



# GEOGRAPHICAL DISTRIBUTION INCIDENCE AND MORTALITY OF BREAST CANCER AND ITS RELATIONSHIP WITH THE HUMAN DEVELOPMENT INDEX (HDI): AN ECOLOGY STUDY IN 2018

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**Abstract – Objective:** Cancer is one of the reasons for the increased burden of disease in the coming decades. Breast cancer is the most common cancer in women. Therefore, the aim of this study was to investigate the epidemiology, incidence and mortality of breast cancer and its relationship with the Human Development Index (HDI).

**Materials and Methods:** Data about the incidence and mortality rate of breast cancer for the year 2018 was obtained from the Global Cancer Project for 185 countries. To analyze data, correlation test and regression tests were used to evaluate the correlation between the 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:** According to cancer registry data in 2018, the highest incidence of breast cancer in the world was observed in the countries of Belgium (11.23 per 100,000) and Luxembourg (109.3 per 100,000), and the highest mortality rate for Fiji (36.9 per 100,000) and Barbados (33.1 per 100,000). Our study showed a positive and significant correlation between incidence ( $r=0.724$ ,  $p<0.0001$ ) and HDI index. However, there was a negative correlation between breast mortality ( $r=-0.08$ ,  $p > 0.05$ ) and HDI. Linear regression showed that increasing MYS ( $B=2.02$ ,  $p<0.05$ ) increased the incidence and increase of EYS ( $B=-1.1$ ,  $p<0.05$ ) and significantly decreased mortality.

**Conclusions:** The incidence of breast cancer in developed countries and its death in less developed countries is high. Increasing the HDI, along with the increased screening program in these countries, can help to identify and reduce the mortality of this disease. Increasing the level of education and awareness of women is also one of the health priorities in this area that can be effective in reducing mortality in patient.

**KEYWORDS:** Geographical distribution, Breast cancer, Incidence, Mortality, HDI.

## INTRODUCTION

Cancer is the second leading cause of death after cardiovascular disease worldwide in developed countries, and is the third leading cause of death after heart disease and disasters in less developed countries<sup>1,2</sup>.

The population and epidemiological global transmission of diseases represents an increase in the burden of cancer in the coming decades in

the world, especially in low and middle income countries<sup>3,4</sup>.

Breast cancer is the most common cancer and the most deadly malignancy among women and is considered as one of the most important health concerns of women in the world<sup>5</sup>.

More than one million of new breast cancers are diagnosed worldwide each year<sup>5</sup>, and about one third of all cancers in women are breast cancers<sup>6</sup>. The incidence of breast cancer in the United



States and Europe is double that of Asian countries. And in all countries, the prevalence is increasing. Although its prevalence in Asia is lower than in Western countries<sup>7,8</sup>. The incidence of breast cancer in the North and West of Europe and North America is about four to five times higher than in Eastern and Southeastern Asia<sup>9</sup>.

In Asia, reports have shown that the incidence of breast cancer has doubled or tripled over the past two decades<sup>10</sup>.

The likelihood of breast cancer is 1 per 12 women in the UK, 1 per 13 women in Australia, while in Asian countries is lower<sup>11</sup>.

The main hypothesis for explaining these different observations is the differences in the risk factors for breast cancer<sup>12</sup>. In developing countries, the growing trend of the disease may be due to increased livelihood, lifestyle change and urbanization<sup>13</sup>. One of the important factors associated with the incidence of cancer can be the Human Development Index (HDI), which indicates the social and economic status of people in different countries<sup>14,15</sup>. HDI is a useful category for comparing cancer worldwide. 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 in the next decades<sup>16</sup>. Therefore, the aim of this study was to investigate the epidemiology, incidence and mortality of breast cancer and its relationship with the HDI.

## 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- 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 control cancer by recording cancer cases. 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 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. Rates were estimated as an average of those from selected neighboring countries (3 countries)<sup>17,18</sup>.

## HUMAN DEVELOPMENT INDEX (HDI)

HDI is a combination index consisting of three dimensions: degree of studies, life expectancy, and dominance over required sources for a proper sensible life. All the regions and groups that have experienced a noticeable progress in all HDI components have developed more quickly in comparison with low or moderate HDI countries. According to this index, the world is unequal because the national average value hides most of the various experiences in human life. Many inequalities ex-

ist in Northern and Southern countries. Income inequality has been intensified inside each country as well as between many countries<sup>8,19,20</sup>.

### Statistical Analysis

In this study, the correlation bivariate method was used to assess the correlation between the incidence and mortality rates of breast cancer and HDI. Linear regression models were also used to assess the HDI effect on the incidence rate of breast cancer. Significance level was considered lower than 0.05. Data analysis was conducted by Stata software version 14 (StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX, USA).

## RESULTS

Based on the results of cancer recordings in 2018, about 8622539 new cases (182.6 per 100,000) and 4169387 (83.1 per 100,000) deaths due to cancer in women have been documented. The highest incidence (208884 new cases, 24.2% of all new cancers) and mortality (626679 cases, 15%) of cancer in women worldwide were related to breast cancer (Figure 1).

Table 1 presented the incidence and mortality rate of breast cancer in different countries. The results of the study showed that the highest incidence of breast cancer in the world was in Belgium (11.2 per 100 000), Luxembourg (10.3 per 100 000), and the Netherlands (10.9 per 100 000), respectively. The highest mortality rate for breast cancer was related to Fiji (36.9 per 100,000), Barbados (33.1 per 100,000), and Somalia (29.3 per 100,000) (Table 1, Figure 2).

The results showed a positive and significant correlation between incidence rate and HDI index ( $R = 0.724, p < 0.0001$ ), while there was a negative correlation between breast cancer mortality and HDI ( $R = -0.08, p > 0.05$ ) and this association was not statistically significant (Figure 3).

The highest incidence rate (73.67 cases per 100000) of breast cancer as well as the highest mortality rate (16.23 cases per 100000) were observed in countries with a Very HDI. Also, the lowest incidence rate (29.96 cases per 100000) of breast cancer was indicated in countries with Low HDI and the lowest mortality rate (12.67 cases per 100000) of breast cancer was indicated in countries with Medium HDI. Highest value of LEB, MYS, GNI, EYS and total HDI were estimated to be 79.55, 11.5, 39613, 16.2 and 0.876 (Table 2).

Linear regression model showed that increased HDI, MYS, EYS and LBE are associated with an increased incidence of breast cancer. But this increase was statistically significant only for MYS ( $B = 2.02, p < 0.05$ ). The results of regression analysis showed that increasing HDI decreases mortality. However, this decrease was not statistically significant ( $p > 0.05$ ), while the increase in EYS ( $B = -1.1, p < 0.05$ ) significantly decreased mortality (Table 3).

## DISCUSSION

Comparisons of low-risk populations migrating to high-risk populations have revealed that breast cancer incidence rates rise in successive generations<sup>17</sup>. Public health data shows that the global burden of breast cancer in women, including the incidence, mortality and economic costs of illness, is increasing<sup>18</sup>.

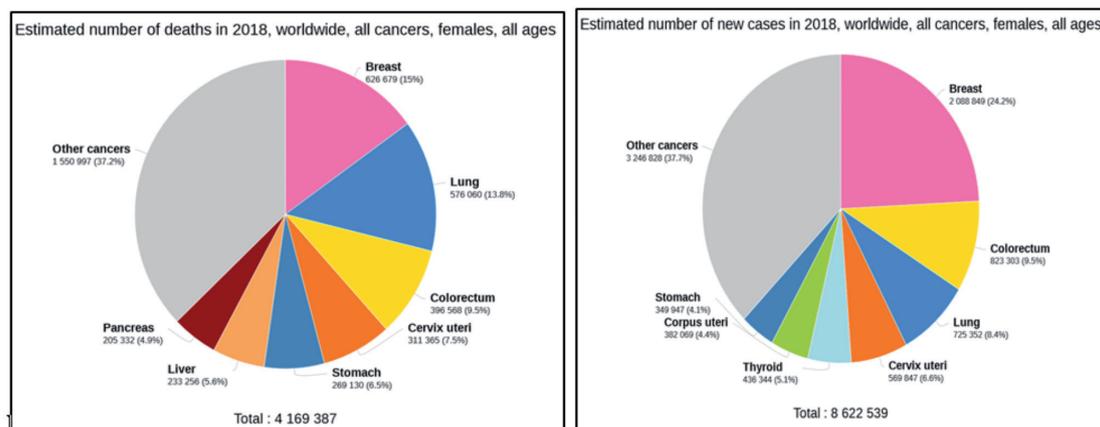


Fig. 1. Pie charts present the distribution of cases and deaths of all cancer in females worldwide in 2018, all age. [Source: GLOBOCAN 2018].



**TABLE 1.** Estimated age-standardized incidence and mortality rates of breast cancer in females for all ages worldwide in 2018.

Country	Incidence			Mortality			HDI
	Crud Rate	ASR	Cum. Risk	Crud Rate	ASR	Cum. Risk	
Afghanistan	17.4	30.0	3.2	9.4	18.2	2.1	0.479
Albania	66.9	48.1	4.9	15.4	11.1	1.2	0.764
Algeria	57.0	55.6	5.6	14.6	16.2	1.7	0.745
Angola	13.8	25.3	2.8	6.6	14.1	1.5	0.533
Argentina	94.5	73.0	8.3	18.7	18.0	2.0	0.827
Armenia	67.8	43.3	5.0	26.2	20.6	2.4	0.743
Australia	149.3	94.5	10.2	15.8	12.3	1.3	0.939
Austria	132.7	71.1	7.7	20.8	14.3	1.5	0.893
Azerbaijan	40.0	32.7	3.6	14.6	14.6	1.6	0.759
Bahamas	81.5	63.0	6.4	33.3	27.9	3.0	0.792
Bahrain	39.6	44.1	4.8	10.4	14.9	1.6	0.824
Bangladesh	15.5	17.0	1.8	6.9	9.3	1.0	0.579
Barbados	109.8	72.8	7.2	44.9	33.1	3.4	0.795
Belarus	89.0	50.4	5.6	21.0	12.9	1.5	0.796
Belgium	203.7	113.2	12.2	23.0	16.3	1.8	0.896
Belize	29.7	37.9	3.5	7.4	13.7	1.4	0.706
Benin	26.5	41.5	4.4	12.2	21.0	2.2	0.485
Bhutan	4.2	5.0	0.6	2.1	2.7	0.4	0.607
Bolivia, Plurinational State of	26.0	26.5	2.5	5.6	7.7	0.7	0.674
Bosnia and Herzegovina	77.7	45.4	5.0	22.6	14.6	1.6	0.75
Botswana	15.0	17.5	1.7	4.2	7.1	0.6	0.698
Brazil	79.8	62.9	6.8	13.8	13.0	1.4	0.754
Brunei	62.6	56.8	6.1	10.1	11.2	1.2	0.865
Bulgaria	111.0	59.1	6.4	28.6	16.4	1.8	0.794
Burkina Faso	14.5	24.3	2.6	8.1	14.7	1.6	0.402
Burundi	11.1	19.5	2.2	6.2	11.7	1.3	0.404
Cabo Verde	17.3	20.6	2.1	4.8	8.7	0.8	0.648
Cambodia	19.1	21.7	2.4	9.1	11.6	1.3	0.563
Cameroon	26.6	37.6	3.6	14.2	21.2	2.0	0.518
Canada	151.3	83.8	9.3	17.3	12.1	1.3	0.92
Central African Republic	22.4	34.0	3.4	14.2	23.9	2.4	0.352
Chad	21.5	36.9	3.7	12.3	23.0	2.3	0.396
Chile	58.7	40.9	4.4	12.7	11.1	1.2	0.847
China	53.3	36.1	3.8	11.1	8.8	0.9	0.738
Colombia	53.2	44.1	4.8	12.1	11.9	1.3	0.727
Comoros	10.2	15.4	1.7	4.9	8.4	0.9	0.497
Congo, Democratic Republic of	14.6	24.6	2.6	7.3	13.6	1.5	0.435
Congo, Republic of	14.6	22.0	2.4	5.4	9.0	1.0	----

*Continued*

**TABLE 1 (CONTINUED).** Estimated age-standardized incidence and mortality rates of breast cancer in females for all ages worldwide in 2018.

Country	Incidence			Mortality			HDI
	Crud Rate	ASR	Cum. Risk	Crud Rate	ASR	Cum. Risk	
Costa Rica	60.6	46.7	5.2	12.4	12.2	1.3	0.776
Croatia	132.5	68.7	7.5	27.5	18.2	1.9	0.827
Cuba	78.3	44.2	5.0	20.5	14.5	1.6	0.775
Cyprus	122.0	81.7	8.7	20.7	16.9	1.9	0.856
Czech Republic	137.7	70.7	7.7	17.9	11.4	1.2	0.878
Côte d'Ivoire	21.6	37.8	4.2	10.3	19.3	2.2	0.474
Denmark	160.0	88.8	9.5	21.5	14.7	1.6	0.925
Djibouti	36.4	41.2	4.0	16.8	21.1	2.1	0.473
Dominican Republic	57.8	57.0	6.1	22.8	26.1	2.8	0.726
Ecuador	33.0	31.8	3.4	7.7	9.1	1.0	0.739
Egypt	47.0	52.4	5.5	15.3	21.3	2.2	0.691
El Salvador	43.7	39.9	4.0	9.9	10.9	1.1	0.68
Equatorial Guinea	22.4	30.9	3.0	13.5	21.2	2.0	0.592
Eritrea	28.6	41.3	4.0	15.0	24.8	2.4	0.42
Estonia	115.4	61.2	6.7	22.8	14.1	1.6	0.865
Ethiopia	28.3	41.2	4.0	14.1	22.9	2.2	0.448
Fiji	67.9	63.4	6.6	34.6	36.9	4.0	0.736
Finland	169.8	89.	9.9	18.7	11.3	1.3	0.895
France	169.4	99.1	10.5	21.8	15.4	1.6	0.897
France, Guadeloupe	114.4	68.9	7.2	23.7	14.9	1.6	---
France, La Réunion	82.5	59.1	6.3	15.6	13.0	1.4	---
France, Martinique	136.7	78.3	8.2	28.0	17.2	2.0	---
France, New Caledonia	128.1	98.0	10.6	19.6	18.3	1.8	---
French Guyana	53.1	55.5	5.7	11.3	13.0	1.3	----
French Polynesia	79.8	65.9	6.7	21.3	20.9	2.2	
Gabon	17.8	22.1	2.2	8.1	11.4	1.1	0.697
The Gambia	4.4	6.9	0.7	2.1	4.0	0.4	
Gaza Strip and West Bank	35.3	56.6	5.7	10.1	21.7	2.1	----
Georgia	55.9	34.0	3.8	24.2	15.9	1.9	0.769
Germany	172.2	85.4	9.1	24.0	15.7	1.7	0.926
Ghana	31.4	43.0	4.6	12.4	17.7	2.0	0.579
Greece	136.7	69.3	7.3	19.6	13.5	1.4	0.866
Guam	55.0	42.2	4.4	16.6	16.8	1.8	---
Guatemala	20.5	26.2	2.8	4.6	7.3	0.8	0.64
Guinea	9.3	15.2	1.6	4.8	9.1	1.0	0.414
Guinea-Bissau	16.8	26.3	2.8	9.0	15.6	1.6	0.424
Guyana	43.9	44.9	4.9	11.6	14.2	1.5	0.638
Haiti	19.7	23.6	2.5	8.8	14.5	1.3	0.493
Honduras	25.3	31.1	3.4	9.4	12.1	1.3	0.625

*Continued*



**TABLE 1 (CONTINUED).** Estimated age-standardized incidence and mortality rates of breast cancer in females for all ages worldwide in 2018.

Country	Incidence			Mortality			HDI
	Crud Rate	ASR	Cum. Risk	Crud Rate	ASR	Cum. Risk	
Hungary	161.8	85.5	9.2	29.3	17.9	2.0	0.836
Iceland	133.8	85.2	9.5	21.1	17.2	1.9	0.921
India	24.9	24.7	2.7	11.6	13.4	1.5	0.624
Indonesia	44.0	42.1	4.6	15.8	17.0	2.0	0.689
Iran, Islamic Republic of	33.8	31.0	3.2	7.7	8.7	1.0	0.774
Iraq	26.5	38.4	4.0	8.2	13.6	1.5	0.649
Ireland	137.7	90.3	9.7	21.6	17.6	1.9	0.923
Israel	100.0	78.5	8.6	16.6	16.6	1.8	0.899
Italy	187.8	92.8	9.8	22.6	13.8	1.5	0.887
Jamaica	66.9	56.8	6.1	24.7	23.2	2.6	0.73
Japan	101.6	57.6	6.0	16.6	9.3	1.1	0.903
Jordan	43.8	57.4	6.2	11.9	18.5	2.0	0.741
Kazakhstan	44.4	37.2	4.2	15.7	14.8	1.7	0.794
Kenya	23.4	40.3	4.5	9.1	17.8	2.0	0.555
Korea, Democratic Republic of	44.2	32.8	3.5	8.6	6.8	0.8	---
Korea, Republic of	91.8	59.8	6.0	9.5	6.0	0.6	0.901
Kuwait	45.5	53.4	6.1	11.6	17.6	2.0	0.8
Kyrgyzstan	22.5	23.7	2.5	8.3	10.2	1.1	0.664
Lao People's Democratic Republic	25.6	32.7	3.6	11.0	16.2	1.9	0.586
Latvia	121.3	62.8	7.0	29.9	17.7	2.0	0.83
Lebanon	106.0	97.6	9.6	20.5	25.3	2.4	0.763
Lesotho	13.1	17.1	1.6	4.9	9.7	0.8	0.497
Liberia	17.2	26.9	2.9	9.0	15.5	1.7	0.427
Libya	23.5	23.2	2.5	5.2	6.2	0.7	0.716
Lithuania	112.3	59.6	6.5	26.8	16.0	1.8	0.848
Luxembourg	175.4	109.3	11.9	19.3	15.8	1.7	0.898
Madagascar	10.1	16.0	1.8	4.3	7.5	0.8	0.512
Malawi	12.6	21.4	2.2	5.5	11.2	1.1	0.476
Malaysia	48.9	47.5	5.1	16.7	18.4	2.1	0.789
Maldives	38.2	41.2	4.5	12.8	16.6	2.0	0.701
Mali	18.4	32.6	3.5	9.5	17.6	1.9	0.442
Malta	165.1	87.6	9.2	19.4	12.7	1.3	0.856
Mauritania	18.3	26.4	2.8	7.9	12.7	1.3	0.513
Mauritius	102.7	69.6	7.4	28.6	21.8	2.4	0.781
Mexico	41.6	39.5	4.3	9.0	9.9	1.1	0.762
Mongolia	11.3	11.3	1.2	3.3	4.0	0.4	0.735
Montenegro	131.8	87.8	9.0	32.2	22.6	2.5	0.807
Morocco	55.5	51.0	5.3	17.0	17.6	1.9	0.647
Mozambique	8.7	14.5	1.6	4.5	8.5	0.9	0.418

*Continued*

**TABLE 1 (CONTINUED).** Estimated age-standardized incidence and mortality rates of breast cancer in females for all ages worldwide in 2018.

Country	Incidence			Mortality			HDI
	Crud Rate	ASR	Cum. Risk	Crud Rate	ASR	Cum. Risk	
Myanmar	22.8	21.0	2.2	10.2	10.2	1.1	0.556
Namibia	23.9	33.2	3.5	7.8	13.2	1.3	0.64
Nepal	13.6	15.0	1.6	6.1	7.6	0.8	0.558
New Zealand	145.1	92.6	9.8	18.7	14.2	1.5	0.915
Nicaragua	31.8	32.9	3.5	9.7	12.0	1.4	0.645
Niger	14.3	24.9	2.5	9.2	17.1	1.8	0.353
Nigeria	27.2	41.7	4.3	11.9	18.8	2.0	0.527
Norway	143.5	87.5	9.5	14.6	11.0	1.2	0.949
Oman	27.8	34.7	3.6	7.6	11.0	1.1	0.796
Pakistan	34.9	43.9	4.7	16.5	23.2	2.6	0.55
Panama	49.2	43.5	4.6	10.1	11.2	1.2	0.788
Papua New Guinea	36.1	45.8	4.9	15.9	25.2	2.7	0.516
Paraguay	47.5	51.2	5.4	12.4	16.8	1.8	0.693
Peru	42.9	40.0	4.3	9.3	10.3	1.1	0.74
Philippines	46.8	52.4	5.6	12.3	17.5	1.8	0.682
Poland	102.5	59.1	6.6	24.7	15.8	1.8	0.855
Portugal	128.7	70.7	7.4	16.7	11.3	1.1	0.843
Puerto Rico	124.6	76.7	8.5	17.7	12.9	1.5	----
Qatar	28.1	42.1	5.0	7.0	13.9	1.7	0.856
Republic of Moldova	78.2	48.2	5.6	28.2	19.7	2.4	----
Romania	95.4	51.6	5.8	23.4	14.6	1.7	0.802
Russian Federation	92.7	53.6	6.0	23.8	15.1	1.8	0.804
Rwanda	17.8	26.4	2.8	8.6	14.3	1.5	0.498
Saint Lucia	66.5	51.6	5.5	25.2	20.6	2.3	0.735
Samoa	70.0	80.1	9.0	19.4	24.3	3.0	0.704
Sao Tome and Principe	11.4	26.1	3.2	4.8	11.1	1.4	0.574
Saudi Arabia	25.3	27.3	2.9	5.8	7.5	0.8	0.847
Senegal	21.2	32.8	3.6	9.6	16.0	1.8	0.494
Serbia	129.6	75.3	8.2	33.7	21.9	2.4	0.776
Sierra Leone	26.6	43.6	4.6	14.3	25.4	2.7	0.42
Singapore	107.1	64.0	6.4	28.2	18.5	2.1	0.925
Slovakia	107.1	59.4	6.6	24.3	16.5	1.8	0.845
Slovenia	131.5	68.5	7.5	19.8	13.4	1.4	0.89
Solomon Islands	34.3	45.6	4.8	11.2	14.9	1.6	0.515
Somalia	23.9	41.3	4.2	15.3	29.1	3.0	----
South Africa	48.2	49.0	5.2	12.6	16.3	1.7	0.666
South Sudan	21.8	33.4	3.5	11.5	19.7	2.1	0.418
Spain	138.8	75.4	7.9	16.0	10.6	1.1	0.884
Sri Lanka	28.4	22.2	2.3	9.8	8.1	0.9	0.766
Sudan	27.3	39.2	3.8	12.1	21.4	2.1	0.49
Suriname	59.7	53.6	6.2	13.9	15.8	1.6	0.725

Continued

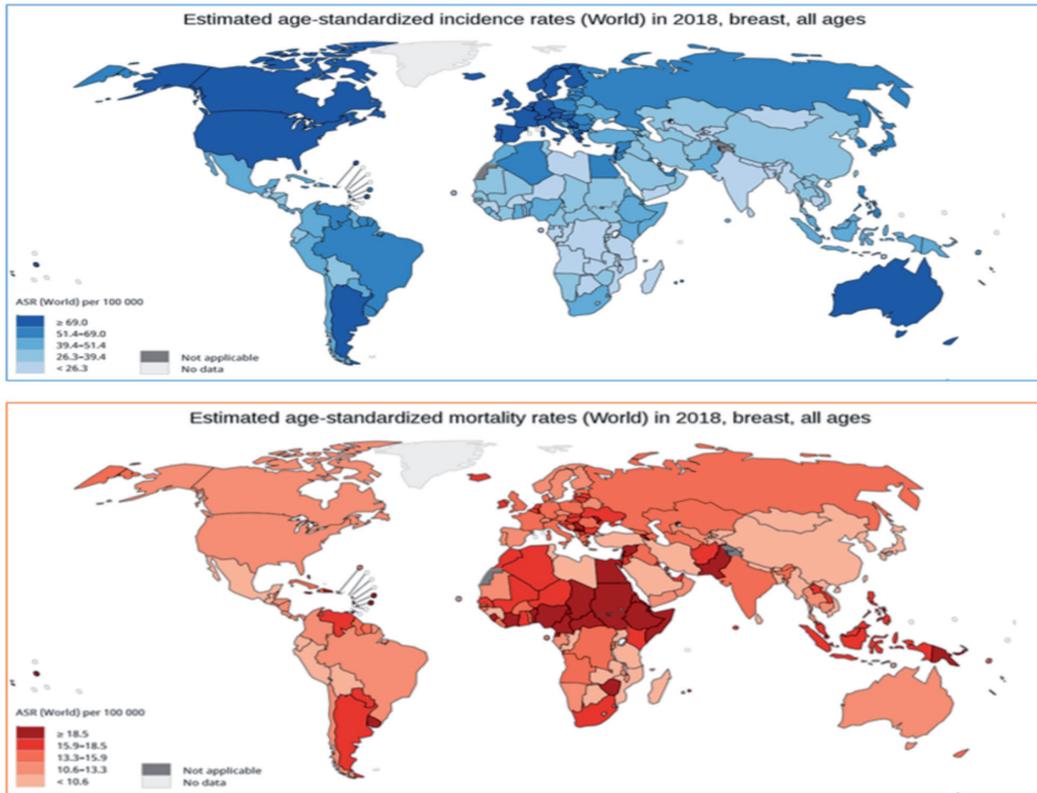


**TABLE 1 (CONTINUED).** Estimated age-standardized incidence and mortality rates of breast cancer in females for all ages worldwide in 2018.

Country	Incidence			Mortality			HDI
	Crud Rate	ASR	Cum. Risk	Crud Rate	ASR	Cum. Risk	
Swaziland	10.4	15.5	1.3	3.2	8.1	0.6	0.541
Sweden	160.9	89.8	9.9	16.0	11.4	1.2	0.913
Switzerland	163.1	88.1	9.7	18.0	12.3	1.4	0.939
Syrian Arab Republic	54.5	67.3	6.9	18.3	26.9	2.8	0.536
Tajikistan	11.7	14.8	1.6	4.6	6.5	0.8	0.627
Tanzania, United Republic of	10.2	17.5	2.0	4.2	7.8	0.9	0.531
Thailand	55.0	35.7	4.0	16.1	10.9	1.2	0.74
The Netherlands	188.9	105.9	11.2	24.5	16.5	1.8	
The former Yugoslav Republic of Macedonia	95.9	61.5	6.7	23.7	17.2	1.9	0.748
Timor-Leste	15.2	24.9	2.7	4.2	8.5	0.9	0.605
Togo	18.6	29.0	3.1	8.3	14.4	1.5	0.487
Trinidad and Tobago	94.3	68.1	7.2	29.9	25.1	2.6	0.78
Tunisia	39.1	32.2	3.3	10.5	10.3	1.1	0.725
Turkey	53.8	45.6	4.8	10.7	10.5	1.1	0.767
Turkmenistan	25.1	27.1	3.1	13.2	14.5	1.5	0.691
Uganda	10.4	21.3	2.4	4.7	10.3	1.2	0.493
Ukraine	80.1	44.6	5.0	28.5	16.7	2.0	0.743
United Arab Emirates	39.5	52.9	5.8	9.0	16.9	1.7	0.84
United Kingdom	164.5	93.6	9.9	18.8	14.4	1.5	0.909
United States of America	141.9	84.9	9.3	17.1	12.7	1.4	0.92
Uruguay	103.8	65.2	7.0	25.1	20.7	2.3	0.795
Uzbekistan	21.6	22.6	2.5	10.7	11.8	1.4	0.701
Vanuatu	25.1	29.5	2.9	9.5	12.5	1.6	0.597
Venezuela, Bolivarian Republic of	56.6	53.2	5.8	15.0	16.9	1.9	0.767
Viet Nam	31.2	26.4	2.9	11.9	10.5	1.2	0.683
Yemen	17.1	24.9	2.5	6.7	12.7	1.3	0.482
Zambia	10.0	19.9	2.3	3.6	8.5	1.0	0.579
Zimbabwe	21.8	38.4	4.2	8.8	18.6	2.0	0.516

According to cancer registry data in 2018, the highest incidence of breast cancer in the world was observed in Belgium (11.23 per 100,000) and Luxembourg (109.3 per 100,000), while the highest mortality rate was found in Fiji (36.9 per 100,000) and Barbados (33.1 per 100,000). Our study showed a positive and significant correlation between incidence rate and HDI ( $r = 0.724, p$

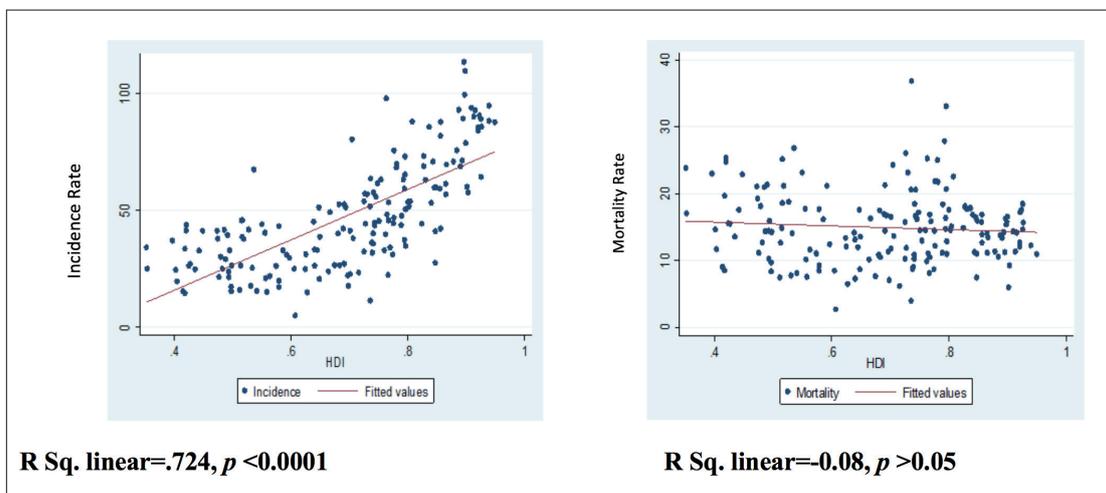
$<0.0001$ ), while there was a negative correlation between breast mortality and HDI ( $r = -0.08, p > 0.05$ ). Linear regression showed that increasing MYS ( $B = 2.02, p < 0.05$ ) increased the incidence and increasing of EYS significantly decreased mortality ( $B = -1.1, p < 0.05$ ). More than one million women with breast cancer are diagnosed each year and more than 410000 die, representing 14%



**Fig. 2.** Global map presenting incidence and mortality rates by world countries for breast cancer in female in all age, in 2018 [Source: GLOBOCAN 2018].

of deaths from cancer in women<sup>21</sup>. In developing countries, it has been reported that the incidence of breast cancer is increasing by 5% every year<sup>21</sup>. About 1.67 million new cases of breast cancer worldwide are diagnosed in 2012 (25% of all cancers). The vast majority of cases occur in women in less developed areas. The incidence of breast cancer varies by up to 4 times in the world, varying from 27 cases per 100,000 people in the middle of Africa and East Asia to 96 cas-

es per 100,000 people in Western Europe<sup>1,10</sup>. Our study showed a positive correlation between incidence of breast cancer and HDI index. A study on HDI and breast cancer in Asia also found that there was a positive correlation between HDI and the incidence of cancer, but this association is unknown<sup>15</sup>. According to cancer registry data in 2018, the highest incidence and mortality of breast cancer were observed in Belgium and Fiji, respectively. Factors making the differences



**Fig. 3.** Correlation between HDI, incidence and mortality rates of breast cancer in 2018.



**TABLE 2.** Breast cancer incidence, mortality and HDI component in different HDI regions in 2018.

HDI	Incidence		Mortality		HDI Component				
	CR	ASR	CR	ASR	LEB	MYS	GNI	EYS	HDI
Very HDI	123.18	73.67	19.18	14.3	79.55	11.5	39613	16.2	0.876
High HDI	60.73	48.1	17.69	16.23	74.1	9.36	13419	13.71	0.746
Medium HDI	26.68	30.38	9.32	12.67	68.35	6.49	7802	11.68	0.629
Low HDI	19.88	29.96	9.28	15.98	59.71	4.36	3498	9.18	0.468
<i>p</i> -value (F-test)	<i>p</i> <0.001	<i>p</i> <0.001	<i>p</i> <0.001	<i>p</i> <0.01	<i>p</i> <0.001	<i>p</i> <0.001	<i>p</i> <0.001	<i>p</i> <0.001	---

**List of Abbreviations:** CR: Crude Rate; ASR, Age-Standardized Rates per 100,000; HDI, Human Development Index; LEB, Life Expectancy at Birth; MYS, Mean Years of Schooling; GNI, Gross National Income per capita, EYS: Expected years of schooling.

in the incidence of breast cancer among countries include the socioeconomic status, the ease of access to screening services, and the accuracy of recording cancer data that may vary from one country to another<sup>22</sup>. The highest incidence of breast cancer in the Asia-Pacific region occurs in countries which recently had a relatively low incidence<sup>22</sup>. The analysis of breast cancer data in China, Japan, the Philippines, Singapore, South Korea, Taiwan, and Thailand has shown that the incidence of the disease is increasing rapidly in these areas, and this increase was demonstrated in all age groups<sup>23</sup>. The main risk factors for breast cancer in Asian women include early menstruation, late menopause, and high age of labor and long-term pregnancies<sup>24</sup>. The mortality rate of breast cancer is lower than the incidence rate of it due to the increase in survival<sup>1</sup>. Early diagnosis of breast cancer is a major cause of the death toll

burden<sup>25</sup>. In developing and less-developed countries, about 75% of women with breast cancer are diagnosed in clinical stages of III and IV, while in North America due to early detection, the introduction of mammography screening, the detection of smaller tumors at an early stage and progress in treatment, about 80% of women are diagnosed in the early stages of the disease<sup>26</sup>. Therefore, the trend of breast cancer in different parts of the world is different, so that in several Asian countries, the death rate has risen and in Australia and New Zealand, the death rate has been decreasing<sup>27, 28</sup>. Lack of survival in developing countries is due to a shortage of diagnostic and therapeutic facilities<sup>15</sup>. In the UK and Switzerland breast cancer mortality rates have dropped by 30% from 1990 to 2006. But declines in the North, South, and West of Europe have been observed between 15% and 25%, and in Eastern Europe the decline

**TABLE 2.** Effect of HDI components of breast cancer incidence and mortality in world in 2018.

variable	Incidence			Mortality		
	B	CI 95%	<i>p</i> -value	B	CI 95%	<i>p</i> -value
HDI	20.3	(-62.8, 103.5)	0.6	-20.07	(-47.1, -7.01)	0.1
Gross national income per 1000 capita	-0.001	(-0.3,0.01)	0.05	-0.003	(-0.001,0.002)	0.2
Mean years of schooling	2.02	(0.1,3.9)	0.03	0.42	(-0.1, 1.05)	0.1
Life expectancy at birth	0.62	(-0.1,1.3)	0.09	-0.15	(-0.3, 0.08)	0.2
Expected years of schooling	0.21	(-1.9,2.3)	0.8	-1.1	(-1.8,-0.4)	0.002

has been low or remains constant<sup>29,30</sup>. Studies have shown that mortality rates have increased in Brazil, Egypt, Guatemala, and Kuwait, and Mexico. This undesirable process may be due to increased risk factors such as increased exposure to external hormones and undesirable changes in diet and lifestyle, including obesity and decreased physical activity<sup>31</sup>. Therefore, in less developed regions, the first step in reducing the mortality rate of women with breast cancer is to improve the women's awareness through community-based education programs and encourage them to screen, diagnose and treat the disease<sup>32</sup>. The major differences in the epidemiology of breast cancer in the Asian and Western countries can be observed in the difference in the prevalence of the disease and the age of breast cancer diagnosis, as in the Asian countries, the age of the diagnosis was reported between 50 and 45 years old. While in Western countries, the age range of 60-55 years is the highest age of diagnosis<sup>33,34</sup>. These differences can be due to differences in life expectancy in Western and Asian countries<sup>35</sup>. Therefore, although the incidence of cancer is more common at the age of 50, it may occur at any age<sup>36</sup>. Studies have shown that age-standardized rates of breast cancer in women have declined in most developed countries<sup>30</sup>. Based on the results of the regression model, our results showed that increasing the level of education increases the incidence and decline of mortality. Screening can help to diagnose the disease early. In countries with higher HDI levels, the prevalence of early detection and diagnosis of the disease is rising in the early stages of the disease. While screening can reduce mortality rates, developing countries have a strong knowledge of and willingness to become involved in screening and post-traumatic care.

## CONCLUSIONS

The incidence of breast cancer in developed countries is higher in less developed countries. Increasing the level of education in women can help to screen and diagnose the early-onset illness and reduce mortality. Therefore, educational programs, raising women's awareness about the cancer and its programs to address it, are among the health priorities. Preventive strategies by changing lifestyle, trying to increase screening, diagnosis and timely treatment of the disease can reduce the mortality from breast cancer.

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## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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