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Assessing global kidney cancer incidence and mortality rates according to population category by income levels in 2020: An ecological study

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ABSTRACT

Introduction: Population categories based on income levels are frequently utilized to compare cancer rates across various countries. It is a valuable tool for assessing global health and helps to classify cancers and measure the incidence and mortality of different types of cancer.
Objectives: This study aimed to evaluate global kidney cancer incidence and mortality rates in 2020 according to population category by income levels, using an ecological study design.
Methods and Materials: This ecological study examines the correlation between the incidence and mortality of kidney cancer in 2020, reported by the GLOBOCAN project, since the population category by income levels was reported by the World Bank report. The linear regression method was conducted to assess this correlation.
Results: Results demonstrated that the global incidence and mortality rate of kidney cancer in 2020 was estimated at 431288 and 179368 cases, respectively. The incidence and mortality rate of kidney cancer were higher in high-income countries, and both rates tend to be higher in more developed regions. However, there was no statistically significant correlation between the population category by income levels and kidney cancer incidence and mortality based on both crude rate (CR) and age-standardized rate (ASR) indicators ($P > 0.05$).
Conclusion: We conclude that incidence and mortality rates of kidney cancer are not associated with population category by income level.

Implication for health policy/practice/research/medical education:
In an ecological study based on the data from the GLOBOCAN project in 2020, we found that high-income countries showed higher rates of new kidney cancer cases.
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Introduction

Cancer is a worldwide problem that accounts for a significant portion of global deaths with an incidence of approximately 23.6 million and mortality of 10 million annually (1). Kidney cancer starts in the kidneys, two bean-shaped organs of the body. The most common type of kidney cancer among adults is renal cell carcinoma, which accounts for about 90% of all kidney cancers, and among

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children is Wilms tumor, known as nephroblastoma. It accounts for about 1.1% of all kidney cancers and is typically found in children (2).

Kidney cancer, with a share of 2% to 3% of all cancers, has shown a high growth rate in all age and racial groups worldwide (3, 4) and accounts for about 5% and 3% of all malignancies and ranks sixth and tenth most common cancer in men and women respectively (5). It is known also as the world's 16th most common cause of cancer death (6) and was reported responsible for 2% of all cancer deaths in 2016 (7). Kidney cancer incidence varies worldwide, with higher rates in developed countries than in developing, men compared to women, and ages more than 60 years (4,8). This increased incidence rate can be due to improved diagnostic procedures and public awareness of health screening (3). Over the past 30 years, despite increasing the incidence of kidney neoplasm, particularly in developed countries, due to early diagnosis and treatment, the mortality rate has decreased rapidly (9).

Several factors can affect the occurrence and death rates of cancer across different ethnic and geographic regions. These factors include the frequency of kidney cancer screenings, accidental diagnoses, genetic and environmental risk factors, and socio-economic status (10,11). One of the most common reasons for varying rates of incidence and mortality across regions is the difference in access to a high standard of living based on gross national income (GNI) because of purchasing power parity, which is mentioned as economic income level. This indicator is commonly employed to compare cancer rates across different countries and is considered a valuable tool for evaluating global health. It helps to classify cancers and is used to measure the incidence and mortality of different types of cancer (12).

Objectives

This study aims to assess the global incidence and mortality rates of kidney cancer in 2020, according to population category by income levels, through an ecological study. The study will provide insights into the epidemiological patterns of kidney cancer in different countries and population categories, which can inform efforts towards equitable cancer control around the world.

Methods and Materials

Study design

This study is an ecological study that evaluates the correlation between population category by income levels reported by the World Bank report (World Bank Atlas method) and the incidence and mortality of kidney cancer in 2020 extracted from the global cancer (GLOBOCAN) project of the World Health Organization (WHO) (https://gco.iarc.fr/).

Population category by income levels

Countries with a GNI per capita of $1,135 or less are considered low-income economies according to the world bank report in 2022 (World Bank Atlas method). Those with a GNI per capita between $1136 and $4465 fall under lower-middle-income economies, while upper-middle-income economies have a GNI per capita between $4466 and $13 845. High-income economies are those with a GNI per capita of $13 846 or more. There were 26 countries in the low-income economies category, 83 in the high-income economies category, and 54 in each of the lower and upper middle-income economies categories.

Incidence definition

The incidence definition was defined based on the global cancer project (https://gco.iarc.fr/today/data-sources-methods). To estimate the incidence rates of cancer in a specific country by age and gender, various methods can be used. These methods are ranked in order of priority below: Projecting observed national incidence rates up to 2020 in 45 countries. Applying the most recent national or regional incidence rates to the 2020 population in 54 countries. Estimating rates from national mortality data by modeling and using cancer registry-derived mortality-to-incidence ratios in 14 countries. Estimating rates from national mortality estimates by modeling and using cancer registry-derived mortality-to-incidence ratios in neighboring countries in 37 countries.

Mortality definition

The mortality definition was defined based on the global cancer project (https://gco.iarc.fr/today/data-sources-methods). To estimate the mortality rates of cancer for different age and gender groups within a specific country, the following methods are conducted in order of priority:

1. Projecting the observed national mortality rates for 2020 (used in 80 countries)
2. Applying the most recent mortality rates (either national or regional) to the 2020 population (used in 21 countries)
3. Estimating rates based on national incidence estimates through modeling, using incidence-to-mortality ratios from neighboring countries' cancer registries (used in 81 countries)
4. Calculating rates as an average of those from selected neighboring countries (used in 3 countries)

Data collection

Data for estimated kidney cancer incidence and mortality in 2020 worldwide (185 countries) were extracted from the GLOBOCAN project (https://gco.iarc.fr/). Data for population category by income levels were derived from the World Bank report (World Bank Atlas method).

Statistical analysis

We used Statistical Package for the Social Sciences (SPSS) software version 27 and the linear regression method to investigate the correlation between kidney cancer incidence

and mortality with population category by income levels. A $P< 0.05$ was considered significant.

Results

Results indicated that according to GLOBOCAN project data in 2020, the estimated kidney cancer incidence and mortality were 431 288 (271 249 males and 160 039 females) and 179 368 (115 600 males and 63 768 females) cases respectively. The countries with the highest incidence frequency were those with high-income levels, while the highest death frequency was found in upper-middle income regions. Countries with low income had the lowest incidence and mortality. In terms of age-standardized rates (ASR), the countries with high-income levels had the highest ASR, and countries with lower middle-income levels had the lowest regarding both incidence and mortality rates. In terms of crude rate (CR), countries with high-income levels had the highest incidence and mortality rates, while countries with lower-middle-income levels had the lowest incidence and low-income levels countries had the lowest mortality (Table 1 and Figure 1).

The frequency distribution and percentage of kidney cancer incidence and mortality according to population category by income levels were demonstrated in Figure 2.

The distribution of estimated kidney cancer incidence based on ASR per 100 000 in the world was reported in Figure 2, and the estimated kidney cancer mortality rate (ASR per 100 000) individuals worldwide was shown in Figure 3. Australia, Argentina, Chile, Europe, and North American countries had the highest ASR regarding both incidence and mortality of estimated kidney cancer in 2020, and Asia and African countries had the lowest (Figures 3 and 4).

Results found that the association between global kidney incidence and mortality rates based on both ASR and CR indicators with population category by income levels was not statistically significant ($P>0.05$; Table 2).

Discussion

Kidney cancer is a significant health problem worldwide and a common malignancy in the United States (13). Its growth rate has shown highest across all age groups and races (14,15). In 2020, it was estimated that there were 431 288 new cases of kidney cancer worldwide, and 179 368

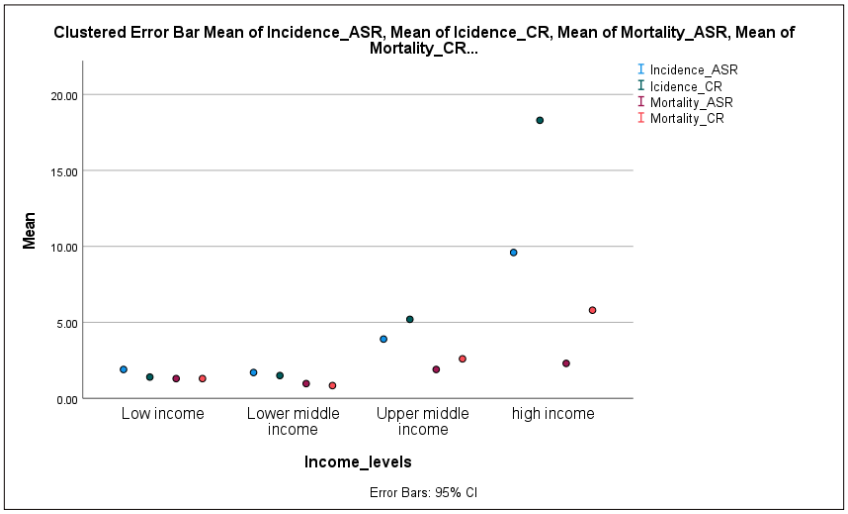

Figure 1. Incidence and mortality rate (Crude Rate and ASR) of global kidney cancer based on population category by income levels in 2020 (Source: GLOBOCAN, 2020).

Table 1. Estimated global kidney cancer incidence and mortality rate in 2020 according to population category by income levels

Indicator	Population (Income levels)	Number	Uncertainty Interval		CR	ASR	Cumulative risk
Incidence	High income	224938	221962	227954	18.30	9.60	2.02
	Upper middle income	152128	146906	157536	5.20	3.90	0.81
	Lower middle income	45604	41287.6	50371.6	1.50	1.70	0.33
	Low income	8421	7226.8	9812.6	1.40	1.90	0.33
Mortality	High income	71303	69455.6	73199.6	5.80	2.30	0.79
	Upper middle income	77045	75892.6	78214.9	2.60	1.90	0.54
	Lower middle income	25423	23409.6	27609.6	0.84	0.97	0.25
	Low income	5534	4664.2	6566	1.30	1.30	0.26

ASR (world), Age-standardized rates per 100 000; CR, Crude rate per 100 000.

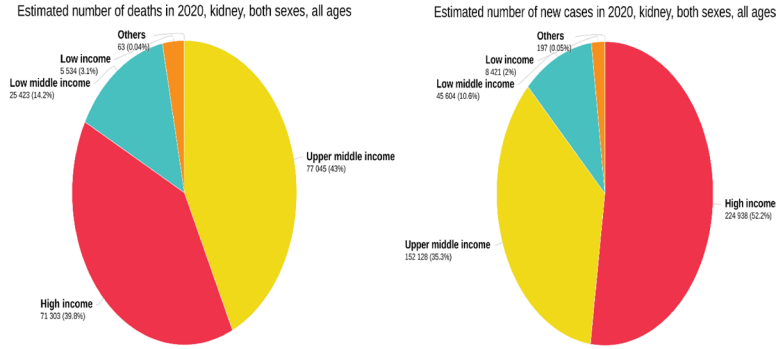

Figure 2. Frequency distribution of deaths and new cases of global kidney cancer in 2020 according to population category by income levels (Source: GLOBOCAN, 2020). Reprinted with permission form IARC/WHO, Copyright (2023). Available from: https://gco.iarc.fr/. Accessed June 2023.

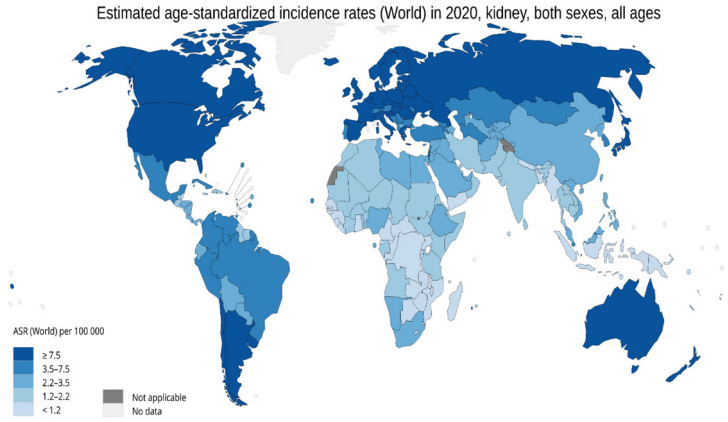

Figure 3. The global kidney cancer incidence (ASR) in 2020. (Source: GLOBOCAN, 2020). Reprinted with permission form IARC/WHO, Copyright (2023). Available from: https://gco.iarc.fr/. Accessed June 2023.

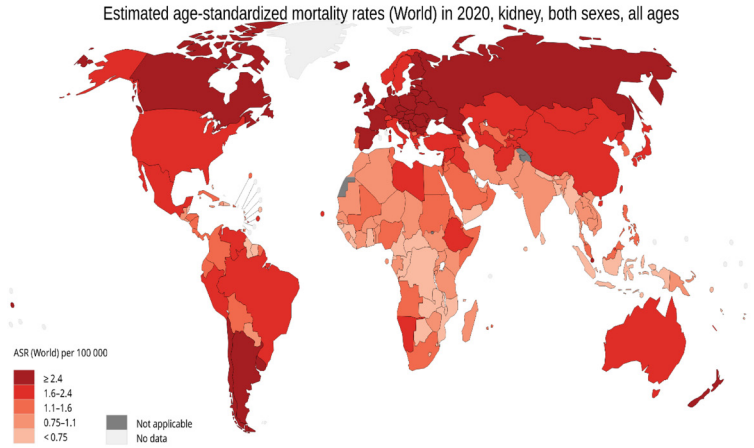

Figure 4. The global kidney cancer mortality (ASR) in 2020. (Source: GLOBOCAN, 2020). Reprinted with permission form IARC/WHO, Copyright (2023). Available from: https://gco.iarc.fr/. Accessed June 2023.

people died from the disease (16). Based on GLOBOCAN data, our assessment showed that kidney cancer incidence and mortality were higher in high-income countries, and both tend to be higher in more developed regions. However, there was no statistically significant correlation between the population category by income levels and kidney cancer incidence and mortality based on both CR and ASR of incidence and mortality for kidney cancer. In line with our study, the studies by Ferlay et al (15) and Fitzmaurice et al (17) demonstrated that in developed

Table 2. The correlation between incidence and mortality rates of estimated kidney cancer with population category by income levels in the world, 2020, using linear regression method

Variables (Indicator)	B	Standard error	*P* value	95% CI	
				Lower	Upper
Incidence (ASR)	2.53	0.93	0.114	-13.08	8.98
Incidence (CR)	5.44	2.09	0.122	-3.57	14.45
Mortality (ASR)	0.39	0.17	0.149	-0.34	1.13
Mortality (CR)	1.52	0.85	0.120	-0.97	4.02

CI, Confidence interval; ASR (world), Age-standardized rates per 100 000; CR, Crude rate per 100 000.

countries, kidney cancer incidence and mortality are higher compared to developing regions.

Our results also showed that the highest ASR of incidence and mortality of kidney cancer in 2020 were found in Australia, Argentina, Chile, Europe, and North American countries. In contrast, Asia and African countries had the lowest ASR regarding both incidence and mortality of estimated kidney cancer. Some studies demonstrated similar results and reported that the occurrence of kidney cancer is rising worldwide, especially in European nations and younger individuals (16). The main decreases in kidney cancer mortality rates were in Scandinavian region and other western European countries (18).

There are several possible explanations for the higher kidney cancer incidence and mortality rates in developed countries, including lifestyle factors; developed countries tend to have higher rates of smoking, alcohol consumption, obesity, and hypertension, which are all risk factors for kidney cancer (6). Environmental factors; developed countries may have higher levels of exposure to environmental toxins, such as heavy metals, pesticides, and industrial chemicals, which have been linked to an increased risk of kidney cancer (18,19). Improved detection; developed countries may have better access to healthcare and more advanced diagnostic tools, which could lead to earlier detection of kidney cancer (20). Aging population; developed countries tend to have older populations, and kidney cancer incidence increases with age (6). Genetic factors, here may be genetic factors that contribute to the greater incidence and mortality of kidney cancer in developed regions (18).

Although our assessment indicated no significant correlation between global kidney incidence and mortality rates based on both ASR and CR indicators with population category by income levels. However, some studies reported that in the next few decades, the number of patients with kidney cancer is expected to increase due to aging and population growth, and by 2030, the occurrence of kidney cancer is predicted to be 62% in regions with low and middle income and 39% in high and very high-income areas (4,19,21). Our results can assist policy-makers and health managers in identifying the causes of kidney cancer incidence and mortality in varying regions and plan better for prevention and further studies.

Conclusion

Based on our study's results, the frequency of new cases and mortality numbers of kidney cancer are higher in high-income countries; however, there is no significant correlation between global kidney incidence and mortality rates based on both ASR and CR indicators with population category by income levels. Therefore, we conclude that incidence and mortality rates of kidney cancer are not associated with population category by income levels. More studies are necessary to investigate kidney cancer incidence and mortality worldwide, as well as its related factors.

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Authors' contribution

Conceptualization: Soleyman Alivand and Farinaz Fattahi

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Project Management: Anna Ghorbani Doshantapeh.

Resources: All authors.

Supervision: Soleyman Alivand.

Validation: Zahra Zarei and Simin Soltani Nejad.

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Writing–reviewing & editing: Farinaz Fattahi, Mehdi Hosseinifard, Hakimeh Karimi Aliabadi, and Anna Ghorbani Doshantapeh.

Conflicts of interest

There are no competing interests.

Ethical issues

The study adhered to the principles of the Declaration of Helsinki and utilized data from the WHO's GLOBOCAN

project. The research protocol was registered on the Research Registry website (UIN: researchregistry9472). Besides, ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the authors.

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