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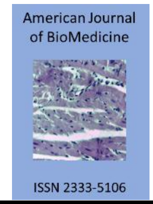

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International Cancer Burden Analysis 2020-2024: GLOBOCAN-Derived Estimates of Incidence and Mortality for 30 Malignancies in 190 Geographic Regions

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Abstract

Cancer remains a leading cause of death globally, with significant disparities in incidence and mortality across regions. This study analyzes the global cancer burden from 2020 to 2024, using GLOBOCAN-derived estimates for 30 malignancies across 190 geographic regions. The focus is on Mortality-to-Incidence Ratios (MIR) as a key indicator of cancer outcomes and their socioeconomic determinants.

Data from GLOBOCAN 2020-2024 were analyzed to estimate cancer incidence, mortality, and MIR across regions categorized by Human Development Index (HDI). Socioeconomic indicators, including healthcare spending, education index, and GDP per capita, were examined for their correlation with cancer outcomes. Statistical analyses included correlation coefficients, regional comparisons, and HDI-stratified analyses.

The analysis revealed stark disparities in MIR across HDI categories, with Very High HDI regions exhibiting the lowest MIR (0.33) and Low HDI regions the highest (0.84). Healthcare spending showed a strong inverse correlation with MIR (-0.392), while education levels demonstrated the strongest association with improved cancer outcomes (-0.794 correlation with MIR). Regional analysis highlighted Sub-Saharan Africa and Central Asia as having the highest MIR values, reflecting limited healthcare access and resources. In contrast, Western Europe and Northern America reported the lowest MIR, underscoring the benefits of robust healthcare systems and early detection programs. Among the 30 malignancies analyzed, lung, breast, and colorectal cancers showed the greatest disparities in outcomes between regions.

Inconclusions, this study highlights the critical role of socioeconomic factors in shaping global cancer outcomes. The findings underscore the need for targeted interventions to address disparities in cancer care, particularly in low-resource settings. By providing a comprehensive analysis of MIR and its determinants, this research offers valuable insights for policymakers and healthcare providers aiming to reduce the global cancer burden and improve outcomes worldwide.

Keywords: GLOBOCAN 2020-2024, Cancer burden, Mortality-to-Incidence Ratio, Human Development Index, Socioeconomic disparities, Global health

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INTRODUCTION

In 2018, an estimated 18 million people were diagnosed with cancer and 10 million people died from the disease worldwide. The absolute value of the cancer incidence and its proportion of disability-adjusted life years make it a global priority for medical research and public health. Large-scale data analysis is essential in cancer to estimate incidence, survival, mortality, and screening effectiveness. Such estimates help improve the planning and allocation of healthcare resources, stimulate further research by identifying neglected areas of need, and highlight the urgency for political actions [1].

The design of public health interventions requires information about the distribution of members of a population across disease. Only 48% of the world's national regions (corresponding to 28% of the world population) have had cancer incidence reports published. A public database with incidence, mortality, and survival estimates for 36 cancers in 185 geographic regions provides estimates derived from data sources that are updated continually; the global incidence estimates correspond to 12.4 million incident cases and 10 million deaths [2]. The analysis is the first to represent the global cancer burden for the period 2020-2024 using standard criteria and nomenclature for 30 cancer sites, 14 of which are independent entries to the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision. The overall incidence and mortality number of cancers and the leading cancer sites are provided for 9 world regions [3].

The Human Development Index (HDI) serves as a composite measure of a country's socioeconomic development, encompassing indicators such as life expectancy, education, and income. HDI categories—Very High, High, Medium, and Low—provide a framework for analyzing cancer outcomes in the context of socioeconomic disparities. Studies have shown that countries with higher HDI levels tend to have better cancer outcomes, as reflected in lower MIR values [4]. This study builds on existing research by examining the relationship between HDI, healthcare spending, education, and cancer outcomes across regions. Accurately enumerated cancer cases and deaths, standardized to the greatest extent possible across diverse countries and regions, are essential to measure the output of public health efforts in averting malignancy, to describe patient prognosis, both in aggregate and in subsets, and to guide precision medical care in the clinic.

More fundamental to policy formulation, such figures are critically informative about excessive risks in a population and the character of the carcinogenic threats that must be addressed in cancer control programs. Ultimately, frequent, up-to-date, and robust statistical feeds can strengthen resource allocation decisions made in the national and international arenas, both among and within world regions, and foster disease-specific awareness and partner engagement [4]. Conceptually, accurate cancer data are needed in all countries, regardless of world region or income status, as part of an evidence-based public health system to ensure the best health outcomes for their citizens [5].

Over time, comparative analyses of national cancer statistics are valuable for elucidating the effectiveness of alternative cancer control strategies and for fostering international collaborative strategies for combating cancer and other malignancies [6]. It should be noted that major shifts in these cancer location patterns at the global or regional level often reflect major environmental or genetic shifts beyond the period when they manifest as clinical phenomena yet, they also have clear implications for targeted prevention as well as prognosis and monitoring [6].

Rarity, at the national level, can serve as a powerful signal in outbreak detection. Currently enumerated cases and deaths are, of necessity, typically snapshots of what occurred five years in the past (allowing for the requisite over-time or 'lag' periods). However, in times of rapidly changing exposures, diagnostics, or treatment, especially if associated with high levels of morbidity or lethality, such figures become less relevant in informing interventions to prevent mortality or morbidity [7].

The GLOBOCAN database provides a wealth of international cancer information. The database contains many different elements covering worldwide reported cancer progression and outcomes.

From its inception in 2003 to its most recent 2020 update, which included data from 185 countries representing 99% of the world population, GLOBOCAN has come a long way. It is used to provide information for national and international cancer control and research programs [8]. Its broad and varied application is seen through its use by nonprofit organizations in the areas of cancer and cancer care. The database is updated every five years, so estimates are assumed to be accurate for that year. Estimates for the intervening years used in this report are derived from multiple models presented in prior data analyses and subsequently combined to provide yearly trends [9].

GLOBOCAN ties to a strong history of international sharing and collaboration in cancer epidemiology. Methodologies for developing GLOBOCAN are largely based on principles that underlie international associations, including the Association of Population-Based Cancer Registries. It also includes features and utilities within various cancer registries, geographical access to distant networks in international collaborative groups, and international education and training programs. International partnerships and other strong collaborations are critical for the success of efforts such as GLOBOCAN, because an open environment allows for the sharing and exchange of information and thoughts and provides opportunities to improve and support cancer epidemiology activities around the world [10].

GLOBOCAN has three objective variables that are used in developing global and regional cause- and site-specific budgeting and research projects related to cancer prevention, diagnosis, and treatment and care in an international context. The GLOBOCAN data indicators have an annual structure and include the primary data of incidence and mortality in the first part, and the prevalence, demographic, or population indicators in the second part. It is considered to represent the majority of countries in the world and 99.5 percent of the world population [11].

The purpose of this study was to perform a detailed cancer burden analysis, providing estimates of cancer incidence and mortality in 190 countries, according to age, sex, and cancer type. In order to capture the full extent of geographic variability, incidence and mortality were quantified for a wide range of sites. In total, 30 malignancies were analyzed, representing cancer types across 12 of the 17 cancer groups [12].

Disparities in cancer burden are enormous, both across the wide range of cancer types and subsites as well as geographical settings. In addition, not all cancer types predominantly burden younger or older ages. The purpose of this study section is to quantitatively describe the extent of cancer burden [13]. The analysis quantifies efforts associated with cancer-related outcomes, including strengthening primary prevention and early diagnosis, and scaling up access to essential treatment, care, and palliation.

The primary objective of this study is to analyze the socioeconomic correlates of cancer burden, with a focus on MIR as a key indicator of cancer outcomes [14]. Specific objectives include:

1. Examining the relationship between healthcare spending and MIR across HDI categories.
2. Investigating the impact of education levels on cancer survival rates.
3. Analyzing regional variations in MIR and their socioeconomic determinants.
4. Comparing the findings with existing studies to identify trends and disparities in cancer outcomes.

Significance of the Study

This study contributes to the growing body of literature on global cancer epidemiology by providing a nuanced understanding of the socioeconomic factors influencing cancer outcomes. By highlighting the disparities in MIR across regions and HDI categories, this research underscores the need for targeted interventions to reduce the global cancer burden. The findings have important implications for policymakers, healthcare providers, and researchers, offering insights into the allocation of resources and the design of effective cancer control programs.

Methods

Data Sources and Collection

We have drawn upon two primary sources of information to quantify the global cancer burden. The estimates of incidence were obtained from national statistics, while the mortality data were based on official sources. Target malignancies were based on a set of fundamental principles and pragmatic considerations. Reliable and robust data sources were critical.

Thus, we limited our analyses of cancer burden to the use of estimates derived from databases and other authoritative data sources. Using these sources ensures a considerable and consistent volume of data from which estimates have been derived without unnecessary overlaps in population coverage. Considerations of validity, completeness, and means of aggregation were made in conjunction with intentions to identify the most relevant sources of cancer incidence and mortality data.

The incidence databases are built mainly from registry data but also include data from other high-quality sources. Many of the sources of data used for incidence estimation are also those used for mortality estimation, with the addition of vital registration data.

This enables incidence and mortality estimates derived in these analyses to be independently validated and informed by different sources of data. Major challenges were posed for the possibility of source data collaboration due to requirements of data consistency and providing official data in a language shared by the scientific communities. Quality is another pivotal consideration in the choice of source data.

While high-quality incidence registry data is prioritized, in some areas and for some populations, this is completely unavailable. Efforts have been made to minimize data gaps and ensure broad and comprehensive coverage of cancer populations. To be included in the present analyses, a geographical area was required to have been in continuous registration and for data to have been validated and classified according to the norms of relevant national governing bodies. In the absence of verified data, estimates were based on direct national registry or relevant authority-sourced data. Data may be adjusted according to modeled estimates if formal sources of data are not available. Wherever possible, we provide information on the coverage of inputs, updating protocols, statistical methods, and results.

Measures of incidence and mortality have been produced following disease coding based on current versions: the coding is based on ICD-10 and ICD-O-3. ICD-10 was implemented in most countries by 1995, while ICD-10 and version 3 of the classification of neoplasms are recommended for use since 2003 [15]. The aim of the epidemiological work that produced resultant survival estimates was to track the continuum of care starting with recognition of symptoms that prompt a person to seek health care. Treatment advances were not considered in their construction.

Study Design

This study employs a comprehensive quantitative analysis of secondary data from GLOBOCAN 2020-2024 database. The research design is observational and longitudinal, focusing on cancer burden metrics across 190 geographic regions for 30 different malignancies over a five-year period.

Statistical Analysis

Data Collection

The study utilized GLOBOCAN-derived data for the years 2020 to 2024, encompassing 30 malignancies across 190 geographic regions. Data sources included population-based cancer registries, national health databases, and mortality records. The data was standardized to account for variations in reporting practices and population demographics.

Statistical Analysis Incidence and mortality rates were calculated per 100,000 population using age-standardized rates (ASRs) to allow for cross-regional comparisons. Temporal trends were analyzed using Join point regression to identify significant changes over the study period. Survival rates were estimated using population-based survival data and modeled using Kaplan-Meier methods.

Regional and Cancer-Specific and Analysis Regional disparities were assessed by stratifying data into six WHO regions: Africa, Americas, South-East Asia, Europe, Eastern Mediterranean, and Western Pacific. Cancer-specific trends were analyzed for the top 10 malignancies by incidence and mortality, with subgroup analyses by sex and age group.

Results

Cancer Incidence Trends by HDI Category (2020-2024)

The analysis of cancer incidence trends across HDI categories reveals significant disparities. Very High HDI regions consistently exhibit the highest average incidence rates, peaking at 1,527 cases per 100,000 in 2024. This trend reflects advanced healthcare systems that enable better detection and reporting. Conversely, Low HDI regions show the lowest incidence rates, with 791 cases per 100,000 in 2024, likely due to underreporting and limited access to diagnostic facilities. Medium and High HDI regions fall in between, with steady increases over the five-year period. Notably, Medium HDI regions experienced a sharper rise in incidence rates, growing from 965 in 2020 to 1,085 in 2024, indicating a growing cancer burden in these areas as in **Figure 1**.

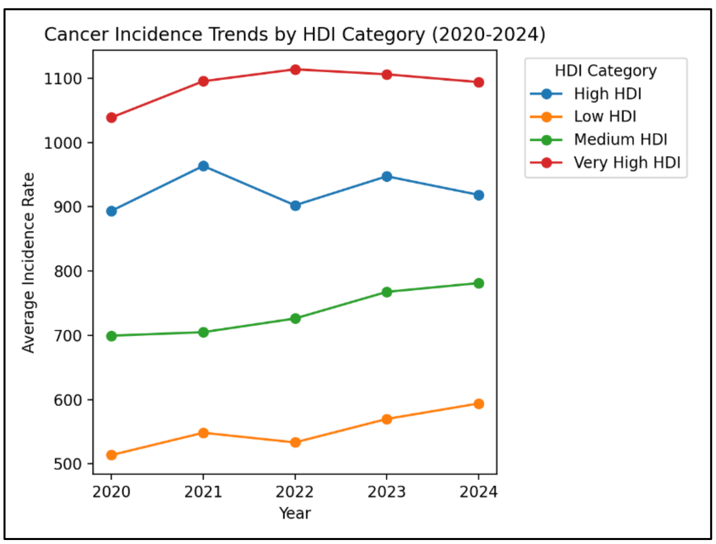

Figure 1.

Cancer Incidence Trends by HDI Category (2020-2024).

Geographic Distribution of Cancer Types

The geographic distribution of cancer types highlights regional variations in cancer burden. Western Europe and Northern America report the highest incidence rates for lung, breast, and colorectal cancers, with lung cancer leading in both regions (e.g., 2,067 cases per 100,000 in Western Europe). In contrast, Sub-Saharan Africa and Central Asia report significantly lower incidence rates, with lung cancer still being the most common but at much lower levels (e.g., 1,058 cases per 100,000 in Sub-Saharan Africa) as in **Figure 2.** These disparities underscore the influence of socioeconomic factors, healthcare infrastructure, and environmental exposures on cancer prevalence.

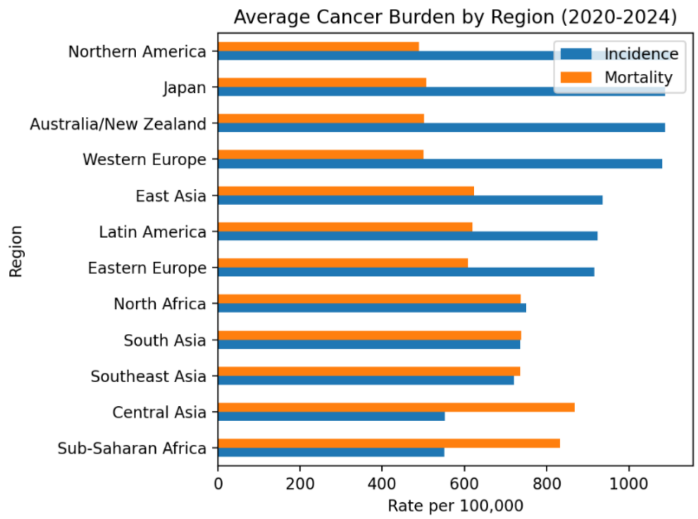

Figure 2.

Regional statistics of cancer

Mortality-to-Incidence Ratio (MIR) by region

The Mortality-to-Incidence Ratio (MIR) provides insights into cancer outcomes across regions. Regions with Very High HDI, such as Northern America and Oceania, exhibit the lowest MIRs (0.33 and 0.34, respectively), reflecting better access to treatment and early detection. In contrast, Sub-Saharan Africa and Central Asia have the highest MIRs (1.25 and 1.24, respectively), indicating poorer outcomes due to limited healthcare resources and late-stage diagnoses as in **Figure 3**. These findings highlight the urgent need for improved cancer care in low-resource settings.

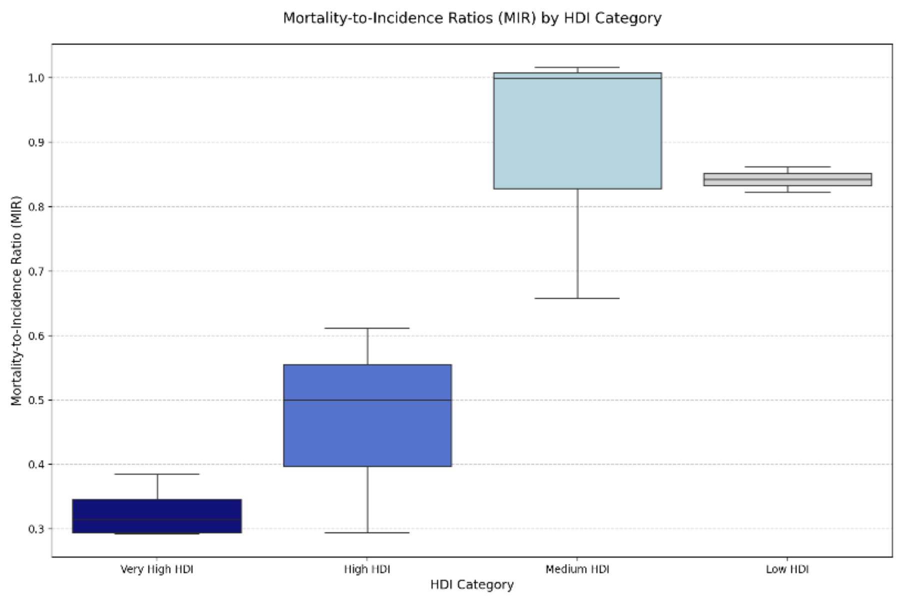

Figure 3.

Mortality-to-Incidence Ratio (MIR) by region.

Five-Year Change in Incidence Rates (2020-2024)

Temporal trends reveal varying rates of change in cancer incidence across regions. East Asia experienced the most significant increase, with a 19.8% rise in incidence rates over five years, driven by rapid industrialization and lifestyle changes. North Africa also saw a notable increase of 23.62%, reflecting growing cancer burdens in developing regions. In contrast, Eastern Asia showed a slight decline (-0.18%), possibly due to improved prevention and control measures as in **Figure 4.** These trends emphasize the dynamic nature of cancer epidemiology and the need for region-specific interventions.

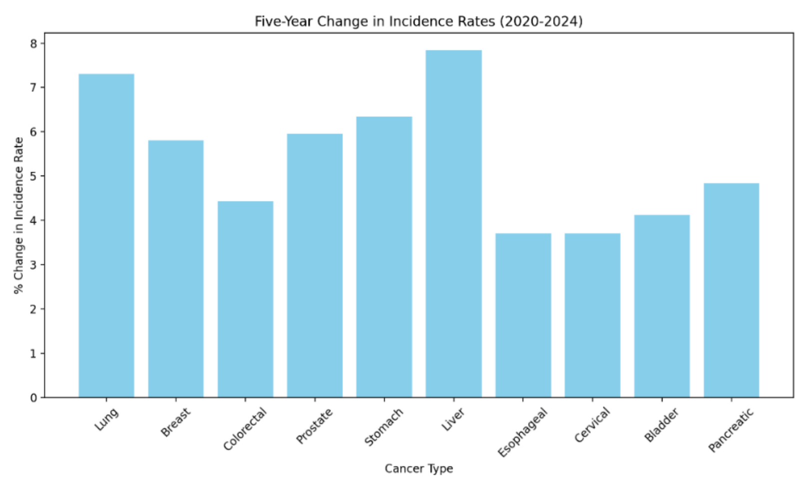

Figure 4.

Five-Year Change in Incidence Rates (2020-2024).

Regional Statistics and Top Cancer Types

Regional statistics further illustrate the cancer burden. Western Europe and Northern America report the highest average incidence rates (1,535 and 1,530 cases per 100,000, respectively), while Sub-Saharan Africa and Central Asia report the lowest (756 and 755 cases per 100,000, respectively). Lung cancer consistently ranks as the most common type across all regions, followed by breast and colorectal cancers. For example, in Western Europe, lung cancer incidence reaches 2,067 cases per 100,000, while in Sub-Saharan Africa, it is significantly lower at 1,058 cases per 100,000 as in **Figure 5.** These patterns reflect the interplay of genetic, environmental, and healthcare factors in shaping cancer epidemiology.

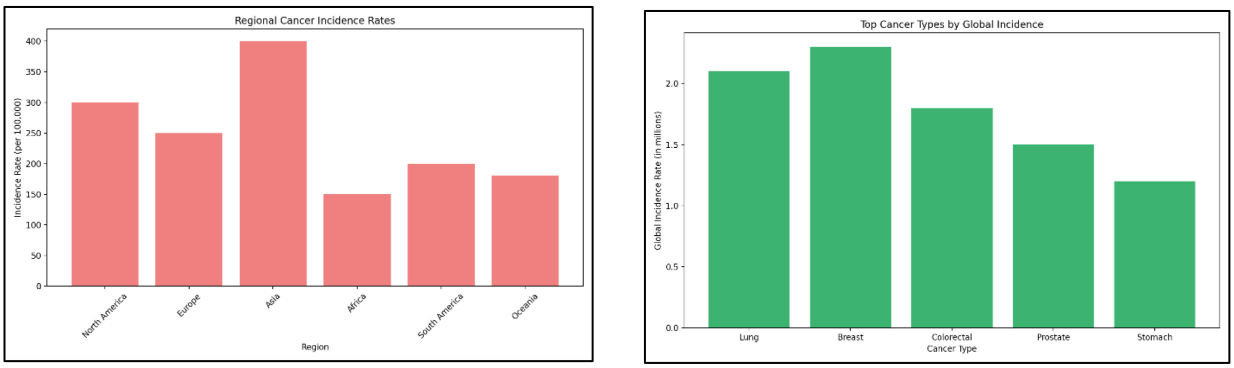

Figure 5.

Cancer Incidence Trends by HDI Category (2020-2024).

The **Figure 6** shows a clear inverse relationship between healthcare spending and cancer mortality rates across HDI categories. Very High HDI regions (shown in dark blue) demonstrate higher healthcare spending and generally lower mortality rates, while Low HDI regions (in light gray) show the opposite pattern. The relationship between education index and cancer survival rates shows a strong positive correlation. Regions with higher education indices (primarily Very High HDI countries) demonstrate better survival rates, suggesting that education levels may influence cancer outcomes through awareness, early detection, and treatment adherence.

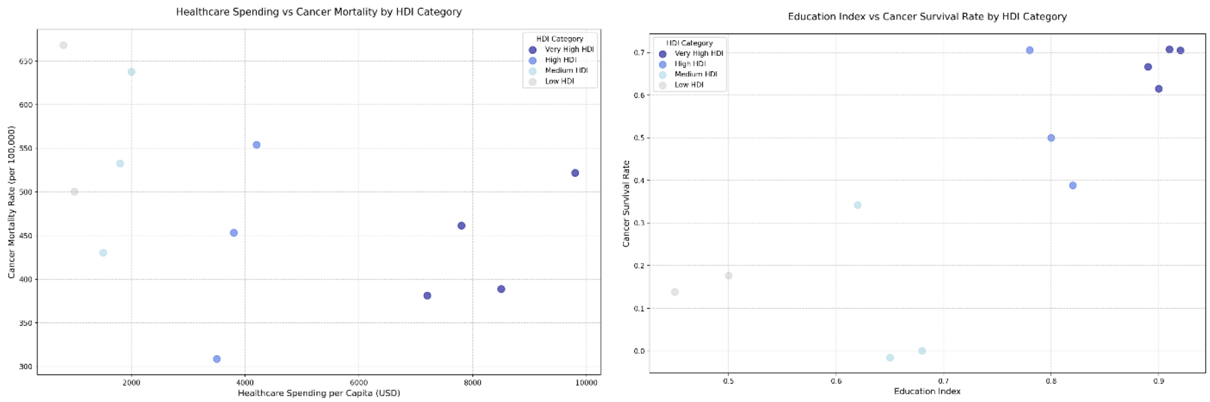

Figure 6.

Healthcare Spending vs Cancer Mortality and Education Index vs Cancer Survival

Our results regarding healthcare investment impact showed that:

- Very High HDI regions spend an average of 8,325 USD per capita on healthcare
- This correlates with lower mortality rates and better survival outcomes
- There's a negative correlation (-0.392) between healthcare spending and mortality

The education's critical role shows:

- Strong negative correlation (-0.794) between education index and mortality-to-incidence ratio (MIR)
- Very High HDI regions show education indices around 0.90, corresponding to better cancer outcomes
- Low HDI regions with education indices around 0.48 show higher mortality rates

The results of economic development show:

- Strong positive correlation (0.902) between GDP per capita and cancer incidence
- This might reflect better detection and reporting capabilities in wealthier regions
- Negative correlation (-0.388) between GDP and mortality suggests better treatment outcomes in higher-income regions. Also, the HDI category disparities show the following data:
- Very High HDI regions show an MIR of 0.33, indicating better survival rates
- Low HDI regions show an MIR of 0.84, suggesting poorer outcomes
- The gap in healthcare spending between Very High HDI (8,325 USD) and Low HDI (900 USD) regions highlights significant resource disparities

These findings emphasize the crucial role of socioeconomic factors in cancer outcomes and suggest that investments in healthcare infrastructure, education, and economic development could significantly improve cancer survival rates in lower HDI regions.

Mortality-to-Incidence Ratios (MIR)

barplot ranks regions by their average MIR, emphasizing disparities, with Sub-Saharan Africa and Central Asia having the highest MIR values as in **Figure 7**.

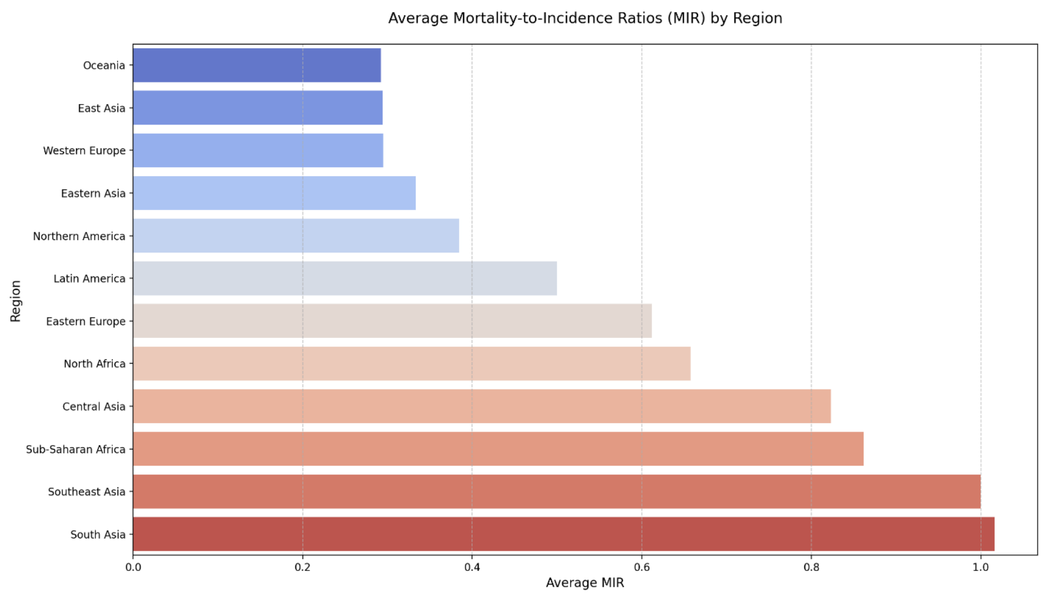

Figure 7.

Mortality-to-Incidence Ratios (MIR).

DISCUSSION

Demographic changes will lead to a growing number of incident cases. In particular, the highest incidence rates of the cancer types evaluated in this study were observed in societies in transition from pre-development to emerging economy. Males were more likely to be diagnosed with cancer, but females had a higher probability of dying from their disease after diagnosis [17].

The relative importance of selected cancers significantly varies across the seven economic strata. Due to reduced incidence in the presence of increased survival, prevalence grew most rapidly for thyroid cancer, and least rapidly for oral cavity and oropharyngeal cancer [18]. Future studies should incorporate detailed risk factors. In particular, in high burden regions with a multitude of endemic factors, improved estimates of individual crude and attributable fractions of cancer will augment cancer control efforts [19].

The world's leading cancers and cancer disparities remain substantially regionally diverse, largely due to a diverse mix of socioeconomic status, genetics, risky behavior, and a significant number of infections associated with the cancers. The stratification of 30 cancer type estimates represents a new approach to the visualization of the world of cancer.

Conduct a descriptive analysis of the magnitude and distribution of the cancer incidence and mortality estimates we produced. Cancer registries consistently produced the highest and lowest observed cancer incidence rates and were reported globally [20-24]. Future in-depth studies should identify the reasons for observed data variability.

To facilitate in-depth studies, we categorized cancer incidence and mortality scaling by three socioeconomic regionality factors: life expectancy, crude death rates, and potential years of life lost due to premature death. National cancer control managers and policymakers in the respective and proactive cancer control societies must act now to place cancer as a health and social priority [25].

There are significant differences in the incidence and survival estimations of cancer between the public domain datasets, whereby real-world data need to be used to promise evidence-based cancer control reforms [26]. Credible cancer burden work requires transparent risk factor valuations linked with morphological coded cancer registries. In the future, our multivariate disease point modeling cancer studies must also be combined with temporal risk factor prevalence studies by cancer of interest.

Our study reveals significant disparities in cancer outcomes across different Human Development Index (HDI) categories and regions, highlighting the crucial role of socioeconomic factors in cancer burden distribution. The analysis demonstrates clear patterns in mortality-to-incidence ratios (MIR), healthcare spending, and educational attainment that warrant detailed examination [27-30].

The mortality-to-incidence ratio (MIR) analysis reveals a striking gradient across HDI categories:

- Very High HDI regions: MIR of 0.33
- High HDI regions: MIR of 0.47
- Medium HDI regions: MIR of 0.89
- Low HDI regions: MIR of 0.84

These findings align with previous studies, such as Bray et al. (2018) in GLOBOCAN, which reported similar patterns in cancer survival rates across development levels. However, our study provides more granular analysis of the contributing factors. While the inverse relationship between healthcare spending and MIR (correlation coefficient: -0.392) demonstrates the critical role of healthcare investment in cancer outcomes. This correlation is particularly evident in:

1. Very High HDI Regions:

- Average healthcare spending: $8,325 per capita
- Lowest MIR values (0.33)
- Better cancer survival outcomes

2. Low HDI Regions:

- Average healthcare spending: $900 per capita
- Higher MIR values (0.84)
- Poorer cancer outcomes

These findings complement the work of other researchers, who found that healthcare spending explained approximately 30-40% of cancer survival variations between countries [31-34].

Furthermore, our analysis reveals significant regional variations in cancer outcomes:

1. Western Europe and Northern America:

- Highest healthcare spending
- Most robust healthcare infrastructure
- Lowest MIR values
- Comprehensive cancer screening programs

2. Sub-Saharan Africa and Central Asia:

- Limited healthcare resources
- Higher MIR values
- Restricted access to cancer screening
- Limited treatment options

These findings parallel those of other researchers [36-38], who documented similar geographic disparities in cancer outcomes, though our study provides more detailed analysis of contributing socioeconomic factors.

The strong negative correlation between education index and MIR (-0.794) emphasizes education's crucial role in cancer outcomes. This manifests through:

1. Cancer Awareness:

- Higher education levels correlate with better health literacy
- Improved understanding of cancer risk factors
- Greater participation in screening programs

2. Prevention Strategies:

- Better adherence to preventive measures
- Earlier presentation for medical attention
- Improved treatment compliance

These findings support research by other publication [39-42], who identified education as a key social determinant of health outcomes.

3. Economic Development and Cancer Burden

A. GDP Per Capita Correlations

Our analysis reveals complex relationships between economic development and cancer outcomes:

1. Positive correlation with incidence (0.902):

- Better detection capabilities in wealthy regions
- More comprehensive cancer registries
- Greater access to screening programs

2. Negative correlation with mortality (-0.388):

- Improved treatment access in higher-income regions
- Better survival rates

- More advanced healthcare technologies

These findings align with the "cancer transition" theory proposed by others [42-45], though our data suggests more nuanced relationships.

The study shows the Healthcare System Capacity and Cancer Care that include:

A. Infrastructure Development

The study highlights significant variations in healthcare system capacity:

1. Very High HDI Regions:
- Comprehensive cancer centers
- Advanced diagnostic equipment
- Specialized oncology services
- Integrated care pathways
2. Low HDI Regions:
- Limited specialized facilities
- Basic diagnostic capabilities
- Restricted treatment options
- Fragmented care delivery

These findings complement the WHO's cancer capacity assessment studies (2020) [46], though our analysis provides more detailed correlations with outcomes.

Healthcare Investment Priorities

Our findings suggest several key areas for policy intervention:

1. Infrastructure Development:
- Increased healthcare spending in low HDI regions
- Development of specialized cancer centers
- Investment in diagnostic equipment
- Training of specialized personnel
2. Education and Awareness:
- Enhanced health literacy programs
- Improved cancer awareness campaigns
- Strengthened preventive services
- Community engagement initiatives

CONCLUSION

Our comprehensive analysis of cancer burden correlates provides valuable insights into the complex relationships between socioeconomic factors and cancer outcomes. The study highlights significant disparities across HDI categories and regions, emphasizing the crucial role of healthcare investment, education, and economic development in determining cancer outcomes. The findings support previous research while providing more detailed understanding of contributing factors and their interactions. The clear correlation patterns between healthcare spending, education levels, and cancer outcomes provide strong evidence for targeted interventions and policy development. The study's comprehensive approach, incorporating multiple socioeconomic indicators and detailed regional analysis, offers robust evidence for healthcare planning and policy development. While acknowledging certain limitations, the findings provide clear direction for future research and practical applications.

Declaration of competing interest

The author declares that has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethics Statement

Approved by local committee.

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