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THE INCIDENCE AND MORTALITY OF THYROID CANCER AND ITS RELATIONSHIP WITH HDI IN THE WORLD

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Abstract – *Objective:* *Thyroid cancer is one of the most common endocrine cancers with high mortality rates compared to other cancers of this subtype. Further knowledge about the incidence and mortality of this disease and its geographical distribution are salient for early diagnosis and prevention of this cancer. Therefore, this study has been implemented with the aim of determining the incidence and mortality rate of thyroid cancer and its relationship with Human Development Index (HDI) in the world in 2012.*

Materials and Methods: *This is an ecological study conducted based on the data from GLOBOCAN project of World Health Organization (WHO) and HDI from World Bank. The correlation between standardized incidence rates (SIRs) and standardized mortality rates (SMRs) of thyroid cancer with HDI and its components was assessed with correlation coefficient by using SPSS 15.*

Results: *A total of 298102 incidences of and 39771 deaths from thyroid cancer were recorded in 2012 worldwide. The standardized incidence and death rate of thyroid cancer were 4 and 0.5 per hundred thousand people, respectively. A positive correlation of 0.408 was seen between the standardized incidence rate of thyroid cancer and human development index. This association was statistically significant if* $p<0.001$. *In stark contrast, however a negative correlation of -0.309 was seen between the standardized mortality rates of thyroid cancer with Human Development Index. This correlation was statistically significant when* $p<0.001$.

Conclusions: *The highest incidence rate of thyroid cancer occurs in very high HDI countries and the highest mortality rate occurs in low and average HDI countries. In order to reduce the incidence and mortality of thyroid cancer, further investigations are needed to prevent this disease.*

KEYWORDS: *Incidence, Mortality, Thyroid cancer, Development, World.*

INTRODUCTION

Nowadays cancers are regarded as one of the most significant health problems around the world[1], meaning that the number of involved person is rising[2] and they impose a major disease burden on the society[3]. Thyroid cancer is the fifth most common cancer among the women[4]. It is worth to mention here that this cancer is one of the most common endocrine diseases[5] which has the most number of mortality rate compared to other subtypes of this cancer[6].

The incidence rate of thyroid cancer shows a twofold increase from 1990 to 2013 in both sexes[7]. It is anticipated that approximately 57 thousand new cases of cancer will occur in 2017 in America and that this number would be 3.4% of all cancer inci-

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dence cases actually[8]. This ascending trend already exists in every continent except Africa, may be due to inadequate detection[9]. Although the incidence and prevalence of thyroid cancer is increasing, the death rate remained stable at 1-2% during 1973 to 2002 due to early diagnosis and treatment[10-13].

Averagely, thyroid cancer is 3 to 4 times more common in women than men[14,15] in all age groups. However, it is more common in people over 30 and its peak is after the fertility years in women; among men, it is more likely observable at about 45 to 49 and 65 to 69 years old[14,16]. The incidence of this cancer is more than 2 times in developed countries compared to developing countries in both sexes[17].

The incidence rate of this cancer may be widely variable around the world due to potential causes, such as access to medical care, ethnical racial differences, geographical and environmental variety including excessive iodine or deficiency and exposure to radiation. This amount has been observed in particular regions such as Hawaii[18-20]. It is worth to point out that Gardner syndrome, familial adenomatous polyposis syndrome, Cowden syndrome, celiac disease, obesity and high levels of thyrotropin (TSH) are presented along with stimulating thyroid cancer cells growth and its metastasis as a mitogen[21-24].

United Nations Development Program (UNDP) has applied the Human Development Index (HDI) for the first time in 1990 in order to measuring human development more comprehensively[25]. Arithmetic HDI represents three indicators of life including expectancy at birth, access to knowledge and per capita income, which are used for investigating the status of illnesses and deaths between countries[26]. As a matter of fact, this index is associated with the incidence and mortality rate of many cancers[27-29]. The knowledge about the incidence and mortality rate of thyroid cancer can be useful for health programs and research activities and considering the possible role of the HDI. This study has been performed with the aim of determining the incidence and mortality rate of thyroid cancer and its relationship with development index and its components worldwide in 2012.

MATERIALS AND METHODS

This is an ecologic study in the world for assessing the correlation between age-specific incidence and mortality rate (ASR) of thyroid cancer with Human Development Index (HDI) and its components that include: life expectancy at birth, mean years of schooling and gross national income (GNI) per capita. Data about the age-specific incidence and mortality rate (ASR) of countries for the year 2012 were obtained from global cancer project (available at http://globocan.iarc.fr/Default.aspx)[30]. Human Development Index (HDI) data were obtained by Human Development Report in 2013[31] including information about HDI and its components for every country in the word in 2012. Evaluation of the age-specific incidence and mortality rates were obtained from global cancer project by international agency for previously published research on cancer[1,30,32].

In this study, the correlation bivariate method was applied for assessing the correlation between age-specific incidence and mortality rate (ASR) with Human Development Index (HDI) and its components.

Statistical Analysis

Statistical analyses were performed using SPSS (Version 15.0, SPSS Inc., Chicago, IL, USA). Statistical significance was assumed if $p<0.05$. All reported p-values are two-sided.

RESULTS

The incidence rate of thyroid cancer

A total of 298102 thyroid cancer cases occurred in 2012 worldwide: 66179 of them were men and 229923 were women (Sex Ratio = 0.28). Among all of thyroid cancer population,147319 were in countries with a very high HDI, 54861 cases in countries with high HDI, 84613 in countries with medium HDI and 11188 cases in countries with low HDI. Five countries which had the highest number of thyroid cancers were America with 52,126 cases, China with 46361 cases, Republic of Korea with 32992 cases, India with 13877 cases and Brazil with 13904 cases. Five countries that had the remarkable rate of thyroid cancer in men were America with 13142 cases, China with 11269 cases, the Republic of Korea with 5350 cases, India with 3960 cases and Italy with 2648 cases, respectively. Five countries that had the highest number of thyroid cancer in women included America with 38,984 cases, China with 35,092 cases, Republic of Korea with 27642 cases, Brazil with 11265 cases and Italy with 9944 cases.

Age-standardized incidence rate of thyroid cancer

The standardized incidence rate of thyroid cancer was four per hundred thousand people which was 1.9 per hundred thousand people in men and 6.1 in women in the world. The standardized incidence rate of thyroid cancer in countries with very high HDI was 9.9 per hundred thousand people, 4.8 per hundred thousand people in countries with high HDI, 2.2 per hundred thousand people in countries with average HDI, and 1.3 per hundred thousand people in countries with low HDI.

Furthermore, the five countries that had the highest age-standardized incidence rate of thyroid cancer included: Republic of Korea with 52.8 per hundred thousand people, New Caledonia with 22.2 per hundred thousand people, Puerto Rico with 16.1 per hundred thousand people, French Polynesia with 15.2 per hundred thousand people, and United States of America with 13.2 per hundred thousand people, respectively. Other countries with highest age-standardized incidence rate of thyroid cancer for men included Republic of Korea with 17.3 per hundred thousand people, New Caledonia with 8.3 per hundred thousand people, French Polynesia with 6.8 per hundred thousand people, Italy with 6.7 per hundred thousand people, and the United States of America with 6.4 per hundred thousand people. The countries with the highest age-standardized incidence thyroid cancer for women included Republic of Korea with 88.6 per hundred thousand people, New Caledonia, with 35.8 per hundred thousand people, Puerto Rico with 25.4 per hundred thousand people, French Polynesia with 24 per hundred thousand people and Canada with 20.6 per hundred thousand people.

Number of deaths from thyroid cancer

The number of 39771 deaths occurred from thyroid cancer worldwide in 2012: 12626 cases of them were men and 27145 cases were women (sex ratio=0.46). The number of cancer deaths in countries with very high HDI was 8620, 8214 in countries with high HDI, 16690 in countries with an average HDI, and 5941 cases in countries with low HDI. Five countries that had the highest number of deaths from thyroid cancer included China with 5484 deaths, India with 3290 deaths, Indonesia with 3103 deaths, Russia with 2020 deaths and America with 1965 cases. Five countries that had the most cases of death from thyroid cancer in men included China with 2272 death cases, India with 953 deaths, Indonesia with 920 deaths, America with 857 deaths and Japan with 593 deaths. Considering female patients, five countries that had the highest number of deaths from thyroid cancer were China with 3212 deaths, India with 2337 deaths, Indonesia with 2183 deaths, Russia with 1538 deaths and Japan with 1171 deaths.

Age-standardized mortality rate of thyroid cancer

Standardized death rate of thyroid cancer was 0.5 per hundred thousand people in 2012 in the world: this amount was 0.3 in men, and 0.6 per hundred thousand people in women. Standardized mortality rate of thyroid cancer was 0.3 per hundred thousand people in countries with very high HDI, 0.7 per hundred thousand people in countries with high HDI, 0.5 per hundred thousand people in countries with average HDI, and 0.9 per hundred thousand people in countries with low HDI. The highest standardized death rate of thyroid cancer were observed in Vanuatu with 4.6 per hundred thousand people, Papua New Guinea with 4.4 per hundred thousand people, Solomon Islands with 4.2 per hundred thousand people, Ethiopia with 2.9 per hundred thousand people and Timor-Leste with 2.8 per thousand people, respectively. Five countries that had the highest standardized mortality rate of thyroid cancer for men were Timor-Leste with 2.5 per hundred thousand people, Ethiopia with 2.1 per hundred thousand people, New Caledonia with 2 per hundred thousand people, Eritrea with 1.9 per hundred thousand people and Guam with 1.9 per hundred thousand people, respectively. Besides, other countries that had the highest standardized death rate of thyroid cancer in female patients included Vanuatu with 7.9 per hundred thousand people, Solomon Islands with 7.3 per hundred thousand people, Papua New Guinea with 6.6 per hundred thousand people, Ethiopia with 3.5 per hundred thousand people and the State of Palestine with 3.3 per hundred thousand people.

The relationship between age-standardized incidence rate of thyroid cancer and human development index

There is statistically significant relationship (p=0.408) between the standardized incidence rate of thyroid cancer and human development index (p<0.001). Also, the positive correlation between components of human development index and the standardized incidence rate of thyroid cancer was observed.

A positive correlation was observed between the components of human development index and standardized incidence rate of thyroid cancer, as well as this correlation was 0.397 between the standardized mortality rate and life expectancy at birth (p<0.001), was 0.375 with mean of education years (p<0.001) and was 0.297 with income level per person of the population (p<0.001).

The relationship between age-standardized mortality rate of thyroid cancer and human development index

A negative correlation of -0.309 was observed between the standardized mortality rates of thyroid cancer with Human Development Index, which was statistically significant (p<0.001). Also, there was a negative correlation between the components of human development index and standardized mortality rate of thyroid cancer, as well as this negative correlation was -0.149 between the standardized mortality rate and life expectancy at birth (p=0.054), was -0.342 with mean of education years (p<0.001) and was -0.230 with income level per person of the population (p=0.003).

DISCUSSION

Overall, the number of 298102 new cases and 39771 deaths of thyroid cancer have been recorded in 2012. The highest incidence rate is apparent in very high HDI countries and the highest mortality rate is observed in countries with low and medium HDI. The incidence rate of this cancer is widely variable around the world, which is associated to potential causes such as ethnical, racial, geographical differences and variety in environment[33].

According to our findings, the standardized incidence rate of thyroid cancer is correlated with the Human Development Index and its markers in the world, and the standardized incidence rate of that is soaring in developed countries. The results of the study conducted in the United States revealed that the incidence of this cancer has been plunged to approximately three-fold from 1975 to 2009 (from 4.9 to 14.3 per 100 thousand people). So, thyroid cancer epidemic is growing in this country but it seems that this climbed incident is due to better diagnosis[34]. Moreover, considering industrial lifestyle, in countries with high HDI, the chance of involving with thyroid cancer risk factors, including exposure to medical radiation, may be raised. As a result, increased incidence rate of thyroid cancer is probably due to a combination of the apparent advancement of detection methods and increasing exposure to carcinogens[4]. Among other risk factors of this cancer, history of benign adenoma or nodules, goiter, or taking too much or lack of iodine, reproductive factors such as the recent pregnancy should be pointed out. Although, some risk factors such as exposure to ionizing radiation and inherited genetic mutations have been well documented, but the main causes of these malignancies remains unclear[35-38].

In this study, the standardized mortality rate of thyroid cancer is associated with human development index and its markers in the world and the countries with the highest standardized mortality rates of thyroid cancer also include low and medium HDI countries. Average death rate of thyroid cancer has changed from 92 in 2010 to 99 in 1990 around the world, meaning that it has increased 50%. However, in areas with low level of development, such as the Middle East and parts of Africa, this rank has reached to 74 in 2010 from 84 in 1990 (has changed 86%)[39]. Overall, 10-year survival rate of this disease is between 80 to 95% depending on the type of thyroid carcinoma[40]. However, the age of diagnosis of thyroid cancer varies widely[41]. Given that cancer survival is lower for people who are diagnosed at a later age, due to this fact, in countries with a lower level of development, later diagnosis is more common, so the higher rate of deaths from thyroid cancer in less-developed countries is more justifiable than in developed ones[42,43].

One of the aspects of the HDI is life expectancy at birth. In this study, it has a significant positive correlation with the standardized incidence rate of thyroid cancer and a negative significant correlation with mortality of that. The results of another study found that life expectancy at birth is directly related to age-related diseases such as cancer. By developing the countries and eliminating other causes of mortality and increased life expectancy, the incidence of cancer and other chronic diseases has increased due to people's increased interacting time with related risk factors[27]. However, in relation to thyroid cancer mortality, it is noteworthy that aging is along with the cumulative incidence of dying from this cancer[44]. A study[41] conducted in Germany showed that survival significantly reduces in patients older than 60 years.

Also in this study, a significant relationship has been observed between the standardized incidence rate and death from thyroid cancer and another component of the human development index (literacy level or average years of education). The level of education had a positive and significant correlation with the incidence of this cancer and a significant negative correlation with mortality rate of that. A study in Switzerland showed that the incidence of thyroid cancer in people with high education levels occurs more than those with lower levels of education[45]. This may be due to detection bias as a result of disparities in the method of diagnosis[46]. In addition, the level of education may be related to health conditions such as stage of diagnosis, timeliness, cancer treatment, and psychological support, which have direct or indirect effects on mortality rates from cancer[47-53].

In this study, a significant positive correlation was seen between the standardized incidence rate of thyroid cancer and another component of human development index (appropriate income levels (GDP)) and a negative significant correlation between the standardized mortality rate and appropriate income levels (GDP). Socio-economic status may be considered as a substitute for access to diagnostic technology. The incidence of this cancer in cities with high economic and social status is higher than that in cities with lower social and economic status[54]. For instance, a study in Los Angeles found that thyroid cancer in people with high socio-economic level is more than in people with low socio - economic status[55]. In addition, delay in providing medical and health care as a result of low socio-economic level, may be a major factor in the increased metastases of thyroid cancer and have a reducing effect on the prognosis of this cancer. So, the prognosis of this cancer is more favorable in developed countries with better economic status in comparison with developing countries. Lower mortality in countries with high development is due to early detection, access to medical care, and appropriate treatment[56].

CONCLUSIONS

The highest incidence rate of thyroid cancer occurs in very high HDI countries and the highest mortality rate of that occurs in low and average HDI countries. In order to reduce the incidence and mortality of thyroid cancer, performing the studies with the aim of investigating the causes of this cancer is necessary.

Conflict of Interest:
The Authors declare that they have no conflict of interests.

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