Non Comunicable Diseases

Global Disparities in Colorectal Cancer: Unveiling the Present Landscape of Incidence and Mortality Rates, Analyzing Geographical Variances, and Assessing the Human Development Index

DARMADI DARMADI[1], ABDOLLAH MOHAMMADIAN-HAFSHEJANI[2], SOLEIMAN KHEIRI[3]
[1] Department of Internal Medicine, Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia;
[2] Assistant Professor of Epidemiology, Modeling in Health Research Center, Shahrekord University of Medical Sciences, Shahrekord, Iran; [3] Professor of Biostatistics, Department of Epidemiology and Biostatistics, School of Public Health, Shahrekord University of Medical Sciences, Shahrekord, Iran

Keywords

Incidence • Mortality • Colorectal cancer • Geographical disparities • Human Development Index

Summary

Background. *Colorectal cancer poses a major global health threat, with increasing incidence and mortality rates worldwide. This study examined the incidence and mortality rates of colorectal cancer globally in 2020 and explored the relationship with the Human Development Index (HDI).*

Material and methods. *This research utilizes data from the International Agency for Research on Cancer's (IARC) GLOBOCAN 2020 project, an esteemed source of up-to-date international cancer statistics. Age-standardized incidence rates (ASIR) and age-standardized mortality rates (ASMR) per 100,000 individuals were calculated. The association between ASIR, ASMR, and the HDI was analyzed using Pearson correlation, considering a statistical significance threshold of $p < 0.05$.*

Results. *In 2020, a total of 1,931,590 new colorectal cancer cases were recorded globally, with a male predominance of 55.18%. The global colorectal cancer ASIR was 19.5 per 100,000 (23.4 in males, 16.2 in females). Furthermore, there were 935,173 colorectal cancer-related mortality, with males accounting for 55.13%. The overall colorectal cancer ASMR was 9 (11 in males, 7.2 in females). A strong positive correlation emerged between ASIR and ASMR (0.895, $p \leq 0.001$), HDI (0.794, $p \leq 0.001$), life expectancy (0.724, $p \leq 0.001$), education (0.743, $p \leq 0.001$), and income (0.706, $p \leq 0.001$). Similarly, positive correlations were also found between ASMR and HDI (0.638, $p \leq 0.001$), life expectancy (0.569, $p \leq 0.001$), education (0.631, $p \leq 0.001$), and income (0.512, $p \leq 0.001$).*

Conclusions. *This global analysis highlights rising colorectal cancer incidence and mortality as a major public health threat worldwide. The findings reveal a positive association between a country's development level, as measured by HDI, and colorectal cancer incidence and mortality.*

Introduction

Colorectal cancer poses a major global health concern, with rising incidence and mortality rates worldwide [1, 2]. In 2018, there were 1,849,518 new cases of colorectal cancer, accounting for 10% of all newly diagnosed cancers globally [3]. Additionally, there were 880,792 deaths attributed to colorectal cancer, representing 9.2% of all cancer-related deaths [3]. It ranks third among the most common cancers and stands as the second leading cause of cancer-related deaths [1, 2]. The geographical distribution of colorectal cancer exhibits substantial disparities, with higher rates reported in developed countries compared to developing nations [4]. These variations can be attributed to differences in risk factors, healthcare infrastructure, and socioeconomic factors [5, 6].

Colorectal cancer arises from the malignant transformation of the colon or rectal epithelium and is influenced by a complex interplay of genetic and environmental factors [7]. Lifestyle choices, such as diet, physical activity, and tobacco use, have been identified as modifiable risk factors for colorectal cancer [8, 9]. Additionally, age, family history of the disease, and certain hereditary syndromes contribute to an individual's susceptibility to colorectal cancer [10]. This highlights the need for public health strategies promoting increased physical activity, healthy diets, smoking cessation, and other beneficial lifestyle changes as part of comprehensive colorectal cancer control.

Research on the global burden of colorectal cancer has identified the Human Development Index (HDI) as a significant factor influencing its incidence and mortality rates. The HDI is a composite metric of social and economic development that includes factors such as life expectancy, education, and income [11]. Research has shown a positive correlation between higher HDI levels and increased colorectal cancer incidence, attributed to increased availability and utilization of screening and diagnostic procedures in more developed nations [4, 12, 13]. In 2018, the incidence of colorectal cancer was highest in areas with very high HDI, with a rate of 61.4 cases per 100,000 population. High

HDI areas had an incidence rate of 24.1, followed by medium HDI areas at 6.35, and low HDI areas at 3.6. The mortality rate due to colorectal cancer also varied based on the level of development, with very high HDI areas having a mortality rate of 27.1, followed by high HDI areas at 13, medium HDI areas at 3.9, and low HDI areas at 2.75 [3].

Though colorectal cancer incidence has declined in some high-income countries, it is rising in several low- and middle-income regions, underscoring the pressing need for comprehensive prevention and control strategies [14]. Early detection through screening programs, coupled with effective treatment modalities, can significantly improve patient outcomes and reduce mortality rates [1]. This paper aims to explore global colorectal cancer incidence, mortality, and geographical disparities, correlating them with the HDI. By analyzing available data, we aim to pinpoint key drivers of the colorectal cancer burden and propose evidence-based strategies for prevention, early detection, and treatment. Understanding the worldwide landscape of colorectal cancer is vital for guiding public health policies and interventions to mitigate its impact on individuals and communities.

Materials and Methods

This research utilizes data from the International Agency for Research on Cancer's (IARC) GLOBOCAN 2020 project, an esteemed source of up-to-date international cancer statistics. The database includes information on the incidence and mortality rates of different types of cancer across 184 countries. It covers a wide range of cancer types, age groups, genders, and global regions. Developed by the World Health Organization (WHO), GLOBOCAN enables researchers to thoroughly investigate and compare cancer rates based on multiple criteria. As a highly reliable data source, GLOBOCAN provides the foundation for analyzing colorectal cancer incidence and mortality in this study [14-16].

This study primarily analyzes the Age-Standardized Incidence Rate (ASIR) and Age-Standardized Mortality Rate (ASMR) of colorectal cancer. The analysis categorizes and presents the rates based on multiple criteria: Continents: Latin America and Caribbean, Africa, Northern America, Oceania, Europe, Asia. WHO regions: Africa (AFRO), East Mediterranean (EMRO), Americas (PAHO), South-East Asia (SEARO), Europe (EURO), Western Pacific (WPRO). Global regions: Southeastern Asia, Western Asia, South-Central Asia, Eastern Asia, North America, South America, Central America, Middle Africa, Western Africa, Southern Africa, Northern Africa, Eastern Africa, Central/Eastern Europe, Southern Europe, Northern Europe, Western Europe, Caribbean, Australia/New Zealand, Melanesia, Micronesia, Polynesia. Income level: Low-income, lower-middle income, upper-middle income, High-income. The standardized rates allow comparative analysis of colorectal cancer incidence and mortality across these different geographic regions and economic groups.

Human Development Index (HDI)

The HDI is a comprehensive measure that assesses a country's achievements in key dimensions of human development. These dimensions include education, life expectancy, and per capita income. By taking the geometric mean of normalized indices for each dimension, the HDI produces values that range from 0 to 1. In essence, the HDI provides a multi-faceted evaluation of human development by combining health, education, and economic prosperity metrics [17].

Statistical analysis

This study presents 2020 incidence and mortality rates for colorectal cancer, including both raw and Age-Standardized rates per 100,000 individuals. Geographical distribution maps were created based on the Age-Standardized rates. The methodology has been extensively detailed in previous reports [12, 13, 18-20]. Specifically, the Pearson correlation method was used to analyze the relationship between ASIR and ASMR of colorectal cancer and the Human Development Index (HDI) and its components. A p-value < 0.05 was considered statistically significant, with all reported P-values being two-sided. SPSS software (Version 26.0, SPSS Inc.) performed the statistical analyses.

Results

Geographical distribution in the world

In 2020, there were 1,931,590 new global colorectal cancer cases – 1,065,960 (55.18%) in men and 865,630 (44.82%) in women. The ASIR was 19.5 overall, 23.4 for men and 16.2 for women. The sex ratio of new cases was 1.23 (Fig. 1).

Additionally, 935,173 deaths were attributed to colorectal cancer that year. Of these, 515,637 (55.13%) occurred in men and 419,536 (44.87%) in women. The ASMR was 9 overall, 11 for men and 7.2 for women. The sex ratio for mortality was also 1.23 (Fig. 2).

Geographical distribution based on the continents

For ASIR, Europe had the highest rate at 30.4 (37.9 for men, 24.6 for women), followed by Oceania at 29.8 (33.8 for men, 26.1 for women), then Northern America at 26.2 (29.4 for men, 23.4 for women). Rates were lower in Asia at 17.6 (21.1 for men, 14.3 for women), Latin America/Caribbean at 16.6 (18.7 for men, 15.1 for women), and Africa at 8.4 (9.4 for men, 7.6 for women). Asia had the highest proportion of cases (52.25%), followed by Europe (26.91%), North America (9.34%), Latin America/Caribbean (6.98%), Africa (3.42%), and Oceania (1.06%) (Tab. I, Fig. 1).

For ASMR, Europe again had the highest rate at 12.3 (16.1 for men, 9.5 for women), followed by Oceania at 9.3 (11.2 for men, 7.5 for women). Rates were lower in Asia at 8.6 (10.6 for men, 6.8 for women), Latin America/

Fig. 1. Distribution of new Colorectal Cancer cases worldwide in 2020.

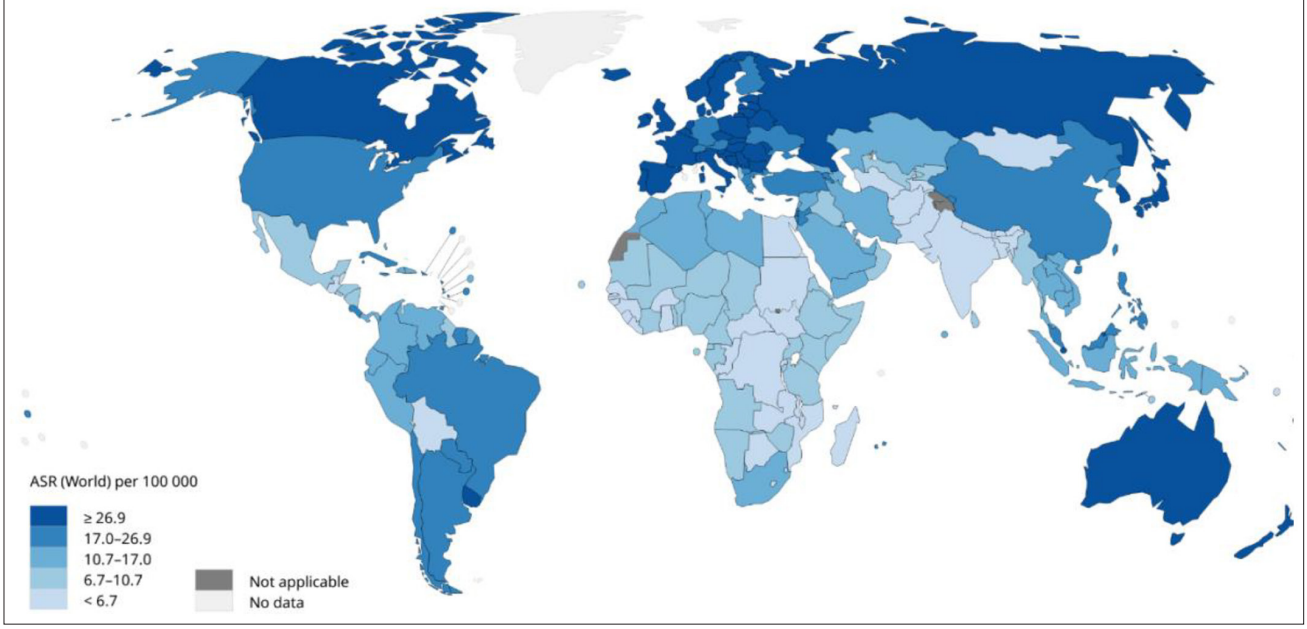
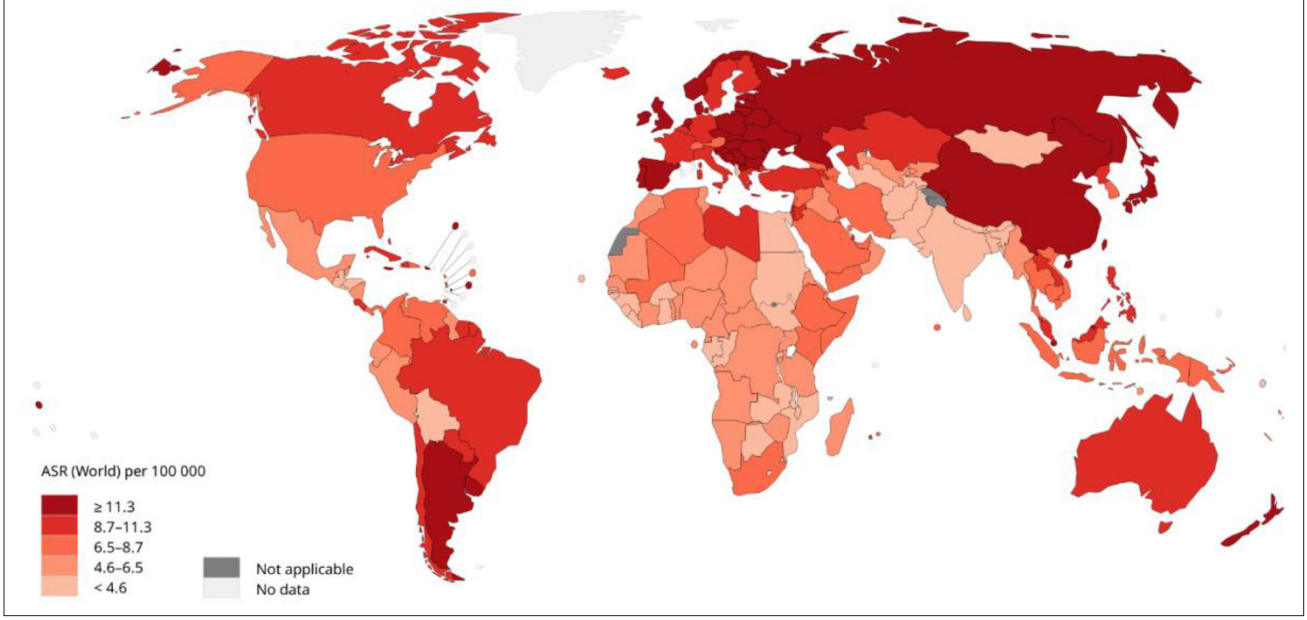


Fig. 2. Distribution of Colorectal Cancer mortality worldwide in 2020.



Caribbean at 8.2 (9.7 for men, 6.8 for women), Northern America at 8.2 (9.4 for men, 7.3 for women), and Africa at 5.6 (6.3 for men, 5.0 for women). Mirroring incidence, Asia had the most deaths (54.15%) followed by Europe (26.17%), Latin America/Caribbean (7.42%), Northern America (6.84%), Africa (4.58%), and Oceania (0.81%) (Tab. II, Fig. 2).

Geographical distribution according to the WHO classification

The ASIR for colorectal cancer varied by WHO region. The highest rate was in EURO at 28.8 (36 for men, 23.3 for women), followed by WPRO at 25.3 (30.6 for men, 20.5 for women), PAHO at 20.7 (23.3 for men, 18.5 for women), EMRO at 9 (10.2 for men, 7.9 for women), AFRO at 8.4 (9.5 for men, 7.5 for women), and SEARO at 7 (8.5 for men, 5.5 for women). WPRO had the highest proportion of cases (42.36%), followed by EURO (28.72%), PAHO (16.34%), SEARO (7.35%), AFRO (2.63%), and EMRO (2.61%) (Tab. I).

For ASMR, EURO again had the highest rate at 12 (15.6 for men, 9.3 for women), followed by WPRO at 11.5 (14.3 for men, 9 for women), PAHO at 8.1 (9.4 for men, 7 for women), AFRO at 5.8 (6.7 for men, 5.2 for

Tab. I. The age-standardized incidence rate of Colorectal Cancer in different regions of the world in 2020.

Population Numbers		All			Men			Women		
		Numbers	Crude Rate	ASR (W)	Numbers	Crude Rate	ASR (W)	Numbers	Crude Rate	ASR (W)
World		1 931 590	24.8	19.5	1 065 960	27.1	23.4	865 630	22.4	16.2
WHO regions	WHO Africa (AFRO)	50 696	4.5	8.4	26 243	4.7	9.5	24 453	4.4	7.5
	WHO Americas (PAHO)	315 518	30.8	20.7	162 356	32.2	23.3	153 162	29.5	18.5
	WHO East Mediterranean (EMRO)	50 403	6.9	9.0	28 269	7.5	10.2	22 134	6.3	7.9
	WHO Europe (EURO)	554 569	59.4	28.8	300 443	66.4	36.0	254 126	52.9	23.3
	WHO South-East Asia (SEARO)	141 928	7.0	7.0	83 942	8.1	8.5	57 986	5.9	5.5
	WHO Western Pacific (WPRO)	818 060	41.6	25.3	464 483	46.5	30.6	353 577	36.6	20.5
Continents	Africa	66 198	4.9	8.4	34 060	5.1	9.4	32 138	4.8	7.6
	Asia	1 009 400	21.8	17.6	576 754	24.3	21.1	432 646	19.1	14.3
	Europe	519 820	69.4	30.4	281 714	77.9	37.9	238 106	61.5	24.6
	Latin America and the Caribbean	134 943	20.6	16.6	67 218	20.9	18.5	67 725	20.4	15.1
	Northern America	180 575	49.0	26.2	95 138	52.1	29.4	85 437	45.9	23.4
	Oceania	20 654	48.4	29.8	11 076	51.8	33.8	9 578	44.9	26.1
Income levels	High income	819 143	66.6	30.2	450 564	73.5	36.2	368 579	59.7	25.0
	Upper middle income	887 025	30.4	21.4	490 846	33.4	25.5	396 179	27.3	17.8
	Low middle income	194 954	6.4	7.4	109 105	7.1	8.6	85 849	5.8	6.3
	Low income	29 542	4.9	8.8	14 959	5.0	9.7	14 583	4.8	8.0
Global regions	Australia and New Zealand	19 644	64.8	33.2	10 491	69.6	37.4	9 153	60.0	29.2
	Caribbean	11 454	26.3	18.2	5 327	24.8	18.5	6 127	27.8	17.8
	Central America	19 535	10.9	10.4	10 181	11.6	12.0	9 354	10.2	9.1
	Central and Eastern Europe	172 950	59.0	29.3	89 189	64.7	38.4	83 761	54.0	23.4
	Eastern Africa	18 306	4.1	7.9	8 888	4.0	8.6	9 418	4.2	7.5
	Eastern Asia	757 849	45.2	25.9	431 501	50.4	31.2	326 348	39.7	21.0
	Melanesia	804	7.2	11.4	466	8.2	14.2	338	6.2	9.0
	Micronesia	93	16.9	16.6	51	18.4	19.5	42	15.5	14.2
	Middle Africa	5 767	3.2	6.8	3 045	3.4	7.7	2 722	3.0	6.1
	Northern Africa	20 858	8.5	9.7	10 662	8.6	10.4	10 196	8.3	9.1
	Northern America	180 575	49.0	26.2	95 138	52.1	29.4	85 437	45.9	23.4
	Northern Europe	81 638	76.8	33.6	44 464	84.7	39.2	37 174	69.1	28.8
	Polynesia	113	16.5	15.5	68	19.6	19.2	45	13.4	11.9
	South America	103 954	24.1	18.5	51 710	24.4	20.6	52 244	23.9	16.8
	South-Central Asia	102 987	5.1	5.5	61 252	5.9	6.6	41 735	4.3	4.4
	South-Eastern Asia	106 995	16.0	14.8	60 505	18.1	18.4	46 490	13.9	11.9
	Southern Africa	7 684	11.4	13.7	3 919	11.8	16.7	3 765	11.0	11.7
	Southern Europe	123 588	80.6	31.9	71 009	94.7	40.6	52 579	67.0	24.5
	Western Africa	13 583	3.4	6.7	7 546	3.7	7.9	6 037	3.0	5.7
	Western Asia	41 569	14.9	16.8	23 496	16.1	19.9	18 073	13.6	14.0
	Western Europe	141 644	72.2	28.7	77 052	80.0	34.3	64 592	64.7	23.9

women), EMRO at 5.1 (5.8 for men, 4.5 for women), and SEARO at 4 (4.9 for men, 3.1 for women). WPRO had the highest proportion of cases (42.36%), followed by EURO (28.16%), PAHO (14.27%), SEARO (8.57%), AFRO (3.65%), and EMRO (2.99%) (Tab. II).

Geographical distribution in the countries

The study revealed that China, the United States of America, and Japan had the highest number of new colorectal cancer cases, with 555,477, 155,008, and 148,505 cases, respectively. On the other hand, Sao Tome and Principe, Vanuatu, and Comoros had the lowest number of cases, with 8, 10, and 20 cases, respectively. Furthermore, Hungary (45.3 per 100,000), Slovakia (43.9), and Norway (41.9) had the highest ASIR of colorectal cancer, while Guinea (3.3), The Republic of the Gambia (3.7), and Bhutan (3.8) had the lowest (Tab. S1). When it comes to mortality, China recorded the highest number of colorectal cancer cases (286,162 cases), followed by Japan (59,912 cases), and the United States of America (54,443 cases). Conversely, Sao Tome and Principe (5 cases), Vanuatu (9 cases), and Comoros (13 cases) had the lowest number of cases. Slovakia (21),

Tab. II. The age-standardized mortality rate of Colorectal Cancer in different regions of the world in 2020.

Population Numbers		All			Men			Women		
		Numbers	Crude Rate	ASR (W)	Numbers	Crude Rate	ASR (W)	Numbers	Crude Rate	ASR (W)
World		935 173	12.0	9.0	515 637	13.1	11.0	419 536	10.9	7.2
WHO regions	WHO Africa (AFRO)	34 132	3.0	5.8	17 634	3.2	6.7	16 498	2.9	5.2
	WHO Americas (PAHO)	133 422	13.0	8.1	69 081	13.7	9.4	64 341	12.4	7.0
	WHO East Mediterranean (EMRO)	27 975	3.8	5.1	15 702	4.2	5.8	12 273	3.5	4.5
	WHO Europe (EURO)	263 314	28.2	12.0	141 801	31.3	15.6	121 513	25.3	9.3
	WHO South-East Asia (SEARO)	80 084	4.0	4.0	47 876	4.6	4.9	32 208	3.3	3.1
	WHO Western Pacific (WPRO)	396 048	20.2	11.5	223 433	22.4	14.3	172 615	17.9	9.0
Continents	Africa	42 875	3.2	5.6	22 046	3.3	6.3	20 829	3.1	5.0
	Asia	506 449	10.9	8.6	288 525	12.2	10.6	217 924	9.6	6.8
	Europe	244 824	32.7	12.3	131 885	36.5	16.1	112 939	29.2	9.5
	Latin America and the Caribbean	69 435	10.6	8.2	34 976	10.9	9.4	34 459	10.4	7.3
	Northern America	63 987	17.3	8.2	34 105	18.7	9.7	29 882	16.0	6.8
	Oceania	7 603	17.8	9.3	4 100	19.2	11.2	3 503	16.4	7.5
Income levels	High income	340 272	27.6	10.5	185 111	30.2	13.2	155 161	25.1	8.2
	Upper middle income	461 511	15.8	10.8	256 244	17.5	13.3	205 267	14.1	8.6
	Low middle income	112 556	3.7	4.3	63 703	4.1	5.1	48 853	3.3	3.6
	Low income	20 392	3.4	6.2	10 343	3.4	6.9	10 049	3.3	5.5
Global regions	Australia and New Zealand	7 038	23.2	9.5	3 755	24.9	11.4	3 283	21.5	7.7
	Caribbean	6 983	16.0	10.4	3 307	15.4	11.0	3 676	16.7	9.8
	Central America	10 439	5.8	5.5	5 494	6.2	6.4	4 945	5.4	4.7
	Central and Eastern Europe	93 384	31.9	14.5	48 378	35.1	20.2	45 006	29.0	11.0
	Eastern Africa	13 236	3.0	5.9	6 365	2.9	6.4	6 871	3.1	5.5
	Eastern Asia	368 072	21.9	11.8	208 090	24.3	14.7	159 982	19.4	9.2
	Melanesia	452	4.1	6.7	279	4.9	8.8	173	3.2	4.8
	Micronesia	53	9.7	9.5	29	10.5	11.7	24	8.8	7.8
	Middle Africa	4 228	2.4	5.2	2 222	2.5	5.9	2 006	2.2	4.6
	Northern Africa	11 530	4.7	5.4	5 900	4.8	5.9	5 630	4.6	5.0
	Northern America	63 987	17.3	8.2	34 105	18.7	9.7	29 882	16.0	6.8
	Northern Europe	33 768	31.8	11.4	17 811	33.9	13.5	15 957	29.7	9.6
	Polynesia	60	8.8	8.4	37	10.7	10.9	23	6.8	6.3
	South America	52 013	12.1	8.9	26 175	12.3	10.2	25 838	11.8	7.8
	South-Central Asia	59 206	2.9	3.2	35 848	3.5	3.9	23 358	2.4	2.5
	South-Eastern Asia	57 064	8.5	7.9	32 205	9.6	10.1	24 859	7.4	6.1
	Southern Africa	3 943	5.8	7.2	2 052	6.2	9.1	1 891	5.5	5.9
	Southern Europe	55 406	36.1	11.5	31 583	42.1	15.1	23 823	30.4	8.5
	Western Africa	9 938	2.5	5.1	5 507	2.7	6.1	4 431	2.2	4.3
	Western Asia	22 107	7.9	8.9	12 382	8.5	10.7	9 725	7.3	7.3
	Western Europe	62 266	31.7	10.2	34 113	35.4	13.1	28 153	28.2	7.8

Hungary (20.2), and Croatia (19.6) had the highest ASMR of colorectal cancer, while Bangladesh (2.3), Bhutan (2.5), and Nepal (2.5) had the lowest (Tab. S2).

ASIR and ASMR

Globally, there was a statistically significant positive correlation of 0.895 ($p \leq 0.001$) between the ASIR and ASMR of colorectal cancer.

ASIR and HDI

Analysis revealed a significant positive correlation of 0.794 ($p \leq 0.001$) between the ASIR of colorectal cancer and the HDI. Furthermore, positive correlations emerged between the ASIR and specific HDI dimensions. Namely, the ASIR correlated positively with life expectancy at birth (0.724, $p \leq 0.001$), education levels (0.743, $p \leq 0.001$), and income per capita (0.706, $p \leq 0.001$) (Tabs. III, S1, S2).

ASMR and HDI

The ASMR for colorectal cancer showed a significant positive correlation of 0.638 with the HDI ($p = 0.001$). Positive correlations were also found between the ASMR

Tab. III. The relationship between the incidence and mortality of Colorectal Cancer with the HDI and its components.

Incidence and mortality rates			HDI	Life expectancy at birth	Mean years of schooling	Gross national Income (GNI) per capita
ASIR	Boys	r p-value	0.757 0.001	0.677 0.001	0.715 0.001	0.652 0.001
	Girls	r p-value	0.811 0.001	0.749 0.001	0.757 0.001	0.749 0.001
	Total	r p-value	0.794 0.001	0.724 0.001	0.743 0.001	0.706 0.001
ASMR	Boys	r p-value	0.604 0.001	0.519 0.001	0.606 0.001	0.459 0.001
	Girls	r p-value	0.626 0.001	0.575 0.001	0.620 0.001	0.535 0.001
	Total	r p-value	0.638 0.001	0.569 0.001	0.631 0.001	0.512 0.001

and life expectancy at birth (0.569, $p \leq 0.001$), education levels (0.631, $p \leq 0.001$), and income per capita (0.512, $p \leq 0.001$) (Tabs. III, S1, S2).

Discussion

This comprehensive analysis reveals stark global disparities in colorectal cancer incidence and mortality, underscoring the impact of geographic differences and human development levels. With over 1.9 million new cases and 0.9 million deaths in 2020, the data highlights the considerable worldwide burden of this disease.

Geographically, incidence and mortality rates varied greatly by continent. Europe had the highest age-standardized rates while Africa had the lowest, likely reflecting disparities in risk factors, genetics, and screening access [21]. Rates also differed by WHO region, with EURO and WPRO having the highest burdens and EMRO, AFRO, and SEARO the lowest. These regional variances further emphasize how geographic factors influence colorectal cancer outcomes.

When observing the data at a country level, the highest number of new colorectal cases were recorded in China, United States, and Japan, while the lowest were in Sao Tome and Principe, Vanuatu, and Comoros. Interestingly, Hungary, Slovakia, and Norway had the highest ASIR, while Guinea, The Republic of Gambia, and Bhutan had the lowest. This discrepancy between the number of cases and ASIR can be attributed to the differences in population sizes, healthcare infrastructure, and cancer surveillance among these countries [2].

A significant positive correlation was found between global colorectal cancer ASIR and ASMR, suggesting that rising incidence rates are often paired with increasing mortality burdens [22, 23].This pattern indicates that many regions lack adequate early detection and treatment access needed to reduce colorectal cancer mortality despite rising incidence levels. Improving screening programs and treatment availability, particularly in less developed areas, is critical to curb worldwide colorectal cancer mortality rates and mitigate the impact of increasing incidence.

The study also found positive correlations between colorectal cancer's standardized incidence and mortality rates and various HDI dimensions, including life expectancy at birth, education levels, and income. This indicates that higher human development is linked to greater colorectal cancer incidence and mortality, possibly due to several factors. These include increased life expectancy resulting in more cases among older populations, dietary and lifestyle changes accompanying development, and improved detection enabled by advanced healthcare systems [24]. This complex relationship between development and colorectal cancer epidemiology highlights the need for multifaceted control strategies encompassing prevention, screening, treatment, and research.

As noted in previous research, men consistently exhibited higher colorectal cancer incidence and mortality rates than women across all global regions analyzed [4, 12, 13, 18-20]. This sex disparity highlights the need for targeted strategies that take into account differences in risk factors, screening behaviors, treatment access, and outcomes between males and females. Gender-specific prevention and control initiatives should be considered to equitably address the worldwide colorectal cancer burden for both sexes.

These disparities could be attributed to a variety of factors, including differences in dietary habits, healthcare infrastructure, access to screening programs, and prevalence of risk factors such as smoking and obesity. For example, higher rates in developed regions might reflect better detection and reporting mechanisms, as well as lifestyle factors such as diet and physical inactivity. Conversely, lower rates in less developed regions could indicate underreporting and limited access to healthcare services [25-28].

Moreover, the observed positive correlation between the Human Development Index (HDI) and colorectal cancer incidence and mortality underscores the impact of socioeconomic factors on health outcomes. Countries with higher HDI tend to have better healthcare systems and more widespread use of screening programs, which can lead to higher detection rates. However, these same countries also exhibit lifestyle factors that increase colorectal cancer risk, such as higher consumption of red and processed meats.

It is also crucial to address potential data quality issues in the GLOBOCAN database. Variations in data collection methods, reporting accuracy, and completeness can affect the reliability of the reported incidence and mortality rates [14]. For instance, underreporting in low-income countries may lead to an underestimation of the true burden of colorectal cancer in these regions. The GLOBOCAN database relies on a combination of cancer registry data, vital statistics, and modeling techniques to estimate cancer incidence and mortality. While this approach allows for comprehensive global estimates, it also introduces potential sources of error [2, 12-14, 29].
This global analysis provides valuable insights into the varying colorectal cancer incidence and mortality rates across countries and regions. The findings can help guide targeted prevention and treatment initiatives tailored to local contexts. Further research should delve deeper into the specific factors driving regional disparities worldwide to inform more effective, context-specific strategies for combating colorectal cancer.
Overall, the results underscore the urgent need for an integrated global approach that accounts for regional differences in colorectal cancer epidemiology, socioeconomic conditions, and local healthcare capacity. Only through coordinated global action can we hope to confront the rising worldwide burden of colorectal cancer. Moving forward, global collaboration and resource mobilization focused on prevention, early detection, treatment access, research, and health system strengthening will be essential to equitably and sustainably reduce the threat posed by this disease worldwide.

Limitations of the study

The quality of cancer data in GLOBOCAN varies, especially for medium or low HDI countries. Thus, estimates for some countries may rely on limited regional cancer recordings or be extrapolated from neighboring countries [29]. See Table S1, Tables I and II for further details on data quality issues across countries.

Conclusions

In conclusion, this study provides valuable insights into the global disparities in colorectal cancer incidence and mortality rates. It underscores the need for comprehensive strategies to reduce colorectal cancer burden, particularly in regions and countries with high incidence and mortality rates. Such strategies should include improving access to early detection and treatment, promoting lifestyle changes, and strengthening cancer surveillance systems.

Acknowledgments

This is to acknowledge that the project leading to the publication of this paper is fully funded by the research deputy of Shahrekord University of Medical Sciences in Iran with grant number: 7026 and ethical code: IR.SKUMS.REC.1402.124.

Data availability

The data used in this study can be retrieved in the tables provided in the text of the article. In addition, the data used in the present study is freely available in the globocan website (https://gco.iarc.fr/).

Conflicts of interest statement

There is no conflict of interest in this study.

Funding source

This work was supported by the research deputy of Shahrekord University of Medical Sciences in Iran with grant number: 7026 and ethical code: IR.SKUMS.REC.1402.124.

Author's contributions

DD: Data curation, writing-original draft, preparation, reviewing, editing, methodology, and software. AMH: Data curation, writing-original draft, preparation, visualization, investigation, project administration, validation, reviewing, editing, methodology, and software. SK: Conceptualization, writing-original draft, and investigation.

References

[1] Smith RA, Andrews KS, Brooks D, Fedewa SA, Manassaram-Baptiste D, Saslow D, Wender RC. Cancer screening in the United States, 2019: A review of current American Cancer Society guidelines and current issues in cancer screening. CA Cancer J Clin 2019;69:184-210. https://doi.org/10.3322/caac.21557.

[2] Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin 2018;68:394-424. https://doi.org/10.3322/caac.21492. Erratum in: CA Cancer J Clin 2020;70:313. https://doi.org/10.3322/caac.21609.

[3] Goodarzi E, Beiranvand R, Naemi H, Momenabadi V, Khazaei Z. Worldwide incidence and mortality of colorectal cancer and human development index (HDI): an ecological study. World Cancer Research J 2019;6:e1433. https://doi.org/10.32113/wcrj_201911_1433.

[4] Arnold M, Sierra MS, Laversanne M, Soerjomataram I, Jemal A, Bray F. Global patterns and trends in colorectal cancer incidence and mortality. Gut 2017;66:683-91. https://doi.org/10.1136/gutjnl-2015-310912.

[5] Siegel RL, Miller KD, Fedewa SA, Ahnen DJ, Meester RGS, Barzi A, Jemal A. Colorectal cancer statistics, 2017. CA Cancer J Clin 2017;67:177-93. https://doi.org/10.3322/caac.21395.

[6] Araghi M, Soerjomataram I, Jenkins M, Brierley J, Morris E, Bray F, Arnold M. Global trends in colorectal cancer mortality: projections to the year 2035. Int J Cancer 2019;144:2992-3000. https://doi.org/10.1002/ijc.32055.

[7] Fearon ER. Molecular genetics of colorectal cancer. Annu Rev Pathol 2011;6:479-507. https://doi.org/10.1146/annurev-pathol-011110-130235.

[8] Murphy N, Moreno V, Hughes DJ, Vodicka L, Vodicka P, Aglago EK, Gunter MJ, Jenab M. Lifestyle and dietary environmental factors in colorectal cancer susceptibility. Mol Aspects Med 2019;69:2-9. https://doi.org/10.1016/j.mam.2019.06.005.

[9] Yang C, Wang X, Huang CH, Yuan WJ, Chen ZH. Passive Smoking and Risk of Colorectal Cancer: A Meta-analysis of Observational Studies. Asia Pac J Public Health 2016;28:394-403. https://doi.org/10.1177/1010539516650724.

[10] Jasperson KW, Tuohy TM, Neklason DW, Burt RW. Hereditary and familial colon cancer. Gastroenterology 2010;138:2044-58. https://doi.org/10.1053/j.gastro.2010.01.054.

[11] United Nations Development Programme. Human Development Index (HDI). 2021. Available at: http://hdr.undp.org/en/indicators/137506 (Accessed on: 20/6/2023).

[12] Ghoncheh M, Mohammadian M, Mohammadian-Hafshejani A, Salehiniya H. The Incidence and Mortality of Colorectal Cancer and Its Relationship With the Human Development Index in Asia. Ann Glob Health 2016;82:726-37. https://doi.org/10.1016/j.aogh.2016.10.004.

[13] Rafiemanesh H, Mohammadian-Hafshejani A, Ghoncheh M, Sepehri Z, Shamlou R, Salehiniya H, Towhidi F, Makhsosi BR. Incidence and Mortality of Colorectal Cancer and Relationships with the Human Development Index across the World. Asian Pac J Cancer Prev 2016;17:2465-73. https://doi.org/10.7314/APJCP.2016.17.5.2465.

[14] Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, Bray F. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA Cancer J Clin 2021;71:209-49. https://doi.org/10.3322/caac.21660.

[15] Bertuccio P, Alicandro G, Malvezzi M, Carioli G, Boffetta P, Levi F, La Vecchia C, Negri E. Cancer mortality in Europe in 2015 and an overview of trends since 1990. Ann Oncol 2019;30:1356-69. https://doi.org/10.1093/annonc/mdz179.

[16] Petrick JL, Florio AA, Znaor A, Ruggieri D, Laversanne M, Alvarez CS, Ferlay J, Valery PC, Bray F, McGlynn KA. International trends in hepatocellular carcinoma incidence, 1978-2012. Int J Cancer 2020;147:317-30. https://doi.org/10.1002/ijc.32723.

[17] Malik K. Human development report 2013. The rise of the South: Human progress in a diverse world. The Rise of the South: Human Progress in a Diverse World (March 15, 2013) UNDP-HDRO Human Development Reports 2013.

[18] Rafiemanesh H, Mehtarpoor M, Mohammadian-Hafshejani A, Salehiniya H, Enayatrad M, Khazaei S. Cancer epidemiology and trends in Sistan and Baluchestan province, Iran. Med J Islam Repub Iran 2015;29:254.

[19] Pakzad R, Moudi A, Pournamdar Z, Pakzad I, Mohammadian-Hashejani A, Momenimovahed Z, Salehiniya H, Towhidi F, Makhsosi BR. Spatial Analysis of Colorectal Cancer in Iran. Asian Pac J Cancer Prev 2016;17:53-8. https://doi.org/10.7314/apjcp.2016.17.s3.53.

[20] Salehiniya H, Ghobadi Dashdebi S, Rafiemanesh H, Mohammadian-Hafshejani A, Enayatrad M. Time Trend Analysis of Cancer Incidence in Caspian Sea, 2004-2009: A Population-based Cancer Registries Study (Northern Iran). Caspian J Intern Med 2016;7:25-30.

[21] Center MM, Jemal A, Smith RA, Ward E. Worldwide variations in colorectal cancer. CA Cancer J Clin 2009;59:366-78. https://doi.org/10.3322/caac.20038.

[22] Doubeni CA, Corley DA, Zauber AG. Colorectal Cancer Health Disparities and the Role of US Law and Health Policy. Gastroenterology 2016;150:1052-5. https://doi.org/10.1053/j.gastro.2016.03.012.

[23] Dorsey K, Zhou Z, Masaoud R, Nimeiri HS. Health care disparities in the treatment of colorectal cancer. Curr Treat Options Oncol 2013;14:405-14. https://doi.org/10.1007/s11864-013-0241-9.

[24] Bray F, Soerjomataram I. The Changing Global Burden of Cancer: Transitions in Human Development and Implications for Cancer Prevention and Control. In: Gelband H, Jha P, Sankaranarayanan R, Horton S, eds. Cancer: Disease Control Priorities. 3rd ed. (Vol. 3). Washington, DC: The International Bank for Reconstruction and Development/The World Bank 2015.

[25] Rasool S, Kadla SA, Rasool V, Ganai BA. A comparative overview of general risk factors associated with the incidence of colorectal cancer. Tumour Biol 2013;34:2469-76. https://doi.org/10.1007/s13277-013-0876-y.

[26] Gausman V, Dornblaser D, Anand S, Hayes RB, O'Connell K, Du M, Liang PS. Risk Factors Associated With Early-Onset Colorectal Cancer. Clin Gastroenterol Hepatol 2020;18:2752-9.e2. https://doi.org/10.1016/j.cgh.2019.10.009.

[27] Degett TH, Dalton SO, Christensen J, Søgaard J, Iversen LH, Gögenur I. Mortality after emergency treatment of colorectal cancer and associated risk factors-a nationwide cohort study. Int J Colorectal Dis 2019;34:85-95. https://doi.org/10.1007/s00384-018-3172-x.

[28] Iversen LH. Aspects of survival from colorectal cancer in Denmark. Dan Med J 2012;59:B4428.

[29] Ferlay J, Soerjomataram I, Dikshit R, Eser S, Mathers C, Rebelo M, Parkin DM, Forman D, Bray F. Cancer incidence and mortality worldwide: sources, methods and major patterns in GLOBOCAN 2012. Int J Cancer 2015;136:E359-86. https://doi.org/10.1002/ijc.29210.

Received on August 22, 2023. Accepted on August 19, 2024.

Correspondence: Abdollah Mohammadian-Hafshejani, Health Research Center, Shahrekord University of Medical Sciences, Shahrekord, Iran. E-mail: amohamadii1361@gmail.com

How to cite this article: Darmadi D, Mohammadian-Hafshejani A, Kheiri S. Global Disparities in Colorectal Cancer: Unveiling the Present Landscape of Incidence and Mortality Rates, Analyzing Geographical Variances, and Assessing the Human Development Index . J Prev Med Hyg 2024;65:E499-E514. https://doi.org/10.15167/2421-4248/jpmh2024.65.4.3071

Supplementary Materials

Tab. S1. Standardized rate of incidence and mortality of Colorectal Cancer in the countries of the world.

Population	ASIR	ASIR in males	ASIR in females	ASMR	ASMR in males	ASMR in females
Afghanistan	5.7	6.3	5.1	3.8	4.2	3.5
Albania	7.7	8.8	6.8	3.8	4.4	3.4
Algeria	15.3	16.5	14.2	8.3	9.0	7.7
Angola	7.2	9.6	5.2	5.2	7.0	3.8
Argentina	25.1	31.0	20.6	12.6	16.3	9.9
Armenia	20.1	22.2	18.5	11.3	12.2	10.6
Australia	33.1	37.3	29.2	8.9	10.8	7.2
Austria	21.0	26.5	16.4	8.7	11.6	6.3
Azerbaijan	14.2	17.8	11.5	8.6	11.3	6.6
Bahamas	16.0	20.5	12.4	10.7	13.5	8.6
Bahrain	13.9	13.7	14.6	7.1	6.8	7.5
Bangladesh	3.8	4.2	3.3	2.3	2.6	2.0
Barbados	25.1	30.5	20.4	16.1	20.9	11.9
Belarus	30.2	39.4	24.8	14.1	19.7	10.9
Belgium	35.3	43.6	28.0	10.0	12.6	7.8
Belize	6.2	5.9	6.6	6.0	5.3	6.6
Benin	7.7	11.3	5.0	5.7	8.5	3.7
Bhutan	3.8	5.4	1.9	2.5	3.7	1.1
Bolivia, Plurinational State of	5.7	6.3	5.1	3.4	3.9	2.9
Bosnia and Herzegovina	27.0	34.6	20.8	14.5	19.6	10.5
Botswana	4.5	4.3	4.5	2.6	2.5	2.6
Brazil	19.4	21.7	17.6	9.0	10.3	7.9
Brunei Darussalam	34.9	42.2	27.7	14.6	18.1	11.2
Bulgaria	27.4	36.6	20.3	14.7	20.7	10.3
Burkina Faso	3.8	3.6	3.8	3.1	3.0	3.1
Burundi	6.9	7.4	6.6	5.6	6.1	5.2
Cabo Verde	8.8	12.6	7.7	3.5	5.0	3.0
Cambodia	12.3	13.7	11.2	7.4	8.4	6.7
Cameroon	7.1	8.0	6.4	5.2	5.9	4.6
Canada	31.2	34.7	27.9	9.9	12.0	8.0
Central African Republic	6.5	7.2	6.0	5.4	6.1	4.9
Chad	6.9	7.9	6.0	5.7	6.5	5.0
Chile	19.9	22.6	17.7	9.4	11.0	8.1
China	23.9	28.6	19.5	12.0	14.8	9.4
Colombia	16.9	17.3	16.7	8.2	8.5	7.9
Comoros	4.5	3.7	5.2	3.0	2.3	3.7
Congo, Democratic Republic of	6.7	7.1	6.3	5.1	5.5	4.8
Congo, Republic of	6.3	6.9	5.8	4.4	5.0	4.0
Costa Rica	17.2	17.6	16.8	9.5	10.2	8.8
Côte d'Ivoire						
Croatia	36.3	50.8	24.9	19.6	28.2	13.5
Cuba	20.1	17.9	22.0	11.3	10.7	11.8
Cyprus	24.3	35.6	14.3	10.7	14.0	7.9
Czechia	33.7	44.4	25.2	12.3	17.0	8.6
Denmark	40.9	47.1	35.6	11.8	13.7	10.2
Djibouti	6.9	7.8	5.9	5.3	6.1	4.6
Dominican Republic	12.9	13.2	12.5	7.5	8.0	7.0
Ecuador	12.9	12.5	13.2	6.4	6.4	6.3
Egypt	6.1	5.8	6.2	3.4	3.3	3.4

▶

Tab. S1 *(follows)*. Standardized rate of incidence and mortality of Colorectal Cancer in the countries of the world.

Population	ASIR	ASIR in males	ASIR in females	ASMR	ASMR in males	ASMR in females
El Salvador	8.5	9.5	7.7	4.5	5.1	4.1
Equatorial Guinea	6.9	8.3	5.5	4.8	5.7	3.9
Eritrea	7.5	8.0	7.1	5.8	6.3	5.5
Estonia	28.3	35.6	23.9	13.8	18.6	11.1
Eswatini	4.1	4.9	3.2	3.0	3.8	2.2
Ethiopia	8.9	9.9	8.1	6.8	7.5	6.2
Fiji	10.9	11.7	10.3	6.8	8.1	5.9
Finland	25.7	29.4	22.8	8.8	10.9	7.2
France	30.1	36.3	24.9	10.4	13.3	8.1
Gabon	7.3	8.8	5.9	4.2	5.0	3.3
Gaza Strip and West Bank						
Georgia	15.6	18.8	13.5	8.3	10.6	6.8
Germany	25.8	30.4	21.8	9.9	12.9	7.3
Ghana	3.9	4.4	3.6	2.8	3.2	2.5
Greece	26.9	34.4	20.5	10.7	14.1	7.8
Guatemala	5.7	6.0	5.4	3.6	3.8	3.4
Guinea	3.3	3.9	2.9	2.6	3.1	2.3
Guinea-Bissau	4.7	5.9	3.8	3.8	4.9	3.1
Guyana	8.5	9.4	7.5	5.0	5.8	4.3
Haiti	12.5	11.6	13.2	8.7	8.2	9.2
Honduras	8.0	8.5	7.6	4.2	4.6	3.9
Hungary	45.3	62.0	33.1	20.2	29.0	14.0
Iceland	28.5	32.8	24.3	9.5	10.9	8.1
India	4.8	6.0	3.7	2.8	3.6	2.1
Indonesia	12.4	16.5	8.6	6.7	9.2	4.6
Iran, Islamic Republic of	13.9	15.9	11.9	7.3	8.3	6.3
Iraq	8.7	10.8	6.9	5.4	6.8	4.4
Ireland	34.9	42.6	27.9	12.4	15.7	9.4
Israel	21.9	24.5	19.8	9.0	10.3	7.9
Italy	29.3	34.2	25.2	10.1	12.7	8.1
Jamaica	21.1	26.4	16.3	13.4	17.2	9.8
Japan	38.5	47.3	30.5	11.6	14.7	8.9
Jordan	17.7	17.2	18.4	9.6	9.7	9.6
Kazakhstan	15.6	18.0	14.3	9.2	11.7	7.6
Kenya	10.5	11.9	9.7	7.5	8.7	6.9
Korea, Democratic Republic of	18.8	22.8	15.9	10.9	13.5	8.7
Korea, Republic of	27.2	34.9	20.6	7.8	10.8	5.5
Kuwait	12.5	13.1	11.9	6.6	7.0	6.1
Kyrgyzstan	7.8	8.8	7.0	5.4	5.9	4.9
Lao People's Democratic Republic	15.0	16.1	14.2	8.9	10.1	7.9
Latvia	36.8	48.8	30.1	12.3	15.9	10.4
Lebanon	12.2	15.2	9.5	6.7	8.8	5.0
Lesotho	5.3	7.8	4.0	3.8	6.0	2.8
Liberia	4.9	5.5	4.4	3.9	4.4	3.5
Libya	15.7	16.7	15.1	10.2	11.0	9.8
Lithuania	27.6	36.4	22.3	11.7	16.1	9.4
Luxembourg	26.3	29.7	23.7	8.7	11.2	6.4
Madagascar	6.2	5.6	6.8	4.7	4.3	5.1
Malawi	4.9	6.3	4.1	3.9	5.0	3.3
Malaysia	19.6	21.2	18.0	10.2	11.0	9.4
Maldives	13.0	16.4	9.3	7.4	10.5	4.1

▶

Tab. S1 *(follows).* Standardized rate of incidence and mortality of Colorectal Cancer in the countries of the world.

Population	ASIR	ASIR in males	ASIR in females	ASMR	ASMR in males	ASMR in females
Mali	9.2	8.8	9.6	7.5	7.2	7.7
Malta	25.7	31.1	21.2	10.1	11.9	8.6
Mauritania	7.2	8.6	6.1	5.4	6.5	4.6
Mauritius	17.8	21.9	14.7	7.9	9.5	6.6
Mexico	10.6	12.4	9.1	5.4	6.4	4.6
Mongolia	6.3	6.6	6.1	4.0	4.0	4.0
Montenegro	27.4	35.2	21.1	13.7	21.5	7.8
Morocco	11.3	12.9	9.9	6.2	7.2	5.4
Mozambique	4.1	3.6	4.4	3.2	2.8	3.5
Myanmar	9.7	11.8	8.2	5.8	7.3	4.8
Namibia	8.2	10.8	6.4	5.8	7.6	4.4
Nepal	4.3	5.5	3.4	2.5	3.2	1.9
New Zealand	33.8	38.3	29.7	12.3	14.5	10.3
Nicaragua	10.5	10.4	10.5	6.0	5.8	6.0
Niger	7.0	8.0	5.9	5.8	6.6	4.9
Nigeria	7.3	8.6	6.0	5.5	6.5	4.5
North Macedonia	26.1	26.6	26.1	13.0	13.9	12.3
Norway	41.9	45.4	38.7	13.5	15.1	12.1
Oman	9.9	11.2	7.7	5.7	6.2	4.5
Pakistan	5.3	6.2	4.4	3.0	3.5	2.5
Panama	13.9	16.3	11.7	7.3	9.0	5.8
Papua New Guinea	11.3	14.5	8.4	6.9	9.2	4.8
Paraguay	18.6	20.5	16.7	9.3	10.5	8.1
Peru	11.4	11.6	11.1	5.6	5.9	5.3
Philippines	18.8	23.7	15.1	10.1	13.4	7.8
Poland	30.5	41.7	21.9	16.1	22.8	11.3
Portugal	39.4	55.2	26.6	13.0	18.6	8.8
Puerto Rico	26.3	32.1	22.0	12.4	15.7	9.9
Qatar	15.7	13.6	20.6	9.0	8.0	10.9
Republic of Moldova	30.0	44.3	19.7	17.6	26.7	11.3
Romania	30.9	41.9	22.4	14.8	21.1	10.2
Russian Federation	27.8	34.4	23.9	13.9	18.6	11.3
Rwanda	5.3	6.6	4.2	4.0	4.9	3.1
Saudi Arabia	13.9	16.1	10.9	7.3	8.7	5.6
Senegal	6.7	7.4	6.2	5.1	5.7	4.7
Serbia	33.6	46.4	22.8	16.7	23.7	11.1
Sierra Leone	5.0	6.0	4.1	4.1	5.0	3.3
Singapore	33.0	38.6	27.4	16.2	19.8	12.8
Slovakia	43.9	60.7	31.1	21.0	29.6	14.8
Slovenia	39.6	55.8	25.4	11.7	16.1	8.4
Solomon Islands	6.7	6.5	7.0	4.2	4.9	3.5
Somalia	9.3	10.1	8.6	7.7	8.4	7.1
South Africa	14.6	17.6	12.5	7.5	9.5	6.2
South Sudan	5.7	6.3	5.1	4.5	5.1	4.0
Spain	35.8	47.7	25.4	11.5	15.5	8.2
Sri Lanka	7.8	7.7	7.9	3.7	3.8	3.7
Sudan	6.3	6.6	6.0	3.9	4.2	3.6
Suriname	18.1	21.3	15.9	11.3	14.3	8.8
Sweden	27.8	30.5	25.2	10.8	12.1	9.7
Switzerland	22.3	25.7	19.4	7.5	9.1	6.2
Syrian Arab Republic	12.9	14.4	11.7	8.2	9.4	7.2
Tajikistan	4.7	6.7	2.9	3.2	4.5	2.0

▶

Tab. S1 *(follows)*. Standardized rate of incidence and mortality of Colorectal Cancer in the countries of the world.

Population	ASIR	ASIR in males	ASIR in females	ASMR	ASMR in males	ASMR in females
Tanzania, United Republic of	8.5	7.7	9.3	6.3	5.8	6.8
Thailand	16.9	19.0	15.2	8.4	9.7	7.5
The Netherlands	41.0	48.4	34.3	13.5	16.2	11.1
The Republic of the Gambia						
Timor-Leste	8.9	10.1	7.9	5.0	6.2	4.0
Togo	8.2	12.1	5.0	6.3	9.3	3.8
Trinidad and Tobago	18.5	23.0	14.7	11.0	13.7	8.8
Tunisia	12.7	14.0	11.7	6.4	7.3	5.6
Turkey	20.6	26.2	16.2	10.1	13.0	7.8
Turkmenistan	6.2	7.0	5.7	3.8	4.3	3.3
Uganda	6.7	7.8	6.0	5.0	5.9	4.4
Ukraine	25.5	33.6	20.5	12.9	18.1	9.9
United Arab Emirates	13.1	11.5	17.3	6.9	6.2	8.7
United Kingdom	34.1	40.0	29.0	11.4	13.5	9.6
United States of America	25.6	28.7	22.9	8.0	9.4	6.7
Uruguay	32.0	40.6	25.6	14.3	19.3	10.9
Uzbekistan	8.9	9.5	8.5	5.2	5.7	4.8
Vanuatu	5.2	4.2	6.3	4.8	4.2	5.4
Venezuela, Bolivarian Republic of	14.2	15.0	13.4	7.8	8.6	7.1
Viet Nam	14.1	17.6	11.6	7.0	9.1	5.5
Yemen	10.7	12.0	9.5	7.7	8.6	6.9
Zambia	5.6	6.3	5.3	4.0	4.8	3.7
Zimbabwe	8.9	10.4	8.0	6.4	7.8	5.6

Tab. S2. Human development index and its components for different countries of the world.

HDI rank	Population	HDI	Life expectancy at birth	Mean years of schooling	Gross national Income (GNI) per capita
1	Norway	0.96	82.40	12.90	66494
2	Switzerland	0.96	83.80	13.40	69394
3	Ireland	0.96	82.30	12.70	68371
4	Germany	0.95	81.30	14.20	55314
4	Iceland	0.95	83.00	12.80	54682
7	Australia	0.94	83.40	12.70	48085
7	Sweden	0.95	82.80	12.50	54508
9	The Netherlands	0.94	82.30	12.40	57707
10	Denmark	0.94	80.90	12.60	58662
11	Finland	0.94	81.90	12.80	48511
12	Singapore	0.94	83.60	11.60	88155
13	Belgium	0.93	81.60	12.10	52085
14	Canada	0.93	82.40	13.40	48527
14	New Zealand	0.93	82.30	12.80	40799
14	United Kingdom	0.93	81.30	13.20	46071
17	United States of America	0.93	78.90	13.40	63826
18	Austria	0.92	81.50	12.50	56197
20	Japan	0.92	84.60	12.90	42932
21	Israel	0.92	83.00	13.00	40187
22	Korea, Republic of	0.92	83.00	12.20	43044
23	Luxembourg	0.92	82.30	12.30	72712
24	Slovenia	0.92	81.30	12.70	38080
25	Spain	0.90	83.60	10.30	40975
26	Czechia	0.90	79.40	12.70	38109
26	France	0.90	82.70	11.50	47173
28	Malta	0.90	82.50	11.30	39555
29	Italy	0.89	83.50	10.40	42776
30	Estonia	0.89	78.80	13.10	36019
30	United Arab Emirates	0.89	78.00	12.10	67462
32	Cyprus	0.89	81.00	12.20	38207
33	Greece	0.89	82.20	10.60	30155
34	Poland	0.88	78.70	12.50	31623
35	Lithuania	0.88	75.90	13.10	35799
37	Latvia	0.87	75.30	13.00	30282
38	Portugal	0.86	82.10	9.30	33967
39	Slovakia	0.86	77.50	12.70	32113
40	Saudi Arabia	0.85	75.10	10.20	47495
41	Bahrain	0.85	77.30	9.50	42522
42	Hungary	0.85	76.90	12.00	31329
43	Chile	0.85	80.20	10.60	23261
44	Croatia	0.85	78.50	11.40	28070
45	Qatar	0.85	80.20	9.70	92418
46	Argentina	0.85	76.70	10.90	21190
47	Brunei Darussalam	0.84	75.90	9.10	63965
48	Montenegro	0.83	76.90	11.60	21399
49	Belarus	0.82	74.80	12.30	18546
49	Romania	0.83	76.10	11.10	29497
49	Russian Federation	0.82	72.60	12.20	26157
53	Kazakhstan	0.83	73.60	11.90	22857
54	Turkey	0.82	77.70	8.10	27701
55	Bulgaria	0.82	75.10	11.40	23325
56	Oman	0.81	77.90	9.70	25944
56	Uruguay	0.82	77.90	8.90	20064
58	Bahamas	0.81	73.90	11.40	33747

▶

Tab. S2 *(follows).* Human development index and its components for different countries of the world.

HDI rank	Population	HDI	Life expectancy at birth	Mean years of schooling	Gross national Income (GNI) per capita
58	Panama	0.82	78.50	10.20	29558
60	Barbados	0.81	79.20	10.60	14936
61	Costa Rica	0.81	80.30	8.70	18486
62	Kuwait	0.81	75.50	7.30	58590
63	Georgia	0.81	73.80	13.10	14429
63	Malaysia	0.81	76.20	10.40	27534
65	Serbia	0.81	76.00	11.20	17192
66	Mauritius	0.80	75.00	9.50	25266
67	Trinidad and Tobago	0.80	73.50	11.00	26231
68	Albania	0.80	78.60	10.10	13998
70	Iran, Islamic Republic of	0.78	76.70	10.30	12447
71	Cuba	0.78	78.80	11.80	8621
72	Armenia	0.78	75.10	11.30	13894
73	Sri Lanka	0.78	77.00	10.60	12707
76	Bosnia and Herzegovina	0.78	77.40	9.80	14872
76	Mexico	0.78	75.10	8.80	19160
78	Peru	0.78	76.70	9.70	12252
78	Ukraine	0.78	72.10	11.40	13216
80	Thailand	0.78	77.20	7.90	17781
82	North Macedonia	0.77	75.80	9.80	15865
83	Colombia	0.77	77.30	8.50	14257
84	Brazil	0.77	75.90	8.00	14263
84	Ecuador	0.76	77.00	8.90	11044
87	China	0.76	76.90	8.10	16057
88	Azerbaijan	0.76	73.00	10.60	13784
89	Dominican Republic	0.76	74.10	8.10	17591
90	Lebanon	0.74	78.90	8.70	14655
91	Algeria	0.75	76.90	8.00	11174
91	Republic of Moldova	0.75	71.90	11.70	13664
93	Fiji	0.74	67.40	10.90	13009
94	Tunisia	0.74	76.70	7.20	10414
97	Mongolia	0.74	69.90	10.30	10839
98	Jamaica	0.73	74.50	9.70	9319
98	Maldives	0.74	78.90	7.00	17417
98	Suriname	0.74	71.70	9.30	14324
101	Venezuela, Bolivarian Republic of	0.71	72.10	10.30	7045
102	Botswana	0.74	69.60	9.60	16437
103	Jordan	0.73	74.50	10.50	9858
104	Paraguay	0.73	74.30	8.50	12224
106	Libya	0.72	72.90	7.60	15688
107	Uzbekistan	0.72	71.70	11.80	7142
108	Belize	0.72	74.60	9.90	6382
108	Bolivia, Plurinational State of	0.72	71.50	9.00	8554
110	Indonesia	0.72	71.70	8.20	11459
111	Philippines	0.72	71.20	9.40	9778
112	Turkmenistan	0.72	68.20	10.30	14909
114	Gaza Strip and West Bank	0.71	74.10	9.20	6417
115	South Africa	0.71	64.10	10.20	12129
117	Egypt	0.71	72.00	7.40	11466
118	Viet Nam	0.70	75.40	8.30	7433
119	Gabon	0.70	66.50	8.70	13930
120	Kyrgyzstan	0.70	71.50	11.10	4864
121	Guyana	0.68	69.90	8.50	9455
121	Morocco	0.69	76.70	5.60	7368

Tab. S2 *(follows)*. Human development index and its components for different countries of the world.

HDI rank	Population	HDI	Life expectancy at birth	Mean years of schooling	Gross national Income (GNI) per capita
123	Iraq	0.67	70.60	7.30	10801
124	El Salvador	0.67	73.30	6.90	8359
125	Cabo Verde	0.67	73.00	6.30	7019
126	Tajikistan	0.67	71.10	10.70	3954
127	Nicaragua	0.66	74.50	6.90	5284
128	Guatemala	0.66	74.30	6.60	8494
129	Namibia	0.65	63.70	7.00	9357
130	India	0.65	69.70	6.50	6681
131	Bhutan	0.65	71.80	4.10	10746
132	Honduras	0.63	75.30	6.60	5308
134	Bangladesh	0.63	72.60	6.20	4976
137	Lao People's Democratic Republic	0.61	67.90	5.30	7413
138	Ghana	0.61	64.10	7.30	5269
139	Eswatini	0.61	60.20	6.90	7919
140	Vanuatu	0.61	70.50	7.10	3105
141	Kenya	0.60	66.70	6.60	4244
141	Timor-Leste	0.61	69.50	4.80	4440
143	Nepal	0.60	70.80	5.00	3457
144	Cambodia	0.59	69.80	5.00	4246
145	Angola	0.58	61.20	5.20	6104
145	Equatorial Guinea	0.59	58.70	5.90	13944
145	Zambia	0.58	63.90	7.20	3326
148	Myanmar	0.58	67.10	5.00	4961
149	Congo, Republic of	0.57	64.60	6.50	2879
150	Zimbabwe	0.57	61.50	8.50	2666
151	Solomon Islands	0.57	73.00	5.70	2253
152	Syrian Arab Republic	0.57	72.70	5.10	3613
153	Cameroon	0.56	59.30	6.30	3581
154	Comoros	0.55	64.30	5.10	3099
154	Pakistan	0.56	67.30	5.20	5005
156	Papua New Guinea	0.56	64.50	4.70	4301
157	Mauritania	0.55	64.90	4.70	5135
158	Benin	0.55	61.80	3.80	3254
159	Rwanda	0.54	69.00	4.40	2155
160	Uganda	0.54	63.40	6.20	2123
161	Côte d'Ivoire	0.54	57.80	5.30	5069
161	Nigeria	0.54	54.70	6.70	4910
163	Madagascar	0.53	67.00	6.10	1596
164	Tanzania, United Republic of	0.53	65.50	6.10	2600
165	Lesotho	0.53	54.30	6.50	3151
166	Djibouti	0.52	67.10	4.10	5689
167	Senegal	0.51	67.90	3.20	3309
168	Togo	0.52	61.00	4.90	1602
169	Afghanistan	0.51	64.80	3.90	2229
170	Haiti	0.51	64.00	5.60	1709
171	Sudan	0.51	65.30	3.80	3829
172	The Republic of the Gambia	0.50	62.10	3.90	2168
173	Liberia	0.48	64.10	4.80	1258
174	Congo, Democratic Republic of	0.48	60.70	6.80	1063
174	Ethiopia	0.49	66.60	2.90	2207
174	Malawi	0.48	64.30	4.70	1035
177	Guinea	0.48	61.60	2.80	2405
178	Guinea-Bissau	0.48	58.30	3.60	1996
179	Yemen	0.47	66.10	3.20	1594
180	Eritrea	0.46	66.30	3.90	2793

Tab. S2 *(follows)*. Human development index and its components for different countries of the world.

HDI rank	Population	HDI	Life expectancy at birth	Mean years of schooling	Gross national Income (GNI) per capita
181	Mozambique	0.46	60.90	3.50	1250
182	Sierra Leone	0.45	54.70	3.70	1668
183	Burkina Faso	0.45	61.60	1.60	2133
184	Burundi	0.43	61.60	3.30	754
184	Mali	0.43	59.30	2.40	2269
186	South Sudan	0.43	57.90	4.80	2003
187	Chad	0.40	54.20	2.50	1555
188	Central African Republic	0.40	53.30	4.30	993
189	Niger	0.39	62.40	2.10	1201