Received: 23 December 2023 | Revised: 20 April 2024 | Accepted: 7 June 2024

DOI: 10.1002/cncr.35458

ORIGINAL ARTICLE

Burden of 30 cancers among men: Global statistics in 2022 and projections for 2050 using population-based estimates

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Abstract

Background: Men exhibit higher prevalence of modifiable risk factors, such as smoking and alcohol consumption, leading to greater cancer incidence and lower survival rates. Comprehensive evidence on global cancer burden among men, including disparities by age group and country, is sparse. To address this, the authors analyzed 30 cancer types among men in 2022, with projections estimated for 2050.

Methods: The 2022 GLOBOCAN estimates were used to describe cancer statistics for men in 185 countries/territories worldwide. Mortality-to-incidence ratios (MIRs) were calculated by dividing age-standardized mortality rates by incidence rates.

Results: In 2022, a high MIR (indicating poor survival) was observed among older men (aged 65 years and older; 61%) for rare cancer types (pancreatic cancer, 91%) and in countries with low a Human Development Index (HDI; 74%). Between 2022 and 2050, cancer cases are projected to increase from 10.3 million to 19 million (≥84%). Deaths are projected to increase from 5.4 million to 10.5 million (≥93%), with a greater than two-fold increase among men aged 65 years and older (≥117%) and for low-HDI and medium-HDI countries/territories (≥160%). Cancer cases and deaths are projected to increase among working-age groups (≥39%) and very-high-HDI countries/territories (≥50%).

Conclusions: Substantial disparities in cancer cases and deaths were observed among men in 2022, and these are projected to widen by 2050. Strengthening health infrastructure, enhancing workforce quality and access, fostering national and international collaborations, and promoting universal health coverage are crucial to reducing cancer disparities and ensuring cancer equity among men globally.

KEYWORDS
age-standardized incidence rates, age-standardized mortality rates, burden and projection, cancer, men, mortality-to-incidence ratio, prevalence

INTRODUCTION

Globally, cancer is the second leading cause of premature death after cardiovascular diseases[1–3] but is projected to be the leading cause of death by the end of this century.[2,3] Its health, social, and economic effects are significant.[1,4,5] Cancer causes high demand and stress on health care systems.[6] Its economic burden is also high, with an estimated cost of US$25.3 billion globally in 2017 and an estimated cumulative cost of US$25.2 trillion between 2020 and 2050.[4]

According to Sung and colleagues, the global age-adjusted cancer mortality rate in 2020 was 43.0% greater among men than among women (120.8 vs. 84.2 deaths per 100,000). Similarly, the incidence rate was 19.0% greater among men than among women (222.0 vs. 186 cases per 100,000).[7] These disparities could arise from men's lower participation in cancer prevention activities; underuse of available prevention, screening, and treatment options; increased exposure to cancer risk factors; and biologic differences.[8,9] Early detection and interventions for female-specific cancers, such as breast and cervical cancer, have been beneficial; however, there are no comparable programs for male-specific cancers, such as prostate or testicular cancer.[8] Males participate less in shared screening programs like those for colorectal cancer[8] and have a higher prevalence of modifiable cancer risk factors, including smoking and alcohol consumption. For instance, 32.6% of men worldwide smoked in 2020 compared with 6.5% of women.[9] Males have more cancer cases attributable to occupational carcinogens than women,[10] emphasizing the need for comprehensive studies targeting men to enhance evidence-based cancer prevention, which is the focus of the current study.

There is some evidence demonstrating disparities in cancer incidence and outcomes within men by age as well as variations in access to healthcare, socioeconomic status, awareness, and unique needs and interests at different ages.[5,11–14] Compared to young adult men, older men have worse cancer outcomes (e.g., lower survival), which could be attributed to age-related lower tolerance to treatment, diagnosis at more advanced stages, and limited access to health services because of financial constraints.[5,11–14] This disparity among men can be measured using the mortality-to-incidence ratio (MIR), in which higher values signify lower survival rates.[15–19] The MIR is useful for measuring disparities in cancer outcomes and has been applied in previous studies[17,18,20] and in government reports in the United States[21] and Australia.[22]

Existing literature on the MIR in men has often focused on specific age groups (e.g., aged 20–39 years),[20] selected cancer types, such as lung,[23] stomach,[17,20] kidney,[24] liver,[25] and bladder[26] cancer, or has addressed limited geographic regions.[17,20] In addition, these estimates cover the period before 2020,[17,24–27] whereas cancer care and outcomes could be affected by the ongoing coronavirus disease 2019 pandemic and armed conflicts, their associated global economic effects, as well as a decline in the global Human Development Index (HDI) after 2020.[28] This highlights the importance of providing continuous and up-to-date cancer data to support informed decision making worldwide. Hence, in this study, we examined the MIR for 30 cancer types among men across all ages and by specific age groups globally. In addition, the numbers and rates of cancer cases and deaths, the prevalence of cancer in 2022, and their projections for 2050 were estimated. The results of this study will offer a relatively comprehensive view of the burden of cancer in men, empowering policymakers to make informed decisions and allocate resources effectively.

MATERIALS AND METHODS

This study used the 2022 Global Cancer Observatory (GLOBOCAN) estimates produced by the International Agency for Research on Cancer. Detailed descriptions of the GLOBOCAN estimates can be found in previously published studies.[7,29] The GLOBOCAN repository encompasses national-level estimates for cancer cases, deaths and rates for each country/territory worldwide.[29–31] Cancer types were identified by their International Classification of Diseases, 10th Revision codes (see Table S1).[29,32] The estimates were further stratified by age, sex, country/territory, World Health Organization (WHO) region, and HDI.[7,29]

Estimates by age were available in 5-year groups, totaling 18 age groups. By considering importance for policy, clinical, public health, and epidemiologic use, men's ages for this study were combined into a working-age group (aged 15–64 years) and an older adult group (aged 65 years and older),[33] with the working-age group further subdivided into adolescents and young adults (AYAs; aged 15–39 years)[5,12] and middle-aged adults (aged 40–64 years). In addition, estimates are presented for all ages combined. Cancer statistics are described by 185 countries/territories, six WHO regions (Africa, Southeast Asia, Eastern Mediterranean, the Americas, Europe, and

Western Pacific), and four HDI classifications (low, medium, high, and very high).[29,34] The HDI was used to represent each country's development in areas of health, knowledge, and standard of living.[34]

Rates for incidence and mortality were calculated by dividing the number of cases and deaths over 1 year in each specific population by the total number of persons.[29,35] The 2022 rates were estimated by using short-term estimation when available or by modelling using MIRs.[29,35] To facilitate cross-comparisons and reduce age-related biases, direct standardization using the 1966 Segi–Doll world standard population was used, with the age-standardized incidence rate (ASIR) and the age-standardized mortality rate (ASMR) reported per 100,000 males.[7,29,35,36] The prevalence of cancer was calculated by dividing the total number of cancer survivors in 2022 in specific regions by their corresponding total population.[37] The MIR, expressed as a percentage, was estimated by dividing the ASMR by the ASIR, and multiplying by 100, with a higher MIR indicating poorer survival and greater mortality.[15–19] The MIR was reported for all cancers excluding nonmelanoma skin cancer, and a sensitivity analysis was presented for all cancers including nonmelanoma skin cancer.

The projected cancer cases and deaths in 2050 were derived through demographic projections, assuming that the 2022 estimated rates remain constant.[7,38–40] The projections were calculated every 5 years (2025, 2030, … 2050) by multiplying the 2022 age-specific rates with their corresponding population projections for the target years (2025, 2030, … 2050), with the projected population extracted from the United Nations world population prospects.[7,38–40] We analyzed the MIR, whereas other estimates, such as counts, rates, prevalence, and projections, were estimated by using GLOBOCAN. Consistent with previous studies using similar data sources,[7,19,41] the GLOBOCAN estimates were extracted from the Global Cancer Observatory website (https://gco.iarc.who.int, Accessed June 27, 2024), which has online tabulation and visualization tools. The tools provide step-by-step selection options for cancer type, age group, region, HDI, and outcome measures (rates, prevalence, and projections), with the specific estimates extracted and merged to achieve the specific study objectives. The analysis was conducted using Microsoft Excel (Microsoft Corporation), Stata version 17 (StataCorp), and the Global Cancer Observatory's online tabulation and visualization tools (e.g., mapping).

RESULTS

Cancer incidence and mortality rates in 2022

In 2022, there were an estimated 10.3 million cancer cases and 5.4 million cancer deaths among men globally (Table 1), with nearly two thirds of cases and deaths occurring among older adults (aged 65 years and older). Lung cancer was the most common cancer in terms of cases and deaths, although slight variations in the leading cancer type were noted across age groups. For instance, testicular cancer cases and leukemia deaths were ranked the highest among AYAs (see Tables S2 and S3). The top 10 ranked cancer types across various age groups are presented in Table 3.

The global ASIR, ASMR, and prevalence of cancer per 100,000 men in 2022 were 212.6, 109.8, and 178.8, respectively, with variations observed across WHO regions (Table 2). The highest and lowest ASIRs were reported in Europe (307.6 per 100,000) and Southeast Asia (110.0 per 100,000), respectively. The ASMR per 100,000 men ranged from 76.4 per 100,000 in Southeast Asia to 136.2 per 100,000 in Europe. The highest prevalence of cancer was observed in Europe (432.5 per 100,000), whereas the lowest was observed in Africa (34.3 per 100,000). The findings for ASIR, ASMR, and prevalence by WHO region among AYAs, middle-aged adults, the working-age group, and older adults were broadly similar to those for all ages combined (Table 2). Crude incidence and mortality rates are provided in Table S4.

Countries that had a very high HDI had an ASIR that was about three times higher (ASIR, 320.6 per 100,000) compared with countries that had a low HDI (ASIR, 98.9 per 100,000; Table 2). The ASMR in men ranged from 72.2 per 100,000 in countries with a low HDI to 119.9 per 100,000 in countries with a high HDI. The prevalence per 100,000 men ranged from 28.0 per 100,000 in low-HDI countries to 478.2 per 100,000 in countries with a very high HDI. The findings for ASIR, ASMR, and prevalence by HDI among AYAs, middle-aged adults, the working-age group, and older adults were broadly similar to those for all ages combined (Table 2).

ASIR, ASMR, and prevalence of cancers differed widely between countries/territories worldwide. The highest and lowest ASIRs per 100,000 men were estimated to be in Australia (514.3 per 100,000) and Niger (74.2 per 100,000), respectively. Likewise, the highest and lowest ASMRs per 100,000 men were estimated to be in Mongolia (227.5 per 100,000) and Saudi Arabia (81.0 per 100,000), respectively. Australia had the highest prevalence (776.7 per 100,000), whereas Somalia had the lowest prevalence (15.4 per 100,000; see Table S5). Countries/territories with the highest ASIR, ASMR, and prevalence varied by age group. For instance, the highest ASMR was estimated to be in Mozambique for AYAs and in Mongolia for other age groups (middle-aged adults, the working-age group, and older adults). Table 3 lists the top 10 countries/territories for ASIR, ASMR, and prevalence by age group. In terms of the total number of cancer cases and deaths among all ages combined, China ranked first, whereas the top 10 rankings differed among specific age groups across various countries/territories (see Table S3).

Prostate cancer was the leading cancer type in terms of cases in about two thirds (n = 117) of the 185 countries/territories (Figure 1A), whereas lung cancer was the leading cancer type in terms of deaths in about one half (n = 93) of countries/territories (Figure 2A). The leading cancer types were similar by age group: prostate cancer cases (n = 75 countries/territories, Figure 1B) and lung cancer deaths (n = 95 countries/territories; Figure 2B) among the working-age group; prostate cancer cases (n = 139 countries/territories, Figure 1C) and lung cancer deaths (n = 90 countries/territories; Figure 2C) among older adults.

TABLE 1 Cancer cases and deaths in 2022 and their projections for 2050 by cancer type, World Health Organization region, and Human Development Index.

	Working-age group						Older adults						All ages combined					
	No. of cases			No. of deaths			No. of cases			No. of deaths			No. of cases			No. of deaths		
	2022	2050	Change, %[a]	2022	2050	Change, %[b]	2022	2050	Change, %[a]	2022	2050	Change, %[b]	2022	2050	Change, %[a]	2022	2050	Change, %[b]
Cancer type																		
All cancers	4,143,419	5,763,278	39.1	1,944,405	2,719,781	39.9	6,053,502	13,122,131	116.8	3,441,381	7,726,482	124.5	10,311,610	19,000,529	84.3	5,430,284	10,490,923	93.2
All cancers excluding NMSC	4,003,419	5,562,273	38.9	1,933,302	2,704,215	39.9	5,449,563	11,673,808	114.2	3,413,011	7,656,707	124.3	9,566,825	17,350,353	81.4	5,390,596	10,405,366	93.0
Lip, oral cavity	168,423	227,600	35.1	80,683	109,417	35.6	99,965	205,167	105.2	49,925	103,940	108.2	268,999	433,380	61.1	130,808	213,557	63.3
Salivary glands	16,695	22,240	33.2	6379	8762	37.4	13,921	30,271	117.5	7524	16,902	124.6	30,963	52,858	70.7	13,989	25,750	84.1
Oropharynx	51,803	72,037	39.1	23,545	32,970	40.0	34,365	68,972	100.7	19,259	39,649	105.9	86,339	141,181	63.5	42,818	72,633	69.6
Nasopharynx	63,852	84,012	31.6	33,992	45,929	35.1	21,416	41,504	93.8	19,758	39,316	99.0	86,289	126,542	46.7	54,104	85,600	58.2
Hypopharynx	41,452	57,690	39.2	17,497	24,415	39.5	30,577	61,695	101.8	17,054	35,269	106.8	72,077	119,433	65.7 0	34,564	59,698	72.7
Esophagus	157,590	222,323	41.1	130,892	184,325	40.8	207,523	434,756	109.5	187,493	402,373	114.6	365,225	657,192	79.9	318,433	586,747	84.3
Stomach	231,664	328,504	41.8	143,501	203,042	41.5	395,410	849,791	114.9	283,894	629,087	121.6	627,458	1,178,681	87.9	427,575	832,310	94.7
Colorectum	433,659	608,726	40.4	156,184	219,689	40.7	635,200	1,371,024	115.8	343,446	789,536	129.9	1,069,446	1,980,340	85.2	499,775	1,009,371	102.0
Liver	308,548	424,986	37.7	254,241	350,388	37.8	289,481	609,098	110.4	266,195	571,763	114.8	600,676	1,036,750	72.6	521,826	923,551	77.0
Gallbladder	15,911	22,339	40.4	10,928	15,344	40.4	27,621	61,533	122.8	20,475	46,375	126.5	43,538	83,878	92.7	31,406	61,722	96.5
Pancreas	97,051	138,005	42.2	82,009	117,283	43.0	172,549	378,456	119.3	165,560	368,663	122.7	269,709	516,570	91.5	247,589	485,966	96.3
Larynx	84,357	119,278	41.4	39,933	56,969	42.7	81,334	166,658	104.9	50,419	106,894	112.0	165,794	286,039	72.5	90,384	163,895	81.3
Lung	567,296	815,365	43.7	394,831	570,499	44.5	1,004,296	2,139,081	113.0	838,206	1,831,061	118.5	1,572,045	2,954,902	88.0	1,233,241	2,401,765	94.8
Melanoma of skin	73,296	100,658	37.3	11,051	15,318	38.6	106,296	237,760	123.7	22,060	51,696	134.3	179,953	338,780	88.3	33,160	67,063	102.2
NMSC	140,000	201,005	43.6	11,103	15,566	40.2	603,939	1,448,322	139.8	28,370	69,775	146.0	744,785	1,650,176	121.6	39,688	85,557	115.6
Mesothelioma	5367	7746	44.3	3804	5513	44.9	16,040	36,253	126.0	14,276	33,374	133.8	21,410	44,002	105.5	18,082	38,890	115.1
Kaposi sarcoma	19,703	23,795	20.8	8852	10,538	19.1	4126	8948	116.9	1317	2908	120.8	24,620	33,537	36.2	10,629	13,908	30.9
Penis	18,611	25,323	36.1	6724	9266	37.8	19,006	41,596	118.9	7004	16,084	129.6	37,700	67,002	77.7	13,738	25,361	84.6
Prostate	387,253	582,372	50.4	40,708	62,001	52.3	1,080,421	2,296,948	112.6	356,698	877,508	146.0	1,467,854	2,879,501	96.2	397,430	939,534	136.4
Testis	65,336	76,712	17.4	6840	8236	20.4	4202	9133	117.4	1818	4048	122.7	72,040	88,362	22.7	9068	12,697	40.0
Kidney	140,105	193,865	38.4	33,875	48,065	41.9	131,299	276,282	110.4	64,033	144,617	125.9	277,800	476,581	71.6	100,343	195,131	94.5
Bladder	134,526	193,872	44.1	29,327	42,728	45.7	336,438	752,501	123.7	136,247	329,893	142.1	471,293	946,705	100.9	165,672	372,719	125.0
Brain, central nervous system	100,050	130,609	30.5	75,800	100,819	33.0	59,991	126,675	111.2	57,210	121,087	111.7	173,699	270,984	56.0	139,823	228,738	63.6
Thyroid	171,068	215,368	25.9	5973	8329	39.4	34,727	68,733	97.9	11,155	24,917	123.4	206,485	284,794	37.9	17,241	33,360	93.5
Hodgkin lymphoma	33,504	40,903	22.1	7259	9215	27.0	9959	21,005	110.9	4893	10,706	118.8	48,774	67,226	37.8	13,674	21,444	56.8
Non-Hodgkin lymphoma	151,697	203,773	34.3	55,351	74,719	35.0	148,323	321,352	116.7	84,198	192,644	128.8	311,375	536,509	72.3	143,740	271,565	88.9
Multiple myeloma	39,919	56,507	41.6	21,293	30,366	42.6	63,801	137,770	115.9	45,593	102,763	125.4	103,805	194,362	87.2	66,966	133,209	98.9
Leukemia	121,343	158,802	30.9	69,911	90,826	29.9	119,266	262,985	120.5	89,265	204,630	129.2	278,120	459,432	65.2	173,289	309,616	78.7

(Continues)

TABLE 1 (Continued)

	Working-age group						Older adults						All ages combined					
	No. of cases			No. of deaths			No. of cases			No. of deaths			No. of cases			No. of deaths		
	2022	2050	Change, %[a]	2022	2050	Change, %[b]	2022	2050	Change, %[a]	2022	2050	Change, %[b]	2022	2050	Change, %[a]	2022	2050	Change, %[b]
WHO regions																		
Africa	204,724	485,182	137.0	132,375	315,289	138.2	143,382	422,906	195.0	107,695	319,991	197.1	370,055	939,315	153.8	251,773	651,926	158.9
Southeast Asia	662,261	989,172	49.4	441,115	671,736	52.3	469,768	1,208,896	157.3	347,775	905,484	160.4	1,156,550	2,218,415	91.8	799,837	1,586,308	98.3
Eastern Mediterranean	213,473	398,588	86.7	131,584	249,389	89.5	153,135	465,951	204.3	119,142	366,478	207.6	382,443	883,492	131.0	257,873	624,402	142.1
The Americas	754,797	993,472	31.6	220,716	291,275	32.0	1,431,173	2,933,714	105.0	530,273	1,139,953	115.0	2,204,545	3,943,166	78.9	755,745	1,435,328	89.9
Europe	871,142	877,676	0.8	344,295	349,977	1.7	1,688,388	2,728,157	61.6	877,549	1,488,154	69.6	2,572,323	3,616,782	40.6	1,224,793	1,840,651	50.3
Western Pacific	1,435,462	1,569,034	9.3	673,514	753,847	11.9	2,165,203	4,379,404	102.3	1,457,302	3,135,686	115.2	3,621,659	5,963,574	64.7	2,137,806	3,894,530	82.2
HDI																		
Low HDI	194,244	462,706	138.2	131,602	316,437	140.5	120,839	310,651	157.1	93,898	240,617	156.3	337,841	806,151	138.6	237,970	575,001	141.6
Medium HDI	663,571	1,103,621	66.3	439,852	744,467	69.3	468,957	1,251,329	166.8	341,685	921,359	169.7	1,162,894	2,383,754	105.0	795,332	1,678,918	111.1
High HDI	1,708,635	2,042,772	19.6	869,748	1,064,384	22.4	2,076,121	4,580,241	120.6	1,502,309	3,495,139	132.7	3,823,126	6,652,363	74.0	2,385,933	4,570,114	91.5
Very high HDI	1,575,409	1,633,715	3.7	502,397	525,253	4.6	3,385,132	5,833,383	72.3	1,501,844	2,763,357	84.0	4,983,714	7,487,212	50.2	2,008,592	3,292,383	63.9

Abbreviations: HDI, Human Development Index; NMSC, nonmelanoma skin cancer; WHO, World Health Organization.

[a]The absolute percentage change was calculated by dividing the number of cancer cases between 2022 and 2050 by the number of cases in 2022, with negative values signifying a decrease in cases.

[b]The absolute percentage change was calculated by dividing the number of cancer deaths between 2022 and 2050 by the number of deaths in 2022, with negative values signifying a decrease in deaths.

TABLE 2 The age-standardized incidence rate, age-standardized mortality rate, mortality-to-incidence ratio, and prevalence among men in 2022 by cancer type, World Health Organization region, and Human Development Index.

	Adolescents and young adults				Middle-aged adults				Working-age group				Older adults				All ages combined			
	ASIR[a]	ASMR[a]	MIR, %[b]	Prevalence[c]	ASIR[a]	ASMR[a]	MIR, %[b]	Prevalence[c]	ASIR[a]	ASMR[a]	MIR, %[b]	Prevalence[c]	ASIR[a]	ASMR[a]	MIR, %[b]	Prevalence[c]	ASIR[a]	ASMR[a]	MIR, %[b]	Prevalence[c]
Cancer type																				
All cancers	28.9	10.6	36.7	22.9	338.9	163.3	48.2	240.2	153.9	72.2	46.9	113.5	1624.2	909.0	56.0	1137.1	212.6	109.8	51.6	178.8
All cancers excluding NMSC	28.3	10.6	37.5	22.4	326.8	162.4	49.7	230	148.7	71.8	48.3	108.9	1470.4	901.7	61.3	991	198.6	109	54.9	162.6
Lip, oral cavity	1.3	0.56	43.1	0.98	13.5	6.6	48.9	9.5	6.2	3.0	48.4	4.5	27.7	13.8	49.8	19.4	5.8	2.8	48.3	4.7
Salivary glands	0.22	0.05	22.7	0.18	1.2	0.51	42.5	0.95	0.62	0.24	38.7	0.50	3.7	2.0	54.1	2.9	0.66	0.29	43.9	0.59
Oropharynx	0.12	0.04	33.3	0.10	4.6	2.1	45.7	3.6	1.9	0.87	45.8	1.6	9.6	5.3	55.2	6.8	1.9	0.91	47.9	1.6
Nasopharynx	0.69	0.24	34.8	0.54	4.8	2.8	58.3	3.6	2.4	1.3	54.2	1.8	6.1	5.6	91.8	4.2	1.9	1.2	63.2	1.6
Hypopharynx	0.12	0.07	58.3	0.05	3.6	1.5	41.7	2.3	1.5	0.65	43.3	1.0	8.5	4.7	55.3	5.1	1.6	0.73	45.6	1.1
Esophagus	0.34	0.28	82.4	0.28	13.9	11.6	83.5	9.3	5.8	4.8	82.8	4.1	56.7	50.5	89.1	32.2	7.6	6.5	85.5	5.6
Stomach	0.70	0.46	65.7	0.46	20.3	12.5	61.6	12.2	8.6	5.3	61.6	5.3	106.5	75.3	70.7	60.4	12.8	8.6	67.2	8.9
Colorectum	1.9	0.76	40.0	1.5	37.1	13.3	35.8	29.6	16.1	5.8	36.0	13.2	170.8	89.5	52.4	133.4	21.9	9.9	45.2	20.7
Liver	1.4	1.1	78.6	0.97	26.1	21.6	82.8	15.1	11.4	9.4	82.5	6.9	79.0	72.1	91.3	40.1	12.7	10.9	85.8	8.2
Gallbladder	0.06	0.04	66.7	0.06	1.4	0.94	67.1	0.94	0.59	0.40	67.8	0.43	7.3	5.4	74.0	4.0	0.88	0.63	71.6	0.64
Pancreas	0.23	0.16	69.6	0.20	8.6	7.3	84.9	4.8	3.6	3.0	83.3	2.1	46.0	43.8	95.2	19.2	5.5	5.0	90.9	3.1
Larynx	0.15	0.07	46.7	0.11	7.5	3.6	48.0	5.7	3.1	1.5	48.4	2.4	22.5	13.7	60.9	16.4	3.5	1.9	54.3	3.1
Lung	0.95	0.58	61.1	0.73	50.7	35.5	70.0	28.0	21.0	14.7	70.0	12.1	271.7	223.9	82.4	130.9	32.1	24.8	77.3	19.7
Melanoma of skin	0.61	0.07	11.5	0.62	5.8	0.91	15.7	5.4	2.7	0.41	15.2	2.6	28.1	5.7	20.3	26.8	3.7	0.65	17.6	4.1
NMSC	0.64	0.06	9.4	0.53	12.1	0.93	7.7	10.2	5.3	0.41	7.7	4.6	153.8	7.3	4.7	146.1	14.1	0.77	5.5	16.2
Mesothelioma	0.02	0.01	50.0	0.02	0.47	0.33	70.2	0.31	0.20	0.14	70.0	0.14	4.2	3.7	88.1	2.3	0.42	0.35	83.3	0.30
Kaposi sarcoma	0.67	0.33	49.3	0.40	0.84	0.34	40.5	0.51	0.74	0.34	45.9	0.44	1.1	0.36	32.7	0.76	0.56	0.25	44.6	0.37
Penis	0.15	0.03	20.0	0.12	1.5	0.57	38.0	1.1	0.69	0.25	36.2	0.52	5.1	1.8	35.3	3.9	0.79	0.28	35.4	0.69
Prostate	0.33	0.10	30.3	0.23	35.6	3.7	10.4	30.3	14.5	1.6	11.0	12.8	291.4	90.1	30.9	245.7	29.4	7.3	24.8	30.5
Testis	2.7	0.25	9.3	2.5	2.1	0.27	12.9	1.8	2.5	0.26	10.4	2.2	1.1	0.49	44.5	0.86	1.7	0.21	12.4	1.6
Kidney	0.63	0.11	17.5	0.58	11.9	3.0	25.2	9.7	5.2	1.3	25.0	4.4	35.8	16.9	47.2	27.4	5.9	2.0	33.9	5.4
Bladder	0.36	0.06	16.7	0.31	11.9	2.6	21.8	9.7	5.0	1.1	22.0	4.2	88.6	34.7	39.2	75.8	9.3	3.1	33.3	9.6
Brain, central nervous system	1.7	1.0	58.8	1.4	6.7	5.5	82.1	5.4	3.7	2.8	75.7	3.1	16.4	15.6	95.1	12.3	3.9	3.1	79.5	3.4
Thyroid	3.8	0.04	1.1	3.4	9.9	0.49	4.9	7.9	6.3	0.22	3.5	5.2	9.8	3.0	30.6	7.0	4.6	0.35	7.6	4.1
Hodgkin lymphoma	1.2	0.18	15.0	0.95	1.5	0.41	27.3	1.2	1.3	0.28	21.5	1.1	2.7	1.3	48.1	1.9	1.1	0.31	28.2	0.96

(Continues)

TABLE 2 (Continued)

	Adolescents and young adults				Middle-aged adults				Working-age group				Older adults				All ages combined			
	ASIR[a]	ASMR[a]	MIR, %[b]	Prevalence[c]	ASIR[a]	ASMR[a]	MIR, %[b]	Prevalence[c]	ASIR[a]	ASMR[a]	MIR, %[b]	Prevalence[c]	ASIR[a]	ASMR[a]	MIR, %[b]	Prevalence[c]	ASIR[a]	ASMR[a]	MIR, %[b]	Prevalence[c]
Non-Hodgkin lymphoma	1.9	0.71	37.4	1.5	11.2	4.1	36.6	8.9	5.7	2.1	36.8	4.6	39.9	22.0	55.1	30.1	6.6	3.0	45.5	5.9
Multiple myeloma	0.11	0.06	54.5	0.09	3.5	1.9	54.3	2.8	1.5	0.79	52.7	1.2	17.1	12.0	70.2	13.3	2.1	1.3	61.9	2.0
Leukemia	2.5	1.5	60.0	1.8	7.7	4.3	55.8	6.0	4.6	2.7	58.7	3.6	31.8	23.3	73.3	23.2	6.2	3.7	59.7	5.1
WHO region																				
Africa	24.0	14.3	61.7	13.0	185.9	124.0	68.0	94.3	89.3	58.5	67.1	35.5	863.4	661.8	78.6	440.4	118.6	84.1	72.6	34.3
Southeast Asia	20.1	10.3	51.5	13.7	210.0	145.5	69.7	123.1	96.7	64.8	67.4	56.0	673.5	498.8	74.5	370.8	110.0	76.4	69.9	64.1
Eastern Mediterranean	23.7	11.5	49.1	16.0	221.0	143.5	65.7	128.1	103.3	64.7	63.4	54.6	859.0	674.3	79.4	483.0	128.1	89.1	70.4	59.0
The Americas	36.4	9.8	27.4	32.6	442.3	130.5	32.0	375.3	200.1	58.5	31.5	179.6	2344.3	838.8	46.6	1865.1	293.3	96.3	39.1	331.9
Europe	39.8	8.4	21.5	39.2	495.0	201.7	41.9	423.3	223.3	86.4	39.7	231.1	2349.8	1165.7	54.1	1857.2	307.6	136.2	46.9	432.5
Western Pacific	36.3	9.8	27.5	32.6	378.3	185.2	49.9	264.9	174.2	80.5	47.1	149.3	1619.2	1068.0	66.9	1030.3	225.1	125.9	56.9	240.5
HDI																				
Low HDI	23.3	13.8	61.2	11.9	164.3	117.3	72.0	78.8	80.1	55.6	70.1	30.2	662.6	516.8	78.1	307.0	98.9	72.2	73.5	28.0
Medium HDI	20.6	11.0	53.7	13.8	209.0	144.1	69.3	122.1	96.6	64.6	67.3	52.9	696.5	508.0	73.5	375.2	111.6	77.0	69.5	58.5
High HDI	33.1	10.5	31.8	28.0	339.0	180.9	54.0	225.1	156.5	79.2	51.2	120.3	1383.9	989.8	72.8	822.1	198.0	119.9	61.4	170.9
Very high HDI	39.8	7.8	20.0	39.9	501.1	163.8	34.8	444.1	225.8	70.7	33.2	240.3	2507.7	1050.8	48.6	2034.8	320.6	118.3	41.1	478.2

Abbreviations: ASIR, age-standardized incidence rate; ASMR, age-standardized mortality rate; HDI, Human Development Index; MIR, mortality-to-incidence ratio; NMSC, nonmelanoma skin cancer; WHO, World Health Organization.

[a]The ASIR and The ASMR per 100,000 were estimated based on the 1966 Segi–Doll World Standard Population. Crude cancer incidence and mortality rates are available in the online material in Table S4.

[b]The MIR by WHO region and the HDI were calculated by excluding nonmelanoma skin cancer. The MIR for all cancers, including nonmelanoma skin cancer, is available in the online material in Table S4.

[c]The figure for prevalence is per 100,000 men.

TABLE 3 Top 10 leading cancer types and countries/territories by the age-standardized incidence rate, age-standardized mortality rate, and mortality-to-incidence ratio among men, 2022 and 2050.

	Adolescents and young adults			Middle-aged adults			Working-age group			Older adults			All ages combined		
Rank	ASIR	ASMR	MIR[a]	ASIR	ASMR	MIR[a]	ASIR	ASMR	MIR[a]	ASIR	ASMR	MIR[a]	ASIR	ASMR	MIR[a]
Top 10 cancer types in 2022 by ASIR, ASMR and MIR															
1	Thyroid	Leukemia	Esophagus	Lung	Lung	Pancreas	Lung	Lung	Pancreas	Prostate	Lung	Pancreas	Lung	Lung	Pancreas
2	Testis	Liver	Liver	Colorectum	Liver	Esophagus	Colorectum	Liver	Esophagus	Lung	Prostate	BNS	Prostate	Liver	Liver
3	Leukemia	BNS	Pancreas	Prostate	Colorectum	Liver	Prostate	Colorectum	Liver	Colorectum	Colorectum	Nasopharynx	Colorectum	Colorectum	Esophagus
4	Colorectum	Colorectum	Gallbladder	Liver	Stomach	BNS	Liver	Stomach	BNS	NMSC	Stomach	Liver	NMSC	Stomach	Mesothelioma
5	NHL	NHL	Stomach	Stomach	Esophagus	Mesothelioma	Stomach	Esophagus	Lung	Stomach	Liver	Esophagus	Stomach	Prostate	BNS
6	BNS	Lung	Lung	Esophagus	Pancreas	Lung	Thyroid	Lip, oral cavity	Mesothelioma	Bladder	Esophagus	Mesothelioma	Liver	Esophagus	Lung
7	Liver	Lip, oral cavity	Leukemia	Lip, oral cavity	Lip, oral cavity	Gallbladder	Lip, oral cavity	Pancreas	Gallbladder	Liver	Pancreas	Lung	Bladder	Pancreas	Gallbladder
8	Lip, oral cavity	Stomach	BNS	NMSC	BNS	Stomach	Esophagus	BNS	Stomach	Esophagus	Bladder	Gallbladder	Esophagus	Leukemia	Stomach
9	Hodgkin lymphoma	Kaposi sarcoma	Hypopharynx	Kidney	Leukemia	Nasopharynx	NHL	Leukemia	Leukemia	Pancreas	Leukemia	Leukemia	NHL	Bladder	Nasopharynx
10	Lung	Esophagus	Multiple myeloma	Bladder	NHL	Leukemia	NMSC	NHL	Nasopharynx	NHL	NHL	Stomach	Leukemia	BNS	Multiple myeloma
Top 10 countries/territories in 2022 by ASIR, ASMR, and MIR															
1	Australia	Mozambique	Sao Tome and Principe	Australia	Mongolia	Niger	Australia	Mongolia	Niger	Australia	Mongolia	Yemen	Australia	Mongolia	The Gambia
2	New Zealand	Malawi	Sierra Leone	New Zealand	Moldova	The Gambia	New Zealand	Moldova	The Gambia	Denmark	Estonia	Mongolia	New Zealand	Belarus	Niger
3	Mozambique	The Gambia	The Gambia	Lithuania	Belarus	Yemen	Hungary	Belarus	Guinea	USA	Croatia	Somalia	USA	Hungary	Yemen
4	Italy	Zambia	Guinea	Hungary	Romania	Afghanistan	Lithuania	Romania	Bhutan	New Zealand	Uruguay	The Gambia	Hungary	Lithuania	Somalia
5	Croatia	Namibia	Niger	FR-M	Hungary	Bhutan	FR-M	Hungary	Yemen	Norway	Latvia	Niger	Denmark	Romania	Mongolia
6	Hungary	Uganda	Congo	Belarus	Serbia	Cambodia	USA	Lithuania	Mali	Ireland	Poland	Djibouti	Lithuania	Latvia	Burkina Faso
7	Denmark	Ghana	Guinea-Bissau	France, Guadeloupe	Lithuania	Guinea	Belarus	Serbia	Cambodia	Canada	Slovakia	Libya	FR-M	Moldova	Bhutan
8	The Netherlands	Zimbabwe	Burkina Faso	USA	Ukraine	Lao PDR	France, Guadeloupe	Ukraine	Afghanistan	FR-M	Hungary	Tajikistan	Ireland	Poland	Cambodia
9	FR-M	Chad	Chad	Romania	Latvia	Mali	Romania	Lao PDR	Burkina Faso	The Netherlands	Belarus	Myanmar	Norway	Croatia	Lao PDR
10	Norway	Niger	Vanuatu	Ireland	Lao PDR	Central African Republic	Denmark	Latvia	Lao PDR	Croatia	Lithuania	Burkina Faso	Croatia	Türkiye	Djibouti

Abbreviations: ASIR, age-standardized incidence rate; ASMR, age-standardized mortality rate; BNS, brain and central nervous system; FR-M, France (metropolitan); Lao PDR, Lao People's Democratic Republic; MIR, mortality-to-incidence ratio; NHL, non-Hodgkin lymphoma; NMSC, nonmelanoma skin cancer.

[a]Countries/territories with a small number of cases or deaths ($n < 10$) were excluded from ranking because their inclusion could potentially affect the accuracy of MIR estimation by affecting the ASIR or the ASMR.

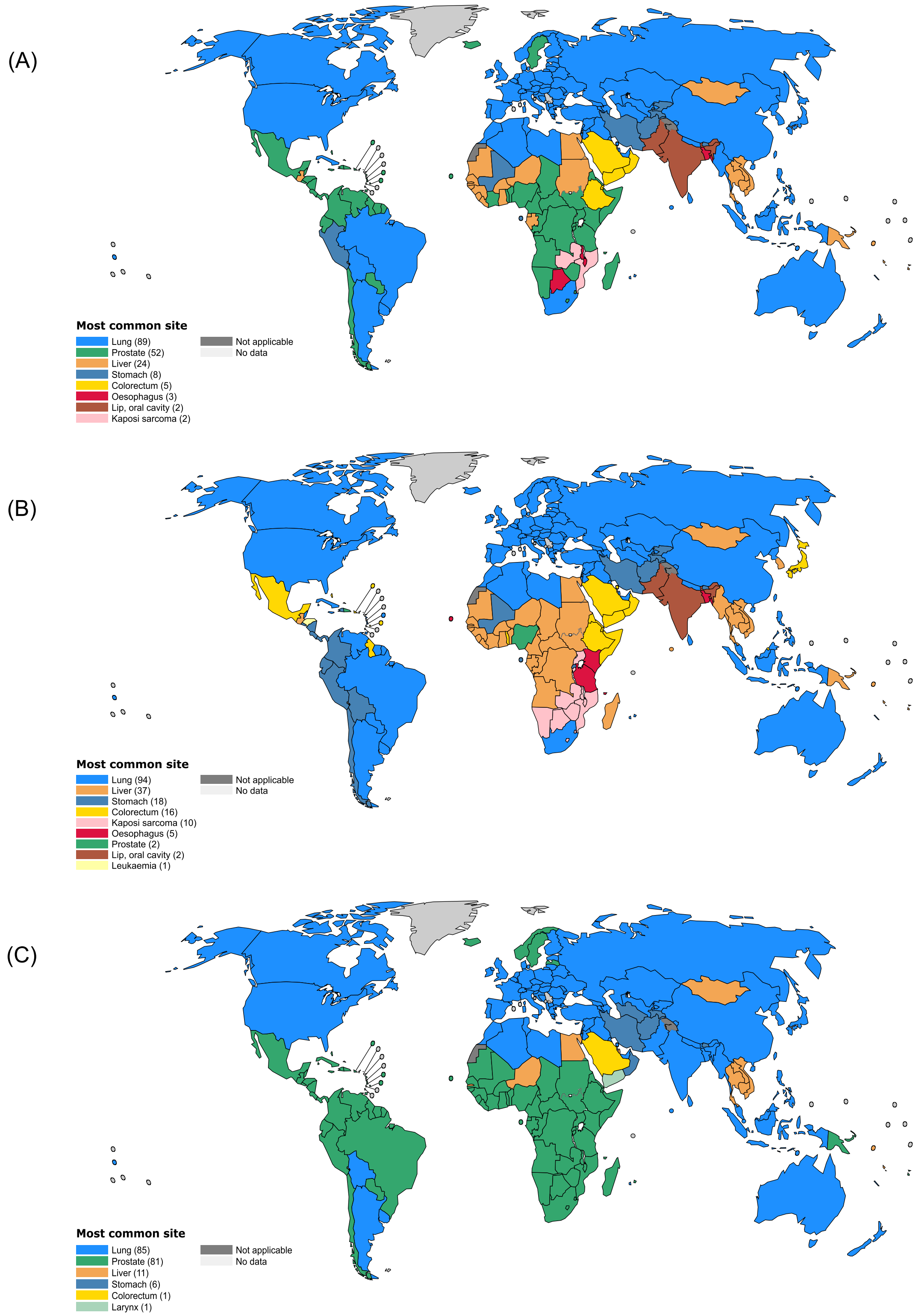

FIGURE 1 The distribution of leading cancer types in numbers for cancer incidence (excluding nonmelanoma skin cancer) in each country/territory among men in 2022 by age group for (A) all ages combined, (B) the working-age group (aged 15–64 years), and (C) older adults (aged 65 years and older). In the map legend, the brackets after the cancer type name indicate the number of countries/territories where the named cancer type was the leading cancer type for cancer incidence. For example, *Prostate (140)* means that prostate cancer was the leading cancer type for cancer incidence in 140 countries/territories.

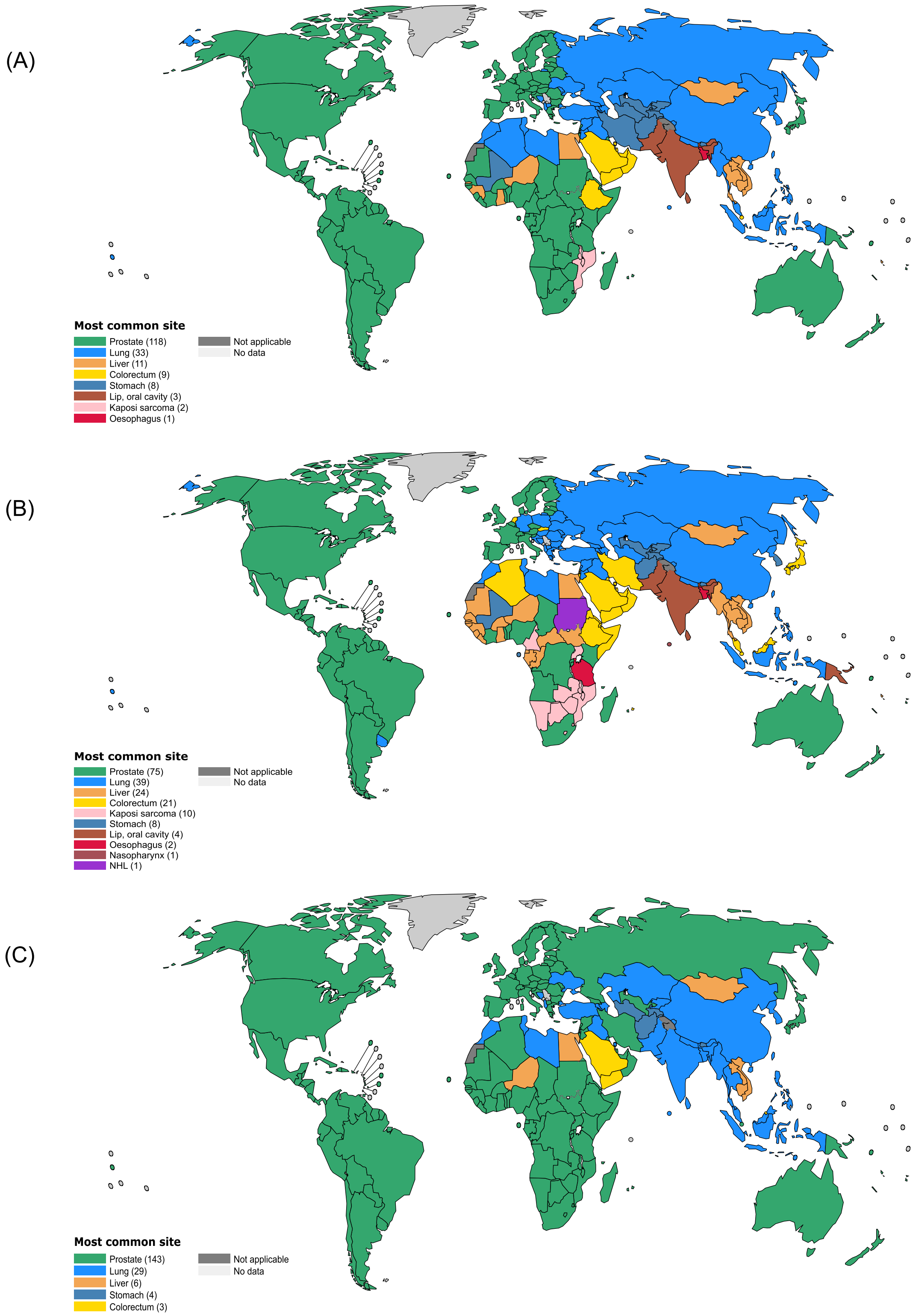

FIGURE 2 The distribution of leading cancer types in numbers for cancer mortality (excluding nonmelanoma skin cancer) in each country/territory among men in 2022 by age group for (A) all ages combined, (B) the working-age group (aged 15–64 years), and (C) older adults (aged 65 years and older). In the map legend, the brackets after the cancer type name indicate the number of countries/territories where the named cancer type was the leading cancer type for cancer mortality. For example, *Prostate (79)* means that prostate cancer was the leading cancer type for cancer mortality in 79 countries/territories. NHL indicates non-Hodgkin lymphoma.

Cancer mortality-to-incidence ratio in 2022

In 2022, the estimated global cancer MIR among men was 54.9%. The MIR ranged from 7.6% for thyroid cancer to 90.9% for pancreatic cancer, with about one half of cancer types (*n* = 14) having an MIR between 40% and 70%, and one quarter (*n* = 7) having an MIR >70% (Table 2). The three cancer types with the highest MIR were cancers of the pancreas, liver, and esophagus (Table 2). This order displayed little variation across the examined age groups (Table 3 shows the highest 10 cancer types for MIR by age).

Of the WHO regions, Africa had the highest MIR (72.6%), followed by the Eastern Mediterranean (70.4%), and this figure was nearly double that in the Americas, which had the lowest MIR (39.1%; Table 2). The region with the highest MIR by age group was Africa for AYAs, Southeast Asia for middle-aged adults and the working-age group, and the Eastern Mediterranean for older adults (Table 2).

The MIR had an inverse relation with the HDI, with the highest estimate among low-HDI countries (73.5%) and the lowest among countries with a very high HDI (41.1%; Table 2). The trend of MIR by HDI among AYAs, middle-aged adults, the working-age group, and older adults was similar to that for all ages combined.

There was a wide disparity (three-fold variation) in the MIR between countries/territories worldwide, ranging from 28.0% in Norway to 86.6% in The Gambia (see Tables S5 and S6). An MIR >50% was observed in three quarters of countries/territories (*n* = 139 of 185). The countries/territories with the highest MIR varied based on age group (Table 3).

2050 projections of cancer cases and mortality

Incident cancer cases are projected to reach 19 million globally by 2050, an 84.3% increase from the 2022 estimate (Table 1). The number of cancer deaths is projected to reach 10.5 million by 2050, a 93.2% increase from the 2022 estimate. Lung cancer is projected to remain the leading cancer type for both cases and deaths by 2050, with both cases and deaths increasing by greater than 87% compared with the 2022 estimate. Table 3 outlines the top 10 leading cancer types by 2050, which varied across age groups.

Between 2022 and 2050, the cancer type with the highest estimated increase is projected to be mesothelioma for incident cases (105.5% increase from 2022) and prostate cancer for deaths (136.4% increase). Testicular cancer is projected to have the lowest increase for both incident cases (22.7% increase) and deaths (40% increase). Changes in cases and deaths from 2022 to 2050 are projected to differ by age group. For each of the different age groups examined, the percentage increase in cancer cases and deaths is projected to be greater in the oldest age group compared with the youngest (Tables 1 and S3). Between 2022 and 2050, in Africa and the Eastern Mediterranean, the number of incident cases and deaths is projected to increase 2.5-fold. In contrast, Europe is projected to experience an increase of about one half. A decline of 5.0%–18.0% in cases and deaths was projected among AYAs in the regions of Europe, the Western Pacific, and the Americas, whereas there are projected increases for middle-aged adults, the working-age group, older adults, and all ages combined (Tables 1, S3).

Between 2022 and 2050, the percentage increase in cancer cases is projected to range from 50.2% in countries with a very high HDI to 138.6% in those with a low HDI, and the increase in deaths is projected to be 63.9% in countries with a very high HDI to 141.6% in those with a low HDI. The percentage change in cases and deaths across the HDI is projected to differ by age group. Among AYAs, it is projected that the number of cases and deaths will decline by approximately 11% in countries with a high and very high HDI (Tables 1, S3).

The projected cases and deaths between 2022 and 2050 among all ages combined (Figure 3A) and among older adults (Figure 3C) indicate a greater relative increase compared with the working-age group (Figure 3B).

DISCUSSION

By using population-based estimates from 185 countries/territories worldwide, this study examined the ASIR, ASMR, prevalence, and MIR of 30 cancers among men in 2022 and projections for 2050. Disparities in burden by cancer type, age group, HDI, WHO region, and countries/territories were observed. A high MIR was observed for rare and less common cancer types, including for cancers of the pancreas, liver, esophagus, and mesothelioma. Compared with countries/territories with a very high HDI, those with a low and medium HDI had an MIR about twice as high, indicating unmet service needs for early diagnosis and the best available treatment options. Between 2022 and 2050, cancer cases and deaths in low-HDI countries/territories are estimated to more than double (an increase of about 140%), whereas much smaller increases of 50% for cases and 64% for deaths are projected in very-high-HDI countries/territories, reflecting widening disparities in cancer burden. The MIR was higher in older age groups compared with younger age groups. Between 2022 and 2050, the number of cancer cases and deaths among older adults were projected to increase by 116.8% and 124.5%, respectively, whereas an increase of about two fifths was projected among the working-age group.

This study contributes to global cancer statistics for men, who have no male cancer-specific screening programs (e.g., prostate cancer) and have a higher prevalence of occupational and other modifiable cancer risk factors, which contribute to higher observed cancer incidence and poorer outcomes compared with women.[9,10] For instance, well adapted, male-specific cancer screening programs are unavailable, whereas female-specific cancer screening (e.g., breast and cervical screening) and prevention programs result in lower cancer mortality.[8] This study provides comprehensive evidence for understanding the existing disparities in cancer outcomes among men, thereby building a case for collective efforts to reduce inequalities and enhance cancer outcomes.

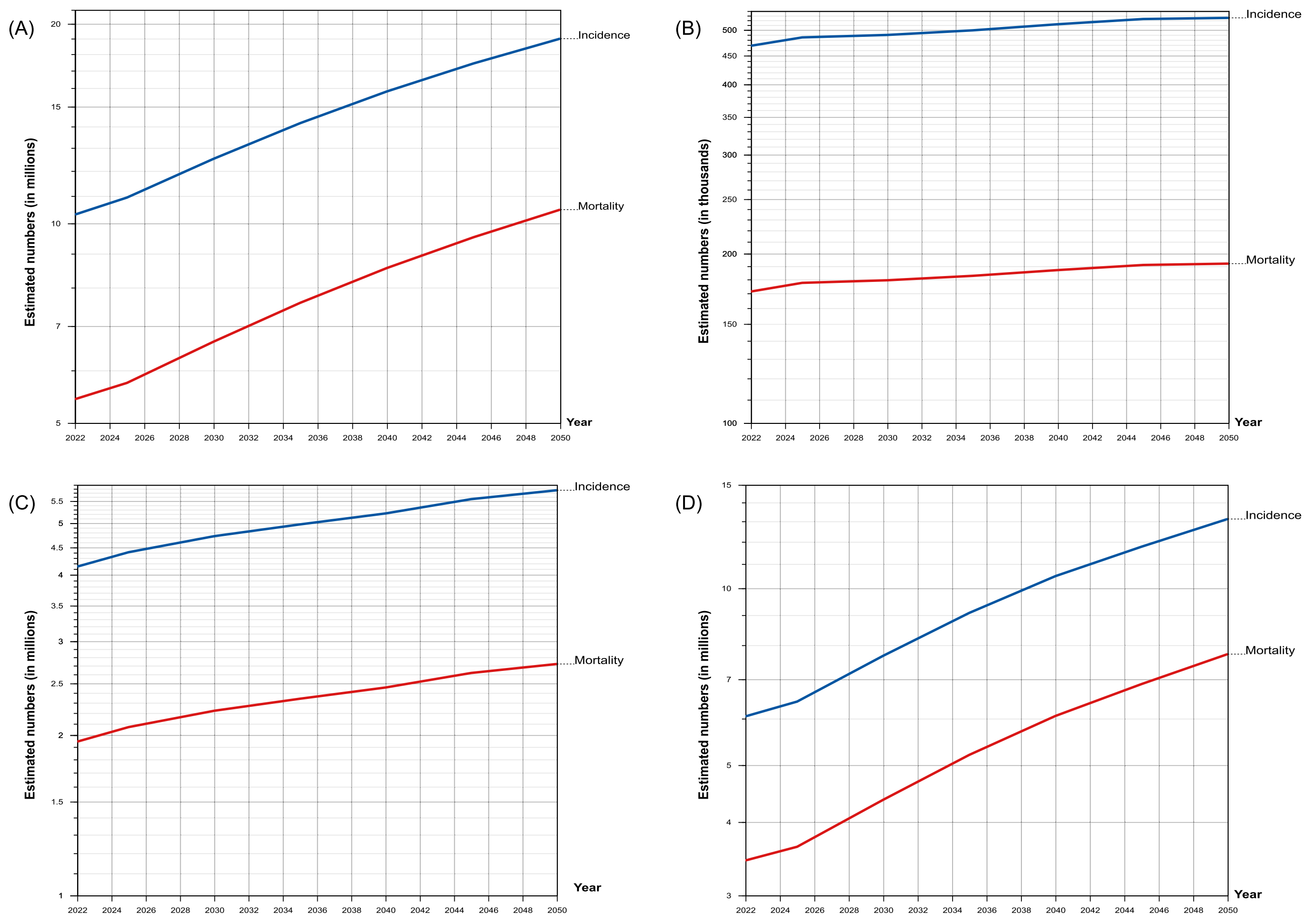

FIGURE 3 Projected global incident cancer cases and deaths in men between 2022 and 2050 by age group for (A) all ages combined, (B) adolescents and young adults (aged 15–39 years), (C) the working-age group (aged 15–64 years), and (D) older adults (aged 65 years and older).

Enhancing health infrastructure, access, and quality through a coordinated, multisectoral approach and national and international collaboration is essential to improve current cancer outcomes in men and to prepare for the anticipated rise in cancer burden by 2050.[31,42–45] Ensuring a competent and adequate health workforce at the global level is important for reducing cancer disparities.[44] Moving forward, expanding publicly funded medical schools and scholarships for training medical staff, providing continuous learning and specialization options, ensuring equitable geographic distribution of medical staff, and retaining medical staff, specifically in low-HDI and medium-HDI countries, are important.[44] Ensuring the equitable and adequate implementation of the Sustainable Development Goals, particularly Target 3.c (training medical staff) could positively affect cancer outcomes.[46] In addition, it is vital to equip health systems with appropriate infrastructure for cancer diagnosis (e.g., medical laboratories, pathology) and treatment services (e.g., radiation therapy) with affordable and cost-effective options, along with the optimal use of available services.[43,44,47] Furthermore, emphasis should be given to low-HDI and medium-HDI countries/territories that have existing high unmet cancer service needs despite high cancer burden.[31,42–45]

Another strategy to reduce disparities and improve cancer outcomes could be to expand universal health coverage worldwide, which could strengthen efforts to provide basic cancer care options.[48] However, there is currently low universal health coverage in low-HDI and medium-HDI countries, which were disproportionately affected by poor cancer outcomes in this study.[48] It is crucial to expand the strategies and lessons learned from low-HDI and medium-HDI countries that have been better at achieving universal health coverage (e.g., Rwanda), to further universal health coverage in comparable countries and globally.[48] In this study, Rwanda had an overall MIR of 73.6%, which is lower than that in 38 low-HDI and medium-HDI countries. It should be noted that factors other than system-level factors (universal health coverage) may also influence the MIR, including personal and interpersonal (health provider) factors. Expanding universal health coverage is also highlighted under the Sustainable Development Goals (Target 3.8), and implementing this target with an emphasis on low-HDI and medium-HDI countries would improve cancer outcomes and equity.[46]

The higher MIR (poorer survival) across older adult men and rare/less common cancer types[42,49] indicates the potential necessity of targeted interventions. Despite cancer-related mortality increasing with age, a large proportion of premature deaths among older adults globally could also be attributed to inadequate health service access because of financial barriers, lower participation in prevention activities (e.g., screening), preferences to preserve quality of life rather than longevity, and unmet evidence-based practice because of lower involvement of older people in clinical trials that are used for developing cancer guidelines.[14,27] Hence, improving access to cancer prevention and care options and further targeted research to discover intervention options, including affordable and acceptable prevention, screening, diagnosis, and treatment options, could improve cancer outcomes among older men and for rare cancer types.[50,51] As noted above, precautions should also be taken when interpreting the findings of this study across different age groups; some cancers are more prevalent in younger age groups, e.g., testicular cancer and Hodgkin lymphoma, and others are more prevalent in older age groups, e.g., prostate and bladder cancer.

The disparities in cancer outcomes between low-HDI and medium-HDI countries compared with high-HDI countries could be attributed to many factors, including fewer interventions to address modifiable risk factors of cancer (e.g., smoking, alcohol consumption), demographic transitions (e.g., aging populations), lower investment in cancer prevention and research, and multiple competing priorities to focus resources on cancer (e.g., because of a higher prevalence of infectious disease).[9,50,51] Additional research is required to better understand the drivers of the projected widening cancer disparity by HDI between 2022 and 2050.

We acknowledge that the findings of this study could be affected by the quality of the GLOBOCAN data set, with some countries/territories providing relatively low-quality data or no data. Estimates in low-HDI and medium-HDI countries could be less accurate because the majority of these jurisdictions have relatively low-quality cancer registries and/or civil and vital statistics registration systems.[30,31] However, GLOBOCAN used best estimation approaches for each specific country/territory, including nationally reported data and modelling based on the data of neighboring countries/territories, to improve the accuracy of estimates.[29] It is also important to note that the coverage and quality of cancer registries and civil and vital statistics registration systems have increased over time, and further expanding and maintaining these systems is essential for accurate estimates of cancer outcomes.[30,52] Consistent with previous studies[15–20] and government report indicators,[21,22] the MIR was used as an indicator for cancer outcome inequalities, with relatively higher MIR used as a proxy for higher fatality or poorer survival, yet caution should be taken when interpreting the MIR because it does not precisely measure survival. The MIR has been used in reports by many countries, such as the United States[21] and Australia,[22] to measure cancer outcomes both within a country and for international comparisons.[21,22]

This study provides comprehensive worldwide evidence on cancer incidence, mortality, prevalence, and future trends by considering 30 different cancer types among men that were measured using population-based estimates from 185 countries/territories. However, it is important to note that other measures of cancer burden, such as years of life lost or years lived with disability, were not available from our data source and thus were not estimated in the current study. The study considered different statistical measures of cancer outcomes, including ASIR, ASMR, prevalence, and MIR, with each measure having unique as well as complementary interpretations. Moreover, the findings of the current study support those of previous global studies[53,54]; for instance, a worldwide study that used population-based estimates from five continents between 2000 and 2014 investigated disparities in cancer survival outcomes between low-HDI/medium-HDI countries indicated poorer survival compared with high-HDI countries.[54] Therefore, the results of this study may be used to inform evidence-based decision-making processes with the goal of improving cancer outcomes among men.

CONCLUSION

Disparities in cancer incidence and mortality among men were observed across age groups, countries/territories, and HDI in 2022, with these disparities projected to widen further by 2050. A higher MIR (poorer survival) was observed in older adults, for rare cancer types (e.g., pancreatic), and in low-HDI and medium-HDI countries. Between 2022 and 2050, cancer cases and mortality are projected to more than double in low-HDI countries/territories and also among older adults. Further strengthening the quality and accessibility of health infrastructure; promoting universal health coverage following a human rights approach; addressing modifiable cancer risk factors, including occupational risk factors; funding research into male-specific cancer screening programs worldwide; and fostering collaborative and multidisciplinary approaches between national and international stakeholders could be keys to improving equity in cancer outcomes. These efforts would ultimately reduce disparities in cancer burden and ensure equity in cancer prevention and care for men across the globe.

AUTHOR CONTRIBUTIONS

Habtamu Mellie Bizuayehu: Conceptualization, writing–original draft, writing–review and editing, methodology, visualization, software, and formal analysis. **Abel F. Dadi**: Conceptualization, methodology, writing–review and editing, visualization, and investigation. **Kedir Y. Ahmed**: Conceptualization, methodology, and writing–review and editing. **Teketo Kassaw Tegegne**: Conceptualization, methodology, and writing–review and editing. **Tahir Ahmed Hassen**: Conceptualization, methodology, and writing–review and editing. **Getiye Dejenu Kibret**: Conceptualization, methodology, and writing–review and editing. **Daniel Bekele Ketema**: Conceptualization, methodology, and writing–review and editing. **Meless G. Bore**: Conceptualization, methodology, and writing–review and editing. **Subash Thapa**: Conceptualization, methodology, and writing–review and editing. **Daniel Bogale Odo**: Conceptualization, methodology,

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ACKNOWLEDGEMENT

Open access publishing facilitated by The University of Queensland, as part of the Wiley - The University of Queensland agreement via the Council of Australian University Librarians.

CONFLICT OF INTEREST STATEMENT

The authors declared no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data that were used in this study can be accessed publicly at https://gco.iarc.fr, with additional information available upon request from the corresponding author.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Bizuayehu HM, Dadi AF, Ahmed KY, et al. Burden of 30 cancers among men: global statistics in 2022 and projections for 2050 using population-based estimates. *Cancer*. 2024;130(21):3708-3723. doi:10.1002/cncr.35458