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GLOBAL CANCER STATISTICS 2018: GLOBOCAN ESTIMATES OF INCIDENCE AND MORTALITY WORLDWIDE STOMACH CANCERS AND THEIR RELATIONSHIP WITH THE HUMAN DEVELOPMENT INDEX (HDI)

Z. KHAZAEI[1], A. MOSAVI JARRAHI[2,3], V. MOMENABADI[4], F. GHORAT[5], H. A. ADINEH[6], M. SOHRABIVAFA[7], E. GOODARZI[8]

[1]Department of Epidemiology, School of Public Health, Ilam University of Medical Sciences, Ilam, Iran
[2]Asia Pacific Journal of Cancer Prevention, Tehran, Iran
[3]Faculty of Health Sciences, Simon Fraser University, Burnaby, BC, Canada
[4]Department of Health Education and Promotion, School of Health, Shiraz University of Medical Sciences, Shiraz, Iran
[5]Iranian Research Center on Healthy Aging, Sabzevar University of Medical Sciences, Sabzevar, Iran
[6]Department of Epidemiology and Biostatistics, Iranshahr University of Medical Sciences, Iranshahr, Iran
[7]Student Research Committee, Dezful University of Medical Sciences, Dezful, Iran
[8]Social Determinants of Health Research Center, Lorestan University of Medical Sciences, Khorramabad, Iran

Abstract – *Objective:* *Stomach cancer is one of the most common cancers in the worldwide and the second most common cause of cancer-induced deaths after lung cancer. The aim of this study was to investigate epidemiology of stomach cancer incidence and mortality in 185 countries and its relationship with HDI index in 2018.*

Materials and Methods: *This study is a descriptive-analytic study that is based on extraction of cancer incidence and mortality data from World Bank Cancer in 2018. The incidence and mortality rates and stomach cancer distribution maps were drawn for world countries. To analyze data, correlation test and regression tests were used to evaluate the correlation between incidence and mortality with HDI. The statistical analysis was carried out by Stata-14 and the significance level was estimated at the level of 0.05.*

Results: *Stomach cancer, with 1033701 cases (5.7% of all cancers), was the fifth most common cancer in 2018, with the highest incidence and mortality related to the Asia continent and Eastern Asia region. There was a positive and significant correlation between incidence of stomach cancer and HDI index (R=0.218,* p*<0.05). While the correlation between stomach cancer mortality index and HDI (R=0.008,* p*>0.05) was not statistically significant. Also, there was a positive and significant correlation between the incidence of stomach cancer with MYS (r=0.19,* p*<0.05), LEB (r=0.22,* p*<0.05) and EYS (r=0.25,* p*<0.05) and there was a negative and significant correlation with GNI (r=-0.19,* p*<0.05).*

Conclusions: *Considering that stomach cancer is the second leading cause of death worldwide, it is important to investigate the risk factors of this disease in the countries of the world. According to the results of this study, paying attention to the development index can be effective in reducing the mortality rate of stomach cancer.*

KEYWORDS: *Incidence, Mortality, Stomach Cancer, HDI, World.*

Corresponding Author: Elham Goodarzi, MSc; e-mail: Elhamgoodarzi@yahoo.com

INTRODUCTION

Cancer is one of the most common causes of death and its incidence is increasing worldwide[1]. More than a half of cancers and 60% of deaths occur in less developed countries; however, with lifestyle changes similar to the Western ones, cancer rates in developing countries are increasing[2]. Stomach cancer is recognized as the fourth most common cancer in the world, and is the second leading cause of cancer death. The prevalence of this cancer is due to the process of creating a cancerous tissue in multi stage in the stomach and is classified as multi-agent disease; its formation is due to presence of infectious, environmental and genetic agents in people[3,4].The incidence of stomach cancer varies from one population to another. Genetic differences and differences in lifestyle, especially in dietary habits, such as salt intake and in detection time, have contributed to the difference in the incidence of cancer in different parts of the world; furthermore, these differences are also due to environmental and racial differences[5]. Stomach cancer is common in countries like China, Chile, Ireland, Costa Rica, Northern and Southern Korea, Finland and Iceland[6]. In 2008, about three quarters of deaths and cases of stomach cancer in low and middle income countries (LMICs) occurred[7]. The mortality rate of stomach cancer in Japan, in parts of South America and Eastern Europe is very high. It varies from one region to another, reflecting the impact of lifestyle, such as smoking, drinking alcohol, occupational factors and environmental impacts[8]. One of the important factors associated with the incidence of cancer is the Human Development Index (HDI), which indicates the social and economic status of people in different countries[9,10]. This index is a function of health, quality of life, health facilities, lack of anxiety, relaxation, and having economic and social security. HDI is a useful classification for comparing cancer globally. Lifestyle in low-income and middle-income countries, as well as high-income countries, will have a major impact on the incidence and mortality of all cancers over the coming decades[11]. Considering the importance of the impact of the HDI on the epidemiology of cancers, the aim of this study was to investigate the epidemiology of stomach cancer incidence and mortality in 185 countries and its relationship with HDI index in 2018.

MATERIALS AND METHODS

Caution must be exercised when interpreting these estimates, given the limited quality and coverage of cancer data worldwide at present, particularly in low-income and middle-income countries. IARC's approach is not only to evaluate, compile, and use the data from the Agency's collaborators in these estimates, but also to work alongside national staff to improve local data quality, registry coverage, and analytical capacity. The clear need for investment in population-based cancer registration in low- and middle-income countries led to the launch of the Global Initiative for Cancer Registry Development (GICR), coordinated by IARC. The goal of the GICR is to inform cancer control through defined improvements in the coverage, quality, and use of population-based cancer registration data worldwide. A summary of the steps used to generate the current set of cancer incidence, mortality, and prevalence estimates is provided below. The methods of estimation are country-specific, and the quality of the national estimates depends on the coverage, accuracy, and timeliness of the recorded incidence and mortality data in a given country.

INCIDENCE

The methods used to estimate the sex- and age-specific incidence rates of cancer in a specific country fall into the following broad categories, in order of priority: 1. Observed national incidence rates were projected to 2018 (45 countries); 2. The most recently observed incidence rates (national or regional) were applied to the 2018 population (50 countries); 3. Rates were estimated from national mortality data by modeling, using mortality-to-incidence ratios derived from cancer registries in that country (14 countries); 4. Rates were estimated from national mortality estimates by modeling, using mortality-to-incidence ratios derived from cancer registries in neighboring countries (37 countries); 5. Age- and sex-specific national incidence rates for all cancers combined were obtained by averaging overall rates from neighboring countries. These rates were then partitioned to obtain the national incidence for specific sites using the available cancer-specific relative frequency data (7 countries); 6. Rates were estimated as an average of those from selected neighboring countries (32 countries).

MORTALITY

The methods used to estimate the sex- and age-specific mortality rates of cancer in a specific country fall into the following broad categories, in order of priority: 1. Observed national mortality rates were projected to 2018 (81 countries); 2. The most recently observed national mortality rates were applied to the 2018 population (20 countries); 3. Rates were estimated from the corresponding national incidence

estimates by modeling, using incidence-to-mortality ratios derived from cancer registries in neighboring countries (81 countries); 4. The mentioned rates were estimated as an average of those from selected neighboring countries (3 countries)[12,13].

HDI

HDI is a compound index of indices in three dimensions: life expectancy, degree of studies, and dominance over required sources for a proper sensible life. All the groups and regions, which have had a remarkable progress in all HDI components, have developed more rapidly in comparison with low or moderate HDI countries. As this index shows, the world is unequal because national average hides most of the different experiences in human's life. There exit a lot of inequalities in Northern and Southern countries. Income inequality has risen inside every country and also between many countries[14-16].

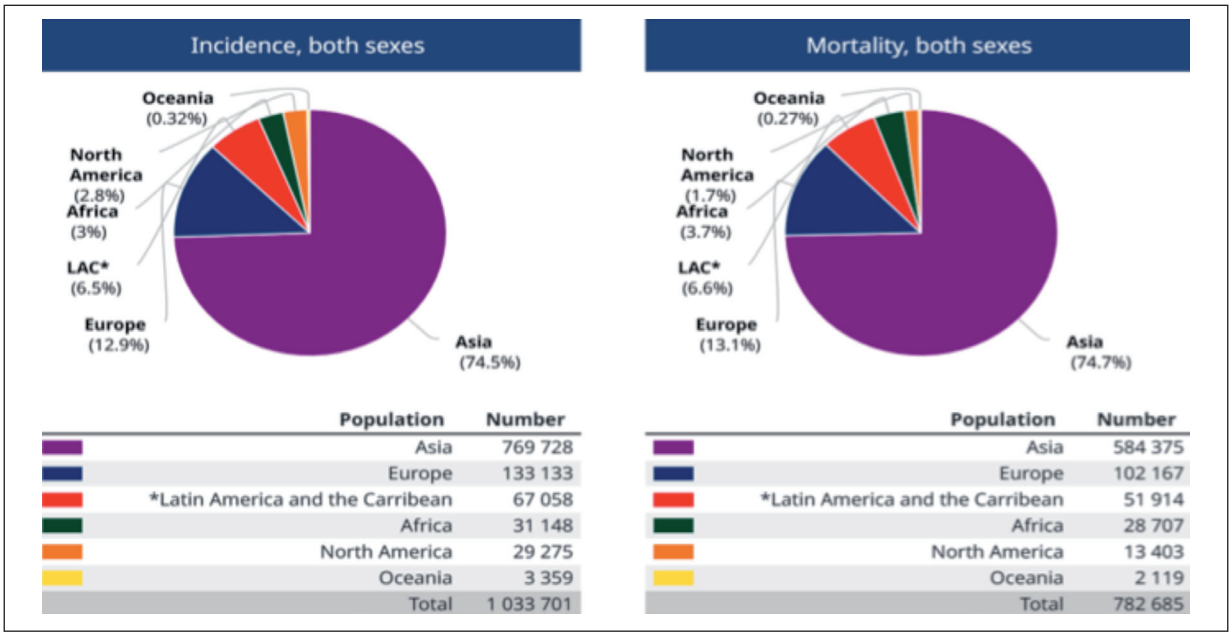
FINDINGS

Based on the results of cancer recordings in 2018, 18078957 cases of cancer have been recorded in both genders; stomach cancer was identified as the fifth most common cancer in 2018 with 1033701 cases (5.7% of all cancers). The highest incidence of stomach cancer 769728 cases (74.5%) was related to the Asia continent and the lowest incidence 3359 cases (32.3%) were related to the Oceania continent. The number of total deaths due to the cancer in 2018 was 9555027 cases, among which stomach cancer, with 78,285 deaths after lung cancer, was the second leading cause of death due to cancer. The highest mortality rate was observed in the Asia continent with 584375 cases (74.7%) and the lowest mortality rate was in the Oceania continent with 2119 cases (0.27%) (Figure 1).

The reported cancer incidence in 2018 showed that the highest incidence of stomach cancer was based on regional segregation in both sexes (619226 cases) in men (428298 cases) and in women (190928 cases) was related to Eastern Asia. And the highest rate of stomach cancer motility in both genders (479659 cases) in men (325453 cases) and in women (154206 cases) was related to high human development (Table 1).

Recorded cancer cases showed the highest incidence of stomach cancer were in the countries of Korea (39.6 per 100,000), Republic of Mongolia (33.1 per 100,000), and Japan (27.5 per 100,000) and the highest mortality rates were in Mongolia (25 per 100,000), Bhutan (19.4 per 100,000), and China (17.5 per 100,000), respectively. The lowest incidence (zero occurrence) and mortality (0.2 per 100,000) was related to the Maldives country (Figure 2).

Based on the results of cancer registries in 2018, the highest incidence of stomach cancer (296.2 out of 100,000) is related to very high HDI and the highest mortality rate (13.7 out of 100,000) is related to high HDI areas (Figure 3).



Population	Number
Asia	769 728
Europe	133 133
*Latin America and the Carribean	67 058
Africa	31 148
North America	29 275
Oceania	3 359
Total	1 033 701

Population	Number
Asia	584 375
Europe	102 167
*Latin America and the Carribean	51 914
Africa	28 707
North America	13 403
Oceania	2 119
Total	782 685

Fig. 1. Pie charts present the distribution of cases and deaths of stomach cancer by continent in 2018 for both sexes, all age. [Source: GLOBOCAN 2018].

TABLE 1. Cancer incidence and mortality statistics worldwide and by region in 2018

Countries	*Incidence*						*Mortality*					
	Both sex		*Meal*		*Female*		*Both sex*		*Female*		*Meal*	
	New cases	*Cum. Risk (%)*	*New cases*	*Cum. Risk (%)*	*New cases*	*Cum. Risk (%)*	*Deaths*	*Cum. Risk (%)*	*Deaths*	*Cum. Risk (%)*	*Deaths*	*Cum. Risk (%)*
Eastern Africa	9215	0.5	4572	0.53	4643	**0.47**	8908	0.49	4404	0.53	4504	**0.47**
Middle Africa	4143	0.51	2213	0.6	1930	**0.44**	3765	0.	1996	0.58	1769	**0.44**
Northern Africa	7702	0.45	4518	0.56	3184	**0.34**	6727	0.8	4066	0.48	2661	**0.28**
Southern Africa	2008	0.42	1176	0.6	832	**0.29**	1636	0.4	965	0.48	671	**0.23**
Western Africa	8080	0.48	4546	0.56	3534	**0.41**	7671	0.46	4214	0.53	3457	**0.4**
Caribbean	4125	0.75	2406	0.98	1719	**0.54**	3203	0.53	1907	0.72	1296	**0.36**
Central America	12881	0.81	6756	0.93	6125	**0.7**	10439	0.63	5544	0.73	4895	**0.53**
South America	50052	1.06	29720	1.46	20332	**0.73**	38272	0.78	23323	1.1	14949	**0.51**
North America	29275	0.48	18488	0.65	10787	**0.31**	13403	0.19	8021	0.26	5382	**0.13**
Eastern Asia	619226	2.64	428298	3.79	190928	**1.5**	453513	1.84	311227	2.65	142286	**1.04**
South-Eastern Asia	38028	0.64	23513	0.87	14515	**0.45**	32033	0.53	19572	0.71	12461	**0.37**
South-Central Asia	92819	0.62	61536	0.84	31283	**0.4**	81837	0.55	54422	0.75	27415	**0.35**
Western Asia	19655	0.98	12230	1.31	7425	**0.68**	16992	0.84	10725	1.15	6267	**0.56**
Central and Eastern Europe	64482	1.41	38427	2.13	26055	**0.89**	53268	1.1	31836	1.72	21432	**0.67**
Western Europe	27596	0.67	17795	0.93	9801	**0.41**	18425	0.36	11421	0.5	7004	**0.22**
Southern Europe	29811	0.87	18276	1.22	11535	**0.55**	22460	0.55	13629	0.79	8831	**0.34**
Northern Europe	11244	0.51	7113	0.68	4131	**0.34**	8014	0.31	4994	0.43	3020	**0.2**
Australia/New Zealand	2702	0.53	1796	0.74	906	**0.32**	1517	0.26	959	0.35	558	**0.17**
Melanesia	583	0.89	327	1.17	256	**0.66**	532	0.84	293	1.1	239	**0.62**
Polynesia	43	0.83	28	1.07	15	**0.61**	53	0.86	28	0.92	25	**0.8**
Micronesia	31	0.69	20	0.93	11	**0.47**	17	0.21	9	0.1	8	**0.33**
Low Human Development	22717	0.49	12486	0.57	10231	**0.41**	21568	0.48	11688	0.55	9880	**0.41**
Medium Human Development	125631	0.6	80479	0.81	45152	**0.4**	110362	0.52	70872	0.71	39490	**0.35**
High Human Development	568166	1.97	386728	2.82	181438	**1.16**	479659	1.61	325453	2.32	154206	**0.94**
Very High Human Development	316953	1.23	203918	1.78	113035	**0.73**	170920	0.55	105437	0.79	65483	**0.33**
World	1033701	1.31	683754	1.87	349947	**0.79**	782685	0.95	513555	1.36	269130	**0.57**

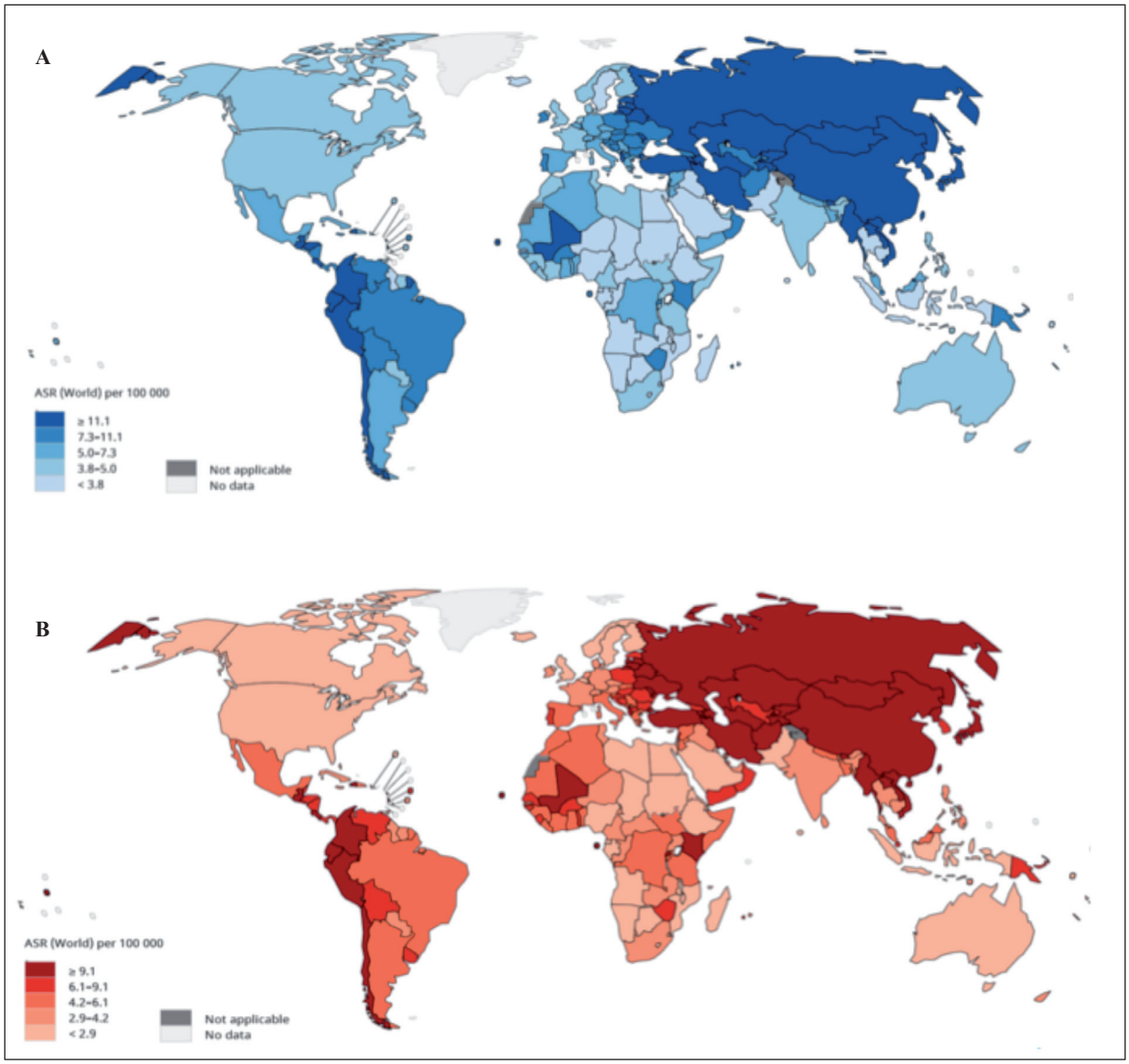


Fig. 2. Global map presenting ***(A)*** incidence and ***(B)*** mortality rates by world countries for stomach cancer in both sexes, in 2018 [Source: GLOBOCAN 2018].

The results of analysis of variance showed that the highest average rate of stomach cancer (8.9 per 100,000) was related to Medium human development and the lowest mean of incidence (4.8 per 100,000) was related to Low human development, and this difference was statistically significant (P <0.001) (Table 2).

The results showed that there is a positive correlation between stomach cancer incidence and mortality and HDI index. This correlation was significant between the incidence of stomach cancer and HDI index (R=0.218, p<0.05). While the correlation between stomach cancer mortality and HDI index (R=0.008, p>0.05) was not statistically significant (Figure 4).

The results showed that there was a positive and significant correlation between incidence rate with MYS (r=0.19, p<0.05), LEB (r=0.22, p<0.05) and EYS (r=0.25, p<0.05). While in the study of the relationship between mortality rates with HDI component there was a negative and significant correlation between GNI (r=-0.19, p<0.05) and mortality rate (Table 3).

DISCUSSION

The prevention and treatment of stomach cancer is pivotal, since it is currently one of the most common malignancies around the world[17]. On average, the rate of stomach cancer among men is nearly two

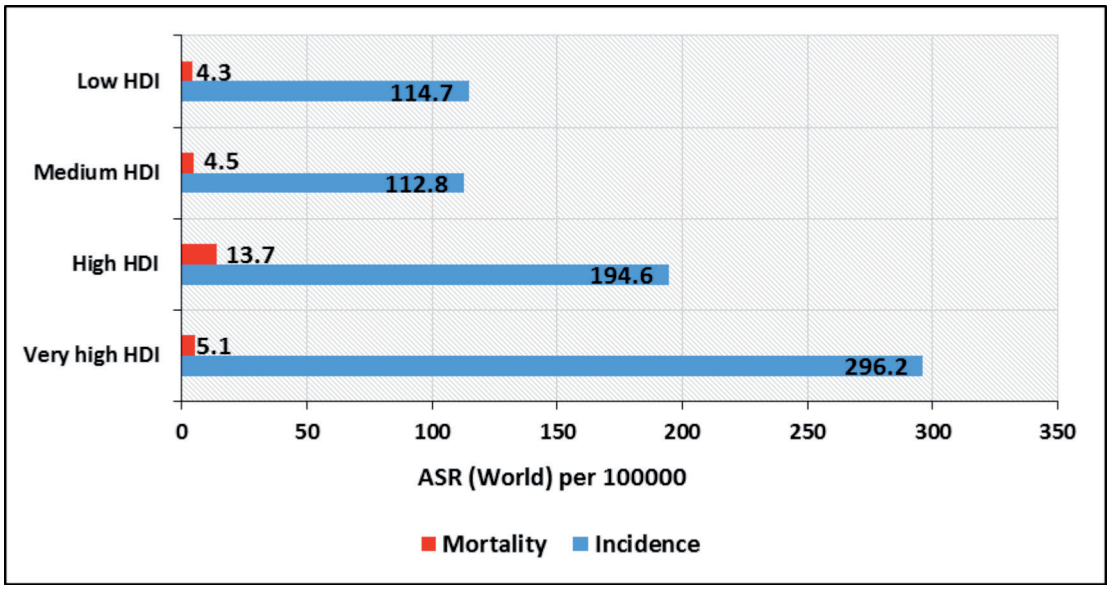


Fig. 3. Distribution of incidence and mortality rates for stomach cancer (based on HDI).

times more than women and varies from country to country[18]. Our study results showed that the highest incidence of stomach cancer was related to Korea (39.6 per 100,000), Republic of Mongolia (33.1 per 100,000), and Japan (27.5 per 100,000) respectively. In general, the highest incidence is in Eastern Asia (especially in Korea, Mongolia, Japan and China), Central and Eastern Europe, and South Africa, and the lowest incidence is in North America. Regional variations in the incidence of this cancer indicate differences in food patterns, food consumed and availability of fresh food, and the prevalence of *Helicobacter pylori* (*H. pylori*) infection. Repeated infections with *H. pylori* are one of the most important risk factors for detecting stomach cancer and 90% of new cases of stomach cancer around the world are related to this bacterium. The prevalence of *H. pylori* infection is higher in a common environment and in lower socioeconomic classes[19]. In recent years, there has been observed a decline in stomach cancer in different countries of Asia (Japan, China, Korea), Latin America (Colombia and Ecuador), and Europe (Ukraine)[20]. Sharp decline of stomach cancer and mortality rates have been observed in most developed countries in North America and Europe since the mid-twentieth century[21, 22]. The increase in the consumption of fresh fruits and vegetables, the decrease in the dependence on salt-based foods, the reduction of chronic helicobacter pylori infection and improve the health status can be attributed to this. Therefore, the primary prevention strategy for stomach cancer is to increase the consumption of fresh fruits and vegetables, stop smoking cigarettes and reduce the prevalence of *H. pylori* infection by improving the social and economic status. Researchers[23-25] have shown that prevalence rates in most industrialized countries have declined over the past three decades and patterns emerging in

TABLE 2. Stomach Cancer Incidence and Mortality in Different HDI Regions in 2018.

HDI	*Incidence Rate*		*Mortality Rate*	
	CR	*ASR*	*CR*	*ASR*
Very high human development	16.8	8	10.9	4.9
High human development	11.5	8.9	9.5	7.3
Medium human development	6	7.5	5.3	6.8
Low human development	2.5	4.8	2.4	4.7
P-value(F-test)	$p<0.001$	$p<0.001$	$p<0.001$	$p<0.001$

Abbreviations: CR: Crude Rate; ASR, Age-Standardized Rates per 100,000.

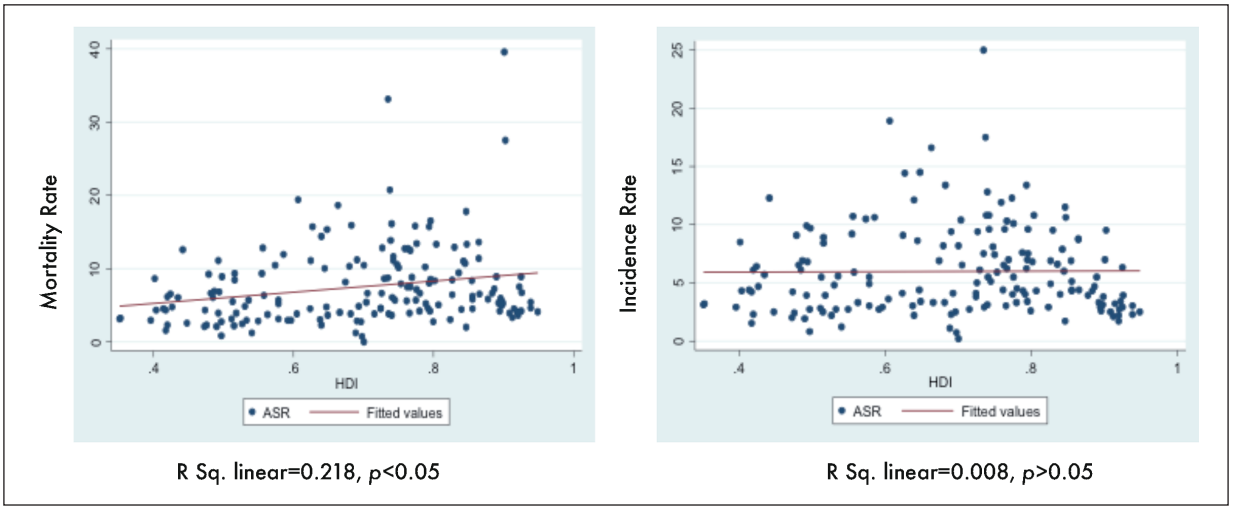


Fig. 4. Correlation between the HDI, incidence and mortality rates of cancer stomach in the world in 2018.

immigrant groups move toward patterns in origin countries. These changes indicate that a close relationship stomach cancer with factors can be altered. Economic growth and life style changes are following by unhealthy nutritious diets, lack of physical activity, overweighting and obesity which are all the cancer risk factors and the reasons of increasing general health concern[26]. On the other hand, the treatment and recovery methods including increasing of physical activity, healthy food consumption, and the proper screening can affect reducing CRC-related deaths. The rate of infection-inducing cancer prevalence and deaths would contribute to high costs among the majority of the countries. Infection-related cancers contain more than 26% of all cancers among low-income and middle-income countries while the rate of non-infectious cancers are increasing in all countries except for level of income. This desired increase is an indicative of higher prevalence of known risk factors such as obesity, lack of physical activity and smoking as well as higher usage of screening methods. Tanaka et al[27] showed that stomach, colorectal, lung and liver cancers are not significantly related with the level of income. The results of our study showed that the highest incidence of stomach cancer was reported in areas with HDI, which was in consistence with the results of Youlden et al[28] and Khazaei et al[8]. Our results also showed that there is a positive correlation between HDI and incidence SC (r=0.218) and also mortality SC (r=0.008) worldwide in 2018. These results were also in consistent with the results of other studies[8,14,29]. Proximal tumors are more common in developed countries and higher social classes, so the incidence is higher[30]. One of the reasons for a higher cancer incidence in higher HDI countries may be the difference in diagnostic programs in high HDI countries compared to low HDI countries. High mortality in developing countries may be due to a higher life expectancy in these countries and an increase in the elderly population of these areas, which could justify a higher mortality rate in these countries. To prevent stomach cancer, IARC has suggested the fruits and vegetables consumption as potential protective agents in stomach cancer. The Global Cancer Research Foundation recommends

TABLE 3. Pearson correlation between HDI component and dependent variable.

*ASMR**	*ASIR**		*Variable*	
	r	*p-value*	*r*	*p-value*
Gross national income per 1000 capita	-0.007	$p>0.05$	-0.19	$p>0.05$
Mean years of schooling	0.19	$p<0.05$	-0.004	$p>0.05$
Life expectancy at birth	0.22	$p<0.05$	0.07	$p>0.05$
Expected years of schooling	0.25	$p<0.05$	0.04	$p>0.05$

*Dependent variables: ASIR and ASMR.

that daily intake of vegetables/fruits over 400 g has a protective effect on stomach cancer[31]. Some foods also have a concentration of natural nitrates (cabbage, cauliflower, carrots, celery, radishes, beets and spinach) nitrate content in fertilizers, water and soil also increases nitrate in the diet that can be effective in stomach cancer[32]. Therefore, lifestyle modification is a practical strategy for preventing stomach cancer, especially among the elderly[32, 33]. On the other hand, *H. pylori* infection in lower socio-economic classes is likely to be due to inappropriate education and hygiene and adverse health conditions in these areas[31]. Other factors associated with the incidence of stomach cancer are genetic and biological features; for example, the incidence of cancer in Africa is the lowest among developing and advanced countries, ranging from 2 to 5.6/100,000[34]. Therefore, the multi-factorial etiology of stomach cancer is a challenge in understanding and developing prevention and surveillance programs that emphasize the need for further studies.

CONCLUSIONS

Considering stomach cancer is the second leading cause of death in the worldwide due to cancer, it is necessary to identify the causes of the risk factors associated with this disease. According to our findings, one of the factors affecting stomach cancer mortality is the HDI of countries; therefore, attention to the HDI can be effective in reducing the mortality rate of stomach cancer.

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Conflict of Interest

The Authors declare that they have no conflict of interests.

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