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BREAST CANCER OUTCOME IN AFRICA IS ASSOCIATED WITH SOCIOECONOMIC DEVELOPMENT AND HEALTH CARE SETUPS

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Abstract – *Background:* *The aim of this study is to investigate the correlation between socioeconomic status and breast cancer outcomes in African countries as well as to analyze the differences in breast cancer Mortality to Incidence Ratio (MIR) based on health care setups in each country.*

Material and Methods: *Standardised incidence and mortality data were obtained from GLOBOCAN (2012) database. Data on Health System Attainment (HSA) were obtained from World Health Report 2000. Data for National Human Development Index (HDI) were obtained from Human Development Report 2015. Pearson correlation and linear regression analysis were performed to investigate the effects of HDI and HSA on breast cancer MIR. SPSS version 20 were used for statistical analysis.* $p \leq 0.05$ *was considered significant.*

Results: *An inverse correlation was revealed by breast cancer MIR with both HDI ($r = -0.911$, $p < 0.001$) and HSA ($r = -0.765$, $p < 0.001$). One-way ANOVA demonstrated that high HDI countries has significantly low MIR as compared to medium and low HDI countries of Africa ($p < 0.001$). Linear regression analysis also reported a negative effect of MIR with both HDI (adjusted $R^2 = 0.827$, $\beta = -0.911$, $p < 0.001$) and HSA (adjusted $R^2 = 0.576$, $\beta = -0.765$, $p < 0.001$).*

Conclusions: *It is concluded that there are significant health care disparities among different African countries due to their different national HDIs. Economic development and improvement in health care setups in under developed countries are required to control their breast cancer burden.*

KEYWORDS: *Breast cancer, Human development index, Health System Attainment, Africa*

INTRODUCTION

Cancer is the leading cause of death worldwide[1]. The global burden of cancer is on rising in developed as well as in developing countries, and if appropriate preventive measures are not implemented, approximately 70% increase is expected within next couple of decades[2]. The lifestyle-related cancer types that were once considered the main cause of morbidity and mortality in developed countries are now diagnosing with a higher rate in developing countries[3].

Breast cancer is considered the most common health issue in women globally, with an estimated 1.7 million new cases and more than 0.25 million deaths in 2012[4]. Each year 1 out of 9 women are at the risk of developing breast cancer[5].

Change in lifestyle, demographic factors and socio-economic aspects of life have led to changes in the incidence of breast cancer in the developing countries[6].

A wide range of variations exists in the incidence rate of breast cancer, ranging from an age-standardized rate (ASR) of 27 in middle

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Africa and eastern Asia to ASR 96 in western European countries[7]. Although the breast cancer risk in some African countries (Malawi, and Rwanda, Mozambique) is less than 2%[8], still their mortality rate is high. Standardized mortality rate does not correspond to the incidence rate all over the world. Now a days a novel measurement (Mortality to incidence ratio) is commonly considered to assess whether a state has higher death rate than to be expected on the basis of its incidence rate[9].

Differences in the risk factors (lifestyle, hormonal, dietary, and reproductive), medical facilities, and health setups for breast cancer in different countries reflect the international variations in its incidence[10].

We aim to determine the correlation between breast cancer burden and socioeconomic development in African countries. Furthermore, we also analyzed the differences in mortality to incidence ratios on the basis of health care systems attained in each African country.

MATERIALS AND METHODS

Data Collection

Data for the breast cancer incidence and mortality in 53 African nations were obtained from GLOBOCAN 2012 database[7]. The methods used for collection of information and calculation of age-standardized incidence rate and age-standardized mortality rate are available on GLOBOCAN website[7]. To calculate MIR, the age-standardized mortality rate of breast cancer of a country is divided by the age-standardized incidence rate of breast cancer of the respective country.

Human development index (HDI) data of 53 African countries for 2015 are downloaded from the database of United Nations Development program[11]. HDI is a combined index of three parameters, i.e. life expectancy at birth, mean and expected years of schooling, and gross national income per capita. The index ranges from 0 to 1. It has four categories; low HDI < 0.536, medium HDI 0.536-0.711, high HDI 0.712-0.804, and very high HDI ≥ 0.805. The African countries are classified into three categories on the basis of HDI as no country has HDI ≥ 0.805[11].

Data for Health System Attainment (HSA) were obtained from World Health Report 2000[12]. HSA index is the weighted average of five indices, i.e. health level (25%), health distribution (25%) level of health care responsiveness (12.5%), distribution of health care responsiveness (12.5%), and fairness of financial contribution (25%). Its value ranges from 0 to 100[12]. A Higher index represents improved attainments in the national health system.

Statistical Analysis

Pearson correlation analysis was used for assessment of correlation between MIR and HDI and MIR and HSA. Linear regression analysis was used to investigate the average effect of HDI and HSA on breast cancer MIR. One-way ANOVA is performed for the assessment of statistical significance of variance in breast cancer MIRs among three different HDI countries[13]. Statistical analysis was performed with SPSS version 20 (SPSS Inc., Chicago, IL, USA). $p \leq 0.05$ was considered statistically significant.

RESULTS

Data for MIR and HDI were available for 53 (out of 54) African countries (Table 1). A significant inverse correlation was reported between MIR and HDI ($r = -0.911$; $p < 0.001$) by Pearson correlation. Similarly, linear regression analysis also confirmed a negative effect of HDI on breast cancer MIR (adjusted $R^2 = 0.827$, $\beta = -0.911$, $p < 0.001$) (Figure 1A).

On the basis of National HDI, these 53 countries are categorized into three groups i.e. 5 countries in high HDI group, 11 in medium and 37 in low HDI group. One-way ANOVA reported significantly different MIRs from countries in different HDI group. High HDI African countries showed MIR = 0.308 ± 0.066 (mean ± standard deviation) which represents significant lower value than that of the countries with medium HDI (0.428 ± 0.048) and low HDI (0.536 ± 0.039) ($p < 0.001$) (Table 2).

Figure 2 A showed the association between age-standardized incidence rate of breast cancer and age-standardized rate of breast cancer mortality in African countries of various HDI groups. Incremental regression coefficients are reported by linear regression analysis from low HDI nations to higher ones. Anyway, with a low incidence rate, the low HDI countries reflect the highest MIR (Figure 2B).

Similarly, in these African countries, the HSA was negatively correlated with MIR ($r = -0.765$, $p < 0.001$). The linear regression analysis also confirmed a significant negative relation between MIR and HSA (Figure 1B) (adjusted $R^2 = 0.576$, $\beta = -0.765$, $p < 0.001$).

TABLE 1. Breast cancer incidence, mortality, mortality to incidence ratio, National HDI, and health system attainment by African countries.

HDI Category	Countries	Incidence	Mortality	Mortality to Incidence Ratio	HDI-2015	Health System Attainment
High HDI	Mauritius	64.20	18.80	0.29	0.777	76.20
	Seychelles	46.60	09.50	0.20	0.770	91.90
	Algeria	48.50	17.50	0.36	0.736	74.40
	Libya	24.10	08.40	0.35	0.724	75.30
	Tunisia	31.80	10.80	0.34	0.721	77.50
Medium HDI Countries	Botswana	19.90	07.90	0.40	0.698	57.40
	Egypt	49.50	19.20	0.39	0.690	73.50
	Gabon	16.10	05.80	0.36	0.684	64.50
	South Africa Republic	41.50	16.50	0.40	0.666	61.00
	Cape Verde	25.10	10.10	0.40	0.646	68.30
	Morocco	40.80	18.00	0.44	0.628	75.70
	Namibia	24.40	09.60	0.39	0.628	58.80
	Congo, Republic	31.70	14.50	0.46	0.591	60.10
	Equatorial Guinea	25.20	12.80	0.51	0.587	60.20
	Zambia	22.40	11.10	0.50	0.586	55.60
	Ghana	25.60	11.70	0.46	0.579	65.80
Low HDI Countries	Kenya	38.30	17.30	0.45	0.548	64.30
	Angola	23.50	11.70	0.50	0.532	52.40
	Swaziland	10.50	05.00	0.48	0.531	59.00
	Tanzania	19.40	09.70	0.50	0.521	60.00
	Nigeria	50.40	25.90	0.51	0.514	51.70
	Cameroon	35.20	17.60	0.50	0.512	59.10
	Madagascar	26.60	13.40	0.50	0.510	57.80
	Zimbabwe	28.50	14.00	0.49	0.509	62.30
	Mauritania	25.80	13.50	0.52	0.506	57.20
	Comoros	17.40	09.80	0.56	0.503	66.40
	Lesotho	09.00	04.40	0.49	0.497	56.00
	Togo	27.20	14.30	0.53	0.484	60.00
	Rwanda	15.90	08.10	0.51	0.483	56.50
	Uganda	27.50	13.60	0.49	0.483	59.30
	Benin	30.20	16.00	0.53	0.480	64.20
	Sudan	27.80	15.20	0.55	0.479	62.30
	Djibouti	35.90	19.00	0.53	0.470	56.80
	South Sudan	31.80	17.20	0.54	0.467	--
	Senegal	22.40	11.70	0.52	0.466	70.50
	Cote d I	33.70	18.50	0.55	0.460	60.00
	Malawi	16.80	08.80	0.52	0.445	52.30
	Ethiopia	41.80	23.00	0.55	0.442	50.50
	The Gambia	09.80	5.00	0.51	0.440	60.20
	Congo, Democratic	23.50	14.20	0.60	0.433	60.10
	Liberia	25.10	14.20	0.57	0.430	50.40
	Guinea-Bissau	26.00	14.30	0.55	0.420	52.40
	Mali	29.80	16.50	0.55	0.419	53.30
	Mozambique	14.50	07.90	0.54	0.416	50.60
	Sierra Leone	24.30	14.70	0.60	0.413	35.70
	Guinea	14.50	07.90	0.54	0.411	56.30
	Burkina	22.70	14.00	0.62	0.402	59.40
	Burundi	23.50	13.90	0.59	0.400	59.30
	Chad	34.10	19.90	0.58	0.392	53.60
	Eritrea	35.90	20.50	0.57	0.391	53.70
	Central	31.40	17.80	0.57	0.350	45.90
	Niger	23.80	14.50	0.61	0.348	50.10
	Somalia	40.60	20.60	0.51	0.285	49.40

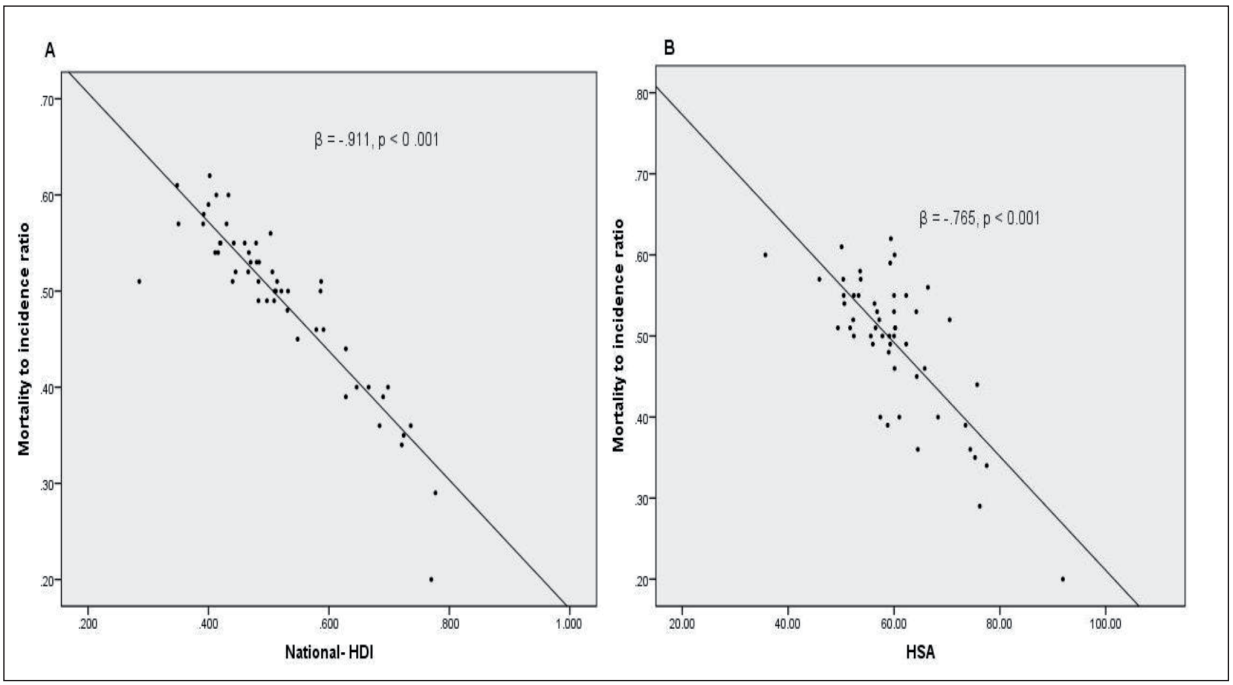

Fig. 1. The coefficients of linear regression analysis between *(A)* (HDI) and *(B)* HSA of breast cancer MIR).

DISCUSSION

In this retrospective investigation, we analyzed breast cancer incidence and mortality, reported by GLOBOCAN database in African countries. The study proved an inverse relation of MIR with both HDI and HSA in African countries. African countries with high HDI have lower MIR. Likewise, the inverse relation of MIR and Health system attainment indicated that improves HSA are warranted for better outcomes of breast cancer in these countries.

The national HDI and HSA are strongly correlated with each other (r = 0.759, $p < 0.001$). Our

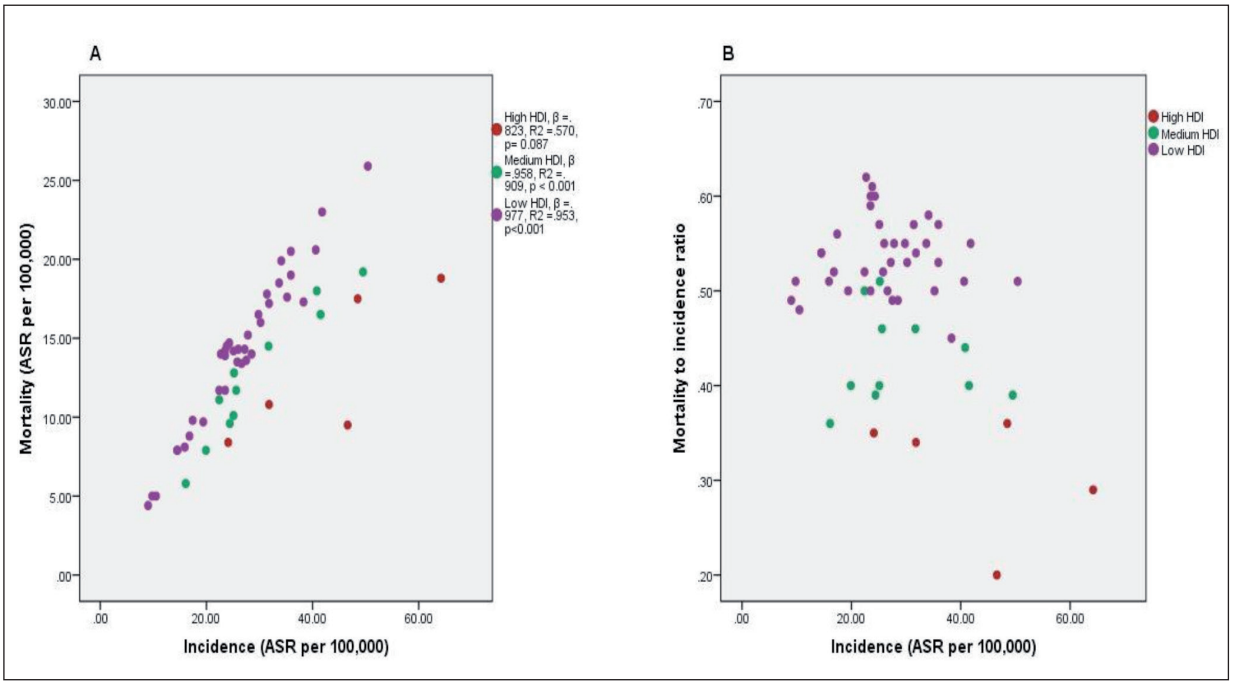

Fig. 2. The relationship between age-standardized rate (ASR) of breast cancer incidence and *(A)* age-standardized rate of breast cancer mortality and *(B)* MIR of African countries in three HDI groups.

TABLE 2. Differences in MIR with respect to National-HDI category.

HDI	*N*	*Mean ± standard deviation*
High HDI	05	0.308 ± 0.066
Medium HDI	11	0.428± 0.048
Low HDI	37	0.536 ± 0.039

Tukey's post hoc $p < 0.001$

results are in concordance with the previous study that was conducted for all countries of the world[14]. This confirms that countries with high HDI spend a high percentage of their income on health facilities and health education than countries with lower HDI. As with better health infrastructure, the mortality from a specific disease decreases. Early diagnosis by mammographic screening and improved cancer therapies has decreased the rate of mortality from breast cancer in various European countries[15].

In African countries, there are logistical and socioeconomic issues that are a hurdle in the way of cancer eradication. A study from south Africa has indicated that women living a long distance from health care centers have a greater chance of being diagnosed with advanced stage of breast cancer[16]. Furthermore, the cost associated with cancer care such as pathology, surgeries, and chemotherapy is not included in insurance, therefore is not affordable by the population in the low HDI countries, and usually this inability to afford the cost of treatment is the principal contributor to the effected women not completing their treatment programs[17].

In most African countries, there are limited facilities for diagnosis and treatment of breast cancer. The scarcity of mammographic facilities is a big problem for breast screening in young women who have mostly dense breast[18]. Although, a cost-effectiveness investigation in Ghana about the breast cancer interventions showed that clinical breast examination in combination with a treatment at all stages was more cost-effective than mammography screening for women aged 40-69 years[19]. In the previous decade, more radiotherapy units were installed but their quantity just meets 18% of the required number[20]. Some African countries have only one machine for radiotherapy and some other having none[21], and often with no chemotherapeutic agents[17].

Also, disparities in the prevalence of the various molecular types of breast cancer, and in survival in different nations also effect the MIR differently. Studies have shown that African American women had the poorest prognosis in the United States compared with other ethnicities[22].

CONCLUSIONS

Our study revealed that African countries with better socioeconomic status such as those with high HDIs are tended to have low MIRs although having a higher incidence rate of breast cancer. The middle and low HDI countries have the worst mortality and MIR due to the poor health resources. Therefore, more attention should be given to breast cancer in women in underdeveloped countries. Economic development and implementation of better health infrastructures for early detection and treatment of female breast cancer in these countries are required to cope with the situation.

Conflict of interests

The Authors declare that they have no conflict of interests.

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