

STUDY PROTOCOL

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A mixed methods protocol for a framework to improve access to radiotherapy services for cancer patients in Gauteng Province, South Africa

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Abstract

Background Cancer is a burden on public health worldwide, with its prevalence and mortality continually rising. Radiotherapy, a commonly used modality for the management of cancer, can be used alone or adjuvantly with other cancer treatment modalities for radical and palliative care. However, access to radiotherapy cancer care remained a challenge in many low- and middle-income countries, including South Africa, due to a shortage of equipment, trained personnel, and limited financial resources. This resulted in long waiting times and poor treatment outcomes. A comprehensive strategic framework is being developed to address these issues and improve overall access to radiotherapy for cancer patients in the region. This protocol was for a research study that aimed to develop a strategic framework encompassing policy reforms, infrastructure development, capacity building, and technology integration to enhance access to radiotherapy for cancer patients in Gauteng.

Methods The study employed a concurrent triangulation mixed methods approach to address the four research objectives, namely: Objective 1: To quantify the current effectiveness of radiotherapy treatment delivery; Objective 2: To assess the socio-economic parameters and demographics that govern access to radiotherapy services for cancer patients in Gauteng Province, South Africa; Objective 3: To explore radiotherapy quality indicators and their impact on patient outcomes, and Objective 4: Based on objectives 1 to 3, develop a practical framework that provides a roadmap for enhancing access to radiotherapy services in Gauteng. Quantitative data (Objectives 1 & 3a) was analysed using IBM SPSS software, while qualitative data (Objectives 2 & 3b) was analysed using ATLAS.ti version 23 through thematic content analysis. Ethical considerations were observed throughout the study.

Discussion The research has the potential to improve access to radiotherapy services. The developed framework will be valuable for policymakers, healthcare providers, and stakeholders in planning and implementing interventions addressing the identified barriers. Enhanced access to radiotherapy services will lead to timely treatment and improved outcomes for cancer patients.

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Background

Cancer is a public health issue worldwide, and radiotherapy is an essential treatment modality for the management of most cancer patients [1]. However, access to radiotherapy cancer care in low- and middle-income countries is limited, which leads to significant disparities in treatment outcomes [2]. South Africa is no exception, the Province of Gauteng faces various challenges in providing equitable and efficient radiotherapy cancer care [3–5]. This study protocol builds on the presentation that was presented at the International Society of Radiographers and Radiological Technologists (ISRRT) World Congress 2024 held in Hong Kong on 6–9 June 2024. To address this issue, this journal article presents a study protocol for developing a framework for improving radiotherapy access in Gauteng that is responsive to the needs of the local community and healthcare system. By doing so, this framework has the potential to improve the patient's quality of life and cancer treatment outcomes for thousands of cancer patients in Gauteng, as well as contribute to the global effort to reduce the burden of cancer in low- and middle-income countries.

Radiotherapy in cancer management

Radiotherapy is a crucial component of cancer management, benefiting 50% of cancer patients by improving local control, survival, and quality of life [5]. However, access to radiotherapy is limited, especially in low- and middle-income countries, due to resource constraints [6]. Lack of access jeopardizes the treatment of millions of cancer patients and can lead to negative outcomes such as disease progression and reduced efficacy [7, 8]. Radiotherapy can be tailored to individual needs, offering targeted treatment and minimal damage to healthy tissues. International efforts are ongoing to standardize radiotherapy practices and expand treatment capacity [9]. Timely access to radiotherapy is crucial for optimal long-term disease control and improved survival. Thus, efforts should be made to ensure equitable and timely access to radiotherapy services [7, 10, 11].

State of public sector radiation oncology in South Africa

The current state of cancer care in South Africa is characterized by long treatment delays, limited resources, high patient volumes, and late-stage disease presentation [12, 13]. The situation is even worse in poorer provinces, leading to delays in radiotherapy access [14]. The public healthcare sector in South Africa also faces a shortage of oncology healthcare staff, including medical physicists, radiotherapists, oncologists, and trained nurses. This shortage is exacerbated by the fact that 25% of registered oncologists are responsible for more for the care of more than 75% of the population [15–17]. Furthermore, Africa's overall unmet need for radiotherapy services stands

at 71.5% [1]. The IAEA has recommended 1 linear accelerator per 250,000 people, a target that has by no means been achieved by any country across the continent [5]. While South Africa has made strides in healthcare infrastructure compared to some of its neighbouring countries, challenges persist, especially in ensuring equitable access to radiotherapy services across all provinces [18, 19]. Comparing the availability of radiotherapy services with population cancer statistics can reveal disparities in access. For instance, while Gauteng province, as the economic hub of South Africa, might have better access to healthcare resources, other provinces, particularly those in rural areas, might face significant shortages (Spotlight 2022).

The two Gauteng Provincial centres, Charlotte Maxeke Johannesburg Academic Hospital and Steve Biko Academic Hospital provide radiotherapy services to Gauteng, Mpumalanga and parts of the Limpopo and North-West provinces. They provide radiotherapy services that cover an excess of 18 million people, with both facilities treating approximately 4,000 new patients annually (Spotlight 2022). The two facilities have 9 newly installed LINACS compared to approximately twice the number available LINACS in the private sector. The latter covers a fraction of patients, the majority of whom are covered by medical aid. It is unsurprising that 8-month treatment delays were recently reported (Spotlight 2022). The existence of a private healthcare sector in South Africa further complicates matters. While private facilities may offer radiotherapy services, access to these services is often limited to those who can afford private healthcare or have medical aid coverage. This creates a barrier to access for most of the population relying on the public healthcare system [18–21]. The absence of a National Health Insurance (NHI) system exacerbates inequalities in access to radiotherapy services. Without a universal healthcare system in place, disparities in access persist based on socioeconomic status, geographic location, and other factors [20]. Comprehensive strategies are needed to address the shortage of radiotherapy services in South Africa, particularly in Gauteng province and other underserved areas. This includes investment in healthcare infrastructure, training and retaining skilled healthcare professionals, and implementing policies to ensure equitable access to essential cancer treatments for all residents, regardless of their socioeconomic status. Additionally, enhancing collaboration with international organizations like the IAEA can help strengthen radiotherapy services and improve cancer care outcomes in South Africa and other regions facing similar challenges [5].

The significance of the proposed study

The proposed study on developing a framework for improving radiotherapy access to radiotherapy services

in Gauteng, South Africa, holds significance for several reasons. Firstly, it will address a critical need in the healthcare system of Gauteng by identifying barriers that hinder equitable access to radiotherapy services. This study's outcomes can impact the lives of cancer patients in Gauteng by improving their access to timely and equitable radiotherapy care. Secondly, the study aligns with the global efforts to reduce cancer-related morbidity and mortality, particularly in low- and middle-income countries. The framework developed can serve as a guide to improve access to radiotherapy services for other regions facing similar challenges. This study will contribute to the global knowledge base by sharing insights and best practices and informing policymakers and practices in improving cancer care in resource-constrained settings.

Aim and objectives

The protocol is for a research study that aimed to develop a strategic framework encompassing policy reforms, infrastructure development, capacity building, and technology integration to enhance access to radiotherapy for cancer patients in Gauteng. The study objectives were:

Objective 1: To quantify the current effectiveness of radiotherapy treatment delivery.

Objective 2: To assess the socio-economic parameters and demographics that govern access to radiotherapy services for cancer patients in Gauteng Province, South Africa.

Objective 3: To explore radiotherapy quality indicators and their impact on patient outcomes.

Objective 4: Based on objectives 1 to 3, develop a strategic framework that provides a roadmap for enhancing access to radiotherapy services in Gauteng.

Materials and methods

Study design and sample

An exploratory research study was conducted in the Gauteng province to develop a strategic framework aimed at improving access to radiotherapy in the province. Data collection and recruitment are now concluded. The project included a quantitative analysis of time intervals in the radiotherapy pathway, an investigation of patient experiences, and assessment of structural quality indicators. Gauteng Province is one of the most populous provinces in South Africa, with a high demand for quality healthcare services. The strategic framework will consider factors such as population demographics, existing infrastructure, and financial resources to ensure that radiotherapy services are accessible to all residents in need. Additionally, the study will explore potential partnerships with local healthcare providers and organisations to enhance the implementation of the framework and improve overall patient treatment outcomes.

A concurrent triangulation mixed-methods design was employed, giving equal priority to the concurrently collected qualitative and quantitative data, as shown in Fig. 1. Quantitative and qualitative approaches that were used included a data sheet for patient file data (Objective 1), in-depth interviews with radiotherapy patients (Objective 2), and the Heads of departments of the Multidisciplinary Teams ((Oncologist, Medical Physicist, Radiation Therapist), and a cross-sectional survey of radiotherapy unit managers in public and private facilities (Objective 3). The data was then triangulated for the development of the framework (Objective 4). The mixed-methods research design was justified for this research as it addressed the research question through a comprehensive analysis of the potential barriers and challenges faced in accessing radiotherapy services in Gauteng province. Integrating quantitative and qualitative data and validation from stakeholders ensures the robustness and applicability of the research findings and the resulting framework [22].

Theoretical framework

Initially, this study's design was conceptualized within the Andersen-Newman Behavioral Model. The model predicts that there is a sequence of predisposing, enabling, and need factors that influence a person's utilisation of health services [23]. As stated by the model, predisposing factors are social and demographic structures. Enabling factors assist people in using services (e.g., resource availability). Access is defined as the means through which patients enter the health system and continue with the treatment process. Health behaviours, such as accessing cancer treatment and other medical services, are complex. However, upon further consideration, particularly considering the framework being developed, a decision was made to utilize Penchansky and Thomas's "5As" framework instead.

This shift is justified for several reasons:

- **Patient-Centered Perspective:** The "5As" framework offers a more patient-centered perspective on access, aligning better with objective that focuses on patient experiences.
- **Direct Applicability:** The "5As" framework is more directly applicable to identifying specific dimensions of access and related barriers.
- **Alignment with Existing Literature:** Using the "5As" aligns the study with existing literature and frameworks in the field of healthcare access, particularly in the Gauteng province. This is consistent with the broader project goal of developing a framework for improving radiotherapy access

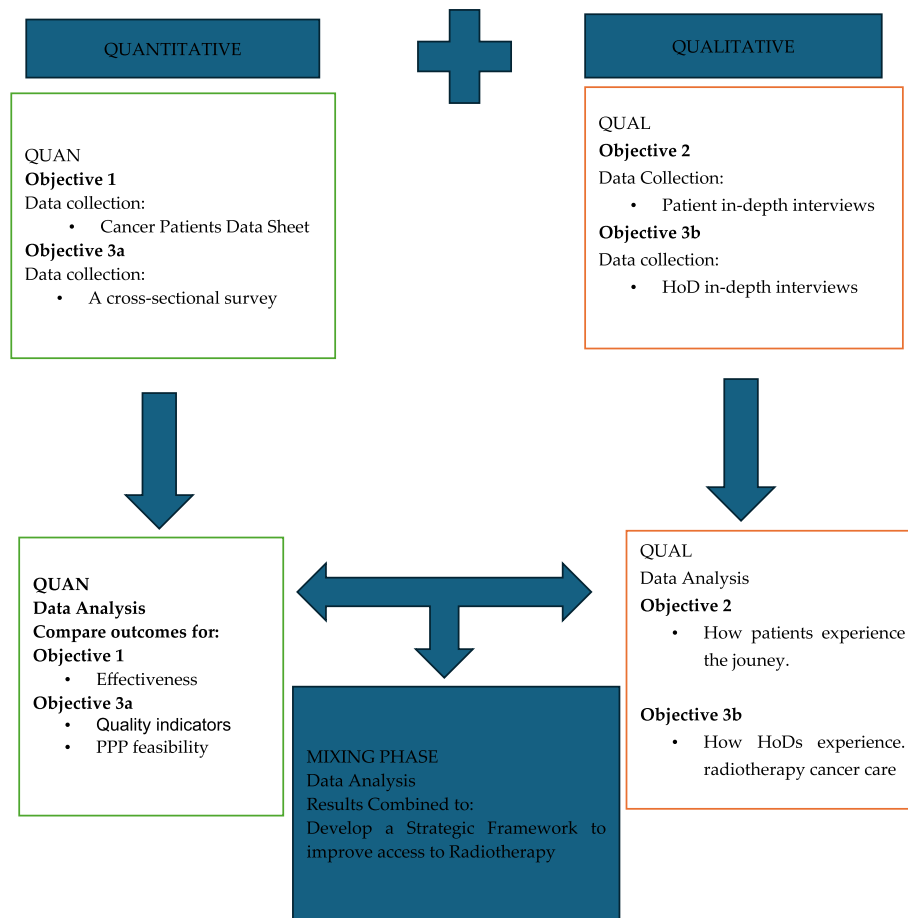


Fig. 1 A summary of research objectives and methods

The "5As" framework suggests that access to healthcare is influenced by five key dimensions: Availability, Accessibility, Affordability, Accommodation, and Acceptability.

Availability

Availability refers to the existence of radiotherapy services within a reasonable distance for patients. This study will assess the following aspects of availability:

- Number and distribution of radiotherapy facilities: Are there enough facilities to meet the needs of the population in Gauteng?
- Capacity of existing facilities: Are the facilities adequately equipped and staffed to provide timely treatment?
- Waiting times for appointments: How long do patients typically have to wait for initial consultations and treatment?

Accessibility

Accessibility concerns the geographic and structural capacity for patients to reach radiotherapy services. This study will investigate the following accessibility factors:

- Distance to facilities: How far do patients have to travel to reach the nearest radiotherapy centre?
- Transportation options: Are there affordable and reliable transportation options available, particularly for patients in rural areas?

Affordability

Affordability relates to the financial capacity of patients to pay for radiotherapy services. This study will examine the following affordability issues:

- Cost of treatment: What are the direct costs of radiotherapy, the treatment charges
- Indirect costs: What are the indirect costs associated with treatment, such as transportation, accommodation, and lost income?

Accommodation

Accommodation refers to the fit between how radiotherapy services are organized and patients' needs and preferences. This study will explore the following aspects of accommodation:

- Communication: Do healthcare providers communicate effectively with patients, providing clear and understandable information about their treatment?
- Cultural sensitivity: Are the services provided in a culturally sensitive manner, respecting patients' beliefs and values?

Acceptability

Acceptability concerns the compatibility between patients' and providers' attitudes, values, and beliefs regarding radiotherapy services. This study will investigate the following acceptability factors:

Cultural beliefs: Do cultural beliefs or misconceptions influence patients' willingness to seek or adhere to radiotherapy treatment?

By applying the "5As" framework, this research aimed to provide a comprehensive understanding of the barriers and facilitators influencing access to radiotherapy services in Gauteng Province. This framework guided the data collection process, analysis, and the development of targeted interventions to improve access to care.

Data collection instruments and procedures

Objective 1

Cancer patients data sheet (Quantitative)

The primary researcher collected data from 400 patient files treated over the same period at each of the two public radiotherapy facilities in Gauteng Province, measuring radiotherapy treatment times, patient waiting time, and overall treatment time (Annexure 1). The data sheet was adapted from the survey by the IAEA that used validated quality indicators [24]. The effectiveness of radiotherapy delivery was assessed using measures such as time from diagnosis to commencement of radiotherapy, time from the first consultation to CT simulation, and overall treatment time. After approval was obtained from ethics committees and gatekeepers, the primary researcher visited the two public radiotherapy facilities and used the probability sampling method—the systemic sampling technique was employed, where the patient files were selected at regular intervals. Data was collected from treatment planning records between January and December 2023. The first 33 to 35 files per month were identified through radiotherapy planning records. The study included files of cancer patients who received radiotherapy for the five most diagnosed cancers at the two public radiotherapy facilities in Gauteng Province. The five most prevalent cancers in South Africa, according to Statistic SA, are cancer of the breast, cervical, lung, prostate, and gastrointestinal [25].

The selected patient files were reviewed to collect data on demographic information, type of cancer, stage of cancer, treatment received, and outcomes. This study

aimed to provide insights into the patterns of radiotherapy utilisation and outcomes for the most common cancers in Gauteng Province. The sample size was large, with 400 files from 4000 patients treated per year at each facility. The total number of files included per facility was 400, as calculated by the biostatistician using an equal precision sample size of 10% of the population. The data analysis was conducted with the assistance of a biostatistician from the University Statistical Consultation Service (STATKON). The data was cleaned and coded on MS Excel and exported to IBM SPSS Version 29 software. The descriptive statistics (mean, median, standard deviation) were done to summarise the demographic and clinical characteristics of the patients, as well as the inferential statistics (t-tests, chi-square tests, regression analysis) to examine relationships or differences between variables of interest.

Objective 2

In-depth interviews with cancer patients (Qualitative)

For the investigation of the socio-economic indicators of cancer patients in Gauteng Province, specifically those diagnosed with the five most common cancers, the study involved a purposeful sampling of radiotherapy patients presenting for treatment and follow-up at the two public radiotherapy facilities. The researcher aimed to get a minimum sample size of 30 patients from each of the two facilities. Thematic Data saturation determined the sample size, ensuring data collection continued until no new themes or information emerged from the interviews [26]. This method helped ensure that the study comprehensively understands the experiences and perspectives of patients at each facility and that the findings are trustworthy and credible. The participants were 18 years and older and willing to sign the consent form and participate voluntarily in the study. Data collection and research measures involved obtaining approval from ethics committees and permission from the hospital CEOs and oncology department managers. Participants were recruited through a paper-based invitation at the two facilities. The study also focused on the ease of access to care by considering the proximity of residents to treatment facilities. In-depth interviews were conducted by the primary researcher (PNR) to capture more accurate data. The interviews were 30–40 min long and audio recorded with participants' permission. They were transcribed verbatim before data analysis. Field notes were used to complement audio-taped interviews where participants had refused to be audio-recorded. Data analysis was conducted using ATLAS.ti version 23, with thematic content analysis used to categorise responses. The developed themes were grouped based on subthemes and categories. The relationship between the themes, research questions, and existing literature was examined.

Objective 3a

Cross-sectional survey of radiotherapy heads of departments/ unit managers of public and private (Quantitative)

With the data from the survey, the study aimed to gather information about infrastructure, equipment, and human resources in the two public radiotherapy facilities and all private practices in Gauteng Province. A sample of two managers from the public facilities and eighteen managers from the private facilities was used. A cross-sectional survey was conducted to determine available resources, staff availability, and equipment functionality (Annexure 2). The data sheet was adapted from the survey by the IAEA that used validated quality indicators (QIs) [24]. After approval from ethics committees and permission from hospital CEOs and private practice managers, participants were recruited through a paper-based invitation. The data was analysed using IBM SPSS version 29 software to determine the staff-to-equipment-to-patient ratio required to meet current and prospective needs and assess if the private sector can supplement state services in improving access to radiotherapy services for cancer patients.

Objective 3b

In-depth interviews with the heads of radiotherapy multidisciplinary sections (Qualitative)

This phase of the study was a qualitative design rooted in social constructionism, as the aim is to understand how individuals within a specific social context (the radiation oncology team) construct and make sense of their roles, relationships, and experiences. The researcher (PNR) looked at how these individuals co-construct knowledge and meaning related to staffing, training, and equipment in the context of radiotherapy practice (Annexure 3). The researcher (PNR) conducted in-depth interviews with the Heads of the radiotherapy multidisciplinary team (Radiation Oncology, Medical Physics, Radiotherapy), covering topics such as staffing, training, and equipment. Participants were recruited from two radiotherapy facilities in Gauteng Province, with exclusion criteria clearly stated. The population for this phase excluded participants from private radiotherapy facilities in Gauteng Province because the study focuses on government facilities, radiotherapy facilities outside the province, and those who do not provide informed consent. Each facility has four heads of radiotherapy multidisciplinary teams. Therefore, the total population was six heads of departments. The interviews were 30–40 min long, audio-recorded with participants' permission for accuracy, and transcribed verbatim for analysis. Qualitative data was analysed using ATLAS.ti version 23, with thematic content analysis used to categorize responses from in-depth interviews. Thematic content analysis was grouped into themes or categories, and common themes

were segmented into smaller units. The researcher analysed these segments to examine their relationship with other themes, research questions, and existing literature.

Objective 4

Development of the framework (Mixing Phase)

This phase uses methodological triangulation to develop a practical framework for improving access to radiotherapy services in Gauteng Province, South Africa. The mixing phase will be used to harness and triangulate data from objectives 1–4, enhancing the validity and credibility of the findings. It will involve analyzing data collected from interviews with the multidisciplinary team, including representatives from radiation oncology (RO), medical physics (MP), radiation therapy technology (RTT), and nursing. By incorporating perspectives from these different disciplines, the framework will be able to address a comprehensive range of factors influencing access to radiotherapy services in Gauteng province. Additionally, this approach will ensure that the framework is practical and applicable to the specific radiotherapy access challenges in South Africa. A conceptual meaning will be created by identifying, defining, and classifying the central concepts. Concepts will be defined using dictionaries and relevant subject literature. The central concept will be classified using Dickoff, James and Wiedenbach's [27] survey list. The researcher will describe how the identified and defined central concepts interrelate with each other [27], and [28]. Then, the framework will be developed using Chinn and Kramer's descriptive components in the process of theory development. The descriptive components include describing the purpose of the framework, identifying the components, defining the concepts, and forming relationship statements for the development of a framework. The framework will be assessed for clarity, understanding, generalization, and significance and will be presented to expert researchers and clinical practitioners to critique and provide feedback. Lastly, the researcher will describe the framework aimed at improving access to radiotherapy, including guidelines for possible implementation [29], and [30].

Data validity, reliability and trustworthiness

For the quantitative data the following approach is to ensure study rigour:

Validity: Field experts and a statistician were involved in designing the questionnaires to ensure that the content was appropriate and aligned with the study objectives. Furthermore, the researcher personally collected the data [31].

Reliability: The research questionnaires were pre-tested. The pre-testing of the questionnaire was performed with 10% of the sample to check the reliability

of the instrument. Once that process had been completed, the instrument was modified/rectified, and the researcher re-administered it to the same respondents within two weeks. The questionnaire was deemed sufficient for use in the actual study if the co-efficient reliability of the instrument was between 0.0 and 1.0, indicating a high reliability level [32], and [33].

For the trustworthiness of the qualitative data, the standards by Lincoln and Guba were applied in this study, which are credibility, transferability, dependability, and confirmability, to build confidence in the accuracy, reliability, and plausibility of the study findings. Credibility was ensured by triangulating the study's quantitative analysis with the qualitative part and by triangulating the study's methods and findings. In addition, credibility was ensured by having prolonged engagement and member checks.

- Prolonged engagement: The researcher spent time with the participants before the data collection process to build rapport and trust. This helped the participants to feel free to speak during the interviews. Maintaining contact with the participants helped the researcher to ensure that they were relevant sources of information for the study.

- Member checks: During the interview sessions, the researcher probed more and paraphrased statements to clearly understand what the participants were saying. A summary of the interview was provided to all participants after each session, and the tape recorder was played back. This process helped the participants add more information or instruct the researcher to remove some of the information shared during the interview. [34].

Dependability was ensured by employing an independent coder who is an expert in the field of research to co-code the data. Furthermore, expert researchers and clinical practitioners were given an opportunity to evaluate the developed framework [34]. To ensure confirmability, the information recorded during the data collection process was transcribed without any alterations. Moreover, the researchers were objective throughout the study, functioned as a research instrument, and did not influence the outcome of the study or channel the participants into giving certain responses [34]. Transferability will be ensured by fully describing the study approach, design, setting, target population, criteria of inclusion, sampling method, procedure, and the theories used. A full description of the study methodology allows the study to be replicated by other researchers in the future and for them to arrive at a conclusion [34].

Study ethical considerations

Ethical approval and gatekeeper permissions were obtained from the University of Johannesburg (registered as HDC-01-154-2023 and REC-2509-2023),

Johannesburg Health District, the City of Johannesburg (registered as NHRD ref no.: GP_202311_078), and all the private oncology practices in Gauteng province. All the participants were informed of the aim and methods of the study prior to data collection. Those who agreed to participate were required to give written and signed consent forms. In addition, the patient's interviews were carried out using the SA indigenous language of choice (Sotho, Tswana, Venda, Xhosa, Zulu) if English was not their preferred language of communication, and participants were given enough time to respond. The participants could withdraw their consent at any time without any consequences. All participants' identity and confidentiality were protected across all activities. This was done using participation numbers (e.g. SBAH/CMJAH PT No. 1) and not the personal details of participants, thus preventing anyone within or outside of the project from linking the individual's identity with their responses. Data storage and management included keeping a hard copy of the records (such as the checklist, interviews, and sampling forms) in a lockable safe and uploading the records as a soft copy in a cloud storage system, which is accessible using a password and only available to the University of Johannesburg and the research team.

Study dissemination

The findings of this study are being used to develop a strategic framework for improving radiotherapy cancer care, and their significance will be communicated to all radiation oncology stakeholders), the institutions' management of the settings included in the study, and other interested stakeholders (administrators, patient advocacy groups, and policymakers) in the review of the proposed framework. Furthermore, some of the findings have been published in DHET-accredited journals (Barriers to Radiotherapy Access in Sub-Saharan Africa for Patients with Cancer: A Systematic Review, 2024; Improving access to radiotherapy: Exploring structural Quality Indicators for radiotherapy in Gauteng province, South Africa, 2025; Improving Access to Radiotherapy Services in Gauteng: Quantitative Analysis of Key Time Intervals from Diagnosis to Treatment, 2025), and the remaining results will be published in the future and presented at local and international conferences. The thesis is still in progress and will be available on the UJ Institutional Repository upon completion.

Expected study results

This research study aimed to develop a strategic framework encompassing policy reforms, infrastructure development, capacity building, and technology integration to enhance access to radiotherapy for cancer patients in Gauteng. The study reviewed existing literature, analysed treatment effectiveness data, and analysed

socio-economic parameters and demographics to identify barriers and challenges different patient populations face. The analysis also explored radiotherapy quality indicators, including adherence to protocols, equipment performance, and staff training, to improve access to radiotherapy. Furthermore, one of the expected results was the assessment of the feasibility of including the private sector as a supplement to state services in improving access to radiotherapy services for cancer patients. The ongoing findings are guiding the development of a strategic framework, which will consider policy reforms, infrastructure development, capacity building, and technology integration to improve access and ensure high-quality care for cancer patients. This comprehensive and actionable framework will help address identified barriers and improve access to radiotherapy services in Gauteng.

Conclusions

This study protocol laid the foundation for developing a strategic framework to improve radiotherapy access for cancer patients in Gauteng, South Africa. The research has the potential to significantly impact cancer care in Gauteng Province by improving access to radiotherapy services. The developed framework will be a valuable resource for policymakers, healthcare providers, and relevant stakeholders in planning and implementing interventions addressing the identified barriers. Enhanced access to radiotherapy services may lead to timely treatment and improved outcomes for cancer patients in Gauteng. These may, in turn, enable the attainment of efficient, accessible, and equitable quality cancer care for the South African population. This may, in turn, assist the country in attaining the United Nations Sustainable Development Goal 3.4 of reducing premature mortality of cancer-related deaths by 30%.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12913-025-13130-9>.

Supplementary Material 1.

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Authors' contributions

Conceptualization, P.N.R.; S.B.; P.B.N. and T.P.M.; methodology, P.N.R.; P.B.N.; S.B. and T.P.M.; validation, P.N.R.; P.B.N.; S.B. and T.P.M.; investigation, P.N.R.; resources, P.N.R.; S.B.; P.B.N. and T.P.M.; data curation, X.X.; writing—original draft preparation, P.N.R.; P.B.N.; S.B. and T.P.M.; writing—review and editing, P.N.R.; visualization, P.N.R.; P.B.N.; S.B. and T.P.M.; supervision, T.P.M. and P.B.N.; project administration, P.N.R. All authors have read and agreed to the published version of the manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Consent for publication

The Johannesburg Health District Research committee and the Hospital CEOs have given their approval for accessing the patient's data, stakeholders and patients in the study. Written informed consent will be obtained from all stakeholders and patients involved before data collection.

Competing interests

The authors declare no competing interests.

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