



## Research article

# Establishing a cancer registry and baseline data for Nyandarua County, Kenya: A step towards establishing a central cancer registry<sup>☆</sup>

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## ABSTRACT

Cancer is a major global public health issue, causing a significant number of premature deaths worldwide. In 2020, the World Health Organization reported that more than 19 million individuals were diagnosed with cancer, and over 10 million lost their lives to the disease. Predictions indicate that cancer-related deaths will exceed 30 million by 2030, with around 75 % occurring in low- and middle-income countries (LMICs) like Kenya. Various factors contribute to this concerning trend, including aging populations, a high prevalence of cancer risk factors, socioeconomic disparities resulting in limited healthcare access, and deficiencies in healthcare systems within LMICs. This study focused on Nyandarua County, Kenya, which lacks a dedicated cancer registry. Without comprehensive incidence data, the county faces challenges in developing targeted programs for cancer prevention, management, and control. The main objective of this investigation was to establish a cancer registry specific to Nyandarua County, capable of continuously gathering accurate cancer data, patient treatment follow-ups and disease outcomes. A demographic survey was conducted to determine the frequency of all-cause and specific cancers among patients who attended selected health facilities between 2013 and 2020. Data were collected from existing hospital records in three main hospitals in the county. A total of 1373 cases were recorded, with 54.9 % of patients being female. North Kinangop Catholic Hospital accounted for the largest number of patients (62 %), followed by JM Kariuki County Memorial Hospital (35 %), while Engineer Hospital contributed the remaining 3 %. The top five cancer sites observed in Nyandarua County were esophagus (16.8 %), cervix uteri (13.4 %), stomach (10.6 %), breast (8.8 %), and prostate (8.6 %). Our findings provide valuable insights into the prevalence and distribution of different types of cancer in the region. With the establishment of this cancer registry, Nyandarua County is now among the pioneering counties in Kenya. It is crucial for the county government to undertake the responsibility of continuously updating the registry to draw inferences regarding cancer prevalence in the region to enhance patients follow up and survival.

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## 1. Introduction

Cancer has emerged as a global public health challenge, constituting a primary cause of premature mortality worldwide [1]. According to the World Health Organization (WHO) statistics, the year 2020 witnessed over 19 million new cancer cases, resulting in more than 10 million deaths [2]. It is projected that cancer-related mortality will surpass 30 million by 2030, with a disproportionate burden falling on low- and middle-income countries (LMICs), including Kenya [3]. Contributing factors to this surge include aging populations, the prevalence of cancer risk factors, socioeconomic disparities leading to delayed healthcare access, and inadequacies in LMIC healthcare systems [3].

Breast cancer ranked as the most prevalent cancer globally in 2020 (11.7 %), followed closely by lung cancer (11.4 %), and colorectal cancer [4]. Notably, lung and breast cancer were the most common cancers in men and women, respectively. In Africa, breast and cervix uteri cancers represent the top two malignancies, while prostate and breast cancers dominate in men and women, respectively [5]. In Kenya, breast and cervix uteri cancers are the most common, with esophageal cancer ranking third [6]. This information is primarily derived from the Nairobi Cancer Registry and the Eldoret Cancer Registry which serve as the primary sources of cancer data for the country. Only in 2020 did Machakos County establish a fully functional and up-to-date cancer registry, which plays a crucial role in validating national and county level figures reported by national level registries [7]. Consequently, it is crucial to establish county-specific cancer registries to provide accurate baseline information for cancer care, management, prevention, and intervention programs but also to facilitate data sharing and collaboration with other registries at both the county and national levels [8]. Such studies, coupled with the creation of cancer registries at the county level, will furnish baseline data to guide cancer care, management, prevention, and intervention programs.

Nyandarua County, located in the former Central Province of Kenya, encompasses a population of 596,268 within an area of 3304 km<sup>2</sup> [9]. The county comprises seven sub-counties, namely Nyandarua Central, Nyandarua West, Nyandarua North, Nyandarua South, Kinangop, Mirangine, and Kipipiri. Like many other counties in Kenya, Nyandarua County lacks a cancer registry, resulting in an absence of recorded cancer incidences within the region. Consequently, the development of targeted programs for cancer prevention, management, and control within the county becomes challenging.

Nyandarua County, a rural region in Kenya, has several facilities offering oncological services. The most notable is the Nyandarua Cancer Centre, which aims to serve close to 20 million people in the Central and Rift Valley regions, Northern Kenya Counties, and the East African region. Additionally, there are several private hospitals, such as North Kinangop Catholic Hospital, which offers a range of services including laboratory services, radiography, dental and optical care, E.N.T, endoscopy, pharmacy, surgical operations, X-ray, and ultrasound services [10].

The limitations in cancer care in Nyandarua County are primarily due to the lack of a dedicated cancer registry, which hampers the development of targeted programs for cancer management. This study aimed to fill this gap by collecting data to determine the baseline cancer cases in Nyandarua County and subsequently establishing a cancer registry capable of continually collating cancer related data. The resulting registry will then relay the data to the national registry. These efforts will aid in developing targeted cancer control, intervention, and management programs for Nyandarua County. Additionally, the success of this study offers a replicable model for collating information on new cases for other non-communicable diseases, including accidents and mental health, within the county.

## 2. Methods

### 2.1. Survey design

The study utilized a survey to analyze the distribution of cancer cases in Nyandarua County, focusing on the sub-county of origin, in order to establish a comprehensive cancer registry. This involved determining the retrospective occurrence rates of both general and specific types of cancer among patients who sought medical care at selected healthcare facilities between the years 2013 and 2020. To accomplish this, a retrospective survey was conducted, whereby relevant information was extracted from existing hospital records in three main hospitals in the county. Trained data clerks underwent training to ensure consistent and standardized manual data extraction using a cancer abstract form. Subsequently, all manually extracted data were transferred into an electronic database utilizing the CanReg software, developed by the International Agency for Research on Cancer (IARC).

### 2.2. Participating health facilities

Participating health facilities were conveniently selected to include county referral hospitals and faith-based or private institutions that provide cancer diagnostic, treatment, management, or palliative care services. The health facilities that were requested to participate in the survey by availing hospital records for data mining by the data clerks were the JM Kariuki County Referral Hospital, Engineer County Hospital, and North Kinangop Catholic Hospital.

JM Kariuki Memorial County Referral Hospital is a government health facility with a bed capacity of 222 beds and offers both inpatient and outpatient services including medical surgery services. Engineer District Hospital is also a government health facility has a bed capacity of six beds and offers outpatient services with inpatient services limited to those undergoing cesarean section. North Kinangop Catholic Hospital on the other hand is a faith-based health institution and has a bed capacity of 309 and offers both inpatient and outpatient services including medical surgery services.

### 2.3. Training of data clerks

Two data clerks were recruited to support the process of data collection. The recruited clerks underwent comprehensive training covering data collection techniques, coding procedures, and data entry using the designated software conducted by hospital data officers. Before deployment for data collection, the hospital data officers thoroughly assessed the clerks' understanding of these techniques. In order to prioritize patient privacy and maintain data confidentiality, the trainees completed an online course on Good Clinical Practices (available at [nidatraining.org](https://nidatraining.org)).

### 2.4. Establishment of baseline data on cancer occurrence in Nyandarua county

Retrospective data extraction was conducted by accessing patient records from participating healthcare facilities for the duration of 2013–2020. Various data variables were collected, including patient information such as age and gender, demographic details including place of residence, cancer type, details pertaining to disease management (e.g., diagnostic methods employed, administered treatment modalities such as chemotherapy or radiotherapy), treatment outcomes, and follow-up records whenever available. Due to limited access to pathological services the classification of the cancers was done using the ICD-10 classification. To facilitate data abstraction from hospital records, the cancer abstract form that used the variables found in the CanReg5 software [11] was utilized. Cumulative cases of both all-cause and specific cancers were estimated on a yearly basis throughout the review period. The incident year of cancer was determined based on the year of diagnosis or the initial encounter with healthcare services. Only clinically confirmed cases were included in the study. In most cases, this was mentioned in the clinical files with no official pathology report attached. In all three hospitals, the primary source of data was the medical records departments, which utilized disease index cards and patient-care registers to identify cancer cases before retrieving corresponding files. For hospitals equipped with palliative care departments, cancer cases were also sourced from these departments. Prior to file retrieval, the list of cancer cases obtained from departments other than the records department underwent a thorough duplicate check against the list from the records department.

### 2.5. Entering data and importation to CanReg5

After completing the process of data abstraction, the forms underwent a thorough examination to ensure their completeness before being entered into the CanReg5 system. In certain cases, the entered data was initially exported to a Microsoft Excel compatible file, specifically a Comma Separated Version (CSV) file, which served as a template for further data entry. Subsequently, the data was imported into CanReg5 utilizing the data import function. The export function was employed to maintain the integrity of the number of variables and the format utilized in CanReg5.

### 2.6. Ethical considerations

This study received ethical approval from the MKU Ethical Review Committee, and a permit was obtained from the National Commission for Science, Technology, and Innovation (NACOSTI). Additionally, permission to conduct the study was obtained from the Director of Medical Health at the county level and the respective hospital administrations. To ensure confidentiality, patient information obtained from hospital record files was handled with strict confidentiality measures. Recording patient details served the purpose of preventing duplication of cases where patients visited different hospitals during the study period without referral records. Each record was assigned a unique identification number distinct from the one in the hospital records, solely for the purpose of mapping cancer occurrences.

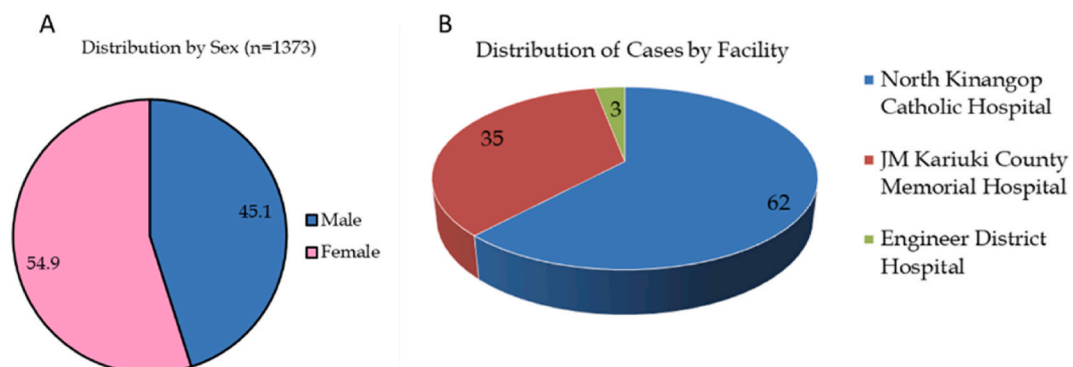


Fig. 1. Proportion of cancer cases managed in Nyandarua county a) clustered by gender and b) clustered by the facility.

### 3. Results

From the three hospitals, a total of 1373 cases were recorded with 54.9 % being female and 45.1 % male patients (Fig. 1a). Distribution by health facility indicated that North Kinangop Catholic hospital had the largest number of patients at 62 % followed by JM Kariuki County Memorial hospital at 35 % while the rest were from Engineer hospital (3 %) (Fig. 1b)

The average age at diagnosis overall was 59.7 years (1–101 years) but males were diagnosed at a later age (64.0 (1–101) than females (56.2 (8–96) years). The age at incidence varies between males and females due to the differences in the most prevalent cancer types between the two genders. In this study, men were diagnosed at an older age with the majority being diagnosed at 75–79 years compared with their female counterparts where the largest proportion was diagnosed at 55–59 years (Fig. 2). In total, there were a total of 17 (1.2 %) cases aged between 0 and 19 years that represented pediatric cancers in the county.

Overall, esophagus (16.8 %), cervix uteri (13.4 %), stomach (10.6 %), breast (8.8 %) and prostate (8.6 %) were the top 5 cancer sites among the cancer patients reviewed (Fig. 3a). In female, the top 5 cancer sites were cervix uteri, breast, esophagus, stomach and colorectum cancers at 24.1 %, 15.4 %, 9.5 %, 9.3 %, and 5.8 % respectively (Fig. 3b). In male, the top 5 cancer sites were esophagus, prostate, stomach, bone marrow, and liver at 25.7 %, 18.7 %, 12.3 %, 6.8 %, and 6.5 % respectively (Fig. 3c).

Over the years, there has been a consistent rise in the number of cancer cases reported within the country. This can be attributed to factors such as improved accessibility to diagnostic facilities, the inclusion of comprehensive cancer care in health insurance, and heightened public awareness. Within the context of this study, a similar trend was observed, with the percentage of cancer cases progressively increasing from 0.9 % of total cases in 2013 to 24.3 % in 2019 (Fig. 4a). Notably, there were fluctuations in the number of cancer cases in 2017 and 2020, potentially influenced by doctor strikes and the impact of the COVID-19 pandemic on healthcare accessibility, respectively.

When analyzing the data based on specific health facilities, a comparable trend was observed in North Kinangop hospital, aligning with the county-wide observations, except for the year 2017, where the number of cases exceeded those of 2018 (Fig. 4b). At JM Kariuki Memorial hospital, cancer cases increased between 2013 and 2016, followed by a significant decline in 2017. Subsequently, the numbers rose again in 2018 and 2019, only to decrease once more in 2020 (Fig. 4c). In Engineer District hospital, no cases were recorded from 2013 to 2015. However, from 2016 to 2019, there was a consistent annual increase in the number of reported cancer cases, displaying a similar pattern of reduced cases observed in 2020 (Fig. 4d).

To assess whether the prevalence of the five major cancer types reported at the county level is consistent with the individual hospitals surveyed, we examined the top five cancer sites at each facility. The findings revealed that while the types of cancers did not vary significantly across the three hospitals, their ranking in terms of prominence differed.

At North Kinangop Catholic hospital, the top five cancer sites were cervix uteri (14.2 %), esophagus (12.6 %), stomach (12.5 %), prostate (9.4 %), and colorectal (7.3 %) cancers, respectively (Fig. 5a). JM Kariuki hospital, on the other hand, had the following top five cancer sites: esophagus (25.4 %), cervix uteri (12.9 %), breast (10.8 %), stomach (8.3 %), and prostate (7.5 %) cancers, respectively (Fig. 5b). In the case of Engineer district hospital, breast cancer accounted for the majority (63.4 %), followed by esophagus (4.9 %), prostate (4.9 %), and cervix uteri (2.4 %) cancers. The remaining cases (14.6 %) were not specified (Fig. 5c).

To determine the residence of the patients visiting the three hospitals in Nyandarua county, data on patients' residency were captured. As shown in Table 1 below, most of the patients (78.7 %) were residents of Nyandarua county while 17.6 % were from the neighboring counties of Nakuru (8.8 %), Laikipia (5.8 %), Kiambu (2.3 %) and Murang'a (0.7 %).

Within Nyandarua county, the ranking of the top 5 cancer sites in each of five constituencies differed from the ranking at the county level except for the Ol Kalou constituency. However, esophagus cancer was the top-most cancer type in all the constituencies (Table 2).

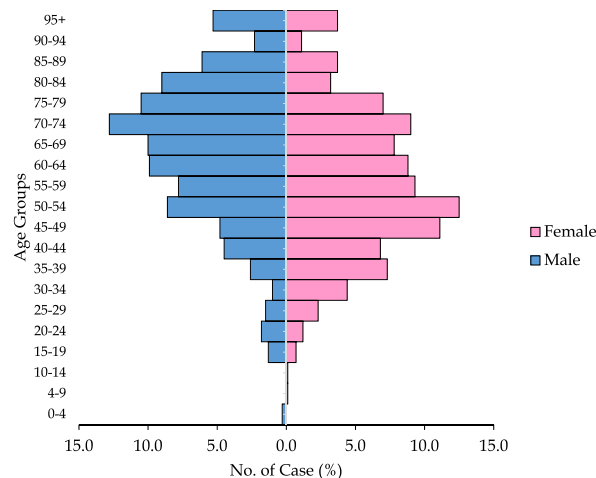
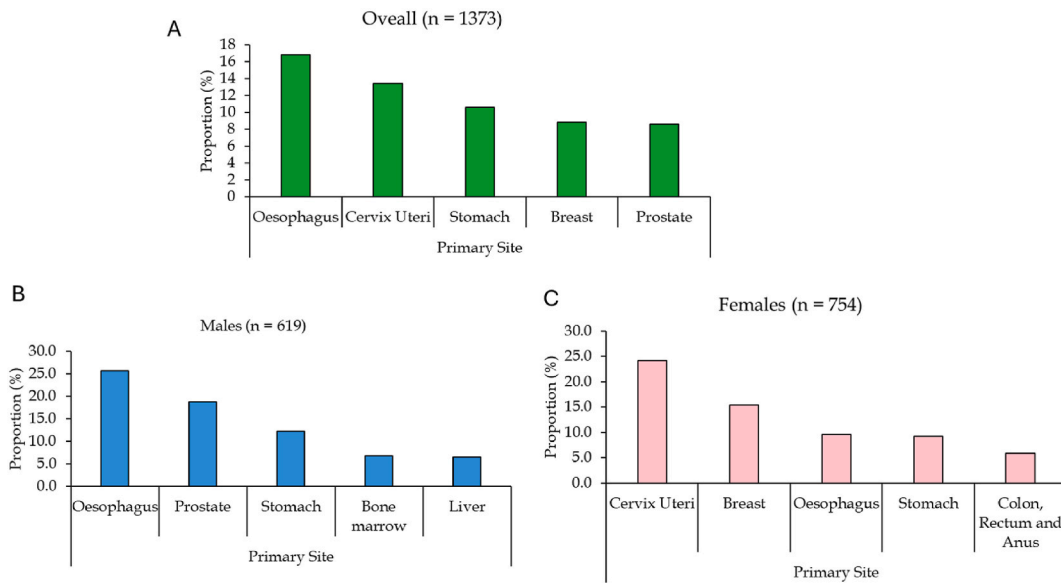
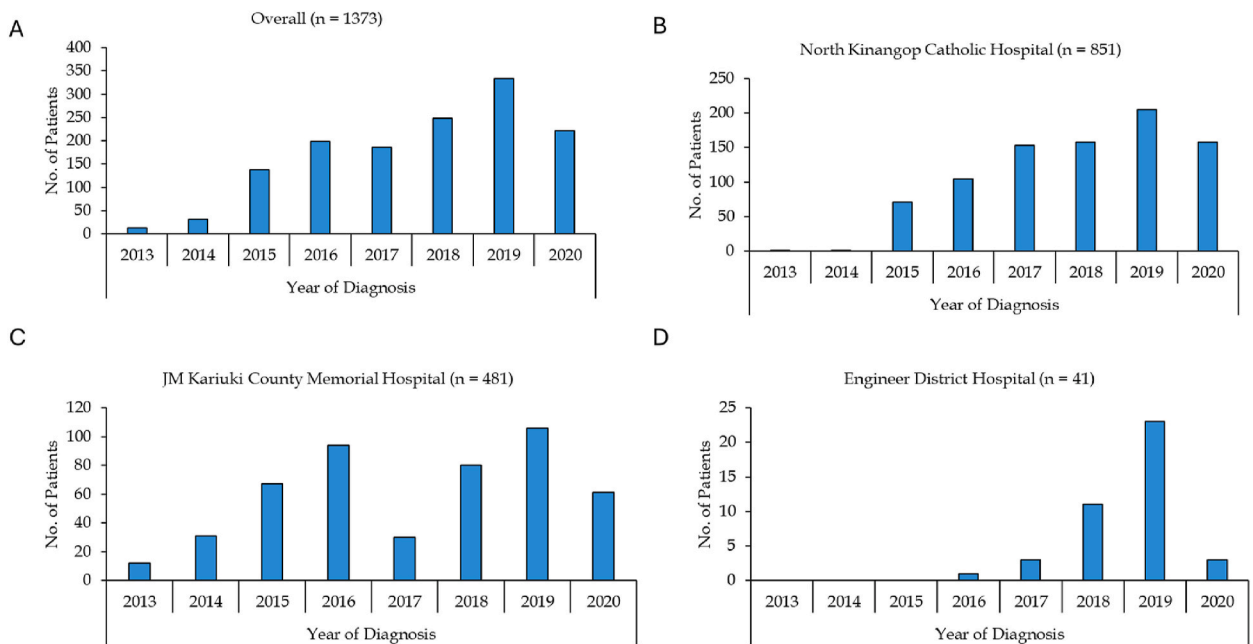


Fig. 2. Distribution of cancer cases recorded in Nyandarua County by age group and sex.



**Fig. 3.** Top 5 cancer sites by gender. a) top 5 cancer sites in both sexes; b) top 5 cancer sites in females; c) top-cancer sites in males.

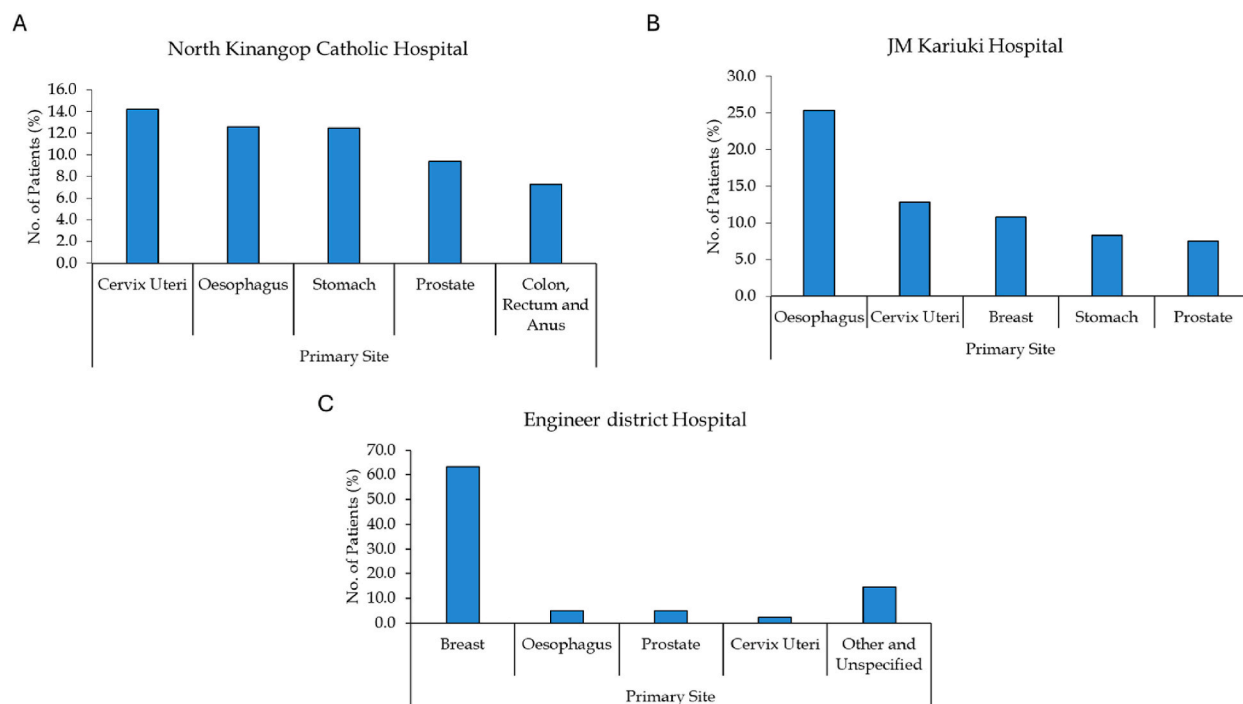


**Fig. 4.** Distribution of cancer cases by year in each of the three facilities. a) Overall trends in the three facilities; b) trends in North Kinangop Catholic hospital; c) trends in JM Kariuki hospital; d) trends in Engineer district hospital.

**4. Discussion**

A demographic survey was conducted in Nyandarua County, Kenya to determine the frequency of all-cause and specific cancers among patients who attended selected health facilities between 2013 and 2020. The study focused on three primary hospitals in the county: JM Kariuki Referral Hospital, North Kinangop Catholic Hospital, and Engineer District Hospital, which manage most cancer cases. The findings indicated high cancer cases in women compared to men, consistent with previous studies conducted in Machakos County [7] and Nairobi County [12]. Similar patterns have been observed at Moi Teaching and Referral Hospital and Kenyatta National Hospital [13].

Among the three hospitals analyzed, North Kinangop Catholic Hospital had the highest number of patients, followed by JM Kariuki



**Fig. 5.** Top 5 cancer cases in each of the three facilities. a) top 5 cases in North Kinangop Catholic hospital; b) top 5 cases in JM Kariuki hospital; c) top 5 cases in Engineer district hospital.

**Table 1**

Residence of cancer patients managed in the three health facilities from top 5 counties.

County	Frequency	Percent (%)
Nyandarua	1080	78.7
Other counties		
Nakuru	121	8.8
Laikipia	79	5.8
Kiambu	31	2.3
Murang'a	10	0.7
Total	1321	

**Table 2**

Ranking of top 5 cancers in each of the five constituencies in Nyandarua county.

Overall n (%)		Kinangop n (%)		Kipipiri n (%)	
Esophagus	198 (18.3 %)	Esophagus	59 (14.5 %)	Esophagus	35 (17.8 %)
Cervix Uteri	129 (11.9 %)	Breast	48 (11.8 %)	Cervix Uteri	29 (14.7 %)
Stomach	118 (10.9 %)	Cervix Uteri	47 (11.6 %)	Prostate	27 (13.7 %)
Breast	111 (10.3 %)	Stomach	43 (10.6 %)	Stomach	25 (12.7 %)
Prostate	85 (7.9 %)	Bone marrow	31 (7.6 %)	Breast	14 (7.1 %)
Ndaragwa. n (%)		Ol Jorok n (%)		Ol Kalou n (%)	
Esophagus	8 (16.7 %)	Esophagus	12 (18.8 %)	Esophagus	84 (23 %)
Stomach	8 (16.7 %)	Breast	8 (12.5 %)	Cervix Uteri	41 (11.2 %)
Breast	7 (14.6 %)	Cervix Uteri	7 (10.9 %)	Stomach	35 (9.6 %)
Cervix Uteri	5 (10.4 %)	Prostate	7 (10.9 %)	Breast	34 (9.3 %)
Ovary	4 (8.3 %)	Stomach	6 (9.4 %)	Prostate	25 (6.8 %)

Memorial Country Referral Hospital, while Engineer District Hospital had fewer cases. This discrepancy can be attributed to the varying capacities and services offered by each hospital. North Kinangop Catholic Hospital, with its larger bed capacity and referral system for pathological services, is preferred by many patients. JM Kariuki Memorial Country Referral Hospital has a smaller bed capacity and lacks a similar referral system, leading to patient referrals for pathological diagnosis. However, the hospital does provide

palliative care for pain management and counseling for advanced-stage cancer patients referred from other hospitals. Engineer District Hospital primarily offers outpatient services, explaining the lower number of cancer cases since most cancer patients require inpatient care. Other facilities that offer cancer services are limited to only cancer screening, which thereafter the patients are referred to the three major cancer treatment hospitals in the county.

The age at diagnosis differs between males and females due to variations in the most prevalent cancer types by sex [14]. In this study, men were diagnosed at an older age, with the majority diagnosed between 75 and 79 years, while women were diagnosed between 55 and 59 years. Only 1.2 % of the cases qualified as pediatric cancer cases and this was mainly because the county does not offer pediatric cancer services. In addition, the county is in proximity with Kijabe hospital, which has a well-established pediatric cancer center. In Kenya, breast cancer is the leading cancer, followed by cervix uteri and prostate cancers [6]. Among the cancers treated in Nyandarua County, the leading cancer was esophageal cancer, followed by cervix uteri and stomach cancers. These trends differ from reports in the Eldoret cancer registry, where cervix uteri cancer is the leading cancer in females, followed by breast cancer. Discrepancies are also observed in Machakos County, where cervix uteri cancer is the leading cancer, followed by esophagus and breast cancers [7,15] and in Meru, where the top five cancer types are stomach, breast, esophagus, cervix, and prostate cancers [16]. It is worth noting that the cases reported here are strictly those recorded in hospitals in Nyandarua without including those cancer patients who seek health care in hospitals outside the county. Collection of cancer cases of Nyandarua residents in hospitals outside Nyandarua county may help validate these observations.

Our data demonstrate that the top five cancer sites in females are cervix uteri, breast, esophagus, stomach, and colorectum cancers. This aligns with reports from other parts of Kenya, such as Moi Teaching and Referral Hospital (MTRH) and Kenyatta National Hospital (KNH) [8]. Data from MTRH between 2008 and 2012 revealed cervix uteri and breast cancer as the leading cancers in females [13]. According to Globocan 2020, the leading cancers in Kenyan females are breast cancer (25.6 %), cervix uteri (19.7 %), and esophagus cancer (6.1 %) [6]. The order differs from observations in Nyandarua, potentially due to differences in the capacity of health facilities to manage various cancer types. For example, North Kinangop Catholic Hospital offers comprehensive care and cervical cancer screening through pap smears, leading to a higher number of cervix uteri cases compared to other facilities [17].

In males, the top cancer sites are the esophagus, prostate, and stomach. This aligns with findings in Machakos County, where prostate cancer is the leading cancer, followed by esophagus cancers [7]. Similar observations have been made at Tenwek Hospital in Western Kenya [18]. However, the order differs from Globocan 2020, where prostate cancer is the leading cancer in males in Kenya, followed by esophagus and colorectum cancers [6]. The number of esophageal cancer cases is high in Nyandarua County, as in other Kenyan counties within the esophageal corridor [19].

From 2013 to 2019, there has been a steady increase in cancer cases, except for 2017 when a nationwide strike by doctors and nurses affected healthcare delivery. This led to patients seeking care in private and mission hospitals, resulting in a higher number of cancer cases reported in North Kinangop Catholic Hospital in 2017 [20]. In 2020, there was a decline in the number of cases in all three facilities, likely due to movement restrictions imposed to combat the spread of COVID-19, the suspension of some services and the direction of major resources towards treatment and care of COVID-19 patients [21]. Similar challenges have been reported in the United States, Bangladesh, and Canada, where limited access to healthcare during the pandemic delayed cancer detection [22–25]. With a population of about 56 million people, estimated new cancer cases in 2022 were 44,726 [26] and this represents 0.08 % of the population. In 2019, Nyandarua recorded a total of 334 new cases representing 0.056 % of the county population. This is an indication that assuming similar rates across the country, the available health facilities do not attend to all the cancer cases in the county. This may be explained by the limited capacities by the health facilities to manage cancer patients resulting in some patients seeking care outside the county.

Since 2013, healthcare in Kenya has been devolved to county governments, leading to efforts to improved local health facilities [27]. In Nyandarua County, most cancer patients managed in the three facilities were county residents. The establishment of cancer registries at the county level is crucial for cancer surveillance programs and should be prioritized. However, only a few counties, including Nairobi, Machakos, Nyeri, Meru, Kisumu, Eldoret (covering Nandi, Uasin Gishu and Marakwet counties), and now Nyandarua, have functional cancer registries due to challenges such as limited resources and trained personnel [28,29].

Establishing efficient healthcare systems and providing financial support can ensure the smooth operation of cancer registries. These registries can generate county-specific reports, contribute to national cancer registries, and provide accurate follow-up data for cancer survival analysis.

This study represents the first collection of cancer data in Nyandarua County, providing a centralized digital system for all cancer cases during the study period. The study found out that gastrointestinal (esophageal & stomach) and reproductive (cervical, breast, and prostate) were the most frequently managed cancers in the county. Programs for prevention, early detection & timely treatment are encouraged to help manage these alarming trends.

### CRediT authorship contribution statement

**Moses Kamita:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Harrison Waweru:** Writing – review & editing, Investigation, Data curation. **Mercy Githinji:** Writing – review & editing, Investigation, Data curation. **Emma Kibiro:** Writing – review & editing, Resources, Project administration, Data curation. **Francis Makokha:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## References

- [1] K.B. Tran, J.J. Lang, K. Compton, R. Xu, A.R. Acheson, H.J. Henrikson, et al., The global burden of cancer attributable to risk factors, 2010–19: a systematic analysis for the Global Burden of Disease Study 2019, *Lancet* 400 (10352) (2022 Aug 20) 563–591.
- [2] WHO. Cancer [internet] [cited 2021 Aug 17]. Available from: <https://www.who.int/news-room/fact-sheets/detail/cancer>, 2021.
- [3] S.M.S. Islam, T.D. Purnat, N.T.A. Phuong, U. Mwingira, K. Schacht, G. Fröschl, Non Communicable Diseases (NCDs) in developing countries: a symposium report, *Glob. Health* 10 (1) (2014 Dec 11) 1–8.
- [4] H. Sung, J. Ferlay, R.L. Siegel, M. Laversanne, I. Soerjomataram, A. Jemal, et al., Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries, *Ca - Cancer J. Clin.* 71 (3) (2021 May 1) 209–249.
- [5] F. Bray, D.M. Parkin, F. Gnanon, G. Tshisimogo, J.F. Peko, I. Adoubi, et al., Cancer in sub-Saharan Africa in 2020: a review of current estimates of the national burden, data gaps, and future needs, *Lancet Oncol.* 23 (6) (2022 Jun 1) 719–728.
- [6] Globocan. Cancer Today [Internet], *Cancer Today* (2020) [cited 2021 Aug 17]. Available from: <https://gco.iarc.fr/today/online-analysis-table?v=2020>.
- [7] M. Kamita, S. Mweni, A. Nzioka, J.D. Figueroa, F. Makokha, Analysis of cancer diagnoses from 2015–2019 within Machakos County, Kenya, support establishment of Cancer Centre in 2019 likely changing referral patterns, *Wellcome Open Res* 5 (2020 Dec 16) 290.
- [8] A. Korir, R. Gakunga, S. Subramanian, N. Okerosi, G. Chesumbai, P. Edwards, et al., Economic analysis of the Nairobi Cancer Registry: implications for expanding and enhancing cancer registration in Kenya, *Cancer Epidemiol* 45 (2016) 520–529.
- [9] KNBS, Kenya Population and Housing Census. Nairobi; 2019, 2019.
- [10] North Kinangop. Comprehensive Care Clinic [Internet]. [cited 2022 Mar 23]. Available from: <http://www.northkinangop.com/index.php/en/reparti-en/ambulatori-en/item/64-s-cura completa-en>.
- [11] IACR, Iacr - CanReg5 [cited 2022 Nov 26]. Available from: [http://www.iacr.com.fr/index.php?option=com\\_content&view=article&id=9:canreg5&catid=68&Itemid=445](http://www.iacr.com.fr/index.php?option=com_content&view=article&id=9:canreg5&catid=68&Itemid=445), 2021.
- [12] A. Korir, N. Okerosi, V. Ronoh, G. Mutuma, M. Parkin, Incidence of cancer in Nairobi, Kenya (2004–2008), *Int. J. Cancer* 137 (2015) 2053–2059.
- [13] L.W. Macharia, M.W. Mureithi, O. Anzala, Burden of cancer in Kenya: types, infection-attributable and trends. A national referral hospital retrospective survey, *AAS Open Res* 1 (2018) 25.
- [14] H.I. Kim, H. Lim, A. Moon, Sex differences in cancer: epidemiology, genetics and therapy, *Biomol Ther (Seoul)*. 26 (4) (2018 Jul 1) 335–342.
- [15] L.W. Macharia, M.W. Mureithi, O. Anzala, Cancer in Kenya: types and infection-attributable. Data from the adult population of two National referral hospitals (2008–2012), *AAS Open Res* 1 (2019) 25.
- [16] F. Kobia, J. Gitaka, F. Makokha, M. Kamita, J. Kibera, C. Mwenda, et al., The state of cancer in Meru, Kenya: a retrospective study, *AAS Open Res* 2 (2019 Dec 3) 167.
- [17] E. Were, Z. Nyaberi, N. Buziba, Perceptions of risk and barriers to cervical cancer screening at Moi teaching and referral hospital (MTRH), Eldoret, Kenya, *Afr. Health Sci.* 11 (1) (2011) 58–64.
- [18] R.K. Parker, S.M. Dawsey, C.C. Abnet, R.E. White, Frequent occurrence of esophageal cancer in young people in western Kenya, *Dis. Esophagus* 23 (2) (2010) 128–135.
- [19] T. Schaafsma, J. Wakefield, R. Hanisch, F. Bray, J. Schütz, E.J.M. Joy, et al., Africa's oesophageal cancer corridor: geographic variations in incidence correlate with certain micronutrient deficiencies, *PLoS One* 10 (10) (2015 Oct 8) e0140107.
- [20] G. Irimu, M. Ogero, G. Mbevi, C. Kariuki, D. Gathara, S. Akech, et al., Tackling health professionals' strikes: an essential part of health system strengthening in Kenya, *BMJ Global Health. BMJ Specialist Journals* 3 (2018) e001136.
- [21] E.N. Wangari, P. Gichuki, A.A. Abuur, J. Wambui, S.O. Okeyo, H.T.N. Oyatsi, et al., Kenya's response to the COVID-19 pandemic: a balance between minimising morbidity and adverse economic impact, *AAS Open Res* 4 (2021 Mar 29) 3.
- [22] M.J. Walker, O. Meggetto, J. Gao, G. Espino-Hernández, N. Jembere, C.A. Bravo, et al., Measuring the impact of the COVID-19 pandemic on organized cancer screening and diagnostic follow-up care in Ontario, Canada: a provincial, population-based study, *Prev. Med.* 151 (June) (2021) 106586.
- [23] D. Patt, L. Gordan, M. Diaz, T. Okon, L. Grady, M. Harmison, et al., Impact of COVID-19 on cancer care: how the pandemic is delaying cancer diagnosis and treatment for American seniors, *JCO Clin Cancer Informatics.* 4 (4) (2020 Nov) 1059–1071.
- [24] P. Basu, E. Lucas, L. Zhang, R. Muwonge, R. Murillo, A. Nessa, Leveraging vertical COVID-19 investments to improve monitoring of cancer screening programme – a case study from Bangladesh, *Prev. Med.* 151 (May) (2021) 106624.
- [25] J.M. Crowell, D.A. Corley, J.E. Lafata, J.S. Haas, J.M. Inadomi, A. Kamineni, et al., Cancer screening in the U.S. through the COVID-19 pandemic, recovery, and beyond, *Prev. Med.* 151 (June) (2021) 106595.
- [26] Globocan, Statistics at a Glance, 2022 Top 5 Most Frequent Cancers Number of New Cases 44 726, 2022.
- [27] B.B. Masaba, J.K. Moturi, J. Taiswa, R.M. Mmusi-Phetoe, Devolution of healthcare system in Kenya: progress and challenges, *Publ. Health* 189 (2020 Dec 1) 135–140.
- [28] M.L. Cheng, L. Zhang, M. Borok, E. Chokunonga, C. Dzamamala, A. Korir, et al., The incidence of oesophageal cancer in Eastern Africa: identification of a new geographic hot spot? *Cancer Epidemiol* 39 (2) (2015 Apr 1) 143–149.
- [29] S. Pilleron, I. Soerjomataram, H. Charvat, E. Chokunonga, N.I.M. Somdyala, H. Wabinga, et al., Cancer incidence in older adults in selected regions of sub-Saharan Africa, 2008–2012, *Int. J. Cancer* 144 (8) (2019) 1824–1833.