INVESTIGATING GEOGRAPHIC AND FINANCIAL ACCESS OF CANCER PATIENTS TO RADIOTHERAPY SERVICES IN UNIVERSITY OF MAIDUGURI TEACHING HOSPITAL CANCER CENTER, NORTH-EAST NIGERIA

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ABSTRACT

Background: Access to radiotherapy remains grossly inadequate, especially in low-and-middle income (LMIC) countries like Nigeria. With only about 17% of cancer patients in low-income countries having access to radiotherapy services within 120 minutes travel, and 80% to 95% of these patients having to pay for radiotherapy services directly out-of-pocket; the is a well-established barrier of access to radiotherapy services in low-income settings like Nigeria.

Objectives: To investigate the geographical and financial access to radiotherapy by cancer patients presenting to the University of Maiduguri Teaching Hospital (UMTH) Cancer Centre, which is a new cancer centre situated in Borno state, Northeast Nigeria.

Methods: It was a retrospective cross-sectional study comprising cancer patients who were treated at UMTH Cancer Centre between August 2023 and September 2024. Data analysis was done using Statistical Packages for Social Sciences (SPSS) version 25.0.

Result: A total of 364 patients were included in the study, with a mean age of patients was 48.7 ± 14.9 years, and a median of 50 years (IQR: 40 – 60 years). Breast 102(28.0%), cervical 73(20.1%) and head & neck cancers 68(18.7%) were the commonest cancers treated. The Median distance of patients' residence from UMTH Cancer Centre was 542 km (IQR: 407- 767 km). Overwhelmingly, 361(99.2%) of patients paid for radiotherapy via out-of-pocket expenditure, despite 39(10.7%) of them having national health insurance coverage.

Conclusion: The study found that there were constraints to geographic and financial access to radiotherapy among most cancer patients at UMTH Cancer Centre. These geographic and financial barriers grossly limit access to radiotherapy by Nigerian cancer patients requiring such essential services.

Keywords: Cancer Patients, Geographic Access, Out-of-Pocket Health Expenditure, UMTH Cancer Centre

INTRODUCTION

Cancer is a disease with rising prevalence globally. Though the incidence of cancer is higher in high-income countries compared to low-and-middle income countries (LMIC), the burden is disproportionately higher in LMICs compared to high-income countries.[1,2] This is due to a complex of factors, including delayed diagnosis, and grossly inadequate access to quality cancer treatments.[1,2] The management of cancer involves the use of multiple modalities, including surgery, chemotherapy, radiotherapy, targeted therapy, immunotherapy, and best supportive care, among others.[3,4]

Radiotherapy is the use of ionising radiation, delivered at an optimal dose to treat cancer. It is usually delivered with precision to the tumour targets with the aid of computer-assisted technology.[5] There are two main modalities of delivering radiotherapy- external beam radiotherapy (EBRT), which directs high-energy radiation from a machine to the tumour, and brachytherapy, which places radioactive sources that emit high-energy radiation close to, or within, the tumour volume.[6] Radiotherapy is a critical component of cancer treatment that is required in conjunction with other treatment modalities for effective cancer treatment. The World Health Organisation (WHO) estimates that over 50% of all cancer patients will require radiotherapy as part of their cancer treatment, as it is used in the treatment of some of the commonest malignancies like breast, cervical, colorectal cancer, etc.[7]

Access to radiotherapy remains inadequate, especially in LMIC countries like Nigeria.[7] With only about 14 functional linear accelerators (EBRT machines) and 8 high-dose rate brachytherapy machines available to serve a population of about 230 million people, access to radiotherapy is grossly limited in Nigeria.[8,9] Even with this gross shortage, there is significant disparity across the various states and geopolitical regions, with 25 of the 36 states of the Federation having no form of radiotherapy facility domiciled within.[8] The radiotherapy facilities in Nigeria fall very short of the International Atomic Energy Agency (IAEA) recommendation of one megavoltage machine per 500 cancer patients requiring radiotherapy.[10] Using the WHO rate of 50% of cancer patients requiring radiotherapy, with a

prevalence of cancer of 269,000, Nigeria will require at least 269 megavoltage machines to effectively treat its cancer patients.[7,10,11]

Geographic access to radiotherapy services is therefore one of the structural barriers to health equity.[12] A comprehensive global spatial analysis in 2025 showed that only 17% of the population in low-income countries had access to radiotherapy facilities within a 120-minute travel distance compared to 93% of the population in high-income countries.[12] The radiotherapy services in low-income countries are often situated in tertiary health institutions in state capitals, which necessitates long distant travels by patients from rural and suburban regions.[12] These usually require significant additional hidden indirect non-medical costs, which usually mask the cost of clinical treatment.[13,14] These include costs of travel, accommodation and feeding for patients and accompanying caregivers;[13,14] and have accounted for disproportionately higher financial toxicity rates in low-income countries (72.3%) compared to high-income countries (39.4%).[15]

Furthermore, several studies highlighted inadequate health insurance infrastructure, with 80% to 95% of cancer patients relying on direct personal payments for radiotherapy, brachytherapy and other oncology services.[16,17] This out-of-pocket expenditure usually causes serious financial strain on cancer patients and their families, with average costs gulping up to 42% of their annual income in low-income countries.[18] This results in many patients being unable to present for radiotherapy services, while others delay presentation to source funding and some abandon treatment due to accumulating financial toxicity.[16,17]

It is in the context of the above background that the University of Maiduguri Cancer Centre, a fully owned government radiotherapy centre, was established with two linear accelerators and two high-dose rate brachytherapy. It was commissioned in August 2023 as the first comprehensive cancer centre in the whole of the Northeast geopolitical region. It provided radiotherapy treatment for cancer patients, including external beam radiotherapy, brachytherapy, chemotherapy, palliative and supportive care.

This study, therefore, attempted to investigate the geographical and financial access to radiotherapy by cancer patients presenting to the University of Maiduguri Teaching Hospital (UMTH) Cancer Centre from the time of its formal commissioning in August 2023.

MATERIALS AND METHODS

Study Area

The study was conducted in UMTH, which is a foremost tertiary healthcare facility in Northeastern Nigeria. The UMTH Cancer Centre was commissioned in August 2023. It was equipped with linear accelerators, two high dose rate brachytherapy, CT simulator. The UMTH Cancer Centre, within a short period of time, became a centre for referral of cancer patients, not just for patients from the North-east geopolitical region, but from across the states of the Federation, and from neighbouring countries. The centre provided outpatient clinic services, CT simulation, Contouring, treatment planning, external beam radiotherapy and brachytherapy. Furthermore,

administration of chemotherapy to patients as well as admission to wards for resuscitation and blood transfusion. The centre was fully functional from August 2023 to September 2024, and its operation was significantly halted due to the flooding in Maiduguri, which affected the radiotherapy machines, rendering them non-functional.

Study Design

It was a retrospective cross-sectional study.

Study Population

The study population comprised cancer patients who were treated at UMTH Cancer Centre between August 2023 and September 2024.

Study Eligibility

The inclusion criteria were all histologically diagnosed cancer patients who presented to UMTH Cancer Centre for treatment between August 2023 and September 2024. All cancer patients who were neither planned for nor received radiotherapy in the UMTH Cancer Centre within the study period were excluded from the study. Patients with missing or incomplete records from their case notes were excluded from the study.

Sample Size and Sampling Technique

A total population sampling was used to include all patients who met the study criteria.

Data Collection Tool

Data was collected from patients' clinical case notes and treatment records. These were recorded using a semi-structured questionnaire that was developed using Kobo Toolbox version manufactured by Kobo, Cambridge. The information retrieved from the patients' case notes includes: **A**: Socio-demographic characteristics of patients like age, gender, marital status, education, occupation, tribe and religion; **B**: Clinic-pathological characteristics including Cancer type and histology diagnosis, date of histology diagnosis, date of referral to UMTH Cancer Centre, and date of first presentation to UMTH Cancer Centre. **C:** Geographic details of patients, including town and state of their residential address; name and state of referring hospital; and distance from patients' residential address (town of residence was used as point of reference) to the UMTH Cancer Centre were calculated in Kilometers using the online Google Map Application (2025). **D:** Patients' sources of funding were obtained from their case notes. These included self-funding, use of the national Health Insurance Scheme, use of retainerships and Cancer Health Fund (CHF)

Statistical Analysis

Data was saved using the Microsoft Excel application and then transferred into the Statistical Packages for Social Sciences (SPSS) version 25.0, manufactured by the International Business Machines Corporation (IBM), California. The variables were analysed and summarised using tables and charts. Socio-demographic, clinical and treatment variables of patients were presented in tables, graphs, histograms, and charts using frequency and percentages. The Referral-Presentation interval was calculated in Days by subtracting the date of referral from the date of first presentation. The association between the distance of patients' residence from UMTH Cancer Centre and referral- Presentation interval was plotted using a scatter plot diagram and Spearman coefficient. The P value of 0.05 or less was considered statistically significant.

Ethical Consideration

Ethical approval was waived by the University of Maiduguri Teaching Hospital Health Research and Ethics Committee, considering it was a retrospective study that does not involve samples from human subjects. The data obtained were de-identified to avoid tracing information obtained to any of the cancer patients of the study, whether they are dead or alive.

RESULTS

A total of 364 cancer patients were included in the study. These patients were from numerous states across the federation (Figure 1). The mean age of patients was 48.7 ± 14.9 years, and the median was 50 years (IQR: 40 – 60 years). Breast 102(28.0%), cervical 73(20.1%), and head & neck cancers 68(18.7%) were the commonest cancers treated in the UMTH Cancer Centre (Figure 2), with nearly all patients having either locally advanced – 312(85.7%), or metastatic- 51(14.0%) disease. Most of the patients were female- 222 (61.0%), married- 302(83.0%) and Muslims- 259(71.2%) (Table 1). The predominant occupation of patients was civil service- 110 (30.2%) and trading 78(21.4%), with 79(21.7%) of patients not having an occupation at all (Table 1).

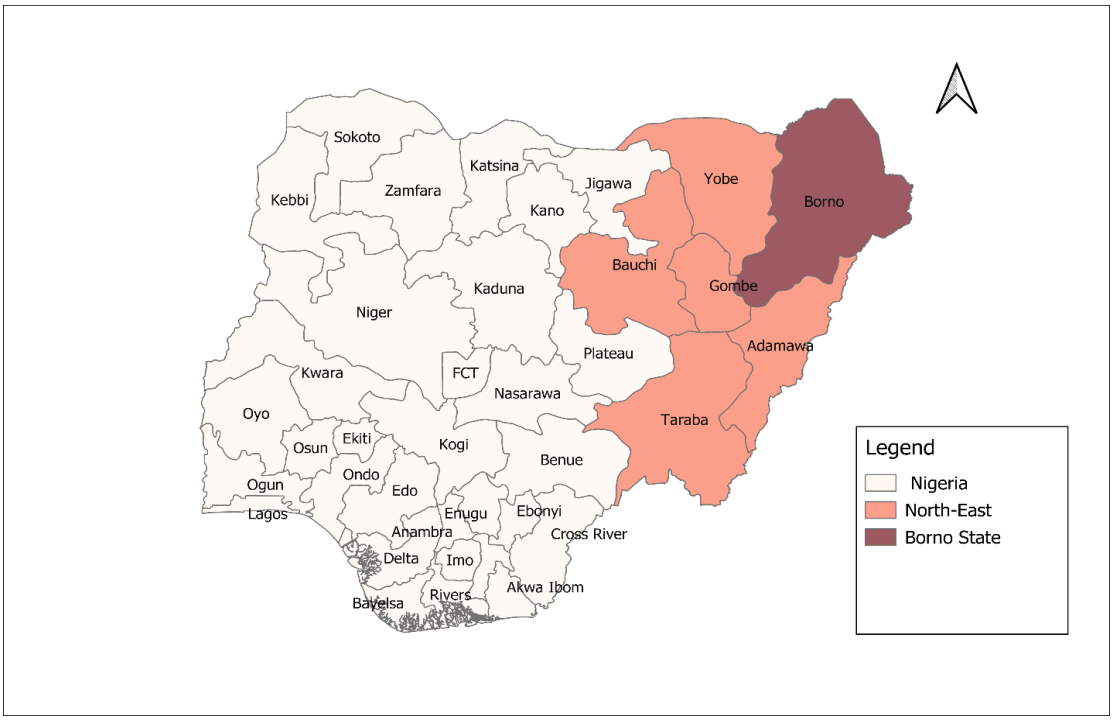

Figure 1: Map of Nigeria Showing Borno and Other States of the Federation

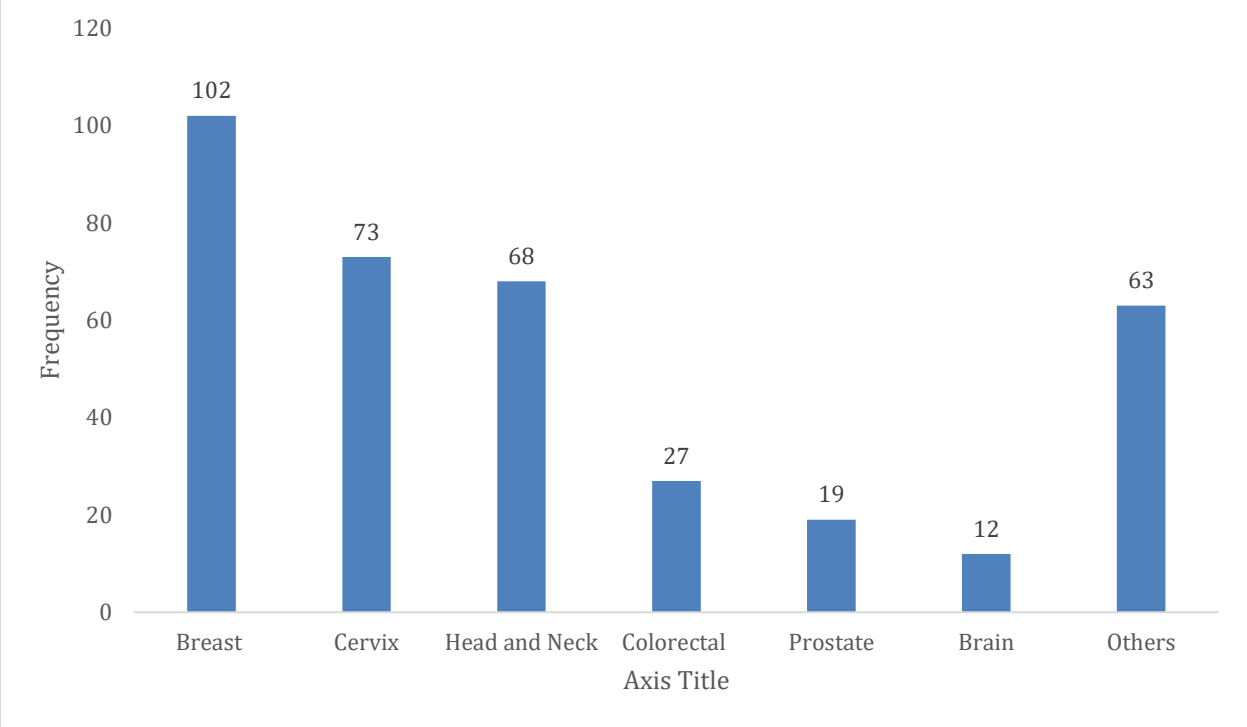

Figure 2: Distribution of Cancer Type Being Managed in UMTH Cancer Centre

Table 1: Sociodemographic Characteristics of Cancer Patients (n= 364)

Variable	**Frequency (%)**
Age (years)	
< 20	15 (4.1)
21- 40	89 (24.5)
41- 60	185 (50.8)
61- 80	73 (20.1)
>80	2(0.5)
Gender	
Female	222 (61.0)
Male	142 (39.0)
Marital status	
Married	302 (83.0)
Single	31 (8.5)
Divorced	13 (3.6)
Widowed	18 (4.9)
Education	
None	17 (4.7)
Non- formal	87 (23.9)
Primary	42 (11.5)
Secondary	67 (18.4)
Tertiary	151 (41.5)
Occupation	
None	79(21.7)
Student	20 (5.5)
Trading	78 (21.4)
Civil servant	110 (30.2)
Artisan	23 (6.3)
Farmer	21 (5.8)
Retiree	23 (6.3)
Others	10 (2.7)
Religion	
Islam	259 (71.2)
Christianity	105 (28.8)
Tribe	
Hausa	140 (38.4)
Yoruba	27 (7.4)
Igbo	13 (3.6)

Fulani	36 (9.9)
Kanuri	24 (6.6)
Others	106 (29.1)

Geographic Access

Median distance of patients' residence from Maiduguri was 542 km, with an interquartile range of 407 km (25th percentile) and 767 km (75th percentile). The least distance recorded was 1 km, while the furthest distance was 1520 km. The most common travel distance was between 401- 600 km, with 137(37.6%) of cancer patients covering these distances from their residence to UMTH Cancer Centre to access radiotherapy services (Figure 3). The North-west Geo-political zone has the highest number of patients referred, while Kano State had the highest referral of cancer patients amongst the 36 states of the Federation and Abuja (Figures 5a-5d). In some instances, patients received initial specialist care from hospitals located in different states (or geopolitical regions) from their places of residence (Figure 5a-5d). This has been well highlighted for FCT Abuja and Plateau state (Figure 5a).

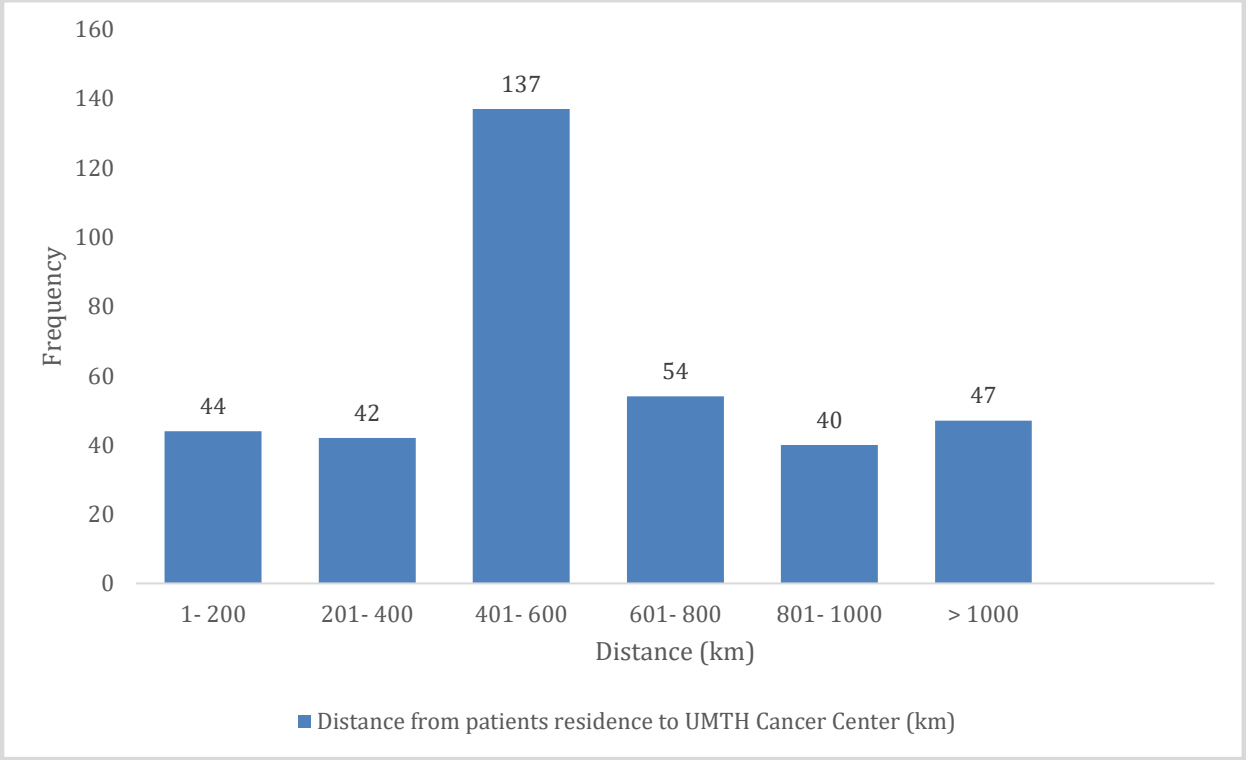

Figure 3: Distance from Patients' Residence to UMTH Cancer Centre (km) (n= 364)

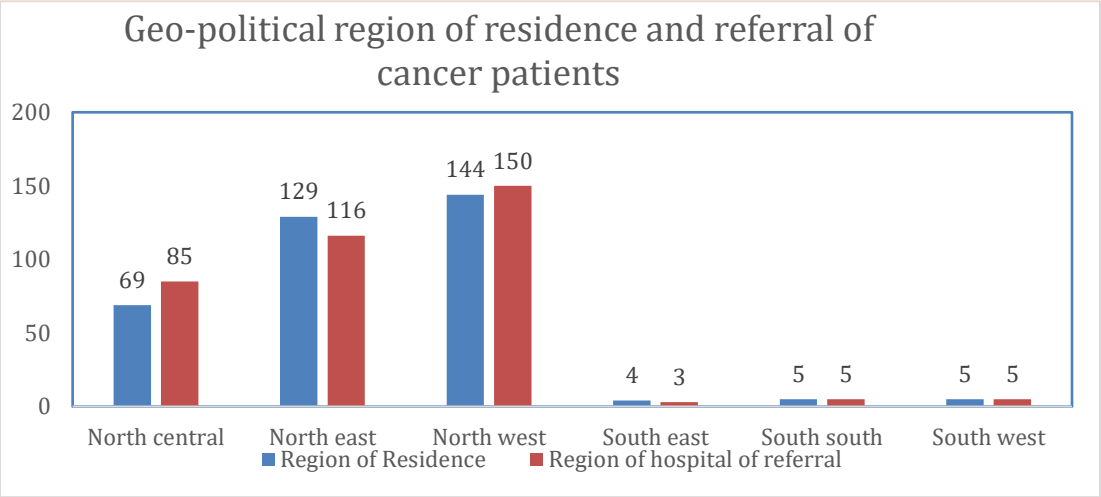

Figure 4: Geopolitical Region of Residence and Referral Of Cancer Patients Treated at the UMTH Cancer Centre

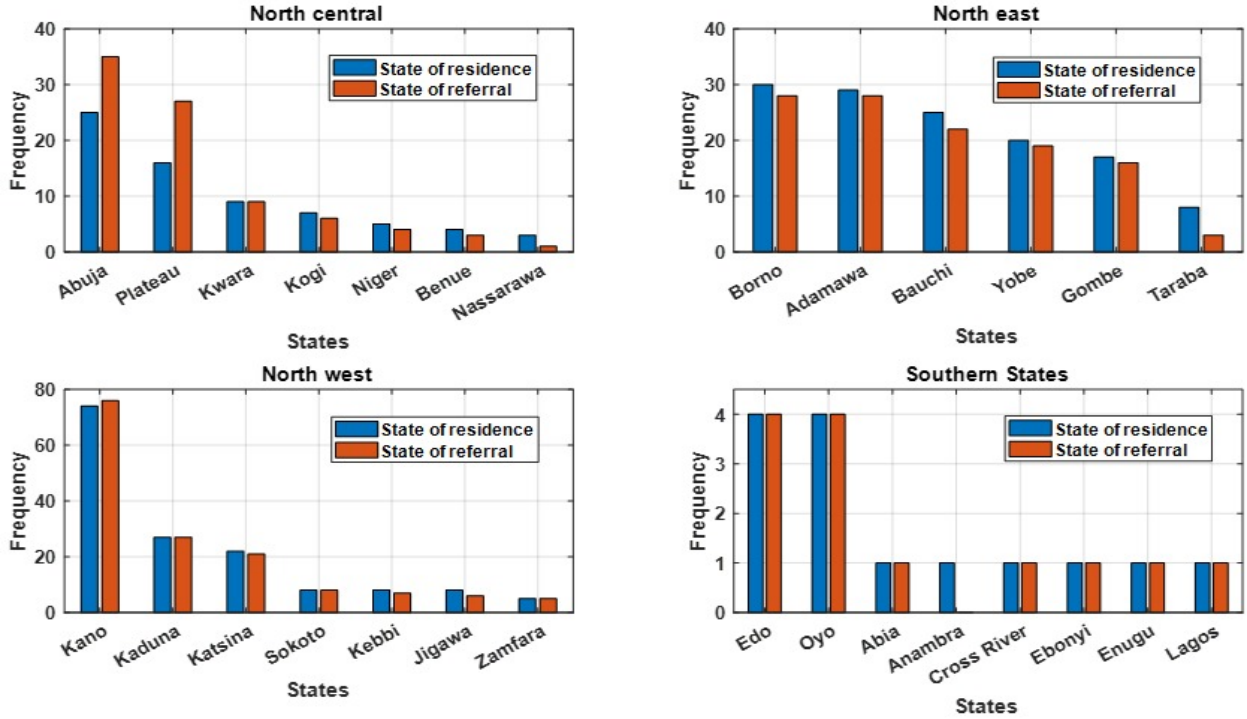

Figure 5: State of Residence and Referral of Cancer Patients Treated at the UMTH Cancer Centre- 5a) North-central, 5b) North-east, 5c) North-west and 5d) Southern Nigeria.

Interval between referral and first presentation to Oncology department UMTH

The median Interval between referral and first presentation to Oncology department, UMTH was 13 days (IQR: 6.25 to 24 days). There was no significant correlation between this and the distance of patients' residences from UMTH Cancer Centre (Figure 6). Spearman's correlation coefficient, r = +0.090, with p = 0.095.

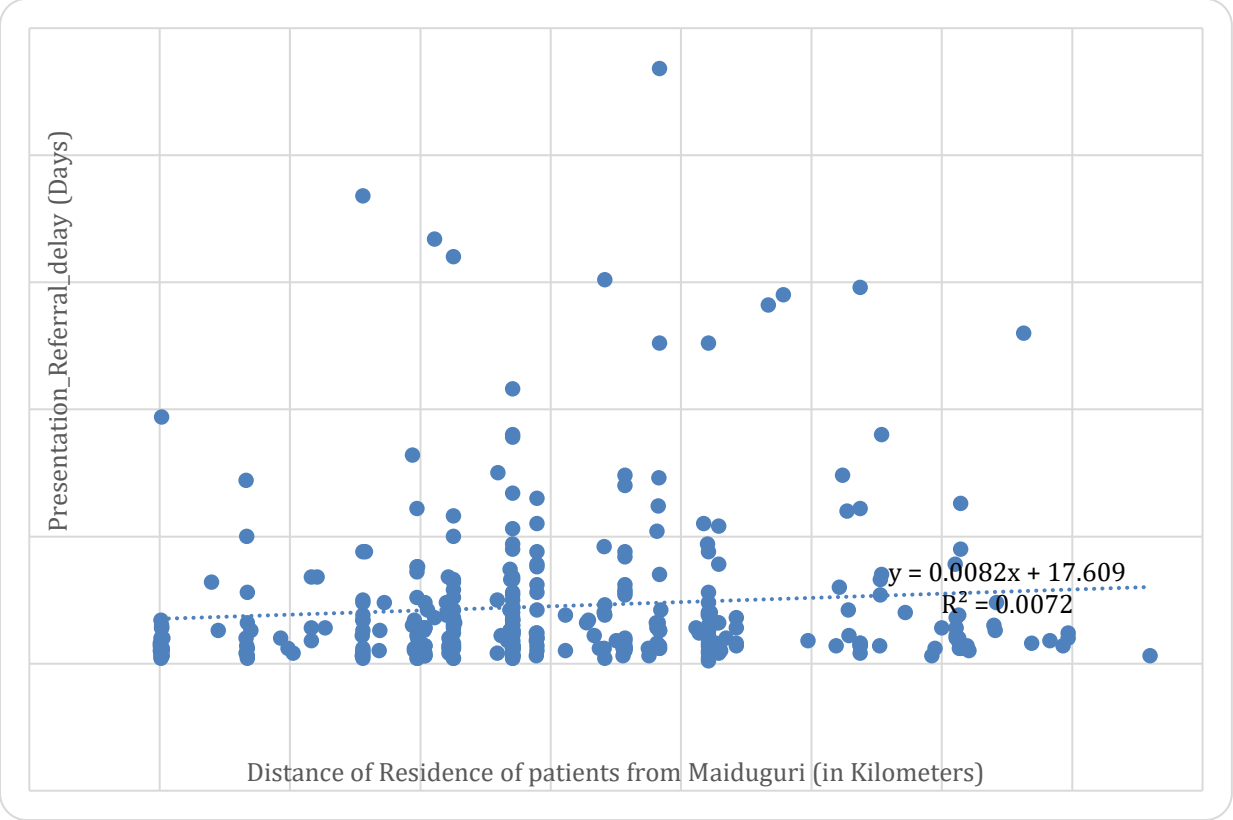

Figure 6: Scatter Plot Showing the Correlation Between the Distance of Patients' Residences from Maiduguri and the Referral-Presentation Interval
Spearman's Coefficient n= 352, r= 0.090, p= 0.095

Sources of funding for cancer patients at UMTH Cancer Centre

Predominantly, most patients 361 (99.2%) had to pay for the oncology services received out-of-pocket. Only 39 (10.7%) of patients had National Health Insurance coverage to complement self-funding. Only 3 (0.8%) of patients had retainerships that funded the cancer care. None of the patients benefited from the National Cancer Health Fund (NCHF), as the Oncology centre was not yet enrolled on the NCHF (Figure 7).

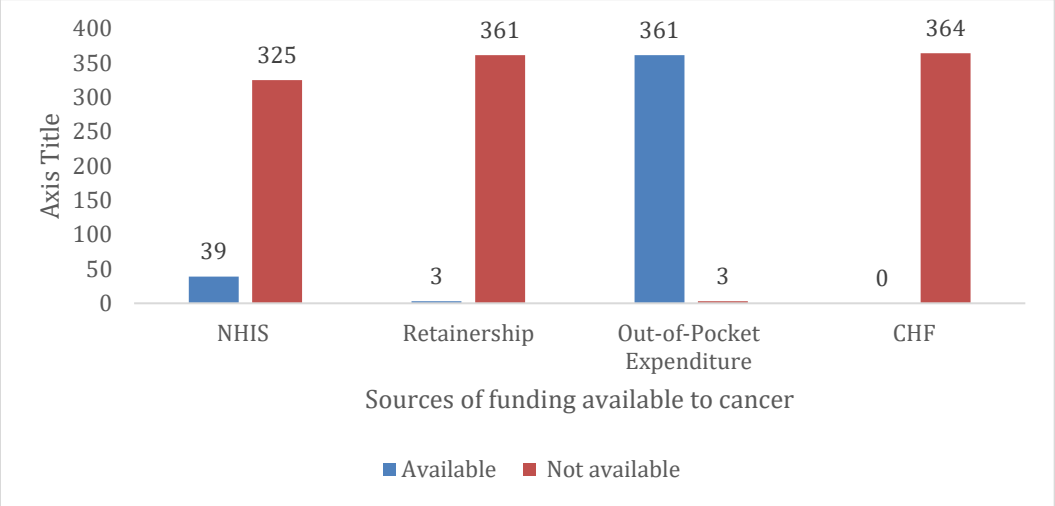

Figure 7: Sources of Funding Available to Cancer Patients on Treatment at UMTH Cancer Centre
NHIS- National Health Insurance, NCHF- National Cancer Health Fund

DISCUSSION

The mean age of cancer patients managed at UMTH Cancer Centre was 48.7 years, and the median was 50 years, reflecting a relatively young cancer population, with over three-fifths of them being females, which was a result of the high prevalence of breast and cervical cancers. This finding was consistent with a study on cancer epidemiology in North-eastern Nigeria, which surveyed 4681 cancer patients over a 4- year period (2019- 2022) across six states in the Northeast geo-political region. [19] The median age of cancer patients in this study was 50 years, with females accounting for 69% of the cases; while breast, cervical, prostate and colorectal cancers were the commonest malignancies diagnosed in the region.[19]

The vast majority of cancer patients in this study presented with locally advanced disease, followed by those with metastatic disease. This finding was in keeping with findings from other studies from Nigeria and other LMICs from Sub-Saharan Africa, depicting a predominant pattern of late-stage presentation with advanced disease.[20,21] The advanced or metastatic cancers are usually inoperable and more often than not, streamlined for palliative, rather than curative intent. This pushes the increased demand for radiotherapy treatment in these patients, further stretching the already scarce radiotherapy facilities.[22,23]

The study found a median distance of UMTH Cancer Centre from patients' residences was 542 km, with 75% of patients travelling over 400 km to the Cancer Centre, while 25% of patients had to travel over 760 km to the radiotherapy centre. Patients mostly had to travel long distances by road through regions with insecurity, over several hours, and in many cases, breaking their journeys for a couple of days. This finding is in sharp contrast with a systematic review on the distance travelled by cancer patients to access radiotherapy services in the United States, where a median distance of 32.2 km (20 miles) was recorded.[24] The factors that influenced travel distance include preference for high volume centres, limited resources of patients,

access to health insurance and lack of access to radiotherapy facilities nearby.[25-27] The disparity in geographic access to radiotherapy, contrast between LMICs like Nigeria and high-income countries like the United States, was clearly highlighted by a study, which found that only 17.1 % of the population had access to a radiotherapy facility within a 120-minute timeframe when compared to 76.3% obtainable globally.[28] A study conducted in Ghana found that the median distance from patients' district to a radiotherapy facility was 110.6 km, with only 235 of the 524 cancer patients requiring radiotherapy actually utilising it.[29]

The further breakdown of states of residence of cancer patients showed high referral of patients from the Northwest, Northeast and North central geopolitical zones, and a few patients spread from the southern states. One factor that easily explains this pattern is the fact that the Northern region had very limited radiotherapy facilities compared to the Southern states. At the time of commissioning of the UMTH Cancer Centre and one year into operation, it was the only fully functional radiotherapy centre administering EBRT in the entire Northern Nigeria, including the Federal capital Territory, Abuja; unlike the Southern region, with about 8 radiotherapy centres providing radiotherapy services.[8] Furthermore, being a fully owned government hospital, the radiotherapy services of UMTH Cancer Centre were the cheapest in the entire country. This was also a pull factor attracting many patients from across the various regions who are mostly indigent and have to pay out-of-pocket for the services.

A unique pattern observed in this study was the referral of patients from Kano State, situated about 542 km from UMTH Cancer Centre, which more than doubled that of Borno State, the next leading state in terms of patient referral and also the host state of the UMTH Cancer Centre. Though remotely distant, Kano is the most densely populated state in the Northern region of Nigeria and also the economic capital of the region. With no available radiotherapy facility in the entire Northern region, including Kano, during the period of the study, the demographic and economic factors may have been responsible for the high volume of referrals of cancer patients from Kano state.

One of the unique problems of cancer management in LMICs like Nigeria is the catastrophic out-of-pocket expenditure for treatment, with many patients and families expending more than 40% of their annual income in treating cancer.[13,30] Quality cancer treatment requires combinations of surgery, chemotherapy, radiotherapy, targeted therapy, immunotherapy and supportive care, which capital intensive requiring adequate health insurance cover even for patients in high-income countries.[24] Two studies have affirmed that the average cost of treatment of cancer in LMIC like Nigeria is over $ 5000.[14,30] In this index study, most of the patients- including those on national health insurance- paid out-of-pocket to access diagnosis and treatment services. Only about one-tenth of the patients had health insurance coverage. Despite this, cancer patients had to pay 50% to 75% of the total cost, while the insurance covered a fraction of the remaining cost. Only three patients (0.8%) had some retainer ship funding that guaranteed full coverage of the cost of

treatment. The UMTH Cancer Centre, at the time of the study, had not been accredited as a site for the Federal Government NCHF, which is a special intervention that provides funds to treat indigent cancer patients.[31] Neither was the scheme flexible enough to transfer funds of a cancer patient enrolled from an accredited NCHF site for use in a non-accredited NCHF site like UMTH Cancer Centre. As such, none of the cancer patients treated at UMTH Cancer Centre utilised the CHF funds.

Arising from these situations, many of the cancer patients had been stretched to their limits financially due to the catastrophic out-of-pocket expenditure, experiencing financial toxicity to the extent that they cannot afford decent food or accommodation during the course of their treatment.

The above discussion paints the picture of the challenges cancer patients experience in overcoming barriers to geographic and financial access to radiotherapy treatment at UMTH Cancer Centre. What is intriguing is that, for every single cancer patient who was able to gain access to radiotherapy treatment, how many of these cancer patients could not break these economic or geographical barriers to gain such access?

CONCLUSION

The study found that there were constraints to geographic and financial access to radiotherapy among most cancer patients at UMTH Cancer Centre. These geographic and financial barriers grossly limit access to radiotherapy by Nigerian cancer patients requiring such essential services.

Strength of the Study

Though the study is a single institutional study, the spread of patients was across all the geopolitical zones of the country, from 28 of the 36 states of the Federation and the Federal Capital Territory, Abuja; hence, its generalizability to some extent to the Nigerian context. Furthermore, the study integrated financial and geographic access, which gave a more robust view of the challenges of cancer patients as compared to the assessment of financial challenges alone.

Weaknesses of the Study

The study was a retrospective survey; there was a limit to the details of the questions asked to assess financial and geographical access to radiotherapy. For instance, the study could not quantify from the patients the amount of money spent overall on non-medical and clinical treatments, even though the fixed prices of radiotherapy and brachytherapy services were known. The study could also not examine the insecurity challenges and time spent travelling to Maiduguri from patients' residences, as this involved traversing through many regions of insecurity. Finally, most of the patients involved in the study were referrals from other tertiary hospitals outside the state; the study presumed that there were no significant barriers to their presentation to the radiotherapy centre other than finance and distance. This presumption may lead to bias in the interpretation of associations with referral-presentation interval.

Recommendations

- The Federal Government should increase funding for the Cancer Health Funds to expand its access to other tertiary health centres offering specialist cancer care.

- The Federal Government should build more radiotherapy facilities and ensure equitable distribution to ensure that cancer patients have access to a radiotherapy facility within a 100 km radius of their residence, in any location in Nigeria
- The National Institute for Cancer Research and Treatment (NICRAT) and the National Primary Healthcare Development Agency (NPHCDA) can collaborate to establish primary cancer care as routine activities at the Primary Healthcare Centre
- The State Governments and Local Government Authorities should complement the efforts of the federal Government and its partners by establishing and subsidising cancer care in state-owned comprehensive cancer centres in underserved populations
- Communities and organised societies should establish cancer health basket funding through regular and constant subscription from their members to assist members (and their families) in need of huge funds for cancer treatment

Conflict Of Interest

The authors unanimously declare no conflict of interest with regard to this study.

Funding For the Study

The funding of the study was the responsibility of the authors.

Data Availability

The data of the study is stored in a secure computer and can be made available upon request from the corresponding author.

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