RESEARCH ARTICLE

Analysis of cancer diagnoses from 2015-2019 within Machakos County, Kenya, support establishment of Cancer Centre in 2019 likely changing referral patterns [version 1; peer review: 1 approved]

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Abstract

Background: In Kenya, cancer is an increasing public health challenge, with an estimated 48,000 new cancer cases and over 33,000 deaths recorded each year. Machakos County, Kenya, recently opened a cancer centre with an aim of bringing cancer services such as surgical oncology, chemotherapy, radiotherapy, and pathological services closer to the residents of Machakos County. The county is also one of four counties selected for the universal health coverage pilot programme making it uniquely poised to inform cancer control programs at the local, national, and international levels.

Methods: This study aimed to build a cancer database to enable future population-based cancer studies by reviewing cancer diagnosis records for selected major public hospitals in Machakos County from 2015-2019. Medical records data were retrieved from Machakos Level 5 Hospital and Kangundo, Matuu, Kathiani and Mwala Level 4 Hospitals.

Results: A total of 522 cancer cases were recorded across the study period with more than a third (N=172, 33%) diagnosed August-December of 2019 when the Machakos Cancer Centre opened. Among the cancers diagnosed, the majority were in women (59.2%), with cervix uteri (n=106, 34.3%) followed by breast (n=62, 20.1%) as the most common cancers. For males, oesophagus (n=52, 24.4%) followed by prostate (n=43, 20.2%) were the most common cancer types. The highest crude rates per 100,000 persons were for Kangundo 67.4 and Matungulu 53.2 subcounties.

Conclusion: It is clear that access to cancer care treatment will change referral patterns for residents in Machakos County and with

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the establishment of this database we expect to enable future population-based surveillance of the cancer burden and research studies, to inform cancer control programs.

Keywords

Cancer, incidence, Kenya, breast, cervix, oesophagus, prostate

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Introduction

In Kenya, cancer is the third-leading cause of death after infectious and cardiovascular diseases. An estimated 48,000 incident cancer cases and more than 33,000 deaths are recorded every year in Kenya (Globocan, 2018). Age-standardised mortality rates are 1.4 fold higher in Kenya with 129 deaths/100,000 persons compared to North America (Globocan, 2018; Siegel *et al.*, 2020). Kenya, like many countries in Africa are undergoing a demographic transition and there is consensus that the cancer burden is increasing due to multiple factors including an aging population and increased prevalence of risk factors associated with cancer (Brinton *et al.*, 2014; Brinton *et al.*, 2017; Parkin *et al.*, 2014). Compounding the burden of increasing cancer incidence is also higher frequency of poor prognosis tumours, delayed presentation, late diagnosis and access to preventative care. For example 60% of breast cancer cases in sub-Saharan Africa are diagnosed at late stage and 18% at metastatic stage (Joko-Fru *et al.*, 2020; Makau-Barasa *et al.*, 2018; Sayed *et al.*, 2013). Yet, the true burden is likely underestimated given a deficiency in cancer registry and surveillance networks.

In Kenya, cancer incidence and mortality estimates have been derived from three population-based cancer registries in Nairobi, Eldoret and Kisumu (AFCRN, 2020; Korir *et al.*, 2016; Kruk *et al.*, 2018). Additional cancer registries that have been proposed and are at different levels of development include Meru, Embu, Mombasa, Garissa, Nakuru, Kitui, Kakamega, Machakos and Kiambu (KEMRI, 2019). Data from 2018 based on these registries show crude cancer incidence rates estimated at 93.5 per 100,000 persons and a mortality rate of 63.7 cases per 100,000 persons. In total, cancer accounted for 7% of all deaths (Globocan, 2018). The majority of those affected by cancer in Kenya have an earlier age of onset compared to European countries, with approximately 60% diagnosed below the age of 70 years. Indeed, studies have shown that African ancestry is associated with earlier onset of some types of cancers such as breast cancer (Churpek *et al.*, 2015). The Ministry of Health further estimates the risk of getting cancer at 14%, while the risk of dying from cancer is estimated at 12% in a lifetime (Ministry of Health, 2018a).

Rising cancer incidence and increased public concerns in Kenya led to the passing of the Cancer Control and Prevention Bill by Parliament in 2011 (Ministry of Health, 2018a), followed by publication of the national Cancer Control Strategy and increased investment in cancer diagnostic equipment. Yet, investments in cancer surveillance and registry activities to allow objective assessment of programs to monitor and improve cancer control programs are limited.

Machakos County borders the eastern side of the Nairobi metropolitan area and has a total population of 1,421,898 people according to the Kenya National Bureau of Statistics (KNBS). The county covers an area of 6,208 square kilometres, giving a population density of about 229 persons per square kilometre (KNBS, 2019). The county is dominated by the Akamba people with a major emphasis on farming and

agriculture (Machakos Assembly, 2019). In December 2018, the Government of Kenya launched the Universal Health Coverage (UHC) Pilot Program, which aims to enable Kenyans to have access to affordable healthcare by reducing the cost of health services. The pilot phase targeted four counties in the country, which are Kisumu, Nyeri, Isiolo and Machakos (Ministry of Health, 2018b). In August 2019, the Machakos County government established a new cancer centre to tackle the increasing burden of cancer care. At the centre, residents of Machakos County who are registered in the UHC Programme have access to free cancer screening, diagnosis, counselling and treatment (Mutavi, 2019). Before these developments, most of the residents of Machakos County preferred to seek health care in Nairobi where advanced laboratory services and medical services are available. Given Machakos County's UHC pilot programme and newly opened cancer centre here we aimed to establish the cancer burden and determine if establishment of access to cancer services change referral patterns across the five county public hospitals in order to inform future national efforts for population-based reporting of cancer incidence and mortality for improved monitoring of cancer prevention and control programs.

Methods

Ethical statement

The study protocol was approved by the Institutional Ethics Research Committee of Mount Kenya University (MKU/ERC/1515) and licensed by the National Commission for Science, Technology, and Innovation (NACOSTI/P/19/3043). Cancer registrars were trained on how to abstract data manually using a standardized data extraction tool and on maintaining confidentiality while handling patient files. The filled abstraction forms were kept in a secure room under lock and key within the Directorate of Research and Innovation, Mount Kenya University with limited access to only authorised and trained personnel on data ethics. Authorization to conduct the study was obtained from the county department of health and administrators at each participating health facility. Patient consent was not sought since the study was only retrospective and no active follow up was done. The ethics committee waived consent of individual patients due to the nature of the work being minimal to no risk and the nature of it being secondary data analysis.

Study population

Machakos County borders Nairobi and Kiambu counties to the West, Embu County to the North, Kitui County to the East, Makueni County to the South, Kajiado County to the South East and Murang'a and Kirinyaga counties to the South West (Figure 1). The county is divided into nine sub-counties, which are Masinga, Yatta, Kangundo, Matungulu, Kathiani, Mavoko, Machakos, Kalama and Mwala sub-counties. The classification of health facilities in Kenya is into six levels of hierarchy; Level 1 are community health providers; Level 2 are dispensaries and clinics; Level 3 are health centres and nursing homes; Level 4 are sub-county hospitals; Level 5 are county referral hospitals and large private hospitals; and Level 6 are national referral and large private teaching

Figure 1. Location of Machakos County in Kenya. A map of Kenya showing the location of Machakos County where data collection took place.

hospitals (Murkomen, 2012). In this study, all major Level 4 and 5 hospitals in Machakos County were selected for data abstraction since these are the facilities where cancer patients receive medical and palliative care.

Data collection

Data from 2015–2019 calendar years for five hospitals were obtained, specifically: Machakos Level 5 Hospital and Kangundo, Matuu, Kathiani and Mwala Level 4 Hospitals. In all the Level 4 health facilities, records are centrally located at the records departments (Figure 2). At Machakos Level 5 hospital, hospital files for patients with chronic conditions such as diabetes, and cancer are kept in the specialty clinics. In some cases, the files are centrally located at the health records

department and are retrieved and taken to different clinics or wards whenever the patients have a scheduled clinic or are admitted, respectively. The Health Records Officer (HRO) in-charge at each hospital organized retrieval of patient files a day prior to the visits to the facilities. Retrieved files were reviewed and information abstracted to a predesigned abstraction form. Information abstracted from the files included patient's name, age, sex, county of residence, cancer's primary site, histology, facility name date of incidence, and any comorbidities. Initially, the study aimed to analyse cancer cases reported from 2013 to 2019. However, most of the patient files for 2013 and 2014 were missing in the central records department since patient files are archived after five years since the last visit. A total of 587 cancer cases were recorded

Figure 2. Flow chart of data collection of cancer cases diagnosed in Machakos County. The flow of how patient files were retrieved at Machakos Level 5 hospital where cancer centre is located and the other hospitals. Cancer files dated before the cancer centre was established were located in the records department, while all the other files opened after the cancer centre was opened were in the cancer centre.

from the five facilities visited. Incomplete entries and any duplicates belonging to the same person based on name, gender, age, primary site, and residency, as well as those cases diagnosed in 2013 and 2014, resulted in removal of 65 entries. The cases were given unique patient identifiers and then imported into the Statistical Package for Social Sciences programme (IBM-SPSS) version 26.

Statistical analysis

Crude rates for the period under study were calculated by dividing the number of cancer cases reported at each sub-county by the number of people in the sub-county. The 2019 national census (KNBS, 2019) was used as the source of population denominators for the whole of Machakos County and each sub-county and to describe the population age structure (population pyramid). The cancers were listed according to the International Classification of Diseases for Oncology (ICD-O) third edition. With an aim of establishing a cancer registry at the hospital, the abstracted data was entered into the CanReg5 software from International Agency for Research on Cancer (IACR, 2020), which the hospital is expected to continuously update.

Results

Machakos County population demographics (Figure 3) show that it is a relatively young population with more than 85% under the age of 50 (Kamita *et al.*, 2020). During the five-year period (2015–2019), a total of 522 cases were registered in Machakos County public health facilities. The majority of patients (80.6%) were residents of Machakos County, 56 (10.1%) were from Makuini County and 23 (4.2%) were from Kitui, while the rest were from other counties. Table 1

summarizes the frequency distributions and age at diagnoses for cancer cases. Women accounted for 59.2% (309 cases).

For males, oesophagus ($n=52$, 24.4%) followed by prostate ($n=43$, 20.2%) were the most common cancer types. Among females, the most common types were cervix uteri ($n=106$, 34.3%) followed by breast ($n=62$, 20.1%). A little less than half of cancer patients (42.1%) in this population were diagnosed between 50–70 years of age, and the median age at diagnosis was 58 years (Table 1).

The number of cancer cases per facility varied, with Mwala Level 4 hospital documenting the fewest cancer cases ($n=9$, 2%) and Machakos Level 5 hospital, where the new cancer centre was established, seeing to the highest number of cases ($n=353$, 66%). Kangundo Level 4 hospital was the other facility that saw a high number of cancer patients ($n=123$, 24%). Figure 5a shows that, in the two facilities that saw the highest number of patients (Machakos and Kangundo), the number of cancer patients seen per year did not vary much from 2015 to 2018. However, in 2019, there was a significant increase in the number of cancer cases reported at Machakos Level 5 with not much increase at Kangundo Level 4 hospital. In terms of the four most common cancers, Kangundo Level 4 hospital more frequently saw oesophageal cancer as the most common cancer, while cervix uteri cancer was the leading cancer at Machakos Level 5 hospital (Figure 5b).

Using the 2019 census, crude rates per 100,000 people for each sub-county were calculated for the cancer cases of the patients who indicated Machakos County as their county of residency. Matungulu (86 cases) had the highest number of

Figure 3. Population pyramid based on 2019 Kenya census data of Machakos county by gender and five-year age groups. Population pyramid of Machakos County population as reported by the Kenya National Bureau of Statistics in 2019.

cases, while Mavoko sub-county had the least number of cases (five cases). Machakos sub-county, where the Level 5 hospital is domiciled was second in terms of the number of cancer cases (N=76). Crude rates were highest in Kangundo (67.4/100,000) followed by Matungulu (53.2), while Masinga (15.5) and Mavoko (1.6) had the lowest rates. Overall, the crude rate of cancer in Machakos was 30.9, which is lower than the rates in most of the sub-counties (Figure 4). In our data abstraction form, we aimed to capture additional information such as the patient's HIV status, comorbidities and their smoking or drinking status. However, such information was missing in most of the files. For instance, only 28% (n=144) and 26% (n=134) of the patient files had indicated the smoking and drinking statuses of the patients, respectively, while only 41% (n=213) and 24% (n=123) of the files indicated the occupation of the patient or whether the patient had a family history of a familial disease, respectively.

Machakos County opened its first cancer centre in August 2019 and within just five months of its opening we observed over an eight-fold increase in the number of cancer cases diagnosed at the Level 5 hospital with little to no change in the peripheral facilities.

Discussion

The current study aimed to establish cancer referral patterns and the most common types of cancers diagnosed at Level 4 and 5 Machakos County hospitals based on hospital records

from 2015 – 2019 to facilitate future cancer data science, cancer registration and epidemiologic studies that could improve cancer control and services programmes.

Our data show that women have the higher burden of cancers, with cervix uteri and breast the most common cancer types. Our data are consistent with those from Moi Teaching and Referral Hospital and Kenyatta National Hospital (Macharia *et al.*, 2019). In Eldoret cancer registry, data collected between 2008 and 2012 showed the leading cancer in women is cervix uteri (20.7%) followed by breast cancer (19.7%). In 2018, Globocan reported that the leading cancer in women is breast cancer (12.5%) followed by cervix uteri (11.1%). In men, prostate cancer (14.9%) was the leading cancer type followed by oesophagus cancer (12.4%) (Globocan, 2018). The data are also comparable with reports from the Kenya National cancer control strategy and Tenwek Hospital in Western Kenya (Parker *et al.*, 2010), where prostate and oesophageal were reported to be the major cancer types affecting men.

Although oesophageal cancer is ranked as the eighth most common cancer worldwide, more than 80% of cases and deaths from oesophageal cancer are reported in developing countries, including Kenya (Van Loon *et al.*, 2018). Higher incidence of oesophageal cancer has been well documented, and our data are consistent with other reports showing it to be a major contributor of cancer incidence and deaths affecting the eastern corridor of Africa, which spans from Ethiopia to South

Table 1. Descriptive characteristics of adult cancer cases seen at Machakos County hospitals from 2015–2019.

Primary Site	ICD	Male			Female			Total		
		No. of Cases	%	Median Age	No. of Cases	%	Median Age	No. of Cases	%	Median Age
Lip, Oral Cavity and Pharynx	C00-14	12	5.6%	54	6	1.9%	65	18	3.4%	54.5
Oesophagus	C15	52	24.4%	60	20	6.5%	62	72	13.8%	60.5
Stomach	C16	9	4.2%	59	11	3.6%	67	20	3.8%	59
Colon, Rectum and Anus	C18-21	10	4.7%	48	18	5.8%	61.5	28	5.4%	58
Liver	C22	6	2.8%	51	12	3.9%	58.5	18	3.4%	52.5
Pancreas	C25	2	0.9%	69	3	1.0%	57	5	1.0%	57
Larynx	C32	7	3.3%	69	1	0.3%	64	8	1.5%	68
Lung	C33-34	12	5.6%	40	11	3.6%	72	23	4.4%	61
Skin	C44	3	1.4%	67	10	3.2%	52	13	2.5%	54
Breast	C50	4	1.9%	55	62	20.1%	48	66	12.6%	48
Cervix uteri	C53				106	34.3%	53	106	20.3%	53
Ovary	C56				9	2.9%	48	9	1.7%	48
Prostate	C61	43	20.2%	71				43	8.2%	71
Kidney	C64-66	2	0.9%	53	3	1.0%	52	5	1.0%	52
Bladder	C67	4	1.9%	53	1	0.3%	75	5	1.0%	56
Brain and Central Nervous System	C70-72	3	1.4%	38	5	1.6%	58	8	1.5%	55.5
Thyroid	C73				2	0.6%	70	2	0.4%	70
Blood	C91-95	14	6.6%	47.5	13	4.2%	56	27	5.2%	50
Other and Unspecified		30	14.1%	50.5	16	5.2%	52	46	8.8%	51
Total		213			309			522		58

Africa. Studies have shown that there are certain geographical areas that are high-risk regions for oesophageal cancer. Such high-risk regions include western Kenya, northern China, north-eastern Iran, and northern France (Parker *et al.*, 2010). Indeed, the number of oesophageal cancer cases has been increasing in Kenya and at a higher rate compared with other populations (Patel *et al.*, 2013) with an earlier age at onset (Cheng *et al.*, 2015). A study conducted by Cheng *et al.* (2015) reported that up to 11% of all cases of oesophageal cancer reported at Tenwek Hospital occurred in patients who were aged 30 years or less. In Kenya, more than 70% of oesophageal cancer cases are diagnosed when the disease is at its late stages, primarily due to lack awareness amongst both the patients and

healthcare workers, as well as lack of sufficient diagnostic capabilities. These factors have resulted in the use of stents as the only viable palliative treatment for oesophagus cancer, with a lower chance of using curative treatments (Odera *et al.*, 2017). In contrast, Linxian, China, where oesophageal cancer incidence has also been noted to be high, cases in those under 30 years of age are rare and account for less than 1% of all cases (Zhang *et al.*, 2012). In the USA, studies have shown that the proportion of oesophageal cancers in patients aged 30 years or less is under 0.2% (SEER, 2020). Hence, further studies are needed to determine risk factors and target those that are modifiable that could lower the incidence of oesophageal cancer in Machakos County.

Figure 4. Sub-county crude cancer rates reported at different health facilities between 2015 and 2019 in Machakos county. Machakos county and its eight sub-counties. The shading is based on the crude rates of cancer in the sub-counties.

The current data show that 80% of the cancer patients receiving care from the health facilities in Machakos County are residents and that the number of cancer cases diagnosed increased significantly in 2019, coincident with the recently established Machakos Cancer Care and Research Center. The

opening of this centre, which is now providing diagnostic and chemotherapy services along with the pilot UHC services, has likely impacted a change in referral patterns for this population, allowing more patients to receive care at Machakos Level 5 Hospital as opposed to other referral centres in Nairobi

Figure 5. Number of cancer cases by diagnosis year and by the two major facilities (Kangundo and Machakos hospitals).
a) Number of cancer patients who were recorded each year in all the health facilities studied. **b)** The number of cases for the top five cancer types at the two health facilities that recorded the largest number of cancer patients.

or Kiambu counties. Out of the five health facilities that were included in the study, about 90% of the cases were from Kangundo Level 4 hospital and Machakos Level 5 hospitals. This illustrates the important of these two facilities in their role in cancer patient management either as a screening and treatment centre or a palliative centre. Limitations of our analysis are that we cannot compute population-based rates due to incomplete cancer case assessment since given its specialised nature, cancer care was predominantly obtained outside of Machakos County prior to 2019. The data presented are also limited to the patients seeking cancer care in public hospitals in Machakos County. The data, therefore, miss those patients who may have sought medical care from private hospitals in Machakos County where screening of some cancer types such as cervical cancer is also done. While we aimed to obtain additional data on patients, there was incomplete ascertainment and documentation of histology information, mortality status as well as risk factor data such as smoking and drinking status. Another limitation is that accuracy of the place of residency cannot be ascertained since some patients take residency to mean county of birth, and would provide the county where they were born as the place of residency even when they reside in a different county.

Conclusions

The study established a cancer database for public hospitals in Machakos County from patient files who attended the hospitals between January 2015 and December 2019. As reported in other parts of the country and from the data at some of the already established cancer registries in the country, cervix, breast, and oesophagus cancers are the major cancer types reported at the health facilities in Machakos County. Although the current data do not include cancer cases of all the county residents that have been handled in private hospitals in the county or other counties where cancer care is common (e.g. Nairobi, Eldoret and Kiambu), it documents the changing referral patterns of cancer care and baseline data for establishing a cancer registry. Future efforts to obtain a national cancer registry would allow a more comprehensive picture of cancer burden and referral patterns. This study also allows the possibility for future population-based epidemiology studies to assess risk factors to understand the etiologic factors associated with increasing cancer incidence in the county.

Data availability

Kamita, Moses; Mweni, Sharon; Nzioka, Ancent; Figueroa, Jonine; Makokha, Francis (2020), "Machakos Cancer Registry

Data 2015–2019”, Mendeley Data, V1, <http://dx.doi.org/10.17632/znzvysxx6f.1> (Kamita *et al.*, 2020).

Data are available under the terms of the [Creative Commons Attribution 4.0 International license](#) (CC-BY 4.0).

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Walburga Yvonne Joko Fru

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This is an important article that highlights the importance of cancer surveillance for monitoring the effectiveness of cancer control policies, as well documenting changes in the cancer referral patterns.

However, I do have a few remarks and questions for the authors:

1. From the primary data you made available, we observe there are approximately 11 cases with cancers among children aged 15 and below. Could you make an estimate of pediatric cancer incidence in Machakos? And comment on this estimate for 2019 in reference to Nairobi and Eldoret? Could there be under-reporting or incomplete case ascertainment for pediatric cases differentially?
2. Were there any cases of Kaposi Sarcoma recorded? How does this compare with rates seen in other parts of Kenya?
3. There are very few liver cancer cases recorded in this period, any comments on that?
4. The formatting of Table 1 needs to be corrected. The column lines demarcating the number of cases of males and females are wrongly positioned.
5. As concerns formatting, Figure 4 is mentioned after Figure 5 in the text, please correct figure numbering.
6. You mentioned entering data into IBM-SPSS version 26 and again into CANREG-5. Was data entered twice into different electronic databases?
7. Do you think it would be more accurate to show incidence rates for 2019 separately? Given that the referral patterns changed significantly in this year, and that this may be the only year, where cases in Machakos were more likely to be diagnosed and treated in Machakos? I think you could present results for 2015-2018 and then for 2019. So we have a more

accurate representation of incidence rates in Machakos in 2019?

8. Were any standardized training materials used for the staff entering the data? For example, resources developed by the African Cancer Registry Network/IARC?

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Partly

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Cancer epidemiology/breast cancer/cancer in Africa.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.