RESEARCH ARTICLE

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Association between Socioeconomic Inequality and the Burden of Colon and Rectum Cancer in Asia: GLOBOCAN Sources and Methods

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Abstract

Introduction: Colon cancer is the third most common malignancy worldwide, which is increasing in middle-income countries. Our aim in this study was to investigate the association between socioeconomic inequality and the burden of Colon and rectum cancer in Asia. **Methods:** All accessible data sources from 1990 to 2019 Global Burden of Disease study were used to estimate the prevalence, mortality, and disability-adjusted life years and the burden of Colon and rectum cancer in Asia. We estimated all-cause and cause-specific mortality, years of life lost (YLLs), years lived with disability (YLDs), and disability-adjusted life-years (DALYs). All estimates were presented as counts and age-standardized rates per 100,000 populations with uncertainty intervals (UIs). The concentration index was used to calculate inequality. **Results:** The incidence and mortality of colon and rectum cancer have been increasing in recent years. The highest incidence (49.37 per 100,000) and mortality (30.25 per 100,000) belong to Brunei. The concentration index showed that the incidence and mortality rate of colon cancer is higher in countries with a high life expectancy, education level, and Gross domestic product (GDP). The highest DALY of disease (626.12 per 100,000) and YLL (603.43 per 100,000) belonged to Brunei, and the highest YLD of disease (32.67 per 100,000) belonged to Taiwan. The results revealed that the burden of the disease, YLL, and YLD for colon cancer are concentrated more in countries with a higher human development index. **Conclusion:** Considering the rising trend of colon cancer burden in Asia and given the fact that the incidence, mortality, and burden of the disease are concentrated more in countries with a higher socioeconomic status, it is essential to obtain accurate estimations in these countries and to identify the associated factors to prepare for potential changes in the burden of public health caused by the disease.

Keywords: Colon and rectum cancer- Incidence- Mortality- inequality- Asia

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Introduction

Non-communicable diseases (NCDs) are the main cause of death in the world today, all around the world, the burden of communicable diseases has decreased, while non-communicable diseases are increasing [1-4]. WHO estimated that cancer was the first or the second cause of death before the age of 70 in most countries of the world in 2015 [5]. Increased life expectancy, changes in lifestyle, and economic development are among the reasons for the increase in the prevalence of cancer in the world. Cancers are the main cause of death in some developed countries and the second cause of death after cardiovascular diseases in developing countries [6-9]. Colon cancer is an important cancer, the prevalence of which has increased in recent decades, especially with the increase in the socio-economic status of people. It is the second most common type of cancer in women and the third in men [10, 11]. Colon cancer is the second most common cause of cancer, accounting for 935,000 cancer-caused deaths in 2020 [12]. According to the GLOBOCAN 2020, colon cancer is among the most common types of cancer in the world, and factors affecting the quality of life index have a significant impact on its incidence and

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mortality [13-15].

According to the 2020 GLOBOCAN report, this cancer is one of the most common cancers in the world, and the factors affecting the quality-of-life index have a significant impact on its incidence and mortality. Given the high survival rate of patients with colon cancer in the early stages of diagnosis and its impact on the patients' quality of life, it is an important and noteworthy type of cancer in terms of economic costs and mortality [16].

Family history, genetic history, physical inactivity, obesity, and alcohol consumption are among the most important factors causing colon cancer, Environmental and socio-economic factors are also influential in colon cancer mortality [17-20]. The general pattern of incidence and death from colon cancer can be observed in all regions of the world and at all levels of socio-economic development. The difference in the incidence of colon cancer in the world is not only due to causing factors; it can also be due to the availability of accurate screening methods in advanced countries, diagnosis in the early stages of the disease, and patient follow-up in different countries [2].

New cases of colon cancer in increasing worldwide [21]. The continuation of the global demographic and epidemiological trends is a clear indicator of the increase of this type of cancer in recent decades, especially in low- and middle-income countries. Colon cancer is more prevalent in western countries than in eastern ones. Also, the death rate in developed countries is higher than in developing countries, which has been stabilizing or decreasing in some countries recently [12, 22, 13] . This type of cancer is also known to be directly related to the indicators of economic-social development [23] . In some eastern European, Asian, and South American countries with moderate Human Development Index (HDI) such as Poland and India, the incidence and mortality of colon cancer are increasing [12, 13, 24]. The incidence of colon cancer has decreased in high HDI countries such as the United States [14, 25].

Colon cancer accounted for 9.4% of cancer deaths in 2020, which was the second leading cause of cancer after lung cancer [26]. The death rate of this type of cancer has increased in people over the age of 50 [27]. The death rate of this type of cancer is expected to increase by 60% by the year 2030. The incidence of colon cancer in men and women in developed countries is higher than in developing countries, while the highest death rate of colon cancer is related to developing countries [12, 23, 28] . Also, according to the (HDI) estimates, the burden of diseases caused by colon cancer is higher in regions with high HDIs [23, 29].

The Human Development Index (HDI) is a summary measure of human development dimensions. The index measures average achievement in a country in three key dimensions of human development: a long and healthy life, being knowledgeable, and having a decent standard of living [30, 31].

Considering the global pattern of colon cancer and its time trend in recent years, it is necessary to be aware of this type of cancer while planning and managing financial and human resources to be able to prevent it. Despite the increase in the burden of the disease in developing countries, only 50% of global health resources has been allocated to these countries. Each country must compare its data with those of other countries and reach a firm conclusion on whether socioeconomic status still has an impact on cancer risk factors.

The present study aims to investigate the effect of socioeconomic development (as measured by in the Human Development Index) on the worldwide pattern of the incidence and mortality of colon cancer in the world based on the data available from the World Bank in 2019. This study aims to investigate the critical features of colon cancer transmission in the world by studying the relationship between incidence rate of the disease and the Human Development Index, which consists of life expectancy, education, and gross national income.

Materials and Methods

This ecological study in Asia aims to investigate the relationship between the epidemiology of Colon and rectum cancer and the Human Development Index in Asia in 2019. All the data used in this research were available to the public at http://ghdx.healthdata.org/gbd-results-tool. Data were extracted using Global Burden of Disease (GBD) results. These data,and, including mortality and incidence estimates for all age and sex groups along with the 95% UI, were accessible. For some indices, the percentage change between 1990 and 2019 was reported. The Institute for Health Metrics and Evaluation (IHME) has produced annual updates to the GBD study, including temporal and geographic trends, since 1990. They were updating new data and methodological advances to provide policymakers with the most up-to-date information for health care planning and resource allocation. The 2019 GBD study estimated incidence, prevalence, and mortality by age, sex, year, and location for 354 diseases and injuries and 3484 sequelae i.e., disabling consequences of these diseases and injuries [32].

Disability-Adjusted Life Years (DALY)

DALY is a type of health gap index that calculates the years of life lost, either due to premature death or due to non-fatal diseases. This index was defined and used in the GBD and Injuries Study to calculate the burden of diseases [33].

Years of Life Lost Due to Premature Death (YLL)

The years of life lost due to premature death index, developed by the World Health Organization in the burden of diseases study, can be used to identify and prioritise the causes of premature deaths. This index considers not only the number of deaths but also the age of the deceased at the time of death, and the younger the age of the deceased at the time of death, the higher the number of years of life lost. The lost years of life are the years lost due to premature death that a person could have had a useful life [33].

Years Lived with Disability (YLD)

It refers to the years a person had a disability due to an illness [33].

Human Development Index (HDI)

The Human Development Index (HDI) is a statistical tool used to measure a country's overall achievements in its social and economic dimensions. According to this index, a country's social and economic dimensions are evaluated based on people's health, education level, and standard of living [34]. The United Nations measures the HDI index annually for the member countries of the United Nations in a report based on which different countries are ranked [35, 15, 20].

Concentration Index

In this study, the Concentration Index will be used to study the inequality in the burden of mental disorders at the national level. The concentration index, defined concerning the Lorenz Curve, shows the degree of inequality in a health variable at an income distribution level. The concentration curve (the Lorenz curve) shows the cumulative percentage of people ranked based on income or socioeconomic status on the X axis and the cumulative percentage of the health variable on the Y axis. Suppose the curve is below the diagonal line. In that case, it indicates that the concentration of the health status variable is in the upper socio-economic class. If it is above the diagonal line, it suggests that the concentration of the health status variable is in the lower socio-economic class. If the diagonal line touches the curve, it means lack of inequality. The amount of inequality is twice the area between the curve and the diagonal line. The value of the concentration index varies between +1 and –1, which is a standard index for the calculation of inequalities related to income or socioeconomic status [36].

Statistical analysis

The present study used a bivariate correlation analysis to study the correlation between the burden of Colon and rectum cancer and HDI. The significance level was set at $p < 0.05$. All statistical analyses were performed using the Stata software, version 14 (Stata Corp, College Station, TX, USA).

Results

The incidence and mortality of colon and rectum cancer in men and women in Asia from 1990 to 2019 followed an increasing trend in the given period, and the incidence and mortality rates in men are higher than in women (Figure 1).

Table 1 shows the incidence and mortality of colon and rectum cancer in Asian countries in men and women in 2019. The results show that the highest incidence of Colon and rectum cancer in both (men and women) belongs to Brunei, with an incidence of 49.37 per 100,000, and the lowest incidence belongs to Bangladesh, with an incidence of 3.63 per 100,000. The highest mortality rate for colon cancer is related to Brunei, with 30.25 deaths per 100,000, and the lowest mortality rate is related to Bangladesh, with 4.93 deaths per 100,000 (Table 1).

Figure 2 shows inequality in the incidence and mortality of colon and rectum cancer in Asian countries based on the Human Development Index. As can be seen, the incidence and mortality rates of Colon and rectum cancer in both men and women are concentrated more in countries with a high human development index.

Table 2 shows the concentration index based on the dimensions of the human development index. As can be seen, in the incidence and mortality of Colon and rectum cancer, the value of the concentration index for human development index dimensions is positive, which shows that the incidence and mortality of Colon and rectum cancer is concentrated more in countries that have better life expectancy, education level, and GDP.

Figure 3 shows the burden of the disease for disability-adjusted life years (DALY), years of life lost due to premature death (YLL), and years lived with disability (YLD). As can be seen, the burden of the disease has been increasing in the given period.

Table 3 shows the burden of the disease for disability-adjusted life years (DALY), years of life lost due to premature death (YLL), and years lived with disability (YLD) for Colon and rectum cancer in Asia by country. As can be seen, the highest burden of the disease for Colon and rectum cancer was related to Taiwan (32.67 per

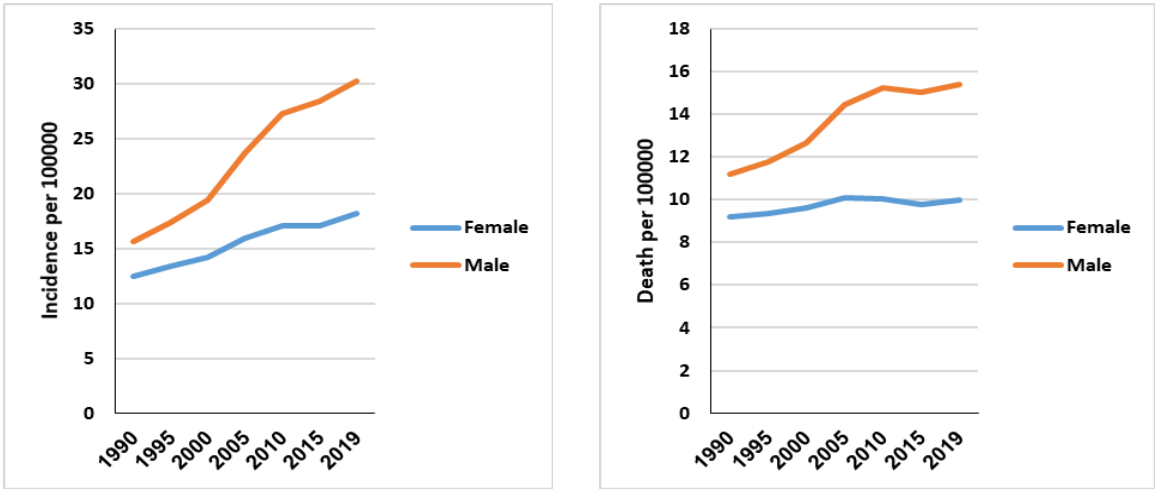

Figure 1. The Incidence and Mortality Rates of Colon and Rectum Cancer in Asia from 1990 to 2019. (Source: Global Burden of Disease)

Table 1. Incidence and mortality of Colon and rectum cancer in Asian countries in 2019. (Source: Global Burden of Disease)

Country	Age-standardized incidence rate per 100000			Change 2010-2019	Age-standardized death rate per 100000			Change 2010-2019
	Male	Female	Both		Male	Female	Both	
Afghanistan	8.41	9.04	8.69	0.11 (-0.07,0.33)	7.98	8.91	8.43	0.09 (-0.08, 0.31)
Armenia	23.16	20.08	21.36	0.06 (-0.12,0.36)	15.55	13.39	14.3	0.002 (-0.14, 0.17)
Azerbaijan	19.21	13.94	16.31	0.09 (-0.05,0.29)	14.29	10.5	12.19	0.03 (-0.11, 0.2)
Bahrain	19.93	13.03	16.96	-0.03 (-0.23,0.21)	12.9	9.91	11.42	-0.11 (-0.29, 0.08)
Bangladesh	5.77	5.45	5.63	0.12 (-0.1,0.38)	5.06	4.78	4.93	0.04 (-0.16, 0.28)
Bhutan	7.807	8.27	8.02	0.2 (0.005, 0.41)	6.79	7.15	6.96	0.13 (-0.04, 0.33)
Brunei	67.51	38.65	49.37	0.03 (-0.090.18)	43.03	23.96	30.25	-0.02 (-0.14, 0.11)
Cambodia	20.1	14.26	16.6	0.23 (0.04, 0.44)	17.08	11.93	14.01	0.15 (-0.02, 0.33)
China	41.42	21.1	30.55	0.16 (-0.02, 0.38)	19.31	9.67	13.85	-0.02 (-0.18, 0.15)
Georgia	25.43	14.44	19.13	0.13 (-0.05, 0.36)	17.58	10.02	13.19	0.1 (-0.08, .31)
India	8.48	8.69	8.58	0.28 (0.08, 0.49)	7.41	7.57	7.5	0.22 (0.04, 0.44)
Indonesia	20.73	16.52	18.52	0.17 (-0.02, 0.36)	17.54	13.84	15.57	0.12 (-0.05, 0.27)
Iran	16.83	10.97	13.88	0.26 (0.17, 0.38)	10.21	8.42	9.31	0.12 (0.04, 0.21)
Iraq	13.53	8.85	11.12	0.23 (0.03,0.47)	9.51	7.25	8.31	0.12 (-0.05, 0.33)
Japan	62.44	34.6	47.58	-0.013 (-0.15, 0.14)	20.27	12.14	15.85	-0.05 (-0.08, -0.03)
Jordan	22.51	15.42	19.13	0.07 (-0.11,0.29	14.11	11.96	13.07	-0.05 (-0.08, -0.03)
Kazakhstan	24.54	16.91	19.72	-0.01 (-0. 15, 0.14)	17.22	11.41	13.49	-0.1 (-0.22, 0.01)
Kuwait	22.1	11.46	17.77	0.11 (-0.06, 0.34)	11.65	7.85	10.13	-0.001 (-0.15, 0.18)
Kyrgyzstan	11.48	9.69	10.51	0.02 (-0.09, 0.16)	8.81	7.71	8.23	-0.03 (-0.14, 0.09)
Lao People's Democratic Republic	16.43	13.48	14.9	0.18 (-0.02, 0.41)	14.81	11.99	13.33	0.13 (-0.06, 0.34)
Lebanon	37.19	23.73	29.82	0.13 (-0.06, 0.35)	19.64	15.85	17.55	-0.001 (-0.16, 0.16)
Malaysia	32.34	26.77	29.56	0.31 (0.04, 0.62)	22.08	18.53	20.31	0.17 (-0.04, 0.43)
Maldives	12.53	15.07	13.8	0.19 (-0.01, 0.4)	7.76	9.7	8.7	0.07 (-0.1, 0.26)
Mongolia	13.64	9.21	11.09	0.11 (-0.11, 0.37)	11.49	7.8	9.31	0.06 (-0.13, 0.31)
Myanmar	17.69	12.94	15.02	0.17 (-0.03, 0.37)	15.12	11.07	12.81	0.1 (-0.08, 0.28)
Nepal	5.69	6.03	5.88	0.3 (0. 05, 0.55)	5.27	5.49	5.39	0.25 (0.01, 0.49)
Oman	16.17	14.39	15.32	-0.08 (-0.24, 0.14)	10.11	10.57	10.2	-0.11 (-0.25, 0.05)
Pakistan	10.26	7.94	9.14	0.07 (-0.13, 0.37)	9.38	7.23	8.33	0.03 (-0.15, 0.29)
Philippines	23.07	15.24	18.93	0.19 (-0.03, 0.47)	17.98	12.21	14.88	0.15 (-0.05, 0.39)
Qatar	22.03	34.87	25.054	-0.08 (-0.26, 0.12)	13.69	25.85	16.47	-0.13 (-0.29, 0.04)
Saudi Arabia	16.78	13.12	15.357	0.13 (-0.08, 0.36)	9.49	9.86	9.65	-0.03 (-0.19, 0.15)
Singapore	46.92	33.56	39.93	-0.08 (-0.26, 0.13)	17.12	12.92	14.88	-0.14 (-0.2, -0.09)
Sri Lanka	10.69	9.69	10.17	0.18 (-0.11, 0.54)	6.7	6.12	6.4	0.04 (-0.21, 0.33)
Syrian Arab Republic	9.67	7.56	8.54	0.01 (-0.25, 0.32)	6.4	6.38	6.28	-0.02 (-0.27, 0.25)
Tajikistan	13.31	10.07	11.62	0.11 (-0.1, 0.38)	11.64	8.96	10.22	0.11 (-0.09, 0.37)
Thailand	20.86	13.98	17.18	-0.23 (0.05, 0.41)	12.78	8.63	10.54	-0.04 (-0.28, 0.26)
Timor-Leste	14.17	13.68	13.9	-0.008 (0.21, 0.47)	12.65	11.96	12.29	0.15 (-0.04, 0.39)
Turkey	27.2	14.44	20.5	-0.12 (0.13, 0.48)	15.57	10.9	13.1	0.02 (-0.18 0.29)
Turkmenistan	10.48	8.2	9.19	0.08 (0.32, 0.65)	8.14	6.32	7.08	0.24 (0.02, 0.52)
United Arab Emirates	22.86	17.75	21.36	-0.34 (-0.13, 0.13)	18.42	14.9	17.4	-0.2 (-0.39, 0.04)
Uzbekistan	13.86	11.86	12.82	-0.006 (0.15, 0.34)	10.95	9.75	10.35	0.07 (-0.06, 0.23)
Viet Nam	37.77	17.91	26.35	0.03 (0.25, 0.49)	25.69	11.91	17.49	0.12 (-0.06, 0.32)
Yemen	7.911	6.88	7.39	-0.23 (-0.006, 0.24)	6.83	6.48	6.65	-0.02 (-0.24, 0.2)
Republic of Korea	50.47	26.56	37.16	-0.05 (-0.19, 0.12)	18.6	10.5	13.87	-0.09 (-0.16, -0.09)
Democratic People's Republic of Korea	19.15	12.64	15.42	0.02 (-0.15, 0.21)	13.82	8.93	13.33	-0.02 (-0.18, 0.15)

100,000) and Japan (27.24 per 100,000. The highest DALY index belonged to Brunei (626.12 per 100,000) and Taiwan (588.35 per 100,000), and the highest YLL index belonged to Brunei (603.43 per 100,000) and Taiwan (556.67 per 100,000) (Table 3). The results of studying inequality in the burden of colon and rectum cancer showed that the

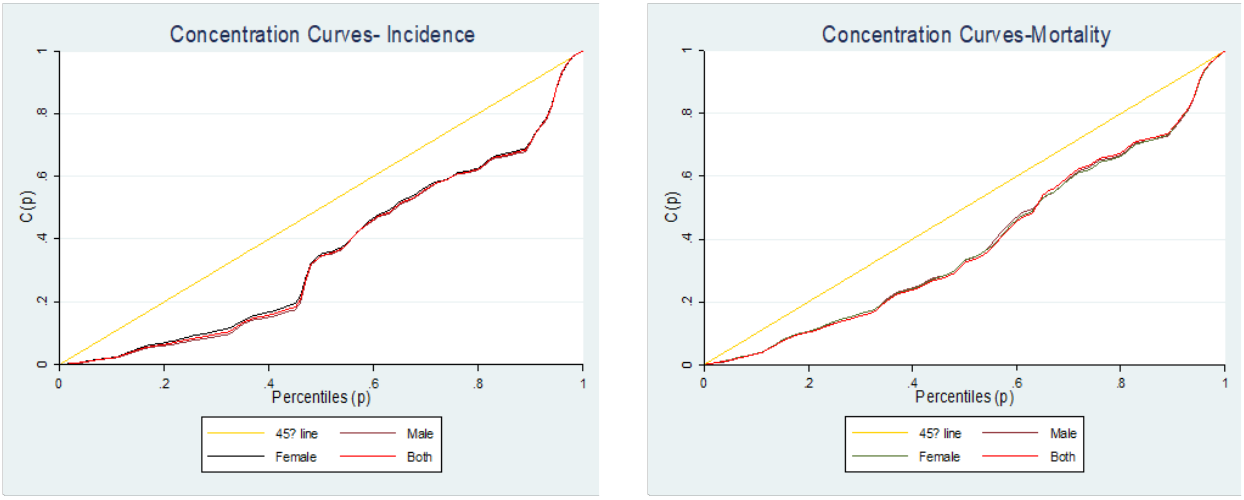

Figure 2. Concentration Index Incidence and Mortality Colon and Rectum Cancer by Sex

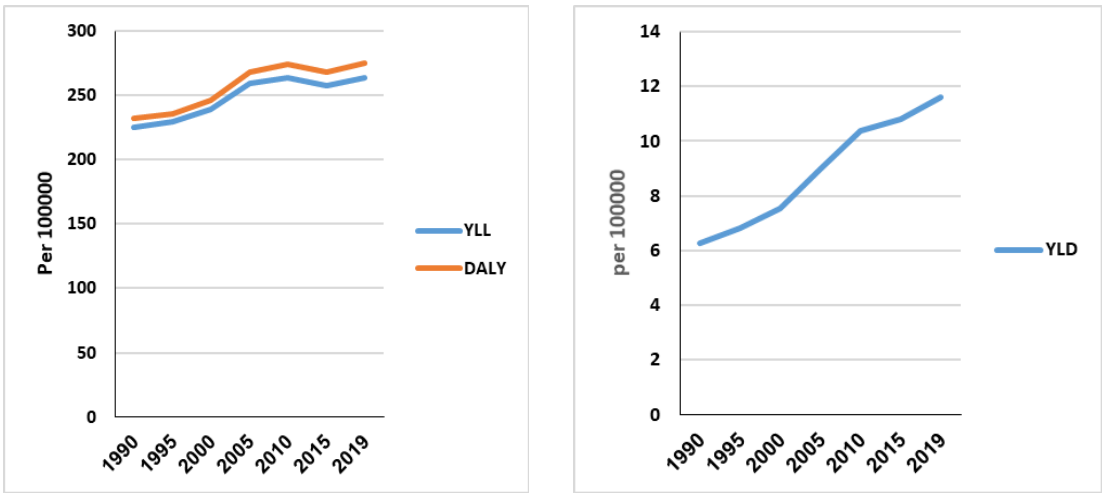

Figure 3. burden of Colon and Rectum Cancer during 1990-2019 (source: Global Burden of Disease)

burden of the disease for YLL and YLD is concentrated more in countries with a high human development index (Figure 4).

The concentration index for the burden of Colon and rectum cancer is positively optimistic based on the dimensions of the human development index, and it shows that the burden of the disease is concentrated more in countries with a high average education level, life expectancy, and a high GDP (Table 4).

Discussion

The prevalence of colon cancer has increased way alarmingly in recent years [26, 15] . Men are more likely to develop the symptoms of this type of cancer [17]. The results of the present study showed that the highest incidence (49.37 per 100,000) and mortality (30.25 per 100,000) belong to Brunei, the highest DALY of disease (626.12 per 100,000) and YLL (603.43 per 100,000) belonged to Brunei and highest YLD of disease (32.67 per 100,000) belonged to Taiwan

The difference in the incidence of colon cancer in these regions can be due to the difference in their socioeconomic status. The incidence and mortality rates of colon cancer are higher in countries with high HDI. Factors such as early screening, careful health care, diagnosing the disease

Table 2. The Concentration Index based on the Dimensions of Human Development Index

Variable	Incidence	Mortality
HDI	0.29 (0.11, 0.47)	0.23 (0.1, 0.35)
Life expectancy at birth	0.31 (0.15, 0.48)	0.23 (0.1, 0.36)
Mean year of schooling	0.31 (0.17, 0.46)	0.23 (0.1, 0.37)
Expected years of schooling	0.21 (0.01, 0.42)	0.23 (0.13, 0.33)
Gross national income per 1000 capita	0.19 (0.001, 0.38)	0.15 (0.03, 0.28)

Table 3. Burden of Colon and Rectum Cancer for Disability-Adjusted Life Years (DALY), Years of Life Lost due to Premature Death (YLL) (source: Global Burden of Disease)

The provinces	YLL per 100000			YLD per 100000			DALY per 100000		
	Male	Female	Both	Male	Female	Both	Male	Female	Both
Afghanistan	186.44	227.3	206.21	3.039	3.134	3.071	189.48	230.43	209.28
Algeria	162.38	161.37	161.62	5.067	3.771	4.422	167.44	165.14	166.04
Armenia	339.39	288.76	310.4	10.1	8.76	9.324	349.49	297.52	319.72
Azerbaijan	346.32	242.5	290.1	8.058	5.814	6.836	354.37	248.31	296.94
Bahrain	235.68	196.69	216.42	8.72	5.253	7.294	244.4	201.95	223.71
Bangladesh	107.68	102.16	105.25	2.192	2.055	2.131	109.88	104.21	107.38
Bhutan	138.28	146.46	142.08	2.941	3.061	2.996	141.22	149.52	145.08
Brunei Darussalam	778.66	490.5	603.43	30.23	17.79	22.69	808.89	508.3	626.12
Cambodia	393.42	271.59	322.78	7.639	5.437	6.361	401.06	277.02	329.14
China	413.75	206.78	305.19	20.73	10.49	15.37	434.49	217.28	320.56
Democratic People's Republic of Korea	345	220.35	275.89	8.357	5.56	6.788	353.36	225.91	282.67
Georgia	436.07	239.39	325.56	10.93	6.26	8.283	447.01	245.65	333.84
India	161.95	169.97	165.84	3.188	3.257	3.22	165.14	173.23	169.06
Indonesia	388.71	301.88	343.54	7.918	6.291	7.074	396.62	308.17	350.62
Iran (Islamic Republic of)	222.93	178.73	200.63	7.753	4.456	6.095	230.68	183.19	206.73
Iraq	211.73	171.14	190.54	5.809	3.505	4.636	217.54	174.65	195.17
Japan	403.25	237.19	315.73	35.97	19.58	27.24	439.22	256.78	342.97
Jordan	295.1	252.39	274.46	10.09	6.165	8.23	305.19	258.56	282.69
Kazakhstan	368.45	256.22	299.22	10.33	7.34	8.472	378.78	263.56	307.7
Kuwait	223.33	150.78	193.99	10.59	4.939	8.282	233.92	155.72	202.27
Kyrgyzstan	199.33	159.64	178.03	4.878	4.049	4.428	204.21	163.69	182.45
Lao People's Democratic Republic	344.28	276.79	309.5	6.145	5.022	5.566	350.43	281.81	315.07
Lebanon	393.33	331.2	359.19	17.34	10	13.33	410.67	341.21	372.53
Libya	275.16	308.32	291.07	7.836	6.284	7.07	282.99	314.6	298.14
Malaysia	459.05	359.74	409.58	13.66	11.09	12.38	472.72	370.83	421.96
Maldives	159	174.57	167.55	5.783	6.59	6.2	164.78	181.16	173.75
Mauritius	339.92	232.76	282.05	10.23	7.303	8.655	350.15	240.07	290.7
Mongolia	262.77	170.12	211.04	5.447	3.727	4.476	268.22	173.85	215.51
Morocco	189.23	190.12	189.53	4.656	3.55	4.1	193.89	193.68	193.63
Myanmar	354.81	250.84	296.89	6.758	4.914	5.729	361.57	255.76	302.62
Nepal	109.48	117.14	113.7	2.065	2.175	2.126	111.54	119.31	115.83
Oman	184.2	206.56	192.46	7.312	5.845	6.662	191.51	212.4	199.12
Pakistan	218.96	169.13	194.92	3.811	2.932	3.386	222.77	172.07	198.31
Palestine	468.7	391.21	424.2	13.13	8.061	10.45	481.83	399.27	434.66
Philippines	450.04	282.76	362.66	9.378	6.085	7.65	459.42	288.84	370.31
Qatar	222.76	432.15	272.38	9.661	13.52	10.58	232.42	445.68	282.97
Republic of Korea	343.21	191.82	260.48	27.67	14.3	20.32	370.89	206.13	280.8
Saudi Arabia	209.81	225.77	216.25	7.873	5.349	6.88	217.69	231.12	223.13
Seychelles	634.13	445.15	539.45	17.12	12.38	14.75	651.25	457.54	554.21
Sri Lanka	143.82	122.33	132.47	4.849	4.344	4.588	148.67	126.67	137.06
Sudan	167.92	152.46	161.22	3.585	2.666	3.167	171.51	155.13	164.39
Syrian Arab Republic	143.92	130.31	136.3	4.385	3.109	3.724	148.3	133.42	140.02
Taiwan (Province of China)	738.26	391.48	556.67	41.27	22.9	31.67	779.54	414.39	588.35
Tajikistan	261.82	186.35	223.06	5.209	3.889	4.527	267.03	190.24	227.59
Thailand	290.58	184.08	233.99	9.598	6.393	7.894	300.18	190.47	241.88
Timor-Leste	283.65	268.49	275.62	5.307	5.094	5.192	288.96	273.58	280.81
Tunisia	202.31	201.51	201.78	7.412	5.206	6.292	209.72	206.71	208.07

Table 3. Continued

The provinces	YLL per 100000			YLD per 100000			DALY per 100000		
	Male	Female	Both	Male	Female	Both	Male	Female	Both
Turkey	343.04	221.99	280.12	12.55	5.785	9.043	355.59	227.78	289.17
Turkmenistan	187.12	142.27	162.66	4.445	3.473	3.906	191.56	145.75	166.56
United Arab Emirates	322.34	324.44	318.79	8.936	6.891	8.323	331.28	331.33	327.11
Uzbekistan	238.34	192.6	214.27	5.803	4.828	5.286	244.14	197.43	219.55
Viet Nam	573.25	261.82	397.91	16.03	7.733	11.36	589.29	269.55	409.27
Yemen	153.97	152.59	153.23	3.087	2.526	2.803	157.06	155.12	156.03

Table 4. The Concentration Index for the Burden of Colon and Rectum Cancer based on the Dimensions of Human Development Index

Variable	Burden of Colon and rectum cancer		
	YLL	YLD	DALY
HDI	0.14 (0.04, 0.25)	0.39 (0.23, 0.55)	0.18 (0.08, 0.27)
Life expectancy at birth	0.13 (0.02, 0.24)	0.4 (0.24, 0.56)	0.17 (0.07, 0.27)
Mean year of schooling	0.14 (0.03, 0.24)	0.34 (0.15, 0.52)	0.17 (0.07, 0.27)
Expected years of schooling	0.16 (0.08, 0.24)	0.34 (0.22, 0.46)	0.18 (0.1, 0.26)
Gross national income per 1000 capita	0.1 (0.004, 0.21)	0.3 (0.15, 0.45)	0.13 (0.03, 0.23)

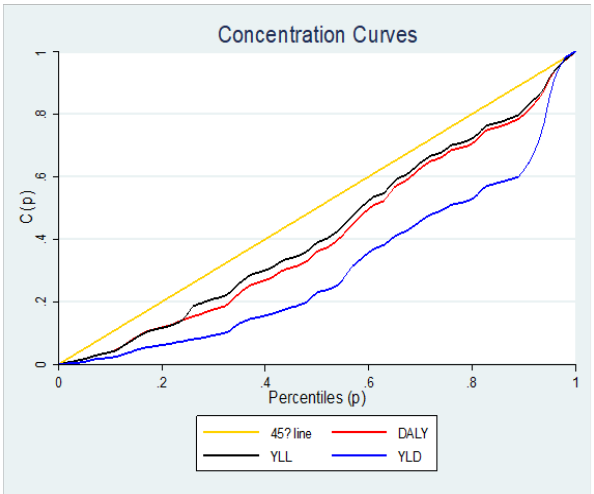

Figure 4. The Concentration Index

at the early stages, and an accurate registration system are among the reasons for the incidence of colon cancer in these countries [37, 29].

Colon cancer is four times more common in countries with a high HDI than in countries with a low HDI. In recent years, the incidence of colon cancer has decreased in countries with a high HDI [38, 25, 14]. Britain and India have experienced an increase in the incidence of colon cancer, especially in people under the age of 50. In Germany, Australia, the United States, Sweden, Canada, and Britain, the incidence rate of the disease has been decreasing or stabilising in people over the age of 50 [25, 23] . The highest incidence rate of colon cancer in 2020 belonged to China and the United States [16].

Jian et al. [36] investigated colorectal cancer survival rates using population data. They showed that the five-year relative survival rates for colorectal cancer in the Republic of Korea (2010-2014), Queensland, Australia (2005–2012), and the United States (2005–2009) were ranked relatively higher compared to other countries. The increase in the survival rate was attributed to socioeconomic changes and the improved quality of life in these regions [39].

Sawicki et al. [13] showed that there is a significant relationship between HDI and the incidence of colon cancer and that the incidence rate of colon cancer in people living in developing countries with a low HDI is lower than in people living in developed countries with a high HDI. These results are consistent with the results of the present study. These studies show that cancer is still a global and vital issue in health communities, and more extensive studies are needed to understand the relationship between economic development and colon cancer.

Rajesh et al. [1] showed that there is a significant positive relationship between the incidence of colon cancer and socioeconomic status, and that developing countries can reduce the burden of this type of cancer by changing people's lifestyle, using accurate screening methods, and rapid treatment [2].

Socioeconomic developments have significantly impacted the incidence and attenuation of cancer. The risk of developing cancers is increasing in countries with low- or middle-income levels. Cancer-causing infections account for about 26% of cancers in middle- and low-income countries. Increasing life expectancy, aging, changes in lifestyle, and exposure to biological hazards are the risk factors of colon cancer. Colon cancer is associated with the industrialization of societies, and statistics show that most of the deaths from this type of cancer have occurred in developing countries [40].

The results of this study showed that there was a positive correlation between HDI and the incidence of colon cancer ($P<0.0001$) and between HDI and death from colon cancer ($P<0.001$) in 2019.

DALLY and the Burden of Colorectal Cancer Across Different Countries

DALLY (Disability-Adjusted Life Years) is a vital metric for assessing the overall burden of colorectal cancer, encompassing both years lost due to premature death and years lived with disability [41]. In developed countries, advancements in screening, early detection, and effective treatment options result in a lower DALLY associated with colorectal cancer, despite higher incidence rates [42]. In contrast, developing and underdeveloped countries face higher DALLY figures due to limited access to healthcare services, reflecting the significant impact of late diagnosis and inadequate treatment, this disparity underscores the urgent need to improve healthcare infrastructure, implement public health initiatives, and develop educational programs aimed at enhancing awareness and prevention strategies for colorectal cancer globally [42, 15].

The existence of suitable infrastructure, advanced diagnostic methods, easy access to basic health services, high standards of living, and early screening are among the reasons for the higher incidence of colon cancer in countries with a higher HDI. Also, the reason for the higher mortality rate in developing countries is the lack of access to proper diagnostic and treatment facilities, population aging, and changes in lifestyle in these countries. The human development index is the average of the geometric development of normal indicators that measure achievements in each dimension (a long and healthy life, knowledge, and decent living standard). The goals of this index go beyond income and material things to evaluate life satisfaction in the long term for people of different societies and paying attention to human development and emphasizing the point that the real goal of development programs should ultimately be to create conditions for a healthy, creative, and happy life for humans.

Strengths and limitations of the study

This study suffers from the general limitations of GBD studies. The availability and quality of primary data, which are the foundation of the GBD analysis, is the main limitations of GBD estimates, particularly in regions with countries that have poor completeness. Ecological studies have substantial limitations and, although valid for hypothesis generation, are not considered useful for hypothesis testing because of unmeasured and uncontrolled confounding

In conclusion, the incidence, mortality, and burden of colon cancer are increasing in Asia, and the highest concentration of the disease belongs to countries with a human development index, which highlights the necessity of knowing factors related to the increase in the incidence of this disease as well as the need for more screenings in countries with a low level of human development. It is possible to take an effective step in reducing the occurrence of this disease by providing primary prevention strategies for colon cancer, such as reducing exposure to occupational hazards in work environments and to electromagnetic fields. Despite the existence of a relationship between these two factors, the interpretation of such studies should be done with caution because, in addition to the epidemiological risk factors for the incidence of colon cancer, one should also pay attention to the inherent limitations of ecological studies. To summarize, the incidence and mortality rates of colon cancer have increased in many countries. An effective step can be taken in reducing the disease burden and improving the countries' health system by providing primary prevention methods and conducting epidemiology studies, timely treatment, and follow-up of colon cancer patients, especially for people from less developed countries.

Author Contribution Statement

E.G, Z.K and A.N.T. contributed to design, E.G, Z.K and A.N.T contributed to Data Collection and/or Processing, E.G and V.M contributed to Analysis or Interpretation, E.G, F.A, R.A, A.N.T and Z.K helped in the writing of the manuscript.

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Availability of data and materials

The corresponding author can provide the datasets generated during the present study upon reasonable request.

Ethics approval and consent to participate

The study was approved by the ethics committee of the Kerman University of Medical Sciences (KUMS) with ID number IR.KMU.REC.1398.505.

Availability of data and materials

The datasets generated and/or analyzed during the present study can be requested from the corresponding author upon reasonable inquiry.

Competing interests

The authors declare that they have no competing interests.

Abbreviations

YLLs: years of life lost

DALYs: disability-adjusted life-years

YLD: Years Lived with Disability

UIs: uncertainty intervals, NCDs: Non-communicable Diseases

HDI: Human Development Index

GBD: Global Burden of Disease

IHME: Institute for Health Metrics and Evaluation

GDP: Gross domestic product

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