RESEARCH ARTICLE

Editorial Process: Submission:12/13/2025 Acceptance:07/18/2026 Published:07/27/2026

Cancer Distribution Pattern in the City of Kenitra, Morocco (2017-2022): A Pathology-Based Study

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Abstract

Background: Cancer epidemiological surveillance is essential for implementing an effective prevention policy. In Morocco, only two population-based cancer registries (Rabat and Casablanca), along with a limited number of local studies, provide data on cancer incidence. This report aims to describe the pattern of cancer incidence rates in the region of Kenitra. **Methods:** This was a pathology-laboratory-based retrospective and descriptive study of all newly diagnosed cancers in public and private pathology laboratories in Kenitra between January 2017 and December 2022. Data on gender, age, and cancer locations were collected from medical records. Statistical analysis was limited to descriptive statistics, including frequencies, percentages, crude incidence rates, and age-standardized rates. **Results:** 2,682 cancer cases were recorded, with 1,535 males (57.23%) and 1,147 females (42.77%). The female-to-male ratio is 0.74. The median age at diagnosis was 59 (55 for females and 62 for males). The crude incidence rate was 254 per 100,000 population (291 per 100,000 for males and 217 per 100,000 for females). The overall age-standardized rate (ASR) was 283 per 100,000 (162 per 100,000 for males and 120 per 100,000 for females). The leading cancers among males were prostate (34.31%), bladder (19.27%), skin (13.54%), non-Hodgkin lymphoma (5.34%), stomach (3.97%), lung (3.84%), and colon (3.84%). The leading cancers among females were breast (27%), skin (15%), cervix (8%), non-Hodgkin lymphoma (5%), thyroid (5.49%), uterus (5%), and stomach (3.83%). **Conclusion:** Our study is the first to explore the occurrence of cancers in the city of Kenitra. The high rates of bladder and skin cancer in this area warrant further epidemiological studies to identify etiological factors, develop control programs, and formulate prevention strategies.

Keywords: Cancer- Incidence- Epidemiology- Population-based cancer registries (PBCR)- Morocco- Kenitra

Asian Pac J Cancer Prev, **27 (7)**, 2663-2671

Introduction

Cancer is a global health problem, especially in low and middle-income countries. It is one of the leading causes of morbidity and early death in the 21st century. In Morocco, it is the second leading cause of mortality after cardiovascular diseases, with 11% of all of all deaths [1].

Besides being a barrier to increasing life expectancy, cancer is also linked with high economic, financial, and social costs that differ according to the cancer types, geography, and gender. The rates of many cancers are continually increasing, and several factors contribute to this trend. According to the latest GLOBOCAN estimates by the International Agency for Research on Cancer (IARC), published in Cancer Today on the Global Cancer Observatory in 2022, there were about 63,609 new cases of cancer and 36,947 deaths in Morocco. In comparison, in 2018, there were 52,783 new cases and 32,962 deaths [2]. Cancer is more common because of population aging, unhealthy habits (e.g., Smoking, poor diet), lifestyle changes (e.g., sedentary behavior and obesity), and improved access to cancer diagnosis and treatment [3].

Specific cancer epidemiology research, cancer registration, and surveillance are crucial for the development of healthcare policies, the formulation of cancer prevention strategies, the implementation of control programs, monitoring their success, prioritizing healthcare resource allocation, and assessing cancer trends over time.

The Ministry of Health and Social Affairs, in close collaboration with the Lalla Salma Foundation, has established the National Cancer Prevention and Control Plan (NCPCP) in Morocco. The second edition of this plan outlines strategic guidelines for programs for the next decade (2020-2029), focusing on the implementation and enhancement of cancer prevention research, increasing awareness, improving early detection, and strengthening [4, 5].

Two population-based cancer registries (PBCRs) are

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available in Morocco: those of Casablanca and Rabat, which are usually used to extrapolate cancer incidence rates for the rest of the country. These two PBCRs cover less than 15 % of the Moroccan population [6], highlighting the scarcity of cancer data from other cities. The most recent reports cover the period from 2013 to 2017.

Several measures are being established to improve cancer research in Morocco. While the country is ranked among the top African nations in research, there is still a lack of research output publications [5]. A manual search on PubMed for scientific publications related to cancer epidemiology in Morocco, using keywords 'cancer', 'neoplasm', 'tumor',' epidemiology', 'incidence', 'pattern', 'distribution', and 'trend', revealed far fewer results compared to Western countries. Over the past 10 years, a total of 1,229 such articles were published in Morocco. In contrast, China had 215,169 cancer-related publications and the United States had 192,097 during the same period. This paper takes all its relevance as the first study of its kind addressing the cancer distribution pattern in the region of Kenitra.

This study provides a six-year overview (2017–2022) of the cancer landscape in Kenitra and aims to describe the distribution of histologically confirmed cancers, as well as to estimate crude and age-standardized incidence rates by sex, age group, and cancer site.

Materials and Methods

Study design

We carried out a laboratory-based retrospective incidence study of all new histologically confirmed cancers diagnosed between January 2017 and December 2022 (6 years) in the city of Kenitra to assess the cancer incidence distribution pattern in the region.

Study setting and population

Kenitra, the ninth most populated city in Morocco, covers an area of 3,052 km² and is located at 34.26° N latitude and 6.58° W longitude. It is renowned for its agricultural exports and is often referred to as the agricultural capital of Morocco, with 193,173 hectares of agricultural land, with 20 out of its 23 communes classified as rural and only 3 as urban (Figure 1). The surrounding communities are largely composed of farms and farmlands [7]. According to the last general census of the population and the habitat (RGPH) conducted by the High Commission for Planning (Haut-Commissariat au Plan, HCP), Kenitra has a population of 1,052,177, with 526,362 females and 525,815 males [7].

Population estimates for Kenitra were obtained from census data provided by the Haut-Commissariat au Plan (HCP). The overall population served as the denominator for incidence rate calculations and was stratified by age group and sex to derive crude, age-specific, and age-standardized incidence rates.

The study included all new microscopically verified and confirmed invasive cancers, diagnosed between January 2017 and December 2022, in the two main Pathological Anatomy laboratory departments of the city of Kenitra: the pathology laboratory of the provincial public hospital and Ibn Sina private pathology laboratory (only 3 pathology laboratories are serving the region of Kenitra).

We excluded from the study all duplicate files, in situ lesions, borderline tumors, recurrent cancers, and medical files that are incomplete or unexplainable.

Variables

The extracted variables were Diagnosis dates, Identification number, gender, age at diagnosis, and the tumor location.

Data resource and measurement

All cases were compiled from the medical reports and pathology records of the pathology department in the Idrissi Public Hospital and from the private laboratory in Kenitra. The medical records include the reports of surgical specimens and biopsies received from different private clinics, public hospitals, and the offices of some private practitioners in the city of Kenitra. Patients were classified into 5-year age groups.

Several steps were taken while collecting data. Lists of patients were collected from both laboratories, and we have filtered patients to avoid duplication by hand searching in medical records and local information systems. We also carefully made a comparison of different variables (Identification number, names, sex, ages, and tumor location).

For tumor classification, anatomical sites were coded according to the International Classification of Diseases, Tenth Revision (ICD-10).

Statistical methods

The cancer cases were stratified by age groups, sex, and cancer type.

Cancer incidence cases were estimated using the parameters of the Crude incidence rates (CR), the age-specific incidence rates (ASIR), and the age-standardized incidence rates (ASR), which were calculated and expressed per 100,000 population.

Crude Incidence Rates (CR) are the number of all new cases occurring in a specified population, usually expressed as the number of cases per 100,000 population at risk [8]:

$$CR = R/N*100000 = \sum r_i / \sum n_i * 100{,}000$$

R: the total number of cases in the i^{th} age group with $R=\sum ri$

N: the total number of person-years of observation in the i^{th} age group with $N= \sum n_i$

The age-specific Incident rate (ASIR) represents the age-specific rate in each ith age class. It is calculated as follows [9]

$$ASIR= r_i/n_i$$

Age-standardized rates (ASR) are the rates that would be observed if the population had the same age structure as the standard reference population. It is calculated as

follows [10]

$$ASR=\sum ASIR*w_i / \sum w_i$$

Wi is the corresponding standard world population for the ith age group.

The ASR was defined as the weighted average of the age-specific rates, in which the weights represent the proportions of people in the corresponding age groups in a standard population. As the standard reference population, we have used the Segi-Doll world standard population, and the standardization was performed by the direct method. The mid-year population was set according to data provided by the High Commission for Planning (HCP), which estimates the rate of the Moroccan population.

The data were analyzed using Microsoft Excel and the SPSS (Statistical Package for Social Science) program version 25.

Results

A total of 2,682 new cancer cases across all sites were recorded in Kenitra between January 2017 and December 2022. Of these, 1,535 cases (57.23%) were males, and 1,147 cases (42.77%) were females, yielding a female-to-male ratio ASR 33.87; CR 28.13 (F/M) of 0.74. The median age at diagnosis was 59 years (55 years for females and 62 years for males), with a range from 3 to 100 years. Notably, 91% of the patients were older than 30 years.

Based on the Kenitra population used as the denominator, the crude incidence rate (CR per 100,000) for both sexes over the six years was 254 per 100,000. The CR was 217 per 100,000 in females and 291 per 100,000 in males. The age-standardized rate (ASR per 100,000) for both sexes was 283 per 100,000, including 120 per 100,000 in females and 162 per 100,000 in males.

The most common cancers for both sexes were prostate (19.79%), skin (14.53%), bladder (12.77%), breast (11.94%), non-Hodgkin lymphoma (5.65%), and cervical cancer (4.02%) (Supplementary Tables 1,2). Among males, the most frequent cancers were prostate (34.31%), bladder (19.27%), skin (13.54%), non-Hodgkin lymphoma (5.34%), stomach (3.97%), lung (3.84%), and colon (3.84%) (Supplementary Table 1).

Among females, the top recorded cancers are breast (27%), skin (15%), cervix (8%), non-Hodgkin lymphoma (5%), thyroid (5.49%), uterus (5%), and stomach (3.83%) (Supplementary Table 2). In terms of age-specific incidence rates (ASIRs), rates in males increased markedly after age 65, peaking in the ≥75-year age group (Supplementary Table 1). In females, ASIRs peaked in the 65–69 age group at 1,741 per 100,000 and declined slightly thereafter.

Between ages 25 and 54, ASIRs were higher in females, whereas after age 55, rates were higher in males. The proportions, ASIRs, CR per 100,000, and ASR per 100,000 of cancers by site and sex (ICD-10 classification) are presented in Supplementary Tables 1, 2.

In males, the most common cancers were prostate (34.31%, ASR 55.85 per 100,000; CR 50.09 per 100,000), bladder (19.27%, ASR 33.87 per100,000; CR 28.13 per 100,000), skin (13.54%, ASR 21.18; CR 19.67), non-Hodgkin lymphoma (5.34%, ASR 8.32; CR 7.79), lung (3.84%, ASR 7.63; CR 6.65), stomach (3.97%, ASR 6.57; CR 5.80), and colon (3.84%, ASR 4.10; CR 3.90).

In females, the most common cancers were breast (27.72%, ASR 33.67 per 100,000; CR 30.22), skin (15.69%, ASR 18.31; CR 17.10), cervix (8.46%, ASR 10.56; CR 9.21), non-Hodgkin lymphoma (5.75%, ASR 7.05; CR 6.27), thyroid (5.49%, ASR 5.64; CR 5.99), uterus (5.23%, ASR 6.57; CR 5.70), and stomach (3.83%, ASR 4.90; CR 4.18).

Age-specific incidence rates for major cancers are shown in Figures 2 and 3. Rates increased progressively with age, particularly after 60 years. In males, prostate cancer incidence rose after age 65 and peaked at 991 per 100,000 at age 75. Bladder cancer peaked at 337 per 100,000 around age 65, while skin cancer peaked at age 75 (197 per 100,000).

Lung cancer and non-Hodgkin lymphoma peaked in the 65–69 age group, with rates of 64 and 46 per 100,000,

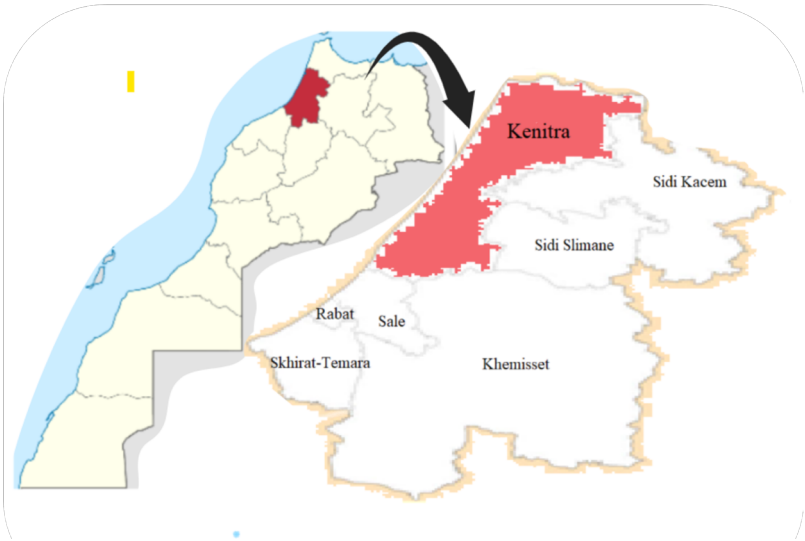

Figure 1. Geographical Location of the City of Kenitra, Morocco

Table 1. Age Standardized Incident Rate (ASR) Compared to Other National Registries and Countries

	ASR Female	ASR Male	ASR Both genders
Our study			
Kenitra, Morocco (2017-2022)	120.12	162.96	283
Rabat, Morocco cancer registry (2009-2012)	124.7	141.5	132.4
Casablanca, Morocco cancer registry (2013-2017)	123.0	101.9	111.9
Marrakech, Morocco (2012 -2019)	70.0	45.0	68.0
Algeria[2]	152.2	130.6	141.2
Egypt[2]	161.1	175.1	166.1
Tunisia[2]	115.3	159.4	135.4
France[2]	301	386.4	339
Spain[2]	238	274.6	319.9
United state[2]	341.7	401.7	367
Canada[2]	331.8	365.9	345.9

respectively. In females, incidence patterns also increased with age. Breast cancer rose after age 60, peaking at 65–69 years (262 per 100,000), then declining gradually. Cervical cancer remained rare before age 30 and peaked at 65–69 years (58 per 100,000). Skin cancer increased steadily after age 60, peaking at 75 years (197 per 100,000). Thyroid cancer was most frequent in women aged ≥75 years (69 per 100,000).

Discussion

It is worth mentioning that this is the first study on cancer incidence in the city of Kenitra. It should be noted that less than 15% of Moroccans are covered by the current Moroccan population-based cancer registry (PBCR), meaning national data remain limited and additional regional information is required [6].

Overall Incidence and demographic patterns

In our study, males were more affected by cancer than females (F/M=0.74), although this differs from Casablanca and Rabat PBCRs [11], it remains consistent with some international trends showing higher male incidence. [12], And this is in line with the international publications that

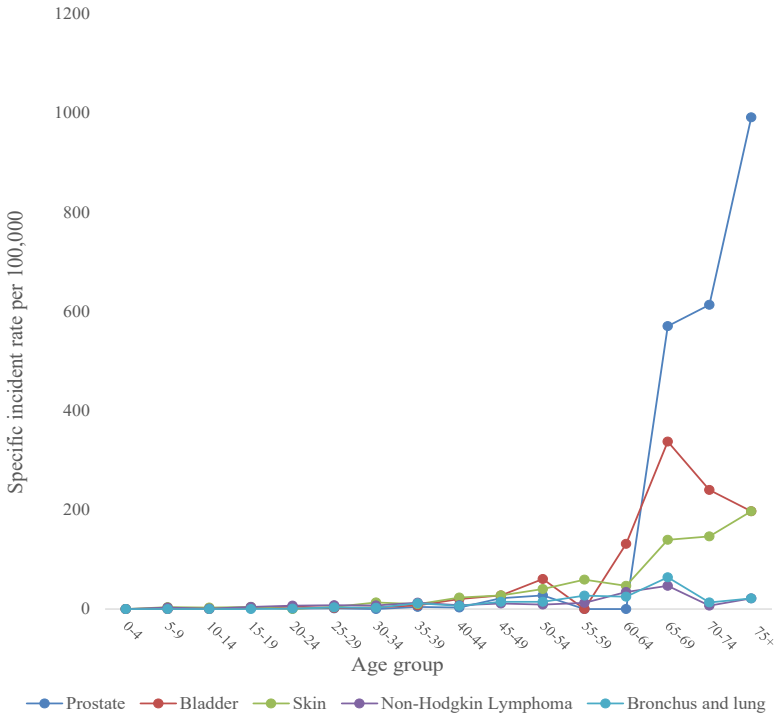

Figure 2. The Age-Specific Incident Rate of the Top Leading Sites in Males, Kenitra, Morooco, (2017-2022)

Table 2. Comparing the Distribution Patterns of the Top most Frequent Cancers in Different Cities, Morocco

Series	Gender	1st	2nd	3rd	4th	5th
Our study (2017-2022)	F	Breast	Skin	Cervix	NHL	Thyroid
	M	Prostate	Bladder	Skin	NHL	Stomach
Casablanca (2013-2017)	F	Breast	Thyroid	Cervix	Colon	Ovary
	M	Lung	Prostate	Colon	Bladder	NHL
Rabat (2009-2012)	F	Breast	Cervix	Colon	Ovary	NHL
	M	Lung	Prostate	Bladder	Colon	NHL
Marrakech (2012 -2019)	F	Breast	Cervix	Ovary	Colon	Stomach
	M	Lung	Stomach	Prostate	Colon	Rectum
Eastern Morocco (2005–2012)	F	Breast	Cervix	Colon	Ovary	Stomach
	M	Lung	Colon	Nasopharynx	Prostate	Stomach

Rates are per 100,000

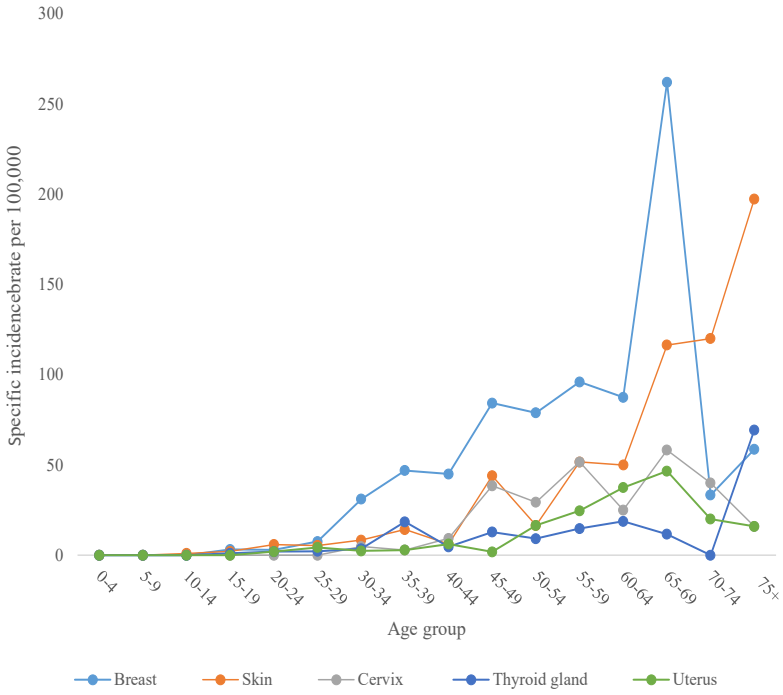

Figure 3. The Age-Specific Incidence Rate of the Top Leading Sites in Females, Kenitra, Morooco, (2017-2022)

confirm that the incidence of cancer was 20% higher in men than in women [13]. This difference may reflect biological, occupational, and behavioral factors [13].

The mean age at diagnosis for females is lower than men (7 years difference). This finding is similar to all local PBCRs, which can be explained either by the earlier effective implementation of female-related cancer screening programs (breast, cervix) in Morocco, compared to other male cancers (lung, prostate).

Based on the current population of Kenitra, Table 1 highlights the differences in ASRs between our study and other countries worldwide. The distribution of ASRs by sex in our study, compared to the national PBCR, did not reveal any significant differences. However, European and North American populations continue to exhibit the highest rates [2].

Differences may partly reflect outdated PBCR data (last published 2009–2017) [11]; therefore, the observation period effect is not taken into consideration in this discrepancy, since every year major changes can happen in the demography, risk factors, population growth, and lifestyles, time will undoubtedly have a significant impact on cancer epidemiologic trends.

Globally, the cancer incidence rate is higher in developed industrialized countries compared to developing countries, and Africa had the lowest ASR compared to the rest of the world [2].

Table 2 presents the cancer cases ranking by the two Moroccan PBCRs and several national studies. The distribution patterns of the most common malignancies in our study differ slightly from other national findings. Notably, skin cancer shows a high incidence in our study for both genders, ranking second among females and third among males.

Major cancers in women

Breast cancer is the most frequent cancer among women in our study, consistent with global patterns where

it ranks first or second [2, 14]. Its incidence begins to rise after age 40, peaking between 65 and 70 years. The age-standardized incidence rate (ASR) in Kenitra (33 per 100,000) is consistent with rates reported in Rabat, Casablanca, and Marrakech [6, 11].

These differences are linked to variations in reproductive and hormonal factors, age at menarche and menopause, parity, breastfeeding, hormone exposure, genetic predisposition, diet, and physical activity. Further regional research is needed to better understand the specific risk profile of Moroccan women [15].

Morocco has prioritized breast and cervical cancer prevention through nationwide early detection initiatives. Screening programs integrated into primary healthcare facilities and the annual "Octobre Rose" campaign target women aged 40–69. While these programs have contributed to a reduction in mortality, they may temporarily increase incidence due to improved early detection of previously undiagnosed cases [4, 16].

In our study, breast cancer shows patterns consistent with national trends, but continued surveillance is crucial. Strengthening screening coverage, improving diagnostic pathways, and investigating local risk factors will help refine prevention strategies and reduce the burden of breast cancer in the Kenitra region and Morocco as a whole.

Cervical cancer was the third most common cancer among women in our study, with an age-standardized incidence rate (ASR) of 10.57 per 100,000, predominantly affecting women aged 65–69. These rates are consistent with national PBCR data (Rabat: 12, Casablanca: 10, Marrakech: 11 per 100,000) and remain higher than in most Western countries, but lower than in sub-Saharan Africa.

Major risk factors in developing countries include early marriage, multiple sexual partners, and inadequate screening, with 99.7% of cases linked to human papillomavirus (HPV) [17]. To improve prevention, Morocco introduced HPV vaccination in 2022 and maintains cervical cancer screening programs in primary healthcare centers using visual inspection and cytology. Continued efforts in vaccination, screening, and awareness are crucial to reduce cervical cancer incidence and mortality among women in Kenitra and across the country [4].

Major cancers in men

The prostate cancer incidence rate in our study is higher than the rates reported in the Moroccan PBCRs, and in most Maghreb and sub-Saharan countries. However, it remains significantly lower than the rates recorded in Western developed countries (Spain: 66.5 per 100,000; France:82.3 per 100,000; United States: 75.2 per 100,000) [18]. It increases after the age of 60, which aligns with numerous other studies, confirming that Prostate cancer predominantly affects the elderly [19].

Prostate cancer incidence is greatly influenced by early screening [20]. Since its establishment in 2005, The Lalla Salma Foundation or Cancer Prevention and Treatment has carried out several campaigns in Morocco, promoting awareness about the benefits of early individual screening. As a result, physicians, particularly urologists, are more likely to prescribe prostate-specific antigen (PSA) testing and perform biopsies for elderly men, contributing to the higher recorded incidence of prostate cancer and regional disparities. While age is a well-established main risk factor for prostate cancer, several other factors are associated, such as physical activity, family history, genetic predisposition, and baldness [19].

Furthermore, regionally tailored research is needed to understand the higher incidence of Prostate cancer in the Kenitra area and to determine whether any preventive measures can be implemented.

Lung cancer in men is surprisingly low, lower than the rate reported by the two PBCR reports [11]. This can be partly explained by the very short life expectancy of lung cancer, along with inadequate or late diagnostic procedures in the region and a healthcare focus on tuberculosis rather than cancer.

Skin and bladder cancer and environmental/occupational context

The incidence rate of skin cancer increases significantly after the age of 60, with age-standardized incidence rates (ASR) of 18.31 per 100,000 for females and 21.18 per 100,000 for males. These rates are considerably higher than those reported in Rabat and Casablanca [11]. Several recent studies show that the incidence of skin cancer has dramatically grown in recent years [21–23]. About 65-90% of all skin cancers are attributed to UVR exposure. This risk is further heightened by occupational exposure among outdoor workers, such as farmers [24–26].

Kenitra is one of the most prominent agricultural regions in Morocco, with 20 of its 23 communes classified as rural and only 3 as urban. The surrounding communities predominantly consist of farms and farmlands, with the majority of the rural population working in farming and agriculture as their primary source of income [7].

This context may suggest a potential link between the high rate of skin cancer in Kenitra and the rural population's lifestyle. However, it is premature to confirm such an association. Limited studies on solar radiation exposure in Morocco and the lack of substantial evidence currently hinder a definitive conclusion [27, 28]. Further investigations are needed to explore the distribution of and exposure to risk factors within the local population. Despite the high level of sunshine exposure in Morocco, skin cancer is not currently regarded as a major public health concern.

Bladder cancer ranks third overall and second among men, with an ASR of 33.87 per 100,000 in males, five times higher than in females, exceeding national PBCR rates [11]. Following schistosomiasis elimination, few or no cases are reported in Kenitra [29], suggesting other risk factors such as smoking and occupational or environmental exposures[30, 31].Given the predominantly agricultural rural population, pesticide and chemical exposures may contribute, as supported by studies linking agricultural work to bladder cancer [32–34]. Further research is needed to clarify these associations and also assess the role of tobacco use.

In our study, the age-standardized incidence rates

(ASR) of Non-Hodgkin lymphoma (NHL) are 8.32 per 100,000 in males and 7.05 per 100,000 in females. These rates are comparable to those reported in Rabat, Casablanca, the GLOBOCAN database, and other African countries; however, Western countries continue to report higher incidence rates [2, 11]. NHL is more prevalent in males than females and is more commonly diagnosed after the age of 50, which may be partly attributed to an altered and weakened immune system associated with aging. Around 90% of all lymphomas are non-Hodgkin lymphomas (NHLs), with the remaining 10% being Hodgkin lymphomas.NHL has been associated with several factors, including Epstein-Barr virus (EBV) infection, immunodeficiency virus (HIV), and Hepatitis C virus (HCV) [35].

Stomach cancer ranks 7th among all cancers, and the rates show a slight increase in the 65–70 age group, which is in line with the PBCR of Rabat data, but remain relatively low compared to Asia and South America [2, 11]. This rate disparity raises questions about regional dietary patterns and the prevalence of Helicobacter pylori infection [36]. Thyroid cancer was more common in females, with ASRs of 5.6 per 100,000 versus 1.9 in males. Colon cancer showed ASRs of 4.10 in males and 2.32 in females, while nasopharyngeal cancer had 3.00 and 3.44 per 100,000, respectively; all occurred at similar proportions in the population. These rates align with national PBCR data and highlight lower incidence compared to more prevalent cancers in Kenitra [11].

Overall, Kenitra's cancer incidence rates share many similarities with other Moroccan PBCRs and Maghreb countries, while also revealing notable differences and exceptions. These facts warrant a thorough investigation to identify the etiologic risk factors contributing to the occurrence of certain cancers, such as skin and bladder cancer in our study, or the decline in others, such as lung cancer. Nevertheless, cancer rates in Morocco remain lower than those in most North African countries and significantly lower than rates in many other parts of the world. However, these rates are expected to rise in the coming years due to Morocco's aging population and lifestyle westernization.

This paper provides an accurate description of cancer trends in Kenitra, while supporting previous findings from Morocco. It highlights specific cancers that require targeted and tailored screening and awareness efforts.

Strengthening regional cancer registries remains essential to support the Moroccan National Plan for Prevention and Cancer Control (NPPCC).

Limitations

Data sources: As a pathology-laboratory–based study, our incidence estimates likely underestimate cancers diagnosed without histology (e.g., some lung, brain, hematological malignancies), and may overrepresent cancers more often biopsied.

Incomplete data

Exclusion of records with missing demographic or diagnostic information may have caused selection bias and underestimated incidence in some subgroups.

Geographical scope

Migration in and out of Kenitra during the study period could not be fully accounted for; therefore, denominators are approximate and the study is limited to one geographic area, which may affect generalizability.

Histological grading

Histological grading and staging were not included; future studies should incorporate this to better assess severity and prognosis.

In conclusion, the data presented in this paper represent a crucial first step in understanding the cancer incidence pattern in Kenitra. It highlights the coexistence of two types of cancers within the population: infection-related cancers and cancers associated with a Westernized lifestyle. Morocco is undergoing an epidemiological transition known as the "double burden," with cancers typical of developing countries (e.g., stomach and cervical) occurring alongside those more common in developed countries (e.g., breast, prostate, and bladder).

The limitations of this study offer insights for further research. Incidence rates are influenced by the availability of health facilities and screening practices, while information on mortality, survival, histological stages, and etiologic factors such as environmental exposures, lifestyle influences, and socio-economic disparities was not recorded.

This study also emphasizes the importance of a robust local PRBP to develop a comprehensive database to guide policymakers in primary and secondary prevention programs, control strategies, and resource allocation. Active involvement of both public and private sectors is crucial to achieving these goals. These findings provide a foundation for future research and support targeted interventions to address the evolving cancer burden in Kenitra.

Author Contribution Statement

El Gui Radia: Conceptualization, Methodology, Investigation, Writing-Original Draft, Formal Analysis. Ed-Day Soumia: Visualization, Writing-Original draft. Haddan Azzouz: Resources, Data Curation. Saad Mohamed: Resources, Data Curation. Boulbaroud Samira: Supervision, Validation. Azzaoui Fatima Zahra: Supervision, Validation, Project Administration.

Acknowledgements

The authors would like to express their sincere gratitude to all individuals and institutions who contributed to data availability and data registration throughout this study. We especially thank the laboratories and departments of pathological anatomy and cytology, as well as the dedicated technicians, for their invaluable support and collaboration.

Conflict of Interest

The authors declare that they have no conflicts of interest related to this study.

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