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Current Status of Radiotherapy Services in Kenya

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Abstract

Purpose: Owing to the missing recent data regarding cancer case volumes in Kenyan hospitals since 2012, the aim of the study was to fill the gap by providing data for two hospitals in Nairobi, the post year 2012. The general situation of radiation oncology and recommendation for improvement of radiotherapy services in the country were also highlighted. Further assessment was to investigate and determine the relationship between age, different types of cancer, and gender for cancer patients undergoing radiotherapy treatment. *Materials and Methods*: A data compilation, analysis, and evaluation process were conducted at two cancer treatment centers in Kenya followed by an assessment of radiotherapy cancer treatment facilities in the country. The number of the patients treated for cervical, breast prostate, esophagus, rectum, and lung cancer against their ages and gender were also compiled for assessment. *Results*: The number of cancer patients treated by radiotherapy continuously increased annually and he trends of the graphs in both centers were similar. Cervical cancer was the most common cancer treated by radiotherapy at the two centers, followed by breast and prostate cancer. Different types of cancer assessed were dependent on age and that cancer appeared at younger ages in female cervical and breast cancer patients as opposed to the male prostate cancer. *Conclusion*: The results indicate a continuous annual increase in cancer patients treated by radiotherapy in Kenya radiotherapy centers. The increase may be attributed to the rising population, limited access to cancer awareness, and the growing adoption of unhealthy lifestyles, among other factors. Female cervical and breast cancer patients contracted the disease at younger ages (46 - 50 years) compared to the male prostate cancer patients with a mean age of 61 - 65 years. Socio-economic factors, the organization of healthcare systems, and a limited workforce have been identified as some of the barriers to the provision of proper radiotherapy services in the country.

Keywords

Cancer Treatment, Radiotherapy Services, EBRT, Brachytherapy, Age Dependence

1. Introduction

Cancer treatment by radiotherapy in Kenya started in the 1970s when a Cobalt-60 EBRT treatment machine was donated to KNH by the Karolinska Institute through a Swedish and Kenya Government partnership. One Radiation Oncologist and a Medical Physicist, also from Sweden, initiated the cancer treatment program and started training the local personnel.

Based on 2002 data from the Nairobi Cancer Registry, of all the cancers registered, breast cancer accounted for 23.3%, cervical cancer 20%, and prostate cancer 9.4% [1].

Cervical, breast, and prostate cancer have continued to be the most prevalent types of cancer in the country, even to date [2] and in agreement with other published data [3]. Similar to prostate cancer, the majority of our cancer patients only seek treatment when the disease is already advanced, contributing to high mortality rates [4].

Screening of cervical and breast cancer can be done in the majority of the County and Sub-county hospitals, but the screening programs lack organization, and their availability is now widely known, and thus are less beneficial to the needy population.

The only public cancer treatment center in Kenya had been operational since the 1970's. Recently (2009-2021), six private and three public hospitals have opened modern facilities for cancer care and treatment (**Table 1**).

The major workload, however, remains at the public institutions where the costs for cancer care and treatment are affordable compared to the private hospitals. Seven other proposed public cancer centers are also close to offering radiotherapy services, as well (**Table 1**).

Although systemic therapy and surgery are also part of cancer treatment here in Kenya, radiotherapy is an essential part of the treatment and is divided into external beam radiation therapy (EBRT) and brachytherapy.

Based on a past publication on the history of cancer and treatment in Kenya, [2], both EBRT by use of Co-60 teletherapy machine and brachytherapy treatments of thyroid cancer using I-131 oral solution, gynecological cancer treatment, and even Strontium/Yttrium-90 eye plaque treatment started in the early 1970's. In the early 1980s, the first Kenyan radiation oncologists, medical physicists, and therapy radiographers began training through International Atomic Energy Agency (IAEA) fellowship programs, and the cancer treatment activities continued to grow.

The theme of the study was to assess statistics of cancer patients treated by ra-

diotherapy in Kenya before 2019. Kenyatta National Hospital (KNH) and The Nairobi Hospital (TNH), both in Nairobi, were the two cancer centers selected as representative of the other cancer centers in the country that had radiotherapy equipment and were actively in practice. The only public hospital (KNH) with radiotherapy treatment facilities in Kenya was selected, and the second one (TNH) was a private hospital.

Table 1. Nine Kenya hospitals and their respective equipment that provide radiotherapy cancer treatment services currently (2021). Seven other cancer treatment centers have been proposed, and construction is progressing.

INSTITUTION	EQUIPMENT	TYPE OF RADIATION	RADIATION ENERGY
1. Kenyatta National Hospital	Co-60 Teletherapy—2	Gamma	1.17 MV and 1.33 MV
	Linear Accelerator—1	Photons, Electrons	6, 15 MV—photons
			6, 9, 12, 15 MeV—electrons
	HDR Brachy—1	Gamma (Ir-192)	0.38 MeV
	I-131	Gamma	364 keV
2. The Nairobi Hospital	Linear Accelerators—2	Photons, Electrons	6, 15 MV—photons
			6, 9, 12, 15 MeV—electrons
	HDR Brachy—1	Gamma (Ir-192)	0.38 MeV
	Prostate LDR Brachytherapy—1	I-125 Permanent seed Implants	
	I-131	Gamma	364 keV
3. Agha Khan University Hospital	Linear Accelerator-2	Photons, Electrons	6, 15 MV—photons
			6, 9, 12, 15 MeV—electrons
	HDR Brachy—1	Gamma (Ir-192)	0.38 MeV
	I-131	Gamma	364 keV
4. Cancer Care (K)	Linear Accelerator—1	Photons, Electrons	6, 15 MV—photons
			6, 9, 12, 15 MeV—electrons
5. Texas Cancer Center	Linear Accelerator—1	Photons	6, 15 MV—photons
	I-131	Gamma	364 keV
6. EQURA (Eldoret)	Linear Accelerator—1	Photons, Electrons	6, 15 MV—photons
7. Kenyatta University Teaching & Referral Hospital	Linear Accelerator—1	Photons, Electrons	6, 15 MV—photons
			6, 9, 12, 15 MeV—electrons
	HDR Brachy—1	Gamma (Ir-192)	0.38 MeV
8. Nairobi West Hospital	Linear Accelerator—1	Photons, Electrons	6, 15 MV—photons
			6, 9, 12, 15 MeV—electrons
9. Moi Teaching & Referral Hospital, Eldoret	Linear Accelerator—1	Photons, Electrons	6, 15 MV—photons
			6, 9, 12, 15 MeV—electrons
	HDR Brachy—1	Gamma (Ir-192)	0.38 MeV

Continued

OTHER PROPOSED CENTERS			
a. Garissa Referral County Hospital	Linear Accelerator—1 HDR Brachy—1	Gamma (Ir-192)	0.38 MeV
b. Coast General Hospital	Linear Accelerator—1 HDR Brachy—1	Gamma (Ir-192)	0.38 MeV
c. Nakuru Referral County Hospital	Linear Accelerator-1		
d. Kisii Teaching & Referral Hospital	Linear Accelerator		
e. Kilifi County Referral Hospital			
f. Kimathi University (Nyeri County)			
g. Kisumu County Referral Hospital			

The major reason why the above two cancer treatment centers were chosen for the study is that during the beginning of the study in 2013, these were the only centers with facilities and actively involved in radiotherapy treatment, the others had not yet begun. The public hospital (KNH) was the main referral and teaching hospital and received all public referrals and consultations for cancer treatment across the country.

2. Materials and Methods

A data compilation, analysis, and evaluation process was conducted at two cancer treatment centers in Kenya; Kenyatta National Hospital (KNH) and The Nairobi Hospital (TNH), public and private hospitals, respectively, were selected for the study.

The main equipment for cancer treatment by EBRT at KNH included only two Co-60 machines and one Elekta linear accelerator (linac). There was also one Nucletron HDR brachytherapy treatment unit that accommodated Iridium-192 sources. A conventional 2D treatment technique using Co-60 was used for EBRT treatments before the linac was acquired, and calculations of the tumor dosage for the treatment were based on ICRU Report No. 24 [5]. Radiotherapy treatment data collected at this hospital were for treatments using the Co-60 beams only.

The private cancer center was the second institution where cancer treatment data were collected and compiled. Radiotherapy treatment here started in 2012 with the use of two Varian Linacs (2300D series) for EBRT that provide 6 MV and 15 MV photon beams. Superficial tumors and keloids can also be treated here with the Linac electron beams (6, 9, 12, and 15 MeV).

3D CRT technique was used for EBRT treatments, and all captured data for the patients treated represent treatment with the technique alone.

There is also one Varian HDR brachytherapy machine at TNH and a BK Medical Systems machine for Iodine-125 permanent seeds ultrasound-guided

prostate brachytherapy. For the first two years of treatment, we managed to treat 37 prostate cancer patients with this procedure.

In summary, an assessment of the types of equipment available at different operational and proposed cancer centers in the country was done as presented in Table 1.

Treatment of thyroid cancer by the use of I-131 capsules is also practiced in both cancer centers. This is a brachytherapy treatment procedure, but thyroid cancer can also be treated by EBRT depending on the clinical diagnosis.

Further to the above, a total of 1210 different types of cancer patients being treated at the two cancer treatment centres were also investigated and analysed for their ages and gender. At Kenyatta National Hospital (KNH), 125 cervical cancer patients treated by use of Co-60 gamma radiation were assessed. The other 1085 types of cancer patients were being treated at The Nairobi Hospital with Linear Accelerator photon beams for EBRT (except the prostate cancer patients). These were breast (291), cervical (399), lung (39), rectum (58), oesophagus (248), and prostate (60) cancer. Our investigation applied hospital-based data for the patients undergoing radiotherapy treatment from the two hospitals. For each type of cancer, the number of patients against their age was plotted on a graph, Figure 2. Also, it was clearly demonstrated in Figure 3 that, of all the assessed cancer types, each of them appeared at a different mean age.

Since the data that was created or retrieved from patient files was not complicated, analysis and data compilation did not present any challenges.

Treatment Modalities

Currently, the majority of the operational cancer centers here now treat EBRT patients with three Dimensional Conformal Radiotherapy (3D CRT) treatment technique by use of linear accelerator photon and electron energy beams, but the initial public hospital also treats some cancer cases with two dimensional (2D) conventional technique using Co-60 beams.

Two centers now use intensity modulation radiotherapy (IMRT) treatment technique while one center treats some cancer patients with Volumetric Modulated Arc Therapy (VMAT) External Beam technique.

Prostate cancer was initially treated by EBRT before 2017 when the private center began prostate brachytherapy treatment with I-125 ultrasound-guided permanent seed implants.

The major advantages of this treatment technique for prostate cancer have been characterized by Butler [6] as a one-time outpatient procedure, continuous low dose-rate treatment, dose conformity, and sparing of normal tissue, among other reasons [6]. Also, I-125 permanent seeds brachytherapy treatment has been reported to be comparable to radical prostatectomy and to control the prostate PSA 10 years longer than EBRT [7] [8]. Prostate cancer screening can also be done in county hospitals, but its popularity is lower compared to screening for cervical and breast cancer.

The majority of our patients come with "high grade" prostate cancer currently

managed by a combination of an initial brachytherapy treatment with I-125 permanent seed implants (110 Gy) followed by an EBRT "boost" dose of 45 Gy. For those patients diagnosed with clinically localized prostate cancer, radical prostatectomy, brachytherapy, and EBRT treatments are recommended.

The protocol for the treatment of cervical cancer by radiotherapy at the two cancer centers is a combination of 50 Gy of EBRT dose (2 Gy per day, 5 days a week) followed after one month by a brachytherapy "boost" dose of 16 Gy (8 Gy weekly for two weeks), 21 Gy (7 Gy weekly for three weeks) or 24 Gy (8 Gy weekly for three weeks). The radiotherapy dose would be supplemented by systemic therapy, as well. Breast cancer is treated here by a combination of surgery, EBRT, or systemic therapy depending on the stage and the extent of the disease.

Treatment of breast cancer by interstitial brachytherapy is not common at our two centers.

3. Results

The patients' information and treatment data for the study were retrieved by the author between 2013 and 2019. During this period, the Research & Ethics Committees of Kenyatta National Hospital, University of Nairobi, and The Nairobi Hospital had granted the relevant approvals for the study to be undertaken. The patients included were those on radiotherapy treatment and did not include palliative or distant metastatic treatment from the primary site.

Cancer treatment data at the two institutions indicate a continuous increase in the numbers of cancer patients treated by radiotherapy annually [2], and **Figure 1**.

Although the increase may be a contribution to the increasing population and the growing adoption of unhealthy lifestyles [9], it is true that there is some increase in cancer awareness now compared to past years.

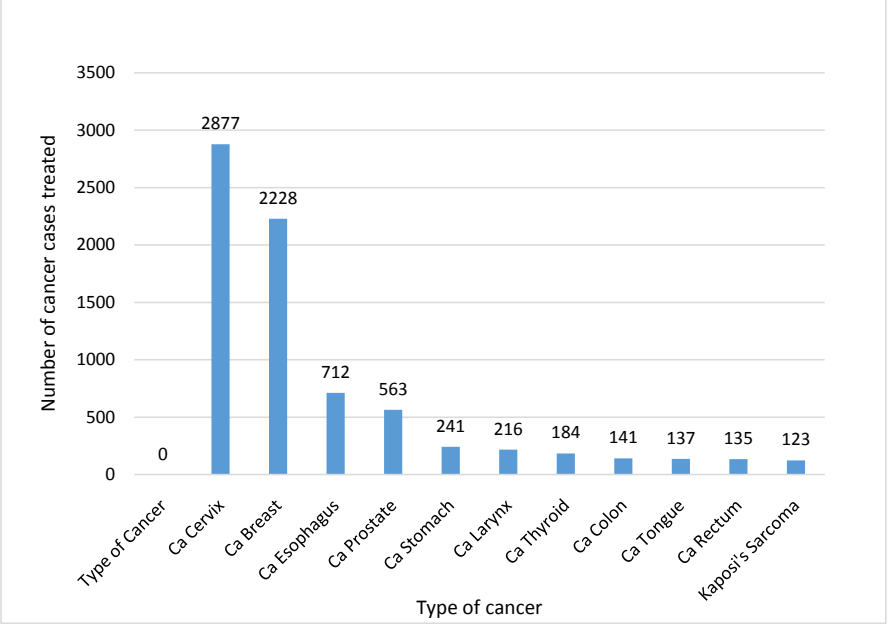

Figure 1. Most common cancers treated by EBRT at KNH between 2007 and 2012.

The trends of the graphs of cancer treatment data for different types of cancer in both centers were similar and some cancers were more common compared to others [6], Figure 1. Cervical cancer was the most common cancer treated by radiotherapy at the two centers followed by breast and prostate cancer, respectively.

An assessment study of TNH cancer patients treated with EBRT (2982), Ir-192 Brachytherapy (1881), I-131 thyroid treatment (69), I-125 Prostate therapy (37), was done to compare the different treatments. Table 2 shows the results in the percentage of the respective treatments.

Radiotherapy EBRT had the highest percentage of treatments (60%) followed by Ir-192 brachytherapy treatments (38%), I-131 thyroid treatment (1.4%), and prostate brachytherapy (0.7%) treatment with I-125 permanent seed implants respectively.

For the age analysis of the cancer patients treated, a combined graph of all the number of patients against their age was plotted in Figure 2 and shows the mean age of each type of cancer. Also, a combined graph (Figure 4) of the three most common types of cancer (cervical, breast, and prostate) was plotted and clearly demonstrate that female cervical and breast cancers are presenting in patients at younger mean age (46 - 50 years) compared to the male prostate cancer appearing in older patients at a mean age of 61 - 65 years.

A summary of Figure 2 was clearly demonstrated in Figure 3 that, of all the assessed cancer types, each of them appeared at a different mean age.

Although cancer treatment data at the two centers was not done extensively, a comparison of age data for cervical cancer patients treated was done and the results were analyzed graphically in Figure 5. The mean age for the cervical cancer patients treated at the two centers was between 46 - 50 years.

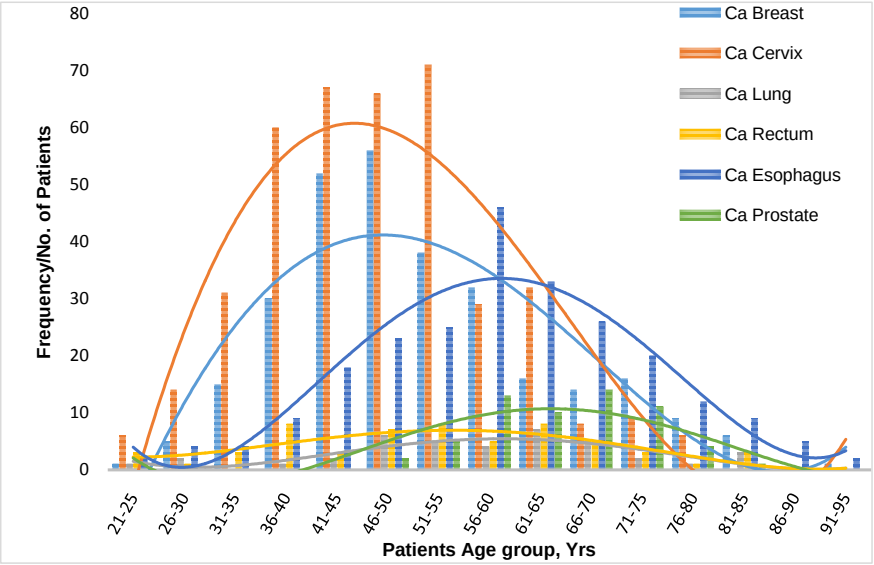

Figure 2. A combined plot of all the six types of cancer. Frequency against age of the cancer patients.

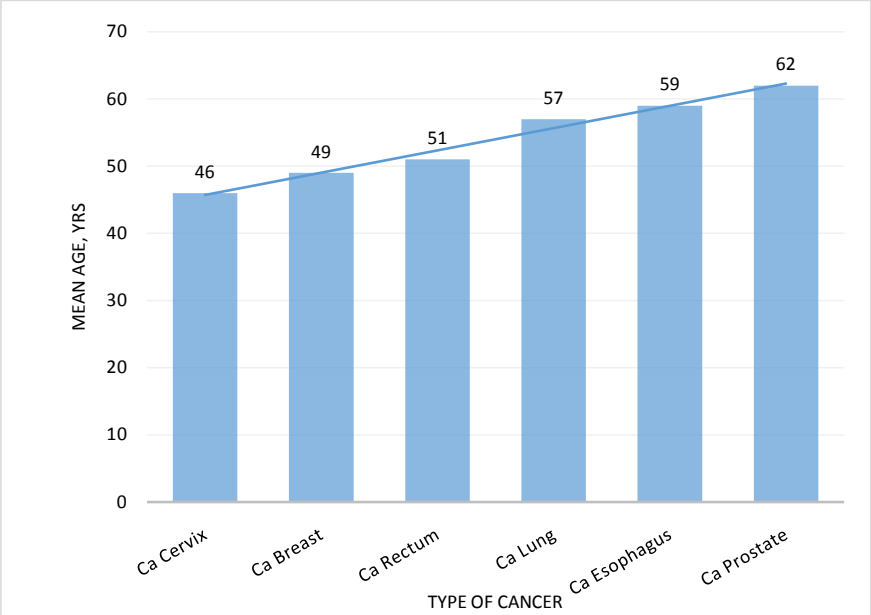

Figure 3. Summary of mean ages of different types of cancer for radiotherapy patients at TNH and KNH hospitals.

Table 2. Data for cancer patients treated at TNH by radiotherapy between 2013 and 2018, including the total percentage for all the procedures.

YEAR OF TREATMENT	EBRT TREATMENT	Ir-192 BRACHYTHERAPY	I-131 THYROID TREATMENTS	PROSTATE BRACHYTHERAPY
2013	307	198		
2014	474	190	5	
2015	264	182	8	
2016	545	263	6	
2017	695	641	23	21
2018	697	407	27	16
Total & Percentage	2982 (60%)	1881 (38%)	69 (1.4%)	37 (0.7%)

4. Discussion

Cancer treatment data at the two institutions indicate a continuous increase in the numbers of cancer patients treated by radiotherapy annually [2], "and **Figure 1**". The trends of the graphs of cancer treatment data for different types of cancer in both centers were similar and some cancers were more common compared to others [6], **Figure 1**. Cervical cancer was the most common cancer treated by radiotherapy at the two centers followed by breast and prostate cancer, respectively

Results of analysis of TNH patients treated by different modalities showed that EBRT accounted for 60% of all radiotherapy patients treated compared to 40% of those treated by brachytherapy (Ir-192 treatments, I-125 prostate permanent seeds, and I-131 thyroid capsules),

The plotted data of ages of cervical, breast, and prostate cancer patients treated at TNH (Figure 4) clearly demonstrate that female cervical and breast cancers are presenting in patients at younger mean age (46 - 50 years) compared to the male prostate cancer appearing in older patients at a mean age of 61 - 65 years. This is consistent with past published data, [4] [7] [11]. Figure 5 compared the ages of cervical cancer patients treated at the two hospitals and had similar mean ages (46 - 50 years), which may suggest that the patients treated at different hospitals in the country were normally distributed.

Figure 2 and Figure 3 plotted graphs of all the cancer types against their ages as a clear demonstration that each type of cancer appeared at a unique mean age and that the female cervical and breast cancers appeared at younger ages than their male esophageal and prostate cancers.

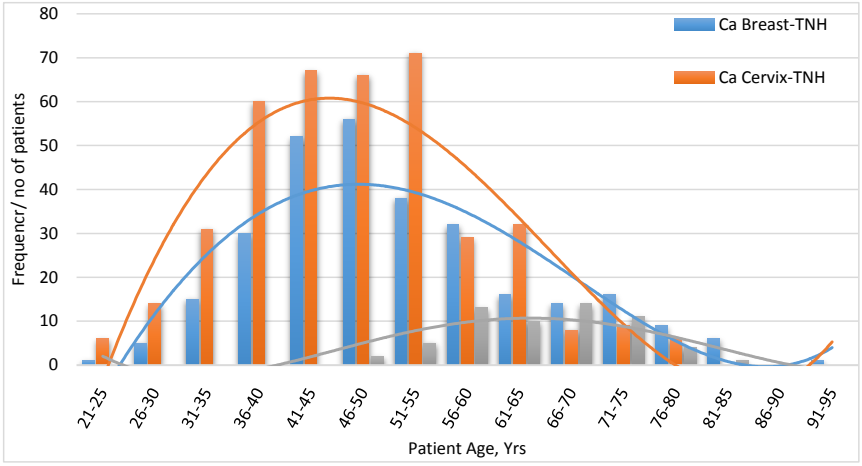

Figure 4. Graph of the frequency (number of patients) against their ages in years for TNH cervical, breast and prostate cancer patients treated in year 2017-2019.

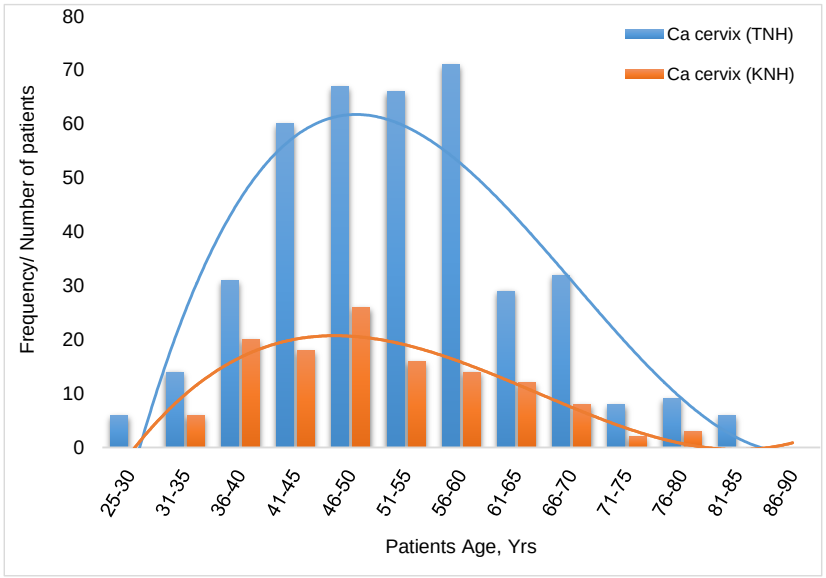

Figure 5. Graph of the number of cervical cancer patients against their ages for KNH and TNH treatment centers, showing a mean age of 46 - 50 years for both centers.

4.1. Cancer Burden in the Country

Just like in other low- and middle-income countries where sustainable development goals have not been achieved, the existing infrustructure, manpower, cancer awareness, Government funding, and affordable insurance cover, among others, are inadequate for the existing and rising population of cancer patients who require cancer treatment.

Radiotherapy equipment for cancer treatment is also not only expensive, but very specialized. Kenya's annual budget (2018) for health was 6%, which was too small to cover the health sector requirements. For our government to facilitate easy access to cancer treatment facilities, we must implement the "Abuja declaration" that proposed to designate a 15% budget for healthcare for every African country's annual budget. If implemented, this would facilitate increases in the annual budgets allocated to the 47 counties for inrastructure, staff training, and other logistics necessary for at least one complete cancer center in each county.

Both infrastructure and trained manpower are basic requirements for an operational cancer treatment center. The current nine oprational centers have the basic infrastructure, as well as at least a minimal number of trained clinical radiation oncologists, medical physicists, and therapy radiographers. Even the long-established operational centers have trained oncology nurses and biomedical technicians.

The IAEA, through her collaborative support in human resource development in developing IAEA member states, initiated a project for training therapy radiographers in Kenya in 2012. Although the IAEA ceased to participate in the project, two Kenyan institutions took over the training program. The majority of the RTTs now operating the cancer therapy equipment in the operational nine centers have been trained in the program. Recently, the IAEA also initiated another training project for radiation oncologists and, in the future, the possibility of another project to train medical physicists.

The strengths of the current operational cancer facilities include availability though not enough of trained personnel, modern infrastructure, availability of patients to serve, and some insurance coverage for the patients in need (NHIF). The majority of these facilities have maintenance contracts with the equipment suppliers.

Regulatory requirements in the application of radiation in the treatment of cancer have been strengthened through the Nuclear Regulatory Authority, Ministry of Health, which has been operational since the 1980s. To date, radiation safety culture has continued to grow with the expansion of cancer treatment developments.

The weaknesses include the following; centralized facilities within the city of Nairobi, lack of training programs, especially for medical physicists, and limited training programs for radiation oncologists and oncology nurses. Each of the operational cancer centers has at least one qualified medical physicist who takes care of all QA of the equipment and treatment procedures. The centers also participate in the IAEA/WHO dose audits once every two years, and the audit results of the dose inter-comparisons have been satisfactory for most of the cen-

ters.

4.2. Kenya Health System

Treatment of cancer by radiotherapy in Kenya faces many challenges as a result of inadequate and centralized facilities, inadequate healthcare funding by the government, and poverty, among other factors. The National Hospital Insurance Fund (NHIF) is the major insurance coverage for the majority of the population, but not all Kenyans can afford to make the monthly contribution as required.

On the "Four Agenda" for the President in his final five-year term is the implementation of a "universal health coverage program" which is on trial as a pilot program in our counties (Machakos, Kisumu, Nyeri, and Isiolo), out of a total 47 counties [10], **Figure 6** and **Table 3**, beginning in 2019. It is working well so far and would be rolled out to all the 47 counties in the future. It covers the cost of most, but not all outpatient and inpatient expenses. The coverage can be accessed only at public hospitals, not at private ones. The program should be a continuous journey and would need support from all stakeholders if it is to succeed.

Specifically, the current cost of treatment per daily session of external beam radiotherapy at the public hospital is USD. 36, while at the private center the cost is USD. 60. The National Hospital Insurance Fund (NHIF) would cover USD. 36 for each daily treatment at any hospital, but only for those patients with insurance coverage.

Of note, all the operational cancer centers also have fully operational radiology and pathology facilities and qualified staff that support the required cancer patient management.

4.3. Challenges in Provision of Radiotherapy Services

Some of the current challenges that the Kenya cancer service face include the following;

- Centralized cancer treatment centers. Out of the nine operational radiotherapy centers in the country, seven are in Nairobi, and only two centers are outside the city. The majority of the cancer patients are poor, and travelling long distances from rural areas to access radiotherapy services in Nairobi is costly and very challenging.
- Limited access to cancer treatment at public hospitals. Only three public cancer centers out of nine fully operational centers are currently available. The majority of the cancer patients cannot afford cancer treatment services at the private hospitals compared to the public hospitals which are less expensive owing to Government subsidization.
- Unaffordable public healthcare insurance coverage. The National Hospital Insurance Fund (NHIF) insurance that funds the majority of the public cancer patients, does not cover all the cancer care costs required by the patients. Thus, the patient is left to pay significantly for the treatment to be completed.

Table 3. Kenya county distribution of population of the 47 counties of the country [10].

KEY:	
County	**Population**
Mombasa	1,208,333
Kwale	866,820
Kilifi	1,453,787
Tana River	315,943
Lamu	143,920
Taita/Taveta	340,671
Garissa	841,353
Wajir	781,263
Mandera	867,457
Marsabit	459,785
Isiolo	268,002
Meru	1,545,714
Tharaka-Nithi	393,177
Embu	608,599
Kitui	1,136,187
Machakos	1,421,932
Makueni	987,653
Nyandarua	638,289
Nyeri	759,164
Kirinyaga	610,411
Murang'a	1,056,640
Kiambu	2,417,735
Turkana	926,976
West Pokot	621,241
Samburu	310,327
Trans Nzoia	990,341
Uasin Gishu	1,163,186
Elgeyo/Marakwet	454,480
Nandi	885,711
Baringo	666,763
Laikipia	518,560
Nakuru	2,162,202
Narok	1,157,873
Kajiado	1,117,840
Kericho	901,777
Bomet	875,689
Kakamega	1,867,579
Vihiga	590,013
Bungoma	1,670,570
Busia	893,681
Siaya	993,183
Kisumu	1,155,574
Homa Bay	1,131,950
Migori	1,116,436
Kisii	1,266,860
Nyamira	605,576
Nairobi City	4,397,073
Total Kenya Population	47,564,296

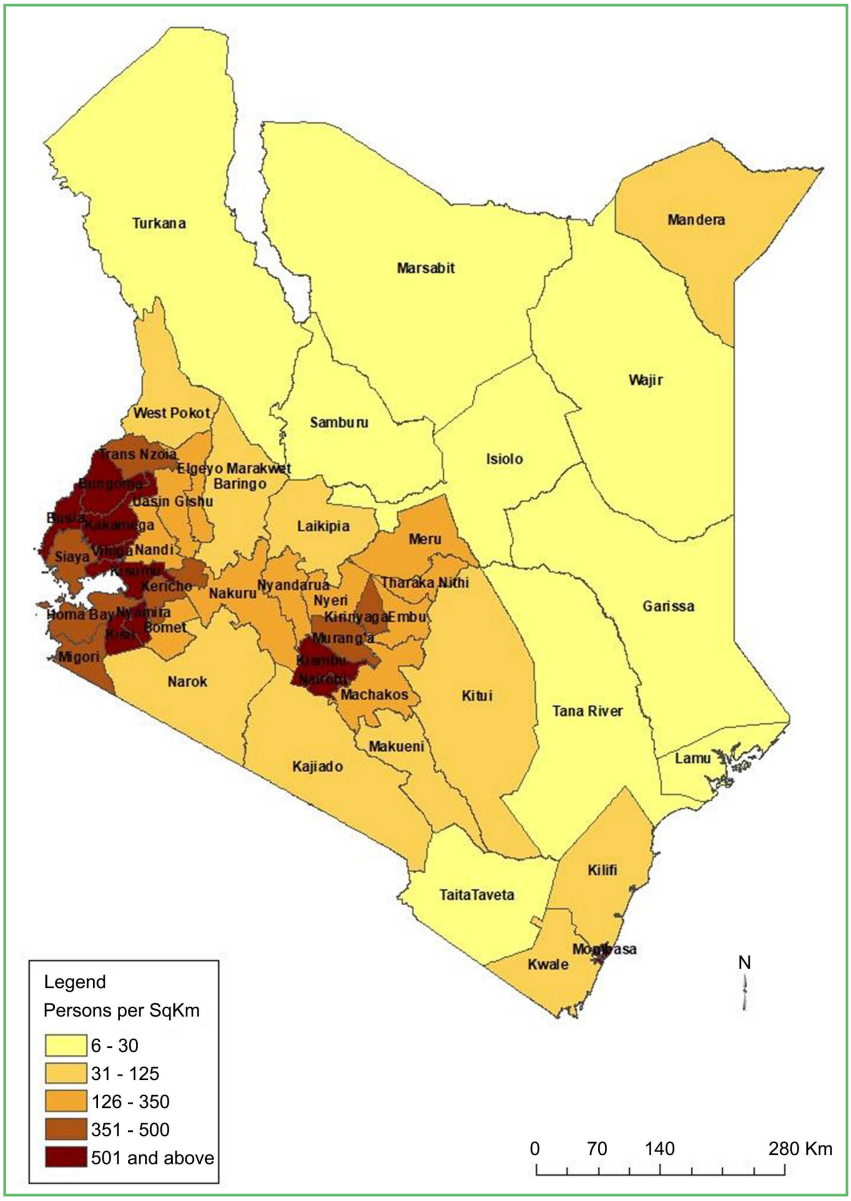

Figure 6. Kenya county population density map of the 47 counties of the country [10].

Equipment and specialized staff for cancer treatment are not enough for the current population of Kenya, approximately 47.6 million people [10], **Figure 6** and **Table 4**.

For example, the WHO recommended ratio of Clinical Oncologist to cancer patients is 1:1000, while in Kenya, this ratio is 1:6833 [12].

In 2018, the two institutions under review had 10 Radiation Oncologists, 8 Medical Physicists, and 18 Therapy Radiographers who were in practice. So, the ratios for the three specialized cadres to the current estimated 70,000 cancer patients were about 1:7000, thus, rendering care inaccessible to most. **Table 4** describes recommendations for the current required staffing, infrastructure, and percentage deficit for LMICs like Kenya.

Table 4. Present status of radiation therapy infrastructure and staffing in LMICs (similar to Kenya) [12] [13].

Infrastructure and Personnel	Number of units or personnel /Number of patients	Existing/ Required	% of present deficit
Teletherapy units	1/450 patients	4138/10,735	61.4
Radiation oncologists	1/450 patients	11,803/19,323	38.9
Medical physicists	1/450 patients	3392/10,735	68.4
Radiotherapy technologists	1/150 patients	10,780/32,204	66.5

In summary, the situation of radiation oncology development in Kenya appears to have been slowed down by economic-related factors. Proper planning and other factors have also contributed to the present situation of the sector, but not to a great extent compared to the economic issues.

4.4. Proposed Solutions

A formalized national cancer registry for the country would create a friendly environment during planning for cancer facilities in the country. The implementation of data collection for such a cancer registry is now long overdue, several institutions and individuals [1] [14] have shown much effort in compiling their own data because of the unavailability of a formalized national registry. Researchers who wish to use cancer-related data currently depend on hospital or regional-based data. It is noteworthy that high-quality cancer registry data, the basis for planning and implementing evidence-based cancer control programs, are not available in most low- and middle-income countries [15].

The country that implemented a devolved system of government in 2014 should now be far along in planning the distribution of cancer facilities country-wide, but that was not the case. At least among the 47 counties of Kenya, each county should now be planning to have at least one cancer treatment center.

4.5. Limitations of the Study

The major limitations experienced in the study included the following;

1) Lack of a formalized National Cancer Registry where cancer patients' data can be easily accessed by researchers.

2) It was not easy to get patient data or other information connected to the cancer treatment or equipment information from other private hospitals

3) Available time to acquire treatment data was very limited because of patient occupancy on the treatment equipment. Patients on treatment especially at the public cancer centers are more than the available treatment equipment, and that results in the occupation of patient treatments from early hours of the day to late in the evening.

5. Conclusions

Patients who need radiotherapy for cancer treatment have been on the increase annually. This may be due to the rising population, limited cancer awareness, and the growing adoption of unhealthy lifestyles, as well as access to limited cancer treatment facilities. Cervical, breast, and prostate cancer are among the most frequent types in Kenya, just like in other developing countries.

Results of analysis of TNH patients treated by different modalities showed that EBRT accounted for 60% of all radiotherapy patients treated compared to 40% of those treated by brachytherapy (Ir-192 treatments, I-125 prostate permanent seeds, and I-131 thyroid capsules), The female cervical and breast cancer patients had an overall mean age of 46 - 50 years, quite young compared to the male prostate cancer patients who had a mean age of 61 - 65 years. Cervical cancer was identified as the most commonly treated by radiotherapy in Kenya with 37% - 41% of all cancers treated by EBRT.

Our proposed solutions to the observed challenges would include strengthening cancer awareness in Kenya through social media to include the more remote areas, a well-organized national cancer screening program for the most common cancers, such as cervical, prostate, and breast cancer, need to be implemented and would require funding.

A formalized National Cancer Registry [16] [17] should be implemented through the Ministry of Health, so that future planning of cancer treatment and the relevant infrastructure can be possible. This is now long overdue, several institutions and individuals have shown substantial effort in compiling their own data due to the unavailability of a formalized national registry.

The Government should adopt the "Abuja declaration" that proposed a 15% budget for healthcare for every African country's annual budget.

Training of relevant personnel needs to be strengthened and expanded to cover the referring 47 county hospitals.

Thus, Socio-economic factors, the organization of healthcare systems, and a limited workforce have been identified as some of the barriers to the provision of proper radiotherapy services in the country.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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