Worldwide incidence and mortality of ovarian cancer and human development index: an ecology study in 2018

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Abstract

Background: Ovarian cancer is the seventh most common cancer among women, accounting for about 4% of all cancers associated with women.

Method: This is a descriptive cross-sectional study based on extraction of cancer incidence data and cancer mortality rates from the Global Cancer Data in 2018. The incidence and mortality rates and ovarian cancer distribution maps were drawn for World countries. To analyze data, correlation test and regression tests were used to evaluate the correlation between its incidence and mortality with HDI.

Results: The results showed that there was a positive and significant correlation between ovarian cancer incidence (R = 0.409, P <0.0001) and mortality (R = 0.193, P <0.05) with HDI. The results showed that there was a positive and significant correlation between incidence with GNI ,MYS ,LEB and EYS (P <0.0001). The results also demonstrated that there was a positive and significant correlation between mortality and GNI, MYS, LEB and EYS (P <0.05).The linear regression model showed that a higher MYS [B = 0.2, CI95%: (- 0.03,0.5)] significantly increased the incidence of ovarian cancer and increased MYS [B = 0.2, CI95% (0.03, 0.4)] increased mortality.

Conclusion: Given the positive and significant correlation between ovarian cancer incidence and mortality with HDI, attention to risk factors in these countries can be effective in curbing its incidence and mortality.

Background

Noncommunicable diseases (NCDs) are among the leading causes of death worldwide today. Due to major changes in fertility and life expectancy, the world's population is growing rapidly and non-communicable diseases, including cancers, are increasing significantly[1]. According to WHO estimates in 2015, cancer is the first or second leading cause of mortality before 70 in most countries in the world. Population growth, aging, and economic development are among the reasons for the increasing prevalence of cancer worldwide. Cancers are the leading cause of death in some developed countries and the second leading cause of death after cardiovascular disease in developing countries[2]. Ovarian cancer is the sixth malignant cause of cancer deaths in women[3]. Given the high prevalence, high mortality rate, its impact on patients' quality of life and economic costs, ovarian cancer is among the important and significant cancers[4, 5].

Among the most significant factors affecting the incidence of ovarian cancer is family history, pregnancy, childbirth and age[6, 7]. Environmental and socioeconomic factors also influence ovarian cancer mortality rate. The overall rising trend of ovarian cancer incidence and mortality can be seen in all regions of the world across different social and economic levels. Variations in ovarian cancer incidence rate in the world is not restricted to the above factors. It can also be due to differences in the cancer registration system in different countries[8].

Socio-economic developments have profound effects on the scale and characteristics of cancer. The epidemiological transmission of cancer distribution in countries around the world has changed. In middle- and low-income countries, compared to high-income ones, the prevalence of global demographic and epidemiological trends has shown a significant decline in cancer in recent decades. In some regions in Africa, the standardized age prevalence of ovarian cancer is less than 5 per 100,000 women and in Eastern and Central Europe it is more than 11 per 100,000 women[4, 9].

Annually 225,000 new cases of ovarian cancer are diagnosed of whom 140,000 die[10]. The risk of complications from this cancer in women is 1 in 71 and the chance of death is 1 in 95[10, 11]. Estimates of the disability-adjusted life- years (DALYs) lost in ovarian cancer are on the rise[12]. Ovarian cancer is more common in industrialized countries than in developing countries. However, the highest proportion of age-specific mortality in ovarian cancer is in developing countries[13]. According to a United Nations record on HDI, the disease burden associated with ovarian cancer in areas with a high HDI is higher. The HDI is a summary index for human development measurements. It measures the mean achievement of a country in three main dimensions of human development: long and healthy life, access to knowledge and living standards[14].

Given the global trend of ovarian cancer and its progress in recent years, awareness to the incidence and mortality of the cancer and its relation to the HDI can be effective in planning and managing financial and human resources to prevent it. Despite the increasing burden of cancers in developing countries, only 5% of global resources are spent on developing countries[15]. It is necessary for all countries to conduct further research through comparing their data with other countries to find out whether socioeconomic conditions still affect cancer risk factors.

The purpose of this study is to assess the impact of socioeconomic development (based on HDI) on the global trend of incidence and death of ovarian cancer in the world based on Global Cancer Data for 2018. We intend to measure the key characteristics of ovarian cancer transmission in the world by examining the relationship between the incidence rate and the HDI, which consists of life expectancy, education, and gross national income.

Material And Methods

The methods used for measuring incidence rate according to age and gender for each country are ranked broadly as follows: 1. National incidence rate observed by 2018 (45 countries). 2. The most recent (national or regional) incidence rates according to population in 2018 (50 countries). 3. Rates were calculated using national mortality data through modeling and the ratio of mortality to incidence rate obtained from cancer records of countries (14 countries). 4. Rates were calculated using national mortality data through modeling and the ratio of mortality to incidence rate obtained from cancer records of neighboring countries (37 countries). 5. National incidence rates according to age and gender for all cancers were obtained by averaging the overall incidence rates from neighboring countries. These values were then partitioned to obtain the national incidence for each specific site using relative cancer

frequency data (7 countries). 6. The rates were calculated as the median of selected neighboring countries.

Mortality

The methods used for measuring incidence rate according to age and gender for each country are ranked as follows: 1.The national mortality rate observed and published by 2018 (81 countries). 2. Recent national mortality rates according to population in 2018 (20 countries). 3. Rates were calculated using national mortality data through modeling and the ratio of mortality to incidence rate obtained from cancer records of neighboring countries (81 countries). 4. The rates were calculated as the median of selected neighboring countries (three countries)[2, 16].

Human Development Index (HDI)

The numerical value of the HDI is between 0 and 1. The HDI value shows how much a country has gone through its way to achieve the highest possible value of 1, and also allows comparisons between countries. The Human Development Index (HDI) is a summary measure of the average achievement in three dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living. The HDI is the geometric mean of normalized indices for each of the three dimensions, which measures the success of each dimension. Life expectancy is measured by life expectancy at birth, the education dimension is measured by mean of years of schooling (elementary, secondary, and higher education), and standard of living is measured by gross national income (GNI) per capita[17, 18].

Statistical analysis

In this study, the correlation bivariate method was used to assess the correlation between the incidence and mortality rates of ovary cancer and the HDI. Linear regression models were also used to assess the HDI effect on the incidence rate of ovary cancer. Significance level was considered lower than 0.05. Data analysis was conducted by Stata software version 14.

Results

Based on cancer record results in 2018, 8,622,539 new cancer cases and 4,169,387 cancer deaths was recorded in women of which 1.72 were new (4.4%) and 184799 (01/1%) deaths were due to ovarian cancer. The highest number of new cancer cases 153075 (51.8%) and the highest death cases from ovarian cancer (92527, 50.01%) is reported for Asia (Fig. 1).

Table 1 shows the incidence and mortality rate of ovarian cancer in each continent. The results showed that the highest ovarian cancer incidence in the world was in Serbia (16.6 per 100,000), Brunei (16 per 100,000) and Belarus (15.4 per 100,000), respectively. The highest mortality rates for ovarian cancer were in Samoa (12 per 100,000), Solomon Islands (8.4 per 100,000) and Poland (8.7 per 100,000) (Fig. 2).

Based on the reported results for cancer in 2018, the highest incidence (8.6 per 1000000) and mortality (4.3 per 100,000) of the ovarian cancer are related to the very high HDI areas (Fig. 3).

The variance analysis showed that the highest mean incidence (8.4 out of 100,000) was related to very high HDI areas, and the lowest incidence (3.4 out of 100,000) was related to low HDI areas, which was statistically significant (P <0.0001). The highest mortality rate (4.8 per 100,000) was related to very high HDI areas, while the lowest (3.6 per 100,000) was found for medium HDI areas, which was statistically significant (P <0.0001) (Table 1).

Table 1. Ovarian Cancer Incidence and Mortality in Different HDI Regions in 2018

HDI Levels	Incidence Rate		Mortality Rate	
	CR	ASR	CR	ASR
Very high human development	14.7	8.4	10.1	4.8
High human development	8.7	6.7	5.6	4.1
Medium human development	4.5	5.1	2.9	3.6
Low human development	2.9	4.4	2.3	3.8
P-value(F-test)	P<0.0001	P<0.0001	P<0.0001	P<0.0001

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

According to the results, there is a positive and significant correlation between incidence (R = 0.409, P <0.0001) and ovarian cancer mortality (R = 0.193, P <0.05) with HDI (Fig. 4).

The results demonstrated that there was a positive and significant correlation between incidence with GNI (r = 0.326, P <0.0001), MYS (r = 0.503, P <0.0001), LEB (r = 0.42, <0.0001) and EYS (r = 0.439, P <0.0001). There was a positive and significant correlation between the ovarian cancer mortality with GNI (r = 0.169, P <0.05), MYS (r = 0.249, P <0.05), LEB (r = 0.163, <0.05) and EYS (r = 0.118, P <0.05) (Table 2).

Table 2. Pearson Correlation between HDI Component and Dependent Variable

HDI Components	ASIR*		ASMR*	
	r	P-value	r	P-value
Gross national income per 1000 capita	0.326	P<0.0001	0.169	P<0.05
Mean years of schooling	0.503	P<0.0001	0.249	P<0.05
Life expectancy at birth	0.420	P<0.0001	0.163	P<0.05
Expected years of schooling	0.439	P<0.0001	0.118	P>0.05

*Dependent variables: ASIR and ASMR

The linear regression model showed that increased MYS [B = 0.2, CI95% (-0.03, 0.5)] significantly decreased the ovarian cancer incidence (P <0.05). According to the regression analysis of mortality rates, the increase in MYS [B = 0.2, CI95% (0.03, 0.4)] leads to higher mortality rates; Meanwhile, LBE [B = -0.2, CI95% (-0.4, -0.01)] significantly increased ovarian cancer mortality (P <0.05) (Table 3).

Table 3. Effect of HDI Components on Ovarian cancer Incidence and Mortality in World in 2018

HDI Components	Incidence			Mortality		
	B	CI95%	P-value	B	CI95%	P-value
HDI	7.6	(-5.6, 21)	0.2	1.1	(-7.1, 9.5)	0.7
Gross national income per 1000 capita	-0.004	(-0.04, 0.002)	0.7	-0.004	(-0.0001, 0.002)	0.6
Mean years of schooling	0.2	(-0.03, 0.5)	0.03	0.2	(0.03, 0.4)	0.02
Life expectancy at birth	-0.01	(0.1, 0.09)	0.7	0.006	(0.06, 0.08)	0.8
Expected years of schooling	-0.1	(0.4, 0.2)	0.4	-0.2	(-0.4, -0.01)	0.04

The results showed that the mean incidence and mortality rate in women over 50 was significantly higher than women under 50 (P <0.05) (Table4).

Table 4- Relationship incidence and mortality rates ovarian cancer to age group in female in world in 2018

Variable		Incidence				Mortality			
		CR		ASR		CR		ASR	
		Mean ±SD	P-value	Mean ±SD	P-value	Mean ±SD	P-value	Mean ±SD	P-value
Age group	0-49	3.1±2.1	P<0.0001	2.7±1.4	P<0.0001	1.1±0.6	P<0.0001	1±0.04	P<0.0001
	50-85	21.6±10.8		21.05±10		17.7±8.8		16.4±	

CR: Crude Rate, ASR: Age-Standardized Rate

Discussion

Usually occurring after menopause, ovarian cancer is one of the deadliest in women worldwide. As a result of the late diagnosis of the disease, it progresses rapidly and its survival rate is low[19]. The results showed that the highest ovarian cancer incidence in the world was in Serbia (16.6 per 100,000), Brunei (16 per 100,000) and Belarus (15.4 per 100,000), respectively. The highest death rates for ovarian cancer were in Samoa (12 per 100,000), Solomon Islands (8.4 per 100,000) and Poland (7.8 per 100,000), respectively. The highest ovarian cancer incidence is reported for Asia (51.8%), followed by Europe (22.9%), North America (9.2%), Latin America (7.9%), Africa (7.4%) and Oceania (0.73%). The lowest incidence is in the Oceania. Differences in the incidence of cancer in these areas can be due to

differences in the economic situation of individuals. An indicator for measuring a country's condition is the human development index (HDI). The index examines the conditions of a country in three fundamental aspects of development, including life expectancy, education and standard of living. Life expectancy is measured with life expectancy at birth, years of potential education, and standards of living with per capita income or GDP. In high levels HDI countries, ovarian cancer incidence and mortality is higher. Causes of high incidence include environmental and genetic factors, early screening, proper health care, early-stage disease recognition, and accurate registration systems[20].

The incidence of ovarian cancer in the United States in 2015 was 21,290 and the death rate was 14180. The cancer is reported as 11.4 percent for Eastern Europe and 6% for Central Europe[20]. Eighty four percent of cancer cases are reported for Asian countries. The highest standardized rates of ovarian cancer were in Asian countries such as Singapore and Kazakhstan. Standardized ovarian cancer mortality rates showed that five countries including India, China, Indonesia, Japan and Pakistan had the highest rates of ovarian cancer mortality[17].

The results of Rahmani et al.'s study in 2018 showed a significant positive relationship between the prevalence of ovarian cancer and HDI ($p < 0.001$)[13]. A study by Momenimovahed et al. (2019) showed that although the prevalence of ovarian cancer is higher in areas with higher HDI, but it is inversely proportional to the mortality rate[21]. A 2016 study by Razi et al. showed that there was a significant positive relationship between HDI levels and ovarian cancer. Ovarian rates are higher in high-income individuals. The findings of the above study are in line with our results[1]. These studies show that cancer is still a global issue and there is a need for more extensive studies[4].

Socio-economic changes have had profound effects on cancer incidence and mortality. In countries with low or average incomes, the risk of cancers is increasing. Cancer-induced infections account for about 26% of cancers in low-income countries. Low physical activity levels, obesity, malnutrition, infant lactation and the affluent social class are called risk factors for ovarian cancer[21]. Ovarian cancer is associated with the industrialization of societies, and statistics show that most of the deaths from cancer have occurred in developing countries.

Ovarian cancer is associated with the industrialization of societies, and statistics show that most of the deaths from this cancer have occurred in developing countries. Our results also showed that there was a positive correlation between HDI and ovarian cancer incidence ($r = 0.409$, $P < 0.0001$) and mortality ($r = 0.0771$, $P < 0.05$) in 2018.

The study also found that the reason for a higher ovarian cancer incidence in countries with higher HDIs could be due to appropriate infrastructure, optimal health care, use of modern medical equipment, high standard of living and screening for the early detection of the disease. The cause of higher mortality in developing countries is lack of access to optimal health care, changing lifestyle and high diagnostic and therapeutic costs. HDI is the mean for normal indices which measures optimal lifestyle, knowledge, and life expectancy. For measuring satisfaction, the index aims higher goals than income and material aspects. Given the recent advancements and the fact that the true purpose of any development plan is

achieving a healthy creative and happy life, HDI has to be taken into account. Genetic factors are among the major causes of ovarian cancer. Therefore, early prevention strategies for ovarian cancer can be effective in reducing its incidence. In spite of the relationship between the above factors, the interpretation of such studies should be cautious. As, in addition to the epidemiological risk factors of ovarian cancer, the inherent constraints of ecological studies should also be taken into account. In sum, ovarian cancer incidence and mortality rate has increased in many countries. Through adopting preventive measures and doing epidemiological studies, in time treatment, monitoring patients with ovarian cancer, particularly individual residing in less-developed countries, the burden of the disease could be reduced and effective steps taken to improve the health systems of different countries.

Conclusion

Given the positive and significant correlation between ovarian cancer incidence and mortality with HDI, attention to risk factors in these countries can be effective in curbing its incidence and mortality. Higher incidence in these countries may be due to better and earlier detection of the disease in these countries. Therefore, it can be said that life expectancy, education, and GDP can be factors associated with this cancer that may also contribute to reducing its incidence and mortality.

Abbreviations

HDI: Human development Index

NCDs: Non-communicable diseases

GNI: Gross national income per 1000 capita

MYS: Mean years of schooling

LEB: Life expectancy at birth

LYS: Expected years of schooling

ASIR: Age Standard Incidence Rate

ASMR: Age Standard Mortality Rate

CR: Crude Rate

ASR: Age-Standardized Rate

Declarations

Conflict of interest

This research has no conflict of interest for other authors.

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Figures

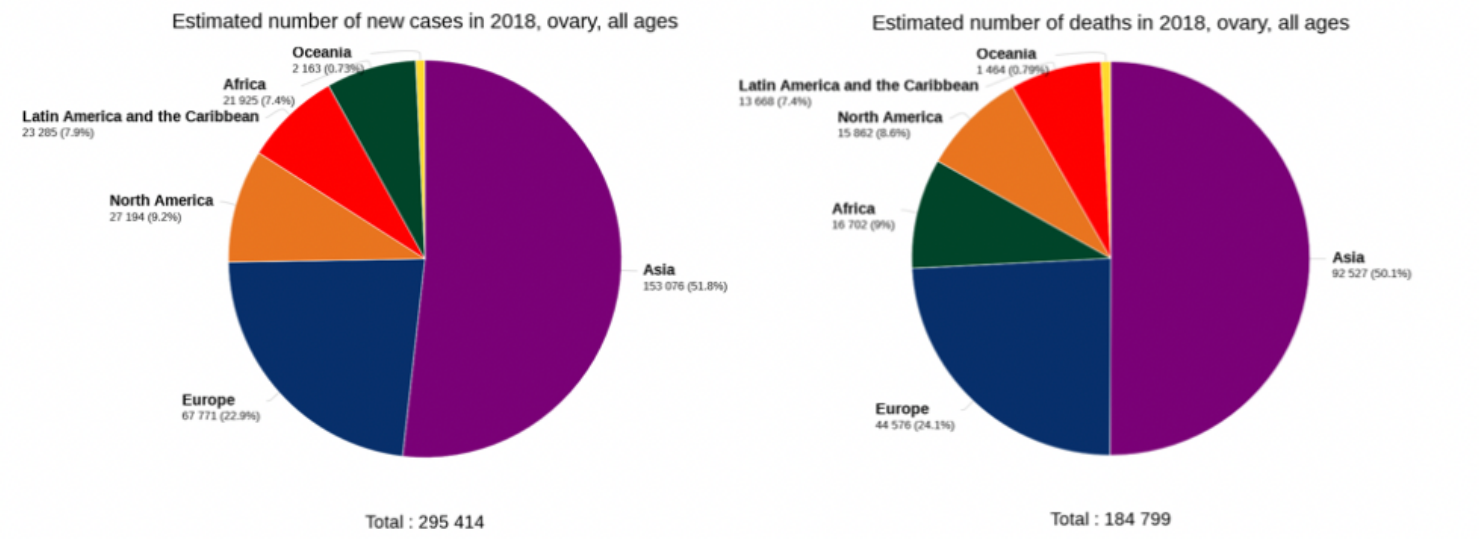


Figure 1

Pie charts present the distribution of cases and deaths ovary cancer by continent in 2018 for female, all age. [Source: GLOBOCAN 2018].

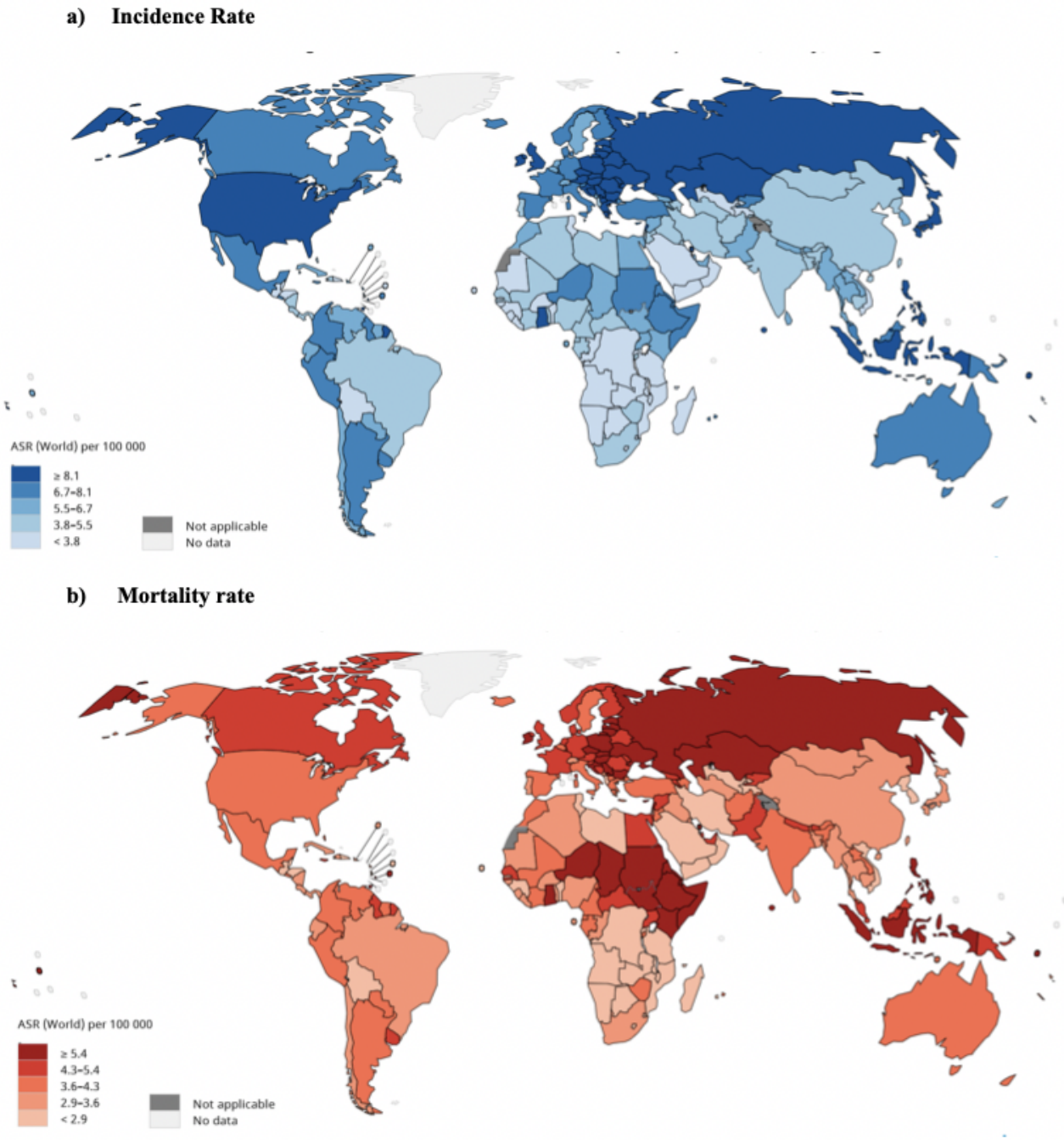
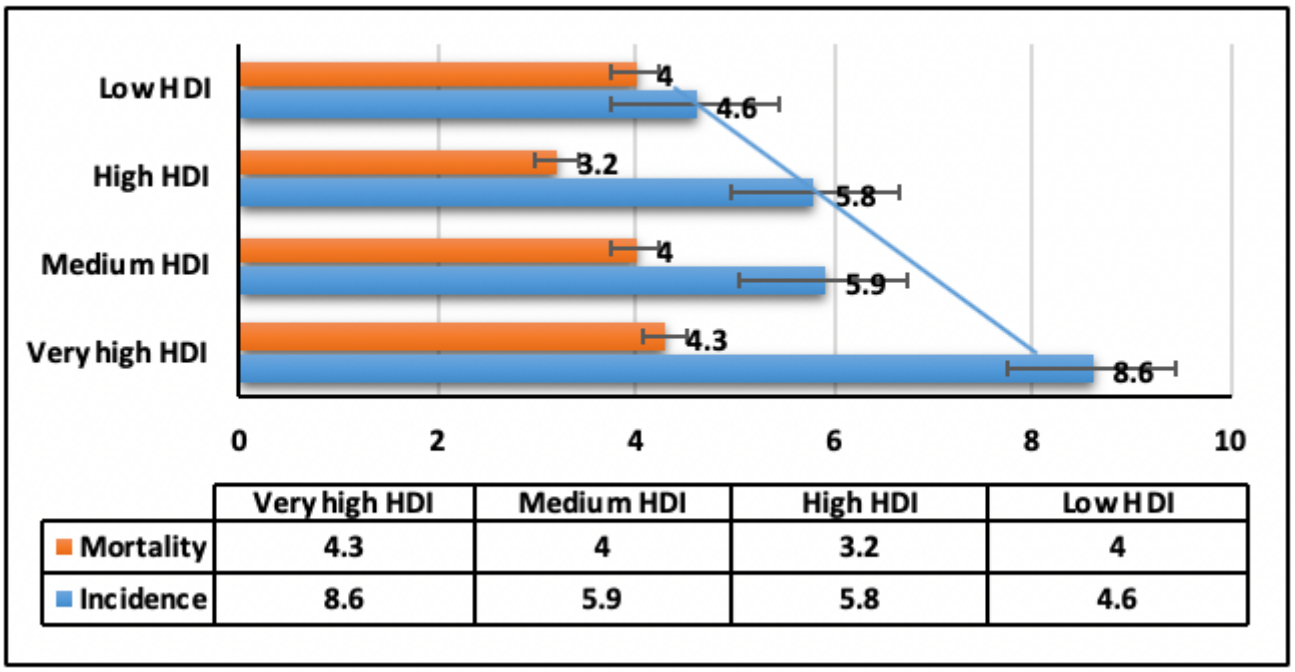


Figure 2

The map of presenting (A) incidence and (B) mortality rates due to ovary cancer among women in world in 2018. [Source: GLOBOCAN 2018]. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.



	Very high HDI	Medium HDI	High HDI	Low HDI
Mortality	4.3	4	3.2	4
Incidence	8.6	5.9	5.8	4.6

Figure 3

Distribution of incidence and mortality rates Ovarian cancer by HDI.

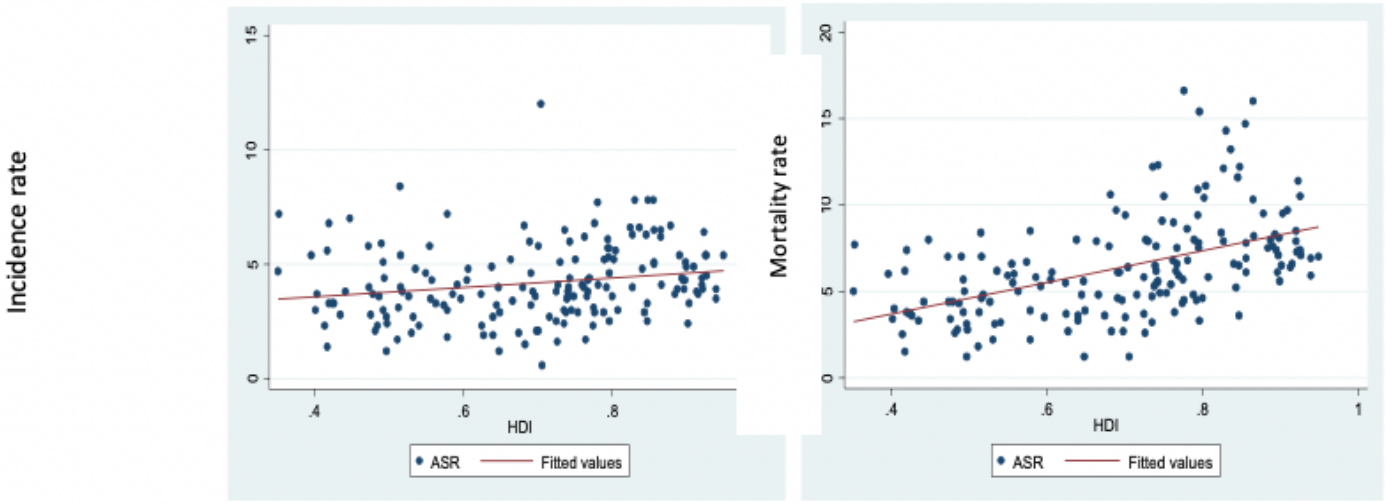


Figure 4

Correlation between the Human Development Index, incidence and Mortality rates of ovarian cancer in World in 2018.