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Author/s:
Fitzmaurice, C;Dicker, D;Pain, A;Hamavid, H;Moradi-Lakeh, M;MacIntyre, MF;Allen, C;Hansen, G;Woodbrook, R;Wolfe, C;Hamadeh, RR;Moore, A;Werdecker, A;Gessner, BD;Te Ao, B;McMahon, B;Karimkhani, C;Yu, C;Cooke, GS;Schwebel, DC;Carpenter, DO;Pereira, DM;Nash, D;Kazi, DS;De Leo, D;Plass, D;Ukwaja, KN;Thurston, GD;Yun Jin, K;Simard, EP;Mills, E;Park, EK;Catalá-López, F;DeVeber, G;Gotay, C;Khan, G;Hosgood, HD;Santos, IS;Leasher, JL;Singh, J;Leigh, J;Jonas, JB;Sanabria, J;Beardsley, J;Jacobsen, KH;Takahashi, K;Franklin, RC;Ronfani, L;Montico, M;Naldi, L;Tonelli, M;Geleijnse, J;Petzold, M;Shrime, MG;Younis, M;Yonemoto, N;Breitborde, N;Yip, P;Pourmalek, F;Lotufo, PA;Esteghamati, A;Hankey, GJ;Ali, R;Lunevicius, R;Malekzadeh, R;Dellavalle, R;Weintraub, R;Lucas, R;Hay, R;Rojas-Rueda, D;Westerman, R;Sepanlou, SG;Nolte, S;Patten, S;Weichenthal, S;Abera, SF;Fereshtehnejad, SM;Shiue, I;Driscoll, T;Vasankari, T;Alsharif, U;Rahimi-Movaghar, V;Vlassov, VV;Marcenes, WS;Mekonnen, W;Melaku, YA;Yano, Y;Artaman, A;Campos, I;MacLachlan, J;Mueller, U;Kim, D;Trillini, M;Eshrati, B;Williams, HC;Shibuya, K;Dandona, R;Murthy, K;Cowie, B;Amare, AT

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Special Communication

The Global Burden of Cancer 2013

Global Burden of Disease Cancer Collaboration

IMPORTANCE Cancer is among the leading causes of death worldwide. Current estimates of cancer burden in individual countries and regions are necessary to inform local cancer control strategies.

OBJECTIVE To estimate mortality, incidence, years lived with disability (YLDs), years of life lost (YLLs), and disability-adjusted life-years (DALYs) for 28 cancers in 188 countries by sex from 1990 to 2013.

EVIDENCE REVIEW The general methodology of the Global Burden of Disease (GBD) 2013 study was used. Cancer registries were the source for cancer incidence data as well as mortality incidence (MI) ratios. Sources for cause of death data include vital registration system data, verbal autopsy studies, and other sources. The MI ratios were used to transform incidence data to mortality estimates and cause of death estimates to incidence estimates. Cancer prevalence was estimated using MI ratios as surrogates for survival data; YLDs were calculated by multiplying prevalence estimates with disability weights, which were derived from population-based surveys; YLLs were computed by multiplying the number of estimated cancer deaths at each age with a reference life expectancy; and DALYs were calculated as the sum of YLDs and YLLs.

FINDINGS In 2013 there were 14.9 million incident cancer cases, 8.2 million deaths, and 196.3 million DALYs. Prostate cancer was the leading cause for cancer incidence (1.4 million) for men and breast cancer for women (1.8 million). Tracheal, bronchus, and lung (TBL) cancer was the leading cause for cancer death in men and women, with 1.6 million deaths. For men, TBL cancer was the leading cause of DALYs (24.9 million). For women, breast cancer was the leading cause of DALYs (13.1 million). Age-standardized incidence rates (ASIRs) per 100 000 and age-standardized death rates (ASDRs) per 100 000 for both sexes in 2013 were higher in developing vs developed countries for stomach cancer (ASIR, 17 vs 14; ASDR, 15 vs 11), liver cancer (ASIR, 15 vs 7; ASDR, 16 vs 7), esophageal cancer (ASIR, 9 vs 4; ASDR, 9 vs 4), cervical cancer (ASIR, 8 vs 5; ASDR, 4 vs 2), lip and oral cavity cancer (ASIR, 7 vs 6; ASDR, 2 vs 2), and nasopharyngeal cancer (ASIR, 1.5 vs 0.4; ASDR, 1.2 vs 0.3). Between 1990 and 2013, ASIRs for all cancers combined (except nonmelanoma skin cancer and Kaposi sarcoma) increased by more than 10% in 113 countries and decreased by more than 10% in 12 of 188 countries.

CONCLUSIONS AND RELEVANCE Cancer poses a major threat to public health worldwide, and incidence rates have increased in most countries since 1990. The trend is a particular threat to developing nations with health systems that are ill-equipped to deal with complex and expensive cancer treatments. The annual update on the Global Burden of Cancer will provide all stakeholders with timely estimates to guide policy efforts in cancer prevention, screening, treatment, and palliation.

Editorial page 425

Author Audio and Video Interviews at jamaoncology.com

Supplemental content at jamaoncology.com

The Authors/Members of the Global Burden of Disease Cancer Collaboration are listed at the end of this article.

Corresponding Author: Mohsen Naghavi, MD, PhD, MPH, Global Health Department, Institute for Health Metrics and Evaluation, University of Washington, 2301 Fifth Ave, Ste 600, Seattle, WA 98121 (nagham@uw.edu).

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Cancer caused over 8 million deaths worldwide in 2013 and has moved from the third leading cause of death in 1990 to the second leading cause behind cardiovascular disease in 2013.[1-3] Substantial progress has been made in recent years with regard to prevention and treatment options for certain cancers.[4-6] However, despite this progress, cancer burden is increasing owing to a growing and aging global population as well as risk factors like smoking, obesity, and dietary patterns. To appropriately allocate resources to prevention, screening, diagnosis, treatment, and palliative care and to monitor their effectiveness, it is necessary to have timely information about cancer burden for individual countries. The Global Burden of Disease (GBD) study provides a comprehensive assessment of incidence, mortality, and disability for all major diseases and injuries. Herein, we present detailed results of the GBD 2013 study[1] for 28 cancer groups covering cancer incidence, mortality, and disability for 188 countries from 1990 to 2013 for both sexes and different age groups.

A **Video** summary of this article is available on the *JAMA Oncology* website.

Methods

The general methods that have been used in the GBD study have been published previously.[1,2,7-14] The present study specifically explains the methodological components pertaining to cancer estimation for GBD 2013. **Box 1** includes a list of the figures and tables in this article. Further details about methods and data sources are provided in the eAppendix, eFigures, and eTables in the Supplement, and **Box 2** contains a list of the supplementary figures and tables. Additional information is available from the authors in web tables 1 through 9, which are available at the web addresses listed in **Box 3**. Hereinafter, citations to web tables are for those given in Box 3.

The analytical strategy can be broken into 7 components, as shown in eFigure 1 in the Supplement. The first step involved extraction of mortality and incidence data from data sources collected for the GBD study. Data on cancer incidence and cancer mortality were sought from individual cancer registries, literature reviews, and the Cancer Incidence in Five Continents (CI5) series.[15-24] Only data representative of the registries' catchment area and including all cancer sites for both sexes were used. The most recent data available for any source until 2012 were incorporated. eTable 1 in the Supplement lists cancer registry data used by country. Just over half (53%) of cancer incidence data were reported in CI5, whereas 47% came from cancer registries from other sources. Data were extracted at the most detailed cause- and age-specific level. *International Classification of Diseases, Ninth Revision (ICD-9)* and *International Classification of Diseases, Tenth Revision (ICD-10)* codes for each GBD cancer group as well as steps explaining data preparation can be found in the eAppendix in the Supplement. Twenty-eight cancer groups were defined that include all *ICD* codes pertaining to neoplasms (*ICD-9*, 140-239; *ICD-10*, C00-D49) except for Kaposi sarcoma (KS) (C46) and nonmelanoma skin cancer (NMSC) (C44). eTable 3 in the Supplement lists the *ICD-9* and *ICD-10* codes included in each cancer group.

In the second step, mortality incidence (MI) ratios (cancer deaths divided by cancer incident cases) were estimated for each cancer site, country, age, sex, and year.

At a Glance

- In 2013, there were 14.9 million new cancer cases and 8.2 million cancer deaths.
- For women, breast cancer was the leading cause of disability-adjusted life-years (DALYs) globally and in developed and developing countries.
- For men, lung cancer was the leading cause of DALYs globally and in developed and developing countries.
- For men, incident cases have increased the most for prostate cancer at the global setting and in developed and developing countries.
- For women at the global level, incident cases have increased the most for non-Hodgkin lymphoma; in developed countries, incident cases have increased the most for kidney cancer; in developing countries, incident cases have increased the most for breast cancer.

Box 1. List of Figures and Tables in the Article

Figure 1. Age-Specific Global Contributions of Cancer Types to Total Cancer Incidence and Mortality, 2013

Figure 2. Relative Changes in Age-Standardized Incidence and Death Rates in Both Sexes for All Cancers Except NMSC and KS in 188 Countries From 1990 to 2013

Figure 3. Cancers Ranked by Numbers of Incident Cases in Both Sexes, Globally, by Development Status, and in the 50 Most Populous Countries, 2013

Figure 4. Cancers Ranked by Numbers of Deaths in Both Sexes, Globally, by Development Status, and in the 50 Most Populous Countries, 2013

Figure 5. Cancers Ranked Globally and for Both Sexes by Absolute Years of Life Lost (YLLs) Including the Percentage Change in Absolute YLLs and the Percentage Change in the Age-Standardized YLL Rate Between 1990 and 2013

Figure 6. Trends in Age-Standardized Incidence Rates for Tracheal, Bronchus, and Lung Cancer, 1990-2013

Figure 7. Trends in Age-Standardized Incidence Rates for Female Breast Cancer, 1990-2013

Figure 8. Trends in Age-Standardized Incidence Rates for Colon and Rectum Cancer, 1990-2013

Figure 9. Trends in Age-Standardized Incidence Rates for Prostate Cancer, 1990-2013

Figure 10. Trends in Age-Standardized Incidence Rates for Stomach Cancer, 1990-2013

Figure 11. Trends in Age-Standardized Incidence Rates for Liver Cancer, 1990-2013

Figure 12. Trends in Age-Standardized Incidence Rates for Cervical Cancer, 1990-2013

Figure 13. Trends in Age-Standardized Incidence Rates for Non-Hodgkin Lymphoma, 1990-2013

Figure 14. Trends In Age-Standardized Incidence Rates for Esophageal Cancer, 1990-2013

Figure 15. Trends in Age-Standardized Incidence Rates for Leukemia, 1990-2013

Table 1. Incidence and Deaths for All Cancers and 28 Cancer Groups

Table 2. Decomposition Analysis of Cancer Trends in Global Incidence, Both Sexes, 1990 to 2013

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Box 2. List of Supplementary Figures and Tables

eFigure 1. Flowchart for GBD cancer estimation process

eFigure 2. Percent increase in mortality by GBD cancer category after redistribution of different categories of garbage code (2008, only countries using *ICD-10*)

eFigure 3. Flowchart of algorithm used to adjust MI ratios

eFigure 4a. Cancer ranking by total incidence based on global level for developing and developed regions and all countries, both sexes, 2013

eFigure 4b. Cancer ranking by total deaths based on global level for developing and developed regions and all countries, both sexes, 2013

eFigure 5a. Proportion of deaths due to underlying causes, global, both sexes, all ages, 2013. Non-communicable causes are shown in blue, communicable, maternal, neonatal and nutritional causes are shown in red, and injury causes are shown in green

eFigure 5b. Proportion of deaths due to underlying causes, global, both sexes, all ages, 1990. Non-communicable causes are shown in blue, communicable, maternal, neonatal and nutritional causes are shown in red, and injury causes are shown in green

eFigure 6a. Top ranked cancers by absolute cases for all ages in males, 2013

eFigure 6b. Top ranked cancers by absolute cases for all ages in females, 2013

eFigure 6c. Top ranked cancers by absolute death for all ages in males, 2013

eFigure 6d. Top ranked cancers by absolute death for all ages in females, 2013

eFigure 7. Trends in age-standardized incidence rates for lip & oral cavity cancer, females and males, global level, developed and developing countries, 1990-2013

eFigure 8. Trends in age-standardized incidence rates for bladder cancer, females and males, global level, developed and developing countries, 1990-2013

eFigure 9. Trends in age-standardized incidence rates for uterine cancer, females, global level, developed and developing countries, 1990-2013

eFigure 10. Trends in age-standardized incidence rates for pancreatic cancer, females and males, global level, developed and developing countries, 1990-2013

eFigure 11. Trends in age-standardized incidence rates for brain & nervous system cancer, females and males, global level, developed and developing countries, 1990-2013

eFigure 12. Trends in age-standardized incidence rates for kidney cancer, females and males, global level, developed and developing countries, 1990-2013

eFigure 13. Trends in age-standardized incidence rates for malignant skin melanoma, females and males, global level, developed and developing countries, 1990-2013

eFigure 14. Trends in age-standardized incidence rates for thyroid cancer, females and males, global level, developed and developing countries, 1990-2013

eFigure 15. Trends in age-standardized incidence rates for ovarian cancer, females, global level, developed and developing countries, 1990-2013

eFigure 16. Trends in age-standardized incidence rates for gallbladder cancer, females and males, global level, developed and developing countries, 1990-2013

eFigure 17. Trends in age-standardized incidence rates for larynx cancer, females and males, global level, developed and developing countries, 1990-2013

eFigure 18. Trends in age-standardized incidence rates for other pharynx cancer, females and males, global level, developed and developing countries, 1990-2013

eFigure 19. Trends in age-standardized incidence rates for multiple myeloma, females and males, global level, developed and developing countries, 1990-2013

eFigure 20. Trends in age-standardized incidence rates for Hodgkin lymphoma, females and males, global level, developed and developing countries, 1990-2013

eFigure 21. Trends in age-standardized incidence rates for nasopharynx cancer, females and males, global level, developed and developing countries, 1990-2013

eFigure 22. Trends in age-standardized incidence rates for testicular cancer, males, global level, developed and developing countries, 1990-2013

eFigure 23. Trends in age-standardized incidence rates for mesothelioma, females and males, global level, developed and developing countries, 1990-2013

eTable 1. Sources for cancer incidence and MI ratio data by country and registry

eTable 2. Number of site years for cause of death data by source

eTable 3. List of *International Classification of Diseases* (*ICD*) codes mapped to the Global Burden of Disease cause list for cancer

eTable 4. Undefined cancer code categories (*ICD-10*) and respective target codes for cancer registry incidence data

eTable 5. Countries within GBD regions

eTable 6. Countries by development status

eTable 7. Results of regression analysis for undefined malignant neoplasms of the lip, oral cavity and pharynx (C14) by age group and region, male

eTable 8. Carcinoma in situ, neoplasm of uncertain behavior and benign neoplasm assigned to GBD cancer in CoD redistribution

eTable 9. Increase in mortality after redistributing benign, in situ neoplasms or neoplasms of uncertain behavior to respective cancer by different years and *ICD* coding system

eTable 10. Increase in mortality estimates for the year 2008 after redistribution of different categories of garbage code for all countries using *ICD-10* in 2008

eTable 11. Covariates selected for CODEm for each GBD cancer group

eTable 12. Results for CODEm model testing

eTable 13. Sources of procedure sequelae data

eTable 14. Reference life expectancy

eTable 15. *ICD-10* codes for "other cancer" group

eTable 16a. Decomposition of trends in incidence, developed countries, both sexes, 1990 to 2013

eTable 16b. Decomposition of trends in incidence, developing countries, both sexes, 1990 to 2013

eTable 17. Probability of developing cancer within selected age intervals, global, by sex, 2010-2013

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Box 3. Web Table Addresses

Web table 1. http://ja.ma/healthdataorg_webtable1
Web table 2. http://ja.ma/healthdataorg_webtable2
Web table 3. http://ja.ma/healthdataorg_webtable3
Web table 4. http://ja.ma/healthdataorg_webtable4
Web table 5. http://ja.ma/healthdataorg_webtable5
Web table 6. http://ja.ma/healthdataorg_webtable6
Web table 7. http://ja.ma/healthdataorg_webtable7
Web table 8. http://ja.ma/healthdataorg_webtable8
Web table 9. http://ja.ma/healthdataorg_webtable9

In the third step, the MI ratios were applied to cancer incidence data to transform incidence data to mortality estimates. Mortality data from cancer registries were only used to generate MI ratios and did not contribute to the cancer mortality estimates to avoid counting the cancer registry data twice. eTable 1 in the Supplement lists which cancer registry data were used for MI ratio estimation. The incidence-based mortality estimates became part of the GBD CoD (cause of death) database. The methods used to generate the CoD database are reported in detail elsewhere.[1] In brief, all published and unpublished data relevant to estimating causes of death for 188 countries from 1980 to 2013 were identified. The sources include vital registration systems, verbal autopsy studies, and other sources (eTable 2 in the Supplement). Cancer registry data contributed 37% to the cancer-specific data in the CoD database; the other sources contributed 63%.

In the fourth step, the CoD database mortality data (including the cancer incidence data transformed to mortality estimates through the use of MI ratios) were used as input into the Cause of Death Ensemble Model (CODEm) to estimate the number of deaths attributable to each cancer assessed in the analysis.[25] The CODEm results were adjusted using CoDcorrect, an algorithm that uses uncertainty distributions around cause fraction estimates for each GBD cause of death to scale estimates to all-cause mortality estimates in each country, year, age, and sex group. These death estimates were used to calculate years of life lost (YLLs).

The fifth step was to apply MI ratios to CoDcorrect death estimates to obtain cancer incidence estimates for each country, year, age, and sex group.

In the sixth step, MI ratios were transformed into an access-to-care variable to scale countries between a theoretical best-case and worst-case survival to generate relative survival curves. The relative survival was then adjusted for background mortality using GBD life-tables, and absolute survival rates were estimated.

In step 7, the absolute survival estimates were used to generate 10-year cancer prevalence estimates. Total prevalence was subdivided into general cancer sequelae like (1) diagnosis and treatment, (2) metastatic phase, and (3) terminal phase for the estimated deaths. After these 3 sequelae were assigned, the remaining prevalent time was considered remission. Prevalence for cancer-specific sequelae for breast cancer (mastectomy), larynx cancer (laryngectomy), colon and rectum cancer (stoma), bladder cancer (incontinence), and prostate cancer (impotence and incontinence) was also estimated. To calculate years lived with disability (YLDs), each sequela was multiplied with specific disability weights, which were derived from population-based surveys.[11,26] Disability-adjusted life-years (DALYs), which combine health loss with premature mortality, were calculated by using the sum of YLLs and YLDs.

This analysis does not provide estimates for NMSC or KS because NMSC is an exceptional cancer with a very high incidence, which is usually not collected by cancer registries, and low mortality, and KS is attributed to human immunodeficiency virus in the GBD framework.

Results

Global Incidence, Mortality, and DALYs

In 2013, there were 14.9 million incident cancer cases worldwide and 8.2 million cancer deaths as detailed in **Table 1**. Cancer caused 196.3 million DALYs in 2013 (web table 9); 56% of incident cases, 62% of deaths, and 70% of DALYs occurred in developing countries. eFigure 5 in the Supplement shows that between 1990 and 2013, the proportion of deaths from noncommunicable diseases (NCDs) substantially increased (from 57% in 1990 to 70% in 2013), with a decrease in deaths due to communicable, maternal, neonatal, and nutritional diseases (from 34% in 1990 to 22% in 2013). The proportion of cancer deaths as part of all deaths has increased from 12% in 1990 to 15% in 2013. Between 1990 and 2013, absolute DALYs due to all cancers (excluding NMSC and KS) for both sexes increased by 29% globally, by 10% in developed countries, and by 40% in developing countries. Age-standardized DALYs decreased by 20% globally, by 21% in developed countries, and by 18% in developing countries (web table 9).

Men were more likely to develop cancer between birth and age 79 years, with 1 in 3 men and 1 in 5 women developing cancer worldwide, as detailed in eTable 17 in the Supplement. In 2013, the cancers with the highest incidence on a global scale for men were prostate cancer (1.4 million), tracheal, bronchus, and lung (TBL) cancer (1.3 million), and colon and rectum cancer (873 000), as detailed in Table 1. The top 3 causes of cancer death and DALYs for men were TBL cancer (1.2 million deaths, 24.9 million DALYs), liver cancer (564 000 deaths, 15.2 million DALYs), and stomach cancer (530 000 deaths, 11.7 million DALYs) (Table 1; web table 6). For women, the cancers with the highest incidence were breast cancer (1.8 million), colon and rectum cancer (700 000), and TBL cancer (535 000). The top 3 causes of cancer death for women were TBL cancer (485 000), breast cancer (464 000), and colon and rectum cancer (357 000) (Table 1). In 2013, the top 3 causes for DALYs in women were breast cancer (13.1 million), TBL cancer (9.8 million), and cervical cancer (6.9 million) (web table 3).

The contribution of different cancers to total incidence and death by age group is shown in **Figure 1**. Brain and nervous system cancer, Hodgkin lymphoma, non-Hodgkin lymphoma (NHL), leukemia, and the combined "other cancer" group (a group containing rare cancers like malignant neoplasm of bone and articular cartilage of limbs, malignant neoplasm of thymus, and others—see eTable 15 in the Supplement for a full list of *ICD* codes) are the main contributors to cancer incidence in children and adolescents (age <20 years). Brain and nervous system cancer, NHL, leukemia, and cancers from the other cancer group cause most of the cancer deaths in this young age group. In young and middle-aged adults breast, cervical, colon and rectum cancer, brain and nervous system cancer, and cancers

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Table 1. 2013 Incidence and Deaths for All Cancers and 28 Cancer Groups[a]

	Incident Cases, Global (Thousands)			ASIR, Both Sexes (per 100 000)			Deaths, Global (Thousands)			ASDR, Both Sexes (per 100 000)		
Cancer	Total	Male	Female	Developing	Developed	Global	Total	Male	Female	Developing	Developed	Global
All except NMSC and KS	14 943	8048	6894	190.4	327.9	237.4	8196	4723	3473	123.0	147.9	133.1
Esophageal	442	309	133	8.9	3.9	7.1	440	308	132	9.1	3.8	7.2
Stomach	984	630	354	16.9	14.4	16.1	841	530	311	15.3	11.1	13.8
Liver	792	559	233	14.7	7.4	12.5	818	564	254	15.6	7.3	13.0
Larynx	177	155	22	2.8	2.9	2.8	88	75	12	1.5	1.3	1.4
Tracheal, bronchus and lung	1798	1263	535	25.2	37.7	29.4	1640	1155	485	24.1	32.9	27.0
Breast	1804	25	1779	21.0	40.8	27.4	471	7	464	5.9	10.1	7.4
Cervical	485	…	485	8.0	5.0	7.1	236	…	236	4.3	2.2	3.6
Uterine	353	…	353	4.2	7.7	5.4	68	…	68	0.9	1.4	1.1
Prostate	1442	1442	…	14.3	43.2	24.3	293	293	…	3.6	7.4	5.2
Colon and rectum	1573	873	700	16.3	42.3	25.8	771	414	357	9.4	18.2	12.8
Lip and oral cavity	409	275	134	6.7	6.0	6.4	135	87	48	2.3	1.9	2.1
Nasopharynx	84	62	22	1.5	0.4	1.2	60	43	17	1.2	0.3	0.9
Other pharynx	140	117	22	2.0	2.6	2.1	79	63	16	1.3	1.2	1.2
Gallbladder and biliary tract	186	79	107	2.5	3.8	3.1	140	54	86	2.0	2.7	2.3
Pancreatic	350	184	166	3.7	9.5	5.8	352	185	167	3.7	9.6	5.9
Malignant skin melanoma	272	143	130	1.5	10.8	4.2	57	32	25	0.4	1.9	0.9
Ovarian	226	…	226	2.4	5.6	3.5	158	…	158	1.8	3.7	2.5
Testicular	59	59	…	0.6	1.8	0.8	8	8	…	0.1	0.1	0.1
Kidney	295	195	99	2.3	9.7	4.7	134	87	47	1.3	3.7	2.2
Bladder	401	312	89	3.2	12.8	6.7	174	130	44	2.4	3.7	3.0
Brain and nervous system	305	167	137	4.1	5.9	4.5	204	118	86	2.9	3.8	3.1
Thyroid	226	50	176	2.7	4.9	3.3	34	12	21	0.5	0.6	0.6
Mesothelioma	34	24	10	0.4	0.8	0.5	34	24	10	0.4	0.8	0.5
Hodgkin lymphoma	93	56	38	1.2	1.9	1.3	24	14	10	0.4	0.4	0.4
Non-Hodgkin lymphoma	465	264	202	5.2	11.3	7.3	226	133	92	2.9	4.5	3.6
Multiple myeloma	117	64	53	1.0	3.5	1.9	79	42	37	0.7	2.3	1.3
Leukemia	414	243	172	5.1	8.1	6.3	265	149	116	3.5	4.8	4.1
Other neoplasms	1015	496	518	12.0	23.0	15.7	370	195	175	5.4	6.2	5.8

Abbreviations: ASDR, age-standardized death rate; ASIR, age-standardized incidence rate; DALYs, disability-adjusted life-years; GBD, Global Burden of Disease; *ICD-9*, *International Classification of Diseases, Ninth Revision*; *ICD-10*, *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision*; KS, Kaposi sarcoma; NMSC, nonmelanoma skin cancer; YLDs, years lived with disability; YLLs, years of life lost.

[a] Cancer groups are defined based on *ICD* codes and include all codes pertaining to neoplasms (*ICD-9* 140-239; *ICD-10* C00-D49) except for NMSC and KS. eTable 3 in the Supplement details how the original *ICD* codes were mapped to the standardized GBD cause list.[1] Detailed results for incidence, mortality, YLDs, YLLs, and DALYs by country development status (developed vs developing), region, and country are reported in web tables 1 through 9. Sums might not total precisely due to rounding.

from the other cancer group add the largest fraction to total incidence. Stomach, liver, TBL, and breast cancer contribute the most to cancer deaths. For older adults (>54 years) stomach, TBL, breast, prostate, and colon and rectum cancers are the biggest contributors to incidence. Stomach, liver, TBL, and colon and rectum cancer cause the majority of cancer deaths in older adults.

For all cancers combined (excluding NMSC and KS), ASIRs between 1990 and 2013 increased in 153 of 188 countries (**Figure 2**A), with many countries in parts of Northern Africa and the Middle East, sub-Saharan Africa, Southeast Asia, and Oceania having experienced increases of over 20%. However, ASDRs for all cancers combined (excluding NMSC and KS) decreased within that timeframe in 126 of 188 countries (Figure 2B).

Top 10 Cancers (Ranked by the Highest Number of Incident Cases Globally in 2013)

Tracheal, Bronchus, and Lung Cancer

In 2013, there were an estimated 1.8 million incident cases of TBL cancer and 1.6 million deaths. Tracheal, bronchus, and lung cancer caused 34.7 million DALYs in 2013, with 62% occurring in developing countries and 38% occurring in developed countries (web table 9). Men were more likely to develop lung cancer than women, with 1 in 18 men and 1 in 51 women being diagnosed between birth and age 79 years. Tracheal, bronchus, and lung cancer has the second highest absolute incidence globally as well as in developing countries and ranks fourth in developed countries (**Figure 3**). It was the most common cause of cancer death by

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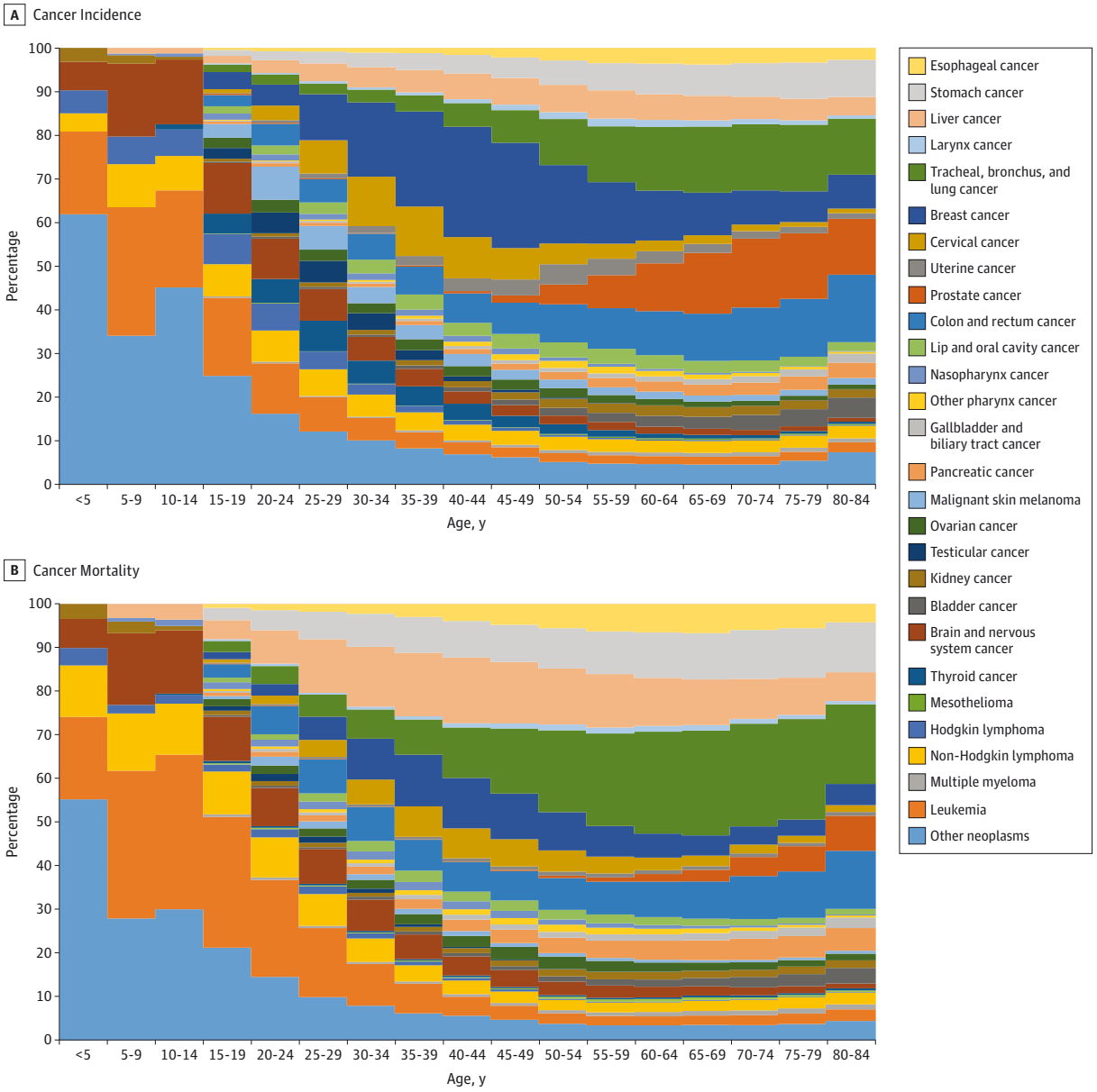
Figure 1. Age-Specific Global Contributions of Cancer Types to Total Cancer Incidence and Mortality, 2013



For *International Classification of Diseases* codes included in the other neoplasms group, see eTable 15 in the Supplement.

absolute cases globally as well as in developing and developed regions (**Figure 4**).

As detailed in web tables 4 and 5, ASIRs per 100 000 for men were the lowest in western sub-Saharan Africa (with ASDRs per 100 000 reported for comparison) (ASIR, 6.33; ASDR, 6.36), eastern sub-Saharan Africa (ASIR, 8.01; ASDR, 8.52), and central sub-Saharan Africa (ASIR, 12.77; ASDR, 13.08) and the highest in central Europe (ASIR, 66.10; ASDR, 63.87), east Asia (ASIR, 64.68; ASDR, 60.13), and high-income North America (ASIR, 61.5; ASDR, 51.02).

For women in 2013, incidence rates per 100 000 were the lowest in western sub-Saharan Africa (with death rates per 100 000 reported for comparison) (ASIR, 2.76; ASDR, 2.96) followed by eastern sub-Saharan Africa (ASIR, 3.15; ASDR, 3.51), and south Asia (ASIR, 3.80; ASDR, 4.12) and the highest in high-income North America (ASIR, 41.83; ASDR, 31.33), Australasia (ASIR, 25.23; ASDR, 20.46), and east Asia (ASIR, 22.88; ASDR, 22.16) (web tables 1 and 2).

eFigure 6a and c in the Supplement shows that TBL cancer was the cancer with the most incident cases for men in 40 countries, with a predominance in central and eastern Europe, Asia, and northern Africa, and TBL was the most common cause for cancer death in 103 countries. For women, TBL cancer was the most common cause of cancer death in Albania, Andorra, Australia, Brunei, Canada, China, Cuba, Denmark, United Kingdom, Hungary, Ireland, Iceland, Cambodia, South Korea, Laos, Myanmar, Netherlands, New Zealand, Poland, North Korea, Singapore, Timor-Leste, Taiwan, and the United States (eFigure 6d in the Supplement).

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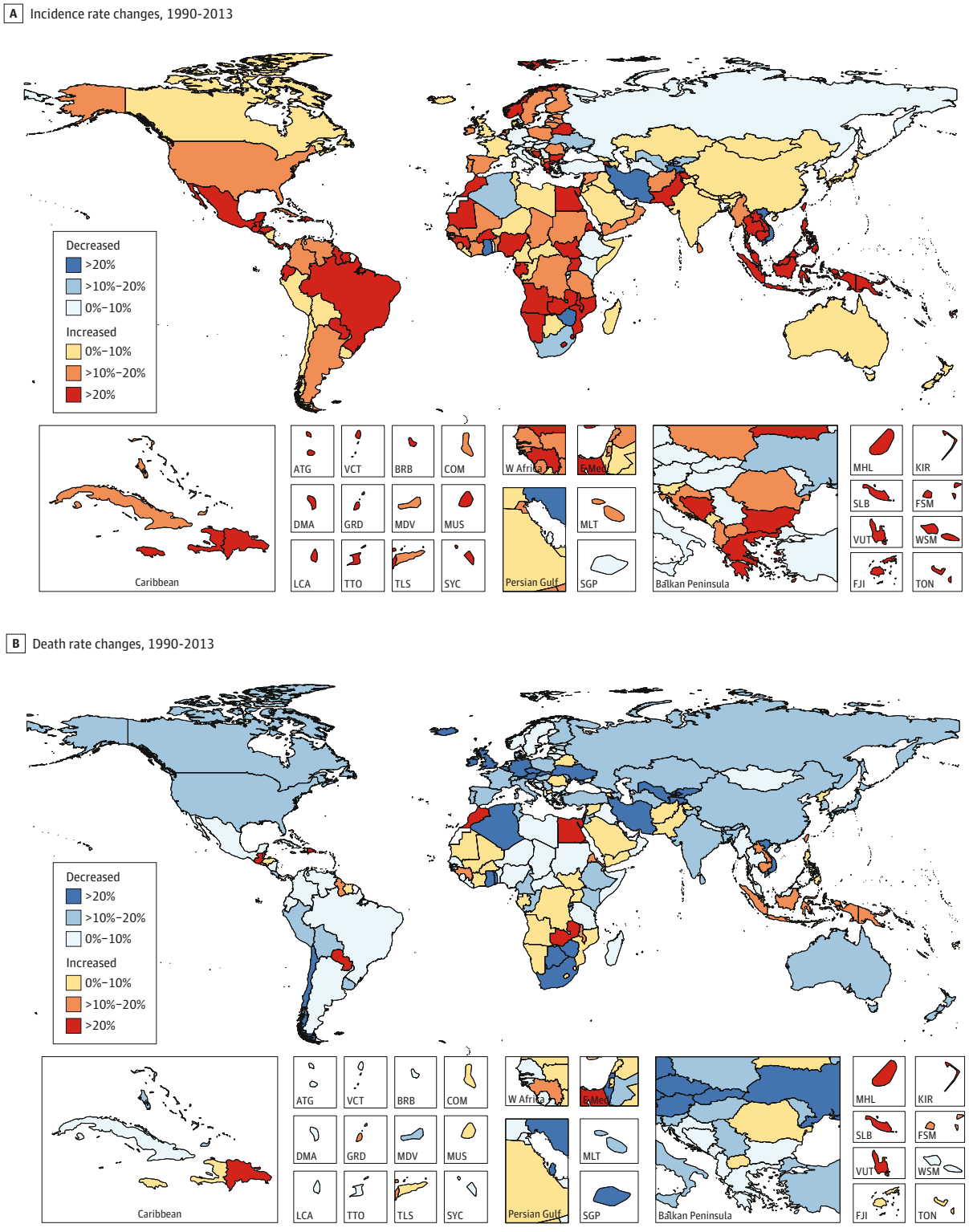
Figure 2. Relative Changes in Age-Standardized Incidence and Death Rates in Both Sexes for All Cancers Except NMSC and KS in 188 Countries From 1990 to 2013



ATG indicates Antigua and Barbuda; BRB, Barbados; COM, Comoros; DMA, Dominica; E Med: Eastern Mediterranean; FJI, Fiji; FSM, Federated States of Micronesia; GRD, Grenada; KIR, Kiribati; KS, Kaposi sarcoma; LCA, Saint Lucia; MDV, Maldives; MLT, Malta; MUS, Mauritius; MHL, Marshall Islands; NMSC, nonmelanoma skin cancer; SGP, Singapore; SLB, Solomon Islands; SYC, Seychelles; TLS, Timor-Leste; TON, Tonga; TTO, Trinidad and Tobago; VCT, Saint Vincent and the Grenadines; VUT, Vanuatu; W Africa, West Africa; WSM, Samoa.

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Figure 3. Cancers Ranked by Number of Incident Cases in Both Sexes, Globally, by Development Status, and in the 50 Most Populous Countries, 2013

Region	Country	Breast cancer	Tracheal, bronchus, and lung cancer	Colon and rectum cancer	Prostate cancer	Stomach cancer	Liver cancer	Cervical cancer	Non-Hodgkin lymphoma	Esophageal cancer	Leukemia	Lip and oral cavity cancer	Bladder cancer	Uterine cancer	Pancreatic cancer	Brain and nervous system cancer	Kidney cancer	Malignant skin melanoma	Ovarian cancer	Thyroid cancer	Gallbladder and biliary tract cancer	Larynx cancer	Other pharynx cancer	Multiple myeloma	Hodgkin lymphoma	Nasopharynx cancer	Testicular cancer	Mesothelioma
Global		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Developed		3	4	2	1	5	11	17	7	20	12	14	6	13	8	16	10	9	15	18	19	22	23	21	24	27	25	26
Developing		1	2	4	6	3	5	7	11	8	10	9	16	13	14	12	20	23	18	15	19	17	21	25	24	22	26	27
High-income Asia Pacific	Japan	4	2	1	6	3	5	17	10	11	13	14	9	18	7	22	12	23	15	16	8	21	20	19	27	26	25	24
	South Korea	5	2	1	8	3	4	13	10	15	14	18	11	19	9	16	12	23	17	6	7	21	22	20	25	24	27	26
High-income North America	Canada	4	3	2	1	12	18	20	5	19	10	14	6	8	11	13	9	7	15	17	21	22	23	16	24	27	25	26
	United States	2	3	4	1	13	18	20	7	19	11	12	6	9	10	17	8	5	15	14	23	21	22	16	24	27	25	26
Southern Latin America	Argentina[a]	1	4	3	2	5	18	6	8	14	12	16	10	7	9	19	11	15	17	21	13	20	25	23	24	26	22	27
Western Europe	France	3	4	2	1	10	14	19	6	18	13	12	5	7	11	16	9	8	17	22	23	21	15	20	24	27	25	26
	Germany	3	4	2	1	6	16	21	9	18	11	15	5	12	8	14	7	10	13	22	17	23	19	20	26	27	24	25
	Italy	2	4	1	3	6	8	21	7	22	11	19	5	12	9	14	10	13	15	18	16	20	24	17	25	27	26	23
	Spain	4	3	1	2	6	11	20	7	23	12	13	5	8	9	15	10	14	16	22	19	17	21	18	24	27	25	26
	United Kingdom	4	3	2	1	7	18	19	6	12	11	17	5	14	9	15	10	8	13	24	23	20	22	16	26	27	25	21
Central Asia	Uzbekistan[a]	1	3	8	11	2	9	4	12	5	6	10	20	13	16	7	17	18	19	24	21	14	23	25	15	26	22	27
Central Europe	Poland	3	1	2	4	6	19	11	14	20	12	16	5	9	8	13	7	17	10	21	18	15	23	22	25	26	24	27
Eastern Europe	Russia	3	2	1	5	4	17	9	14	19	12	11	8	10	7	18	6	16	13	15	21	20	22	24	23	26	25	27
	Ukraine	2	3	1	4	5	21	9	15	20	11	8	10	17	7	14	6	13	12	16	19	18	22	24	23	27	26	25
Andean Latin America	Peru[a]	3	6	4	1	2	9	5	7	21	8	18	20	10	12	15	14	17	16	11	13	24	25	19	23	27	22	26
Central Latin America	Colombia[a]	2	6	4	1	3	10	5	9	17	7	16	23	13	12	11	20	18	14	8	15	19	25	22	21	26	24	27
	Mexico[a]	2	7	3	1	5	10	4	9	22	8	18	24	16	12	14	11	20	13	6	17	19	25	23	21	27	15	26
	Venezuela[a]	2	4	5	1	6	13	3	7	19	8	16	22	10	11	17	12	20	15	9	18	14	25	21	23	26	24	27
Tropical Latin America	Brazil[a]	2	4	3	1	5	17	6	11	14	8	10	21	16	12	7	18	13	20	9	22	15	19	23	24	26	25	27
East Asia	China[a]	5	1	4	9	2	3	12	11	6	8	19	14	7	13	10	20	26	21	17	18	16	25	24	22	15	27	23
	North Korea[a]	4	1	5	11	3	2	7	12	6	9	14	17	8	13	10	22	23	21	20	19	16	25	24	18	15	27	26
Southeast Asia	Indonesia[a]	1	2	4	7	5	10	3	8	21	11	6	18	13	15	12	19	23	14	9	16	20	22	25	24	17	26	27
	Malaysia[a]	1	2	3	4	7	6	10	5	19	8	14	15	12	17	18	16	22	11	9	23	20	21	25	24	13	26	27
	Myanmar[a]	1	2	5	11	12	4	3	9	17	7	6	22	8	15	14	23	24	10	13	16	19	20	25	21	18	26	27
	Philippines[a]	1	2	4	3	12	7	5	11	23	6	10	20	9	15	14	18	21	13	8	19	17	22	26	25	16	24	27
	Thailand[a]	3	1	4	5	7	2	6	10	19	11	8	13	17	16	14	18	23	15	12	9	20	21	26	25	22	24	27
	Vietnam[a]	4	2	5	12	3	1	8	6	10	11	7	18	13	17	9	21	25	20	14	19	15	16	26	24	22	23	27
South Asia	Afghanistan[a]	3	2	8	10	1	9	4	12	17	5	14	11	13	18	6	20	23	22	16	21	15	25	24	7	19	26	27
	Bangladesh[a]	3	4	7	11	6	2	8	5	10	9	1	19	17	22	14	23	24	12	26	18	15	13	25	20	16	21	27
	India[a]	1	6	4	15	5	8	3	11	7	10	2	19	24	22	12	21	16	14	17	20	13	9	25	18	23	26	27
	Nepal[a]	1	4	6	13	7	9	3	12	5	8	2	21	22	17	14	23	25	11	20	16	15	10	24	18	19	26	27
	Pakistan[a]	1	3	6	8	13	12	15	5	4	7	2	9	17	24	14	22	25	11	18	20	10	16	23	19	21	26	27
North Africa and Middle East	Algeria[a]	1	3	2	10	4	15	7	6	23	5	21	14	20	16	8	22	24	17	12	9	18	25	19	13	11	26	27
	Egypt[a]	1	6	7	3	9	2	11	13	20	4	14	8	15	10	5	16	23	19	12	18	17	24	25	22	26	21	27
	Iran[a]	2	5	6	3	1	9	15	10	4	7	14	12	24	17	8	18	21	19	13	16	11	26	23	20	25	22	27
	Iraq[a]	1	2	5	8	6	7	10	11	19	3	15	14	9	12	4	16	26	17	13	20	18	24	23	21	25	22	27
	Morocco[a]	1	2	6	3	5	9	4	10	20	8	13	15	11	12	7	21	23	17	16	14	19	25	26	18	22	24	27
	Saudi Arabia[a]	1	4	2	6	9	3	16	5	17	8	13	14	22	11	7	15	26	18	10	12	19	21	23	24	25	20	27
	Sudan[a]	1	2	4	5	3	8	11	9	15	6	14	10	18	17	7	19	22	20	12	21	16	26	24	13	23	25	27
	Turkey[a]	2	1	3	4	5	13	18	7	24	6	20	10	11	9	8	16	22	14	12	19	15	27	21	23	25	17	26
	Yemen[a]	1	2	5	8	3	9	6	10	19	4	15	11	12	18	7	22	23	20	13	16	17	26	24	14	21	25	27
Central sub-Saharan Africa	DRC[a,b]	1	7	5	3	4	6	2	9	8	11	10	16	17	15	12	19	14	20	24	18	21	23	22	13	25	26	27
Eastern sub-Saharan Africa	Ethiopia[a]	1	8	4	3	7	6	2	9	5	18	11	21	15	16	10	12	13	19	22	17	25	24	20	14	26	23	27
	Kenya[a]	1	10	5	4	6	9	3	8	2	14	7	15	23	13	12	20	18	11	17	24	16	25	19	21	22	26	27
	Mozambique[a]	2	7	4	1	5	6	3	8	10	14	11	19	18	16	9	13	15	20	25	17	24	23	21	12	26	22	27
	Tanzania[a]	1	10	4	2	8	5	3	7	6	14	11	21	18	17	9	13	15	19	23	16	25	24	20	12	26	22	27
	Uganda[a]	3	9	6	1	8	7	2	4	5	12	11	16	15	19	21	18	20	10	13	25	24	22	23	14	17	26	27
Southern sub-Saharan Africa	South Africa[a]	2	4	3	1	10	11	6	7	5	13	8	15	14	9	21	17	12	16	20	23	18	22	19	24	27	25	26
Western sub-Saharan Africa	Ghana[a]	3	10	5	1	6	4	2	8	13	12	17	15	7	9	11	20	19	14	21	18	25	26	22	16	24	23	27
	Nigeria[a]	3	9	5	4	6	1	2	7	16	11	17	13	8	12	14	18	20	10	21	19	23	25	22	15	26	24	27

Colors correspond to the ranking, with dark red as the most common cancer and dark green as the least common cancer for the location indicated. Rankings do not include the "other cancer" group (eTable 15 in the Supplement). The numbers inside each box indicate the ranking.

[a] Developing country.

[b] Democratic Republic of Congo.

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Figure 4. Cancers Ranked by Number of Deaths in Both Sexes, Globally, by Development Status, and in the 50 Most Populous Countries, 2013

Region	Country	Tracheal, bronchus, and lung cancer	Stomach cancer	Liver cancer	Colon and rectum cancer	Breast cancer	Esophageal cancer	Pancreatic cancer	Prostate cancer	Leukemia	Cervical cancer	Non-Hodgkin lymphoma	Brain and nervous system cancer	Bladder cancer	Ovarian cancer	Gallbladder and biliary tract cancer	Lip and oral cavity cancer	Kidney cancer	Larynx cancer	Multiple myeloma	Other pharynx cancer	Uterine cancer	Nasopharynx cancer	Malignant skin melanoma	Mesothelioma	Thyroid cancer	Hodgkin lymphoma	Testicular cancer
Global		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Developed		1	3	7	2	4	11	5	6	8	17	9	14	10	13	15	18	12	21	16	22	20	26	19	23	24	25	27
Developing		1	3	2	4	6	5	9	12	8	7	11	10	14	15	16	13	18	17	22	19	21	20	24	26	23	25	27
High-income Asia Pacific	Japan	1	2	4	3	9	7	5	8	11	16	10	18	12	14	6	17	13	23	15	19	20	24	25	22	21	26	27
	South Korea	1	3	2	4	8	7	5	9	11	13	10	14	12	16	6	20	15	18	17	21	22	24	23	25	19	26	27
High-income North America	Canada	1	7	13	2	3	12	5	4	8	20	6	9	10	11	17	18	14	22	15	23	19	25	16	21	24	26	27
	United States	1	9	8	2	3	13	4	5	7	18	6	12	14	10	20	19	11	21	15	22	17	26	16	23	24	25	27
Southern Latin America	Argentina[a]	1	4	8	2	3	7	6	5	11	10	13	16	14	15	12	19	9	17	20	23	18	26	21	24	22	25	27
Western Europe	France	1	7	6	2	4	11	5	3	8	20	10	14	9	13	17	16	12	21	15	18	22	25	19	23	24	26	27
	Germany	1	6	10	2	3	14	4	5	7	19	11	13	9	12	15	18	8	23	16	20	21	26	17	22	24	25	27
	Italy	1	3	6	2	4	16	5	7	9	22	10	12	8	13	14	18	11	20	15	23	21	26	17	19	24	25	27
	Spain	1	3	7	2	5	14	6	4	9	21	10	11	8	12	16	18	13	17	15	22	19	26	20	23	24	25	27
	United Kingdom	1	7	14	2	3	6	5	4	10	21	8	13	11	9	20	19	12	22	15	23	18	26	16	17	24	25	27
Central Asia	Uzbekistan[a]	2	1	5	7	4	3	10	18	6	9	11	8	16	15	17	12	14	13	24	20	19	23	21	27	26	22	25
Central Europe	Poland	1	3	12	2	4	16	5	6	11	14	15	8	7	9	13	18	10	17	21	22	19	25	20	26	23	24	27
Eastern Europe	Russia	1	3	7	2	4	13	5	6	10	12	16	11	14	9	18	15	8	17	22	21	19	25	20	26	23	24	27
	Ukraine	1	3	14	2	4	16	5	8	11	10	15	12	9	7	18	13	6	17	23	20	21	25	19	24	22	26	27
Andean Latin America	Peru[a]	2	1	6	3	7	17	8	4	9	5	10	12	16	14	11	20	13	22	18	23	15	27	19	24	21	25	26
Central Latin America	Colombia[a]	2	1	7	3	5	12	9	4	8	6	10	11	15	14	13	18	17	16	19	24	22	25	21	27	20	23	26
	Mexico[a]	1	2	3	5	6	15	8	4	9	7	10	13	17	12	14	19	11	16	18	26	22	27	23	25	20	21	24
	Venezuela[a]	1	2	7	4	5	13	8	3	9	6	10	14	17	11	16	19	12	15	18	23	20	25	21	27	22	24	26
Tropical Latin America	Brazil[a]	1	3	8	2	5	7	6	4	11	9	12	10	13	14	18	15	17	16	20	19	21	25	22	26	23	24	27
East Asia	China[a]	1	3	2	5	8	4	6	15	7	12	11	9	13	18	14	20	17	19	22	23	16	10	26	21	24	25	27
	North Korea[a]	1	3	2	4	7	5	10	20	6	9	12	8	11	16	14	19	18	17	22	24	15	13	26	25	23	21	27
Southeast Asia	Indonesia[a]	1	3	6	2	5	14	8	19	7	4	10	9	16	12	13	11	17	20	24	18	21	15	23	25	22	26	27
	Malaysia[a]	1	5	3	2	4	13	7	12	6	10	8	17	15	11	18	16	14	21	20	19	23	9	24	27	22	25	26
	Myanmar[a]	1	7	2	4	5	13	11	20	6	3	9	14	15	8	12	10	17	21	25	19	18	16	24	26	22	23	27
	Philippines[a]	1	6	2	4	3	16	8	11	5	7	10	12	19	9	15	13	17	22	23	21	20	14	24	27	18	25	26
	Thailand[a]	2	4	1	3	6	12	9	16	8	5	13	11	15	14	7	10	17	20	24	19	22	18	23	26	21	25	27
	Vietnam[a]	2	3	1	4	11	5	12	14	9	8	6	7	16	22	19	10	21	15	24	13	18	20	26	27	17	25	23
South Asia	Afghanistan[a]	2	1	5	7	3	12	13	14	4	6	10	9	8	18	17	20	16	11	24	23	21	19	26	25	22	15	27
	Bangladesh[a]	2	3	1	8	9	7	19	18	5	10	4	13	14	11	16	6	20	15	24	12	21	17	25	26	27	22	23
	India[a]	4	1	2	7	5	3	15	20	10	6	11	13	16	12	17	8	19	14	21	9	25	18	22	27	23	24	26
	Nepal[a]	2	3	6	5	4	1	16	20	8	7	11	15	17	10	14	9	19	13	21	12	23	18	25	27	22	24	26
	Pakistan[a]	1	10	5	9	2	3	18	19	8	16	4	13	7	11	15	6	20	12	21	14	22	17	26	27	23	24	25
North Africa and Middle East	Algeria[a]	1	3	9	4	2	18	13	15	5	12	6	8	10	14	7	22	19	16	17	23	24	11	25	26	20	21	27
	Egypt[a]	2	7	1	8	3	11	9	10	5	14	12	4	6	17	16	18	13	15	23	21	20	27	24	25	19	22	26
	Iran[a]	3	1	9	5	8	2	12	7	4	17	14	6	10	16	13	18	15	11	20	24	26	19	22	27	21	23	25
	Iraq[a]	2	5	4	7	1	15	8	11	3	12	10	6	9	13	17	19	14	16	21	23	18	22	25	27	20	24	26
	Morocco[a]	1	3	5	4	2	15	9	6	10	7	11	8	12	14	13	19	17	16	24	23	18	20	25	26	21	22	27
	Saudi Arabia[a]	2	6	1	3	4	12	8	10	7	17	9	5	13	15	11	16	14	18	22	21	25	20	24	27	19	23	26
	Sudan[a]	1	2	6	4	3	12	11	10	5	13	9	7	8	16	15	18	17	14	22	24	23	19	25	27	20	21	26
	Turkey[a]	1	2	10	3	4	16	5	6	7	18	11	8	9	12	15	22	13	14	17	27	19	23	24	21	20	25	26
	Yemen[a]	1	2	6	5	3	13	12	11	4	10	9	7	8	16	14	18	17	15	23	24	20	19	25	26	21	22	27
Central sub-Saharan Africa	DRC[a,b]	6	2	5	4	3	7	11	9	10	1	8	14	12	17	13	15	16	18	21	22	20	24	23	27	25	19	26
Eastern sub-Saharan Africa	Ethiopia[a]	7	6	4	3	5	2	10	9	14	1	8	12	16	17	13	15	11	22	18	21	20	26	23	27	25	19	24
	Kenya[a]	8	4	5	6	3	1	9	11	14	2	7	15	13	10	19	12	18	16	17	22	25	20	24	27	23	21	26
	Mozambique[a]	7	3	4	1	5	9	12	6	13	2	8	11	15	18	14	16	10	21	19	20	22	26	23	25	27	17	24
	Tanzania[a]	8	6	2	3	4	5	13	9	12	1	7	10	16	17	14	15	11	22	19	20	21	25	23	26	27	18	24
	Uganda[a]	9	8	4	6	7	2	13	5	11	1	3	20	12	10	24	16	15	21	18	17	23	14	25	27	19	22	26
Southern sub-Saharan Africa	South Africa[a]	1	9	8	3	5	2	7	4	11	6	10	17	14	12	21	13	16	20	15	22	19	25	18	23	24	26	27
Western sub-Saharan Africa	Ghana[a]	9	3	1	6	5	10	7	4	14	2	8	15	12	11	16	19	17	25	18	24	13	23	21	26	22	20	27
	Nigeria[a]	7	3	1	5	4	10	9	8	13	2	6	15	11	12	14	18	17	21	20	23	16	25	22	26	24	19	27

Colors correspond to the ranking, with dark red as the cancer with the most deaths and dark green as the cancer with the least deaths for the location indicated. Rankings do not include the "other cancer" group (eTable 15 in the Supplement). The numbers inside each box indicate the ranking.

[a] Developing country.

[b] Democratic Republic of Congo.

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Figure 5. Cancers Ranked Globally and for Both Sexes by Absolute Years of Life Lost (YLLs) Including the Percentage Change in Absolute YLLs and the Percentage Change in the Age-Standardized YLL Rate Between 1990 and 2013

1990		2013			
Rank	Cancer	Cancer	Rank	Change in Absolute YLLs, %	Change in YLL Age-Standardized Rate, %
1	Tracheal, bronchus, and lung cancer	Tracheal, bronchus, and lung cancer	1	39.2	-17.6
2	Stomach cancer	Liver cancer	2	42.2	-13.7
3	Liver cancer	Stomach cancer	3	-2.5	-41.9
4	Colon and rectum cancer	Colon and rectum cancer	4	43.9	-15.6
5	Leukemia	Breast cancer	5	36.9	-19.6
6	Breast cancer	Esophageal cancer	6	31.9	-22.8
7	Esophageal cancer	Leukemia	7	-9.0	-31.0
8	Cervical cancer	Pancreatic cancer	8	73.7	1.4
9	Brain and nervous system cancer	Cervical cancer	9	13.7	-32.4
10	Non-Hodgkin lymphoma	Brain and nervous system cancer	10	26.4	-13.4
11	Pancreatic cancer	Non-Hodgkin lymphoma	11	42.3	-3.7
12	Ovarian cancer	Ovarian cancer	12	50.0	-11.4
13	Bladder cancer	Prostate cancer	13	69.7	-4.0
14	Gallbladder and biliary tract cancer	Lip and oral cavity cancer	14	52.4	-9.9
15	Prostate cancer	Kidney cancer	15	43.9	-8.8
16	Lip and oral cavity cancer	Bladder cancer	16	17.9	-31.4
17	Kidney cancer	Gallbladder and biliary tract cancer	17	11.3	-35.4
18	Larynx cancer	Other pharynx cancer	18	54.7	-9.3
19	Nasopharynx cancer	Larynx cancer	19	5.8	-37.5
20	Hodgkin lymphoma	Nasopharynx cancer	20	3.9	-35.5
21	Other pharynx cancer	Multiple myeloma	21	64.3	-3.8
22	Uterine cancer	Uterine cancer	22	35.6	-20.0
23	Malignant skin melanoma	Malignant skin melanoma	23	32.6	-19.3
24	Multiple myeloma	Hodgkin lymphoma	24	-40.5	-55.5
25	Thyroid cancer	Mesothelioma	25	82.9	9.9
26	Mesothelioma	Thyroid cancer	26	29.8	-21.8
27	Testicular cancer	Testicular cancer	27	11.4	-23.4

The "other cancers" group (eTable 15 in the Supplement) is not included here because it contains multiple different types of cancers. Solid lines connecting the 1990 and 2013 charts indicate increased or unchanged rank for the connected cancers; dotted lines indicated decreased rank.

Between 1990 and 2013, TBL cancer remained the leading cause of cancer YLLs (**Figure 5**). A decrease in incidence rates between 1990 and 2013 with stable population size and age structure would have resulted in a 13% decrease in incident cases (**Table 2**). However, overall incident cases increased by 62% because of population growth and aging. The ASIRs per 100 000 for both sexes between 1990 and 2013 decreased by 6% at the global level (31.12 to 29.36), by 14% for developed countries (43.81 to 37.74) but increased by 9% in developing countries (23.04 to 25.18) (web table 7).

At the global level, incidence for women has risen slowly, whereas rates have fallen for men since the mid-1990s (**Figure 6**). The same trends can be seen in developed regions. However, in developing regions, rates are still increasing for men. Age-standardized DALY rates for both sexes between 1990 and 2013 have decreased by 17% at the global level, by 23% for developed countries, and by 7% for developing countries (web table 9).

Breast Cancer

Since only 1% of breast cancer cases in 2013 occurred in men, only female breast cancer is discussed herein. In 2013, there were 1.8 million incident cases of breast cancer and 464 thousand deaths. Breast cancer caused 13.1 million DALYs in 2013 (web table 3), with 63% occurring in developing countries and 37% occurring in developed countries. One in 18 women developed breast cancer between birth and age 79 years.

As detailed in web tables 1 and 2, in 2013, ASIRs per 100 000 were the lowest in western sub-Saharan Africa (with ASDRs per 100 000 reported for comparison) (ASIR, 28.24; ASDR, 10.65), east Asia (ASIR, 33.52; ASDR, 6.87), and eastern sub-Saharan Africa (ASIR, 33.67; ASDR, 13.71) and the highest in Oceania (ASIR, 133.38; ASDR, 28.89), high-income North America (ASIR, 111.01; ASDR, 19.07), and Australasia (ASIR, 91.12; ASDR, 19.63).

Breast cancer was the cancer with the highest incidence for women in 161 countries (eFigure 6b in the Supplement) and the

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Table 2. Decomposition Analysis of Cancer Trends in Global Incidence, Both Sexes, 1990 to 2013

	Incident Cases, No.		Expected Incident Cases, 2013, No.		Change in Incident Cases, 1990 to 2013, %		
Cancer[a]	1990	2013	Given Population Growth Alone	Given Population Growth and Aging	Due to Population Growth[b]	Due to Change in Age Structure[c]	Due to Change in Incidence Rates[d]
All except NMSC and KS	8 510 588	14 942 583	11 486 507	14 515 059	35.0	35.6	5.0
Esophageal	303 510	441 767	409 640	530 592	35.0	39.9	−29.3
Stomach	800 136	984 206	1 079 922	1 401 995	35.0	40.3	−52.2
Liver	465 014	792 203	627 617	800 507	35.0	37.2	−1.8
Larynx	137 785	176 687	185 964	238 499	35.0	38.1	−44.9
Tracheal, bronchus and lung	1 113 162	1 798 179	1 502 405	1 937 791	35.0	39.1	−12.5
Breast	906 618	1 804 209	1 223 637	1 568 145	35.0	38.0	26.0
Cervical	447 344	485 297	603 768	747 821	35.0	32.2	−58.7
Uterine	216 793	353 117	292 599	375 986	35.0	38.5	−10.5
Prostate	454 412	1 442 460	613 308	801 983	35.0	41.5	140.9
Colon and rectum	818 440	1 572 590	1 104 626	1 443 985	35.0	41.5	15.7
Lip and oral cavity	238 789	409 360	322 287	413 567	35.0	38.2	−1.8
Nasopharynx	67 658	83 702	91 316	112 072	35.0	30.7	−41.9
Other pharynx	80 691	139 567	108 907	140 604	35.0	39.3	−1.3
Gallbladder and biliary tract	136 503	186 253	184 234	242 255	35.0	42.5	−41.0
Pancreatic	183 076	350 361	247 093	323 423	35.0	41.7	14.7
Malignant skin melanoma	151 601	272 481	204 612	254 748	35.0	33.1	11.7
Ovarian	137 417	226 204	185 467	234 642	35.0	35.8	−6.1
Testicular	37 982	59 279	51 263	56 101	35.0	12.7	8.4
Kidney	142 463	294 501	192 279	241 697	35.0	34.7	37.1
Bladder	263 307	401 174	355 378	466 220	35.0	42.1	−24.7
Brain and central nervous system	193 980	304 528	261 809	293 291	35.0	16.2	5.8
Thyroid	115 627	225 566	156 058	187 946	35.0	27.6	32.5
Mesothelioma	16 972	33 744	22 906	29 561	35.0	39.2	24.6
Hodgkin lymphoma	103 249	93 345	139 353	142 599	35.0	3.1	−47.7
Non-Hodgkin lymphoma	226 661	465 488	305 918	373 548	35.0	29.8	40.6
Multiple myeloma	62 738	116 947	84 676	110 140	35.0	40.6	10.8
Leukemia	297 404	414 443	401 398	437 862	35.0	12.3	−7.9
Other neoplasms	391 255	1 014 928	528 066	607 480	35.0	20.3	104.1

Abbreviations: GBD, Global Burden of Disease; *ICD-9*, *International Classification of Diseases, Ninth Revision*; *ICD-10*, *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision*; KS, Kaposi sarcoma; NMSC, nonmelanoma skin cancer; YLDs, years lived with disability; YLLs, years of life lost.

[a] Cancer groups are defined based on *ICD* codes and include all codes pertaining to neoplasms (*ICD-9* 140-239; *ICD-10* C00-D49) except for NMSC and KS. eTable 3 in the Supplement details how the original *ICD* codes were mapped to the standardized GBD cause list.[1]

[b] To estimate the effect of population growth we applied the population size of 2013 onto the rate, sex, and age structure of 1990. Since the global population grew by 35% between 1990 and 2013, and rates and age structure remained the same as in 1990, incidence due to all cancers increased by 35% in this counterfactual scenario.

[c] To estimate the effect of aging on incident cases we applied the age structure of 2013 onto the rate, sex distribution, and population size of 1990. The change in incident cases reported herein shows the proportion of the change in incident cases between 1990 and 2013 that can be attributed to the changing age structure of the population.

[d] To estimate the effect of changing incidence rates on the incident cases we applied the incidence rates for 1990 onto the population size and age structure of 2013. The change in incident cases reported herein shows the proportion of the change in incident cases between 1990 and 2013 that can be attributed to a change in incidence rates.

most common cause for cancer deaths in women in 98 countries (eFigure 6d in the Supplement).

Figure 5 shows that breast cancer ranked sixth in 1990 for cancer YLLs, but it moved to fifth place in 2013. Compared with 1990, in 2013, incident cases increased by 898 000 (99% increase). With stable population size and age structure, breast cancer incidence would have increased by 26% due to increasing incidence rates. Population aging with unchanged incidence rates or population growth would have led to a 38% increase in incidence (Table 2).

Globally, female breast cancer incidence has been continuously increasing, with a slower increase since 2000 (**Figure 7**). Even though female breast cancer incidence is lower in developing countries, it is increasing rapidly compared with developed countries, where rates have been stable to declining since the early 2000s. Between 1990 and 2013, ASIRs per 100 000 have increased by 17% globally (44.36 to 51.73), by 46% in developing countries (27.74 to 40.40) and by 8% in developed countries (69.75 to 74.98) (web table 1). Age-standardized DALY rates have decreased by 17% at the global

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Figure 6. Trends in Age-Standardized Incidence Rates for Tracheal, Bronchus, and Lung Cancer, 1990-2013

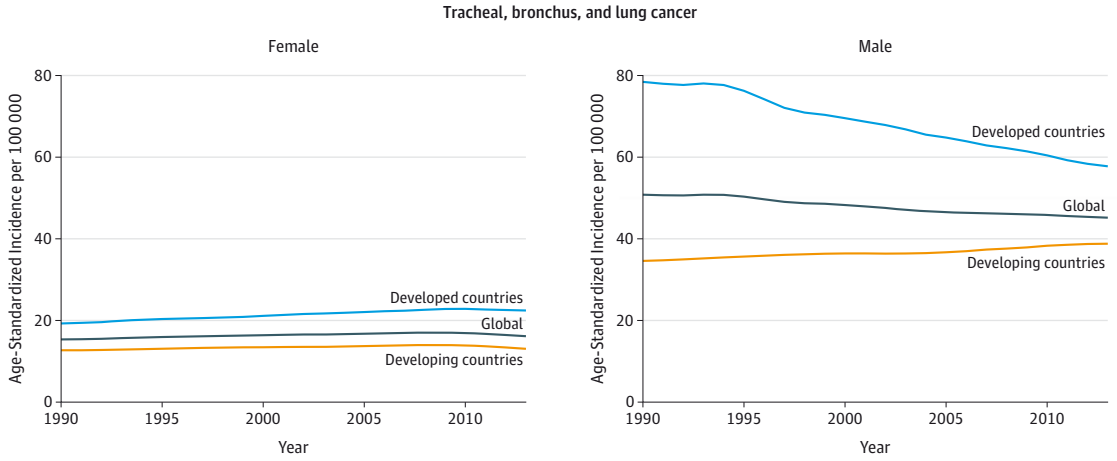
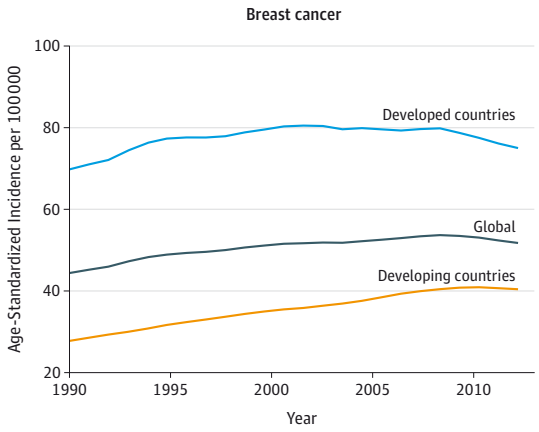


Figure 7. Trends in Age-Standardized Incidence Rates for Female Breast Cancer, 1990-2013



level, by 25% for developed countries, and by 3% for developing countries (web table 3).

Colon and Rectum Cancer

In 2013, there were 1.6 million incident cases of colon and rectum cancer, and it caused 771 000 deaths. Colon and rectum cancer caused 15.8 million DALYs in 2013, with 56% occurring in developing countries and 44% occurring in developed countries (web table 9). The probability of developing colon and rectum cancer before age 79 years was higher for men than for women (1 in 27 men; 1 in 43 women).

Globally, colon and rectum cancer ranked third for cancer incidence and fourth for cancer death in 2013 (Figures 3 and 4). For developed countries it ranked second for incidence and mortality, and in developing countries it ranked fourth for both incidence and mortality.

As detailed in in web tables 4 and 5, the 2013 incidence rates per 100 000 for men were the lowest in western sub-Saharan Africa (with ASDRs per 100 000 reported for comparison) (ASIR, 9.12; ASDR, 6.51), south Asia (ASIR, 10.26; ASDR, 6.07), and eastern sub-Saharan Africa (ASIR, 12.73; ASDR, 9.91) and the highest in Australasia (ASIR, 60.64; ASDR, 22.29), high-income Asia Pacific (ASIR, 58.48; ASDR, 22.56), and western Europe (ASIR, 55.69; ASDR, 24.24). For women, incidence rates per 100 000 in 2013 were the lowest in south Asia (with ASDRs per 100 000 reported for comparison) (ASIR, 6.04; ASDR, 3.98), western sub-Saharan Africa (ASIR, 6.95; ASDR, 5.49), and eastern sub-Saharan Africa (ASIR, 9.86; ASDR, 8.57) and the highest in Australasia (ASIR, 43.75; ASDR, 15.95), high-income North America (ASIR, 39.95; ASDR, 13.12), and western Europe (ASIR, 33.96; ASDR, 15.01) (web tables 1 and 2). eFigure 6a and c in the Supplement show that colon and rectum cancer was the cancer with the highest incidence in 2013 for men in Bulgaria, Brunei, Hungary, Japan, Kuwait, Saudi Arabia, Singapore, Slovakia, and Taiwan and the most common cause of cancer death in Ethiopia and Tanzania. For women, colon and rectum cancer was the cancer with the highest incidence in Japan and the most common cause of death in Spain, Japan, Norway, Portugal, and Sweden (eFigure 6b and d in the Supplement).

Figure 5 shows that colon and rectum cancer remained the fourth leading cause for cancer YLLs between 1990 and 2013. Table 2 details how in 2013 almost twice as many people were diagnosed with colon and rectum cancer as in 1990 (818 000 in 1990, 1.6 million in 2013). Most of this increase can be explained by an aging and growing population, but even with the same population size and structure, colon and rectum cancer cases would have increased by 16% between 1990 and 2013 due to an increase in incidence rates.

Figure 8 shows that worldwide ASIR for colon and rectum cancer for women between 1990 and 2013 remained stable but increased for men. As detailed in web tables 1 and 4, ASIRs increased by 1% between 1990 and 2013 for women and by 16% for men. In developed countries, ASIRs decreased by 3% in women and increased by 8% in men. However, in developing regions, rates have risen rapidly, with a 53% increase in men and a 31% increase in women between 1990 and 2013. Between 1990 and 2013, age-standardized DALY rates for both sexes have decreased by 15% at the global level, by 18% in developed countries, and by 2% in developing countries (web table 9).

Prostate Cancer

In 2013, there were 1.4 million incident cases of prostate cancer and 293 000 deaths. Prostate cancer caused 4.8 million DALYs glob-

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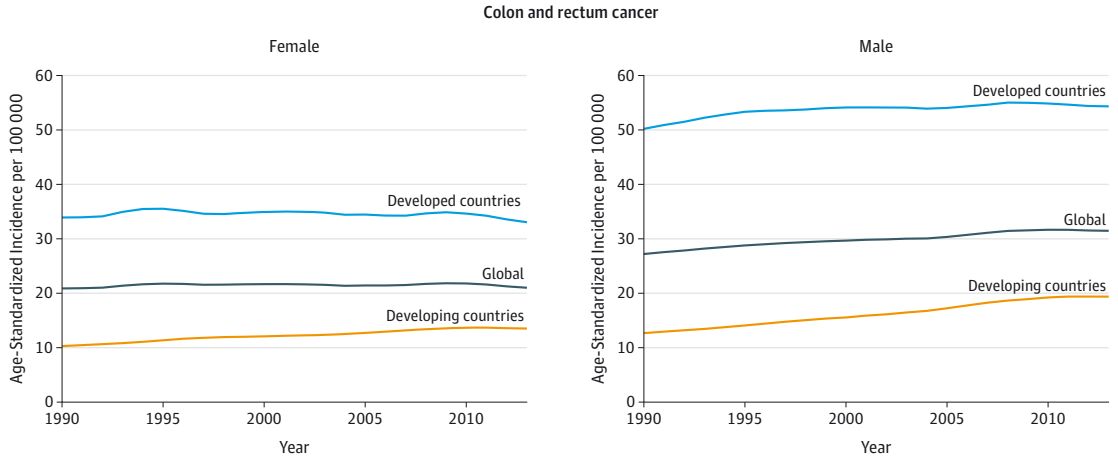
Figure 8. Trends in Age-Standardized Incidence Rates for Colon and Rectum Cancer, 1990-2013



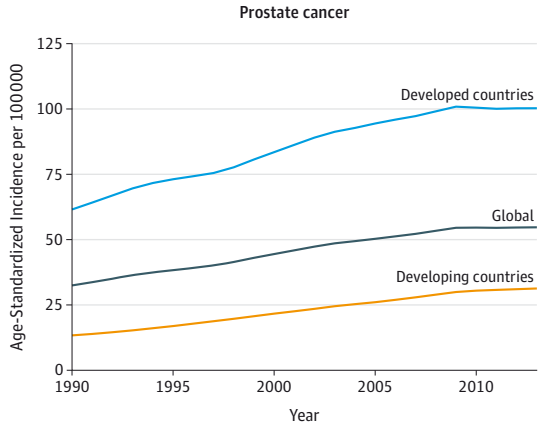
ally in 2013, with 57% occurring in developed countries, and 43% occurring in developing countries (web table 9). The probability of developing prostate cancer is detailed in eTable 17 in the Supplement, with 1 in 15 men developing prostate cancer between birth and age 79 years.

Our web tables 4 and 5 detail how incidence rates per 100 000 in 2013 were the lowest in south Asia (with ASDRs per 100 000 reported for comparison) (ASIR, 9.9; ASDR, 2.39), east Asia (ASIR, 13.99; ASDR, 3.43), and central Asia (ASIR, 25.57; ASDR, 7.91) and the highest in high-income North America (ASIR, 184.23; ASDR, 19.7), the Caribbean (ASIR, 154.97; ASDR, 49.05), and Australasia (ASIR, 144.81; ASDR, 26.53).

eFigure 6a and c in the Supplement shows that in 2013, prostate cancer was the cancer with the highest incidence for men in 104 of 188 countries, and the leading cause of cancer death for men in 24 countries.

Prostate cancer ranked 15th for cancer YLLs in 1990 and 13th in 2013 as can be seen in Figure 5. Table 2 details how the increasing incidence together with an aging and growing population have led to a more than 3-fold increase in prostate cancer cases since 1990 (454 000 in 1990, 1.4 million in 2013). The ASIR for prostate cancer had the steepest increase between 1990 and 2013 of all cancers in men (**Figure 9**). As listed in web table 4, ASIRs per 100 000 increased by 69% globally (32.42 to 54.68), by 135% in developing countries (13.29 to 31.25), and by 63% in developed countries (61.51 to 100.29). Prostate cancer incidence rates are still lower in developing countries than in developed countries, but because of a faster increase in rates in developing countries, the gap decreased between 1990 and 2013 from a 4-fold to a 3-fold difference. During the same timeframe, age-standardized DALY rates have decreased by 3% at the global level and by 9% in developed countries but have increased by 28% in developing countries (web table 9).

Figure 9. Trends in Age-Standardized Incidence Rates for Prostate Cancer, 1990-2013



Stomach Cancer

In 2013, there were 984 000 incident cases of stomach cancer and 841 000 deaths. Stomach cancer caused 17.9 million DALYs in 2013, with 77% occurring in developing countries, and 23% occurring in developed countries (web table 9). One in 36 men and 1 in 84 women developed stomach cancer before age 79 years. Globally, stomach cancer ranked fifth for cancer incidence and second for cancer deaths in 2013 (Figures 3 and 4). For developed countries, it ranked fifth for incidence and third for mortality, and in developing countries, it ranked third for both incidence and mortality.

The ASIRs and ASDRs per 100 000 in 2013 for both sexes were higher in developing countries vs developed countries (ASIR, 16.9 vs 14.38; ASDR, 15.33 vs 11.07) (web tables 7 and 8). As detailed in web tables 4 and 5, the 2013 incidence rates per 100 000 for men were the lowest in southern sub-Saharan Africa (with ASDRs per 100 000 reported for comparison) (ASIR, 8.27; ASDR, 6.97), south Asia (ASIR, 9.01; ASDR, 9.19), and eastern sub-Saharan Africa (ASIR, 9.12; ASDR, 10.01) and the highest in high-income Asia Pacific (ASIR, 42.31; ASDR, 31.61), east Asia (ASIR, 39.16; ASDR, 34.12), and Andean Latin America (ASIR, 32.61; ASDR, 27.96). For women, incidence rates per 100 000 in 2013 were the lowest in southern sub-Saharan Africa (with ASDRs per 100 000 reported for comparison) (ASIR, 4.54; ASDR, 3.93), high-income North America (ASIR, 4.65; ASDR, 2.94), and Australasia (ASIR, 5.37; ASDR, 3.84) and the highest in Andean Latin America (ASIR, 24.62; ASDR, 21.69), high-income Asia Pacific (ASIR, 20.00; ASDR, 14.86), and east Asia (ASIR, 14.78; ASDR, 13.37) (web tables 1 and 2).

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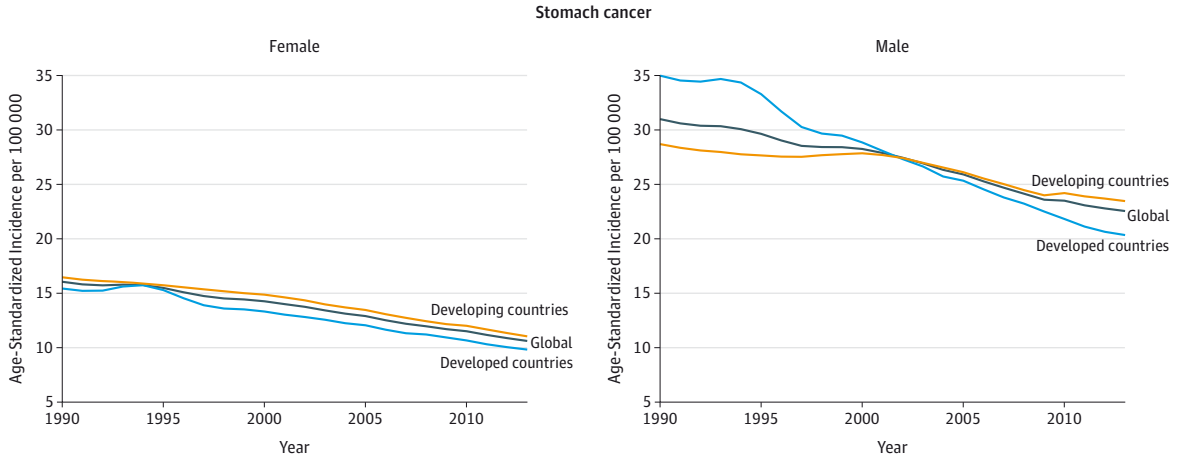
Figure 10. Trends in Age-Standardized Incidence Rates for Stomach Cancer, 1990-2013



Stomach cancer was the cancer with the highest absolute incidence in 2013 for men in Honduras, Iran, Kyrgyzstan, and Tajikistan and the leading cause of cancer death in Bolivia, Central African Republic, Chile, Democratic Republic of the Congo, Congo, Colombia, Cape Verde, Costa Rica, Ecuador, Guatemala, Honduras, Iran, Kyrgyzstan, Oman, Peru, El Salvador, and Tajikistan (eFigure 6a and c in the Supplement). For women, it was the cancer with the most incident cases in Cape Verde and the leading cause of cancer death in Afghanistan, Bolivia, Cape Verde, Ecuador, Guatemala, Honduras, Peru, Tajikistan, and Vietnam (eFigure 6b and d in the Supplement).

Stomach cancer decreased from the second highest cause for crude cancer YLLs in 1990 to the third highest in 2013, with a 2.5% decrease in absolute YLLs due to cancer (Figure 5). If the population age structure and size had remained the same in 2013 as it was in 1990, incidence would have dropped by 52.2% due to decreasing rates (Table 2). As illustrated in **Figure 10**, ASIRs have dropped substantially since 1990, Between 1990 and 2013 age-standardized DALYs for both sexes decreased by 42% globally, by 49% in developed countries, and by 40% in developing countries (web table 9).

Liver Cancer

In 2013, there were 792 000 incident cases of liver cancer globally and 818 000 deaths. Liver cancer caused 20.9 million DALYs in 2013, with 86% occurring in developing countries and 14% occurring in developed countries (web table 9). Liver cancer is more common in men, with 1 in 45 men being diagnosed before age 79 years compared with 1 in 121 women. Globally, liver cancer ranked sixth for cancer incidence and third for cancer death in 2013 as shown in Figures 3 and 4. For developed countries it ranked 11th for incidence and seventh for mortality, and in developing countries it ranked fifth for incidence and second for mortality.

The ASIRs and ASDRs for liver cancer per 100 000 in 2013 for both sexes were higher in developing countries vs developed countries (ASIR, 14.72 vs 7.42; ASDR, 15.59 vs 7.26) (web tables 7 and 8). As web tables 4 and 5 detail, in 2013 incidence rates per 100 000 for men were the lowest in tropical Latin America (with ASDRs per 100 000 reported for comparison) (ASIR, 5.86; ASDR, 6.45), eastern Europe (ASIR, 6.07; ASDR, 6.46), and Australasia (ASIR, 6.26; ASDR, 5.69) and the highest in east Asia (ASIR, 36.66; ASDR, 36.88), western sub-Saharan Africa (ASIR, 30.53; ASDR, 33.68), and high-income Asia Pacific (ASIR, 30.16; ASDR, 29.48). For women incidence rates in 2013 per 100 000 were the lowest in eastern Europe (ASIR, 2.52; ASDR, 2.85), Australasia (ASIR, 2.72; ASDR, 2.68), and high-income North America (ASIR, 2.87; ASDR, 2.72) and the highest in western sub-Saharan Africa (ASIR, 13.17; ASDR, 14.79), east Asia (ASIR, 11.89; ASDR, 13.09), and Oceania (ASIR, 10.01; ASDR, 11.18) (web tables 1 and 2).

Liver cancer was the most commonly diagnosed cancer in 2013 for men in Benin, Burkina Faso, Cameroon, Guinea, The Gambia, Guinea-Bissau, Liberia, Mali, Mongolia, Mauritania, Niger, Senegal, Sierra Leone, Chad, Togo, Thailand, and Vietnam (eFigure 6a in the Supplement) and the most common cause of cancer death in Burundi, Benin, Burkina Faso, Bangladesh, Côte d'Ivoire, Cameroon, Egypt, Eritrea, Fiji, Ghana, Guinea, The Gambia, Guinea-Bissau, Liberia, Madagascar, Mali, Mongolia, Mauritania, Niger, Nigeria, Rwanda, Saudi Arabia, Senegal, Sierra Leone, Chad, Togo, Thailand, Taiwan, and Vietnam (eFigure 6c in the Supplement).

For women in 2013, liver cancer was the most commonly diagnosed cancer as well as the leading cause of cancer death in Mongolia (eFigure 6b and d in the Supplement).

Figure 3 shows a marked difference between the 50 most populous countries for liver cancer incidence rankings. For example, while it ranks in most of these countries among the top 10 cancers for incidence, it ranks 21st in Ukraine, 19th in Poland, and 18th in the United States, the United Kingdom, Argentina, and Canada.

Liver cancer has increased from the third leading cause for cancer YLLs in 1990 to the second leading cause in 2013 (Figure 5). Aging and population growth are the drivers of the increase from 465 000 cases in 1990 to 792 000 cases in 2013 (Table 2). If the population age structure and size had remained the same in 2013 as they were in 1990, 1.8% fewer cases of liver cancer would have been diagnosed in 2013 than in 1990. Worldwide, as well as in developing regions, ASIRs appear to have peaked in the late 1990s, with a slow decrease in rates since 2000 (**Figure 11**). Between 1990 and 2013, age-standardized DALY rates for both sexes for liver cancer decreased by 14% at the global

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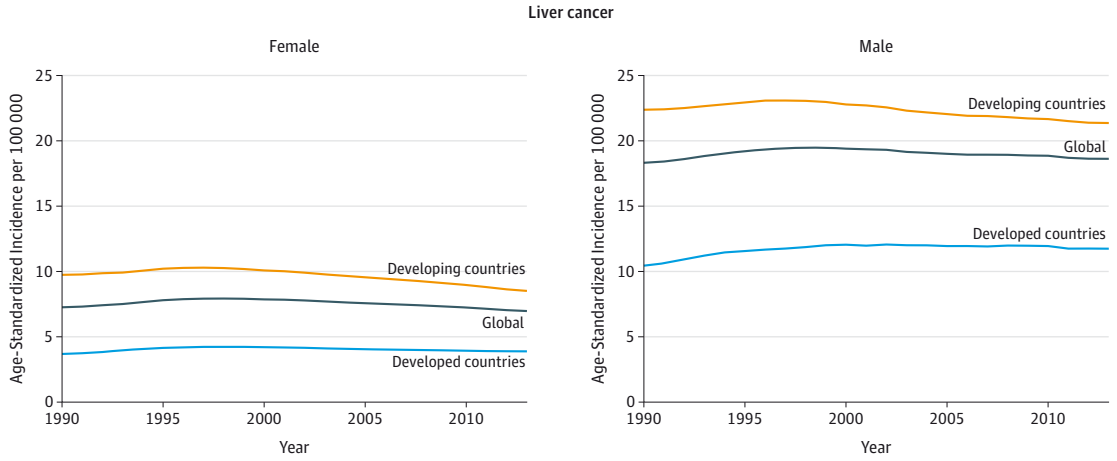
Figure 11. Trends in Age-Standardized Incidence Rates for Liver Cancer, 1990-2013



level, by 20% in developing countries, and by 4% in developed countries (web table 9).

Cervical Cancer

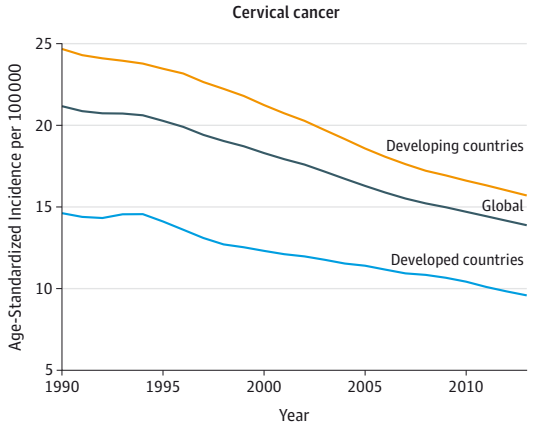
In 2013, 485 000 women were diagnosed with cervical cancer worldwide, and it caused 236 000 deaths. Cervical cancer caused 6.9 million DALYs, with 85% occurring in developed countries and 15% occurring in developing countries. One in 70 women developed cervical cancer between birth and age 79 years.

The ASIRs and ASDRs per 100 000 in 2013 were higher in developing countries vs developed countries (ASIR, 15.70 vs 9.58; ASDR, 8.32 vs 3.96) (web tables 1 and 2). In 2013, incidence rates per 100 000 were the lowest in Australasia (with ASDRs per 100 000 reported for comparison) (ASIR, 6.83; ASDR, 2.65), north Africa and Middle East (ASIR, 7.23; ASDR, 3.19) and high-income North America (ASIR, 7.26; ASDR, 2.84), and the highest in Oceania (ASIR, 58.4; ASDR, 26.49), eastern sub-Saharan Africa (ASIR, 31.5; ASDR, 25.57), and western sub-Saharan Africa (ASIR, 30.2; ASDR, 22.3).

Cervical cancer was the most commonly diagnosed cancer in 2013 for women in Afghanistan, Benin, Central African Republic, Cameroon, Eritrea, Ghana, Guinea, The Gambia, Guinea-Bissau, Guatemala, Liberia, Lesotho, Mali, Mauritania, Malawi, Niger, Nigeria, Nicaragua, Senegal, Sierra Leone, El Salvador, Somalia, Chad, Togo, Uganda, Zambia, and Zimbabwe (eFigure 6b in the Supplement) and the most common cause of cancer death for women in Angola, Burundi, Benin, Burkina Faso, Central African Republic, Côte d'Ivoire, Cameroon, Democratic Republic of the Congo, Congo, Comoros, Djibouti, Eritrea, Ethiopia, Ghana, Guinea, Guinea-Bissau, Equatorial Guinea, Indonesia, Kenya, Liberia, Lesotho, Madagascar, Mali, Mozambique, Mauritania, Malawi, Niger, Nigeria, Nicaragua, Papua New Guinea, Paraguay, Rwanda, Senegal, Sierra Leone, El Salvador, Somalia, South Sudan, Sao Tome and Principe, Swaziland, Chad, Togo, Tanzania, Uganda, Zambia, and Zimbabwe (eFigure 6d in the Supplement).

Cervical cancer was the eighth leading cause for cancer YLLs in 1990 and the ninth leading cause in 2013, with a 32% decrease in age-standardized YLLs (Figure 5). Total incidence would have decreased by 59% if the population size and age structure had remained the same in 2013 as it was in 1990 due to decreasing incidence rates (Table 2). Both globally and in developing regions, ASIRs for cervical cancer have decreased (**Figure 12**). Between 1990 and 2013, age-standardized DALYs decreased globally by 32%, in developing countries by 36%, and in developed countries by 34% (web table 3).

Figure 12. Trends in Age-Standardized Incidence Rates for Cervical Cancer, 1990-2013



Non-Hodgkin Lymphoma

In 2013, there were 465 000 incident cases of NHL and 226 000 deaths. Non-Hodgkin lymphoma caused 6.4 million DALYs in 2013, with 71% occurring in developing countries and 29% occurring in developed countries (web table 9). One in 103 men and 1 in 151 women developed NHL cancer between birth and age 79 years.

Globally, NHL ranked eighth for cancer incidence and 11th for cancer death in 2013 (Figures 3 and 4). For developed countries, it ranked seventh for incidence and ninth for mortality, and in developing countries it ranked 11th for both incidence and mortality.

As detailed in web tables 4 and 5, 2013 NHL incidence and rates per 100 000 for men were the lowest in Oceania (with ASDRs per

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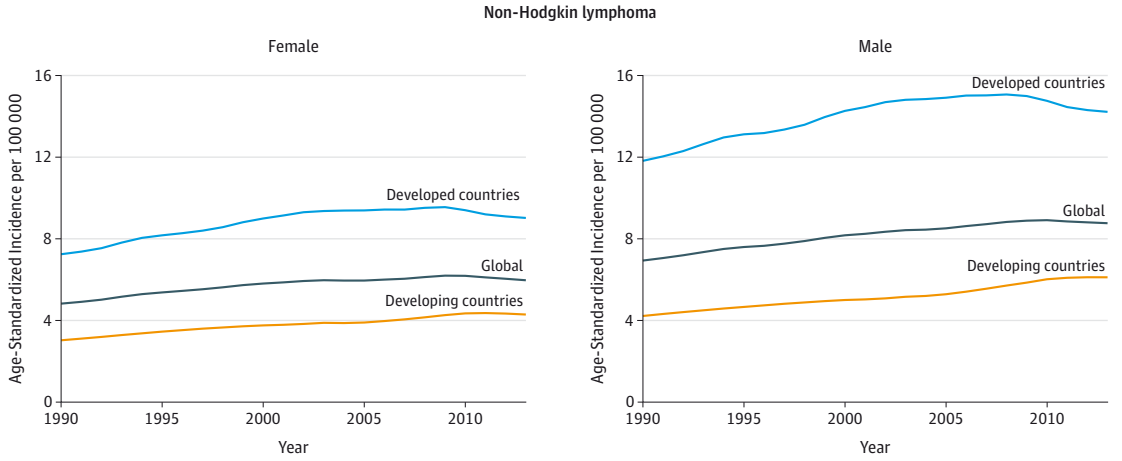
Figure 13. Trends in Age-Standardized Incidence Rates for Non-Hodgkin Lymphoma, 1990-2013



100 000 reported for comparison) (ASIR, 3.13; ASDR, 1.80), western sub-Saharan Africa (ASIR, 4.10; ASDR, 3.50), and central Asia (ASIR, 4.52; ASDR, 3.04) and the highest in high-income North America (ASIR, 22.09; ASDR, 7.74), Australasia (ASIR, 15.43; ASDR, 7.49), and western Europe (ASIR, 14.19; ASDR, 6.04).

For women, NHL incidence rates per 100 000 in 2013 were the lowest in central Asia (ASIR, 2.35; ASDR, 1.32), western sub-Saharan Africa (ASIR, 2.68; ASDR, 1.96), and south Asia (ASIR, 3.27; ASDR, 2.37) and the highest in high-income North America (ASIR, 15.01; ASDR, 4.79), Australasia (ASIR, 10.74; ASDR, 4.71), and Western Europe (ASIR, 9.56; ASDR, 3.66) (web tables 1 and 2). Non-Hodgkin lymphoma was the most commonly diagnosed cancer in 2013 for men in the United Arab Emirates and Qatar (eFigure 6a in the Supplement).

Non-Hodgkin lymphoma ranked 10th for cancer YLLs in 1990 and 11th in 2013 (Figure 5). More than twice as many cases of NHL were diagnosed in 2013 as in 1990 (465 000 vs 227 000). Population growth alone would have increased incidence by 35%; population aging alone would have increased incidence by 30%; and an increase in incidence rates assuming stable population age structure and size between 1990 and 2013 would have led to a 41% increase in new cases (Table 2). **Figure 13** illustrates the slight increase in ASIRs between 1990 and 2013. On the global level, ASIRs per 100 000 for both sexes for NHL increased by 26% (5.8 to 7.3), with a larger increase in developing countries (44%, 3.6 to 5.2) than in developed countries (23%, 9.2 to 11.3) (web table 7).

During this timeframe, age-standardized DALY rates for both sexes decreased by 3% at the global level, by 8% in developing countries, and increased by 2% in developing countries (web table 9).

Esophageal Cancer

In 2013 there were 442 000 new cases of esophageal cancer and 440 000 deaths. Esophageal cancer caused 9.8 million DALYs in 2013, with 84% occurring in developing countries and 16% occurring in developed countries (web table 9). Men had a higher probability than women for developing esophageal cancer between birth and age 79 years, with 1 in 73 men being diagnosed vs 1 in 203 women.

Globally, esophageal cancer ranked ninth for cancer incidence and sixth for cancer death in 2013 (Figures 3 and 4). In developed countries, esophageal cancer was only the 20th greatest cause for cancer incidence but the 11th leading cause for cancer death. In developing countries, esophageal cancer ranked eighth for cancer incidence and fifth for mortality.

Esophageal cancer ASIRs and ASDRs per 100 000 in 2013 for both sexes were higher in developing countries vs developed countries (ASIR, 8.94 vs 3.90; ASDR, 9.11 vs 3.79) (web tables 7 and 8). As detailed in web tables 4 and 5, in 2013 incidence rates per 100 000 for men were the lowest in Andean Latin America (ASIR, 2.41; ASDR, 2.49), central Latin America (ASIR, 3.46; ASDR, 3.51), and north Africa and Middle East (ASIR, 3.46; ASDR, 3.74) and the highest in east Asia (ASIR, 22.04; ASDR, 22.4), southern sub-Saharan Africa (ASIR, 21.81; ASDR, 22.33), and central Asia (ASIR, 14.42; ASDR, 14.55). For women, incidence rates per 100 000 in 2013 were the lowest in Andean Latin America (with ASDRs per 100 000 reported for comparison) (ASIR, 0.64; ASDR, 0.64), eastern Europe (ASIR, 0.88; ASDR, 0.92), and central Europe (ASIR, 0.99 ASDR, 1.02) and the highest in eastern sub-Saharan Africa (ASIR, 12.74; ASDR, 13.78), southern sub-Saharan Africa (ASIR, 8.79; ASDR, 8.55), and south Asia (ASIR, 7.28; ASDR, 7.44) (web tables 1 and 2).

Esophageal cancer was the most commonly diagnosed cancer in 2013 for men in Malawi and Turkmenistan (eFigure 6a in the Supplement) and the most common cause of cancer death in Comoros, Djibouti, Kenya, Malawi, Somalia, South Sudan, Turkmenistan, and Zimbabwe (eFigure 6c in the Supplement). For women, it was the most common cause of cancer death in 2013 in Iran and Turkmenistan (eFigure 6d in the Supplement).

Figure 3 shows a marked difference between the 50 most populous countries for esophageal cancer incidence rankings in 2013. For example, while this cancer ranked in most countries among the least common cancers for incidence, it was the second most common cancer for both sexes in Kenya, and the fourth most common cancer in Iran. The same holds true for cancer death rates, where esophageal cancer ranks first in Kenya and Nepal, second in Ethiopia, Iran, South Africa, and Uganda, but only 16th in the Philippines and 17th in Peru.

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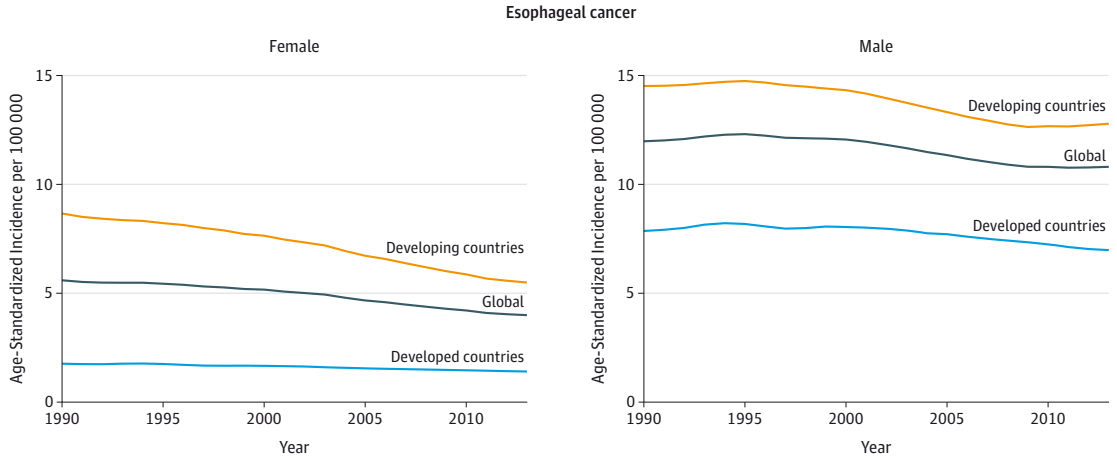
Figure 14. Trends in Age-Standardized Incidence Rates for Esophageal Cancer, 1990-2013



Esophageal cancer has increased from the seventh leading cause for cancer YLLs in 1990 to the sixth leading cause in 2013 (Figure 5). Aging and growing populations are the drivers behind the increase in esophageal cancer cases from 304 000 in 1990 to 442 000 in 2013. If the population age structure and size had remained the same in 2013 as in 1990, 29.3% fewer cases of esophageal cancer would have been diagnosed in 2013 than in 1990 (Table 2). Worldwide and in developing regions, age-standardized incidence rates appear to be declining (**Figure 14**). Between 1990 and 2013, age-standardized DALY rates for both sexes decreased by 23% globally, by 28% in developing countries, and by 18% in developed countries (web table 9).

Leukemia

In 2013, there were 414 000 new cases of leukemia worldwide and 265 000 deaths. Leukemia caused 9.3 million DALYs globally, with 78% occurring in developing countries and 22% occurring in developed countries (web table 9). One in 127 men vs 1 in 203 women developed leukemia between birth and age 79 years.

Globally, leukemia ranked 10th for cancer incidence and ninth for cancer deaths in 2013. In developed countries, leukemia ranked 12th for incidence and eighth for cancer deaths. In developing countries, it ranked 10th for cancer incidence and eighth for cancer deaths (Figures 3 and 4).

The ASIRs and ASDRs per 100 000 in 2013 for both sexes were higher in developed countries vs developing countries (ASIR, 8.15 vs 5.09; ASDR, 4.78 vs 3.46) (web tables 7 and 8). In 2013 incidence rates per 100 000 for both sexes were the lowest in western sub-Saharan Africa (with ASDRs per 100 000 reported for comparison) (ASIR, 1.34; ASDR, 1.15), eastern sub-Saharan Africa (ASIR, 1.58; ASDR, 1.47), and central sub-Saharan Africa (ASIR, 2.30; ASDR, 2.03) and highest in high-income North America (ASIR, 10.67; ASDR, 5.54), Australasia (ASIR, 9.97; ASDR, 5.13), and Western Europe (ASIR, 8.24; ASDR, 5.08).

Leukemia was the cancer with the most incident cases in 2013 for men in Iraq (eFigure 6a in the Supplement).

eFigure 4a in the Supplement shows a marked difference in incidence rankings between countries. Leukemia ranks among the top most common cancers for both sexes in Iraq, Jordan, and Kuwait, while it is much less common in most other countries. Leukemia has decreased from the fifth leading cause of cancer YLLs in 1990 to the seventh leading cause in 2013, with a 9% decrease in absolute YLLs and a 31% decrease in age-standardized YLLs (Figure 5).

Between 1990 and 2013, incident cases at the global level increased from 297 000 to 414 000, with population growth and aging being the drivers behind this increase. Had ASIRs remained the same in 2013 as in 1990, there would be 8% more cases of leukemia in 2013 (Table 2). For women, trends in ASIRs appear to be decreasing globally as well as in developed and developing countries (**Figure 15**). For men, ASIRs increased up to the mid-1990s and have decreased since in developing countries, with a stable trend in developing countries.

Between 1990 and 2013, age-standardized DALY rates for both sexes decreased by 30% at the global level, by 33% in developed countries, and by 30% in developing countries (web table 9).

Trends in Incidence for Less Common Cancers

As detailed in web table 7, ASIRs per 100 000 for both sexes increased substantially between 1990 and 2013 for certain cancers. Kidney cancer ASIRs, for example, increased for both sexes by 23% (from 3.82 to 4.7). Rates in developing countries were lower than in developed countries but the relative increase was similar: 34% increase in developing countries (from 1.69 to 2.27) and 36% increase in developed countries (from 7.15 to 9.71).

For thyroid cancer, ASIRs per 100 000 on a global scale for both sexes increased by 20% (from 2.74 to 3.3), with a larger relative increase in developing countries (33%; from 2.06 to 2.74) than in developed countries (19%; from 4.16 to 4.95).

Mesothelioma ASIRs per 100 000 increased by 15% for both sexes globally (from 0.48 to 0.55), with a larger relative increase in developing countries of 26% (from 0.31 to 0.39) compared with a 14% increase in developed countries (from 0.7 to 0.8).

Pancreatic cancer ASIRs per 100 000 have increased globally for both sexes by 9% (5.31 to 5.78) with a larger relative increase in developing (29% from 2.84 to 3.66) compared with developed countries (10% from 8.6 to 9.54).

For other cancers, rates substantially decreased between 1990 and 2013. Globally, ASIRs per 100 000 for both sexes for gallblad-

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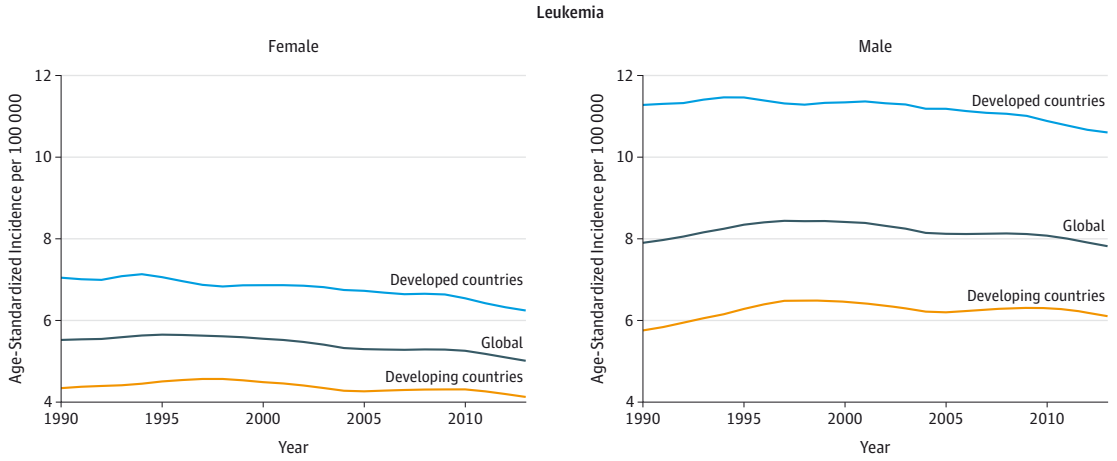
Figure 15. Trends in Age-Standardized Incidence Rates for Leukemia, 1990-2013



der and biliary tract cancer decreased by 23% (from 3.99 to 3.09), with a smaller relative decrease of 18% in developing countries (from 3.09 to 2.52) compared with a 25% decrease in developed countries (from 5.1 to 3.81). eFigure 4a in the Supplement shows that gallbladder and biliary tract cancer is exceptionally common in Chile, Bolivia, and South Korea, where it ranks sixth and seventh for cancer incident cases vs most other countries, where it is much less common. Specific ASIRs per 100 000 confirm this finding: 14.85 in Bolivia, 11.54 in South Korea, and 16.03 in Chile (web table 7). Larynx cancer ASIRs per 100 000 for both sexes decreased globally by 25% (from 3.7 to 2.78), with a smaller decrease of 14% in developing countries (from 3.22 to 2.76) compared with a 37% decrease in developed countries (4.62 to 2.92).

On a global scale, nasopharynx cancer ASIRs per 100 000 decreased for both sexes by 25% (from 1.64 to 1.23), with a smaller decrease of 27% in developing countries (from 2.07 to 1.52) compared with a 46% decrease in developed countries (from 0.79 to 0.43).

Hodgkin lymphoma ASIRs per 100 000 for both sexes decreased globally by 34% (from 2.02 to 1.33), with a larger 37% decrease in developing countries (from 1.9 to 1.2) compared with a 19% decrease in developed countries (from 2.31 to 1.87).

Discussion

Descriptive cancer epidemiology has a long tradition and has influenced research and policy alike. Trends in cancer incidence are especially informative from both a health systems and a scientific perspective. They can help with resource allocation planning as a window into the future, and they can be hypothesis generating with regard to the driving factors behind changes. The GBD provides a unique source for data on cancer for 3 reasons: (1) a standardized statistical framework has been used to analyze both cancer registry data and cause of death data by country and over time; (2) in addition to incidence and mortality, other metrics such as DALYs have been used to quantify health loss; and (3) the burden caused by an individual disease can be placed in the context of other diseases or injuries, which is sine qua non to inform health policy and resource allocation decisions.

The estimates presented in this study reveal remarkable differences in trends between cancers. On a global level between 1990 and 2013, incident cases for every cancer increased (increases ranging from 9% for cervical cancer to 217% for prostate cancer) except for Hodgkin lymphoma, for which incidence has decreased by 10% (from 103 000 to 93 000). Since the risk for most cancers increases with age, it is not surprising that aging contributed between 20% and 43% to the absolute increase in incident cases between 1990 and 2013 (Table 2). With life expectancy increasing globally, the future burden of cancer will likely increase, unless incidence rates fall substantially.[1] An example of such dramatically decreasing incidence rates from the present study is cervical cancer; incidence rates in this disease decreased by 59% between 1990 and 2013, which led to only a 8.5% increase in incident cases. In contrast, the increase in incident cervical cancer cases would have been 67% if incidence rates had remained constant. Additional examples of countervailing trends include cancers more common in younger age groups like Hodgkin lymphoma, leukemia, testicular cancer, and brain and nervous system cancer, where population aging does not contribute to an increase in incident cases.

Of special concern are the increasing incidence rates in cancers that are also more common in older age groups, since this combination leads to the largest increase in incident cases. Prostate cancer, NHL, thyroid cancer, breast cancer, mesothelioma, colon and rectum cancer, and pancreatic cancer all fall into this category. Prostate cancer cases increased by 217% between 1990 and 2013 on a global scale, by 169% in developed countries, and by 361% in developing countries. Population aging has contributed a larger proportion to this increase in developing countries vs developed countries (54% vs 39%) (eTable 16 in the Supplement), which is not surprising, given the faster rise in life expectancy in developing countries. However, 265% of the 361% increase in incidence numbers is due to an increase in age-specific incidence rates. It is unclear how much of the overall increase can be attributed to ascertainment bias, but it is unlikely that this would fully explain such a substantial increase in developing countries, given

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that screening for prostate cancer is not widely practiced in low- and middle-income countries.

Between 1990 and 2013, kidney cancer cases for both sexes increased by 107%, with equal contribution from aging populations and increasing incidence rates. Incidence rates are still over 4-fold lower in developing countries than in developed countries but with a surprisingly similar relative increase in ASIRs (34% in developing countries, 36% in developed countries). This is an exception to most other cancers for which relative changes in trends show a marked difference by development status. Many potential risk factors for kidney cancer have been described in the literature, including smoking, obesity, hypertension, and occupational exposures.[27-30] One possible explanation for the similar trend in incidence rates between developing and developed countries is that even though single risk factors for kidney cancer differ by development status, the overall risk factor pattern might compensate for this disparity.

Thyroid cancer is another example of a cancer with an alarming rise in incidence. For both sexes, incident cases almost doubled between 1990 and 2013 (95% increase). Population growth, aging, and increasing rates contributed similar proportions to this increase. However, while ASIRs increased globally by 20%, ASDRs decreased by 19% (web table 8). This finding supports the previously recognized notion that at least part of the "thyroid cancer epidemic" can be attributed to overdiagnosis due to the increased use of imaging examinations.[31-33]

In contrast to the group of cancers where rising incidence rates contribute substantially to the increase in absolute cases are the group of cancers with decreasing rates. Population growth and aging still result in a larger number of cases in 2013 compared with 1990, but part of this increase is offset by falling rates. At the global level, Hodgkin lymphoma and cervical, stomach, larynx, nasopharynx, gallbladder and biliary tract, esophageal, and bladder cancer fall into this group.

Focusing on Cancer Prevention

Obviously the interpretation of trends simplifies substantial differences between and within regions and countries as well as between age groups. The estimates are therefore also provided at the country level, by age and sex groups. However, the description of patterns by development status or region can help correct misconceptions. Cancer has long been regarded as a problem of economically developed countries, with the reasoning that cancer burden is substantially higher in affluent countries and that cancer care requires too many resources and is too complex to provide in less developed countries. The lack of focus on cancer and other NCDs is highlighted by the Millennium Development Goals (MDGs),[34] which do not include any NCDs. However, even though the total 2013 ASIR per 100 000 for cancer was 1.7 times higher in developed regions vs developing regions (328 vs 190), death rates per 100 000 were only 1.2 times higher (148 vs 123). Between 1990 and 2013, ASIRs increased in most countries (Figure 2A), including developing countries, where the existing health care systems are already overwhelmed by the burden of communicable diseases. This rise in cancer incidence has been attributed to increased life expectancy and an increasing prevalence of risk factors like overweight and obesity, smoking, alcohol consumption, and hypertension.[1,35-37] To avoid an NCD epidemic that could reverse health care advances already achieved in reducing the burden of communicable disease, cancer prevention efforts must be a priority.

Tracheal, bronchus, and lung cancer, cervical cancer, and liver cancer are good examples in this aspect. Currently, TBL cancer ASIRs for men in regions with low smoking prevalence like sub-Saharan Africa (except southern sub-Saharan Africa) are 5 to 10 times lower than in countries with historically high smoking prevalence like high-income North America, Europe, and east Asia. For women, the difference is even more striking, with a 15-fold difference in 2013 ASIRs per 100 000 between western sub-Saharan Africa and high-income North America (2.76 vs 41.8), and it is critical that public health efforts ensure that smoking rates remain low in the future.[38,39] However, smoking is only 1 risk factor for TBL cancer. East Asian women have the third highest ASIR for TBL cancer (23 per 100 000), behind high-income North America (42 per 100 000) and Australasia (25 per 100 000), even though smoking rates are substantially lower for women in east Asia than they are in other countries with similar incidence rates.[38] Genetic susceptibility might play a role, but preventable risk factors like household air pollution have also been identified as a reason behind this unusual pattern.[40-44]

Cervical cancer rates in regions with screening programs, like Australasia, high-income North-America, Western Europe, and high-income Asia Pacific, are below 10 per 100 000, whereas rates are up to 3 times as high in countries without screening programs (29 per 100 000 in Andean Latin America, 30 per 100 000 in western sub-Saharan Africa, and 58 per 100 000 in Oceania). It is encouraging that between 1990 and 2013, cervical cancer ASIRs decreased in all regions between 8% and 47% (web table 1). However, in 2013, cervical cancer, a preventable and treatable cancer, remains the cancer with the highest incidence in women in 27 countries and the leading cause of cancer death in women in 45 countries. Efforts to determine the most cost-effective strategies to reduce cervical cancer burden through human papillomavirus vaccination and screening are ongoing and will hopefully lead to a continued decrease in cervical cancer incidence in the most affected areas of the world.[45-50]

Liver cancer ranks second for mortality in developing countries. Treatment for liver cancer is not very effective, with 2013 ASIRs and ASDRs per 100 000 being very similar in both developing and developed countries (ASIRs, 14.72 and 7.42, respectively; ASDRs, 15.59 and 7.26, respectively). The main risk factors for liver cancer are hepatitis B infection, hepatitis C infection, and chronic hepatitis and cirrhosis due to alcohol and other causes.[51-56] In 2013, of the 818 000 deaths in men and women, 300 000 (37%) were estimated to be due to hepatitis B infection, 343 000 (42%) due to hepatitis C infection, 92 000 (11%) due to alcohol abuse, and 83 000 (10%) due to other causes.[1] Hepatitis B vaccination has proven cost-effective in preventing liver cancer due to hepatitis B, and treatment for hepatitis C, although expensive, has recently shown success.[57,58]

Study Limitations

The core components of the GBD cancer estimates are cancer registry and vital registry data. However, these sources are sparse in many low- and middle-income countries, and in the absence of data, the estimates are dependent on covariate selection and regional patterns. This is accounted for by estimating uncertainty intervals (provided for all estimates in eTables in the Supplement). Even though

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cancer registry data are considered the gold standard for cancer surveillance, the quality of registries can vary substantially. Underreporting of cancer cases or deaths or a high proportion of undefined codes can lead to cancer registry data that do not represent the true cancer burden.[59-62] As described in the Methods section, our analysis is therefore heavily based on cause-of-death data and to a lesser degree on cancer registry data. This explains why the estimates reported might be different from cancer registry data. To ensure consistency, robustness, and clarity in this framework, the same estimation methods were used for all cancers, as well as advanced modeling techniques like ensemble models with a large pool of covariates and out-of-sample validation. The benefit of estimating the different cancers within the GBD framework is that it ensures that cancer estimates are adjusted to be consistent with the all-cause mortality estimates, preventing inflation or underestimation of cause-specific estimates. A detailed description of these methods is provided in the eAppendix in the Supplement. While quite advanced, these methodologies still result in only estimates, which should be used as placeholders until high-quality data become available. Hopefully, the newly launched Global Initiative for Cancer Registry Development,[63] an effort to expand cancer registries in low- and middle-income countries, will lead to improved data availability and quality in these countries.

Underreporting of new cancer cases to cancer registries or miscoding cause of death can lead to MI ratios that are either too low or too high.[64,65] Miscoding is especially common in countries with limited diagnostic resources and arises when metastatic lesions are coded as primary cancers, which can lead to overestimation of primary cancers in anatomic sites where metastases are often found (eg, liver or brain). Also, increasing incidence rates with stable mortality rates can lead to an underestimation of MI ratios, and decreasing incidence rates with stable mortality rates can lead to MI ratios higher than 1. These factors can result in seemingly implausible estimates like higher estimates for cancer deaths compared with cancer incident cases in the same year. Changing classification systems (eg, from *ICD-9* Basic Tabulation List to *ICD-9* detail) can also lead to substantial changes in estimates over time. To improve the quality of the data sources and to ensure comparability, garbage codes or undefined cancer codes were redistributed , and different coding systems were mapped to a set of uniform GBD causes.

To estimate YLDs, MI ratios were used as surrogates for cancer survival owing to lack of high-quality survival data in most countries. Using MI ratios as a surrogate for survival is problematic because of the different patient cohorts with changing survival probabilities that are captured in the mortality numerator. The approach taken in the present analysis, therefore, was to use MI ratios as a surrogate for access to care, which avoids the problem with "backscattering" of different cohorts.[66] However, survival data remain the gold standard, and availability of survival data has increased with the recently published CONCORD-2 study,[4] which provides survival estimates for 67 countries.

Conclusions

Cancer was the second leading cause of death in 2013 after cardiovascular disease (eFigure 5a in the Supplement), and cancer burden as part of the NCDs is expected to increase in all countries due to population growth, aging, and an increasing prevalence of certain risk factors.[1] The health community has responded to this global health threat through endorsing the "25 by 25" strategy as part of the NCD Global Monitoring Framework during the World Health Assembly in 2012,[67] with the goal of reducing avoidable mortality from NCDs by 25% by 2025. This is a challenging goal and will require commitment from all levels of society. Population-level observations of cancer burden and time trends as presented herein help highlight aspects of cancer epidemiology that can guide intervention programs and advance research in cancer determinants and outcomes.

Cancer control strategies have to be prioritized based on local needs, and current data on cancer burden will be necessary for the development of national NCD action and cancer control plans. In acknowledgment of this need, annual updates of the burden of cancer will be published.

ARTICLE INFORMATION

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The Global Burden of Disease Cancer Collaboration: Christina Fitzmaurice, MD, MPH; Daniel Dicker, BS; Amanda Pain, MPH, MSW; Hannah Hamavid, BA; Maziar Moradi-Lakeh, MD, MPH; Michael F. MacIntyre, EdM; Christine Allen, BA; Gillian Hansen, MSW; Rachel Woodbrook, MA, MLIS; Charles Wolfe, MD; Randah R. Hamadeh, BSc, MSc, DPhil; Ami Moore, PhD; Andrea Werdecker, Dipl.Oec.Troph; Bradford D. Gessner, MD, MPH; Braden Te Ao, MPH; Brian McMahon, MD; Chante Karimkhani, BA; Chuanhua Yu, PhD; Graham S. Cooke, DPhil; David C. Schwebel, PhD; David O. Carpenter, MD; David M. Pereira, PhD; Denis Nash, PhD, MPH; Dhruv S. Kazi, MD, MSc, MS; Diego De Leo, DSc, PhD, MD; Dietrich Plass, Dr; Kingsley N. Ukwaja, MBBS; George D. Thurston, ScD; Kim Yun Jin, MD, PhD; Edgar P. Simard, PhD, MPH; Edward Mills, PhD; Eun-Kee Park, PhD; Ferrán Catalá-López, PhD, MPH; Gabrielle deVeber, MD; Carolyn Gotay, PhD; Gulfaraz Khan, PhD; H. Dean Hosgood III, PhD; Itamar S. Santos, MD, PhD; Janet L. Leasher, OD, MPH, FAAO; Jasvinder Singh, MD, MPH; James Leigh, PhD, MD, MSc; Jost B. Jonas, MD; Juan Sanabria, MD, MSc, FRCSC, FACS; Justin Beardsley, FRACP; Kathryn H. Jacobsen, PhD; Ken Takahashi, MD, PhD; Richard C. Franklin, PhD, MSocSc, BSc; Luca Ronfani, PhD; Marcella Montico, MSc; Luigi Naldi, MD; Marcello Tonelli, MD; Johanna Geleijnse, PhD; Max Petzold, PhD; Mark G Shrime, MD; Mustafa Younis, PhD, MA, MBA; Naohiro Yonemoto, MPH; Nicholas Breitborde, PhD; Paul Yip, PhD; Farshad Pourmalek, MD, MPH, PhD; Paulo A. Lotufo, MD, DrPH; Alireza Esteghamati, MD; Graeme J. Hankey, MBBS, MD, FRACP, FRCP, FRCPE, FAHA; Raghib Ali, FRCP; Raimundas Lunevicius, PhD, Habil, Dr; Reza Malekzadeh, MD; Robert Dellavalle, MD, PhD, MSPH; Robert Weintraub, MB BS; Robyn Lucas, BSc, MBChB, MPH, TM MHE, PhD, FAFPHM; Roderick Hay, DM; David Rojas-Rueda, MD, MPH, PhD; Ronny Westerman, PhD; Sadaf G. Sepanlou, MD, MPH; Sandra Nolte, PhD; Scott Patten, MD, PhD; Scott Weichenthal, PhD; Semaw Ferede Abera, MSc; Seyed-Mohammad Fereshtehnejad, MD, MPH, MSc; Ivy Shiue, PhD; Tim Driscoll, MBBS, BSc(Med), MOHS, PhD; Tommi Vasankari, MD, PhD; Ubai Alsharif, DMD, MPH; Vafa Rahimi-Movaghar, MD; Vasiliy V. Vlassov, MD; W. S. Marcenes, PhD; Wubegzier Mekonnen, PhD; Yohannes Adama Melaku, MPH; Yuichiro Yano, MD, PhD; Al Artaman, MD, PhD, MHA; Ismael Campos, MD, PhD; Jennifer MacLachlan, MSc (Epi); Ulrich Mueller, MD, PhD; Daniel Kim, MD, DrPH; Matias Trillini, MD; Babak Eshrati, PhD; Hywel C. Williams, DSc; Kenji Shibuya, MD; Rakhi Dandona, PhD; Kinnari Murthy, MBBS, MPH; Benjamin Cowie, MBBS, PhD, FRACP; Azmeraw T. Amare, MPH, MSc; Carl Abelardo Antonio, MD, MPH; Carlos Castañeda-Orjuela, MD, MSc; Coen H. van Gool, PhD; Francesco Violante, MD; In-Hwan Oh, MD, PhD; Kedede Deribe, MPH; Kjetil Soreide, MD, PhD; Luke Knibbs, PhD; Maia Kereselidze, MD, PhD; Mark Green, PhD; Rosario Cardenas, ScD; Nobhojit Roy, MD, MPH; Taavi Tillmann, MBchB; Yongmei Li, PhD; Hans Krueger, PhD; Lorenzo Monasta, DSc; Subhojit Dey, MD, PhD, MPH; Sara Sheikhbahaei, MD, MPH; Nima Hafezi-Nejad, MD, MPH; G. Anil Kumar, PhD;

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Chandrashekhar T. Sreeramareddy, MD; Lalit Dandona, MD, MPH; Haidong Wang, PhD; Stein Emil Vollset, MD, DrPH; Ali Mokdad, PhD; Joshua A. Salomon, PhD; Rafael Lozano, MD; Theo Vos, PhD; Mohammad Forouzanfar, MD, PhD; Alan Lopez, PhD; Christopher Murray, DPhil, MD; Mohsen Naghavi, MD, PhD, MPH.

Affiliations of The Global Burden of Disease Cancer Collaboration: Division of Hematology, Department of Medicine, University of Washington, Seattle (Fitzmaurice); Institute for Health Metrics and Evaluation, University of Washington, Seattle (Fitzmaurice, Dicker, Pain, Hamavid, Moradi-Lakeh, MacIntyre, Allen, Hansen, Woodbrook, L. Dandona, Wang, Mokdad, Lozano, Vos, Forouzanfar, Murray, Naghavi); Gastrointestinal and Liver Disease Research Center, Iran University of Medical Sciences, Tehran, Iran (Moradi-Lakeh); King's College London, London, England (Wolfe); Arabian Gulf University, Manama, Bahrain (Hamadeh); University of North Texas, Denton (Moore); Institute of Medical Sociology and Social Medicine, Marburg, Germany (Werdecker); Agence de Medecine Preventive, Paris, France (Gessner); Department of Biostatistics and Epidemiology, School of Public Health and Psychosocial Studies, Auckland University of Technology, Auckland, New Zealand (Te Ao); Liver Disease and Hepatitis Program, Alaska Native Tribal Health Consortium, Anchorage, Alaska (McMahon); College of Physicians and Surgeons, Columbia University, New York, New York (Karimkhani); Department of Epidemiology and Biostatistics, School of Public Health, Wuhan University, Wuhan, China (Yu); Imperial College London, London, England (Cooke); Department of Psychology, University of Alabama at Birmingham, Birmingham, Alabama (Schwebel); Institute for Health and the Environment, University at Albany, Rensselaer, New York (Carpenter); Laboratório de Farmacognosia, Departamento de Ciências Químicas, Faculdade de Farmácia, University do Porto, REQUIMTE/LAQV, Porto, Portugal (Pereira); School of Public Health, Hunter College Campus, City University of New York, New York (Nash); University of California, San Francisco (Kazi); Griffith University, Brisbane, Australia (De Leo); Federal Environment Agency Section on Exposure Assessment and Environmental Health Indicators, Berlin, Germany (Plass); Department of Internal Medicine, Federal Teaching Hospital, Abakaliki, Nigeria (Ukwaja); Nelson Institute of Environmental Medicine, New York University School of Medicine, Tuxedo, New York (Thurston); Faculty of Chinese Medicine, Southern University College, Johor, Malaysia (Yun Jin); Rollins School of Public Health, Emory University, Atlanta, Georgia (Simard); University of Ottawa, Ottawa, Ontario, Canada (Mills); Department of Medical Humanities and Social Medicine, Kosin University College of Medicine, Busan, South Korea (Park); Division of Pharmacoepidemiology and Pharmacovigilance, Spanish Medicines and Healthcare Products Agency (AEMPS), Ministry of Health, Madrid, Spain (Catalá-López); University of Toronto, Toronto, Ontario, Canada (deVeber); School of Population and Public Health, University of British Columbia, Vancouver, British Columbia, Canada (Gotay, Krueger); Department of Microbiology & Immunology, College of Medicine and Health Sciences, United Arab Emirates University, Al-Ain, United Arab Emirates (Khan); Albert Einstein College of Medicine, Bronx, New York (Hosgood); Centre for Clinical and Epidemiological Research, University of São Paulo, São Paulo, Brazil (Santos, Lotufo); Nova Southeastern University, Fort Lauderdale, Florida (Leasher); Division of Clinical Immunology and Rheumatology, University of Alabama at Birmingham, Birmingham, Alabama (Singh); University of Sydney, Sydney, Australia (Leigh); Department of Ophthalmology, University of Heidelberg, Mannheim, Germany (Jonas); Department of Surgery, Case Western Reserve University, Cleveland, Ohio (Sanabria); Nutrition and Preventive Medicine, Chicago Medical School at Cancer Treatment Centers of America, Rosalind Franklin University, Chicago, Illinois (Sanabria); Nuffield Department of Medicine, Oxford University, Ho Chi Minh City, Vietnam (Beardsley); Department of Global and Community Health, George Mason University, Fairfax, Virginia (Jacobsen); Department of Environmental Epidemiology, University of Occupational and Environmental Health, Kitakyushu, Japan (Takahashi); College of Public Health, Medical and Veterinary Sciences, James Cook University, Townsville, Australia (Franklin); Institute for Maternal and Child Health IRCCS Burlo Garofolo, Trieste, Italy (Ronfani, Montico, Monasta); Azienda Ospedaliera papa Giovanni XXIII, Bergamo, Italy (Naldi); University of Calgary, Calgary, Alberta, Canada (Tonelli); Division of Human Nutrition, Wageningen University, Wageningen, the Netherlands (Geleijnse); Centre for Applied Biostatistics, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden (Petzold); School of Public Health, University of the Witwatersrand, Johannesburg, South Africa (Petzold); Harvard University, Boston, Massachusetts (Shrime, Campos); Jackson State University, Jackson, Mississippi (Younis); National Center of Neurology and Psychiatry, Kodira, Japan (Yonemoto); University of Arizona, Tucson (Breitborde); The University of Hong Kong, Hong Kong, China (Yip); Faculty of Medicine, University of British Columbia, Vancouver, British Columbia, Canada (Pourmalek); Endocrinology and Metabolism Research Center, Tehran University of Medical Sciences, Tehran, Iran (Esteghamati, Sheikhbahaei, Hafezi-Nejad); School of Medicine and Pharmacology, University of Western Australia, School of Medicine and Pharmacology, Perth, Australia (Hankey); Nuffield Department of Population Health, University of Oxford, Oxford, England (Ali); Department of Neuropsychopharmacology, Aintree University Hospital NHS Foundation Trust, Liverpool, England (Lunevicius); Digestive Disease Research Institute, Tehran University of Medical Sciences, Tehran, Iran (Malekzadeh); Veterans Affairs Eastern Colorado Health Care System, Denver (Dellavalle); Department of Dermatology, University of Colorado School of Medicine, Denver (Dellavalle); University of Melbourne, Melbourne, Australia (Weintraub); Royal Children's Hospital, Melbourne, Australia (Weintraub); National Centre for Epidemiology and Population Health, Research School of Population Health, The Australian National University, Canberra, Australia (Lucas); International Foundation for Dermatology, London, England (Hay); Centre of Research in Environmental Epidemiology (CREAL), Barcelona, Spain (Rojas-Rueda); University of Marburg, Marburg, Germany (Westerman); Digestive Diseases Research Institute, Shariati Hospital, Tehran, Iran (Sepanlou); Charité University Medicine Berlin, Berlin, Germany (Nolte); Department of Community Health Sciences, University of Calgary, Calgary, Alberta, Canada (Patten); Air Health Science Division, Health Canada, Ottawa, Ontario, Canada (Weichenthal); College of Health Sciences, Mekelle University, Mekelle, Ethiopia (Abera); Department of Neurobiology Care Sciences and Society (NVS), Karolinska Institutet, Stockholm, Sweden (Fereshtehnejad); Northumbria University, Newcastle upon Tyne, England (Shiue); University of Edinburgh, Edinburgh, Scotland (Shiue); Sydney School of Public Health, University of Sydney, Sydney, Australia (Driscoll); UKK Institute for Health Promotion Research, Tampere, Finland (Vasankari); Charité–Universitätsmedizin Berlin, Berlin, Germany (Alsharif); Sina Trauma and Surgery Research Center, Tehran University of Medical Sciences, Tehran, Iran (Rahimi-Movaghar); National Research University Higher School of Economics, Moscow, Russia (Vlassov); Barts and The London School of Medicine and Dentistry, University of London, London, England (Marcenes); School of Public Health, Addis Ababa University, Addis Ababa, Ethiopia (Mekonnen, Deribe); College of Health Sciences, School of Public Health, Mekelle University, Mekelle, Ethiopia (Melaku); Department of Preventive Medicine, Northwestern University, Chicago, Illinois (Yano); Windsor, Ontario, Canada (Artaman); Victorian Infectious Diseases Reference Laboratory (VIDRL), The Peter Doherty Institute for Infection and Immunity, WHO Collaborating Centre for Viral Hepatitis, Melbourne, Australia (MacLachlan, Cowie); Philipps-University Marburg, Marburg, Germany (Mueller); Department of Health Sciences, Northeastern University, Boston, Massachusetts (Kim); Mario Negri Institute for pharmacological Research, Ranica, Italy (Trillini); Arak University of Medical Sciences and Health Affairs, Arak, Iran (Eshrati); University of Nottingham, Nottingham, England (Williams); University of Tokyo, Tokyo, Japan (Shibuya); Public Health Foundation of India, National Capital Region, India (R. Dandona, Murthy, Kumar, L. Dandona); Department of Epidemiology, University of Groningen, Groningen, the Netherlands (Amare); University of the Philippines Manila, College of Public Health, Manila, Philippines (Antonio); Colombian National Health Observatory Instituto Nacional de Salud, Bogota, Colombia (Castañeda-Orjuela); National Institute for Public Health and the Environment, Bilthoven, the Netherlands (van Gool); Department of Medical and Surgical Sciences, University of Bologna, Bologna, Italy (Violante); Kyung Hee University, Seoul, South Korea (Oh); Brighton and Sussex Medical School, Brighton, England (Deribe); Department of Gastrointestinal Surgery, Stavanger University Hospital, Stavanger, Norway (Soreide); University of Bergen, Stavanger, Norway (Soreide); Department of Clinical Medicine, The University of Queensland, Brisbane, Australia (Knibbs); National Centre for Diseases Control and Public Health, Tbilisi, Georgia (Kereselidze); University of Sheffield, Sheffield, England (Green); Universidad Autonoma Metropolitana, Mexico City, Mexico (Cardenas); Department of Public Health Sciences, Karolinska Institutet, Mumbai, India (Roy); University College London, London, England (Tillmann); Genentech Inc, San Francisco, California (Li); Indian Institute of Public Health, National Capital Region, India (Dey); Faculty of Medicine and Health Sciences, Universiti Tunku Abdul Rahman Selangor, Malaysia (Sreeramareddy); Department

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of Global Public Health and Primary Care, University of Bergen, Bergen, Norway (Vollset); Norwegian Institute of Public Health, Bergen, Norway (Vollset); Harvard University, Boston, Massachusetts (Salomon); National Institute of Public Health, Cuernavaca, Mexico (Lozano); School of Population and Global Health, University of Melbourne, Melbourne, Australia (Lopez).

Author Contributions: Drs Fitzmaurice and Naghavi had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Fitzmaurice, Dicker, Pain, MacIntyre, Hansen, Leigh, Younis, Marcenes, Tillmann, Forouzanfar, Lopez, Murray, Naghavi.
Acquisition, analysis, or interpretation of data: Fitzmaurice, Dicker, Pain, Hamavid, Moradi-Lakeh, Allen, Woodbrook, Wolfe, Hamadeh, Moore, Werdecker, Gessner, Te Ao, McMahon, Karimkhani, Yu, Cooke, Schwebel, Carpenter, Pereira, Nash, Kazi, De Leo, Plass, Ukwaja, Thurston, Yun Jin, Simard, Mills, Park, Catalá-López, deVeber, Gotay, Khan, Hosgood, Santos, Leasher, Singh, Leigh, Jonas, Sanabria, Beardsley, Jacobsen, Takahashi, Franklin, Ronfani, Montico, Naldi, Tonelli, Geleijnse, Petzold, Shrime, Younis, Yonemoto, Breitborde, Yip, Pourmalek, Lotufo, Esteghamati, Hankey, Ali, Lunevicius, Malekzadeh, Dellavalle, Weintraub, Lucas, Hay, Rojas-Rueda, Westerman, Sepanlou, Nolte, Patten, Weichenthal, Abera, Fereshtehnejad, Shiue, Driscoll, Vasankari, Alsharif, Rahimi-Movaghar, Vlassov, Marcenes, Mekonnen, Melaku, Yano, Artaman, Campos, MacLachlan, Mueller, Kim, Trillini, Eshrati, Williams, Shibuya, Dandona, Murthy, Cowie, Amare, Antonio, Castañeda-Orjuela, van Gool, Violante, Oh, Deribe, Soreide, Knibbs, Kereselidze, Green, Cardenas, Roy, Li, Krueger, Monasta, Dey, Sheikhbahaei, Hafezi-Nejad, Kumar, Sreeramareddy, Dandona, Wang, Vollset, Mokdad, Salomon, Lozano, Vos, Forouzanfar, Naghavi.
Drafting of the manuscript: Fitzmaurice, Dicker, Pain, Hamavid, Allen, Woodbrook, Wolfe, Sanabria, Hay, Rojas-Rueda, Vasankari, Alsharif, Sheikhbahaei, Forouzanfar, Murray, Naghavi.
Critical revision of the manuscript for important intellectual content: Fitzmaurice, Dicker, Pain, Hamavid, Moradi-Lakeh, MacIntyre, Allen, Hansen, Hamadeh, Moore, Werdecker, Gessner, Te Ao, McMahon, Karimkhani, Yu, Cooke, Schwebel, Carpenter, Pereira, Nash, Kazi, De Leo, Plass, Ukwaja, Thurston, Yun Jin, Simard, Mills, Park, Catalá-López, deVeber, Gotay, Khan, Hosgood, Santos, Leasher, Singh, Leigh, Jonas, Beardsley, Jacobsen, Takahashi, Franklin, Ronfani, Montico, Naldi, Tonelli, Geleijnse, Petzold, Shrime, Younis, Yonemoto, Breitborde, Yip, Pourmalek, Lotufo, Esteghamati, Hankey, Ali, Lunevicius, Malekzadeh, Dellavalle, Weintraub, Lucas, Hay, Rojas-Rueda, Westerman, Sepanlou, Nolte, Patten, Weichenthal, Abera, Fereshtehnejad, Shiue, Driscoll, Rahimi-Movaghar, Vlassov, Marcenes, Mekonnen, Melaku, Yano, Artaman, Campos, MacLachlan, Mueller, Kim, Trillini, Eshrati, Williams, Shibuya, Dandona, Murthy, Cowie, Amare, Antonio, Castañeda-Orjuela, van Gool, Violante, Oh, Deribe, Soreide, Knibbs, Kereselidze, Green, Cardenas, Roy, Tillmann, Li, Krueger, Monasta, Dey, Hafezi-Nejad, Kumar, Sreeramareddy, Dandona, Wang, Vollset, Mokdad, Salomon, Lozano, Vos, Lopez, Murray, Naghavi.
Statistical analysis: Fitzmaurice, Dicker, Hamavid, Moradi-Lakeh, Woodbrook, Ukwaja, Yun Jin, Simard, Park, Petzold, Younis, Yonemoto, Yip, Ali, Rojas-Rueda, Rahimi-Movaghar, Marcenes, Campos, MacLachlan, Mueller, Dandona, Cowie, Kereselidze, Cardenas, Sreeramareddy, Wang, Vos, Forouzanfar, Naghavi.
Administrative, technical, or material support: Dicker, Pain, Hansen, Carpenter, Pereira, Nash, Simard, Mills, Catalá-López, Hosgood III, Singh, Leigh, Jonas, Esteghamati, Hay, Weichenthal, Abera, Vlassov, Mekonnen, Melaku, Murthy, Oh, Soreide, Knibbs, Green, Monasta, Dey, Kumar, Dandona, Mokdad.
Study supervision: Pain, MacIntyre, Mills, Jonas, Sanabria, Malekzadeh, Rojas-Rueda, Westerman, Marcenes, Yano, Mokdad, Vos, Forouzanfar, Lopez, Murray, Naghavi.

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