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Disparity and trends in the incidence and mortality of lung cancer in the world

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Abstract

Background: Lung Cancer (LC) is one of the most common cancers in the international arena. The aim of this study was to investigate the geographical distribution of LC incidence and mortality in the world in 2012, as well as the trend of incidence and mortality of LC during 1975 to 2010 based on the gender. **Material and methods**: In the present study, we extracted the information on the incidence and mortality of LC in 184 countries from the International Agency for Research on Cancer (IARC) (Project GLOBOCAN, 2012). The present study categorized and presented the information on the Age-Standardized Incidence Rate (ASIR) and Age Standardized Mortality Rate (ASMR) of LC based on the continents, world regions based on the development level and Human Development Index (HDI). ASIR and ASMR of LC expressed per 100,000 people. **Results**: The highest ASIR and ASMR of LC occurred in North America (ASIR=38.3 and ASMR=28.6), more developed regions (ASIR=30.8 and ASMR=24.2), and the WPRO region of the WHO (ASIR=32.8 and ASMR=28.5), and those regions with very high HDI (ASIR=31 and ASMR=23.9). Furthermore, the lowest ASIR and ASMR of LC occurred in Africa (ASIR=5 and ASMR=4.5), the less developed regions (ASIR=20 and ASMR=18), the AFRO region (ASIR=3.9 and ASMR=3.5), and regions with low HDI (ASIR=5.4 and ASMR=4.8). **Conclusion**: The highest ASIR and ASMR of LC occurred in North America, more developed regions, and the WPRO region of the WHO, and those regions with very high HDI. Most regions of the world had decreasing incidence and mortality of LC in men and increasing trend in women.

1. Background

Despite the advances made in the field of prevention and control of communicable diseases over the last decade, the incidence and prevalence of Non-communicable diseases has increased dramatically and in most countries after the illness Cardiovascular disease is the second most common cause of death [1–5]. Lung Cancer (LC) is one of the most common cancers in the international arena. This disease is the most important cause of mortality from cancer, so that 20% of the cancer deaths are specifically due to the LC. 17% of men and 9% of women, who are diagnosed as the newly cases of cancer peer year, have LC [6].

Cigarette smoking is one of the most important risk factors for LC. Despite the descending prevalence of cigarette smoking in the United States since the 1950s, LC is now known as one of cancers with very high incidence, so that LC has the highest number of new cases after Prostate cancer in men and after breast cancer in women [7,8]. In the United States, different studies have shown a significant disparity in the incidence of LC in different races with an incidence of 50% in African Americans men higher than white males [7,8]. In another study on the incidence of disease in the United States, it was found that the incidence of LC was ascending in men until 1980 and in women up to 2007, but it was descending since then [8]. In the United States, LC accounts for a significant proportion of mortality from cancer, so that about 27 out of 100 deaths from cancer occurred due to LC [9].

The five-year survival rate for LC is very low, so that the 5-year survival rate of this cancer was equal to 12.3% in 1970 and 16.3% in 2007. However, the survival rate of this disease is highly associated with the diagnosis stage in such a way that the 5-year survival rate of this disease was equal to 52% in patients, whose diseases were at the local stages, and 24% in patients with diseases at the regional stage, while the 5-year survival rate for patients was equal to 4% in those whose diseases were at distant stage. However, there are other factors that affect the survival rate of disease, so that the survival rate is lower in males than females, in the elderly than adults, and in the African American race than other races [10,11].

As the burden of this disease on public health is so much, and the changes in its risk factors such as smoking is very different in the world, and due to the population growth and the increasing proportion of older people in societies, it is essential to perform the continuous and accurate epidemiology studies of this disease [12]. The incidence and mortality of LC are properly

and regularly monitored in developed countries [13–16] however, there are not enough numbers of studies on the disparity in the distribution of incidence and mortality of this cancer based on different geographical or Socio-Economic indexes for areas at the national and international level [17]. Therefore, there are not identified geographical disparities caused by this disease at the global level. The aim of this study was to investigate the geographical distribution of LC incidence and mortality based on the development level, WHO classification, human development index levels and the world's continents in 2012, as well as the trend of incidence and mortality of LC during 1975 to 2010 based on the gender in the worldwide.

2. Methods

In the present study, we extracted the information on the incidence and mortality of LC in 184 countries from the International Agency for Research on Cancer (IARC) (Project GLOBOCAN, 2012). GLOBOCAN is a database on various types of cancers and it is created by the World Health Organization. It covers information on the number, raw rates, and age standardization of cancer incidence, prevalence and mortality for different regions and countries. Currently, the available data in GLOBOCAN is known as one of the newest international database on the cancer. Based on the data of GLOBOCAN project, it is possible to investigate and compare the incidence and mortality of cancer based on the type of cancer, age and gender groups for different regions of the world.

The present study categorized and presented the information on the Age-Standardized Incidence Rate (ASIR) and Age Standardized Mortality Rate (ASMR) of LC based on the continents (Africa, Latin America and Caribbean, Northern America, Europe, Oceania, Asia), world regions based on the development level (More developed regions and Less developed regions) and human development index (very high, high, medium, or low).

We provided the information about the incidence and mortality of LC based on the number, raw rates and the Age-Standardized rates in 2012. We also expressed raw and standardized rates of incidence and mortality per 100,000 people. Geographical Distribution Map was prepared for the ASIR and ASMR of this disease based on the age-specific rates. Detailed descriptions of applied methods are presented in previous reports [18–21].

3. Results

(a) **The ASIR and ASMR of LC in the world**

In 2012, 1824701 new cases of LC were diagnosed worldwide. From this number, 1241601 (68.04%) cases occurred in men and 583100 (31.96%) in women. In general, the ASIR of LC was equal to 23.1 (34.2 in men and 13.6 in women). The sex ratio (male to female) of the newly diagnosed LC was equal to 2.13 (**Figure 1**).

There were also 1589925 deaths from LC during this year. From this number, 1098702 (69.1%) cases occurred in men and 491223 (30.9%) in women. In general, the ASMR of LC was equal to 19.7 (30 were in men and 11.1 in women). The sex ratio of the mortality of LC was equal to 2.24 (**Figure 2**).

(b) **The ASIR and ASMR of LC based on the continents**

The ASIR of LC was equal to 38.3 (44 in men, and 33.8 in women) in North America, 29 (46.2 in men, and 15.1 in women) in Europe, 25.3 (31.3 in men and 20 in women) in Oceania, 23.4 (35.2 in men and 12.7 in women) in Asia, 13.7 (18.7 in men and 9.6 in women) in Latin America, and 5 (7.7 in men and 2.6 in women) in Africa. From the total number of this disease in the world, the highest proportion occurred in Asia and the lowest proportion in Oceania, so that 57.3% of cases occurred in Asia, 22.5% in Europe, 13.2% in North America, 4.7% in Latin America, 1.6% in Africa and 0.7% in Oceania (**Table 1** and **Figures 1, 2 and 3**).

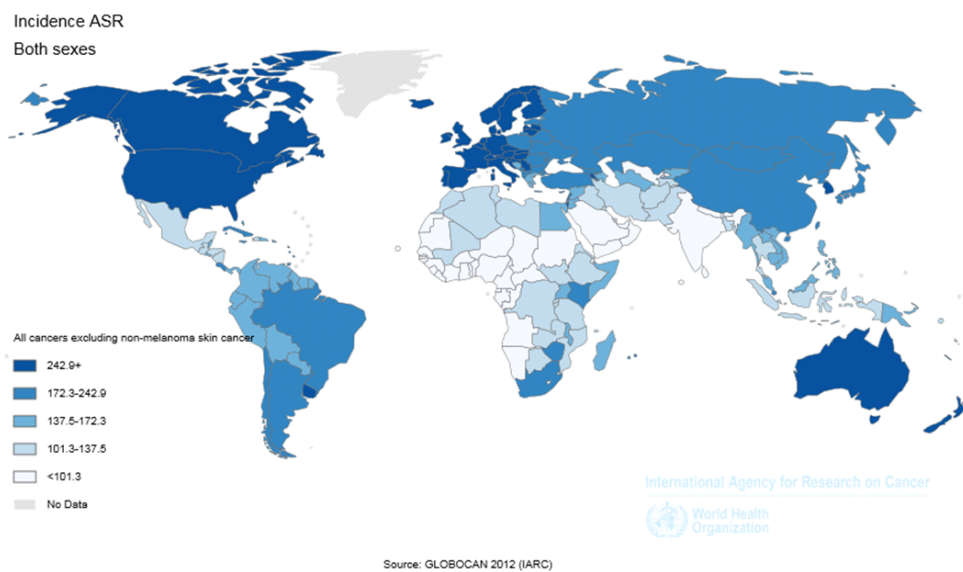**2352**

Figure 1. Distribution of Age-Standardized Incidence Rate (ASIR) of Lung Cancer in the world based on the results of the International Agency for Research on Cancer data (Globocan, 2012).
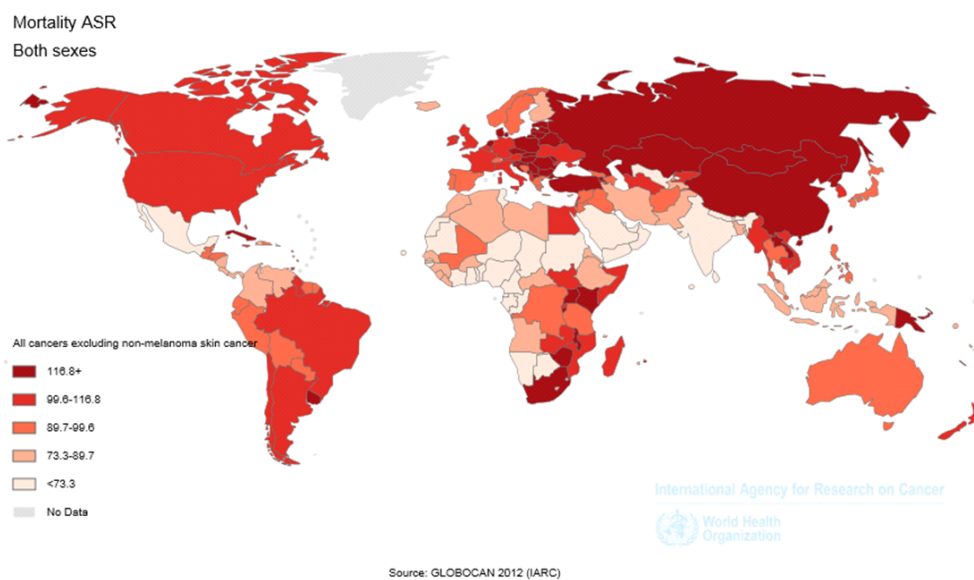

Figure 2. Distribution of Age-Standardized Mortality Rate (ASMR) of Lung Cancer in the world based on the results of the International Agency for Research on Cancer data (Globocan, 2012).

Table 1: **The incidence rate of LC in different parts of the world in 2012**

Population	Male			Female			All		
	Numbers	Crude Rate	ASR (W)	Numbers	Crude Rate	ASR (W)	Numbers	Crude Rate	ASR (W)
World	1241601	34.9	34.2	583100	16.7	13.6	1824701	25.9	23.1
More developed regions	490267	80.9	44.7	267947	41.9	19.6	758214	60.9	30.8
Less developed regions	751334	25.5	30.0	315153	11.0	11.1	1066487	18.4	20.0
Very High Human Development	440520	77.4	42.2	265905	45.6	21.8	706425	61.3	31.0
High Human Development	166118	32.4	32.1	54657	10.3	8.1	220775	21.2	18.7
Medium Human Development	607578	33.4	35.6	250192	14.4	13.1	857770	24.1	23.8
Low Human Development	26870	4.1	7.9	12039	1.9	3.1	38909	3.0	5.4
WHO Africa region (AFRO)	11786	2.7	5.5	6265	1.4	2.5	18051	2.1	3.9
WHO Americas region (PAHO)	177861	37.8	31.4	146440	30.3	21.6	324301	34.0	26.0
WHO East Mediterranean region (EMRO)	25592	8.0	12.6	6950	2.3	3.3	32542	5.2	7.9
WHO Europe region (EURO)	322752	73.8	46.9	125866	27.0	14.4	448618	49.7	28.7
WHO South-East Asia region (SEARO)	115658	12.2	15.7	46345	5.1	5.7	162003	8.7	10.5
WHO Western Pacific region (WPRO)	587774	62.2	48.9	251204	28.0	18.4	838978	45.5	32.8
IARC membership (24 countries)	514385	39.2	32.3	279144	21.5	14.6	793529	30.4	22.6
Middle-East and Northern Africa (MENA)	43562	19.1	27.1	9342	4.2	5.2	52904	11.8	15.6
Africa	21756	4.1	7.7	8558	1.6	2.6	30314	2.8	5.0
Sub-Saharan Africa	9891	2.3	4.8	5917	1.4	2.5	15808	1.8	3.6
Eastern Africa	3102	1.8	3.8	2049	1.2	2.2	5151	1.5	2.9
Middle Africa	584	0.9	2.0	288	0.4	0.8	872	0.7	1.4
Northern Africa	11865	11.4	15.6	2641	2.5	3.1	14506	7.0	9.0
Southern Africa	4821	16.6	26.1	2588	8.8	10.2	7409	12.6	16.9
Western Africa	1384	0.9	1.7	992	0.6	1.1	2376	0.7	1.4
Latin America and Caribbean	52325	17.6	18.7	32195	10.5	9.6	84520	14.0	13.7
Caribbean	5999	28.6	25.8	3542	16.7	13.5	9541	22.6	19.2
Central America	6874	8.7	10.2	3909	4.8	4.9	10783	6.7	7.4

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South America	39452	19.9	20.8	24744	12.2	10.7	64196	16.0	15.2
Northern America	125536	72.4	44.0	114245	64.4	33.8	239781	68.4	38.3
Asia	742718	34.2	35.2	302977	14.6	12.7	1045695	24.6	23.4
Eastern Asia	556089	68.0	50.4	240446	31.2	19.2	796535	50.2	34.1
South-Eastern Asia	74031	24.5	29.6	30987	10.2	10.5	105018	17.3	19.2
South-Central Asia	80901	8.7	11.9	24843	2.8	3.4	105744	5.8	7.5
Western Asia	31697	25.5	37.6	6701	5.8	7.1	38398	16.0	21.7
Europe	290904	81.4	46.6	119316	31.1	15.1	410220	55.3	29.0
European Union (EU-28)	213663	86.0	45.1	98982	38.2	18.2	312645	61.6	30.5
Central and Eastern Europe	106961	77.6	53.5	31654	20.3	10.4	138615	47.2	27.8
Northern Europe	33458	67.8	34.6	26703	52.4	23.7	60161	60.0	28.6
Southern Europe	69933	90.3	46.4	21772	27.2	12.8	91705	58.2	28.2
Western Europe	80552	86.7	44.0	39187	40.5	20.0	119739	63.1	31.1
Oceania	8362	44.2	31.3	5809	30.8	20.0	14171	37.6	25.3
Australia/New Zealand	7811	57.3	32.7	5547	40.3	21.7	13358	48.8	26.8
Melanesia	331	7.1	14.3	163	3.6	5.8	494	5.4	9.7
Micronesia/Polynesia	220	35.2	42.7	99	16.3	17.5	319	25.9	29.7
Micronesia	108	39.1	47.5	58	21.3	22.9	166	30.3	34.8
Polynesia	112	32.1	39.3	41	12.2	13.5	153	22.4	25.9

The ASMR of LC was equal to 28.6 (34.8 in men, and 23.5 in women) in North America, 24 (39.8 in men, and 11.8 in women) in Europe, 20.7 (31.6 in men and 11 in women) in Asia, 18.3 (23.1 in men and 14.1 in women) in Oceania, 12 (16.7 in men and 8.1 in women) in Latin America, and 4.5 (7 in men and 2.4 in women) in Africa. From the total number of deaths of LC in the world, the highest proportion occurred in Asia and the lowest proportion in Oceania, so that 58.8% of cases occurred in Asia, 22.3% in Europe, 11.8% in North America, 4.7% in Latin America, 1.7% in Africa and 0.7% in Oceania (**Table 2** and **Figure 3**).

(c) The ASIR and ASMR of LC based on the development level

The ASIR of LC was equal to 30.8 (44.7 in men, and 19.6 in women) in more developed countries, and 20 (30 in men, and 11.1 in women) in less developed regions. 58.4% of cases occurred in more developed countries and 41.6% in less developed regions.

The mortality of LC was equal to 24.2 (36.8 in men, and 14.3 in women) in more developed regions, and 18 (27.2 in men, and 9.8 in women) in less developed regions. 39.4% of cases occurred in more developed regions and 60.6% in less developed regions.

Table 2: **The mortality rate of LC in different parts of the world in 2012**

Population	Male			Female			All		
	Numbers	Crude Rate	ASR (W)	Numbers	Crude Rate	ASR (W)	Numbers	Crude Rate	ASR (W)
World	1098702	30.9	30.0	491223	14.0	11.1	1589925	22.5	19.7
More developed regions	416711	68.8	36.8	209859	32.8	14.3	626570	50.3	24.2
Less developed regions	681991	23.1	27.2	281364	9.8	9.8	963355	16.6	18.0
Very High Human Development	371192	65.2	34.1	206330	35.4	15.6	577522	50.1	23.9
High Human Development	148383	29.0	28.6	47284	8.9	6.9	195667	18.8	16.4
Medium Human Development	554792	30.5	32.6	226602	13.1	11.7	781394	22.0	21.6
Low Human Development	23881	3.7	7.1	10738	1.7	2.8	34619	2.7	4.8
WHO Africa region (AFRO)	10522	2.4	5.0	5586	1.3	2.3	16108	1.8	3.5
WHO Americas region (PAHO)	149462	31.7	25.9	112852	23.4	15.9	262314	27.5	20.4
WHO East Mediterranean region (EMRO)	22759	7.1	11.3	6218	2.0	2.9	28977	4.7	7.1
WHO Europe region (EURO)	283324	64.8	40.3	104879	22.5	11.3	388203	43.0	24.0
WHO South-East Asia region (SEARO)	104264	11.0	14.2	41952	4.6	5.2	146216	7.9	9.5
WHO Western Pacific region (WPRO)	528212	55.9	43.3	219708	24.5	15.4	747920	40.6	28.5
IARC membership (24 countries)	437684	33.3	27.0	219446	16.9	10.9	657130	25.1	18.2
Middle-East and Northern Africa (MENA)	38948	17.1	24.5	8225	3.7	4.6	47173	10.5	14.0
Africa	19430	3.6	7.0	7653	1.4	2.4	27083	2.5	4.5
Sub-Saharan Africa	8861	2.1	4.4	5282	1.2	2.2	14143	1.6	3.2
Eastern Africa	2809	1.6	3.5	1848	1.0	2.0	4657	1.3	2.7
Middle Africa	525	0.8	1.8	258	0.4	0.7	783	0.6	1.2
Northern Africa	10569	10.2	14.0	2371	2.3	2.8	12940	6.2	8.1
Southern Africa	4302	14.8	23.8	2316	7.8	9.1	6618	11.3	15.2
Western Africa	1225	0.8	1.5	860	0.5	1.0	2085	0.7	1.2
Latin America and Caribbean	47047	15.8	16.7	27555	9.0	8.1	74602	12.4	12.0
Caribbean	5607	26.8	23.7	3259	15.3	12.1	8866	21.0	17.5
Central America	6180	7.8	9.0	3482	4.3	4.3	9662	6.0	6.5

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South America	35260	17.8	18.4	20814	10.3	8.9	56074	14.0	13.1
Northern America	102415	59.1	34.8	85297	48.1	23.5	187712	53.5	28.6
Asia	668765	30.8	31.6	267286	12.9	11.0	936051	22.0	20.7
Eastern Asia	501654	61.4	44.8	211141	27.4	16.2	712795	44.9	29.6
South-Eastern Asia	65763	21.8	26.6	27772	9.1	9.4	93535	15.4	17.2
South-Central Asia	72969	7.8	10.7	22519	2.5	3.1	95488	5.3	6.8
Western Asia	28379	22.8	34.0	5854	5.0	6.2	34233	14.2	19.4
Europe	254706	71.2	39.8	99142	25.8	11.8	353848	47.7	24.0
European Union (EU-28)	185589	74.7	37.7	82111	31.7	14.1	267700	52.7	24.7
Central and Eastern Europe	95692	69.5	47.6	26299	16.9	8.3	121991	41.5	24.1
Northern Europe	29606	60.0	29.7	22865	44.9	19.1	52471	52.3	23.8
Southern Europe	61345	79.2	39.1	18288	22.8	10.0	79633	50.6	23.2
Western Europe	68063	73.2	35.3	31690	32.7	14.8	99753	52.6	24.1
Oceania	6339	33.5	23.1	4290	22.8	14.1	10629	28.2	18.3
Australia/New Zealand	5838	42.9	23.5	4053	29.5	15.0	9891	36.1	18.9
Melanesia	303	6.5	13.3	139	3.1	5.0	442	4.8	8.8
Micronesia/Polynesia	198	31.7	38.4	98	16.2	17.3	296	24.0	27.4
Micronesia	93	33.7	41.7	52	19.1	20.8	145	26.5	30.8
Polynesia	105	30.1	36.0	46	13.7	14.8	151	22.1	24.9

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(A) 20 highest in world areas

(B) 20 highest in the world

(C) 20 highest in Africa

(D) 20 highest in America

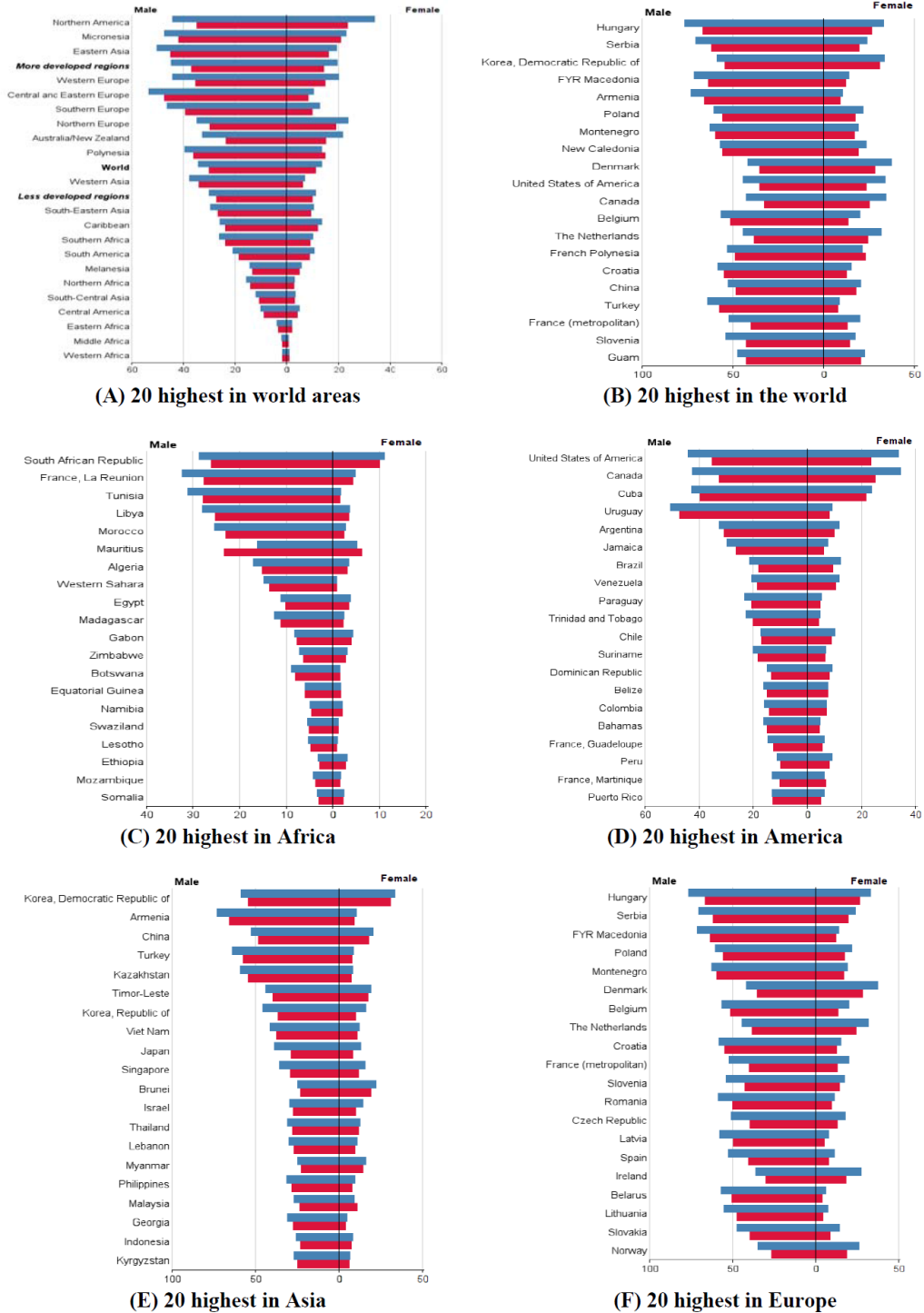**(E) 20 highest in Asia**

(F) 20 highest in Europe

Figure 3. Regions and countries with highest Age-Standardized Incidence Rate (ASIR) and Age-Standardized Mortality Rate (ASMR) of lung cancer in the world.

(d) The ASIR and ASMR of LC according to the WHO classification

The ASIR of LC was equal to 32.8 (48.9 in men, and 18.4 in women) in WPRO, 28.7 (46.9 in men, and 14.4 in women) in EURO, 26 (31.4 in men and 21.6 in women) in PAHO, 10.5 (15.7 in men and 5.7 in women) in SEARO, 7.9 (12.7 in men and 3.3 in women) in EMRO, and 3.9 (5.5 in men and 2.5 in women) in AFRO. From the total incidence of this disease, 46% occurred in WPRO, 24.6% in EURO, 17.7% in PAHO, 8.9% in SEARO, 1.8% in EMRO, and 1% in AFRO (**Table 1**).

The ASMR of LC was equal to 28.5 (43.3 in men, and 15.4 in women) in WPRO, 24 (40.3 in men, and 11.3 in women) in EURO, 20.4 (25.9 in men and 15.9 in women) in PAHO, 9.5 (14.2 in men and 5.2 in women) in SEARO, 7.1 (11.3 in men and 2. in women) in EMRO, and 3.5 (5 in men and 2.3 in women) in AFRO. From the total mortality of this disease, 47.1% occurred in WPRO, 24.4% in EURO, 16.5% in PAHO, 9.2% in SEARO, 1.8% in EMRO, and 1% in AFRO (**Table 2**).
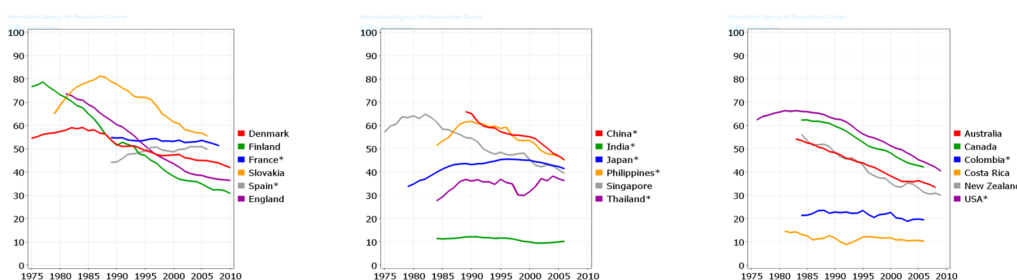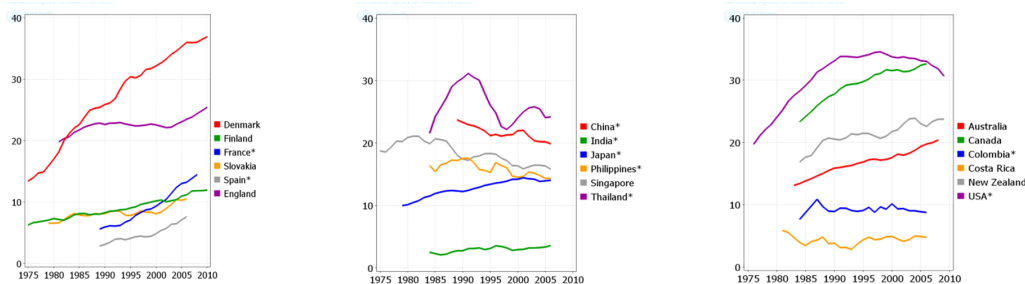

Figure 4. Trends in Age-Standardized Incidence Rate (ASIR) of lung cancer in selected countries (per 100,000 men)
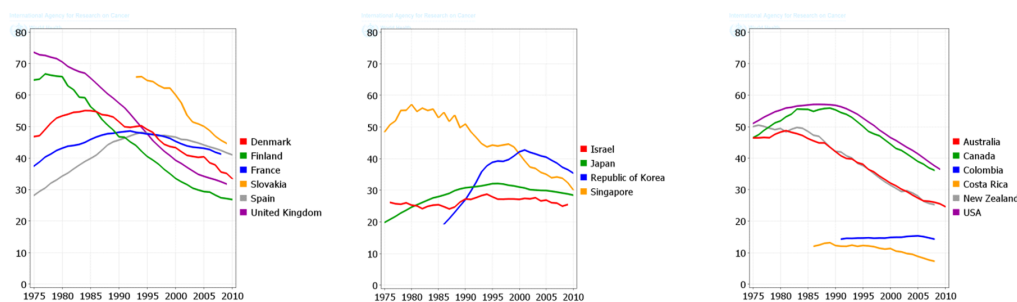
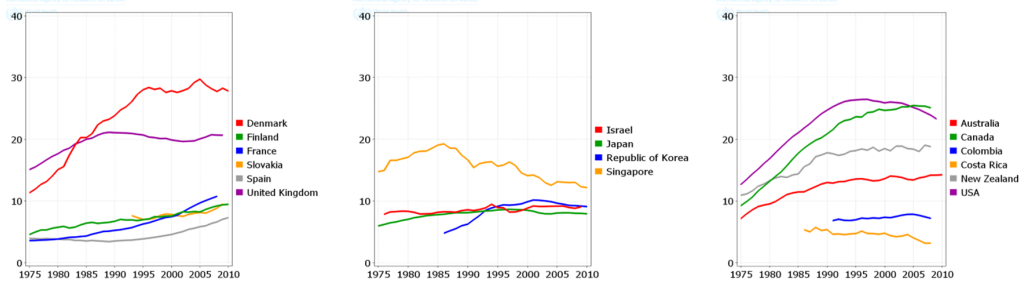**Figure 5. Trends in Age-Standardized Mortality Rate (ASMR) from lung cancer in selected countries (per 100,000 men)**

(e) The ASIR and ASMR of LC according to the levels of Human Development Index (HDI)

The ASIR of LC was equal to 31 (42.2 in men, and 21.8 in women) in regions with very high HDI, 18.7 (32.1 in men, and 8.1 in women) in regions with high HDI, 23.8 (35.6 in men and 13.1 in women) in regions with medium HDI, and 5.4 (7.9 in men and 3.1 in women) in regions with low HDI. From the total incidence of this disease, 47% occurred in regions with medium HDI, 38.7%

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in regions with very high HDI, 12.1% in regions with high HDI, and 2.2% in regions with low HDI (**Table 1**).

The ASMR of LC was equal to 23.9 (34.1 in men, and 15.6 in women) in regions with very high HDI, 16.4 (28.6 in men, and 6.9 in women) in regions with high HDI, 21.6 (32.6 in men and 11.7 in women) in regions with medium HDI, and 4.8 (7.1 in men and 2.8 in women) in regions with low HDI. From the total mortality of this disease, 49.1% occurred in regions with medium HDI, 36.4% in regions with very high HDI, 12.3% in regions with high HDI, and 2.2% in regions with low HDI (**Table 2**).

Figure 6. Trends in Age Standardized Incidence Rate (ASIR) of lung cancer in selected countries (per 100,000 women).

Figure 7. Trends in Age Standardized Mortality Rate (ASMR) from lung cancer in selected countries (per 100,000 women).

(f) **The trend of LC ASIR and ASMR during 1950 to 2010**

The total trend of ASIR and ASMR of LC was descending in men during 1975 to 2010, while it was quite different in women and it was ascending during this period. **Figures 4, 5, 6 and 7** show the trend of incidence and mortality of LC in men and women in some countries during 1975 to 2010.

4. Discussion

The present study aimed to investigate the distribution of LC incidence and mortality worldwide based on the WHO classification, the world's continents, development level, and the HDI level

based on the gender in 2012. It also studied the trend of incidence and mortality of LC based on the gender for some selected countries during 1975 to 2010. In 2012, there were 1824701 new cases of LC in worldwide, of which 68.04% were in men and 31.96% in women. This year also had 1589925 deaths from this disease of which 69.1% were in men and 30.9% in women. The highest ASIR and ASMR of LC occurred in North America, more developed regions, and the WPRO region of the WHO, and regions with very high HDI. Furthermore, the lowest ASIR and ASMR of LC occurred in Africa, the less developed regions, the AFRO region, and regions with low HDI. The ASIR and ASMR of LC was descending in men, but ascending in women in most of the world's countries from 1975 to 2010.

The highest ASIR and ASMR of LC occurred in areas with very high HDI, but the lowest rate was seen in areas with low HDI. Similar results with the present research were found in a study by Pakzad *et al* on the relationship between the HDI and the ASIR and ASMR of LC in Asian countries. According to their study, an increase in the HDI led to the increased ASIR and ASMR of LC, so that the correlation was equal to 0.345 between the HDI and the ASIR, and equal to 0.289 with ASMR, that it was statistically significant [17]. High life expectancy and average life span were the main reasons for the high ASIR and ASMR of LC in regions with very high HDI. These regions may also have much higher prevalence of smoking than other regions of the world. For instance, the annual cigarette consumption per capita was increased more than 70 times (from 54 to 4,000 cigarettes) in the United States from 1880 to 1970 (12). On the other hand, there might be the under estimate of incidence and mortality number of cancer cases in regions with low HDI due to the existing problems with diagnosis of the disease as well as problems with the registration of cancer cases, and thus the actual cases of this disease were higher than the diagnosed and recorded cases. These problems have also been observed in other cancer studies [19,20,22–28].

In this study, the incidence and mortality number of LC in men was twice as high as in women, so that 68% of incidence and 69% of mortality of LC occurred in men. Similar results were observed in a study by Pakzad *et al* in Asian countries, to that 71.13% of new cases and 71.45% of deaths occurred in men in Asia during 2012 [17]. Probably, the main reason for the disparity in the incidence and mortality of LC among men and women is the disparity in their exposure to the risk factors of the disease.

The geographical distribution of LC was largely associated with the prevalence of cigarette smoking, so that in Kentucky State of the United States, where the prevalence of cigarette smoking was equal to 30%, the ASIR of LC was 125.9 in men, and 80.3 in women per 100,000 people, while in California, where the prevalence of cigarette smoking was 14%, the ASIR of LC was 60.4 in men and 44.4% in women per 100,000 people [29]. During 1973 to 2007, the incidence of LC was steadily decreasing in white women in California, while no decreasing trend of mortality was seen in women in Midwestern and Southern States, indicating the effectiveness of control programs in reducing the incidence of cigarette smoking in California State [30].

The maximum prevalence of cigarette smoking in men has been two decades earlier than women; hence, it is expected that the epidemic of this LC will begin in women at a time interval after men. The incidence of LC in men has been descending over the past few decades, while the incidence of this disease is still ascending in women [30]. Despite the fact that the number of men, who annually die from LC, is much higher than women, it is expected that over the years to come the disparity in mortality rates between both genders will become minimal [10].

Cigarette is thus one of the most important factors affecting the incidence of LC worldwide. Furthermore, due to the high cost and limited effectiveness of screening methods and therapeutic measures in LC, cigarette is one of the key factors in the death from LC [31]. Therefore, effective measures can be taken to reduce the incidence of cigarette smoking to reduce the burden of LC in the global arena especially in the African regions and some Asian countries with limited access to screening and treatment programs [32]. In areas such as Australia, California and Hong Kong, which have begun the cigarette prevention programs, the incidence of LC is expected to reduce significantly especially in men. Since there is a long latency interval between smoking and occurrence of LC, the incidence of LC will significantly increase in countries like China, where

there is not any adequate program to reduce the prevalence of cigarette smoking, in the upcoming decades [33].

Therefore, governments should adopt appropriate planning and policies to prevent LC. In addition to reduction of the prevalence of smoking, they should also reduce the exposure to other well-known risk factors such as Asbestos, Radon, air pollution, occupational carcinogens and second-hand smoke [34,35].

Study Limitations

This study, has been conducted using data of GLOBOCAN project of World Health Organization(WHO) in 2012. The aim of the GLOBOCAN project is to provide contemporary estimates of the incidence, mortality and prevalence from major types of cancer, at national level, for 184 countries of the world. Although data from the GLOBOCAN project is currently the most comprehensive source of information on the distribution of cancers worldwide. Nevertheless, one of the limitations of this study is the use of data of 2012, due to the lack of newer data in the global level. Also, the quality of collected cancer data in the GLOBOCAN project is not similar in all countries especially those with medium or low HDI, so that the estimates of some countries are based on the recorded cases of cancer in limited areas or based on estimates from neighboring countries [36].

5. Conclusions

The highest ASIR and ASMR of LC occurred in North America, more developed regions, and the WPRO region of the WHO, and those regions with very high HDI. Furthermore, the lowest ASIR and ASMR of LC occurred in Africa, the less developed regions, the AFRO region, and regions with low human development indexes. Most regions of the world had decreasing incidence and mortality of LC in men and increasing trend in women.

6. Open Access

7. List of abbreviations

AFRO: WHO Africa region, **ASIR**: Age- Standardized Incidence Rate, **ASMR**: Age- Standardized Mortality Rate, **EMRO**: WHO East Mediterranean region, **EURO**: WHO Europe region, **HDI**: Human Development Index, **IARC**: International Agency for Research on Cancer, **PAHO**: WHO Americas region, **SEARO**: WHO South-East Asia region, **WHO**: World Health Organization, **WPRO**: WHO Western Pacific region

8. Ethics approval and consent to participate

Not to be applied

9. Competing interests

The authors declare that they have no conflicts of interest.

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11. Authors' contributions

All authors contributed to the design of the research. MM, HS, MA, FAB and AMH extracted the data and summarized it. All authors drafted the first version. HSG, AS, AMH and KAB edited the first draft. All authors reviewed, commented and approved the final draft.

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