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GLOBAL INCIDENCE AND MORTALITY OF SKIN CANCER BY HISTOLOGICAL SUBTYPE AND ITS RELATIONSHIP WITH THE HUMAN DEVELOPMENT INDEX (HDI); AN ECOLOGY STUDY IN 2018

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Abstract – *Objective:* *Skin cancer is one of the most common cancers in the world, ranking first in men and second in women. The aim of this study was to determine the incidence and prevalence of skin cancer and its association with the Human Development Index (HDI) in the world.*

Materials and Methods: *The present study is a descriptive-analytic study based on extraction of cancer incidence data and cancer mortality rates from the World Bank for Cancer in 2018. The incidence and mortality rates and skin cancer distribution maps were drawn for world 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: *Countries with the highest incidence of melanoma and non-melanoma cancer were Australia and New Zealand. The results of the study showed a positive and significant correlation between the incidence (R = 0.572,* p*<0.0001) and mortality (R=0.413,* p*<0.0001) of melanoma cancer with HDI index. Further, in non-melanoma cancer, there was a positive and significant correlation between incidence and HDI index (R=0.731,* p*<0.0001), while there was a negative correlation between non-melanoma and HDI (R=-0.437,* p*<0.0001); the linear regression model showed that increase in MYS, EYS and GNI caused to increases the incidence of melanoma and non-melanoma cancer. While increasing HDI leads to a decrease in mortality (R=4.5,* p*<0.05).*

Conclusions: *The incidence and mortality of skin cancer (melanoma and non-melanoma) are related to the development index (HDI). By increasing the HDI, the mortality rate of this cancer type decreases, so paying attention to the HDI in countries and increasing the education level of people to receive treatment can be effective in reducing the mortality rate of the patient.*

KEYWORDS: *Incidence, Mortality, Melanoma, Non-Melanoma, HDI.*

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INTRODUCTION

Skin cancer is one of the most common cancers in the world. The incidence of skin cancer has been increasing in recent decades, and since most of these cancers are caused by repeated exposure to sunlight, climate change, including changes in the thickness of the protective layer of ozone together with changes in individual and social habits, can justify this increase. Skin cancer is classified into two subtypes of Melanoma: Skin Cancer (MSC) and Non-Melanoma Skin Cancer (NMSC)[1].

NON-MELANOMA SKIN CANCER

Non-melanoma cancer is divided into two types of basal cell carcinoma (BCC) and squamous cell carcinoma (SCC)[2]. This type of cancer usually has a worse prognosis. Both of these types of cancer originate from epidermal cells and have common epidemiological and carcinogenic features. The incidence of non-melanoma cancers in white people is higher than blacks and others. Basal cell carcinoma accounts for 80% of non-melanoma skin cancers. Exposure to UV rays is the most important risk factor for BCC outspread[3].

MELANOMA CANCER

Malignant melanoma accounts for 1% of skin tumors and causes of 60% mortality due to skin cancers. Over the past four decades, the incidence of melanoma has increased throughout the world and is currently the highest incidence in Australia, with 40 new cases per 100000 population per year[4]. The incidence of melanoma in men is higher than women. In the United States, this type of cancer is 15 times more common in whites than blacks. The disease is observed in people with a better socioeconomic status, but in groups with low economic status, the mortality rate is higher[5]. The most important risk factor for malignant melanoma is the presence of etiologic melanocytic macules with a history of malignant melanoma family history. Family history increases the risk of the disease by 2 to 8 times. Environmental studies have shown that the incidence of melanoma worldwide is related to geographic and height changes. And in low latitudes, near the equator and higher altitudes, the incidence of melanoma is higher[6]. In the United States, melanoma was the fifth most common cancer in men and the seventh most common cancer among women in 2015. The US Academy of Dermatology has reported that melanoma is prevalent in Australia and New Zealand, but it is also common in Asia, Africa and Latin America. In the United States, Europe and Australia, 25, 20 and 45% of reported cancers in one year are skin cancers, respectively[7,8]. Various studies have shown that the most important risk factors for skin cancer are personal, genetic and environmental factors. Effective personal and genetic factors, such as skin color, eye color, hair color, age, and poor body immunity. Environmental factors include ultraviolet radiation, life in low geographic latitudes, high alcohol consumption, consuming fatty foods, long-term outdoor activities in outdoor (Work in open spaces and front of the sun), and type of coverage. One of the important factors associated with the incidence of cancer is the Human Development Index (HDI), which indicates the social and economic status of people in different countries[9, 10]. HDI is one of the world-wide approved indicators that illustrate the economic and social well-being of the community under study. This indicator is a set of three dimensions of health, education and income and shows quality of life[11]. Skin cancer is one of the most common cancers, but it is also one of the most preventable cancers. With the knowledge of epidemiological factors and individual and environmental risk factors, the incidence of this disease can be prevented. Therefore, the purpose of this study was to determine the incidence and prevalence of skin cancers and its association with the HDI in the world.

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 inform cancer control through defined improvements in the coverage, quality, and use of population-based cancer registration data worldwide. A summary of the steps used to generate the current set of cancer incidence, mortality, and prevalence estimates is provided below.

The methods of estimation are country-specific, and the quality of the national estimates depends on the coverage, accuracy, and timeliness of the recorded incidence and mortality data in a given country.

INCIDENCE

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

1. Observed national incidence rates were projected to 2018 (45 countries).
2. The most recently observed incidence rates (national or regional) were applied to the 2018 population (50 countries).
3. Rates were estimated from national mortality data by modeling, using mortality-to-incidence ratios derived from cancer registries in that country (14 countries).
4. Rates were estimated from national mortality estimates by modeling, using mortality-to-incidence ratios derived from cancer registries in neighboring countries (37 countries).
5. Age- and sex-specific national incidence rates for all cancers combined were obtained by averaging overall rates from neighboring countries. These rates were then partitioned to obtain the national incidence for specific sites using 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)[12, 13].

HDI

HDI is a compound index of indices in three dimensions: life expectancy, degree of studies, and dominance over required sources for a proper sensible life. All the groups and regions, which have had a remarkable progress in all HDI components, have developed more rapidly in comparison with low or moderate HDI countries. As this index says, the world is unequal because national average hides most of the different experiences in human's life. There exit a lot of inequalities in Northern and Southern countries. Income inequality has risen inside every country and also between many countries[11, 14, 15].

RESULTS

Based on the results of cancer recordings in 2018, 18078957 (197.9 per 100000) have been reported in both genders, of which 9456418 (218.6 per 100000) in men and 8622539 cases (182.6 per 100000) in women. The number of deaths due to cancer in 2018 was 9555027 (101/1 per 100000), which was estimated to be 5385640 men (122.7 per 100000) and for women 4169387 (83.1 per 100000). The results showed that non-melanoma cancer with 1042056 (6.08 per 100000) cancer ranked fifth in the world's most prevalent cancers, and melanoma of skin cancer with 287723 cases (1.68 in 100000) is the 21st cancer among the 36 cancer in the world. In terms of mortality, non-melanoma cancer causes 65155 (0.73 per 100000) deaths and melanoma cancer is the causes of 60712 deaths of cancers in the world. Table 1 shows the distribution of incidence and mortality of skin cancer in the context of melanoma and non-melanoma. As is shown, the highest incidence of melanoma cancers is related to Australia (33.6 per 100000) and New Zealand (33.3 per 100000), and non-melanoma cancers is related to Australia (147.5 per 100000) and New Zealand (138.4 per 100000) (Figure 1). The highest mortality rate for melanoma was related to New Zealand (4.4 per 100000) and Norway (3.5 per 100000), and in non-melanoma cancers was related to the cases of Papua New Guinea (7.2 per 100000) and Namibia (6.2 per 100000) (Figure 2).

According to the cancer record in 2018, the highest incidence (28.3 per 100000) and mortality (3 per 100000) of melanoma cancer were related to Oceania. Non-melanoma cancer also has the highest incidence (56.2% in 100000) and mortality (1 in 100000) in the Oceania continent (Figure 3).

According to the cancer record in 2018, the highest incidence of melanoma (239719 cases, equivalent 83.3%) and non-melanoma (879605 cases, equivalent 84.4%) is related to countries with very high HDI (Figure 4).

The results of the study showed a positive and significant correlation between the incidence ($R=0.572$, $p<0.0001$) and mortality ($R=0.413$, $p<0.0001$) of melanoma cancer with HDI index. In non-melanoma cancer, there was a positive and significant correlation between incidence and HDI index ($R=0.731$, $p<0.0001$), while there was a negative and significant correlation between non-melanoma and HDI ($R=-0.437$, $p<0.0001$) (Figure 5-6).

TABLE 1. Estimated age-standardized incidence and mortality rates skin cancer, all ages in World in 2018.

Countries	Melanoma of skin cancer						Non-melanoma skin cancer						HDI
	Incidence (ASR)			Mortality (ASR)			Incidence (ASR)			Mortality (ASR)			
	M	F	Total	M	F	Total	M	F	Total	M	F	Total	
Afghanistan	0.3	0.3	0.3	0.2	0.2	0.2	1.4	1.3	1.4	0.7	0.5	0.6	0.479
Albania	1.7	1.6	1.7	0.6	0.4	0.5	6.7	3.1	4.8	1.0	0.4	0.6	0.764
Algeria	0.7	0.6	0.7	0.5	0.3	0.4	3.5	2.4	2.9	1.6	0.8	1.2	0.745
Angola	1.7	1.6	1.7	1.2	1.1	1.1	5.2	2.8	3.9	4.6	1.5	2.8	0.533
Argentina	3.8	2.2	2.9	1.4	0.6	0.9	7.9	4.2	5.7	0.9	0.3	0.5	0.827
Armenia	1.4	1.8	1.6	0.5	0.4	0.4	2.8	2.9	2.9	1.2	0.9	1.0	0.743
Australia	40.4	27.5	33.6	4.3	2.2	3.2	233.8	64.7	147.5	2.0	0.5	1.2	0.939
Austria	15.0	12.6	13.6	2.2	1.2	1.6	17.3	8.8	12.7	0.6	0.2	0.4	0.893
Azerbaijan	0.7	0.4	0.5	0.3	0.1	0.2	2.9	1.9	2.3	1.3	0.7	0.9	0.759
Bahamas	1.7	1.1	1.4	0.4	0	0.2	8.8	2.9	5.7	0	0	0	0.792
Bahrain	0.2	0	0.1	0.2	0	0.1	0	0	0	0	0	0	0.824
Bangladesh	0.4	0.3	0.3	0.3	0.2	0.2	0.9	0.6	0.7	0.5	0.2	0.4	0.579
Barbados	1.1	0.3	0.7	0	0	0	8.2	2.8	5.5	0	0.2	0.1	0.795
Belarus	5.5	5.7	5.5	2.1	1.3	1.7	6.9	5.3	5.8	0	0	0	0.796
Belgium	16.2	23.9	19.9	2.0	1.8	1.9	28.9	19.2	23.3	0.5	0.2	0.3	0.896
Belize	4.1	1.8	3.0	0	0	0	12.4	8.1	10.2	0	0	0	0.706
Benin	0.6	0.2	0.3	0.4	0.1	0.2	2.7	1.8	2.1	2.1	1.1	1.5	0.485
Bhutan	1.2	0.2	0.8	1.2	0.2	0.8	0.9	0.3	0.6	0.9	0.3	0.6	0.607
Bolivia, Plurinational State of	2.0	3.3	2.7	0.7	0.9	0.8	4.0	3.0	3.5	0.8	0.6	0.7	0.674
Bosnia and Herzegovina	3.7	4.2	3.9	1.6	1.0	1.3	4.8	5.1	5.0	0.7	0.6	0.7	0.75
Botswana	1.7	2.0	1.8	0.8	1.3	1.1	5.7	2.9	4.1	4.6	1.2	2.6	0.698
Brazil	2.9	2.8	2.8	1.0	0.6	0.8	14.5	9.1	11.4	1.2	0.6	0.8	0.754
Brunei	1.3	0	0.6	1.3	0	0.6	4.5	3.6	4.0	0	0	0	0.865
Bulgaria	4.5	3.6	4.0	1.7	1.0	1.3	11.0	5.8	8.0	0.9	0.5	0.6	0.794
Burkina Faso	0.5	1.2	0.9	0.4	1.0	0.8	2.8	2.5	2.6	2.3	1.6	1.9	0.402
Burundi	1.0	1.5	1.3	0.9	1.3	1.1	2.9	1.9	2.4	2.2	1.1	1.6	0.404
Cabo Verde	0.0	2.4	1.4	0	1.2	0.7	0	0	0	0	0	0	0.648
Cambodia	0.4	0.4	0.4	0.3	0.3	0.3	2.3	1.5	1.8	1.5	0.8	1.1	0.563
Cameroon	1.1	1.1	1.1	0.7	0.7	1.7	2.0	1.7	1.8	1.2	0.8	1.0	0.518
Canada	13.4	11.7	12.4	2.3	1.0	1.6	62.3	36.8	48.5	0.9	0.3	0.5	0.92
Central African Republic	1.1	1.1	1.1	1.1	1.0	1.1	1.5	1.2	1.4	1.1	0.9	1.0	0.352
Chad	0.6	0.8	0.7	0.5	0.7	0.6	2.5	2.2	2.4	1.9	1.2	1.5	0.396
Chile	2.7	2.4	2.5	1.0	0.6	0.8	9.8	5.3	7.3	1.2	0.4	0.7	0.847
China	0.4	0.3	0.4	0.2	0.1	0.2	1.1	0.9	1.0	0.5	0.4	0.5	0.738
Colombia	3.4	3.2	3.3	1.1	0.7	0.9	9.6	6.2	7.7	1.2	0.5	0.8	0.727
Comoros	0.0	1.0	0.5	0	1.0	0.5	3.4	3.9	3.7	2.2	2.3	2.3	0.497
Congo, Democratic Republic of	1.3	1.4	1.4	1.1	1.1	1.1	1.3	1.1	1.1	1.1	0.5	0.8	0.435

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TABLE 1. Estimated age-standardized incidence and mortality rates skin cancer, all ages in World in 2018.

Countries	Melanoma of skin cancer						Non-melanoma skin cancer						HDI
	Incidence (ASR)			Mortality (ASR)			Incidence (ASR)			Mortality (ASR)			
	M	F	Total	M	F	Total	M	F	Total	M	F	Total	
Congo, Republic of	1.6	1.7	1.6	1.0	1.0	1.0	1.0	0.5	0.7	0.9	0.3	0.6	
Costa Rica	2.1	2.2	2.2	1.1	0.4	0.8	20.5	16.1	18.2	1.0	0.5	0.8	0.776
Croatia	9.3	7.0	8.0	3.1	1.7	2.3	9.9	5.0	6.7	1.3	0.6	0.9	0.827
Cuba	1.6	1.2	1.4	0.5	0.3	0.4	17.3	12.7	14.9	1.8	0.9	1.3	0.775
Cyprus	5.1	4.1	4.5	2.2	0.9	1.5	10.7	7.2	8.7	0.7	0.3	0.5	0.856
Czech Republic	13.3	12.4	12.6	2.2	1.2	1.7	17.5	9.2	12.6	0.7	0.3	0.5	0.878
Côte d'Ivoire	0.3	0.5	0.4	0.3	0.4	0.3	1.2	1.7	1.4	1.0	0.9	1.0	0.474
Denmark	22.4	33.1	27.6	2.8	2.1	2.4	21.2	13.4	16.8	0.6	0.2	0.4	0.925
Djibouti	0.0	0	0	0	0	0	2.3	2.3	2.3	1.9	1.5	1.7	0.473
Dominican Republic	0.4	0.5	0.4	0.2	0.2	0.2	1.7	1.0	1.4	1.8	0.9	1.3	0.726
Ecuador	2.1	2.2	2.2	0.7	0.5	0.3	5.5	4.5	4.9	0.9	0.8	0.9	0.739
Egypt	0.3	0.3	0.3	0.2	0.1	0.1	1.8	1.4	1.6	1.4	1.0	1.2	0.691
El Salvador	0.1	0.1	0.1	0	0.0	0	1.4	1.5	1.4	0.8	0.6	0.6	0.68
Equatorial Guinea	1.6	11.4	1.2	1.5	0.8	1.1	2.5	3.0	2.7	2.0	1.7	1.9	0.592
Eritrea	0.4	0.1	0.2	0.4	0.1	0.2	1.6	2.5	2.1	1.2	1.3	1.2	0.42
Estonia	9.1	11.4	10.1	2.4	1.3	1.7	5.1	3.1	3.6	0.7	0.5	0.5	0.865
Ethiopia	0.4	0.1	0.2	0.3	0.1	0.2	1.6	3.4	2.6	1.2	1.7	1.5	0.448
Fiji	0.3	1.3	0.9	0	0	0	1.3	1.0	1.1	0	0.4	0.2	0.736
Finland	16.2	15.9	15.8	2.9	1.1	1.9	13.4	7.7	10.2	0.3	0.1	0.2	0.895
France	14.4	12.9	13.6	2.1	1.2	1.6	29.8	14.1	21.1	0.5	0.3	0.2	0.897
France, Guadeloupe	2.2	0.8	1.5	0.2	0.1	0.1	11.8	7.9	9.7	0.1	0	0.4	
France, La Réunion	3.8	2.9	3.3	0.8	0.1	0.5	0.3	0.1	0.2	0	0.1	0	
France, Martinique	2.5	1.5	2.0	0.3	0	0.1	11.9	8.2	9.9	0	0.1	0.1	
France, New Caledonia	8.1	6.6	7.3	1.6	0	0.7	9.4	5.9	7.6	0.6	0.3	0	
French Guyana	3.4	4.0	3.7	0	0	0	12.2	7.0	9.6	0	0	0.4	
French Polynesia	5.8	7.3	6.5	0	0	0	0	0	0	0	0	0	
Gabon	1.6	1.4	1.5	1.0	1.0	1.0	3.0	3.2	3.0	2.6	1.1	1.8	0.697
The Gambia	0.0	0	0	0	0	0	0	0	0	0	0	0	
Gaza Strip and West Bank	0.8	0.8	0.8	0.6	0.5	0.6	3.3	1.6	2.3	2.1	1.0	1.4	
Georgia	4.0	2.0	3.0	1.2	0.6	0.9	3.3	1.9	2.5	1.3	0.6	0.9	0.769
Germany	19.6	24.0	21.6	2.1	1.3	1.6	36.9	20.4	27.5	0.4	0.2	0.3	0.926
Ghana	0.7	0.5	0.5	0.6	0.3	0.4	1.6	0.9	1.2	1.4	0.5	0.9	0.579
Greece	7.2	10.3	8.7	1.5	1.1	1.3	9.6	4.6	6.8	0.6	0.2	0.4	0.866
Guam	0.0	0	0	0	0	0	0	0	0	0	0	0	
Guatemala	0.7	0.8	0.8	0.3	0.2	0.2	2.6	3.3	3.0	1.3	1.1	1.2	0.64
Guinea	0.3	1.1	0.7	0.2	1.0	0.6	3.1	2.4	2.7	2.6	1.6	2.0	0.414
Guinea-Bissau	0.0	0.6	0.3	0	0.6	0.3	2.6	2.5	2.5	1.9	1.3	1.6	0.424
Guyana	0.0	0	0	0	0	0	0.2	0	0.1	0	0	0	0.638
Haiti	0.5	0.3	0.4	0.2	0.1	0.2	0.7	2.3	1.5	0.6	0.5	0.5	0.493
Honduras	0.7	1.0	0.9	0.3	0.3	0.3	1.8	1.2	1.5	0.9	0.4	0.6	0.625

Continued

TABLE 1 (CONTINUED). Estimated age-standardized incidence and mortality rates skin cancer, all ages in World in 2018.

Countries	Melanoma of skin cancer						Non-melanoma skin cancer						HDI
	Incidence (ASR)			Mortality (ASR)			Incidence (ASR)			Mortality (ASR)			
	M	F	Total	M	F	Total	M	F	Total	M	F	Total	
Hungary	10.3	10.1	10.1	2.0	1.5	1.7	19.2	11.6	14.7	1.0	0.5	0.7	0.836
Iceland	8.5	11.7	10.1	1.7	1.2	1.5	13.3	11.5	12.3	0	0	0	0.921
India	0.2	0.3	0.2	0.2	0.1	0.2	0.9	0.7	0.8	0.5	0.3	0.4	0.624
Indonesia	0.7	0.5	0.6	0.4	0.3	0.3	2.9	2.2	2.5	1.3	0.9	1.1	0.689
Iran, Islamic Republic of	0.7	0.6	0.6	0.3	0.1	0.2	5.5	2.4	4.0	0.5	0.3	0.4	0.774
Iraq	0.4	0.4	0.4	0.2	0.1	0.2	5.0	3.3	4.0	2.2	0.9	1.5	0.649
Ireland	13.6	19.0	16.3	2.3	1.5	1.9	60.2	28.6	43.4	1.2	0.4	0.7	0.923
Israel	9.5	7.2	8.3	2.7	1.1	1.8	1.4	0.8	1.1	1.2	0.6	0.9	0.899
Italy	14.0	11.0	12.4	2.1	1.1	1.6	19.2	9.1	13.6	0.6	0.2	0.4	0.887
Jamaica	0.2	0.2	0.2	0.1	0.1	0.1	2.5	1.5	2.0	0.1	0.1	0.1	0.73
Japan	0.6	0.6	0.6	0.2	0.2	0.2	2.1	1.2	1.6	0.2	0.2	0.2	0.903
Jordan	0.3	0.4	0.4	0.3	0.2	0.3	0.5	0.6	0.6	0.3	0.3	0.3	0.741
Kazakhstan	1.3	1.2	1.2	0.8	0.6	0.7	7.4	6.0	6.5	1.0	0.5	0.7	0.794
Kenya	0.6	1.9	1.3	0.4	1.2	0.8	2.5	3.6	3.1	2.1	1.8	1.9	0.555
Korea, Democratic Republic of	0.3	0.3	0.3	0.1	0.1	0.1	0.9	0.8	0.8	0.3	0.3	0.3	
Korea, Republic of	0.7	0.7	0.7	0.1	0.3	0.3	2.4	2.4	2.4	0.2	0.2	0.2	0.901
Kuwait	0.4	0.3	0.3	0.4	0.3	0.3	0.9	0.5	0.8	0.7	0.5	0.6	0.8
Kyrgyzstan	0.6	0.8	0.7	0.6	0.5	0.5	4.0	4.4	4.4	0.8	0.6	0.7	0.664
Lao People's Democratic Republic	0.4	0.3	0.4	0.3	0.3	0.3	2.3	1.9	2.1	1.1	0.8	0.9	0.586
Latvia	6.2	5.4	5.6	2.0	1.5	1.7	6.6	4.0	4.8	1.4	0.6	0.9	0.83
Lebanon	2.1	1.5	1.8	0.8	0.6	0.7	8.8	4.4	6.6	4.4	1.6	2.9	0.763
Lesotho	1.6	2.1	1.8	1.3	1.5	1.4	3.7	2.0	2.6	3.0	0.9	1.7	0.497
Liberia	0.3	0.7	0.5	0.3	0.6	0.5	2.2	2.0	2.1	1.8	1.3	1.5	0.427
Libya	0.3	0.4	0.3	0.1	0.2	0.1	1.7	0.8	1.2	0.4	0.2	0.3	0.716
Lithuania	8.8	9.0	8.8	2.1	1.2	1.6	8.1	4.6	5.8	0.7	0.3	0.5	0.848
Luxembourg	18.1	15.4	16.5	2.1	1.1	1.6	28.8	20.3	23.9	0.2	0.1	0.1	0.898
Madagascar	1.4	1.6	1.5	1.0	1.1	1.1	3.7	4.1	3.9	2.4	1.9	2.2	0.512
Malawi	2.4	2.4	2.5	1.8	1.9	1.9	3.6	3.2	3.4	2.8	1.5	2.1	0.476
Malaysia	0.3	0.3	0.3	0.1	0.1	0.1	1.8	1.2	1.5	0.8	0.5	0.6	0.789
Maldives	0.0	0	0	0	0	0	2.2	0	1.1	0	0	0	0.701
Mali	0.8	1.0	0.9	0.6	0.8	0.7	2.6	2.7	2.7	2.1	1.5	1.8	0.442
Malta	7.6	8.5	8.0	1.4	0.9	1.1	11.1	3.5	6.7	0.3	0	0.1	0.856
Mauritania	0.3	9.0	0.6	0.3	0.8	0.6	2.7	2.3	2.5	2.1	1.2	1.6	0.513
Mauritius	0.4	0	0.2	0	0	0	1.1	0.8	0.9	0.4	0	0.1	0.781
Mexico	2.1	2.3	2.2	0.6	0.4	0.5	6.7	5.0	5.8	0.9	0.6	0.7	0.762
Mongolia	0.2	0.4	0.4	0.3	0.5	0.4	1.3	2.1	1.8	0.1	0.3	0.2	0.735
Montenegro	2.6	2.3	2.6	0.9	0.8	0.9	8.2	5.6	6.7	0.1	0.1	0.1	0.807
Morocco	0.6	0.6	0.6	0.4	0.4	0.4	2.5	1.3	1.9	1.2	0.6	0.8	0.647
Mozambique	1.5	1.3	1.4	1.1	1.0	1.0	4.3	5.6	5.0	3.0	2.7	2.8	0.418
Myanmar	0.3	0.2	0.2	0.2	0.1	0.2	3.8	3.0	3.3	2.2	1.5	1.8	0.556
Namibia	3.5	2.3	2.8	2.0	1.3	1.6	13.1	6.3	9.0	11.2	2.9	6.2	0.64
Nepal	0.5	1.5	1.0	0.4	0.9	0.7	2.2	1.8	2.0	1.3	0.7	1.0	0.558
New Zealand	35.8	31.1	33.3	7.2	2.8	4.8	205.1	77.0	138.4	1.8	0.7	1.2	0.915
Nicaragua	0.7	0.4	0.5	0.4	0.2	0.3	5.8	2.1	3.7	1.0	0.4	0.7	0.645
Niger	0.5	0.9	0.7	0.4	0.8	0.6	3.2	3.5	3.3	2.6	2.1	2.3	0.353

Continued

TABLE 1 (CONTINUED). Estimated age-standardized incidence and mortality rates skin cancer, all ages in World in 2018.

Countries	Melanoma of skin cancer						Non-melanoma skin cancer						HDI
	Incidence (ASR)			Mortality (ASR)			Incidence (ASR)			Mortality (ASR)			
	M	F	Total	M	F	Total	M	F	Total	M	F	Total	
Nigeria	0.5	0.7	0.6	0.4	0.5	0.4	3.1	1.8	2.5	2.3	0.9	1.6	0.527
Norway	29.0	30.7	29.6	4.2	2.8	3.5	17.4	13.5	15.2	0.5	0.2	0.3	0.949
Oman	0.6	0.5	0.5	0.5	0.4	0.4	1.8	1.4	1.6	0.4	0.3	0.3	0.796
Pakistan	0.3	0.2	0.3	0.2	0.2	0.2	2.1	1.7	1.9	1.1	0.6	0.8	0.55
Panama	1.2	1.0	1.1	0.4	0.2	0.3	12.0	8.3	10.1	0.4	0.3	0.3	0.788
Papua New Guinea	3.3	3.8	3.6	1.0	0.7	0.8	15.0	12.0	13.3	9.5	5.5	7.2	0.516
Paraguay	2.8	1.1	2.0	1.0	0.3	0.7	7.4	4.9	6.1	1.0	0.8	0.9	0.693
Peru	3.0	2.5	2.7	1.2	0.8	1.0	8.0	5.3	6.5	1.3	0.6	0.9	0.74
Philippines	0.5	0.4	0.4	0.3	0.2	0.3	1.4	0.8	1.0	0.5	0.3	0.4	0.682
Poland	5.9	4.7	5.3	2.7	1.6	2.1	5.6	3.5	4.3	4.4	1.8	2.8	0.855
Portugal	7.2	6.3	6.7	1.7	1.1	1.4	9.0	5.7	7.2	0.8	0.4	0.6	0.843
Puerto Rico	2.5	1.5	2.0	0.4	0.2	0.3	17.3	12.7	14.7	0.7	0.2	0.4	
Qatar	0.0	0	0	0	0	0	0.6	0.1	0.5	0.6	0.2	0.5	0.856
Republic of Moldova	4.7	3.9	4.3	2.0	1.2	1.5	7.4	6.6	6.9	1.0	0.4	0.6	
Romania	3.3	3.5	3.4	1.4	1.0	1.2	3.7	2.4	3.0	1.3	0.7	0.9	0.802
Russian Federation	4.5	4.9	4.7	1.9	1.4	1.6	5.5	4.7	5.0	0.8	0.4	0.5	0.804
Rwanda	1.1	1.2	1.2	0.7	0.8	0.7	1.6	1.6	1.6	1.2	0.7	0.9	0.498
Saint Lucia	0.0	0.8	0.4	0	0	0	5.3	1.4	3.2	0	0	0	0.735
Samoa	0.0	0	0	2.4	0	1.2	0	0	0	0	0	0	0.704
Sao Tome and Principe	0.0	0	0	0	0	0	0	0	0	0	0	0.1	0.574
Saudi Arabia	0.2	0.2	0.2	0.1	0.1	0.1	0.4	0.4	0.4	1.5	0.1	0.1	0.847
Senegal	0.5	0.8	0.6	0.4	0.6	0.5	2.1	2.0	2.0	1.7	1.1	1.4	0.494
Serbia	9.7	8.4	9.0	3.3	1.9	2.5	8.4	4.9	6.4	1.4	0.7	1.0	0.776
Sierra Leone	0.4	0.9	0.6	0.3	0.7	0.5	2.9	2.3	2.6	2.3	1.4	1.8	0.42
Singapore	0.8	0.6	0.7	0.6	0.2	0.4	4.3	2.2	3.2	0.3	0.1	0.2	0.925
Slovakia	9.7	7.8	8.5	3.2	2.2	2.6	8.6	4.8	6.3	0.9	0.4	0.6	0.845
Slovenia	18.0	19.7	18.6	3.2	2.2	2.7	11.6	5.6	8.1	0.5	0.3	0.4	0.89
Solomon Islands	0.5	0.5	0.5	0	0	0	0	1.0	0.5	0	0	0	0.515
Somalia	0.4	0.6	0.5	0.4	0.5	0.5	1.9	3.4	2.7	1.5	2.1	1.8	
South Africa	2.9	1.9	2.2	1.5	0.8	1.1	17.4	7.5	11.3	1.5	0.8	1.0	0.666
South Sudan	0.9	1.0	1.0	0.7	0.9	0.8	2.0	2.2	2.1	1.6	1.2	1.4	0.418
Spain	5.5	7.2	6.4	1.3	0.9	1.1	18.9	8.6	12.9	0.5	0.2	0.4	0.884
Sri Lanka	0.4	0.3	0.4	0.3	0.1	0.2	1.0	0.8	0.9	0.5	0.3	0.4	0.766
Sudan	0.5	0.5	0.5	0.3	0.3	0.3	1.8	1.7	1.7	1.2	1.1	1.1	0.49
Suriname	1.1	0.2	0.6	0.4	0	0.2	1.0	2.5	2.5	0	0	0	0.725
Swaziland	1.1	1.7	1.5	0.8	1.0	0.9	5.9	3.1	4.1	4.7	1.1	2.5	0.541
Sweden	23.5	26.2	24.7	3.2	1.8	2.5	17.8	14.9	16.1	0.2	0.2	0.2	0.913
Switzerland	23.4	19.5	21.3	2.7	1.2	1.9	55.1	35.6	44.4	0.6	0.2	0.4	0.939
Syrian Arab Republic	0.9	0.8	0.9	0.4	0.3	0.4	4.8	2.7	3.7	2.7	1.0	1.7	0.536
Tajikistan	0.3	0.3	0.3	0.3	0.3	0.3	0.7	1.0	0.9	0.5	0.4	0.5	0.627
Tanzania, United Republic of	1.3	1.8	1.6	0.9	1.3	1.1	3.1	2.7	2.9	2.1	1.5	1.7	0.531
Thailand	0.5	0.5	0.5	0.3	0.3	0.3	2.5	1.7	2.1	0.9	0.6	0.7	0.74

Continued

TABLE 1 (CONTINUED). Estimated age-standardized incidence and mortality rates skin cancer, all ages in World in 2018.

Countries	Melanoma of skin cancer						Non-melanoma skin cancer						HDI
	Incidence (ASR)			Mortality (ASR)			Incidence (ASR)			Mortality (ASR)			
	M	F	Total	M	F	Total	M	F	Total	M	F	Total	
The Netherlands	26.4	25.4	25.7	3.2	2.2	2.7	38.5	25.8	31.3	0.3	0.2	0.2	
The former Yugoslav Republic of Macedonia	8.8	5.4	7.1	2.8	1.4	2.1	6.7	3.0	4.7	1.0	0.4	0.7	0.748
Timor-Leste	0.3	0.3	0.3	0.3	0.3	0.3	0.6	0	0.3	0.6	0	0.3	0.605
Togo	1.1	1.1	1.1	0.8	0.8	0.8	5.8	4.0	4.9	4.7	2.2	3.4	0.487
Trinidad and Tobago	0.6	0.6	0.6	0.1	0.1	0.1	2.6	1.6	2.1	0.1	0.1	0.1	0.78
Tunisia	0.6	0.5	0.5	0.4	0.2	0.3	3.3	2.0	2.6	1.5	0.7	1.0	0.725
Turkey	1.9	1.6	1.7	0.9	0.5	0.7	8.6	3.9	6.0	1.0	0.6	0.7	0.767
Turkmenistan	0.8	0.8	0.8	0.6	0.4	0.5	2.3	2.6	2.5	0.9	0.5	0.7	0.691
Uganda	0.8	1.3	1.1	0.6	0.9	0.8	2.8	1.3	2.0	2.5	0.7	1.5	0.493
Ukraine	5.6	5.3	5.3	2.5	1.4	1.8	7.3	6.7	6.8	0.9	0.5	0.6	0.743
United Arab Emirates	0.5	0.2	0.4	0.2	0	0.1	8.4	4.2	6.6	4.9	1.3	3.5	0.84
United Kingdom	15.0	15.3	15.0	2.3	1.3	1.8	33.2	14.1	22.8	0.6	0.2	0.4	0.909
United States of America	14.9	11.0	12.7	2.0	0.9	1.7	78.9	36.8	55.8	1.0	0.3	0.6	0.92
Uruguay	5.6	4.3	4.8	1.8	0.9	1.3	16.4	7.0	10.8	0.8	0.2	0.4	0.795
Uzbekistan	0.8	0.6	0.7	0.3	0.2	0.2	0.8	0.6	0.7	0.4	0.3	0.4	0.701
Vanuatu	0.9	0.9	0.9	0	0	0	0	1.8	0.9	0	0	0	0.597
Venezuela, Bolivarian Republic of	1.8	1.1	1.4	0.6	0.3	0.4	14.7	7.7	10.7	2.1	0.9	1.4	0.767
Viet Nam	0.2	0.1	0.1	0.1	0.1	0.1	0.9	1.0	0.9	0.3	0.3	0.3	0.683
Yemen	0.3	0.1	0.2	0.2	0.0	0.1	1.7	1.0	1.3	0.8	0.3	0.5	0.482
Zambia	0.4	1.1	0.8	0.2	0.7	0.5	1.8	1.9	1.8	1.6	0.9	1.2	0.579
Zimbabwe	1.6	1.9	1.8	1.1	1.4	1.3	3.9	3.7	3.8	3.4	2.1		0.516

The highest incidence rate (10.63case per 100000) and mortality rate (1.54 case per 100000) of melanoma of cancer were observed in very high human development. The highest incidence rate (18.1 case per 100000) of Non-melanoma cancer was observed in very high human and highest mortality rate (1.7case per 100000) of prostate cancer were observed in vow human development. Highest value of LEB, MYS, GNI, EYS and total HDI were estimated to be 79.55, 11.5, 39613, 16.2 and 0.876 (Table2).

The linear regression model showed that increased MYS, EYS, LBE and GNI cause to increase the incidence of melanoma and non-melanoma cancer, but this increase was not statistically significant in LBE. In the study of melanoma mortality, the results of regression analysis showed that increased HDI caused to decrease motility (R= 4.5, $p<0.05$). In non-melanoma cancer, increasing in LBE caused to significantly reduce mortality (Table 3).

DISCUSSION

While skin cancer is the most common type of cancer, its catching can be prevented. Many cancers are caused by genetic mutations; in the event that skin cancer is simply a result of excessive exposure to the sun, its risk can be greatly reduced using sunscreen[16]. The economic burden and health melanoma will increase by 2030 without taking preventive measures. Although death from NMSC is generally rare, NMSC treatment has significantly created the burden on the health system[17]. Studies have shown that the cost of treatment for newly diagnosed melanomas will triple from 2011 to 2030 without new interventions. One of the strategies to prevent melanoma cancer can be reduced exposure to sunlight and increased sun protection[18]. According to the results of the GLOBOCAN cancer record in 2018, the highest incidence of melanoma and non-melanoma

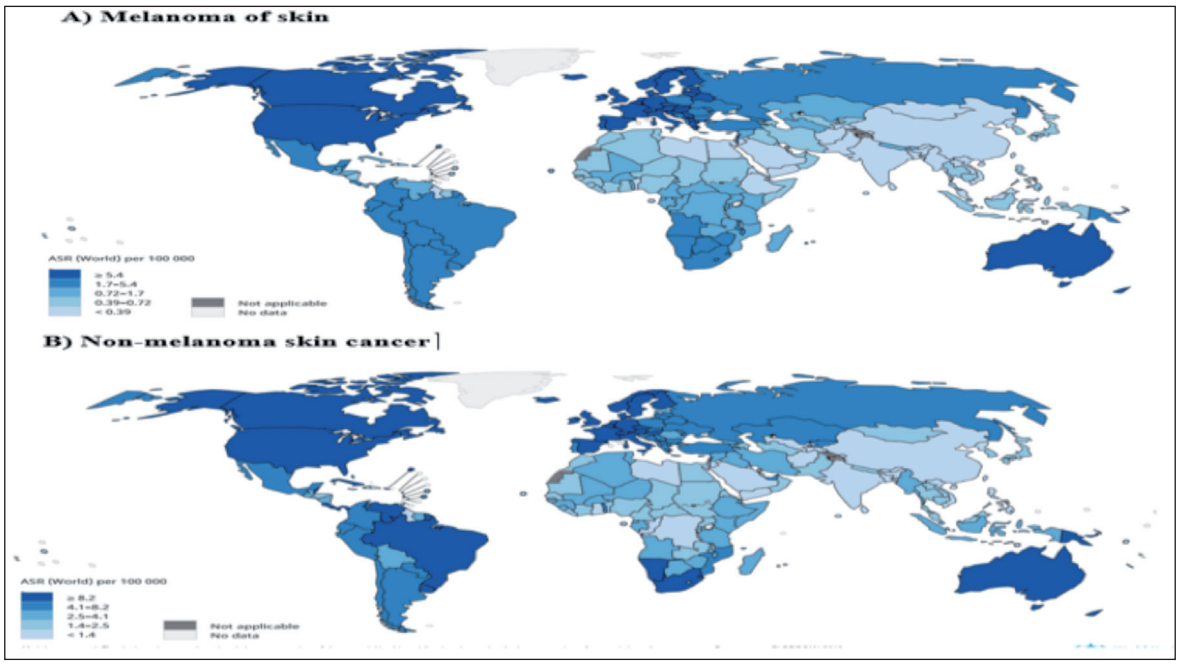

Fig. 1. Incidence rate melanoma and non-melanoma cancer in the world in 2018. Source: GLOBOCAN 2018.

cancer was related to Australia and New Zealand. The results of the study showed that there is a positive and significant correlation between the incidence (R=0.572, p<0.0001) and mortality (R=0.413, p<0.0001) of melanoma cancer with HDI index. In non-melanoma cancer, there was observed a positive and significant correlation between incidence and HDI index (R=0.731, p<0.0001), while between non-melanoma and HDI there was a negative correlation (R=-0.437, p<0.0001). The linear regression model showed that increasing MYS, EYS and GNI cause to increase the incidence of melanoma and non-melanoma cancer, while increasing HDI leads to a decrease in mortality (R=4.5, p<0.05). One of the reasons for the change in the incidence around the world is the level of exposure to ultraviolet radiation in different parts of the world. In the southern hemisphere countries, the incidence of cancer is

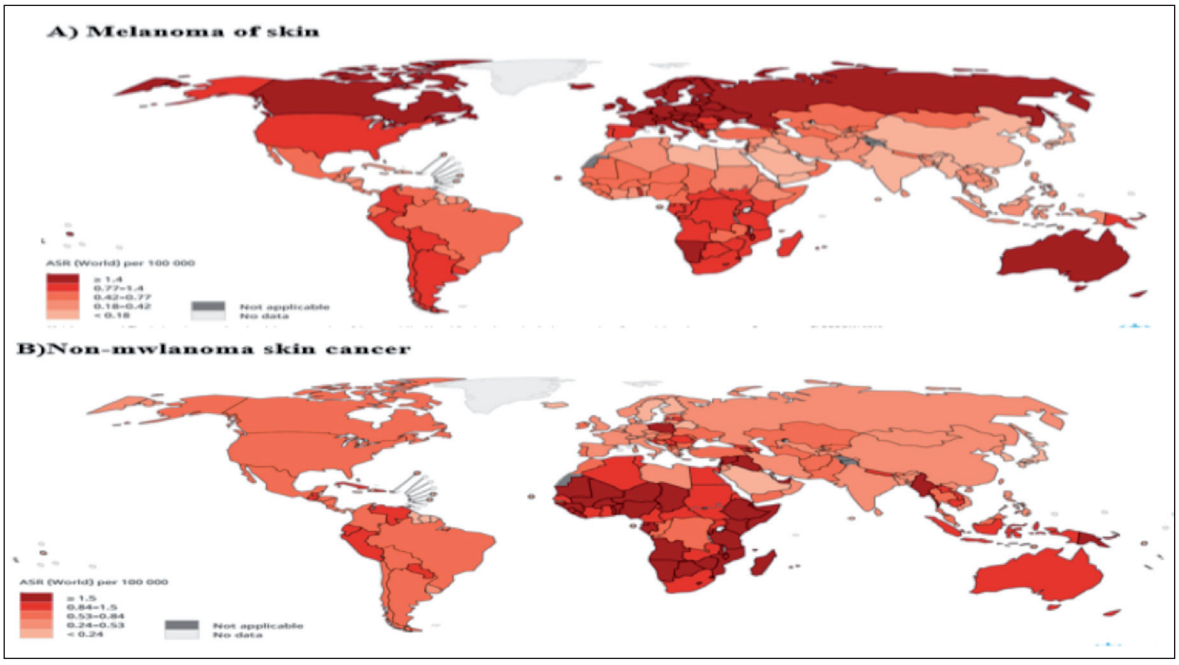

Fig. 2. Mortality rate melanoma and non-melanoma cancer in the world in 2018. Source: GLOBOCAN 2018.

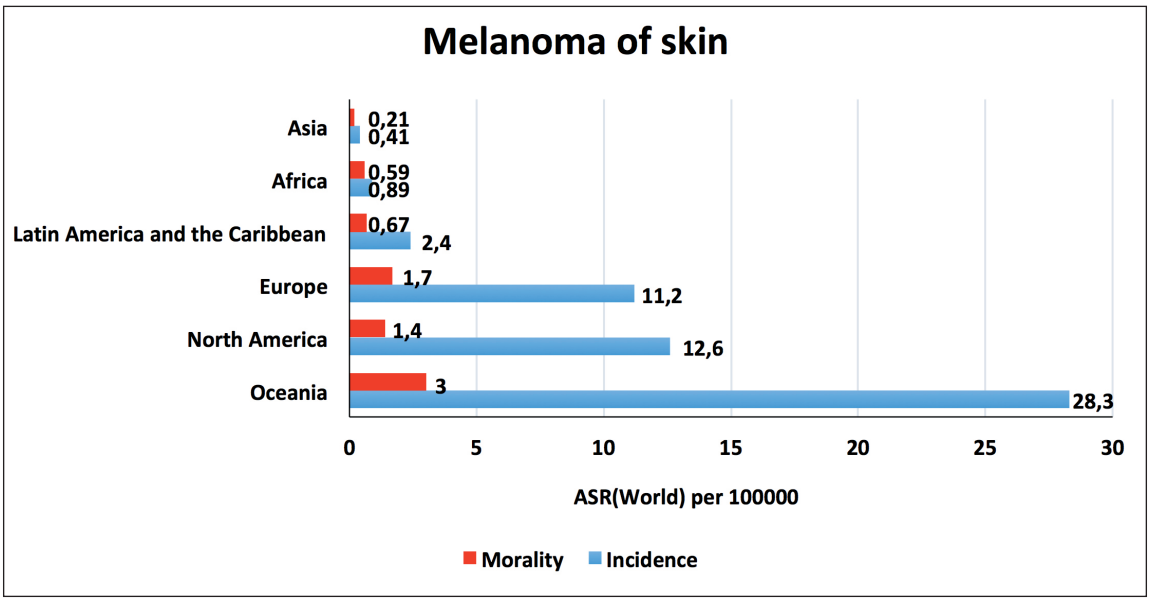

Fig. 3. Estimated age-standardized incidence and mortality rates melanoma skin cancer (World) in 2018, both sexes, all ages. Source: GLOBOCAN 2018.

higher due to more intense UV radiation, although the amount of melanoma is higher among whites, but people who are known as non-white are also at risk for melanoma. Lack of awareness may lead to a risk[19]. According to the World Health Organization (WHO), 2-3 million cases of melanoma can be reported annually[17] The incidence of malignant melanoma in Europe and the United States has almost tripled in the last 30 years[20] The United States Dermatology Academy has stated that melanoma is prevalent in Australia and New Zealand. Australia has the highest incidence of skin cancer in the world. Non-melanoma skin cancer (NMSC), including basal cell carcinoma (BCC) and squamous cell carcinoma (SCC), is the most common cancer in Australia. In Germany 120000 new NMSC cases were estimated in 2009[21]. In Spanish, its incidence is 4 per 100000 in African Americans incidence is 1 in 100000; however, in the Caucasus, the incidence is 25 per 100000. According to the estimates has recorded in 2012, 168000 cases of UV-related cancer have occurred worldwide. Studies have shown that about 230000 cases are reported annually and 55000 deaths from melanoma are estimated in the worldwide[22]. Melanoma is more common in men than in women. Men have high levels of melanoma compared to women, because its incidence rate is three times higher in men over 80 and older than women in the same age.

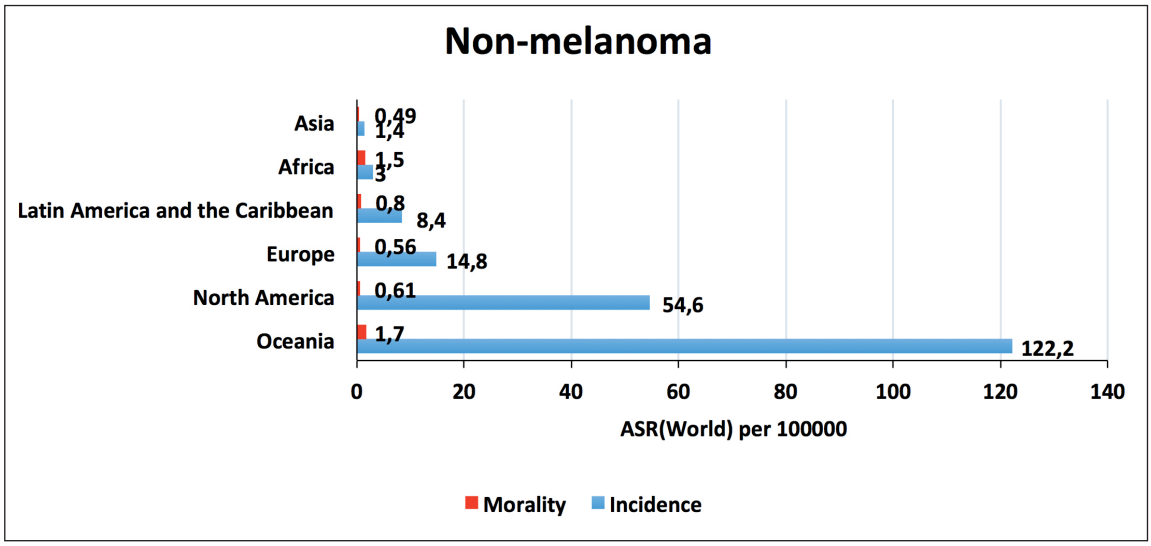

Fig. 4. Estimated age-standardized incidence and mortality rates non-melanoma skin cancer (World) in 2018, both sexes, all ages. Source: GLOBOCAN 2018 .

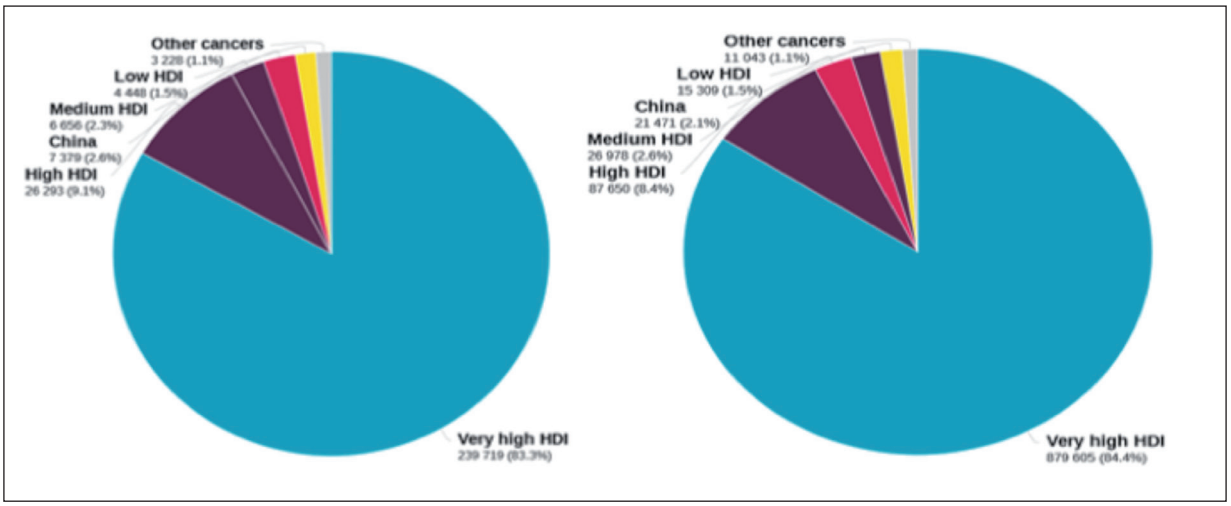

Fig. 5. Distribution of skin cancer based HDI. Source: GLOBOCAN 2018.

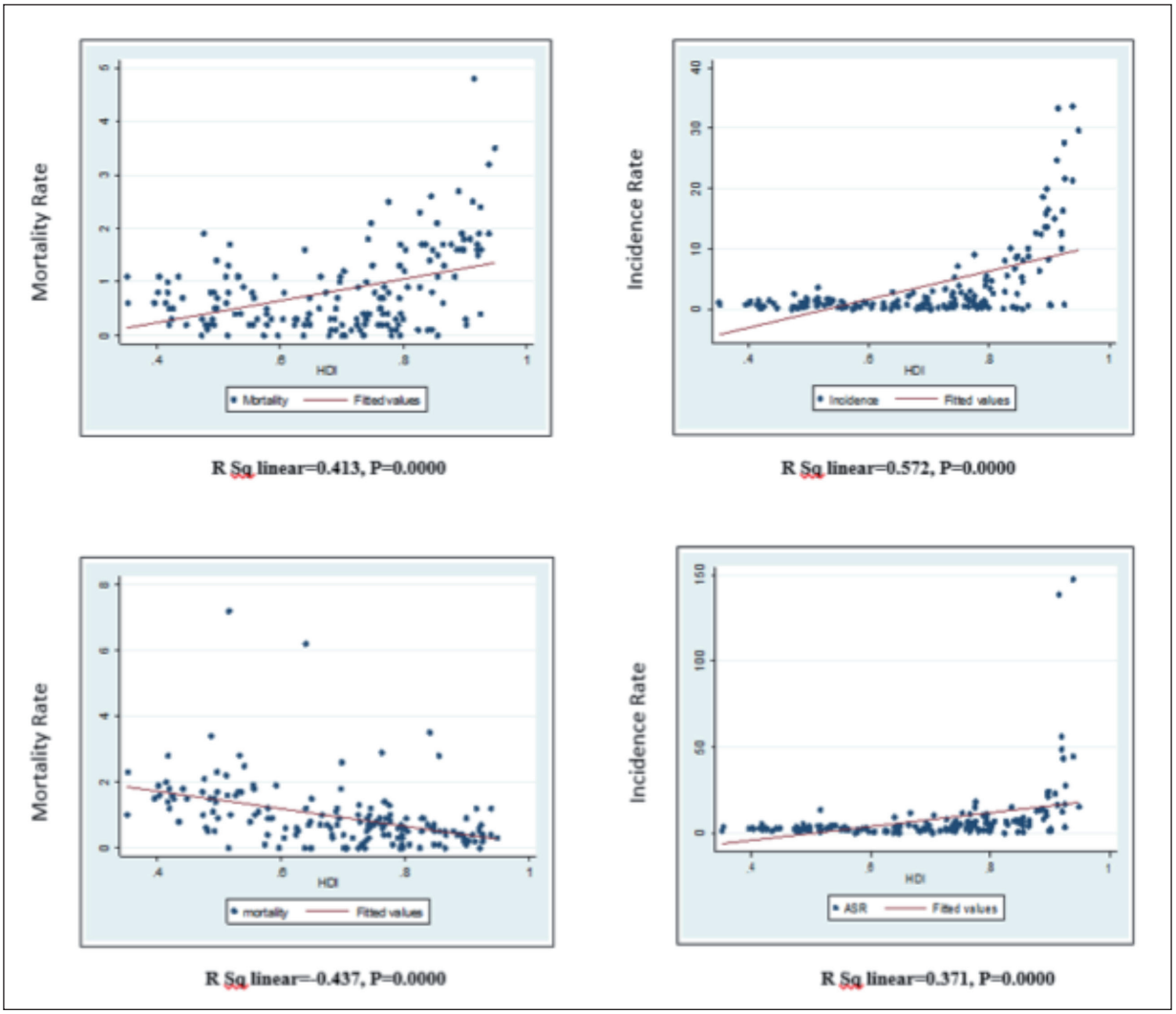

Fig. 6. Correlation between the Human Development Index, incidence and Mortality rates of: *A*, Melanoma skin cancer, *B*, Non melanoma skin cancer in World in 2018.

TABLE 2. Skin Cancer Incidence, Mortality and HDI Component in Different HDI Regions in 2018

Category HDI	Melanoma of skin													
	Incidence	Mortality	HDI Component					Incidence	Mortality	HDI Component				
	ASR	ASR	LEB	MYS	GNI	EYS	HDI	ASR	ASR	LEB	MYS	GNI	EYS	HDI
Very high human development of schooling	10.63	1.54	79.55	11.5	39613	16.2	0.876	18.1	0.56	79.55	11.5	39613	16.2	0.876
High human development	1.73	0.54	74.1	9.36	13420	13.71	0.746	4.6	0.59	74.1	9.36	13420	13.71	0.746
Medium human development	0.84	0.47	68.35	6.49	7803	11.68	0.629	2.5	1.05	68.35	6.49	7803	11.68	0.629
Low human development	0.98	0.7	59.71	4.36	3498	9.18	0.468	2.7	1.7	59.71	4.36	3498	9.18	0.468
p-value (F-test)	**	**	**	**	**	**	_	**	**	**	**	**	**	_

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. **$p<0.0001$

TABLE 3. Effect of HDI components on skin cancer incidence and mortality in world in 2018.

	Melanoma of skin						Non-melanoma skin cancer					
	Incidence			Mortality			Incidence			Mortality		
	B	CI 95%	p-value	B	CI 95%	p-value	B	CI 95%	p-value	B	CI 95%	p-value
HDI	-37.9	(-62.9, -12.8)	**	-4.5	(-7.8,-1.2)	**	-98.2	(-176.6, -19.8)	**	0.9	(-3.5, 5.3)	*
Gross national income per 1000 capita	0.001	(0.0001,1.3)	**	0.07	(0.02,0.3)	**	0.002	(0.0003, 0.04)	**	-2.2	(-3.1, 8.2)	*
Mean years of schooling	0.7	(0.1, 1.3)	**	0.1	(0.03, 0.1)	**	1.4	(-0.3, 3.2)	*	-0.06	(-0.1, 0.03)	*
Life expectancy at birth	0.1	(-0.05, 0.3)	*	-0.007	(-0.03,0.02)	*	0.4	(-0.2, 1.1)	*	-0.05	(-0.09, -0.01)	**
Expected years of schooling	1.6	(0.9,2.2)	**	0.2	(0.1, 0.3)	**	4.2	(2.1, 6.2)	**	0.01	(-0.1, 0.1)	*

*: $p>0.05$, **: $p<0.05$

The higher levels of melanoma among men than women may be due to less use of sun protection and time spent outside the home compared to women. In addition, men use less sunscreen than women[23, 24]. People working outdoors are 43% more likely to be at risk of BCC and 77% more likely to be exposed to SCC[25]. It has been determined that 86% of melanomas are produced by exposure to sunlight, and exposure to sunlight increases the risk of melanoma up to twice[26]. The incidence and the mortality rate of cancer vary considerably between ethnic and racial groups, and has typically the highest rate among the black and the lowest rate among Asians[27]. The racial disparity in cancer in women has fallen from 20% in 1998 to 13% in 2014. Apart from behavioral differences, racial differences resulting from indirect access to health care services, including cancer prevention and early diagnosis, timely diagnosis and optimal treatment, can cause this disparity[28,29]. According to the results of the study, there is a positive correlation between the index and the HDI index, the risk of melanoma in very high HDI countries is much higher than that of less developed countries, Therefore, in very high HDI countries, including Australia and New Zealand, public health measures are urged to prevent further increases in cancer cases. Key interventions should include necessary training and awareness about the melanoma and related risk factors that can mitigate the risk of infection. The dimensions of the human development index are the average years of training, the expected years of education and the GNI index, which has direct relation to cancer which was in consistent with the results of our study. In countries with a high human development index and a higher level of literacy and awareness due to the early diagnosis of the disease, there is a higher incidence of disease and less mortality due to timely treatments that can justify the results of this study[11,30]. The World Health Organization estimates that 65000 people die of melanoma every year around the world. Despite the increased incidence of melanoma, reducing melanoma mortality in people over the age of 65 probably indicates early detection and treatment improvement[31].

CONCLUSIONS

The incidence and mortality of skin cancer (melanoma and non-melanoma) are related to the development index (HDI). The increase in the HDI index increases access to health services and early detection of disease and treatment of the disease at an early stage, thereby reducing mortality. Increasing the level of literacy and awareness in people has increased the desire of patients to receive care and treatment of the disease and reduce the mortality rate of the disease. Therefore, attention to the creation of more specialized healthcare facilities and stronger monitoring systems and increasing the level of education and awareness of people in less developed countries is essential for early diagnosis of the patient and timely treatment to reduce the mortality of the disease.

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Conflict of Interest

The authors declare no conflict of interest.

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