



A cross-sector approach to explore socio-ecological associations with treatment engagement behaviours in Northern Ghana

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ABSTRACT

Background: Cancer presents a growing global burden, not least in African countries such as Ghana where high cancer treatment dropouts has been identified due to numerous social, cultural and financial reasons. There is little understanding regarding patterns of treatment access behaviour, especially in Northern Ghana, which this study was designed to explore.

Methods: Through cross-sector collaboration, we extracted and clinically validated cancer patient records available in the Tamale Teaching Hospital. These were analysed descriptively and through multi-variate logistic regression. A treatment mapping process was also applied to highlight challenges in data collection. Multiple imputation with chained equations was conducted for high levels of missing data. Sensitivity analysis was applied to assess the impact of missing data.

Results: Treatment drop-out was high even when uncertainty due to missing data was accounted for, and only 27 % of patients completely engaged with treatment. High drop-out was found for all cancers including those covered by the Ghana National Health Insurance scheme. Multi-variate logistic regression revealed that social, health condition and systemic factors influence treatment engagement until completion. High missing data was observed for liver, ovarian, colorectal, gastric, bladder, oesophageal and head and neck and skin cancers, and soft tissue sarcomas, which limited model fitting.

Conclusion: Treatment drop-out is a critical issue in Northern Ghana. There was high missing data due to the dynamic, complex and decentralised treatment pathway. Future studies are needed to understand the complex challenges in data recording.

Policy summary: Treatment drop out is a pertinent issue that policy makers should look to address. Further discussion with stakeholders involved in cancer treatment and data collection is required to better understand challenges to routine data collection in the local setting. This will allow policy to be designed to cater for the impact of multiple intersecting health and social factors on treatment completion.

1. Background

Cancer causes an immense burden globally, which is increasing in low- and middle-income settings, such as Ghana, where systems are arguably less prepared to tackle such challenges. We previously conducted a systematic literature review, applying a ‘candidacy’ framework

to articulate the entire patient treatment pathway in Ghana. This highlighted treatment acceptance and completion as aspects of the treatment process that are particularly important to consider in the Ghanaian context[1]. Women declined treatment for reasons relating to marital pressure,[2,3] spiritual beliefs[4–7] and finances[5,6,8]; however this was dynamic, and in some cases they later returned[6]. The majority of

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studies were in breast and cervical cancers, so how other types of cancer patients engaged with services was unknown[1].

The multiple behaviours around accepting treatment have not yet been articulated through candidacy, which has been used primarily in high income settings, where challenges to acceptance are less apparent. There is evidence to suggest it is a key barrier in the Ghanaian context and understanding this could be insightful for policy[1,9]. Understanding drop-out rates in different subgroups will inform planning of services cost-effectively and reducing inequality through designing services to meet the needs of the most vulnerable groups.

Ghanaian cancer treatment access data is mainly focused in Accra and Kumasi's tertiary referral centres[1] which also have a higher share of tertiary public and private facilities[10]. Our review found a resulting evidence gap in Northern Ghana specifically, where social, cultural, economic and health systems differences may also influence patients' behaviours and cancer service engagement; this region is more deprived, has reduced access to basic amenities[11,12] and differences in ethnicity also[13].

2. Research question

The research question addressed in this study was “what characteristics are associated with complete engagement with treatment across all cancers in adults in Northern Ghana?”

3. Methods

A cross- sector collaborative approach between clinical, policy and research, was adopted. This first involved a treatment mapping process followed by an informed data collection and analysis (see results Section 1). The data analysis approach was iterative and took into consideration insights from the treatment mapping (Fig. 1).

4. Setting

Tamale Teaching Hospital (TTH) was selected as the only tertiary centre in Northern Ghana. It serves over 4 million people, with a catchment area covering the five Northern Ghana Regions (North East, Savana, Upper East, Upper West and Northern regions) but also from other regions of Ghana, and internationally from Togo and Burkina Faso. In 2021, an oncology department to treat cancer cases was established there to facilitate treatment access.

5. Data collection

5.1. Treatment pathways

The first stage was to map out the patient treatment pathway. A patient treatment map was developed through discussion with TTH oncology staff and informed by literature reported in other Ghanaian oncology settings. This map is detailed in Fig. 1 and key themes are provided as supplementary files. This highlighted data limitation, assumptions, and a suitable outcome measure to use.

5.2. Data extraction

Relevant data was extracted from routinely collected patients record data for adults (aged 18 and over) with a cancer diagnosis (11/2020–11/2022) using a bespoke template by two TTH health professionals; this included both patients who visited the hospital directly and those referred from facilities across the five northern regions capturing key demographic information, cancer diagnosis details and treatment engagement status and associated notes, if available. We contacted patients referred off-site for radiotherapy and chemo radiation in Accra and Kumasi referral centres for information about treatment engagement for those with key details missing. Descriptive variables were sorted into groups (region, education, occupation, cancer type, treatment required, biopsy status); and binary variables were added for known to have died or had a poor response to the advised treatment.

5.3. Outcome measure

A binary combined measure of whether patients had sufficiently engaged with their entire treatment plan was used. This was based on clinical reference of patient records at the time of data extraction and off-site referral follow-up calls. At this time, homebased treatments were not available.

6. Data analysis

Data were analysed using R. To align with the ‘treatment complete engagement’ outcome, several adjustments were made during analysis to ensure data consistency:

- Where no data was recorded on whether patients had dropped out or completed treatment, they were coded as missing
- patients known to have died during treatment had their engagement outcome coded as missing (we tested the impact this assumption had

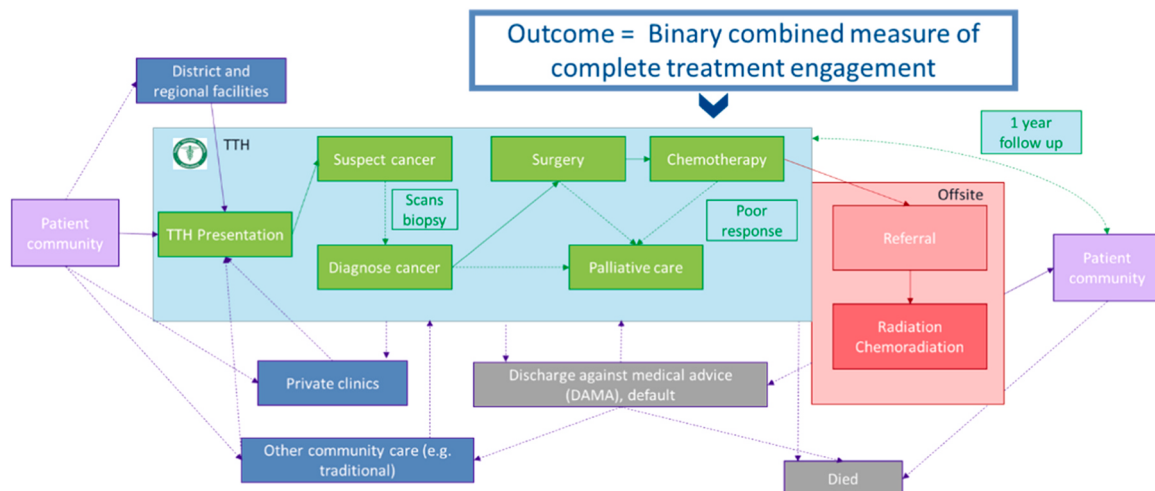


Fig. 1. Treatment map.

- on the data analysis through exploring correlations descriptively and with non-parametric statistics)
- Patients reported to have a poor response to chemotherapy but remained in care and current patients were code as engaged (current patients cross checks in April 2023)
 - Patients with a poor response who left care were coded as missing.

Date of death and last appointment was not always recorded. Therefore, those coded as dead were treated as missing treatment engagement data.

Patients could require different types of treatment based on their clinical need. We define engagement based on the clinical recommendations for any treatment module.

Current patients (attended within 2 months of data extraction) were also cross-checked to ascertain if they were engaged to the present period.

Exploratory sensitivity checks (using descriptive statistics and logit regression) were carried out to test how assumptions made affected the subsequent analysis.

6.1. Prediction of treatment drop-out using logistic regression analysis

A multivariate logistic regression model was fitted. Initially all variables significant in univariate analysis or with rationale for influence were initially included in the multivariate model (Sex, National Health Insurance Scheme (NHIS) status, education, age, region (Northern, Upper East or other), treatment types, occupation, stage, breast and cervical cancers). However, high levels of partial missingness meant a large amount of data points were removed in the combined model. We explored the effect of variables which considerably reduced the size of the dataset or had multiple small groups which restricted model fitting. Sensitivity checks assessed the impact of the selection made. Variables in the initial and selected model, along with their fitting parameters are reported. Interaction terms were explored for significant variables with rationale for joint effect. The effect interaction terms had on model fitting parameters were reported

We inspected the sample used in the model and deviance from the full dataset (which included partial cases) to identify how data represents the full dataset.

6.2. Handling missing data

Given the high amount of missing data and the difference between the sample and the full dataset, we conducted a series of analyses to assess the impact of the missing data, firstly through exploratory, then through sensitivity analysis.

Due to significant associations between the observed variables and missing outcome variables, missing data were assumed to be *missing at random (MAR)*; for this reason, we performed a sensitivity analysis using multiple imputation. Multiple imputation using chained equations (MICE) was conducted. The imputation included all variables that were included in the logistic regression as well as other variables that were found to correlate with the outcome variable missingness or had high rationale to be linked to missingness. We compared the characteristics of the imputed dataset with the full dataset and complete case only data used in the logistic regression model. We graphically reported the outcome variable for the complete case sample, original dataset with missing data and the imputed dataset. Sensitivity analysis was conducted through comparing the parameters of the logistic regression using the final model and presented graphically. Further exploration of variables (that could not be included in the original analysis due to high missingness) were explored using the imputed dataset.

7. Results

7.1. Patient characteristics

Four hundred and ninety three (493) patients' information were included in the analyses. The median age was 39 years, 35 % were males, 57 % were from northern region. Breast and cervical cancers were the most common cancers accounting for 37 % of cases. Most patients were from a low socio-economic group; 75 % of the patients were reported to have no educational background. 72 % were insured by the National Health Insurance Scheme. A summary of the patients' characteristics is provided in Table 1. Treatment engagement was low at 27 %, where known, and the greatest proportion of patients presented at a late stage (4) where known. Engagement was 39 % for breast and cervical cancers, which are anticipated to be covered by national insurance. However, for 33.1 % (25/78) of these cases, financial barriers were noted in their records as the reason for dropping out.

7.2. Univariate analysis of predictors of treatment engagement

Non-parametric and univariate logistic regression analysis suggested significant impact of social demographic factors and those related to disease and treatment, summarised in Table 2.

7.3. Multivariate logistic regression of predictors of treatment engagement

During model fitting occupation and stage reduced fitting significantly and were removed. Education was treated as a binary variable (no

Table 1
Summary of characteristics of dataset.

Characteristic	N= 493
Complete treatment engagement	72 (27 %), unknown 224
Age	51 (39,67)
Sex	Female 318(65 %) Male 175 (35 %)
Educational status	None 369 (75 %) Primary 15 (3 %) Junior High School 26 (5.3 %) Senior High School 28 (5.7 %) Tertiary 54 (11 %) Unknown = 1
Occupational group	Group 1 ¹ 291 (60 %) Group 2 ¹ 39 (8 %) Retired 17 (3.5 %) Student 19 (3.9 %) Unemployed 119 (25 %) Unknown 8
Region (grouped)	Northern 263 (57 %) Other 101 (22 %) Upper East 98 (21 %) Unknown 31
NHIS Status	Yes = 353 (72 %) Unknown 3
Breast or cervical case	Yes = 183 (36 %)
Treatment type advised	Chemo + surgery 72(28 %) Chemo + surgery + radiotherapy (offsite) 109 (42 %) Palliative (supportive) care 53 (20 %) Surgery only 26 (10 %) Unknown 233
Biopsy status	Yes = 420 (86 %) Unknown = 5
Died	Yes = 45 (15 %) Unknown 191
Poor response	Yes = 10 (3.3 %) Unknown = 191

N(%);Median(IQR)
Group 1: unskilled occupations (not requiring further education), Group 2: skilled occupations (requiring further education or training)

Table 2
Results from univariate regression.

Variable	P value (P<0.05)	Odd ratio	Confidence intervals
Stage (4 reference):	0.00065		3.9–128
Stage1	0.41	18	0.28–10
Stage 2	0.0012	2.1	1.6–5.8
Stage 3		2.9	
Treatment (ref = Chemo/ surgery)	0.85 0.33	0.91	0.36–2.4
Radiotherapy offsite	1.1e–06	0.45 27	0.064–1.9
Palliative			7.7–113
Surgery only			
Sex (M)	0.14	0.61	0.31–1.2
Age	0.91	0.99	0.98–1.0
Northern region	0.037	1.9	1.0–3.4
UE region	0.06	0.47	0.21–0.99
NHIS insured	0.0026	3.2	1.6–7.3
Education (ref = no)	0.25	0.29	0.016–1.6
Primary	0.21	0.27	0.014–1.4
Junior	0.11	2.5	0.78–7.9
Senior	0.077	2.0	0.91–4.3
Tertiary			
Breast and cervical (2 binary variables)	0.00014	3.2	1.8–6.0
	0.0063	3.3	1.4–7.6
Breast and cervical as 1 combined variable*	0.0000053	3.3	1.9–5.8

education or education). An NHIS status and breast and cervical cases interaction covariate was explored but had a p value of 0.99, so was not included in the selected model. The model fitting for the initial model with all variables, the selected model and the model with the interaction term, are reported in Table 3.

A visual to show the coefficients and their certainty is provided in Fig. 2. Having NHIS and only requiring surgery were significant at 95 % in the combined model.

The differences between data in the selected model and the full dataset are shown in supplementary table 1.

7.4. Certainty in results using sensitivity analysis accounting for missing data

The outcome variable was missing for 224/493 45.4 % of cases. Missing outcome data was 30.6 % (56/183) for breast and cervical cases treated in oncology. For other cases, outcome data was missing for

54.2 % (168/310). Levels of missing data for all variables is highlighted in Fig. 3. There was correlation between some observed variables and likelihood of the outcome missingness (Table 4). This included breast or cervical cancers, sex, stage, biopsy and treatment type required. For treatment type required, those cured by surgery alone were less likely to have missing data, which suggests missingness was not more likely for curative cases where less follow up may be obtained. It was not possible to assess a correlation between individual cancer types due to small group sizes. There was no outcome variable for those who died during treatment, however death during treatment correlated with several other significant variables and was included in the MICE. The dataset containing missing data and imputed dataset both gave a proportion of 27 % treatment complete engagement. This was 18 % in the sample of complete case data used in the selected logistic regression model. (Fig. 4).

The imputed data and complete case sample regression coefficients are compared in Fig. 5. NHIS coverage and requiring surgery only are significant in the complete case analysis. After imputation, NHIS coverage is no longer significant and breast and cervical cancer becomes significant. There was better alignment between the imputed and original dataset than the complete case sample and the original dataset (supplementary table 1).

8. Discussion

This study has highlighted several pertinent findings regarding the treatment process and levels of cancer treatment engagement in North Ghana. Firstly, the treatment pathway is multi-layered, dynamic and nonlinear. This is not easily captured in standard recording procedures making it challenging to assess. This is compounded by a decentralised nature of patient care, meaning patients move between treatment centres without continuity. This is important for future studies to be able to accurately assess treatment outcomes. Complete treatment engagement is under 30 % after sensitivity analysis, suggesting urgent attention is required to improve treatment engagement. Our results suggest factors associated with treatment engagement, including the treatment modality, cancer type and region. However, the high degree of missing data led to poor model fit. Further study with more complete datasets would could inform equitable service design. With larger or more complete datasets, models to inspect intersecting inequalities in health outcomes, such as Multilevel Analysis of Individual Heterogeneity and Discriminatory Accuracy (MAIHDA)[14], could be explored. Better

Table 3
Parameters of logistic regression model estimating socio economic and health system factors' association with treatment complete engagement in adult cancer patients in Tamale Teaching Hospital (TTH).

Parameter	Null model 0	Model 1 with all variables and education as 5 level factor ^a	Model 2 (model 2 with stage removed) ^b	Final selected model 3 ^c	Model 3 with interaction effect of NHIS and breast/cervical cases ^d
Observations included (n)	269	163	186	190	190
Pseudo-R ² (Cragg-Uhler, McFadden)	0	0.53, 0.40	0.45, 0.33	0.42, 0.31	0.44, 0.33
X ²	0	67.42 (p=0.00) df = 20	60.17 (p = 0.00) df = 17	56.32 (p = 0.00) df = 10	60.59 (p = 0.00) df = 11
AIC	314.53	141.52	155.71	147.21	144.94
BIC	318.13	206.49	213.78	183.98	183.91

*breast/cervical cancer

^a Variables included: sex, NHIS status (insured/uninsured), education (primary, junior high school, senior high school, tertiary or none), stage, occupational group (unemployed, group 1 (low cadre), group 2 (professional), retired, student), age, region (Northern, Upper East, other), whether breast or cervical cancer, modalities of treatment offered

^b Variables included: sex, NHIS status (insured/uninsured), education (primary, junior high school, senior high school, tertiary or none), occupational group (unemployed, group 1 (low cadre), group 2 (professional), retired, student), age, region (Northern, Upper East, other), whether breast or cervical cancer, modalities of treatment offered

^c Variables included: sex, NHIS status (insured/uninsured), education (some/none), age, region (Northern, Upper East, other), whether breast or cervical cancer, modalities of treatment offered

^d Variables included: sex, NHIS status (insured/uninsured), education (some/none), age, region (Northern, Upper East, other), whether breast or cervical cancer, modalities of treatment offered, NHIS status

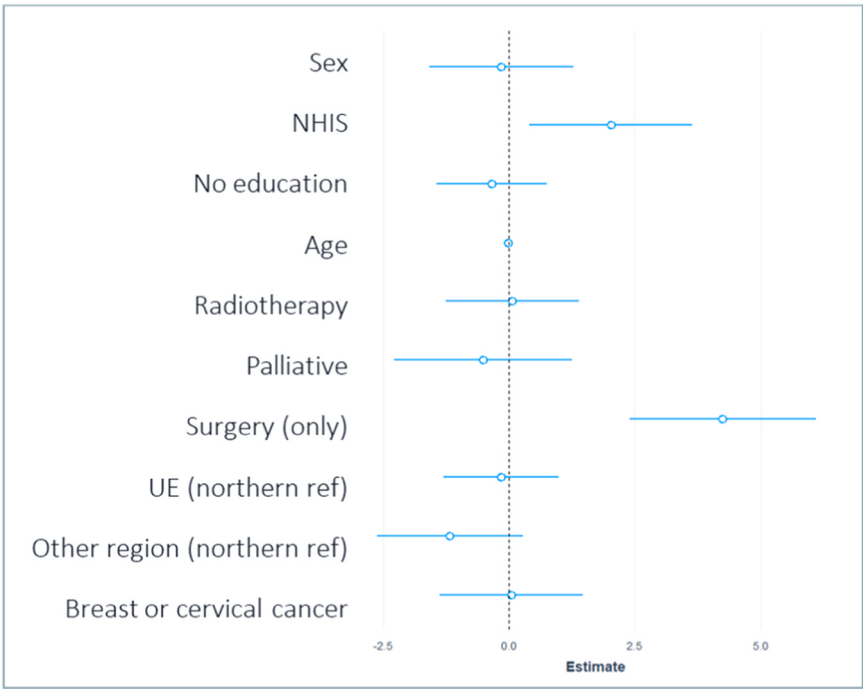


Fig. 2. Coefficients of variables included in the final logit regression model.

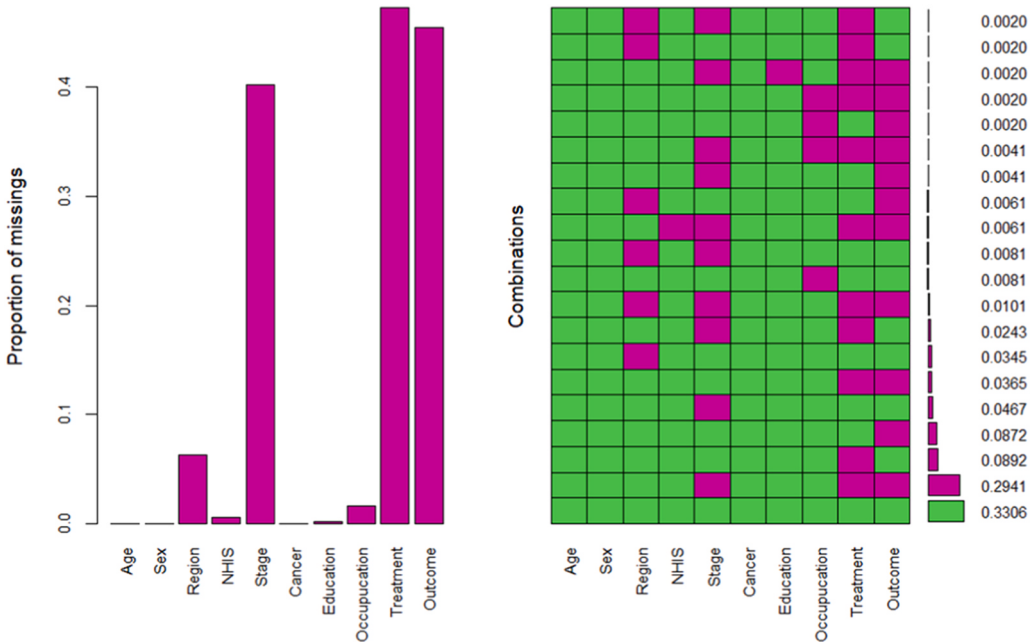


Fig. 3. Overview of missing data for a) each variable in the model b) proportions of missing variables (corresponding to purple squares).

Table 4
Results from significant tests (Fishers) for variables associated with missingness.

Variable	P value
Breast or cervical cancers	3.824e−07
Sex	6.791e−05
Stage	5.084e−05
Biopsy	2.2e−16
Treatment type	6.601e−07

understanding of how data reporting systems can be locally tailored to efficiently monitor service uptake and provide real time feedback to clinical staff is required.

This study supports a growing body of mixed method literature indicating barriers to cancer treatment engagement in Ghana[1,4,8,15]. Our study adds evidence on multiple cancer types in Northern Ghana. In two previous studies, distance was not deemed to significantly influence patient access to health services[16,17]. However, another qualitative study in the Volta Region suggested that lack of facilities in rural areas could lead to delays in seeking cervical cancer treatment[18]. Previous research has also highlighted low-income patients are more likely to

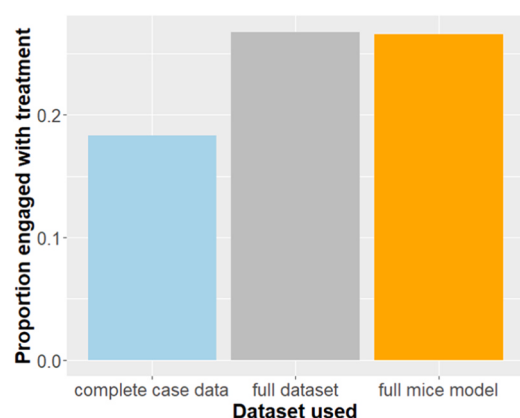


Fig. 4. Proportion of patients completely engaging treatment for each dataset in the sensitivity analysis.

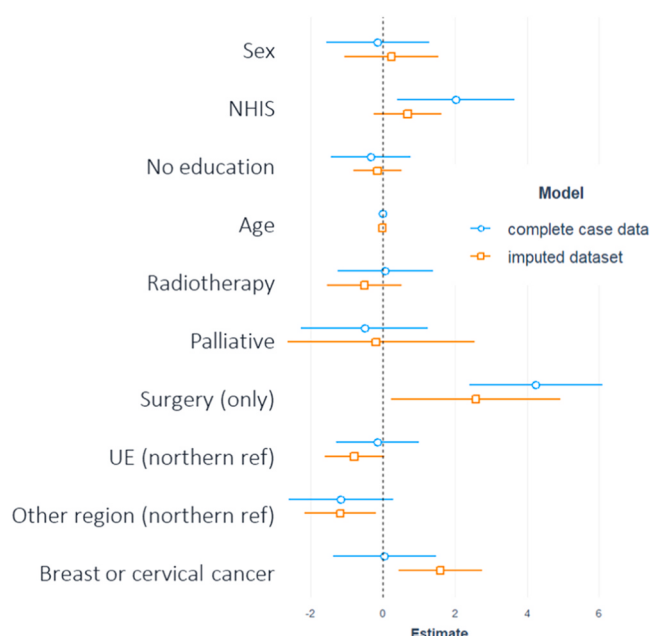


Fig. 5. coefficients for the regression model for the complete case (blue) and imputed dataset (orange).

experience longer wait times[19]. Financial barriers to treatment have been reported for prostate[20], breast[21] and cervical cancer[18], especially for those from low income backgrounds[18,21]. Some research indicates that financial barriers have an impact regardless of socioeconomic status[15]. We found that financial barriers were frequently cited as a reason for not completely engaging with treatment, including for cancers anticipated to be covered by the NHIS such as breast and cervical cancer. This aligns with findings in other settings in Ghana where breast and cervical cancer patients have expressed frustration at their treatment not being covered by the NHIS[22,23]. A study published in 2022 found the average expenditure for the household of a breast cancer patient to be 990.40 USD[24]. Prostate cancer is anticipated to be covered by the NHIS from 2023[25]. Reports suggest prostate cancer patients face an overwhelming financial burden due to diagnostic, surgery and medical treatment costs in 2022[26].

This study highlighted several cancers have poor engagement rates, such as liver, ovarian, colorectal, gastric, bladder, oesophageal and head and neck cancers. This is insightful given the lack of evidence our previous literature review identified[1]. For these cancers, as well as several others, there was high missingness. Further understanding is to

be sought through qualitative research methods.

There was no significant association between breast and cervical cases and treatment engagement in the complete case dataset model, but this became significant after MICE. This suggests that the other cancer cases, which had a higher proportion of missing data on outcomes, were less likely to completely engage with treatment based on estimations of their values using observed data. There is rationale for this being an accurate estimation as anecdotal reports suggest cancers other than breast and cervical cancer have higher drop-out rates.

9. Strengths and limitations

To ensure that the findings were locally relevant, we implemented a cross-sector collaboration, involving clinical staff and policy makers. Routinely collected data were accessed from the TTH electronic reporting system and verified by clinical staff, who were informed and consulted throughout the data sorting and analysis process, to ensure real-world validity.

The mapping process highlighted limitations and challenges in reporting the treatment process that future work could address. Since moving to an electronic recording system in November 2020, the patient's medical records are input into the LHIMS system. This is generally intended for health practitioners so although the records are electronic, they are not designed for research use, so do not contain structured data for quantitative analysis. The electronic recording system contains details of clinic visits and outcomes but is often supplemented with routine follow up scheduling captured by written notes. Routines with respect to documentation of patient repeat appointments and clinic attendance vary depending on the department and clinical staff.

Cancer treatment at TTH is mostly centralised at the oncology department but cases are seen and treated in other departments. For reasons including drop out and offsite referral, not all patients will reach the oncology department. The data reporting routines required to verify electronic reporting were not known outside of oncology. Therefore, only partial datasets on these patients are recorded.

Within oncology, staff highlighted it is common that patients often pause treatment whilst they gather funds. Thus, it is a challenge to ascertain whether patients are currently still engaged in treatment. Furthermore, as not all treatments can be provided at TTH, patients are referred for radiotherapy and chemoradiation at larger facilities in Kumasi and Accra.

Conducting a biopsy with immunohistology staining is routine in the oncology department. Anecdotal reports suggest this is not carried out in all departments due to the costs involved. Staff prefer not to financially burden late-stage palliative patients, yet this creates uncertainty in the diagnosis. It is equally important to weigh up these limitations with the ethical implications of additional tests.

As not all cancers may be clinically diagnosed and electronically reported, it is likely that the dataset may underestimate hospital cases. In addition, not all cancer cases in the region may reach TTH. This may include patients seen at private facilities or from district facilities who are too sick or poor may to travel. The latter group, that may be missing from the data, represent those most vulnerable in Northern Ghana.

The mapping exercise was conducted to argument the data analysis and thus took at TTH oncology perspective. However, the value of obtaining other perspectives (primary care, community health centres, referring district hospitals) was identified. Thus, further work has sought to capture and integrate other perspectives on the pathway.

There were several limitations with the dataset as well as those imposed by the high levels of missing data. A key assumption was that data is missing at random. Missing not at random corresponds to missing data that cannot be accounted for by the observed variables. This could be the case if there were unobserved variables which were not considered but had an effect on how likely patients were to have missing data and affected the outcome variable.

Another limitation was that the Northern region was over-represented. Although the treatment facility serves all five northern regions, the region called 'Northern' where the facility resides accounted for most cases. This suggests less cases from other regions reach the tertiary facility. It may also be due to under-reporting. The location that patients indicate in demographic information may not be accurate if they report temporary lodgings when travelling for treatment. Furthermore, when location is unknown, 'Northern' region is input by the computer system as a default.

The multi-modal nature of treatment meant that patients had to be followed up. Follow-ups were conducted by staff who spoke local languages and had experience dealing with the patients to provide appropriate counselling. Staff phoned patients to ask whether they attended their referrals and completed radiotherapy. Both staff and patients' feedback this was a valuable experience. Staff received gratitude which was reassuring. The patients used this as an opportunity to feedback about the services. This has been more widely adopted since this study.

Quality data is key for planning cancer care. This study has highlighted there would be value in bringing together structured cancer case reporting between units at TTH, as well as working with district and private facilities. Further research is needed to understand the treatment process, the limitations in data gathering, and how capacity can be built between departments. Within this, it will be important to bring together different perspectives to join up the approach between departments and facilities.

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CRediT authorship contribution statement

Richard Cooper: Writing – review & editing, Supervision. **Chloe Zabrina Tuck:** Writing – original draft, Visualization, Validation, Project administration, Methodology, Formal analysis, Conceptualization. **Hamza Suraj:** Validation. **Laura Gray:** Writing – review & editing, Supervision. **Abdul-Rashid Timtoni Iddrisu:** Validation. **Richmond Aryeetey:** Writing – review & editing, Supervision. **Tampuri Rahman Abane:** Validation. **Robert Akparibo:** Writing – review & editing, Supervision. **Braimah Abubakari Baba:** Supervision.

Declaration of Competing Interest

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

Data Availability

The dataset was anonymised and made available from TTH internal records department following ethical review and approval. This is not publicly available.

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Author contribution

CT conceptualised the study with guidance from RAK, LG, RC, ABB and RAr. Data extraction and verification was performed by TRA, HS and ARTI at TTH, who also supported and advised throughout the data

sorting process and on the primary results. RAK, LG, RC and RAr reviewed a draft manuscript and made intellectual inputs to improve quality. All authors read and approved the final manuscript. CT is responsible for the overall content as guarantor and accepts full responsibility for the work and controlled the decision to publish. The corresponding author (CT) attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Ethics approval

Ethical review and approval was obtained through Ghana Health Service Ethics Review Board (GHS-ERC:019/07/22) and ethical clearance provided by TTH.

Consent for publication

Not applicable. Consent was not required as no human participants were involved in this study.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.jcpo.2024.100497.

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