JAMA Oncology | Original Investigation | GLOBAL BURDEN OF DISEASE

Global, Regional, and National Burden of Bone Cancers, 1990 to 2023, With Forecasts to 2050

A Systematic Analysis for the Global Burden of Disease Study 2023

GBD 2023 Bone Cancer Collaborators

IMPORTANCE Primary bone cancers include multiple histologic types, with survival differing by age and location. Results from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2023 were analyzed to support policies and initiatives worldwide.

OBJECTIVE To estimate the global burden of bone cancer from 1990 to 2023 and forecast future trends to 2050.

DESIGN, SETTING, AND PARTICIPANTS This systematic analysis estimated bone cancer incidence, mortality, and disability-adjusted life-years (DALYs) in 204 countries and territories grouped by GBD super-regions and World Bank income groups from 1990 to 2023, with forecasts through 2050. Individuals of all ages with bone cancers included in the GBD 2023 study were included in analyses. Data were analyzed from June 2023 to July 2025.

MAIN OUTCOMES AND MEASURES The GBD 2023 study used standardized estimation methods to describe bone cancer incidence, mortality, and DALYs in 2023, as well as trends over the past 3 decades and forecasts through 2050. All estimates are presented with 95% uncertainty intervals (UIs), and age-standardized rates (ASRs) were calculated using GBD-specific age weights.

RESULTS In 2023, there were 111 000 (95% UI, 81 300-164 000) malignant bone cancer cases, 76 600 (95% UI, 60 700-96 300) deaths, and 3.02 million (95% UI, 2.29 million-3.96 million) DALYs globally. A bimodal age distribution was noted in both incidence (peaking at ages 10 to 14 years and 65 to 69 years) and mortality (peaking at ages 15 to 19 years and 65 to 69 years). The highest ASRs for incidence were in Southeast Asia, East Asia, and Oceania (1.6 per 100 000; 95% UI, 1.1-2.4), while Sub-Saharan Africa had the highest ASRs for DALYs (51.0 per 100 000; 95% UI, 27.7-79.7). By World Bank income group, upper-middle–income countries had the highest ASRs for incidence, whereas low-income countries exhibited the highest ASRs for both mortality and DALYs. Globally, incident cases, deaths, and DALYs increased from 1990 to 2023, while global mortality and DALY ASRs were relatively stable; high-income countries experienced a decline in mortality and DALY ASRs. Forecasts suggest a potential increase in global cases and deaths by 2050.

CONCLUSIONS AND RELEVANCE In this systematic analysis, the burden of bone cancer varied by age, geography, and time, underscoring global disparities. These findings provide valuable insights to inform health system planning and resource allocation tailored to different settings.

Supplemental content

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Group Information: The GBD 2023 Bone Cancer Collaborators appear at the end of the article.

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Bone cancer, though relatively rare, has incidence that varies across age groups[1] and races and ethnicities.[2,3] In children and adolescents, it is an important contributor to cancer burden globally.[4,5] The major primary bone cancer types are osteosarcoma, Ewing sarcoma, and chondrosarcoma.[6] Osteosarcoma has a bimodal age distribution, peaking in adolescents and young adults and later adulthood.[7,8] Ewing sarcoma predominantly affects children and adolescents,[9] whereas chondrosarcoma occurs mainly in adults.[10]

Bone cancer outcomes vary according to disease characteristics and treatment factors[11-13] and are closely linked to health system capacity. Effective management requires multidisciplinary care, including access to imaging; pathology; surgery; systemic therapies, such as chemotherapy and radiation; and rehabilitation.[14] However, these resources are inequitably distributed worldwide. In many low- and middle-income countries, patients experience delayed diagnosis, limited access to specialized surgery and essential chemotherapy, inadequate supportive care and therapeutic monitoring, and financial barriers that may contribute to treatment abandonment.[11,15,16]

This study is the first formal Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) analysis of bone cancer burden across age, sex, GBD super-region, and World Bank income group (WBIG) from 1990 to 2023, with forecasts through 2050. This research aims to inform more equitable health policy and resource allocation for bone cancer globally.

Key Points

Question What was the global burden of bone cancer in 2023, how have trends changed since 1990, and how will they change by 2050?

Findings This systematic analysis estimated 111 000 bone cancer cases, 76 600 deaths, and 3.02 million disability-adjusted life-years globally in 2023. Although counts increased from 1990 to 2023, age-standardized mortality and disability-adjusted life-year rates remained relatively stable globally, with declines in high-income countries, and forecasts suggest an increase in global cases and deaths by 2050.

Meaning These findings highlight the importance of early diagnosis and improving health care access and policies to address the increasing burden equitably across all resource levels.

Methods

Study Overview

This study presents GBD 2023 estimates of disease burden for primary malignant neoplasms of bone and articular cartilage (hereafter referred to as bone cancer or cancers) across GBD age groups, sexes, and locations, for 1990 to 2023 and forecasts through 2050. Here, bone cancer refers to a group of rare and aggressive primary bone malignant neoplasms and excludes cancers that originate elsewhere and metastasize to the bone. Soft tissue and nonbone sarcomas are also not included in this analysis and are estimated as a separate GBD cause (soft tissue and other extraosseous sarcomas). This study complies with the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER) reporting guideline.[17] The study was approved by the University of Washington Institutional Review Board. The GBD study used deidentified data, and a waiver of informed consent was approved.

Data Sources and Processing

GBD 2023 bone cancer estimates were produced using vital registration (VR) system and population-based cancer registry data, which were mapped to the *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* (*ICD-10*) codes for malignant neoplasms of bone and articular cartilage (codes C40-C41).[18] Data sources are listed in the GBD 2023 Sources Tool.[19] Details on data processing were published previously.[4,5,20]

Estimating Bone Cancer Burden, 1990-2023

Processed cancer registry incidence data were transformed to mortality estimates by age, sex, year, and location. Matched data were used in a spatiotemporal Gaussian process regression model to produce mortality to incidence ratios.[4,20] Cleaned incidence data were multiplied by mortality to incidence ratios to produce preliminary mortality estimates, which were combined with VR data for use in mortality modeling. These estimates were cross-walked to VR data using RegMod version 0.2.2 (Institute for Health Metrics and Evaluation)[5] to adjust for systematic differences between data sources; where data overlap existed, only VR data were retained.[5] Final mortality estimates were generated using the GBD Cause of Death Ensemble model, followed by the CoDCorrect algorithm to ensure consistency across cause-specific and all-cause mortality estimates. Complete mortality methods have been published previously.[5,20]

Years of life lost, representing years lost due to premature death, were calculated by multiplying age-specific mortality with a standard age-specific life expectancy.[20] This reflects the lowest mortality risk at each age and ensures comparability across locations and over time. Final mortality estimates were transformed to incidence estimates using modeled mortality to incidence ratio estimates and combined with annual relative survival estimates (from 1 to 10 years; details on estimating survival have been published previously[4,5]) to generate estimates of prevalence at each year after diagnosis. Ten-year prevalence was divided into 4 sequelae based on the predicted person-time spent in each phase of cancer care; for cohorts who did not survive 10 years, phases included (1) diagnosis and treatment, (2) remission, (3) metastatic or disseminated, and (4) terminal. For surviving cohorts, the phases were (1) diagnosis and treatment and (2) remission. Each sequela prevalence was multiplied by a sequela-specific disability weight—which measures the magnitude of health loss—to calculate the number of years lived with disability (YLDs). These YLDs by sequela were summed to produce final YLD estimates for bone cancer. Finally, disability-adjusted life-years (DALYs) were calculated as the sum of YLDs and years of life lost. More detailed methods for estimating were published previously.[4,5,20]

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Table. Incident Cases, Deaths, and Disability-Adjusted Life-Year (DALY) Counts and Age-Standardized Rates and Percentage Change Between 1990 and 2023 for Malignant Neoplasm of Bone and Articular Cartilage Globally, by World Bank Income Group, and GBD Super-Region[a]

Location	Incidence				Mortality				DALYs			
	Count		Age-standardized incidence rate		Count		Age-standardized mortality rate		Count		Age-standardized DALY rate	
	2023 Estimate (95% UI), in thousands	Change from 1990 to 2023, % (95% UI)	2023 Estimate per 100 000 (95% UI)	Change from 1990 to 2023, % (95% UI)	2023 Estimate (95% UI), in thousands	Change from 1990 to 2023, % (95% UI)	2023 Estimate per 100 000 (95% UI)	Change from 1990 to 2023, % (95% UI)	2023 Estimate (95% UI), in thousands	Change from 1990 to 2023, % (95% UI)	2023 Estimate per 100 000 (95% UI)	Change from 1990 to 2023, % (95% UI)
Global	111 (81.3 to 164)	90.4 (25.3 to 200.9)	1.3 (1.0 to 2.0)	11.4 (−25.9 to 75.8)	76.6 (60.7 to 96.3)	89.0 (45.1 to 149.5)	0.9 (0.7 to 1.1)	−0.2 (−22.2 to 30.9)	3020 (2290 to 3960)	59.4 (13.8 to 116.8)	36.2 (27.1 to 48.0)	−0.5 (−28.9 to 34.8)
World Bank income group												
High	17.5 (12.8 to 25.9)	−11.9 (−40.4 to 38.7)	1.2 (0.8 to 1.9)	−26.7 (−54.8 to 25.4)	9.21 (8.35 to 9.89)	−25.8 (−30.4 to −20.9)	0.4 (0.4 to 0.5)	−51.6 (−54.4 to −48.6)	288 (266 to 310)	−37.4 (−41.1 to −33.1)	18.4 (17.0 to 19.9)	−49.3 (−52.4 to −45.4)
Upper-middle	50.6 (37.5 to 68.7)	176.5 (81.3 to 316.3)	1.6 (1.1 to 2.3)	59.6 (4.4 to 152.2)	36.2 (28.2 to 42.3)	180.7 (106.2 to 260.0)	1.0 (0.8 to 1.2)	31.6 (−4.4 to 67.0)	1160 (912 to 1370)	108.3 (59.2 to 162.5)	35.6 (28.2 to 42.0)	26.9 (−3.4 to 58.5)
Lower-middle	33.9 (19.9 to 51.5)	115.7 (4.7 to 310.7)	1.2 (0.7 to 1.8)	9.1 (−47.0 to 98.9)	24.6 (14.6 to 35.2)	109.4 (12.4 to 250.7)	0.9 (0.5 to 1.3)	0.8 (−45.8 to 67.0)	1170 (675 to 1700)	78.4 (−5.5 to 197.8)	38.0 (22.2 to 54.9)	−5.1 (−49.4 to 59.2)
Low	9.34 (4.91 to 15.8)	104.9 (−11.9 to 298.4)	1.5 (0.8 to 2.4)	−11.8 (−60.3 to 63.3)	6.61 (3.60 to 10.2)	91.4 (−2.2 to 229.7)	1.2 (0.6 to 1.8)	−16.4 (−57.4 to 46.5)	395 (213 to 626)	82.8 (−7.1 to 212.5)	56.3 (30.8 to 86.9)	−21.6 (−60.1 to 34.8)
GBD super-region												
Central Europe, Eastern Europe, and Central Asia	4.51 (3.79 to 5.58)	−49.9 (−62.3 to −33.4)	0.9 (0.8 to 1.2)	−53.8 (−66.6 to −34.0)	3.36 (3.05 to 3.67)	−50.8 (−58.4 to −42.9)	0.6 (0.5 to 0.6)	−60.7 (−67.0 to −54.2)	113 (101 to 124)	−56.0 (−63.3 to −48.6)	23.3 (20.7 to 25.8)	−59.5 (−66.4 to −52.2)
High-income	15.5 (10.8 to 23.8)	16.4 (−28.2 to 98.6)	1.4 (0.9 to 2.2)	−5.3 (−47.2 to 76.9)	7.28 (6.55 to 7.86)	2.6 (−6.4 to 12.7)	0.4 (0.4 to 0.5)	−35.3 (−40.7 to −29.1)	227 (208 to 247)	−14.6 (−22.1 to −5.1)	18.7 (17.1 to 20.5)	−32.5 (−39.0 to −25.0)
Latin America and Caribbean	8.76 (7.28 to 11.4)	123.8 (65.8 to 208.2)	1.4 (1.2 to 1.9)	9.2 (−15.5 to 50.4)	6.46 (5.97 to 6.95)	116.4 (93.8 to 138.7)	1.0 (0.9 to 1.1)	−6.8 (−16.5 to 2.4)	234 (217 to 253)	74.5 (55.7 to 92.5)	37.8 (35.0 to 41.0)	−3.7 (−13.6 to 6.1)
North Africa and Middle East	8.75 (5.42 to 15.5)	132.4 (11.0 to 384.7)	1.5 (1.0 to 2.6)	15.9 (−42.0 to 136.5)	5.20 (3.86 to 7.20)	110.1 (29.9 to 233.3)	1.0 (0.7 to 1.4)	−3.5 (−41.8 to 51.9)	222 (164 to 312)	68.4 (4.5 to 172.1)	36.9 (27.3 to 51.6)	−11.2 (−44.7 to 41.2)
South Asia	17.9 (10.6 to 27.6)	106.5 (−6.7 to 268.3)	1.0 (0.6 to 1.5)	7.7 (−50.2 to 86.5)	13.9 (7.98 to 20.4)	101.8 (2.9 to 246.2)	0.8 (0.5 to 1.2)	0.4 (−49.2 to 71.5)	649 (367 to 956)	66.9 (−14.7 to 187.7)	33.7 (19.1 to 49.7)	−7.0 (−52.6 to 60.0)
Southeast Asia, East Asia, and Oceania	40.9 (28.8 to 56.4)	220.2 (102.0 to 408.3)	1.6 (1.1 to 2.4)	80.7 (11.8 to 192.5)	30.0 (21.9 to 36.6)	235.2 (121.1 to 356.2)	1.0 (0.8 to 1.3)	51.1 (−3.1 to 106.4)	928 (675 to 1150)	146.3 (70.9 to 234.2)	35.3 (25.7 to 44.7)	44.0 (−1.1 to 98.0)
Sub-Saharan Africa	15.1 (7.87 to 25.3)	112.2 (−9.5 to 321.0)	1.3 (0.7 to 2.1)	−14.3 (−63.1 to 57.5)	10.5 (5.66 to 16.4)	96.4 (−3.1 to 228.9)	1.0 (0.6 to 1.6)	−19.1 (−60.3 to 35.5)	645 (345 to 1020)	90.1 (−6.3 to 221.9)	51.0 (27.7 to 79.7)	−22.7 (−62.0 to 29.3)

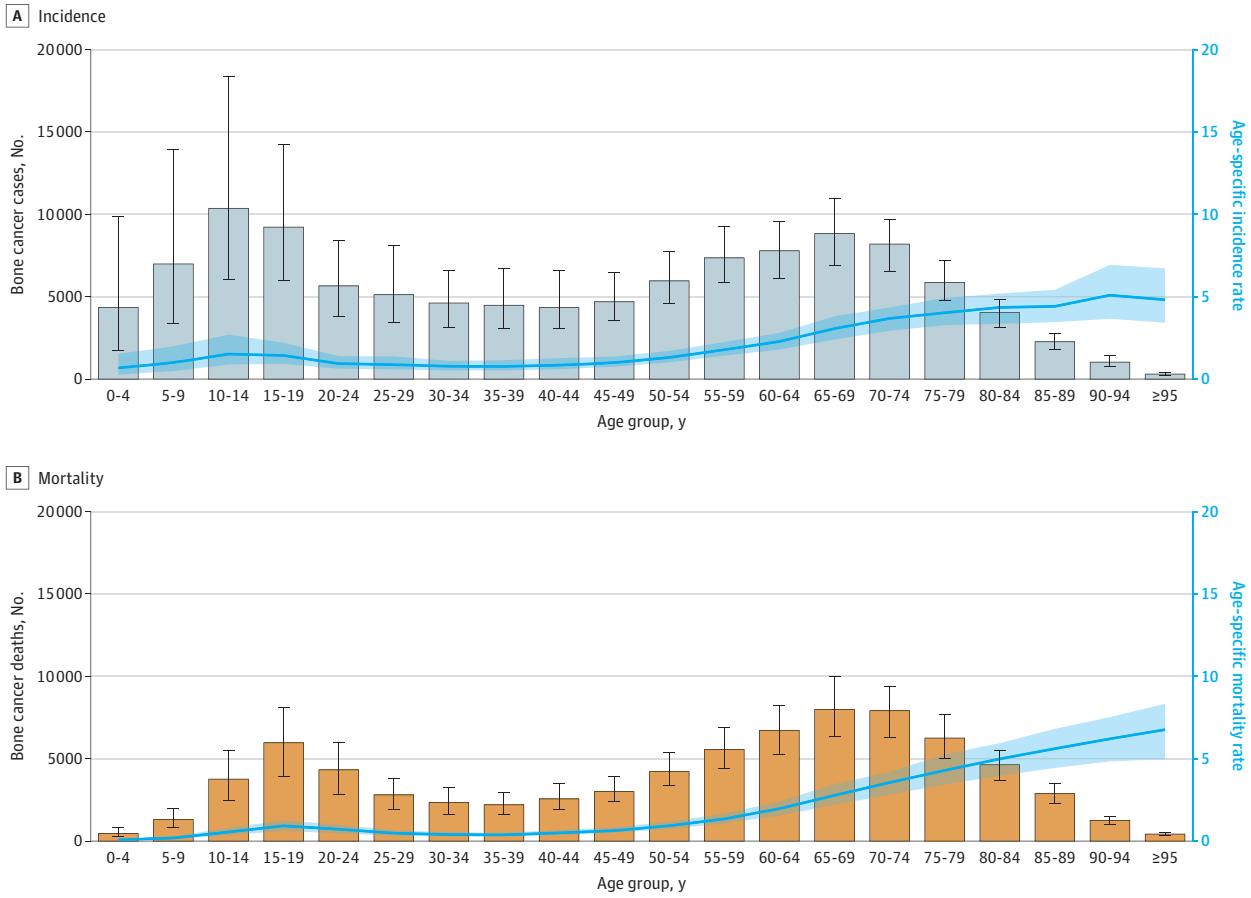
Abbreviations: GBD, Global Burden of Diseases, Injuries, and Risk Factors Study; UI, uncertainty interval.

[a] Values presented are for all ages and both sexes combined.

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Figure 1. Line and Bar Graphs of Global Age-Specific Bone Cancer Counts and Rates for Incidence and Mortality in 2023



Values presented are for both sexes combined. Error bars represent 95% uncertainty intervals. Solid lines represent age-specific values, and shaded areas represent 95% uncertainty intervals. Rates are reported per 100 000 person-years.

Forecasting Bone Cancer Burden, 2024-2050

Detailed forecasting methods have been described previously.[5] The Institute for Health Metrics and Evaluation forecasting framework was used to forecast cause-specific cancer burden from 2024 through 2050 under the reference scenario. Forecasts were based on historical trends in bone cancer burden together with projected changes in Socio-demographic Index (SDI), relevant risk factor exposure (measured as the summary exposure value), fertility rates, age structure, and population growth by age, sex, and location. More details on the forecasting framework have been described previously.[21]

These forecasts were originally produced for GBD 2021 and subsequently shifted to align with GBD 2023 past estimates for 2023 while preserving relative trends over time. More details have been described previously.[5]

Reporting Standards

We provide estimates of incidence, mortality, and DALYs in counts, for all ages combined and by age groups, and age-standardized rates (ASRs) per 100 000 person-years, for 1990 to 2023, and forecasts of bone cancer ASRs for incidence and mortality through 2050.[4,20] ASRs were calculated using the GBD global population structure.[22] 95% Uncertainty intervals (UIs) are presented alongside all point estimates. At each stage of the estimation process, UIs were calculated as the 2.5th and 97.5th percentiles of the distribution of 250 draws. Results for bone cancer are presented at the global level, by GBD super-region,[22] by WBIG,[23] and for 204 countries and territories. Online resources[24,25] include these estimates along with more geographically detailed estimates for national and subnational locations, sex-specific estimates, and additional age groups and additional measures, such as crude rates. Data processing and analysis were performed using Python version 3.10.4 (Python Software Foundation), Stata version 13.1 (StataCorp), and R versions 4.2.1 and 4.4.0 (The R Foundation). The statistical code used for data processing and analysis is available on request. Data were analyzed from June 2023 to July 2025.

Results

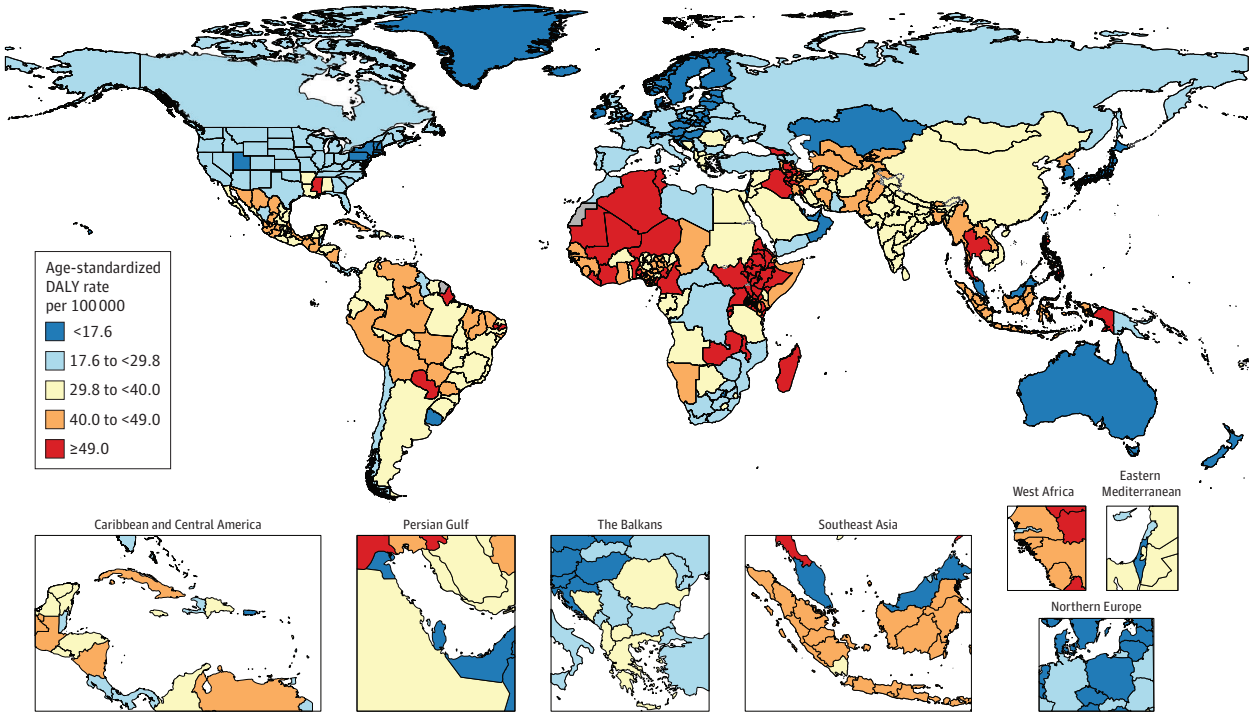
Global Estimates of Bone Cancer Burden in 2023

In 2023, there were 111 000 (95% UI, 81 300-164 000) new bone cancer incident cases globally (**Table**). Among males, the incidence was 61 500 cases (95% UI, 43 200-87 900);

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Figure 2. Global Map of Age-Standardized Disability-Adjusted Life-Year (DALY) Rate Quintiles for Bone Cancer in 2023



Values presented are for all ages and both sexes combined. Quintiles are based on DALYs per 100 000 person-years.

among females, the incidence was 49 900 cases (95% UI, 33 400-81 200).[25] This corresponds to a global incidence ASR for both sexes combined of 1.3 cases (95% UI, 1.0-2.0) per 100 000 (Table). There were 76 600 deaths (95% UI, 60 700-96 300) due to bone cancer worldwide in 2023. There were 43 800 deaths (95% UI, 32 800-60 000) among males and 32 800 deaths (95% UI, 24 700-49 700) among females, yielding a death ASR for both sexes combined of 0.9 deaths (95% UI, 0.7-1.1) per 100 000 (Table).[25] Bone cancers caused an estimated 3.02 million DALYs (95% UI, 2.29 million-3.96 million) or 36.2 age-standardized DALYs (95% UI, 27.1-48.0) per 100 000 worldwide in 2023 (Table).

Age-Specific Global Burden of Bone Cancer in 2023

In 2023, the number of incident cases and deaths due to bone cancer had a bimodal age distribution globally, increasing to an initial peak at age 10 to 14 years for incident cases and age 15 to 19 years for deaths, with the second peak at age 65 to 69 years for both incident cases and deaths (**Figure 1**). The smallest numbers of incident cases and deaths occurred among individuals 95 years and older, followed by those aged 90 to 94 years for incident cases and children younger than 5 years for deaths. Age-specific incidence and mortality rates likewise had small peaks at ages 10 to 14 years and 15 to 19 years, followed by a dip through age 35 to 39 years before increasing through age 90 to 94 years for incidence and 95 years and older for mortality (Figure 1).

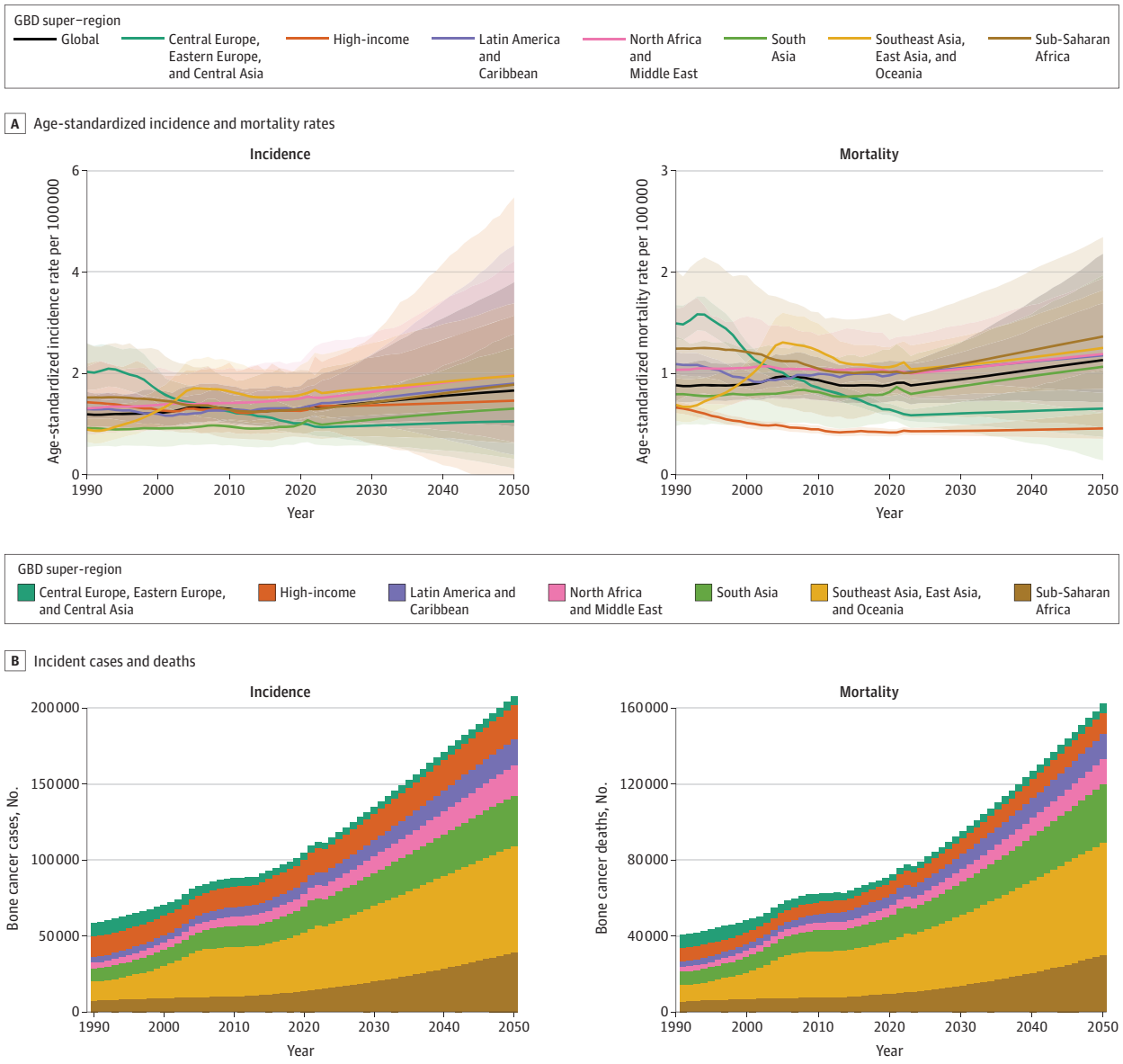
Location-Specific Burden of Bone Cancer in 2023 and Changes Between 1990 and 2023

When assessed by GBD super-region, there was variability in ASRs. In 2023, incidence ASRs were highest in Southeast Asia, East Asia, and Oceania (SEAO; 1.6 incident cases [95% UI, 1.1-2.4] per 100 000) and lowest in Central Europe, Eastern Europe, and Central Asia (0.9 incident cases [95% UI, 0.8-1.2] per 100 000; Table). Estimated mortality ASRs had variation across locations with 1.0 deaths (95% UI, 0.6-1.6) per 100 000 in Sub-Saharan Africa, 1.0 deaths (95% UI, 0.8-1.3) per 100 000 in SEAO, 1.0 deaths (95% UI, 0.7-1.4) per 100 000 in North Africa and the Middle East, 1.0 deaths (95% UI, 0.9-1.1) per 100 000 in Latin America and the Caribbean, 0.8 (95% UI, 0.5-1.2) per 100 000 in South Asia, 0.6 (95% UI, 0.5-0.6) per 100 000 in Central Europe, Eastern Europe, and Central Asia, and 0.4 (95% UI, 0.4-0.5) per 100 000 in the high-income super-region (Table; eFigure in Supplement 1). There was variation in DALY ASRs, which ranged from 51.0 DALYs (95% UI, 27.7-79.7) per 100 000 in Sub-Saharan Africa to 18.7 (95% UI, 17.1-20.5) per 100 000 in the high-income super-region in 2023 (Table).

In 2023, national bone cancer DALY ASRs varied, ranging from 110.5 DALYs (95% UI, 53.7-189.7) per 100 000 in Niger to 2.4 (95% UI, 1.0-6.1) per 100 000 in Palau (**Figure 2**). However, the magnitude of country-level variability differed between GBD super-regions. For example, in Sub-Saharan Africa, there was large variation in DALY ASRs, ranging from 110.5 DALYs (95% UI, 53.7-189.7) per 100 000

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Figure 3. Line and Stacked Area Graphs of Age-Standardized Bone Cancer Incidence and Mortality Rates and Incident Cases and Deaths, 1990-2050



Values presented are for all ages and both sexes combined. Rates are reported per 100 000 person-years. Shaded areas indicate 95% uncertainty intervals. GBD indicates Global Burden of Diseases, Injuries, and Risk Factors Study.

in Niger to 19.0 (95% UI, 12.8-26.8) per 100 000 in South Africa. In contrast, variation was less in South Asia, where rates ranged from 45.4 DALYs (95% UI, 24.7-72.6) per 100 000 in Bhutan to 31.6 (95% UI, 18.2-46.1) per 100 000 in India (Figure 2).

The number of global incident cases, deaths, and DALYs increased between 1990 and 2023 (Table), while the incidence, mortality, and DALY ASRs remained relatively stable. The largest increases in incidence ASRs occurred in SEAO (80.7%; 95% UI, 11.8-192.5), with this super-region increasing from seventh (of 7) in age-standardized incidence and sixth in age-standardized mortality in 1990 to the leading super-region for both measures by 2023 (Table; **Figure 3**). Central Europe, Eastern Europe, and Central Asia was the only super-region to see declines in the number of bone cancer incident cases and deaths over the study period and also experienced the largest decreases in incidence and mortality ASRs (Table; Figure 3).

Income Group–Specific Burden of Bone Cancer in 2023 and Changes Between 1990 and 2023

In 2023, of the WBIGs, bone cancer incidence ASRs were highest in the upper-middle-income group at 1.6 new cases (95% UI, 1.1-2.3) per 100 000 and lowest in the lower-middle-income and high-income groups at 1.2 new cases (95% UI, 0.7-1.8) and 1.2 (95% UI, 0.8-1.9) per 100 000, respectively (Table). In contrast, mortality and DALY ASRs

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were both highest in low-income groups (1.2 deaths [95% UI, 0.6-1.8] and 56.3 DALYs [95% UI, 30.8-86.9] per 100 000) and lowest in high-income groups (0.4 deaths [95% UI, 0.4-0.5] and 18.4 DALYs [95% UI, 17.0-19.9] per 100 000) (Table; Figure 2).

Between 1990 and 2023, high-income groups experienced an estimated change of −26.7% (95% UI, −54.8 to 25.4) in incidence ASRs, alongside marked declines in both mortality (51.6% [95% UI, 48.6-54.4]) and DALY ASRs (49.3% [95% UI, 45.4-52.4]; Table). The upper-middle-income group between 1990 and 2023 had a 59.6% (95% UI, 4.4-152.2) increase in incidence ASRs, an estimated change of 31.6% (95% UI, −4.4 to 67.0) in mortality rates, and an estimated change of 26.9% (95% UI, −3.4 to 58.5) in DALY rates (Table).

Forecasts of Bone Cancer Burden, 2024-2050

Between 2024 and 2050, the global numbers of bone cancer incident cases and deaths are forecasted to increase considerably (77.5% [95% UI, 32.5-125.3] and 100.9% [95% UI, 37.8-174.5] increases, respectively) (Figure 3).[26] SEAO is forecasted to have the largest absolute increases in incident cases and deaths (although Sub-Saharan Africa is forecasted to have the largest relative increases—149.0% [95% UI, 88.9-219.5] and 173.1% [95% UI, 105.8-248.8], respectively), while Central Europe, Eastern Europe, and Central Asia is forecasted to have the smallest increases, both proportionally and in absolute terms. Global ASRs are not forecasted to change significantly over the forecasted period, although mean rates will be slightly higher in 2050, with a global percentage change of 23.7% (95% UI, −5.8 to 56.5) for incidence and 26.9% (95% UI, −9.0 to 72.3) for mortality. In 2050, incidence ASRs are forecasted to be highest in North Africa and the Middle East (2.0 cases [95% UI, 0.6-4.2] per 100 000) and in SEAO (2.0 cases [95% UI, 1.3-3.4] per 100 000), while Central Europe, Eastern Europe, and Central Asia is forecasted to retain the lowest ASR for incidence (1.1 cases [95% UI, 0.1-2.8] per 100 000). Sub-Saharan Africa is forecasted to experience the largest increases in age-standardized mortality (33.6% [95% UI, 6.4-65.8]) and become the highest ASR for mortality by 2050 (1.4 [95% UI, 0.5-2.3] per 100 000). Meanwhile, the high-income super-region is forecasted to retain the lowest mortality rate (0.5 [95% UI, 0.4-0.6] per 100 000), with little change between 2024 and 2050 (6.4% [95% UI, −7.0 to 22.1]) (Figure 3).

Discussion

Main Findings

In 2023, bone cancer accounted for more than 100 000 new cases and 75 000 deaths worldwide, with a bimodal age distribution in both incidence and mortality. Significant disparities persisted across regions and WBIGs, with upper-middle-income economies having the highest ASRs for incidence and low-income economies having the highest ASRs for both mortality and DALYs. Although global cases, deaths, and DALYs increased from 1990 and are forecasted to continue rising through at least 2050, mortality ASRs remain relatively stable. Increases in global incidence and mortality counts likely reflect population growth and aging, while stable ASRs suggest limited change in underlying bone cancer risk.

Age Distribution of Bone Cancer Burden

This study demonstrated a bimodal age distribution in bone cancer incident cases globally, with the highest number of cases occurring in adolescents. Previous studies suggest that this pattern is primarily driven by osteosarcoma.[6,27] A similar bimodal pattern was observed for mortality, although the higher peak occurred in older adults. Survival differences across age groups are likely multifactorial,[28,29] including variations in histologic subtype,[10,30,31] disease location,[8,11,32,33] and treatment tolerance.[34] Adolescents and young adults often face unique care challenges, including fragmented transitions between pediatric and adult oncology systems and unmet psychosocial and rehabilitation needs,[35] which may influence outcomes.

Disease Burden Across Income Groups

Bone cancer incidence, mortality, and DALYs patterns across income groups are likely multifactorial. Lower case counts in high-income countries may reflect differences in population structure, including lower fertility rates and a smaller proportion of children, adolescents, and young adults. Although incidence ASRs were relatively similar across WBIGs from 1990 to 2023, mortality and DALY rates were lower in high-income settings, suggesting a diagnosis-to-outcome gap. Low- and middle-income countries may experience poorer outcomes due to delayed diagnosis,[36] treatment abandonment,[15] and limited access to multimodal treatment[11,37,38] and supportive care.[37,39] Meanwhile, declines in mortality and DALY ASRs in high-income countries may reflect improvements in timely diagnosis, referral systems, and treatment accessibility.[40] These findings underscore persistent global inequities and the need to strengthen timely diagnosis, referral pathways, treatment access,[41-44] and health systems[45-47] in resource-limited settings.

Forecasted Global Burden by Super-Region

In 2023, SEAO had the highest ASRs for bone cancer incidence and mortality, while Sub-Saharan Africa had the highest ASR for DALYs. Forecasts suggest that the largest absolute increases in cases and deaths through 2050 will occur in SEAO, whereas the largest relative increases are expected in Sub-Saharan Africa. From 2024 to 2050, SEAO and North Africa and the Middle East are expected to lead in incidence ASRs, while Sub-Saharan Africa is forecasted to have the highest ASR of mortality by 2050.

These trends may reflect demographic changes by population aging,[4,22,48] heterogeneity in socioeconomic context and health system capacity,[11,27] improvements in diagnostic and cancer registration systems,[49,50] and persistent disparities in access to multidisciplinary care.[11,51,52] The high-income super-region is expected to maintain the lowest ASR of mortality, while Central Europe, Eastern Europe, and Central Asia is forecasted to experience the lowest incident counts and the smallest absolute changes in counts through 2050.

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Suggestions

Given the increasing burden of bone cancer, improving timely diagnosis[53] and referral through robust referral networks, expanding health insurance coverage, and strengthening diagnostic and treatment capacity may reduce late-stage presentation and improve outcomes, particularly in resource-limited settings.[54,55] Cost-effective surgical approaches, such as frozen autografts using liquid nitrogen, may improve quality of life and reduce disability in these settings.[56,57] Expanding rehabilitation and radiotherapy capacity,[58] enhancing workforce training, and implementing quality improvement measures[58] are key strategies to strengthen global bone cancer care systems.

Limitations

Despite its strengths, this study has several limitations. Data scarcity, especially in low- and middle-income countries, and limited medical certification may affect estimate reliability. The analysis modeled malignant neoplasms of bone and articular cartilage as a single cause category and did not include risk factors, such as radiation[59,60] and genetic syndromes,[61] or capture long-term burden of amputation or limb dysfunction. Strengthening cancer registries and VR systems is essential to an improved understanding of cancer burden. Future research by race and ethnicity,[2,3] histologic type, or treatment protocol may better inform targeted policies and public health strategies.

Conclusions

This systematic analysis showed substantial disparities in bone cancer burden across time and geography, with continued disparities forecasted through 2050. Greater disparities in age-standardized mortality and DALYs than incidence suggest gaps in timely diagnosis and access to effective treatment. These findings underscore the need to strengthen early diagnosis, treatment access, and health system capacity, particularly in resource-limited settings.

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