6	15.4	1.4	15.4	125.6	86.0
Melanesia	6.0	2.6	8.6	5.3	8.8	3.3	12.9	5.3	11.7	4.7	13.2	16.6	12.4	119.8	95.9
Micronesia/ Polynesia	3.1	0.0	7.6	3.2	9.8	5.7	9.1	3.4	36.8	13.1	13.2	4.9	13.0	121.1	79.9

cancer in men worldwide (1.1 million cases, 16.5% of the total), with high rates in Central-eastern and Southern Europe, Northern America and Eastern Asia. Very low rates are still estimated in Middle and Western Africa (ASRs 2.8 and 3.1 per 100,000, respectively). In females, incidence rates are generally lower, but, worldwide, lung cancer is now the fourth most frequent cancer of women (513,000 cases, 8.5% of all cancers) and the second most common cause of death from cancer (427,000 deaths, 12.8% of the total). The highest incidence rate is observed in Northern America (where lung cancer it is now the second most frequent cancer in women), and the lowest in Middle Africa (15th most frequent cancer).

Because of its high fatality (the ratio of mortality to incidence is 0.86) and the lack of variability in survival in developed and developing countries, the highest and lowest mortality rates are estimated in the same regions, both in men and women (Fig. 6).

Breast cancer

Breast cancer is by far the most frequent cancer among women with an estimated 1.38 million new cancer cases diagnosed in 2008 (23% of all cancers), and ranks second overall (10.9% of all cancers). It is now the most common cancer both in developed and developing regions with 690,000 new cases estimated in each region (population ratio 1:4). Incidence rates vary from 19.3 per 100,000 women in Eastern Africa to 89.9 per 100,000 women in Western Europe, and are high (greater than 80 per 100,000) in developed regions of the world (except Japan) and low (less than 40 per 100,000) in most of the developing regions (Fig. 7*a*).

Table 8. Estimated numbers of new cancer cases (thousands) by sex, cancer site and regions, 2008

	Oesophagus (C15)		Stomach (C16)		Colorectum (C18-21)		Liver (C22)		Lung (C33-34)		Breast (C50)	Cervix (C53)	Prostate (C61)	All sites (C00-97/C44)	
	M	F	M	F	M	F	M	F	M	F	F	F	M	M	F
World	326.6	155.7	640.6	349.0	663.6	570.1	522.4	225.9	1095.2	513.6	1383.5	529.4	913.8	6639.4	6038.5
More developed regions	64.0	17.8	173.7	102.0	389.7	337.7	81.7	39.9	482.6	241.7	692.2	76.5	658.8	2985.5	2584.8
Less developed regions	262.6	137.9	466.9	247.0	273.9	232.4	440.7	186.0	612.5	272.0	691.3	452.9	255.0	3654.0	3453.8
Eastern Africa	10.5	5.3	4.0	3.3	4.5	4.1	5.8	3.2	2.8	1.2	17.9	31.5	9.1	100.8	120.2
Middle Africa	0.4	0.2	1.7	1.8	1.3	1.2	7.0	3.9	0.8	0.3	8.3	8.2	4.2	29.5	37.4
Northern Africa	1.4	1.3	2.9	1.9	5.4	4.8	5.4	1.9	10.4	1.7	28.0	5.3	5.2	81.5	82.9
Southern Africa	4.0	2.7	0.7	0.5	3.3	1.9	2.6	1.2	4.7	1.8	9.0	6.5	7.8	40.6	38.6
Western Africa	1.1	0.8	3.3	2.6	4.5	3.8	13.9	6.8	2.1	0.9	29.4	28.9	13.3	72.5	111.6
Caribbean	1.1	0.4	2.4	1.6	3.2	3.6	1.3	1.1	5.6	2.9	9.0	4.7	16.0	42.8	36.5
Central America	1.2	0.5	7.7	6.5	4.3	4.4	4.4	4.8	7.6	3.8	17.5	15.6	20.5	84.0	92.6
South America	10.5	4.5	29.3	17.9	23.0	25.1	8.9	8.3	33.8	17.2	88.4	47.5	84.1	318.0	332.3
Northern America	14.2	4.0	15.1	9.4	91.8	85.3	16.6	6.7	125.9	110.7	205.5	12.5	213.7	831.8	772.1
Eastern Asia	195.2	86.7	408.2	193.1	206.9	155.2	340.9	131.4	435.8	209.9	240.3	90.8	82.7	2135.3	1585.4
South-Eastern Asia	6.7	3.8	24.9	18.4	34.4	34.5	50.9	24.0	66.6	31.7	86.9	44.4	17.7	336.7	388.8
South-Central Asia	42.4	31.8	41.9	26.2	32.3	27.2	21.7	10.5	80.0	22.4	172.9	173.7	23.4	651.1	772.0
Western Asia	2.7	2.4	9.2	5.6	9.9	8.6	3.3	1.9	22.5	4.4	28.5	3.9	9.4	118.5	104.8
Central and Eastern Europe	10.7	2.5	43.3	30.6	64.5	65.3	8.9	6.0	109.6	28.3	114.6	31.0	57.6	494.6	490.6
Northern Europe	7.0	3.4	7.8	4.9	32.2	28.0	3.3	1.9	35.4	23.4	69.5	5.3	78.0	258.8	231.8
Southern Europe	5.1	1.3	20.0	12.9	57.8	44.8	13.8	6.6	67.8	16.9	91.3	8.7	79.9	398.8	315.0
Western Europe	11.0	3.4	16.5	10.9	74.5	64.1	12.5	4.9	76.6	31.4	149.4	9.3	170.0	569.6	464.7
Australia/ New Zealand	1.1	0.5	1.5	0.8	9.4	7.9	1.0	0.5	6.9	4.6	16.1	0.8	21.0	70.3	56.7
Melanesia	0.1	0.1	0.2	0.1	0.2	0.1	0.3	0.1	0.3	0.1	0.6	0.7	0.3	3.3	3.7
Micronesia/ Polynesia	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.2	0.1	0.3	0.1	0.2	0.9	0.9

The range of mortality rates is much less (approximately 6–19 per 100,000) because of the more favorable survival of breast cancer in (high-incidence) developed regions (Fig. 7*b*). As a result, breast cancer ranks as the fifth cause of death from cancer overall (458,000 deaths), but it is still the most frequent cause of cancer death in women in both developing (269,000 deaths, 12.7% of total) and developed regions. The estimated 189,000 deaths in the latter is almost equal to the estimated number of deaths from lung cancer (188,000 deaths).

Colorectal cancer

Colorectal cancer is the third most common cancer in men (663,000 cases, 10.0% of the total) and the second in women (570,000 cases, 9.4% of the total) worldwide. Almost 60% of the cases occur in developed regions. Incidence rates vary 10-fold in both sexes worldwide, the highest rates being estimated in Australia/New Zealand and Western Europe, the lowest in Africa (except Southern Africa) and South-Central Asia, and are intermediate in Latin America (Fig. 8). Incidence rates are substantially higher in men than in women (overall sex ratio of the ASRs 1.4:1).

About 608,000 deaths from colorectal cancer are estimated worldwide, accounting for 8% of all cancer deaths, making it the fourth most common cause of death from cancer. As observed for incidence, mortality rates are lower in women than in men, except in the Caribbean. There is less variability in mortality rates worldwide (sixfold in men, fivefold in women), with the highest mortality rates in both sexes estimated in Central and Eastern Europe (20.3 per 100,000 for male, 12.1 per 100,000 for female), and the lowest in Middle Africa (3.5 and 2.7, respectively).

Stomach cancer

About one million new cases of stomach cancer were estimated to have occurred (989,000 cases, 7.8% of the total), making it currently the fourth most common malignancy in

Table 9. Estimated numbers of cancer deaths (thousands) by sex, cancer site and regions, 2008

	Oesophagus (C15)		Stomach (C16)		Colorectum (C18-21)		Liver (C22)		Lung (C33-34)		Breast (C50)	Cervix (C53)	Prostate (C61)	All sites (C00-97/C44)	
	M	F	M	F	M	F	M	F	M	F	F	F	M	M	F
World	276.1	130.7	464.4	273.6	320.6	288.0	478.3	217.6	951.0	427.4	458.4	274.9	258.4	4225.7	3345.8
More developed regions	53.1	14.8	110.9	70.8	166.2	153.9	75.4	39.9	412.0	188.4	189.5	33.2	136.5	1528.2	1223.2
Less developed regions	223.0	115.9	353.5	202.9	154.4	134.1	402.9	177.7	539.0	239.0	268.9	241.7	121.9	2697.5	2122.6
Eastern Africa	10.0	5.1	3.8	3.1	3.5	3.2	5.7	3.1	2.7	1.1	10.0	21.6	7.3	85.4	88.3
Middle Africa	0.4	0.2	1.6	1.7	1.1	1.0	6.8	3.8	0.8	0.3	4.7	5.7	3.4	25.6	27.6
Northern Africa	1.4	1.2	2.7	1.8	4.1	3.6	5.2	1.9	9.6	1.6	14.6	3.1	4.0	65.4	55.4
Southern Africa	3.8	2.6	0.6	0.5	2.4	1.4	2.5	1.1	4.3	1.7	4.5	3.5	2.6	29.3	25.5
Western Africa	1.0	0.8	3.1	2.5	3.6	3.0	13.6	6.6	2.0	0.9	16.3	19.4	10.7	61.3	78.0
Caribbean	0.9	0.3	1.8	1.2	2.0	2.4	1.3	1.1	5.2	2.7	3.4	2.2	6.5	26.3	21.5
Central America	1.1	0.4	6.4	5.6	2.7	2.8	4.4	4.8	7.3	3.7	6.5	7.6	8.1	52.5	55.8
South America	9.4	3.5	24.2	15.1	13.5	14.4	9.2	8.6	31.3	15.5	27.1	21.6	29.3	200.6	185.3
Northern America	12.6	3.4	7.6	5.2	28.7	29.7	13.7	6.5	101.2	79.3	45.6	4.4	32.6	332.5	305.9
Eastern Asia	157.2	69.6	274.3	144.2	93.4	75.0	306.1	123.6	373.0	177.5	61.7	39.7	26.8	1511.8	928.6
South-Eastern Asia	5.8	3.4	20.1	15.3	22.2	22.2	47.0	22.2	58.0	27.9	36.8	22.5	10.9	258.6	242.4
South-Central Asia	39.3	28.3	39.5	24.1	23.1	19.5	19.8	10.0	72.5	20.4	82.6	95.8	16.7	496.8	483.2
Western Asia	2.6	2.2	8.1	4.9	6.2	5.2	3.3	2.0	20.6	3.9	12.3	1.8	5.2	86.7	64.4
Central and Eastern Europe	9.7	2.2	38.2	26.6	40.6	41.2	10.8	7.5	99.5	24.3	47.5	15.8	22.9	351.9	283.0
Northern Europe	6.3	3.2	5.4	3.6	13.9	12.8	3.4	2.1	29.8	21.6	18.3	2.1	17.7	126.4	116.3
Southern Europe	4.5	1.1	14.6	9.8	26.1	20.4	12.5	6.7	61.0	14.8	25.6	3.4	20.6	225.0	155.5
Western Europe	9.0	2.7	11.1	7.9	29.8	27.2	11.9	5.3	66.3	26.6	37.3	3.8	28.7	258.9	204.9
Australia/ New Zealand	1.0	0.4	0.9	0.6	3.5	2.8	0.8	0.4	5.6	3.5	3.4	0.3	4.0	27.6	21.4
Melanesia	0.1	0.1	0.2	0.1	0.2	0.1	0.3	0.1	0.2	0.1	0.3	0.5	0.2	2.6	2.5
Micronesia/ Polynesia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.1	0.0	0.1	0.5	0.4

the world, behind cancers of the lung, breast and colo-rectum. This represents a substantive change since the very first estimates in 1975, when stomach cancer was globally the most common neoplasm.[3] More than 70% of cases (714,000 cases) occur in developing countries (467,000 in men, 247,000 in women), and half the world total occurs in Eastern Asia (mainly in China). Age-standardized incidence rates are about twice as high in men as in women, ranging from 3.9 in Northern Africa to 42.4 in Eastern Asia for men, and from 2.2 in Southern Africa to 18.3 in Eastern Asia for women (Fig. 9).

Stomach cancer is the second leading cause of cancer death in both sexes worldwide (738,000 deaths, 9.7% of the total). The highest mortality rates are estimated in Eastern Asia (28.1 per 100,000 in men, 13.0 per 100,000 in women), the lowest in Northern America (2.8 and 1.5, respectively). High mortality rates are also present in both sexes in Central and Eastern Europe, and in Central and South America.

Prostate cancer

Prostate cancer is the second most frequently diagnosed cancer of men (914,000 new cases, 13.8% of the total) and the fifth most common cancer overall. Nearly three-quarters of the registered cases occur in developed countries (659,000 cases). Incidence rates of prostate cancer vary by more than 25-fold worldwide, the highest rates are in Australia/New Zealand (104.2 per 100,000), Western and Northern Europe, Northern America, largely because the practice of prostate specific antigen (PSA) testing and subsequent biopsy has become widespread in those regions. Incidence rates are relatively high in certain developing regions such as the Caribbean, South America and sub-Saharan Africa. The lowest

Table 10. Estimated cumulative risk to age 74 (percent) by sex, cancer site and regions, 2008—Incidence

	Oesophagus (C15)		Stomach (C16)		Colorectum (C18-21)		Liver (C22)		Lung (C33-34)		Breast (C50)	Cervix (C53)	Prostate (C61)	All sites (C00-97/C44)	
	M	F	M	F	M	F	M	F	M	F	F	F	M	M	F
World	1.3	0.5	2.4	1.0	2.3	1.6	1.8	0.7	4.1	1.6	4.1	1.6	3.5	21.2	16.5
More developed regions	0.8	0.1	2.0	0.8	4.4	2.7	1.0	0.3	5.7	2.3	7.1	0.9	7.9	30.1	22.0
Less developed regions	1.4	0.7	2.5	1.1	1.4	1.1	2.2	0.9	3.3	1.3	2.8	1.9	1.4	17.0	14.0
Eastern Africa	1.8	0.8	0.7	0.5	0.7	0.5	0.8	0.4	0.5	0.2	2.1	3.8	1.8	12.8	13.0
Middle Africa	0.2	0.1	0.5	0.5	0.5	0.4	1.8	0.9	0.3	0.1	2.1	2.5	1.6	8.4	9.4
Northern Africa	0.3	0.2	0.5	0.3	0.8	0.7	0.9	0.3	1.9	0.3	3.2	0.7	1.0	12.0	10.2
Southern Africa	2.6	1.4	0.5	0.2	2.4	0.8	1.2	0.4	3.1	1.0	4.2	2.9	6.2	23.3	16.2
Western Africa	0.2	0.2	0.6	0.4	0.6	0.5	1.8	1.0	0.4	0.2	3.4	3.8	2.8	10.1	13.1
Caribbean	0.6	0.2	1.3	0.7	1.6	1.5	0.8	0.5	3.0	1.4	4.3	2.1	8.3	20.6	15.7
Central America	0.3	0.1	1.5	1.1	0.8	0.7	0.8	0.8	1.5	0.6	2.8	2.2	4.2	14.3	13.7
South America	0.7	0.2	2.0	0.9	1.6	1.3	0.6	0.4	2.5	1.0	4.8	2.5	5.8	19.4	16.2
Northern America	0.7	0.2	0.7	0.3	4.1	2.9	0.8	0.3	6.0	4.6	8.4	0.5	11.0	33.4	26.7
Eastern Asia	2.5	1.0	5.1	2.1	2.5	1.7	4.0	1.5	5.3	2.3	2.6	0.9	0.9	22.9	16.0
South-Eastern Asia	0.4	0.2	1.3	0.7	1.8	1.5	2.4	1.0	3.5	1.4	3.2	1.7	0.9	15.2	14.2
South-Central Asia	0.8	0.6	0.8	0.4	0.6	0.5	0.4	0.2	1.6	0.4	2.5	2.6	0.5	10.9	11.4
Western Asia	0.4	0.3	1.5	0.8	1.5	1.2	0.5	0.3	3.8	0.6	3.4	0.5	1.7	16.4	12.3
Central and Eastern Europe	0.7	0.1	2.7	1.1	4.0	2.5	0.6	0.2	7.1	1.1	5.0	1.4	3.5	27.0	18.7
Northern Europe	1.0	0.3	1.0	0.5	4.2	2.8	0.4	0.2	4.7	2.7	8.9	0.7	10.6	30.1	24.3
Southern Europe	0.5	0.1	1.6	0.7	4.6	2.8	1.2	0.4	5.9	1.2	7.4	0.8	6.1	28.7	20.5
Western Europe	0.8	0.2	1.0	0.5	4.8	2.9	0.9	0.2	5.4	2.0	9.6	0.6	11.9	33.3	24.2
Australia/ New Zealand	0.6	0.2	0.9	0.4	5.4	3.7	0.6	0.2	3.8	2.5	9.4	0.5	12.8	34.3	26.4
Melanesia	0.9	0.3	1.3	0.8	1.3	0.4	1.2	0.5	1.6	0.6	2.4	2.3	1.8	16.0	13.5
Micronesia/ Polynesia	0.6	0.0	1.0	0.8	2.3	1.7	1.2	0.4	5.7	2.0	6.1	1.4	4.2	20.4	19.1

age-standardized incidence rate is estimated in South-Central Asia (4.1 per 100,000, Fig. 10).

With an estimated 258,000 deaths in 2008, prostate cancer is the sixth leading cause of death from cancer in men (6.1% of the total). Because PSA testing has a much greater effect on incidence than on mortality, there is less variation in mortality rates worldwide (10-fold) than is observed for incidence (25-fold, Fig. 10), and the number of deaths from prostate cancer is almost the same in developed and developing regions (136,000 and 122,000, respectively). Mortality rates are generally high in predominantly black populations (Caribbean, 26.3 per 100,000 and sub-Saharan Africa, ASRs 18-19 per 100,000), very low in Asia (ASR 2.5 per 100,000 in Eastern Asia for example) and intermediate in Europe and Oceania.

Liver cancer

Liver cancer is the fifth most common cancer in men (522,000 cases, 7.9% of the total) and the seventh in women (226,000 cases, 6.5% of the total), and most of the burden is in developing countries, where almost 85% of the cases occur, and particularly in men: the overall sex ratio male: female is 2.4. The regions of high incidence are Eastern and South-Eastern Asia, Middle and Western Africa, but also Melanesia and Micronesia/Polynesia (particularly in men). Low rates are estimated in developed regions, with the exception of Southern Europe where the incidence in men (ASR 9.8 per 100,000) is significantly higher than in other developed regions (Fig. 11).

There were an estimated 696,000 deaths from liver cancer in 2008 (478,000 in men, 218,000 in women), and

Table 11. Estimated cumulative risk to age 74 (percent) by sex, cancer site and regions, 2008—Mortality

	Oesophagus (C15)		Stomach (C16)		Colorectum (C18-21)		Liver (C22)		Lung (C33-34)		Breast (C50)	Cervix (C53)	Prostate (C61)	All sites (C00-97/C44)	
	M	F	M	F	M	F	M	F	M	F	F	F	M	M	F
World	1.0	0.4	1.7	0.8	1.1	0.7	1.7	0.7	3.5	1.3	1.3	0.9	0.6	13.5	9.1
More developed regions	0.6	0.1	1.2	0.5	1.7	1.0	0.9	0.3	4.7	1.6	1.7	0.3	0.9	15.0	9.1
Less developed regions	1.2	0.5	1.9	0.9	0.8	0.6	2.0	0.8	2.9	1.1	1.2	1.1	0.5	12.7	9.0
Eastern Africa	1.8	0.7	0.7	0.5	0.5	0.4	0.8	0.5	0.5	0.2	1.3	3.0	1.3	11.1	10.5
Middle Africa	0.2	0.1	0.5	0.5	0.4	0.3	1.8	1.1	0.3	0.1	1.4	1.9	1.1	7.4	7.7
Northern Africa	0.3	0.2	0.5	0.3	0.6	0.5	0.9	0.3	1.8	0.3	1.8	0.5	0.7	10.0	7.4
Southern Africa	2.5	1.3	0.5	0.2	1.8	0.6	1.3	0.4	2.9	0.9	2.1	1.7	1.5	16.6	11.1
Western Africa	0.2	0.1	0.6	0.4	0.5	0.4	1.8	1.1	0.3	0.2	2.1	2.9	2.1	8.7	10.3
Caribbean	0.5	0.1	0.9	0.5	0.9	0.9	0.7	0.5	2.7	1.3	1.6	1.0	2.2	11.6	9.0
Central America	0.2	0.1	1.2	0.9	0.5	0.4	0.8	0.8	1.4	0.6	1.0	1.2	1.1	8.6	8.6
South America	0.7	0.2	1.6	0.7	0.9	0.7	0.6	0.5	2.3	0.9	1.4	1.2	1.4	12.0	9.1
Northern America	0.6	0.1	0.3	0.2	1.1	0.8	0.6	0.2	4.6	3.0	1.6	0.2	0.8	12.8	9.8
Eastern Asia	1.9	0.8	3.3	1.4	1.0	0.7	3.6	1.3	4.4	1.9	0.7	0.4	0.2	16.2	9.1
South-Eastern Asia	0.3	0.1	1.0	0.6	1.1	0.9	2.2	0.9	3.1	1.2	1.4	0.9	0.5	12.0	9.4
South-Central Asia	0.8	0.5	0.8	0.4	0.4	0.3	0.4	0.2	1.5	0.4	1.3	1.6	0.3	8.7	7.8
Western Asia	0.4	0.3	1.3	0.7	0.9	0.7	0.5	0.3	3.6	0.6	1.5	0.3	0.8	12.4	7.9
Central and Eastern Europe	0.7	0.1	2.4	0.9	2.4	1.4	0.7	0.3	6.5	0.9	1.9	0.7	1.2	19.7	10.2
Northern Europe	0.8	0.3	0.6	0.3	1.6	1.0	0.4	0.2	3.7	2.3	1.9	0.2	1.3	13.5	10.4
Southern Europe	0.4	0.1	1.1	0.5	1.8	1.0	1.0	0.3	5.0	1.0	1.7	0.3	0.8	15.4	8.3
Western Europe	0.6	0.1	0.6	0.3	1.6	0.9	0.8	0.2	4.4	1.5	1.9	0.2	1.0	14.1	8.6
Australia/ New Zealand	0.5	0.2	0.5	0.2	1.8	1.1	0.5	0.2	3.0	1.8	1.7	0.2	1.2	12.6	8.9
Melanesia	0.9	0.3	1.3	0.7	1.1	0.3	1.2	0.6	1.5	0.6	1.4	1.7	1.3	13.2	10.3
Micronesia/ Polynesia	0.3	0.0	1.0	0.4	1.2	0.6	1.1	0.4	4.5	1.6	1.5	0.6	1.3	13.6	9.3

because of its high fatality (overall ratio of mortality to incidence of 0.93), liver cancer is the third most common cause of death from cancer worldwide. The geographical distribution of the mortality rates is similar to that observed for incidence.

Cervical cancer

Cervical cancer is the third most common cancer in women, and the seventh overall, with an estimated 529,000 new cases in 2008. As for liver cancer, more than 85% of the global burden occurs in developing countries, where it accounts for 13% of all female cancers. High-risk regions include Eastern and Western Africa, with a cumulative risk (0–74) of 3.8%, Southern Africa (2.9%), South-Central Asia (2.6%), Middle Africa and South America (2.5%). Risks are lowest in Western Asia, Northern America and Australia/New Zealand (0.5%) (Figs. 12*a* and 12*b*). Cervical cancer remains the most common cancer in women only in Eastern Africa, South-Central Asia and Melanesia.

Overall, the mortality: incidence ratio is 52%, and cervical cancer is responsible for 275,000 deaths in 2008, about 88% of which occur in developing countries: 53,000 in Africa, 31,400 in Latin America and the Caribbean, and 159,800 in Asia.

Oesophageal cancer

Oesophageal cancer is the eighth most common cancer worldwide, with 482,000 new cases (3.8% of the total) estimated in 2008, and the sixth most common cause of death from cancer with 407,000 deaths (5.4% of the total). These figures encompass both adenocarcinoma and squamous cell carcinoma (SCC) types. About 83% of the cases and 86% of the deaths occur in developing countries. The incidence rates

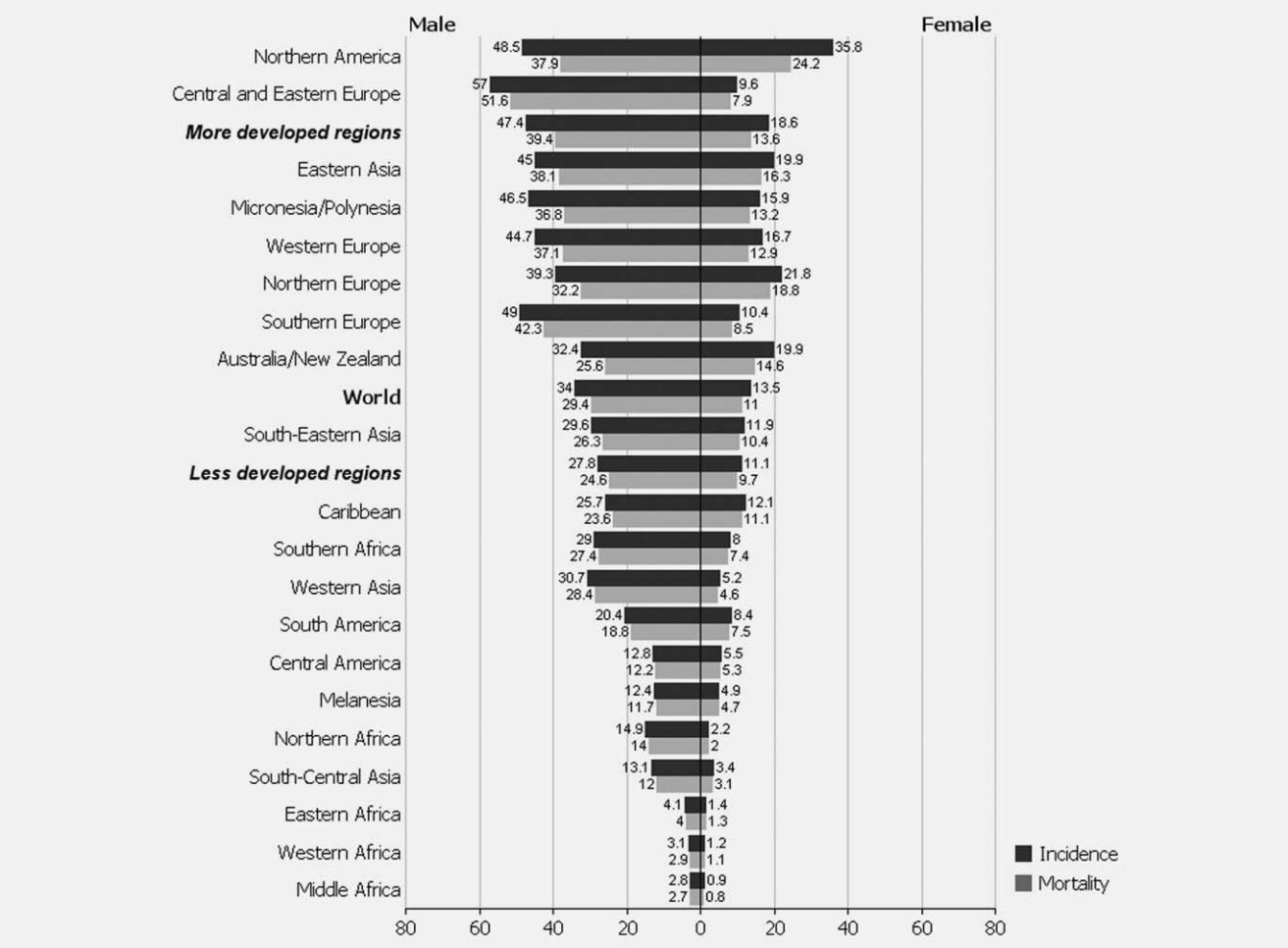

Figure 6. Estimated age-standardized incidence and mortality rates for lung cancer.

of oesophageal cancer vary internationally more than 15-fold in men (ASR 22.3 per 100,000 in Southern Africa compared to 1.4 in Western Africa), and almost 20-fold in women (ASR 11.7 per 100,000 in Southern Africa compared to 0.6 in Micronesia/Polynesia). Oesophageal cancer is two to four times more common among men than women. The highest mortality rates are found in both sexes in Eastern and Southern Africa, and in Eastern Asia (Fig. 13).

Discussion

The global and region-specific estimates presented here are built up from those for 182 countries, ranging in size from 1345 million (China) to 178,000 (Samoa). It should be clear that these estimates are variable in accuracy, depending on the extent and the validity of available data by country, ranging from real, complete and valid counts of cases and deaths, through estimates based on samples, to those based on neighboring incidence rates and on survival. The countries in Northern Europe and America have high quality incidence and mortality data, while in most African countries and in some populous countries in Asia there are no data at all, and the estimates are based on data from neighboring countries. Figure 14 gives an overview of the methods used to estimate incidence in the different countries; the darker tones implying that the method is potentially more accurate. We use the word "potentially" since the nature and percentage coverage of the data source(s) in a country may not always reflect the quality of the estimate. For example, the estimates of the cancer incidence in Finland and Mongolia in 2008 are both based on recent national incidence rates (up to 2007, method 1), but the reliability of the incidence rates is rather different: the data from National Cancer Registry of Mongolia have never appeared in Cancer Incidence in Five Continents, while the Finnish data have appeared in all nine volumes.

Population estimates for 2008 have been taken from a single source, the UN population division.[11] These estimates may differ slightly (especially for older age groups) from those prepared by national authorities.

The current estimates are not completely comparable with those published for earlier periods[3–10] because of substantial changes in data availability and improvements in the methodology of estimation. The methods still rely on the best available data at the country level, and coupled with the increase in the availability of incidence and mortality data

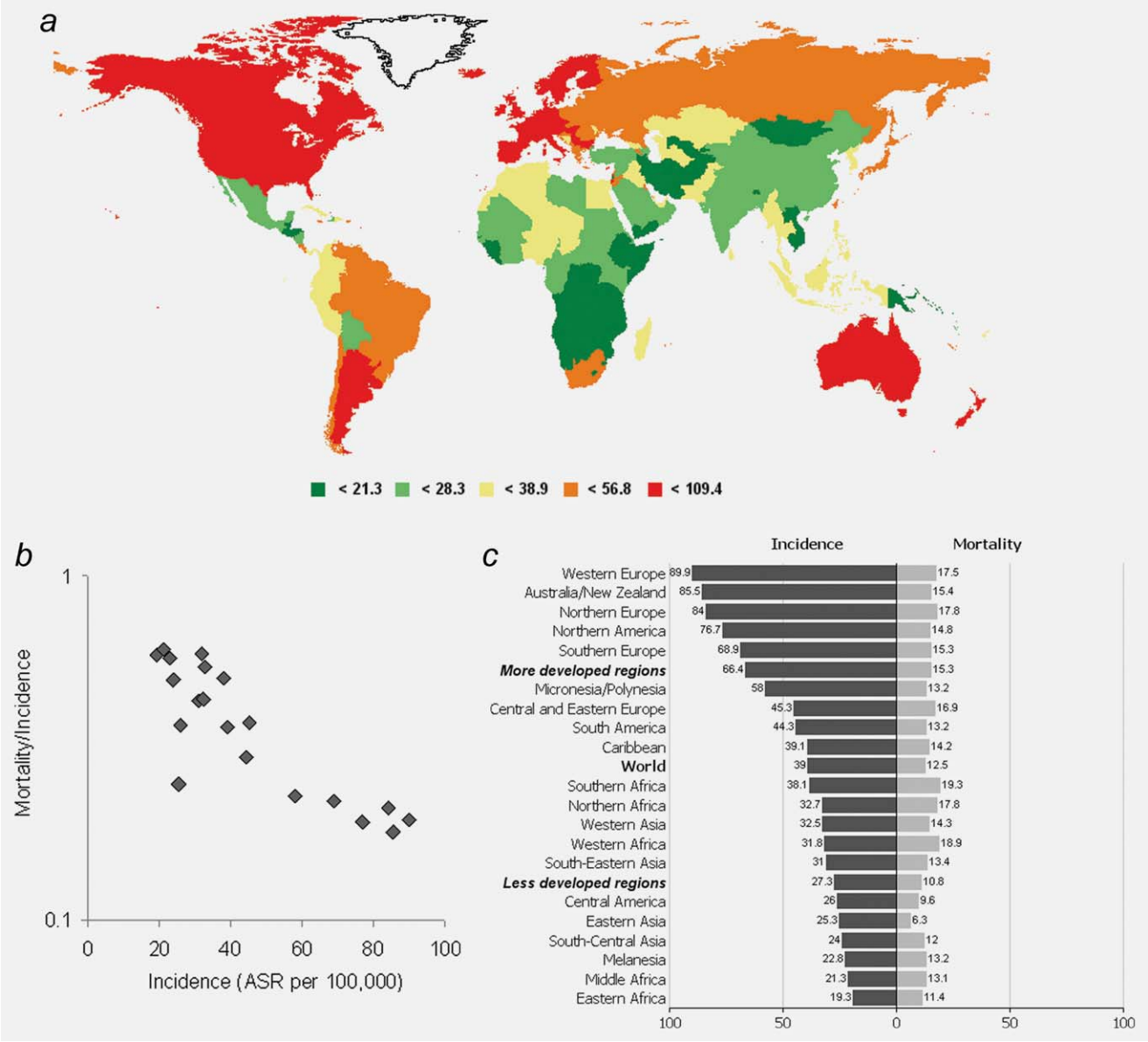

Figure 7. (*a*) Estimated age-standardized incidence rates per 100,000 (World): breast cancer. (*b*) Breast cancer: relationship between incidence and Mortality: Incidence ratio (20 regions). (*c*) Estimated age-standardized incidence and mortality rates for breast cancer.

Epidemiology

(both in term of time and geographic coverage), a substantial improvement has been the provision by WHO of country-specific cancer mortality estimates by sex and age group for 2008. These data were used in estimating the burden of cancer in several large countries of Asia for which no or very limited information were available (*e.g.*, Indonesia, Pakistan), and also to define the overall burden of cancer in some large countries in South-America and Asia such as Brazil, India and China (see incidence method 3B).

The estimates for the five regions of Africa are those based on the sparsest data- there were 22 (of 53) countries with no data at all (Table 2). Nevertheless, the estimates (for all cancers combined) were not derived using the mortality estimates of WHO (which were based on broad cause of death models). This was because these rates were systematically greater than or equal to the incidence recorded by the local cancer registries in urban areas of the few countries where the cancer registry data were considered of good quality. The country-specific cancer incidence rates (and mortality using the 5-year survival method) were therefore based on data reported by local cancer registries that generally cover the capital city or predominantly urban areas. Due to the local circumstances, under enumeration of cancer cases is a distinct possibility,[31] particularly in some of the unpublished datasets that were used. Thus, for example, the estimated age-specific mortality rates from lung cancer for African

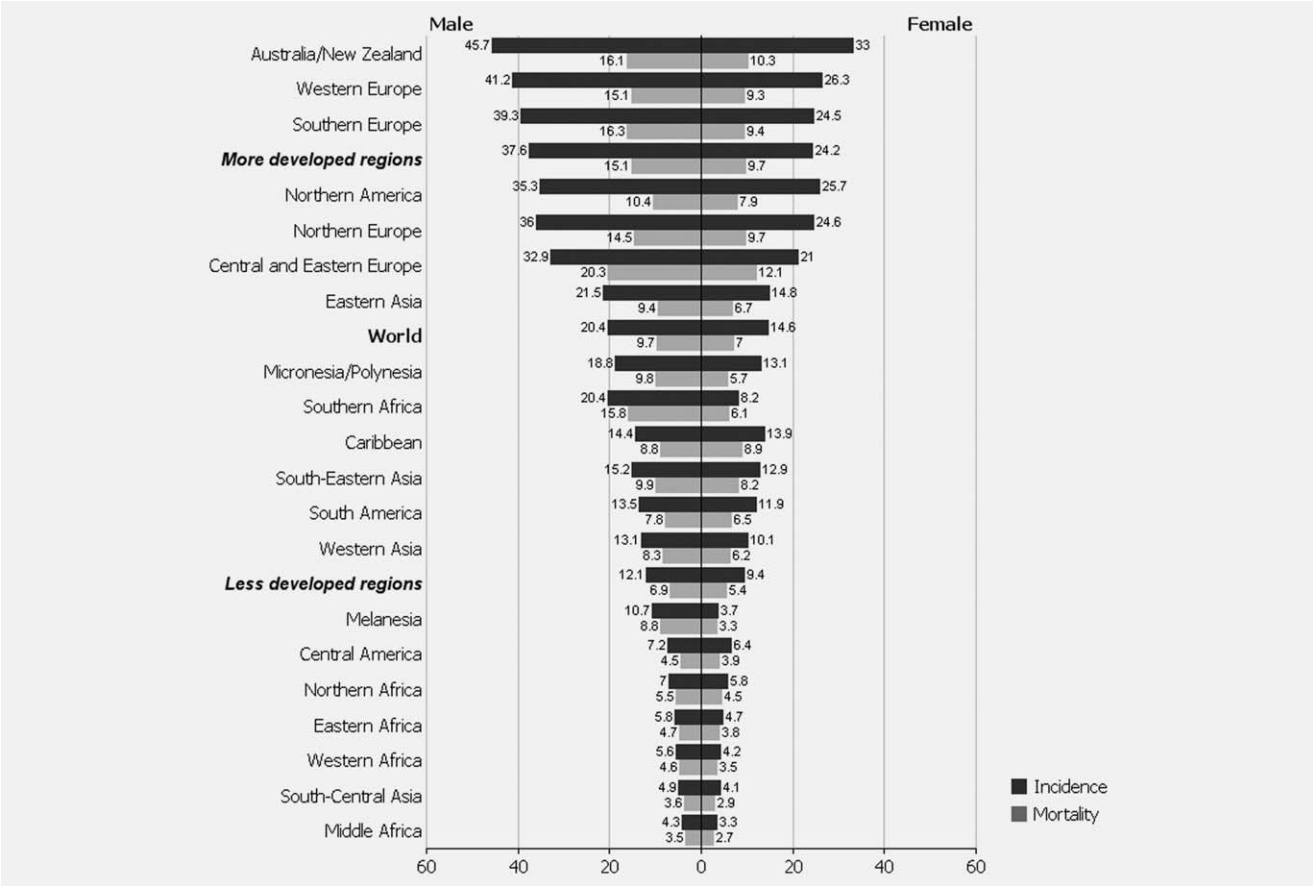

Figure 8. Estimated age-standardized incidence and mortality rates for colorectal cancer.

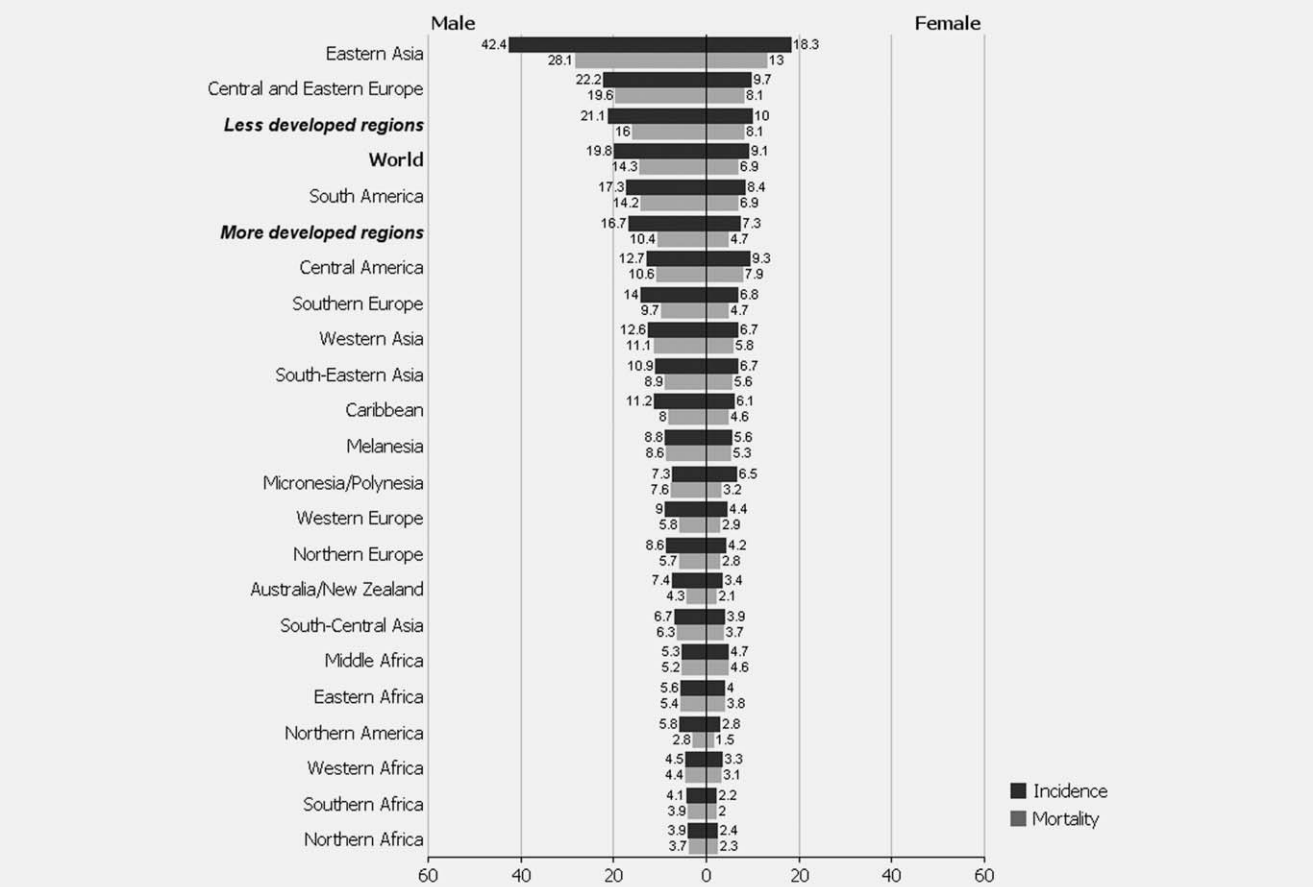

Figure 9. Estimated age-standardized incidence and mortality rates for stomach cancer.

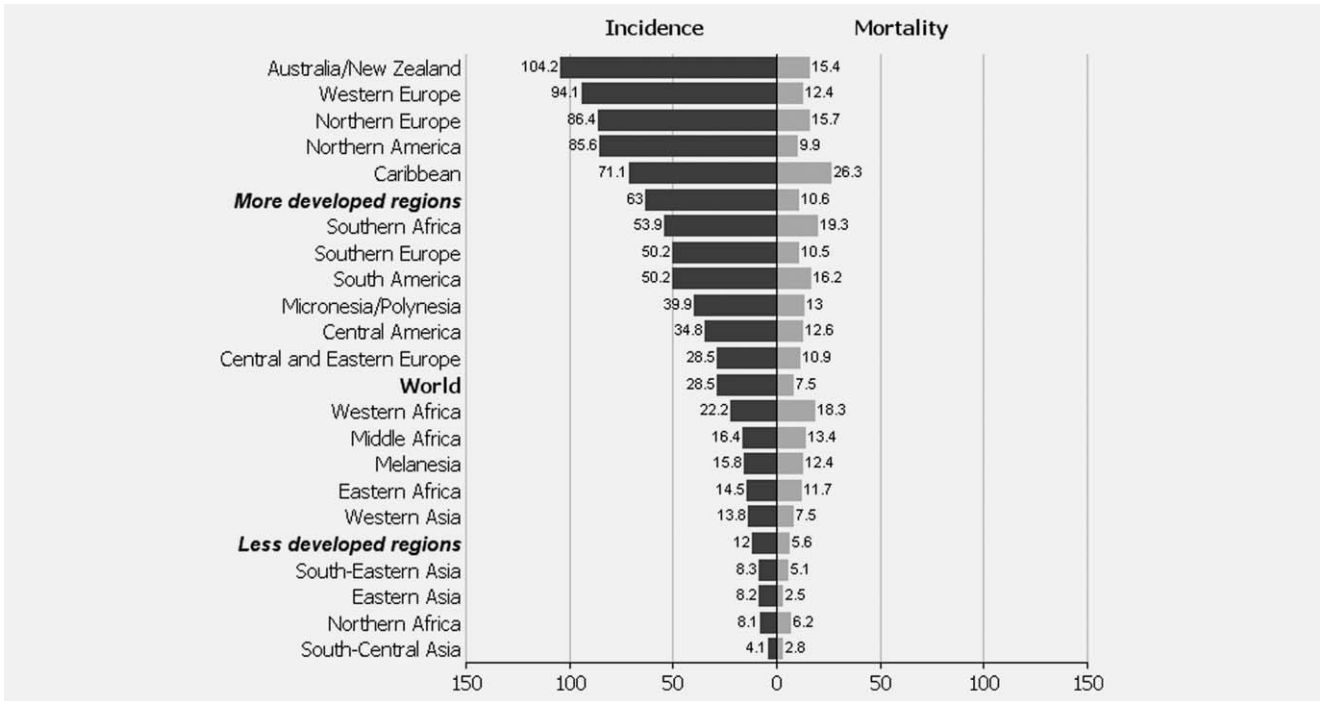

Figure 10. Estimated age-standardized incidence and mortality rates for prostate cancer.

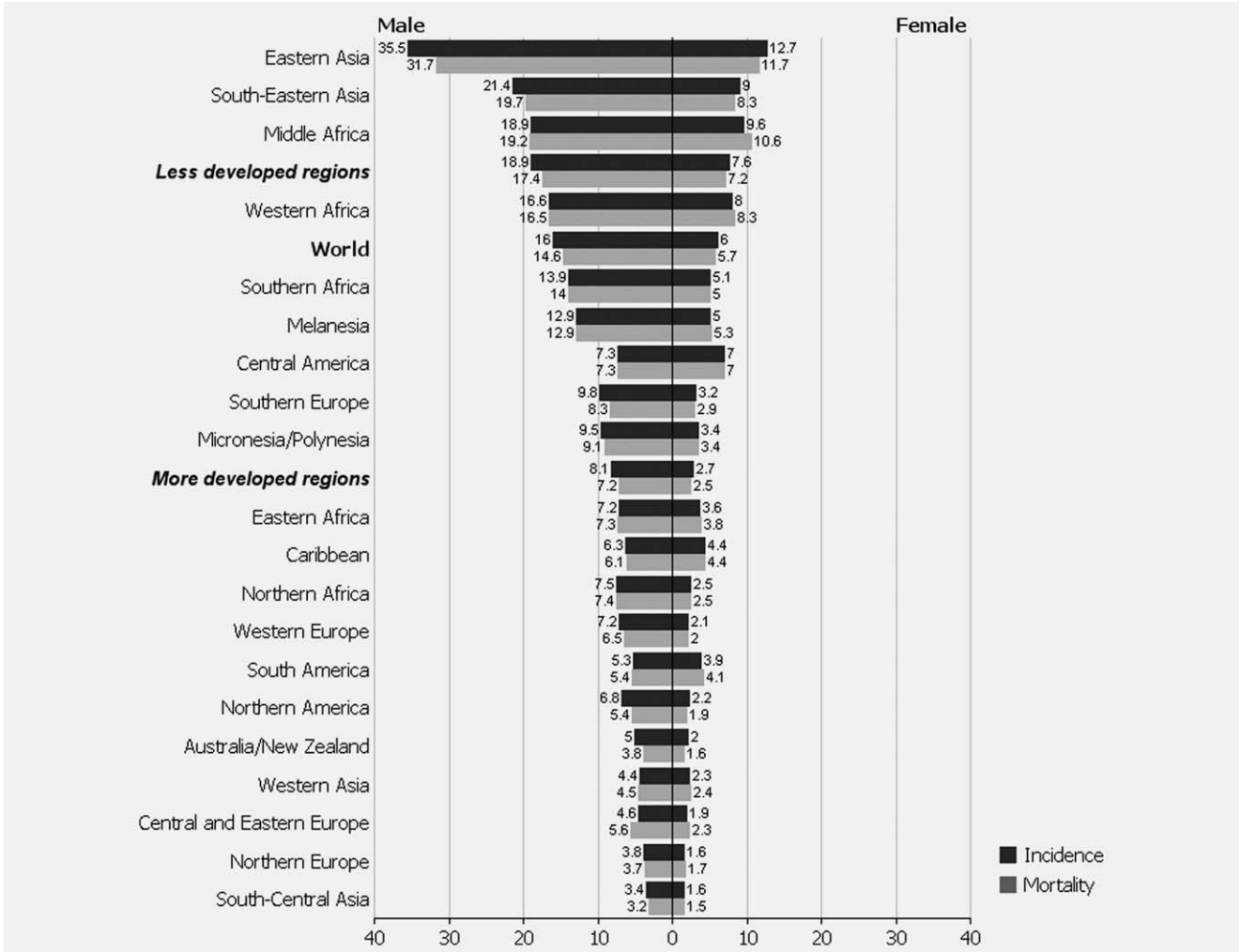

Figure 11. Estimated age-standardized incidence and mortality rates for liver cancer.

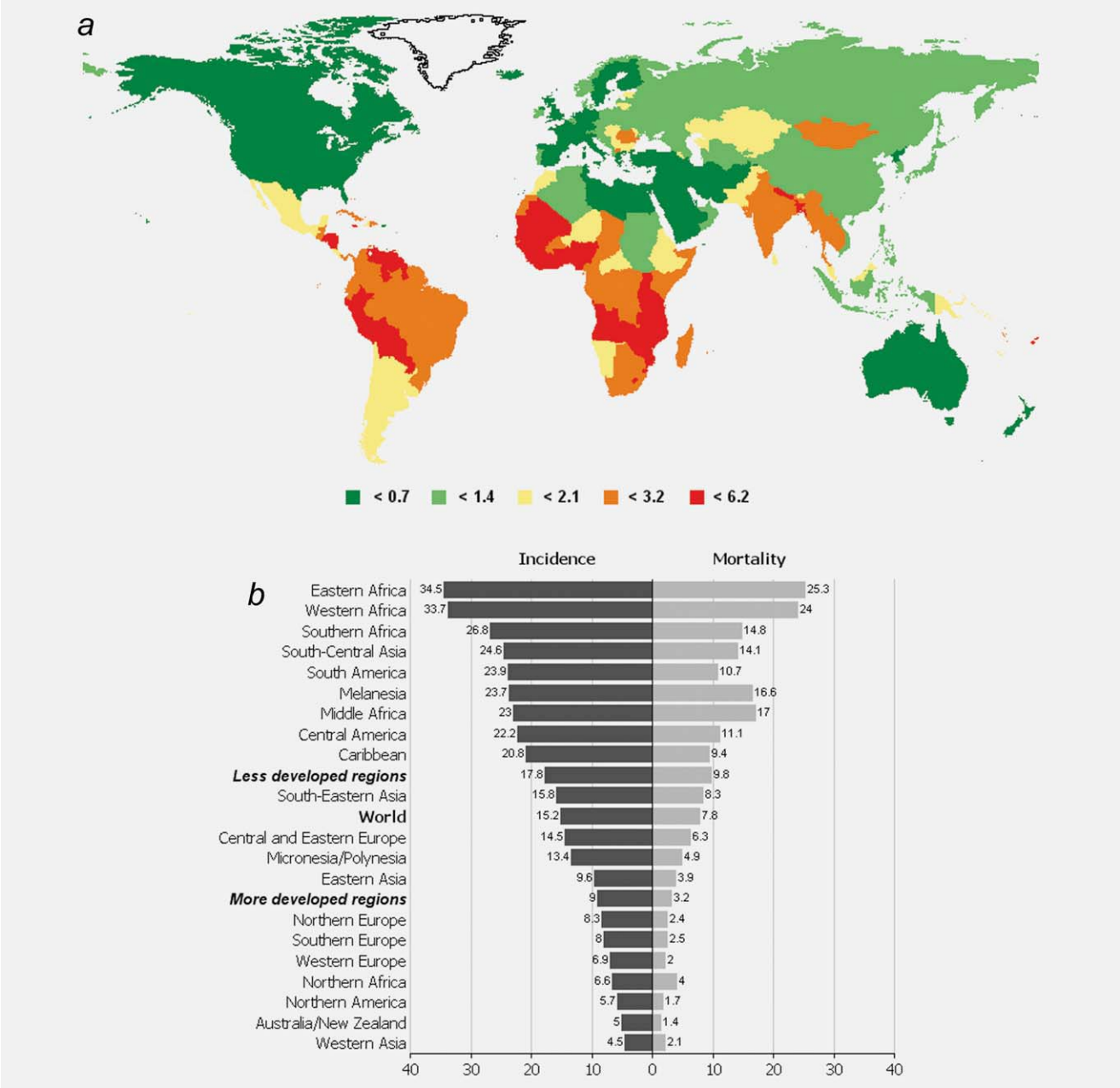

Figure 12. (*a*) Estimated cumulative incidence risk (0–74) percent: cervix uteri cancer. (*b*) Estimated age-standardized incidence and mortality rates for cervix uteri cancer.

females in western, middle and eastern Africa were below those in US nonsmokers,[32] especially in the elderly. However, against this one should consider that the very sparse data available for rural Africa[33] (with a life expectancy less than 50 years), suggest that incidence rates for most cancers are much lower than those reported by cancer registries in urban areas. If the urban: rural incidence rate ratios that are reported by Indian cancer registries (Table 12) were applicable to African countries, then the 2008 estimates for Africa would be over-estimated, since only 40% of the population is urban.[11]

In addition to the more extensive availability of data, some improvements in the methods have been introduced:

1. For the countries for which national incidence or mortality data were available, we performed some predictions to take into account trends in the cancer rates. Although this should produces more accurate estimates at the country level, it has a limited impact globally given these prediction methods were not used for the most populous countries of the world (*e.g.*, China, India, Indonesia and Brazil). In addition, cancer

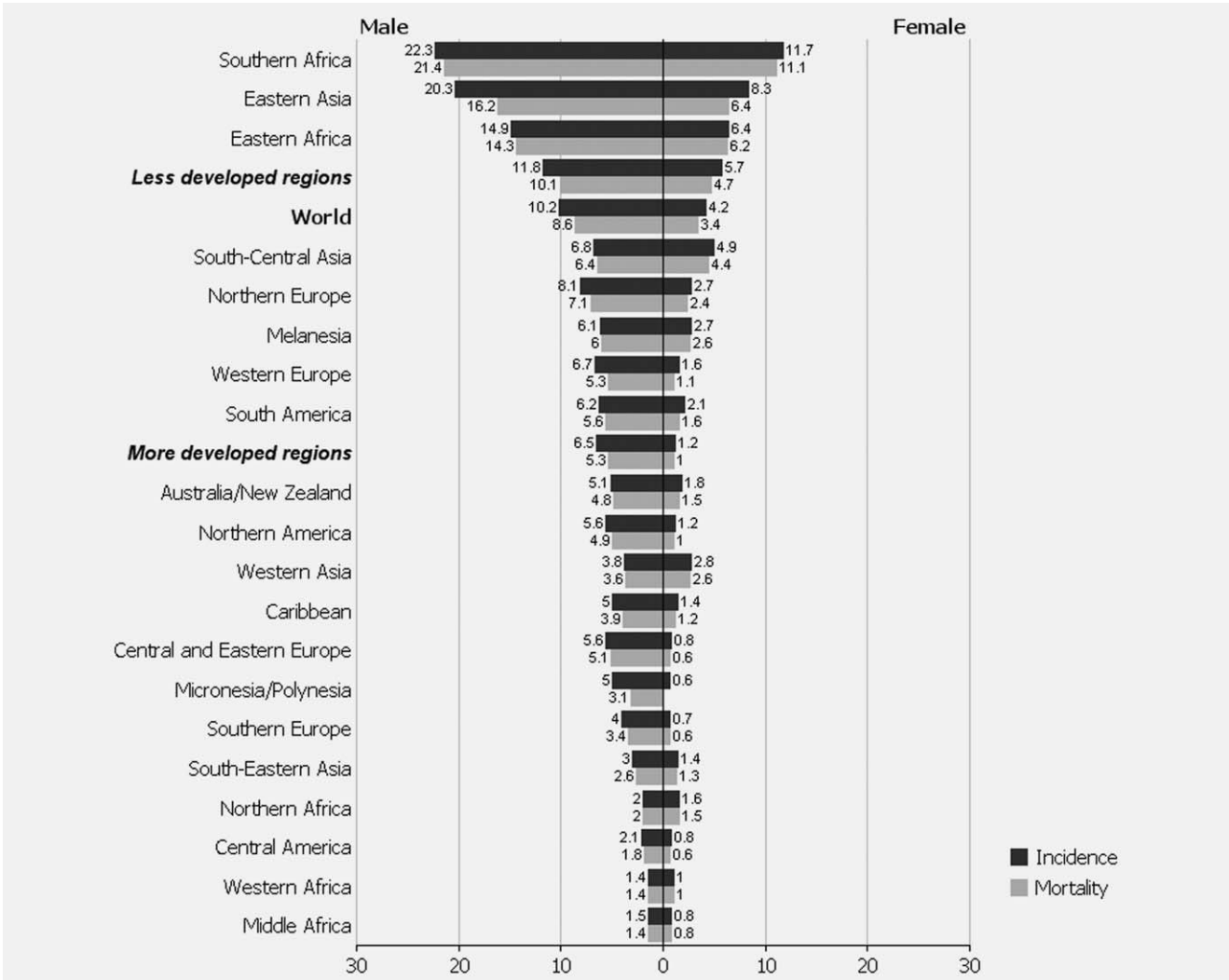

Figure 13. Estimated age-standardized incidence and mortality rates for oesophageal cancer.

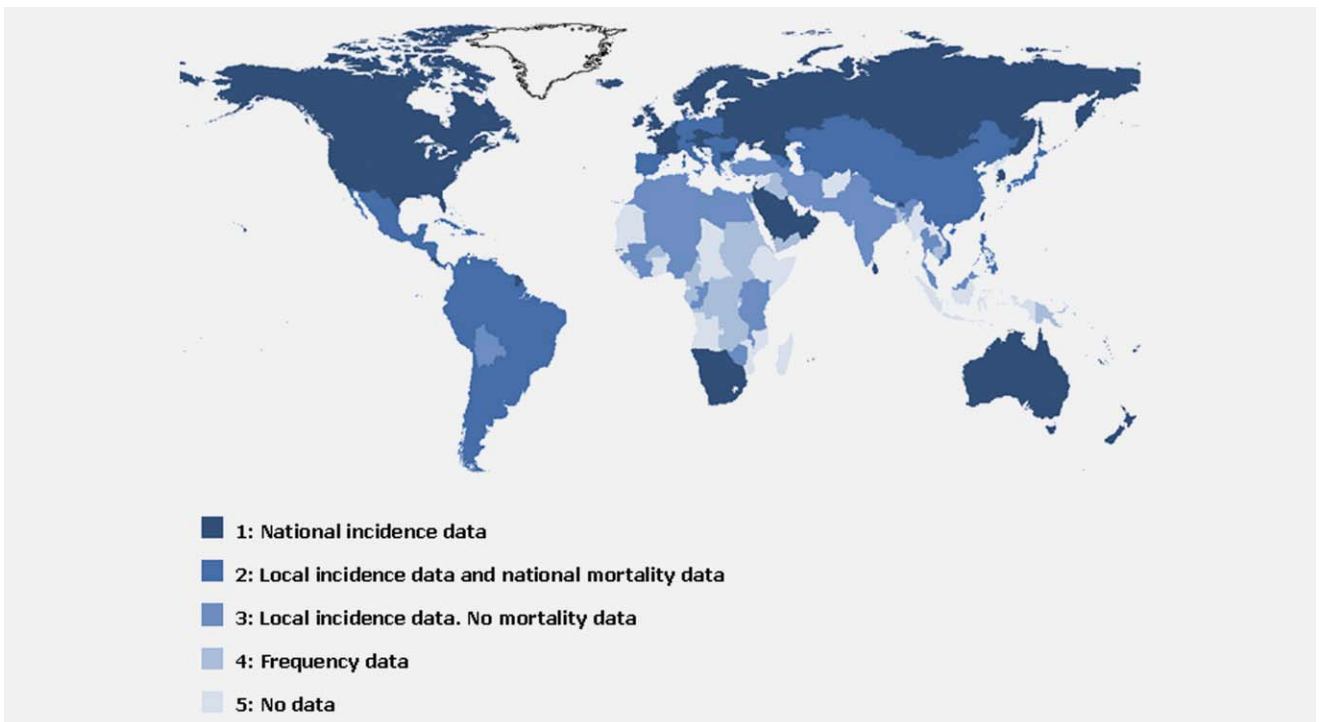

Figure 14. Methods of estimation: incidence data.

Table 12. Age-standardized incidence rates (World) per 100,000 in Indian and African cancer registries From refs. [12,33–36]

	Rural					Urban			
	India			Africa		India			Africa
	Ahmedabad	Ambilikkai, Dindigul district	Barshi	South Africa, PROMEC	The Gambia	Ahmedabad	Chennai	Mumbai	Zimbabwe, Harare city
Male									
Oral cavity and pharynx	24.0	12.6	10.1		1.0	33.3	18.6	17.6	3.0
Oesophagus	3.2	3.7	4.2	31.3	1.4	9.1	8.2	5.9	15.1
Stomach	1.1	5.6	1.8	1.5	2.5	2.0	11.4	4.5	9.0
Lung	6.5	3.2	2.1	6.0	5.1	11.5	11.7	8.9	9.5
Leukemia	3.3	2.0	2.0		0.3	4.2	4.6	4.3	2.6
All cancers excl. skin	66.7	50.4	43.7	71.8	83.5	123.6	101.7	94.2	150.4[1]
Female									
Oral cavity and pharynx	4.4	5.3	2.9		1.1	7.0	9.8	7.6	2.3
Oesophagus	1.7	1.8	2.5	18.0	1.1	5.2	4.7	4.1	5.3
Breast	9.0	10.9	8.8	7.1	7.0	26.5	30.8	28.1	19.0
Cervix	7.7	22.6	20.6	20.2	29.8	14.3	23.8	13.2	47.3
Ovary	3.4	3.3	1.8	0.9	2.0	4.4	5.7	6.9	6.8
Leukemia	2.2	1.4	1.3		0.4	2.4	3.3	3.2	2.0
All cancers excl. skin	41.8	61.9	51.9	58.5	82.3	94.3	113.9	99.7	169.7

[1]Excluding Kaposi sarcoma.

incidence and mortality trends often vary by direction and magnitude according to cancer site, sex and population, so while the overall effect is difficult to determine, it is likely to be small.

2. For the 86 countries of the world (mainly in the developing regions) for which no vital statistics were available (Table 3), we estimated cancer mortality using the estimated incidence and age-, sex- and site-specific survival probabilities. In the previous set of estimates[9,10] we used region-specific survival data, so that the cancer mortality for almost all the countries in developing regions were computed using the same set of survival probabilities. For GLOBOCAN 2008, survival was modeled based on GDP per capita. However, as described earlier in the results section, the most frequent cancers in the regions concerned (liver, lung, stomach oesophagus) have a poor prognosis, so that the differences in survival are rather small, particularly in men, although they are larger in women, in whom breast and cervical cancers predominate.

For 52 countries of the world, cancer incidence rates were estimated using the predicted national mortality in 2008 and mortality to incidence ratios (M:I) of aggregated data from either local cancer registries or neighboring countries (incidence methods 2A and 2B) (Table 2, Fig. 14). The use of M:I ratios from cancer registries in the same country to estimate national incidence rates (incidence method 2A) has been used in successive studies providing global estimates.[5,6,9,10] It corrects for any discrepancy between local and national rates of incidence, and is also robust to any deficiencies in the quality of mortality data, provided these are similar nationally and locally. Cancer incidence rates for China, by far the most populous country of Eastern Asia, have been estimated using this method, but the national mortality estimates for 2008 have been converted to incidence using incidence and mortality data from 36 Chinese cancer registries (Siwei Zhang, personal communication) mainly situated in urban places of Eastern China, and covering less than 2% of the total Chinese population. Although the cancer registry data have been adjusted for population size and place of residence, the national and the regional mortality are not from the same sources, and the resulting national cancer incidence estimate may therefore be distorted, with a possible over-estimation of the incidence rates at some sites. The use of M:I ratios from cancer registries in neighboring countries (incidence method 2B) has been widely used in countries in Latin America and Central Asia, with the same possible over-estimation of the cancer incidence at some sites in these regions.

Conclusions

Despite the various provisos concerning data quality and methods of estimation, we believe that the estimates in GLOBOCAN 2008 are the most accurate that can be made at present, and may be used in setting of priorities for cancer control actions in different regions and countries of the world. The continuing growth and ageing of the world's population mean that, even with current (2008) rates of

incidence and mortality, the burden of cancer will continue to increase. Already the majority of the global cancer burden now occurs in developing countries, these proportions will rise in the next decades if rates remained unchanged. However, it seems likely that changes in lifestyle (tobacco and alcohol consumption, nutritional habits, physical activity) added to those pre-existing risk factors (especially cancer-related infections) will produce dramatic changes in the burden of cancer in many developing countries in forthcoming years.

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References

1. Parkin DM. The evolution of the population-based cancer registry. *Nat Rev Cancer* 2006;6:603–12.
2. World Health Organization. National cancer control programmes. Policies and managerial guidelines, 2nd edn. Geneva: WHO, 2002.
3. Parkin DM, Stjernward J, Muir CS. Estimated of the worldwide frequency of twelve major cancers. *Bull WHO* 1984;62: 163–82.
4. Parkin DM, Laara E, Muir CS. Estimates of worldwide frequency of sixteen major cancers in 1980. *Int J Cancer* 1988;41: 184–97.
5. Parkin DM, Pisani P, Ferlay J. Estimates of worldwide incidence of eighteen major cancers in 1985. *Int J Cancer* 1993;54: 594–606.
6. Parkin DM, Pisani P, Ferlay J. Estimates of the worldwide incidence of twenty-five major cancers in 1990. *Int J Cancer* 1999; 80:827–41.
7. Pisani P, Parkin DM, Ferlay J. Estimates of the worldwide mortality from eighteen major cancers in 1985. Implications for prevention, and projections of future burden. *Int J Cancer* 1993;55: 891–903.
8. Pisani P, Parkin DM, Bray FI. Estimates of the worldwide mortality from twenty-five major cancers in 1990. Implications for prevention, and projections of future burden. *Int J Cancer* 1999; 83:18–29.
9. Ferlay J, Bray F, Pisani P, Parkin DM. GLOBOCAN 2000: cancer incidence, mortality and prevalence worldwide. IARC CancerBase No. 5 [CD-ROM]. Version 1.1. Lyon: IARC Press; 2001.
10. Ferlay J, Bray F, Pisani P, Parkin DM. GLOBOCAN 2002. Cancer incidence, mortality and prevalence worldwide IARC CancerBase No. 5 [Internet]. Version 2.0. Lyon: IARC Press. 2004. Available at http://www-dep.iarc.fr/.
11. United Nations, Population division. World population prospects, the 2008 revision [Internet]. New York: United Nations [cited 2009 Nov 8]. Available at http://www.un.org/.
12. Curado MP, Edwards B, Shin HR, Storm H, Ferlay J, Heanue M, Boyle P, eds. Cancer incidence in five continents, vol. 9. IARC Scientific Publications No. 160. Lyon: IARC, 2007.
13. Parkin DM, Whelan SL, Ferlay J, Storm H. Cancer incidence in five continents, vol. 1–8. IARC CancerBase No. 7 [Internet]. Lyon: IARC, 2005. Available at http://www-dep.iarc.fr/.
14. World Health Organisation (WHO) Databank. WHO statistical information system [Internet]. Geneva: WHO. Available at http://www.who.int/whosis.
15. World Health Organization. World health statistics 2010 [Internet]. Geneva: WHO. 2010. Available at http://www.who.int/whosis/whostat/2010/en/
16. World Health Organization. The global burden of disease: 2004 update. Geneva: WHO; 2008.
17. Dyba T, Hakulinen T. Comparison of different approaches to incidence prediction based on simple interpolation techniques. *Stat Med* 2000;15;19:1741–52
18. Moller B, Fekjaer H, Hakulinen T, Sigvaldason H, Storm HH, Talback M, Haldorsen T. Prediction of cancer incidence in the Nordic countries: empirical comparison of different approaches. *Stat Med* 2003;22: 2751–2766
19. Cancer Registry of Norway. NORDPRED. A software for predicting trends in cancer incidence. [Internet]. Norway: Cancer Registry of Norway. [cited 2008 Dec 17]. Available at http://www.kreftregisteret.no/en/Research/Projects.
20. Ferlay J, Parkin DM, Steliarova-Foucher E. Estimates of cancer incidence and mortality in Europe in 2008. *Eur J Cancer* 2010;46:765–81.
21. Loos AH, Bray F, McCarron P, Weiderpass E, Hakama M, Parkin DM. Sheep and goats: separating cervix and corpus uteri from imprecisely coded uterine cancer deaths, for studies of geographical and temporal variations in mortality. *Eur J Cancer* 2004;40:2794–803.
22. Ministry of Health of China. Report of the 3rd National Retrospective Sample Survey of Mortality. Beijing: China Union Medical University Publishers, 2008.
23. Engholm G, Ferlay J, Christensen N, Bray F, Gjerstorff ML, Klint A, Kotlum JE, Olafsdottir E, Pukkala E, Storm HH. NORDCAN: cancer incidence, mortality, prevalence and prediction in the Nordic countries [Internet]; Version 3.5. Denmark: Association of the Nordic Cancer Registries. Danish Cancer Society. 2009. Available at http://www.ancr.nu.
24. Sankaranarayanan R Swaminathan R, Brenner H, Chen K, Chia KS, Chen JG, Law SC, Ahn YO, Xiang YB, Yeole BB, Shin HR, Shanta V. Cancer survival in Africa, Asia, and Central America: a population-based study. *Lancet Oncol* 2010; 11:165–73.
25. Quaglia A, Vercelli M, Lillini R, Mugnoc E, Coebergh JW, Quinn M, Martinez-Garcia C, Capocaccia R, Micheli A, on behalf of the ELDCARE Working Group. Socio-economic factors and health care system characteristics related to cancer survival in the elderly. A population-based analysis in 16 European countries (ELDCARE project). *Crit Rev Oncol Hematol* 2005; 54117–128.
26. GGDC. Home Maddison. [Internet]. The Netherlands: Faculty of Economics, University of Gronigen. [cited 2009 Nov 18] Available at http://www.ggdc.net/maddison.
27. Gondos A, Brenner H, Chokunonga E, Borok MZ, Chirenje ZM, Nyakabau AM, Parkin DM, Sankila R. Cancer survival in a southern African urban population—Harare, Zimbabwe. *Int J Cancer* 2004;112: 860–864.
28. Gondos A, Brenner H, Wabinga H, Parkin DM. Cancer survival in Kampala, Uganda. *Br J Cancer* 2005 May 9;92:1808–12.
29. Segi M. Cancer mortality for selected sites in 24 countries (1950–57). Japan: Department of Public Health, Tohoku University of Medicine, 1960.
30. Doll R, Payne P, Waterhouse JAH, eds. Cancer incidence in five continents, vol. 1. Geneva: Union Internationale Contre le Cancer, 1966.
31. Shibuya K, Mathers CD, Boschi-Pinto C, Lopez AD, Murray CJ. Global and regional estimates of cancer mortality and incidence by site: II. Results for the global burden of disease 2000. *BMC Cancer* 2002;2:37.
32. Thun MJ, Henley SJ, Burns DM, Jemal A, Shanks TG, Calle EE. Lung cancer death

rates in lifelong non-smokers. *J Natl Cancer Inst* 2006;98:691–9.
33. Somdyala NI, Bradshaw D, Gelderblom WC, Parkin DM. Cancer incidence in a rural population of South Africa, 1998–2002. *Int J Cancer*, 2010 Feb 16 [Epub ahead of print].
34. Swaminathan R, Selvakumaran R, Esmy PO, Sampath P, Ferlay J, Jissa V, Shanta V, Cherian M, Sankaranarayanan R. Cancer pattern and survival in a rural district in South India. *Cancer Epidemiol* 2009;33: 325–31.
35. Indian Council of Medical Research. National Cancer Registry Programme, Consolidated reports of population based cancer registries, 2001–2004, NCRP. Bangalore: Indian Council of Medical Research, 2006.
36. Bah E, Jack A. Cancer incidence in the Gambia (1997–1998). In: Parkin DM, Whelan SL, Ferlay J, Teppo L, Thomas DB, eds. Cancer incidence in five continents, vol. 8. IARC Scientific Publications No. 155. Lyon: IARC, 2002.