TRAVEL DISTANCE FOR RADIOTHERAPY IN NIGERIA: A RETROSPECTIVE ANALYSIS OF CASES MANAGED AT A RADIOTHERAPY CENTER, NORTH-WEST NIGERIA

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ABSTRACT

Background: Travel distance affects access to healthcare services and can influence service utilisation and patient outcomes in cancer care. In Nigeria, the limited availability of radiotherapy facilities, uneven geographical distribution, and unpredictable equipment functionality cause patients to travel long distances to access treatment.
Objective: This study examined the actual distance travelled by patients to access radiotherapy at Ahmadu Bello University Teaching Hospital, Zaria.
Methods: This was a retrospective chart review of patients treated for cervical, breast, and nasopharyngeal cancers at Ahmadu Bello University Teaching Hospital (ABUTH), Zaria, between 2010 and 2014. Data collected included the shortest road distance from the capital city of each patient's state of residence to Zaria, the distance to the nearest radiotherapy centre, radiotherapy waiting time (in days), and cancer stage. Descriptive statistics were used to summarise variables. Spearman's correlation and multiple linear regression were used to examine the relationship between waiting time and travel distance.
Results: A total of 233 cases were reviewed: cervical (55%), breast (31%), and nasopharyngeal cancers (14%). Most patients were female (92%), with a mean age of 46.7 ± 12.0 years. The mean travel distance to Zaria was 407 ± 250.1 km. The mean waiting time was 162 ± 192.7 days. A weak but statistically significant negative correlation was observed between travel distance and waiting time. This finding was confirmed in the regression model, where travel distance was the only significant predictor of waiting time. However, the effect size was small, and the model explained only a limited proportion of variance ($R^2 = 0.092$).
Conclusion: This study shows that travel distances exceed the recommended threshold. Optimising currently available radiotherapy centres in Nigeria is necessary to reduce travel burden and treatment delays.

Keywords: Radiotherapy, Travel distance, Waiting time, Nigeria

INTRODUCTION

Distance to healthcare facilities is a key measure of access and utilisation and an important predictor of clinical outcomes. Studies examining the relationship between travel distance and health outcomes describe

three main patterns: (i) a distance-decay association, where outcomes worsen as distance increases; (ii) a distance-bias association, where longer travel distances are associated with better outcomes; and (iii) no significant association between distance and outcomes.[1,2,3,4]

Cancer care is complex and involves multiple disciplines and treatment modalities. In Nigeria, these modalities are often not all available in some facilities, and patients must travel long distances to access such services. Radiotherapy (RT) is one of the most cost-effective cancer treatment modalities, with approximately 50–70% of patients requiring it for curative or palliative care. However, access to RT remains a major challenge in Nigeria, as in many parts of sub-Saharan Africa. Patients frequently travel across states in Nigeria to access RT, with implications for service utilisation and outcomes.[5,6,7]

Baade et al. demonstrated that patients residing ≥100 km from an RT facility had a 16–30% higher mortality from rectal cancer compared with those living within 50 km. Mortality risk increased by 6% (95% CI, 3%–8%; $p < 0.001$) for every 100 km increase in distance from the nearest RT facility.[8]

A Nigerian study reported a median travel distance of 126 miles (range: 0–847; approximately 203 km), with 85.3% of patients travelling more than 50 km. A greater travel distance was also associated with delays in the initiation of radiotherapy.[9]

Studies in New Jersey, USA, found that women with early-stage breast cancer were less likely to receive breast-conserving surgery due to travel distance or time to RT facilities, despite breast-conserving surgery plus RT being the standard of care.[10]

Currently, Nigeria has seven megavoltage machines and six brachytherapy units for an estimated population of over 200 million, including the one at Ahmadu Bello University Teaching Hospital, Zaria Radiotherapy and Oncology Centre. However, not all centres are operational at any given time, necessitating travel to the nearest functional facility.[11]

This study primarily aims to determine the travel distance to the Zaria Radiotherapy Centre and the nearest available radiotherapy facility to cancer patients. Additionally, it seeks to examine the relationship between travel distance and waiting time for radiotherapy.

MATERIALS AND METHODS

This retrospective chart review included all patients who accessed radiotherapy in Zaria with a diagnosis of breast, cervical, or nasopharyngeal cancer between 2010 and 2014. The Zaria treatment centre, equipped with a megavoltage machine, serves patients from across Nigeria and neighbouring countries, including Chad, Niger, and Cameroon.

Data extracted included age, sex, treatment intent, state of residence, date of first consultation, and date of first radiotherapy treatment.

Actual travel distance is defined as the shortest travel distance by road from the capital city of each patient's state of residence to Zaria. We also estimated the shortest travel distance by road to the nearest radiotherapy centre. This

distance was measured using open-source Google Maps. This method was used because exact residential addresses are not universally available across rural and urban areas in Nigeria.

Radiotherapy waiting time is defined as the interval between consultation in Zaria and initiation of radiotherapy.

Descriptive statistics were used to summarise continuous and categorical variables into means, medians, and frequencies.

Because of the skewed nature of travel distance and waiting time, Spearman's correlation was used to analyse the association between travel distance and radiotherapy waiting time. Similarly, a multivariate linear regression model was used to determine clinical predictors of waiting time. A p-value < 0.05 was considered statistically significant.

The study was approved by the Ahmadu Bello University Teaching Hospital Institutional Review Board.

RESULTS

A total of 233 patient records were reviewed. The mean age of the study population was 46.7 ± 11.9 years, and most patients were female (214/233, 92%). Most patients presented with advanced or metastatic disease (166/233, 71.3%). The distribution of patients across cancer types showed that cervical cancer accounted for the largest proportion (55.4%), followed by breast cancer (30.5%) and nasopharyngeal cancer (14.2%).

Table 1: Summary of Demographic and Clinical Characteristics of the Study Participants (= 233)

Characteristic	Frequency	%	Cumulative %
Age			
≤19 years	2	0.9	0.9
20-29	13	5.6	6.5
30-39	47	20.2	26.7
40-49	71	30.5	57.2
50-59	68	29.2	86.4
60-69	17	7.3	93.7
>70 years	15	6.4	100
Sex			
Male	19	8.2	8.2
Female	214	91.8	100
Diagnosis			
Cervix	129	55.4	55.4
Breast	71	30.5	85.9
Nasopharynx	33	14.2	100
Employment status			
Employed	101	43.3	43.3
Unemployed	132	56.7	100
Clinical Stage			
Early	67	28.8	28.8
Advanced	150	64.4	93.2
Metastatic	16	6.9	100
Treatment intent			
Radical	168	72.1	72.1
Palliative	65	27.9	100.0
Waiting list status			
Routine	185	79.4	79.4
Emergency	48	20.6	100.0

Patients were drawn from 33 of the 36 states in Nigeria, as well as the Federal Capital Territory (Abuja), reflecting the wide catchment area of the Zaria radiotherapy centre (Table 4). The North-

West geopolitical zone accounted for the highest proportion of cases (37.4%), while the South-West contributed the least (1.7%), as shown in Table 1.

The mean travel distance to the Zaria radiotherapy centre was 407.4 ± 250.1 km, with a median distance of 350 km (interquartile range: 165–585 km). Only 18% of patients travelled within 100 km of the centre, and all these patients resided within the same state where the treatment centre is located (Kaduna State). Overall, 43.3% of patients travelled within 300 km, whereas the majority (56.7%) travelled distances greater than 300 km. Furthermore, 40.3% of patients travelled more than 500 km to access radiotherapy services (Table 2).

Table 2: Road Travel Distance from the Capital Cities of Patients' States of Residence To The Zaria Radiotherapy Centre

Distance (Km)	**Frequency**	**%**	**Cumulative %**
≤100	42	18.0	18.0
101-200	23	9.9	27.9
201-300	36	15.5	43.3
>300	132	56.7	100.0
Statistics			**Value**
Mean			407.4
Standard deviation			250.1
Median			350.0
Minimum			95.8
Maximum			941.0

Patients travelling shorter distances were from the same geopolitical region as the facility. Among those who travelled ≤300 km, 83.2% were from the North-West region. In contrast, patients travelling longer distances were distributed across multiple regions.

Table 3: Distribution of Radiotherapy Waiting Times Among Study Participants

Waiting time (days)	**Frequency**	**%**	**Cumulative %**
≤31	72	30.9	30.9
31-62	15	6.4	37.3
>62	10	62.7	100.0
Statistics			**Value**
Mean			162.4
Standard deviation			192.7
Median			145.0
Interquartile range			18-218
Minimum			0.0
Maximum			1170.0

The mean waiting time for radiotherapy was 162.4 ± 192.7 days, with a median waiting time of 145 days (interquartile range: 18–218 days). Approximately two-thirds of patients (63.7%) waited more than 62 days before commencing treatment (Table 3).

Many patients travelled long distances to access care in Zaria; this is not because there are no radiotherapy centres closer to them. The mean distance to the nearest radiotherapy centre from each patient's state of residence was 172.5 ± 89.7 km (Figure 1).

Overall, 32.6% of patients lived within 100 km of a radiotherapy facility, and 98.3% lived within 300 km. Only 1.7% (4/233) of patients resided more than 300 km from a radiotherapy centre. Despite this proximity, many patients bypassed nearer facilities and travelled longer distances to Zaria because the nearest centres were not functional at the time of treatment or for some other reasons.

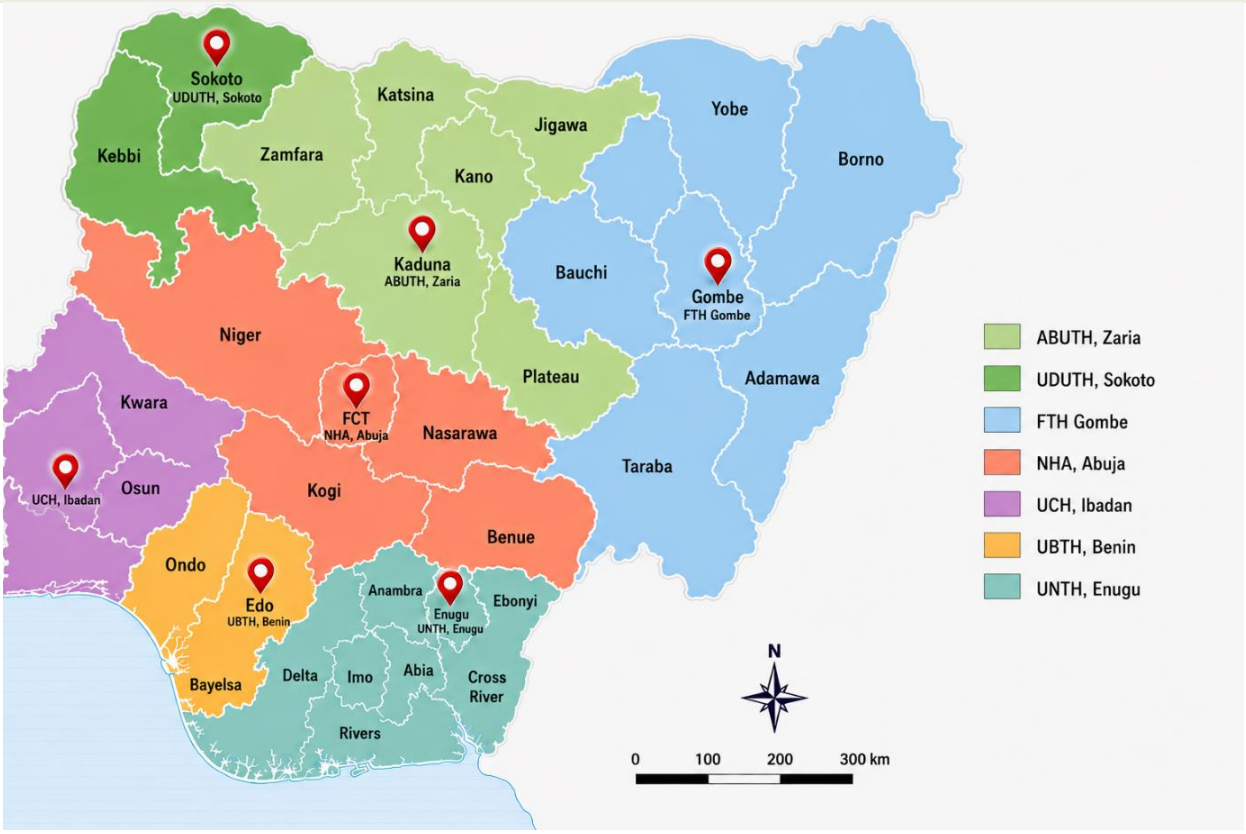

Figure 1: Map of Nigeria Showing the Geographical Distribution of Study Participants by State of Residence and the Location of their Nearest Radiotherapy Centres

Table 4: Distribution of Study Participants by State of Residence, Geopolitical Zone, And Nearest Radiotherapy Centre

S/N	States of residence	Geopolitical zones	Nearest centre, by travel distance	Frequency
1	Jigawa	North-west	ABUTH, ZARIA	3
2	Kaduna	North-west		42
3	Kano	North-west		22
4	Katsina	North-west		16
5	Zamfara	North-west		1
6	Plateau	North-central		17
				101
7	Kebbi	North-west	UDUTH, SOKOTO	2
8	Sokoto	North-west		1
				3
9	Adamawa	North-east	FTH GOMBE	10
10	Bauchi	North-east		11
11	Borno	North-east		4
12	Gombe	North-east		9
13	Taraba	North-east		4
14	Yobe	North-east		5
				43
15	Benue	North-central	NHA, ABUJA	26
16	FCT	North-central		6
17	Kogi	North-central		3
18	Nasarawa	North-central		8
19	Niger	North-central		7
				50
20	Bayelsa	South-south	UBTH, BENIN	1
21	Edo	South-south		4
22	Ondo	South-south		1
				6
23	Kwara	North-central	UCH, IBADAN	1
24	Osun	South-west		1
25	Oyo	South-west		2
				4
26	Abia	South-east	UNTH, ENUGU	1
27	Anambra	South-east		7

28	Ebonyi	South-east	1
29	Enugu	South-east	4
30	Imo	South-east	3
31	Cross river	South-south	4
32	Delta	South-south	3
33	Rivers	South-south	3
			26
Grand total			**233**

Spearman's correlation analysis showed a weak but statistically significant negative association between travel distance and radiotherapy waiting time ($\rho = -0.203$, $p = 0.002$), indicating that longer travel distances were associated with slightly shorter waiting times, as shown in Table 5.

Similarly, in the multivariate analysis, travel distance was the only statistically significant predictor of waiting time, while other variables (Stage, waiting list status, and treatment intent) showed no statistically significant association (Table 6). This finding is consistent with the correlation analysis.

Table 5: Outcome of Spearman's Rank Correlation Analysis Between Travel Distance and Waiting Time

Correlation			**Waiting time**	**Travel distance**	**95% confidence interval**
Spearman's rho	Waiting time	Correlation Coefficient	1.000	-.203**	**-0.32- (-0.08)**
		Sig. (2-tailed)	.	.002	
		N	233	233	
	Travel distance	Correlation Coefficient	-.203**	1.000	
		Sig. (2-tailed)	.002	.	
		N	233	233	

** Correlation is significant at the 0.01 level (2-tailed)

Table 6: Multiple Linear Regression Analysis Examining Predictors of Waiting Time

Predictor	**B**	**SE**	**Beta**	**Beta (95% CI)**	**p-value**
Stage	-45.25	23.92	-0.131	−92.13 - 1.63	0.060
Treatment intent	-13.70	41.20	-0.032	−94.45 - 67.05	0.740
Waiting list status	-68.35	43.53	-0.144	−153.67 -16.97	0.118

Travel distance	-0.136	0.048	-0.179	−0.23 –(−0.04)	0.005*

Model summary: $R^2 = 0.092$, Adjusted $R^2 = 0.076$, $F = 5.743$, $p < 0.001$

Table 7: Travel distances by road from patients' state capitals to the nearest radiotherapy centre

Nearest Radiotherapy Centre to Patients' State of Residence	Travel distances by road in kilometres				Total
	<100	101-200	201-300	>300	
ABUTH, ZARIA	42	23	36	-	100(43)
UCH, IBADAN	2	2	-	-	4(2)
UDUTH, SOKOTO	1	2	-	-	3(1)
UBTH, BENIN	4	1	1	-	6(3)
UNTH, ENUGU	12	7	33	-	52(22)
NHA.ABUJA	6	18	-	-	24(10)
FTH, GOMBE	9	11	19	4	43(19)
Total N (%)	76(33)	64(27)	89(38)	4(2)	233

ABUTH; Ahmadu Bello University Teaching Hospital, Zaria, UCH; University College Hospital, Ibadan, UDUTH; Usman Danfodio University Teaching Hospital, UBTH; University of Benin Teaching Hospital, UNTH; University of Nigeria Teaching Hospital, NHA; National Hospital, Abuja, FTH; Federal Teaching Hospital, Gombe

Table 8: Linear Accelerator Downtime in Selected Radiotherapy Centres (Adapted from Wroe Et Al., 2020)

S/N	Location	Date Commissioned	Data Format	Data Covering	Hours of Data	Calculated Downtime
1	Abuja	2000	Logbook	2008-2017**	17377	22.7%
2	Lagos	2007	Logbook	2009-2018	16720	18.8%
4	Enugu	2007	Logbook	2011-2018	14080	54.7%
3	Sokoto	2010	e-logbook	2009-2018	17423	*20.0%
5	Benin	2012	Logbook	2013-2018	5640	14.2%
6	Abuja	2017	Logbook	2017-2018	1909	4.2%

*Estimate, **decommissioned

DISCUSSION

This study shows that patients experience a significant travel burden to access radiotherapy in many low- and middle-income countries like Nigeria, with the majority of them travelling over 400km.[12,13] Empirical evidence shows travels more than 50-100km increases the probability of poor outcomes or limited utilisation.[14] Although most patients live within 300km of a radiotherapy centre, travel becomes necessary because of frequent machine downtimes, prolonged waiting times and other unknown factors. This highlights the importance of functional availability as opposed to nominal availability.

Additionally, a paradoxical pattern emerged: patients who travelled longer distances had shorter waiting times.[1] This suggests underlying factors that require further investigation, such as referral bias, referral pathways, and patient selection and prioritisation.

These findings are consistent with existing evidence that travel distance influences cancer care utilisation and outcomes.[15,16,17] However, the burden appears greater in low- and middle-income settings such as Nigeria, where there is a convergence of many problems, such as limited number of machines, persistent downtime and prolonged waiting times, which compound the challenges.[18]

This study contributes to the literature by demonstrating the gap between theoretical and functional access to radiotherapy. While most patients live within nominal reach of radiotherapy, equipment breakdowns and service interruptions make long travels to access available service elsewhere necessary. This highlights the need to redefine access beyond geographic proximity to include the functional capacity of radiotherapy centres.

This may have implications for patient care. Long travel distances and delays may likely discourage treatment initiation and completion, and may influence clinical decisions on the part of the physician treating the patients. For instance, patients with early-stage breast cancer may opt for mastectomy rather than breast-conserving surgery with adjuvant radiotherapy to avoid repeated long-distance travel.[19] These factors may likely contribute to poorer clinical outcomes.

From a policy perspective, optimising existing radiotherapy infrastructure represents an immediate and cost-effective approach. Ensuring that current centres are functional, adequately staffed, and properly maintained could reduce both travel burden and waiting time.[1] Our findings suggest that this strategy alone could enable most patients to access services within 300 km.

In the long term, expansion of radiotherapy services remains essential with strategically planned investment in both equipment and workforce. A target of access within 100 km, commonly used for planning purposes, would require at least one radiotherapy centre per state. While ambitious, this is achievable with sustained investment and political commitment.[21]

The inverse relationship between travel distance and waiting time contrasts with conventional expectations and raises important questions about referral and prioritisation processes within the health system. Possible explanations include referral bias or differences in patient preparedness; although statistically significant, the clinical significance, however, requires further investigation.[1]

In addition, the findings reveal that the presence of radiotherapy facilities does not

1

equate to access, emphasising the distinction between nominal and functional availability. Although recent reports indicate a steady increase in the number of private radiotherapy centres, alongside ongoing federal government efforts to expand access to radiotherapy services, greater emphasis must be placed on ensuring that maintenance contracts and spare parts supply agreements are incorporated into procurement processes.[22-26] Such measures are essential to minimise equipment downtime and to reduce the travel demands and waiting-time burden experienced by patients.[27]

This study provides some empirical assessments of radiotherapy access in Nigeria using real-world clinical data. The wide geographic representation of 33 out of 36 states and the federal capital territory enhances its relevance, and the combined evaluation of travel distance and waiting time provides more understanding of access beyond availability.

Future studies should adopt prospective, multicentre designs incorporating precise residential address data and additional determinants of access, including socioeconomic status, insurance coverage, referral pathways, and patient preferences.

Further research is also needed to assess the impact of travel distance and treatment delays on clinical outcomes such as treatment completion, disease progression, and survival. The paradoxical finding regarding travel distance and waiting time also warrants further investigation, particularly in relation to referral practices, patient selection and prioritisation.

This study has some limitations that should guide the interpretation of its findings. Its retrospective design relied on routinely collected data, which may be incomplete or inconsistently recorded. Travel distance was estimated using state capitals rather than precise residential addresses, which may introduce misclassification, underestimate or overestimate actual values. Similarly, the use of Google Maps may not fully capture real-world travel conditions such as road quality and traffic congestion.

The study was conducted at a single tertiary centre, which may limit generalizability, although its role as a major referral centre suggests that the findings reflect broader systemic challenges. Additionally, important determinants of access, such as socioeconomic factors, insurance coverage, and patient preferences, were not assessed. Finally, clinical outcomes were not evaluated, limiting the ability to determine the direct impact of observed delays on patient outcomes.

CONCLUSION

There is a significant travel burden among the study population, which may adversely affect radiotherapy utilisation and clinical outcomes. In the short term, upgrading existing facilities is essential, while sustained long-term investment in additional centres will help reduce travel distances to as low as reasonably achievable.

Conflict of interest

The authors declare no conflict of interest.

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