RESEARCH ARTICLE

Incidence and Mortality of Colorectal Cancer and Relationships with the Human Development Index across the World

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Abstract

Background: This study aimed to investigate the standardized incidence and mortality rate of colorectal cancer and its relationship with the human development index (HDI) across the world in 2012. **Materials and Methods:** This ecologic study was conducted for assessment of the correlation between age-specific incidence rate (ASIR) and age-specific mortality rate (ASMR) with HDI and its components. Data for SIR and SMR for every country for the year 2012 were obtained from the global cancer project. We used a bivariate method for assessment of the correlation between SIR and SMR and HDI. Statistical significance was assumed at $P<0.05$. Statistical analyses were performed using SPSS (Version 22.0, SPSS Inc.). **Results:** Countries with the highest SIR of colorectal cancer in the world in 2012, were Republic of Korea, Slovakia, Hungary and countries with the highest SMR were Hungary, Croatia and Slovakia. The correlation between SIR of colorectal cancer and the HDI was 0.712 ($P≤0.001$), with life expectancy at birth 0.513 ($P≤0.001$), with mean years of schooling 0.641 ($P≤0.001$) and with level of income per each person of the population 0.514 ($P=0.013$). In addition, the correlation between SMR of colorectal cancer and the HDI was 0.628 ($P≤0.001$), with life expectancy at birth 0.469 ($P≤0.001$), with mean years of schooling 0.592 ($P≤0.001$) and with level of income per each person of the population 0.378 ($P=0.013$). **Conclusions:** The highest SIR and SMR of colorectal cancer was in the WHO Europe region. There was a positive correlation between HDI and SIR and SMR of colorectal cancer.

Keywords: Colorectal cancer - incidence - mortality - human development index - world

Introduction

Cancer is the leading cause of death in developed countries and is the second leading cause of death in developing countries (Jemal et al., 2011). The global cancer burden is still increasing in economical developing countries due to an aging population and the growth of the world population with an increase of cancer-causing behaviors, particularly smoking (Jemal et al., 2011; Ghoncheh et al., 2015a). Although the overall incidence of cancer in developing countries is as much as half of the world's developed countries in both sexes, generally overall cancer death rate in these countries is similar and cancer survival tends to be poorer in developing countries (Jemal et al., 2010; Jemal et al., 2011).

According to the World 2008 global statistics, colorectal cancer is the second most common cancer worldwide after lung and breast cancers which, according to sex, for men and women is the third and the second most common cancer respectively (Jemal et al., 2011; Singh et al., 2014). Although appearance of new diagnostic and screening tests for this cancer has reduced the incidence and mortality of that in developed countries (Baxter et al., 2012; Zauber et al., 2012), but yet this cancer accounts for about 12% of all cancer incidences and incidence and mortality rate of this cancer has an increasing trend in developing countries (Jemal et al., 2010; Jemal et al., 2011; Hajmanoochehri et al., 2014). Various studies have shown relationship between development indexes, incidence and mortality of types of cancers (Pakzad et al., 2014; Ghoncheh et al., 2015b). One of these indicators is human development index (HDI) which consists of three components: longevity (life expectancy at birth), knowledge (adult literacy rate and average years of

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schooling) and income (the internal impure income capitation in purchasing power- in dollars). The numerical value of HDI is between zero and one. This index divides world countries into four general categories: Countries with too high HDI (HD≥0.9), Countries with high HDI (HDI≥0.8), countries with moderate HDI (0.5<HDI<0.8) and countries with low HDI (HDI≤0.5) (Programme, 2015). Studies done in Asian countries have shown a relation between the incidence and mortality of breast and bladder cancer and the Human Development Index (HDI) and associated components of this index (Pakzad et al., 2014; Ghoncheh et al., 2015b; Pakzad et al., 2015).

The incidence of colorectal cancer in some low-risk areas including Spain and Eastern Asia and Eastern Europe is increasing rapidly. Some of the undesirable trends are affected by the combination of risk factors such as diet, obesity and smoking and also the downward trend in developed Western countries is due to the advent of screening and diagnostic tests. Mutable risk factors for colorectal cancer include smoking, physical activity, overweight and obesity, consumption of red and processed meat and high alcohol consumption. Population-based screening plans are only feasible for economically developing countries and these program's focus is for countries with a Western lifestyle. Some risk factors can be associated with the HDI and its components and affect the incidence and mortality of cancer as a result (Corrao et al., 2000; Giebel et al., 2010; Bray et al., 2012; Ferrari and Reis, 2013; Liu et al., 2013). Due to the importance of awareness about the incidence and mortality of colorectal cancer in better planning and the possible relation between incidence and mortality of this cancer and developing index, this study aimed to investigate the standardized incidence and mortality rate of colorectal cancer and its relationship with HDI in the world in 2012. Data about the age-specific incidence and mortality rate (ASR) for every country for year 2012 get from global cancer project (Almasi et al., 2015) and HDI from Human Development Report 2013 (Malik, 2013) that include information about HDI and its details for every country for year 2012.

Materials and Methods

Age-specific incidence rate estimate

The methods of estimation are country specific and the quality of the estimation depends upon the quality and on the amount of the information available for each country. In theory, there are as many methods as countries, and because of the variety and the complexity of these methods, an overall quality score for the incidence and mortality estimates combined is almost impossible to establish. However an alpha numeric scoring system which independently describes the availability of incidence and mortality data has been established at the country level. The combined score is presented together with the estimates for each country with an aim of providing a broad indication of the robustness of the estimation.

The methods to estimate the sex- and age-specific incidence rates of cancer for a specific country fall into one of the following broad categories, in priority order:

1- Rates projected to 2012 (38 countries)-2- Most recent rates applied to 2012 population (20 countries)-3-Estimated from national mortality by modelling, using incidence mortality ratios derived from recorded data in country-specific cancer registries (13 countries)-4- Estimated from national mortality estimates by modelling, using incidence mortality ratios derived from recorded data in local cancer registries in neighboring countries (9 European countries)-5-Estimated from national mortality estimates using modelled survival (32 countries)-6- Estimated as the weighted average of the local rates (16 countries)-7- One cancer registry covering part of a country is used as representative of the country profile (11 countries)-8-Age/sex specific rates for "all cancers" were partitioned using data on relative frequency of different cancers (by age and sex) (12 countries)-9- The rates are those of neighboring countries or registries in the same area (33 countries) (Almasi et al., 2015; Ferlay et al., 2015; Razi et al., 2015).

Age-specific mortality rate estimate

Depending of the degree of detail and accuracy of the national mortality data, six methods have been utilized in the following order of priority: 1-Rates projected to 2012 (69 countries)-2- Most recent rates applied to 2012 population (26 countries)-3- Estimated as the weighted average of regional rates (1 country)-4- Estimated from national incidence estimates by modelling, using country-specific survival (2 countries)-5-Estimated from national incidence estimates using modelled survival (83 countries)-6-The rates are those of neighboring countries or registries in the same area (3 countries) (Almasi et al., 2015; Ferlay et al., 2015; Razi et al., 2015).

HDI

HDI, a composite measure of indicators along three dimensions: life expectancy, educational attainment and command over the resources needed for a decent living. All groups and regions have seen notable improvement in all HDI components, with faster progress in low and medium HDI countries. On this basis, the world is becoming less unequal. Nevertheless, national averages hide large variations in human experience. Wide disparities remain within countries of both the North and the South, and income inequality within and between many countries has been rising (Malik, 2013).

Data analysis

In this study, we use of correlation bivariate method for assessment the correlation between age-specific incidence and mortality rate (ASR) with Human Development Index (HDI) and its details that include: Life expectancy at birth, Mean years of schooling and Gross national income (GNI) per capita. Statistical significance was assumed if $P < 0.05$. All reported P-values are two-sided. Statistical analyses were performed using SPSS (Version 15.0, SPSS Inc).

Results

Cancer Incidence in World Regions

In total, 1,360,602 cases of colorectal cancer are

Colorectal Cancer Incidence and Mortality Correlations with the Human Development Index

recorded in the world in 2012 that 746,298 cases (85/54%) were men and 614,304 cases (14/45%) were women (see Table 1). The sex ratio for disease is 1/21.The world's 10 countries with the highest number of new colorectal cancer cases are as follows respectively: 1.China with 253,427 cases, 2.United States of America with 134,349 cases, 3. Japan with 112,675 cases, 4.India with 64,332 cases, 5.Germany with 63,572 cases, 6. Russian Federation with 59,928 cases, 7. Italy with 48,110 cases, 8. France (metropolitan) with 40,825 Cases, 9. United Kingdom with 40,755 cases and 10. Brazil with 33,949 cases and these Ten Countries allocated a total of 851922 (62%) of cases in the world. the world's ten countries with the highest standardized incidence of colorectal cancer are

as follows respectively: 1.Republic of Korea with the standardized incidence rate of 45 per hundred thousand people, 2. Slovakia with 42.7 per hundred thousand people, 3. Hungary with 42.3 per hundred thousand people, 4.Denmark with 40.5 per hundred thousand people, 5.The Netherlands with 40.2 per hundred thousand people, 6. Czech Republic with the standardized incidence rate of 38.9 per hundred thousand people, 7. Norway with 38.9 per hundred thousand people, 8. Australia with 38.4 per hundred thousand people, 9. New Zealand with 37.3 per hundred thousand people and 10. Slovenia with 37 per hundred thousand people. Similarly, the 10 countries which have the lowest standardized incidence rate of colorectal cancer are: 1.Mozambique with 1.2 per

Table 1. The Number and Rate of the Crude and Standardized Colorectal Cancer Incidence in the World in 2012 (Sorted by Age-Standardized Rate from the Highest Value to the Lowest)

Colorectal - Estimated Incidence, All Ages: Both Sexes				Colorectal - Estimated Incidence, All Ages: Male				Colorectal - Estimated Incidence, All Ages: Female			
POPULATION	Numbers	Crude Rate	ASR (W)	POPULATION	Numbers	Crude Rate	ASR (W)	POPULATION	Numbers	Crude Rate	ASR (W)
Australia/New Zealand	18887	69.0	38.2	Australia/New Zealand	10345	75.9	44.8	Australia/New Zealand	8542	62.1	32.2
Oceania	19536	51.8	34.8	Oceania	10721	56.7	41.0	Oceania	8815	46.8	29.2
Western Europe	137109	72.3	31.4	European Union (EU-28)	193426	77.9	39.5	Northern Europe	29890	58.7	25.3
European Union (EU-28)	345346	68.0	31.3	Southern Europe	60029	77.5	39.5	Western Europe	60917	63.0	24.9
Southern Europe	105009	66.7	31.1	Western Europe	76192	82.0	39.1	European Union (EU-28)	151920	58.6	24.4
Very High Human Development	702196	60.9	30.6	Very High Human Development	388706	68.3	37.9	Very High Human Development	313490	53.7	24.4
Northern Europe	65162	65.0	30.4	Europe	241813	67.6	37.3	Southern Europe	44980	56.2	24.1
Europe	447136	60.3	29.5	Northern Europe	35272	71.4	36.5	Europe	205323	53.5	23.6
More developed regions	736867	59.2	29.2	More developed regions	398903	65.8	36.3	More developed regions	337964	52.8	23.6
WHO Europe region (EURO)	471240	52.2	28.2	WHO Europe region (EURO)	254769	58.3	35.7	Northern America	75912	42.8	22.7
Central and Eastern Europe	139856	47.6	26.6	Central and Eastern Europe	70320	51.0	34.5	WHO Europe region (EURO)	216471	46.5	22.6
Northern America	158169	45.1	26.1	Northern America	82257	47.5	30.1	Central and Eastern Europe	69536	44.6	21.7
IARC membership (24 countries)	769099	29.4	21.6	IARC membership (24 countries)	417775	31.8	26.2	IARC membership (24 countries)	351324	27.0	17.8
Micronesia	99	18.1	20.4	Micronesia	58	21.0	24.8	WHO Americas region (PAHO)	120564	25.0	17.6
WHO Americas region (PAHO)	245643	25.8	19.8	Eastern Asia	243157	29.7	22.4	Micronesia	41	15.1	16.6
Eastern Asia	421343	26.5	18.4	WHO Americas region (PAHO)	125079	26.6	22.3	Caribbean	4557	21.4	16.6
WHO Western Pacific region (WPRO)	459958	25.0	18.3	WHO Western Pacific region (WPRO)	264479	28.0	22.3	High Human Development	106740	20.1	15.7
High Human Development	210612	20.2	17.5	World	746298	21.0	20.6	WHO Western Pacific region (WPRO)	195479	21.8	14.6
World	1360602	19.3	17.2	High Human Development	103872	20.3	19.9	Eastern Asia	178186	23.2	14.6
Caribbean	8409	19.9	16.4	Micronesia/Polynesia	97	15.5	18.5	South America	34510	17.0	14.6
South America	67464	16.8	15.7	Western Asia	15112	12.2	17.6	World	614304	17.6	14.3
Micronesia/Polynesia	163	13.2	15.0	South America	32954	16.7	17.1	Latin America and Caribbean	44652	14.6	13.0
Western Asia	27140	11.3	14.8	Asia	347514	16.0	16.5	Western Asia	12028	10.4	12.4
Latin America and Caribbean	87474	14.5	14.0	Caribbean	3852	18.4	16.3	Micronesia/Polynesia	66	10.9	11.8
Asia	607182	14.3	13.7	South-Eastern Asia	38538	12.8	15.2	Asia	259668	12.5	11.1
South-Eastern Asia	69016	11.4	12.5	Latin America and Caribbean	42822	14.4	15.1	South-Eastern Asia	30478	10.0	10.2
Less developed regions	623735	10.7	11.7	Southern Africa	2611	9.0	14.2	Less developed regions	276340	9.7	9.8
Middle-East and Northern Africa (MENA)	40031	8.9	11.4	Less developed regions	347395	11.8	13.7	Middle-East and Northern Africa (MENA)	18134	8.2	9.8
Medium Human Development	407360	11.5	11.3	Polynesia	39	11.2	13.6	Medium Human Development	175212	10.1	9.3
Southern Africa	4871	8.3	10.9	Medium Human Development	232148	12.8	13.4	Southern Africa	2260	7.7	8.7

Table 1. (Continued) Number and Crude and Standardized Colorectal Cancer Incidence in the World in 2012 (Sorted by Age-Standardized Rate from the Highest Value to the Lowest)

Colorectal - Estimated incidence, all ages: both sexes				Colorectal - Estimated incidence, all ages: male				Colorectal - Estimated incidence, all ages: female			
POPULATION	Numbers	Crude Rate	ASR (W)	POPULATION	Numbers	Crude Rate	ASR (W)	POPULATION	Numbers	Crude Rate	ASR (W)
Polynesia	64	9.4	10.6	Middle-East and Northern Africa (MENA)	21897	9.6	13.2	Polynesia	25	7.5	7.9
Melanesia	486	5.3	8.8	Melanesia	279	6.0	11.1	Central America	5585	6.9	7.1
Central America	11601	7.2	8.0	WHO South-East Asia region (SEARO)	68235	7.2	8.9	Northern Africa	6106	5.9	6.9
Northern Africa	12891	6.2	7.6	Central America	6016	7.6	8.8	Melanesia	207	4.6	6.9
WHO South-East Asia region (SEARO)	120225	6.5	7.5	Northern Africa	6785	6.5	8.5	WHO East Mediterranean region (EMRO)	14664	4.8	6.6
WHO East Mediterranean region (EMRO)	32769	5.3	7.4	WHO East Mediterranean region (EMRO)	18105	5.7	8.3	WHO South-East Asia region (SEARO)	51990	5.7	6.3
Eastern Africa	12387	3.5	6.5	Eastern Africa	6228	3.6	7.1	Eastern Africa	6159	3.5	6.1
Africa	41105	3.8	6.3	South-Central Asia	50707	5.4	7.0	Africa	19934	3.7	5.8
WHO Africa region (AFRO)	30542	3.5	6.1	Africa	21171	3.9	7.0	WHO Africa region (AFRO)	15037	3.4	5.7
South-Central Asia	89683	4.9	6.1	WHO Africa region (AFRO)	15505	3.5	6.7	Sub-Saharan Africa	13828	3.2	5.4
Sub-Saharan Africa	28214	3.3	5.8	Sub-Saharan Africa	14386	3.3	6.4	South-Central Asia	38976	4.4	5.2
Low Human Development	39689	3.0	4.9	Low Human Development	21183	3.2	5.5	Middle Africa	1768	2.6	4.8
Middle Africa	3291	2.5	4.8	Middle Africa	1523	2.3	4.7	Low Human Development	18506	2.9	4.4
Western Africa	7665	2.4	4.1	Western Africa	4024	2.5	4.5	Western Africa	3641	2.3	3.8
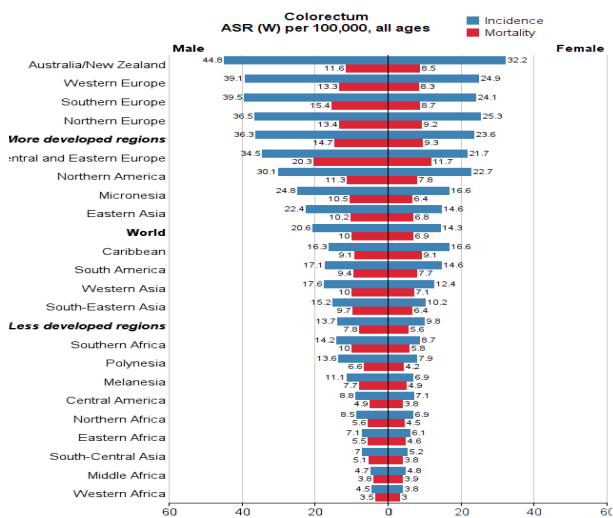
Figure 1. Standardized Incidence and Mortality Rates for Colorectal Cancer in the World in 2012

Figure 2. Geographical Distribution of the Incidence of Colorectal Cancer in the World in 2012

Figure 3. Geographical Distribution of the Mortality from Colorectal Cancer in the World in 2012

hundred thousand people, 2.The Gambia with 1.3 Per hundred thousand people, 3. Guinea with 1.8 per hundred thousand people, 4. Lesotho with 2 per hundred thousand people, 5. Swaziland with the standardized incidence rate of 2.3 per hundred thousand people, 6. Burkina Faso with 2.5 per hundred thousand people, 7. Comoros with 2.7 per hundred thousand people, 8. Liberia with 3.2 per hundred thousand people, 9. Nepal with 3.2 per hundred thousand people and 10. Cameroon with 3.3 per hundred thousand people.

Standardized incidence rate based on the Human Development Index is 30.6 per hundred thousand people in very High Human Developed areas, 17.5 per hundred thousand people in High Human developed areas, 11.3 per hundred thousand people in Medium Human Developed
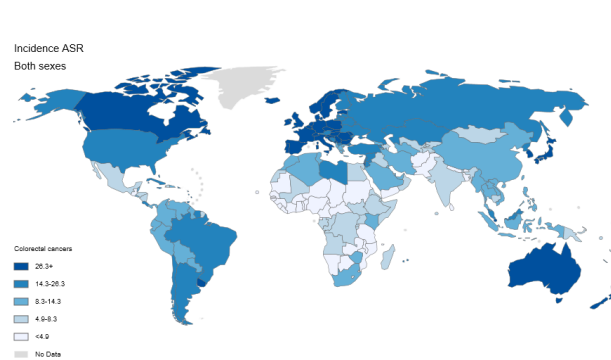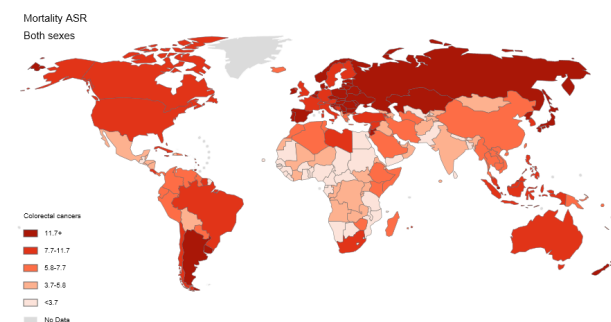
areas and 4.9 per hundred thousand people in Low Human Developed ones respectively. Also the standardized incidence rate in six WHO regions is 28.2 per hundred thousand people in WHO Europe region (EURO), 19.8 per hundred thousand people in WHO Americas region (PAHO), 18.3 per hundred thousand people in WHO Western Pacific region (WPRO), 7.5 per hundred thousand

Table 2. Number and Crude and Standardized Colorectal Cancer Mortality Rates in the World in 2012 (Sorted by Age-Standardized Rate from the Highest Value to the Lowest)

Colorectal - Estimated mortality, all ages: both sexes				Colorectal - Estimated mortality, all ages: male				Colorectal - Estimated mortality, all ages: female			
POPULATION	Numbers	Crude Rate	ASR (W)	POPULATION	Numbers	Crude Rate	ASR (W)	POPULATION	Numbers	Crude Rate	ASR (W)
Central and Eastern Europe	84475	28.8	14.9	Central and Eastern Europe	42547	30.9	20.3	Central and Eastern Europe	41928	26.9	11.7
Europe	214866	29.0	12.5	Europe	113246	31.7	16.2	Europe	101620	26.5	9.9
WHO Europe region (EURO)	228275	25.3	12.2	WHO Europe region (EURO)	120387	27.5	15.7	WHO Europe region (EURO)	107888	23.2	9.7
European Union (EU-28)	152046	30.0	11.8	Southern Europe	27123	35.0	15.4	More developed regions	157768	24.7	9.3
Southern Europe	48098	30.5	11.7	European Union (EU-28)	82959	33.4	15.2	Northern Europe	12645	24.8	9.2
More developed regions	333165	26.7	11.6	More developed regions	175397	28.9	14.7	Caribbean	2694	12.7	9.1
Northern Europe	26812	26.7	11.1	Very High Human Development	157503	27.7	13.9	European Union (EU-28)	69087	26.7	9.0
Very High Human Development	293259	25.4	11.0	Northern Europe	14167	28.7	13.4	Southern Europe	20975	26.2	8.7
Western Europe	55481	29.2	10.6	Western Europe	29409	31.6	13.3	High Human Development	62933	11.9	8.7
Australia/New Zealand	5489	20.0	10.0	High Human Development	61926	12.1	11.7	Very High Human Development	135756	23.3	8.7
High Human Development	124859	12.0	10.0	Australia/New Zealand	2944	21.6	11.6	Australia/New Zealand	2545	18.5	8.5
Oceania	5888	15.6	9.7	Oceania	3172	16.8	11.4	Western Europe	26072	26.9	8.3
Northern America	63465	18.1	9.4	Northern America	33168	19.1	11.3	Oceania	2716	14.4	8.2
IARC membership (24 countries)	353357	13.5	9.3	IARC membership (24 countries)	186665	14.2	11.2	Northern America	30297	17.1	7.8
Caribbean	4932	11.7	9.1	Micronesia	24	8.7	10.5	South America	18988	9.4	7.7
WHO Americas region (PAHO)	112192	11.8	8.5	Eastern Asia	115473	14.1	10.2	IARC membership (24 countries)	166692	12.8	7.7
South America	37335	9.3	8.5	WHO Western Pacific region (WPRO)	124920	13.2	10.1	WHO Americas region (PAHO)	55097	11.4	7.4
Western Asia	15306	6.4	8.4	Western Asia	8439	6.8	10.0	Western Asia	6867	5.9	7.1
Eastern Asia	207716	13.1	8.4	World	373639	10.5	10.0	World	320294	9.2	6.9
WHO Western Pacific region (WPRO)	224808	12.2	8.4	Southern Africa	1753	6.0	10.0	Latin America and Caribbean	24800	8.1	6.9

people in WHO South-East Asia region (SEARO), 7.7 per hundred thousand people in WHO East Mediterranean region (EMRO) and 6.1 per hundred thousand people in WHO Africa region (AFRO). Also it's 29.2 and 11.7 per hundred thousand people in more developed regions and less developed regions respectively.

Geographical Distribution

Data for geographical distribution of the relative incidence and mortality of colorectal cancer in the world in 2012 are illustrated graphically in Figures 1-3, from the Globocan database.

Cancer Mortality in World Regions

By the other hand 693,933 deaths occurred due to colorectal cancer during 2012 in the world that 373,639 (53.84%) of them were men and 320,294 (46.15%) were women (see Table 2). The sex ratio of the disease is 1.16. The highest number of deaths from colorectal cancer are as follows respectively: 1. China with 139416 cases, 2. United States of America with 55259 cases, 3. Japan with 49345 cases, 4. India with 48603 cases, 5. Russian Federation with 39907 cases, 6. Germany with 25473 cases, 7. Italy with 19279 cases, 8. Indonesia with 18398 cases, 9. Brazil with 17607 cases and 10. France (metropolitan) with 17148 cases. A total of 430,435 cases

(62.02%) of deaths occurred just in these ten countries.

In the world, 10 countries with the highest standardized mortality rates from colorectal cancer are as follows respectively: 1. Hungary with the standardized rate of 20.8 per hundred thousand people, 2. Croatia with the rate of 18.7 per hundred thousand people, 3. Slovakia with the rate of 18 per hundred thousand people, 4. Serbia with the rate of 16.6 per hundred thousand people, 5. Republic of Moldova with the rate of 16.5 per hundred thousand people, 6. Slovenia with the standardized rate of 16.2 Per hundred thousand people, 7. Bulgaria with the rate of 16 per hundred thousand people, 8. Montenegro with the rate of 15.9 per hundred thousand people, 9. Uruguay with the rate of 15.7 per hundred thousand people and 10. Jordan with the rate of 15.5 per hundred thousand people. Similarly, the 10 countries with the lowest standardized mortality rates from colorectal cancer include: 1. Mozambique with the rate of 0.9 per hundred thousand people, 2. The Gambia with the rate of 1.2 per hundred thousand people, 3. Guinea with the rate of 1.4 per hundred thousand people, 4. Lesotho with the rate of 1.8 per hundred thousand people, 5. Burkina Faso with the rate of 2.1 per hundred thousand people, 6. Swaziland with the rate of 2.1 per hundred thousand people, 7. Sri Lanka with the rate of 2.2 per hundred thousand people, 8. Cameroon with the rate of 2.4 per hundred thousand

Table 2. (Continued) The Number and Rate of the Crude and Standardized Colorectal Cancer Mortality in the World in 2012 (Sorted by Age-Standardized Rate from the Highest Value to the Lowest)

Colorectal - Estimated mortality, all ages: both sexes				Colorectal - Estimated mortality, all ages: male				Colorectal - Estimated mortality, all ages: female			
POPULATION	Numbers	Crude Rate	ASR (W)	POPULATION	Numbers	Crude Rate	ASR (W)	POPULATION	Numbers	Crude Rate	ASR (W)
Micronesia	40	7.3	8.3	South-Eastern Asia	24120	8.0	9.7	WHO Western Pacific region (WPRO)	99888	11.1	6.8
South-Eastern Asia	43234	7.1	7.9	South America	18347	9.3	9.4	South-Eastern Asia	19114	6.3	6.4
Latin America and Caribbean	48727	8.1	7.6	Caribbean	2238	10.7	9.1	Micronesia	16	5.9	6.4
Southern Africa	3264	5.6	7.4	Asia	185024	8.5	8.6	Asia	146591	7.1	6.0
Asia	331615	7.8	7.2	Latin America and Caribbean	23927	8.0	8.3	Middle-East and Northern Africa (MENA)	10776	4.9	5.8
Middle-East and Northern Africa (MENA)	23602	5.3	6.8	Micronesia/Polynesia	43	6.9	8.2	Southern Africa	1511	5.1	5.8
Medium Human Development	245319	6.9	6.7	Medium Human Development	137997	7.6	8.0	Less developed regions	162526	5.7	5.6
Less developed regions	360768	6.2	6.6	Middle-East and Northern Africa (MENA)	12826	5.6	7.9	Medium Human Development	107322	6.2	5.5
Micronesia/Polynesia	72	5.8	6.6	Less developed regions	198242	6.7	7.8	Micronesia/Polynesia	29	4.8	5.1
Melanesia	327	3.6	6.2	Melanesia	185	4.0	7.7	Melanesia	142	3.2	4.9
WHO South-East Asia region (SEARO)	84916	4.6	5.3	Polynesia	19	5.5	6.6	Eastern Africa	4629	2.6	4.6
Polynesia	32	4.7	5.3	WHO South-East Asia region (SEARO)	48093	5.1	6.3	Northern Africa	3909	3.8	4.5
Northern Africa	8296	4.0	5.0	Northern Africa	4387	4.2	5.6	WHO South-East Asia region (SEARO)	36823	4.1	4.4
Eastern Africa	9276	2.6	5.0	WHO East Mediterranean region (EMRO)	11768	3.7	5.5	WHO East Mediterranean region (EMRO)	9523	3.1	4.3
WHO East Mediterranean region (EMRO)	21291	3.4	4.9	Eastern Africa	4647	2.7	5.5	Polynesia	13	3.9	4.2
Africa	29372	2.7	4.6	South-Central Asia	36992	4.0	5.1	WHO Africa region (AFRO)	11029	2.5	4.2
WHO Africa region (AFRO)	22344	2.5	4.6	Africa	15102	2.8	5.1	Africa	14270	2.7	4.2
Sub-Saharan Africa	21076	2.4	4.5	WHO Africa region (AFRO)	11315	2.6	5.0	Sub-Saharan Africa	10361	2.4	4.1
South-Central Asia	65359	3.6	4.4	Sub-Saharan Africa	10715	2.5	4.9	Middle Africa	1412	2.1	3.9
Central America	6460	4.0	4.3	Central America	3342	4.2	4.9	Central America	3118	3.8	3.8
Middle Africa	2624	2.0	3.9	Low Human Development	16038	2.5	4.3	South-Central Asia	28367	3.2	3.8
Low Human Development	30149	2.3	3.9	Middle Africa	1212	1.8	3.8	Low Human Development	14111	2.2	3.5
Western Africa	5912	1.8	3.3	Western Africa	3103	1.9	3.5	Western Africa	2809	1.8	3.0

people, 9. Botswana with the rate of 2.5 per hundred thousand people and 10. Nepal with the rate of 2.5 per hundred thousand people.

The standardized mortality rate based on the Human Development Index is 11, 10, 6.7 and 3.9 Per hundred thousand people in Very High Human Developed, High Human Developed, medium Human Developed and Low Human Developed areas respectively. Also the standardized incidence rate (in six WHO regions) is 12.2 per hundred thousand people in WHO Europe region (EURO), 8.5 per hundred thousand people in WHO Americas region (PAHO), 8.4 per hundred thousand people in WHO Western Pacific region (WPRO), 5.3 per hundred thousand people in WHO South-East Asia region (SEARO), 4.9 per hundred thousand people in WHO East Mediterranean region (EMRO) and 4.6 per hundred thousand people in WHO Africa region (AFRO). Also it's 11.6 per hundred thousand people in more developed regions and 4.6 per hundred thousand people in less developed ones.

The number and rate of the crude and standardized cancer mortality rates based on gender in the world is presented in Table 2. Various areas of the world are arranged from high to low based on standardized rate in Table 2. So you can see the highest and lowest standardized rate in any type of region. Table 2: The number and rate of the crude and standardized colorectal cancer mortality in the world in 2012 (Sorted by age-standardized rate from the highest value to the lowest)

Standardized incidence rate and the HDI

It was observed a positive correlation of 0.712 between the standardized incidence rate of colorectal cancer and the HDI ($p \leq 0.001$) (see Figure 4). Also it was seen a statistically significant correlation between human development index components with standardized rate. So that we had positive correlation of 0.513 ($p \leq 0.001$) between the standardized incidence rate and life expectancy at birth, positive correlation of 0.641 ($p \leq 0.001$) with average years of schooling and positive correlation of 0.514 ($p \leq 0.001$) with the level of income of the population per one person.
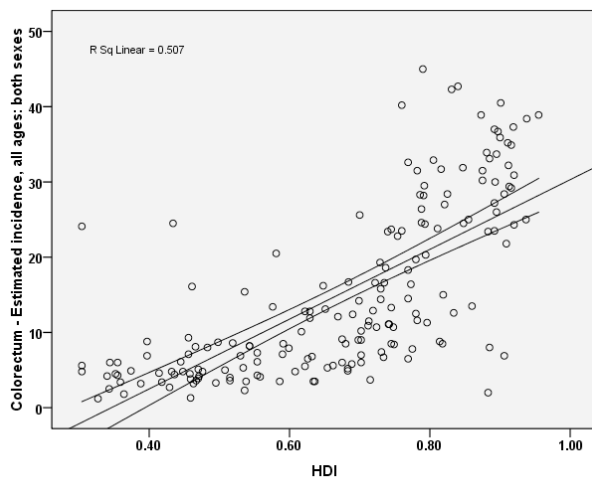
Figure 4. Correlation between HDI and Standardized Incidence Rate of Colorectal Cancer in the World in 2012
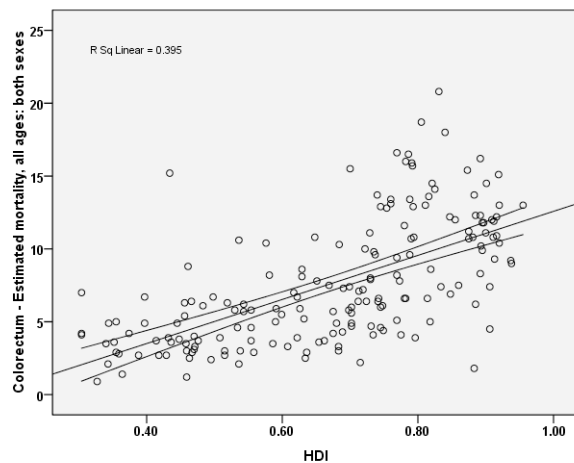

Figure 5. Correlation between HDI and Standardized Mortality Rate of Colorectal Cancer in the World in 2012

In males, a positive correlation of 0.688 between HDI and standardized incidence rate of colorectal cancer was statistically meaningful (p≤0.001). Also we had positive correlation between the components of HDI and standardized rate: 0.491 (p≤0.001) between the standardized incidence rate and life expectancy at birth, 0.624 (p=0.047) with average years of schooling and 0.505 (p≤0.001) with the level of income of the population per one person.

In females, also a positive correlation of 0.725 between HDI and standardized incidence rate of colorectal cancer in women was statistically meaningful (p≤0.001). Also we had positive correlation between the components of HDI and standardized rate 0.528 (p≤0.001) for life expectancy at Birth, 0.644 (p=0.144) for average years of schooling and 0.512 (p≤0.001) for the level of income of the population per one person.

Standardized mortality rate and the HDI

Also we had positive correlation of 0.628 between the standardized mortality rate of colorectal cancer and the HDI and it is statistically meaningful (p≤0.001) (see Figure 5). Also we had positive correlation between the

components of HDI and standardized rate. So that it can be seen positive correlation of 0.469 (p≤0.001) between the standardized mortality rate and life expectancy at Birth, positive correlation of 0.592 (p≤0.001) with average years of schooling and positive correlation of 0.378 (p≤0.001) with the level of income of the population per one person.

It was seen a positive correlation of 0.599 between HDI and standardized mortality rate of colorectal cancer in men and it is statistically meaningful (p≤0.001). Also we had positive correlation between the components of HDI and standardized rate. So that it can be seen positive correlation of 0.438 (p≤0.001) between the standardized mortality rate and life expectancy at Birth, positive correlation of 0.566 (p=0.047) with average years of schooling and positive correlation of 0.375 (p≤0.001) with the level of income of the population per one person.

It was seen a positive correlation of 0.621 between HDI and standardized mortality rate of colorectal cancer in women and it is statistically meaningful (p≤0.001). Also we had positive correlation between the components of HDI and standardized rate. So that it can be seen positive correlation of 0.473 (p≤0.001) between the standardized mortality rate and life expectancy at Birth, positive correlation of 0.578 (p=0.047) with average years of schooling and positive correlation of 0.360 (p≤0.001) with the level of income of the population per one person.

Discussion

Colorectal cancer is the third most common cancer worldwide after lung and breast cancer (Jemal et al., 2011; Singh et al., 2014). Although the incidence and mortality of this cancer is decreasing in developed countries the incidence and mortality of this cancer has an increasing trend in developing countries (Jemal et al., 2011).

The results of this study showed the highest standardized incidence rate for colorectal cancer in Korea, Republic of Slovakia and Hungary and of the six WHO regions, the most standardized incidence was for Europe. The previous global studies also showed the incidence of colorectal cancer higher for European countries (Jemal et al., 2011). Kamangar et al study showed the most standardized incidence rate for colorectal cancer for both sexes in Oceania, North America and Europe between 1993 and 2001 respectively and standardized incidence rate for this cancer during the same period for more developed countries is shown too much higher than less developed countries (Kamangar et al., 2006). Also this study found the most standardized incidence based on HDI for Very High Human Development countries and the lowest one for low Human Development countries. The other global studies for other cancers such as lung, breast, prostate and stomach cancer showed the most cases for countries with very high Human Development Index and Medium Human Development Index (Bray et al., 2012). Various studies have shown relationship between the risk factors for types of cancers and other chronic diseases with HDI and development of countries. So one of the reasons for higher incidence rates of colorectal cancer in countries with high Human Development Index could be the common stage of risk factors in that countries (Corrao et al., 2000; Giebel

et al., 2010; Bray et al., 2012; Ferrari and Reis, 2013; Liu et al., 2013). The etiology studies of Colorectal cancer diet (low fruit and vegeTable consumption, increased consumption of red meat) (Alikhani et al., 2009; Chan and Giovannucci, 2010; Alexander and Cushing, 2011; Aune et al., 2011; Key, 2011) and lifestyle (obesity, low physical activity, smoking) (Chan and Giovannucci, 2010; Donohoe et al., 2010). The global studies have shown a direct relationship between smoking capitation and the Human Development Index so that the highest capitation of cigarettes consumption was for countries with high Human Development Index (Corrao et al., 2000). Ferrari et al. (2013) study showed high Human Development Index in population is accompanied with increased obesity prevalence in men, increased alcohol, Cigarette, fruits and vegeTables capitation and increased red meat consumption and also with high HDI and high Stomach cancer incidence (Ferrari and Reis, 2013).

The results of this study, showed the highest death rate of colorectal cancer for Hungary, Croatia and Slovakia respectively and also the lowest death for Mozambique, Zambia and Guinea. Based on the six WHO regions, the highest and lowest mortality was for Europe and Africa respectively. The standardized mortality rate based on Human Development Index showed a direct relationship and the most death was for countries with too high HDI rate. Also the studies all around the world showed the relationship between mortality from cancers (such as breast and bladder cancer) and the Human Development Index. Ghoncheh et al study that examines the association between incidence rate and standardized death of Breast cancer and HDI, showed positive correlation (r-0.55) between Standardized Incidence rate (ASIR) and HDI and negative correlation (r=0.05) between standardized mortality from Breast cancer and HDI. Another study for bladder cancer showed positive correlation (r= 0.24 (between standardized Incidence rate and HDI and weak positive correlation (r= 0.02) for standardized death rate (Pakzad et al., 2014; Ghoncheh et al., 2015b). The same clear topic in these two studies is that the correlation between incidence rate and Human Development Index is much more stronger than the correlation between death and HDI. However, both studies were in Asian countries. This study that is in global level, showed strong correlation between both incidence rate with HDI (r= 0.71) and standardized death with HDI (r= 0.62). Anyway low mortality rate in countries with low Human Development Index can be due to the low incidence of colorectal cancer in these regions and also, lack of correct diagnosis and absence of registering and reporting this cancer as result (Coleman et al., 2008; Larsen et al., 2009; Coleman et al., 2011; Jung et al., 2013; Mallin et al., 2013). Colorectal cancer mortality is associated with age and diagnosis, diagnosis stage, intervention type, location and race and these factors differ in countries with various levels of development (Torring et al., 2011; Aguero et al., 2012; Downing et al., 2013; Ahmadi et al., 2014; Perdue et al., 2014). Another reason for the difference in incidence and mortality of colorectal cancer with the development index of countries is the existence and usage of screening and diagnostic tests such as sigmoidoscopy and colonoscopy.

Several studies have showed screening tests effective to reduce the incidence and specially mortality of colorectal cancer (Sunkara and Hebert, 2015; Zauber, 2015). Colorectal cancer is one of the world's five leading cancer killer in both sexes (Ferlay et al., 2015) so it is clear that the countries that are on top of this cancer, also have a high mortality.

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