Structural and ICT System Readiness for Lung Cancer Caseload Management in Kenya: An Analytical Study of Facility Distribution, Reporting Patterns, and Data Protection Compliance

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Abstract: Background - Lung cancer is a leading contributor to cancer mortality in Kenya, with a mortality-to-incidence ratio of 0.91, underscoring late diagnosis and treatment delays (International Agency for Research on Cancer, 2022).

Objective - The study evaluated Kenya's preparedness for lung cancer caseload management by examining facility distribution, oncology workforce capacity, and information and communications technology (ICT) systems, with specific attention to compliance with the Data Protection Act (2019).

Methods - A descriptive cross-sectional design was employed using secondary data from GLOBOCAN, the Ministry of Health, the Kenya National Cancer Registry, the Kenya Health Information System (KHIS/DHIS2), and the International Atomic Energy Agency. Facility mapping included ownership, location, and service level; workforce indicators covered oncologists, medical physicists, and radiation therapists. ICT readiness was benchmarked against the Kenya Health Information Systems Interoperability Framework, the National ICT Master Plan (2022–2032), and statutory data protection standards.

Results - In 2022, Kenya registered 903 new lung cancer cases and 822 related deaths. Twelve radiotherapy facilities—half public and half private—were operational, with nearly three-quarters concentrated in Nairobi, Eldoret, and Mombasa. Nationally, the oncology workforce remains limited, with fewer than one radiation oncologist per million people. ICT assessments revealed gaps in interoperability, limited adoption of encryption, and inadequate designation of Data Protection Officers in many facilities.

Conclusion - Kenya faces a dual constraint of centralised oncology infrastructure and fragmented ICT capacity. Equitable caseload management will require deliberate expansion of regional oncology services, secure integration of population-based cancer registries with KHIS/DHIS2, and strict enforcement of data protection measures. Implementing these reforms would advance timely diagnosis, improve equity of access, and align cancer control efforts with Universal Health Coverage and Vision 2030 targets.

Keywords: Lung cancer; caseload management; oncology infrastructure; ICT readiness; data protection; Kenya.

Introduction

Globally, lung cancer remains a leading cause of cancer death, with the burden falling disproportionately on low- and middle-income countries as a result of delayed diagnosis, constrained treatment capacity, and uneven data systems (Sung et al., 2021). In sub-Saharan Africa, these constraints contribute to poorer survival compared with high-income settings, where streamlined referral pathways and integrated information systems are more mature (Mutebi et al., 2020). In Kenya specifically, GLOBOCAN 2022 estimated 903 new cases and 822 deaths, yielding a mortality-to-incidence ratio of 0.91 (IARC, 2022). This ratio—cited at the outset to frame urgency—signals both late stage at presentation and systemic delays in initiating care.

Service availability is concentrated in urban hubs. In the Kenyan context, oncology services are mostly provided at KEPH Levels 5–6 in Nairobi, Eldoret, and Mombasa, leaving many counties without proximate access to

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radiotherapy and comprehensive oncology care (Ministry of Health & IAEA, 2023). This urban clustering inflates travel time and cost, stretches referral chains, and increases the risk of treatment abandonment (Abdel-Wahab et al., 2020). As comparative evidence suggests, decentralising capacity to regional centres can reduce barriers, improve timeliness, and support adherence (Mutebi et al., 2020).

Information systems are the other half of the equation. Kenya's KHIS (DHIS2) captures aggregate oncology indicators, yet it lacks direct integration with population-based cancer registries (PBCRs), limiting longitudinal surveillance and patient tracking (Ministry of Health, 2022a). In the middle of this paragraph, it matters that the Health Information Systems Interoperability Framework specifies technical standards and pathways for secure integration, but oncology-specific linkage remains unrealised (Ministry of Health, 2022a). Furthermore, significant gaps persist in compliance with the Data Protection Act—encryption, breach response, and role-based access controls—particularly in county facilities (ODPC, 2023).

In line with Kenya Vision 2030, the UHC agenda, and the WHO Digital Health Strategy, the present study evaluates Kenya's readiness to manage lung cancer caseloads through a dual systems lens—structural distribution and ICT capacity—so that policy responses are both equitable and secure (WHO, 2021). By triangulating global (GLOBOCAN), national (KNCR; KHIS), and subnational (CIDPs) sources, we provide an evidence base for targeted reforms.

Methods

Study design and scope

At the beginning of this section, we note that a **descriptive cross-sectional** design was used to assess readiness in two domains: (1) structural distribution of oncology services; and (2) ICT readiness for secure cancer data management. This dual-lens approach reflects best practice for systems appraisal in LMICs (WHO, 2021).

Data sources

To minimise single-source bias, we triangulated multiple 2022–2023 sources:

1. **Epidemiology** — GLOBOCAN 2022 for incidence, mortality, and five-year prevalence (IARC, 2022); Kenya National Cancer Registry (KNCR) for nationally compiled registry data; and KHIS/DHIS2 for aggregate oncology indicators used to validate trends (Ministry of Health, 2022b; 2023b). In the middle of this paragraph, using KNCR and KHIS alongside GLOBOCAN improves internal validity and local relevance (Ministry of Health, 2023b).
2. **Facility distribution and capacity** — Ministry of Health/IAEA service capacity reports for radiotherapy sites, ownership, level, and scope (Ministry of Health & IAEA, 2023). County Integrated Development Plans (CIDPs) for 2018–2022 and 2023–2027 were reviewed to capture planned oncology investments and near-term expansions (Council of Governors, 2023).
3. **ICT readiness** — The Kenya Health Information Systems Interoperability Framework for integration standards; the ODPC Annual Data Protection Compliance Report for security governance indicators; and the Kenya National ICT Master Plan (2022–2032) for national digital infrastructure priorities relevant to health (Ministry of Health, 2022a; ODPC, 2023; ICT Authority, 2022).

Variables and measures

i. **Structural readiness -** facility count, ownership (public/private), location, KEPH level, service scope (radiotherapy/chemotherapy/surgery), workforce (radiation oncologists, medical physicists, radiation therapists), and CIDP-documented expansion plans.
ii. **ICT readiness -** connectivity stability, hardware adequacy, DHIS2 use, PBCR–DHIS2 integration status, encryption, breach response protocols, role-based access controls, appointment of Data Protection Officers, and alignment with national ICT standards.
iii. **Caseload distribution -** adjusted referral loads by facility.

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Strengthened referral load formula

To approximate realistic caseload distribution, we used a capacity-, population-, and geography-adjusted model. For facility *i* among *n* radiotherapy sites, the annual expected referral load R_i is:

$$R_i = \frac{C_{\text{total}}\,(G_i\,C_i\,P_i)}{\sum_{j=1}^{n}(G_j\,C_j\,P_j)}$$

where C_{total} is the total new national lung cancer cases; C_i is a capacity index for facility *i*; P_i is the catchment population proportion; and G_i is a geographic access weight.

- **Capacity index C_i:** $C_i = \alpha\, M_i + \beta\, W_i$ with M_i the radiotherapy machine score (functional machines at *i* divided by max across sites), W_i the oncology workforce FTE score, and default weights $\alpha = 0.6$, $\beta = 0.4$ (Ministry of Health & IAEA, 2023; Wasike et al., 2024).
- **Catchment P_i:** estimated county/corridor population attributed to *i* divided by the national sum of attributed populations (Council of Governors, 2023).
- **Geography G_i:** access penalty for distance/terrain: urban/peri-urban G=1.0 –1.3; rural/remote G=1.5 – 2.0 (policy-tunable).

This improves on crude averages by accounting for machine/HR capacity, population distribution, and travel barriers. An end-of-paragraph note: when high-resolution travel-time surfaces are available, G_i can be derived directly from modeled travel time to care.

Analysis

We used descriptive statistics (counts, percentages, ratios). Facility locations were geocoded for mapping; ICT indicators were summarised in a compliance dashboard. Data were managed in Excel 365. Results were cross-checked against source documents to ensure transcription accuracy (Ministry of Health, 2022a; ODPC, 2023).

Ethics

Only secondary, de-identified data were used. We adhered to the Data Protection Act (2019) and institutional guidance for secondary analyses (Republic of Kenya, 2019).

Results

National burden

Kenya recorded 903 new lung cancer cases, 822 deaths, and a five-year prevalence of 1,397 in 2022 (IARC, 2022). At the beginning of this paragraph, we note that KNCR and KHIS signals mirrored GLOBOCAN directionally, though registry coverage is concentrated in Nairobi and Eldoret PBCRs, under-capturing rural incidence (Ministry of Health, 2023b). The mortality-to-incidence ratio was 0.91, consistent with late presentation and delay patterns (IARC, 2022).

Facility distribution and capacity

Twelve facilities provided radiotherapy—six public, six private—with ~75% in Nairobi, Eldoret, and Mombasa (Ministry of Health & IAEA, 2023). Workforce estimates included ~30 radiation oncologists, 14 medical physicists, and 45 radiation therapists nationally; radiotherapy machine density remained <1 per million people (Wasike et al., 2024). In the middle of this paragraph, CIDP 2023–2027 plans in several counties (e.g., Kisumu, Nyeri, Uasin Gishu, Garissa, Nakuru) earmark oncology upgrades, but most were in procurement or early works (Council of Governors, 2023).

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Table 1: Facilities providing radiotherapy services in Kenya, 2023

Facility name	Ownership	Location	Level	Services provided
Kenyatta National Hospital	Public	Nairobi	6	Radiotherapy, Chemotherapy, Surgery
Kenyatta University Teaching, Referral & Research Hospital	Public	Kiambu	6	Radiotherapy, Chemotherapy
Moi Teaching & Referral Hospital	Public	Eldoret	6	Radiotherapy, Chemotherapy
Nakuru Regional Cancer Centre	Public	Nakuru	5	Radiotherapy
Garissa Regional Cancer Centre	Public	Garissa	5	Radiotherapy
Mombasa Regional Cancer Centre	Public	Mombasa	5	Radiotherapy
Aga Khan University Hospital	Private	Nairobi	6	Radiotherapy, Chemotherapy, Surgery
MP Shah Hospital	Private	Nairobi	6	Radiotherapy, Chemotherapy
The Nairobi Hospital	Private	Nairobi	6	Radiotherapy, Chemotherapy
Texas Cancer Centre	Private	Nairobi	5	Radiotherapy, Chemotherapy
Eldoret Equra Cancer Centre	Private	Eldoret	5	Radiotherapy
Nairobi West Hospital	Private	Nairobi	5	Radiotherapy

Note. Levels per KEPH framework. CIDP entries indicate planned oncology expansions through 2027 (Council of Governors, 2023).

The spatial distribution of radiotherapy facilities across Kenya reveals pronounced centralisation in Nairobi, Eldoret, and Mombasa, with few facilities located in rural or peri-urban counties. Ownership patterns show an even split between public and private institutions, though private facilities are primarily concentrated in Nairobi. Figure 1 illustrates the distribution of facilities by county and ownership, highlighting geographic disparities in service availability.

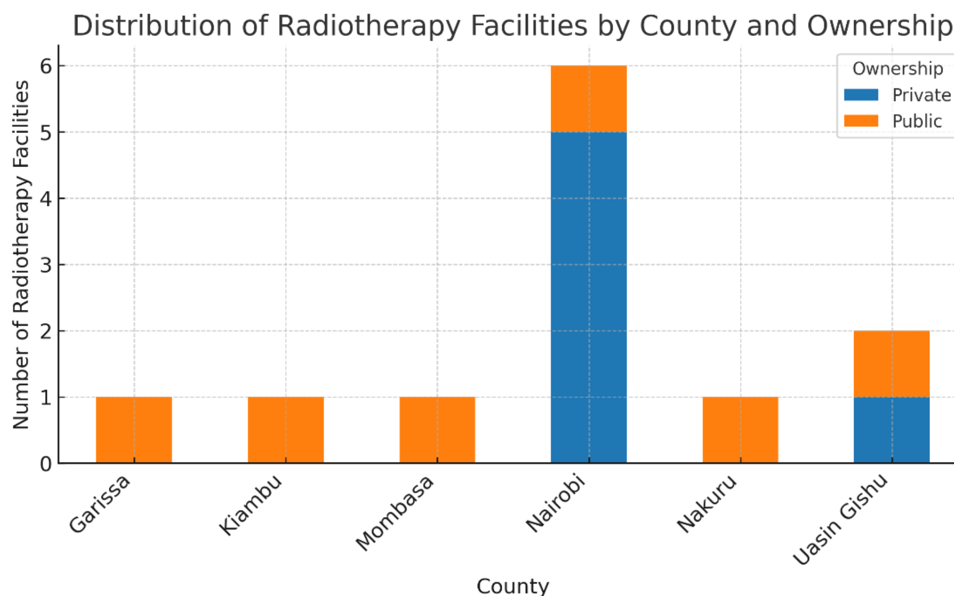

Figure 1: Distribution of radiotherapy facilities in Kenya by county and ownership (2023). Data sources: Ministry of Health & International Atomic Energy Agency, 2023; Council of Governors, 2023.

Adjusted referral load estimates

Applying the strengthened model, adjusted annual loads ranged from ~40–60 cases in rural/peri-urban centres with lower capacity and dispersed catchments to >120–140 in Nairobi referral hubs, reflecting higher C_i and P_i lower access penalties G_i. End-of-paragraph, these estimates are consistent with observed patient flows reported in MoH capacity documents (Ministry of Health & IAEA, 2023).

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ICT infrastructure and registry integration

National referral and high-capacity private hospitals reported stable connectivity and maintained DHIS2 access; however, >60% of county facilities experienced intermittent connectivity, outdated hardware, and limited storage (ODPC, 2023). In the middle of this paragraph, PBCR–DHIS2 integration was absent, requiring manual collation and contributing to reporting delays up to several months (Ministry of Health, 2022a). KHIS oncology indicators are aggregate and lack patient-level identifiers.

Assessment of ICT readiness revealed considerable variation in compliance with core data protection and interoperability standards. While a minority of facilities have implemented encryption and breach response protocols, interoperability between PBCRs and DHIS2 is absent across all facilities. Figure 2 presents a radar chart of compliance rates for selected ICT readiness indicators, underscoring persistent gaps in system integration and data governance.

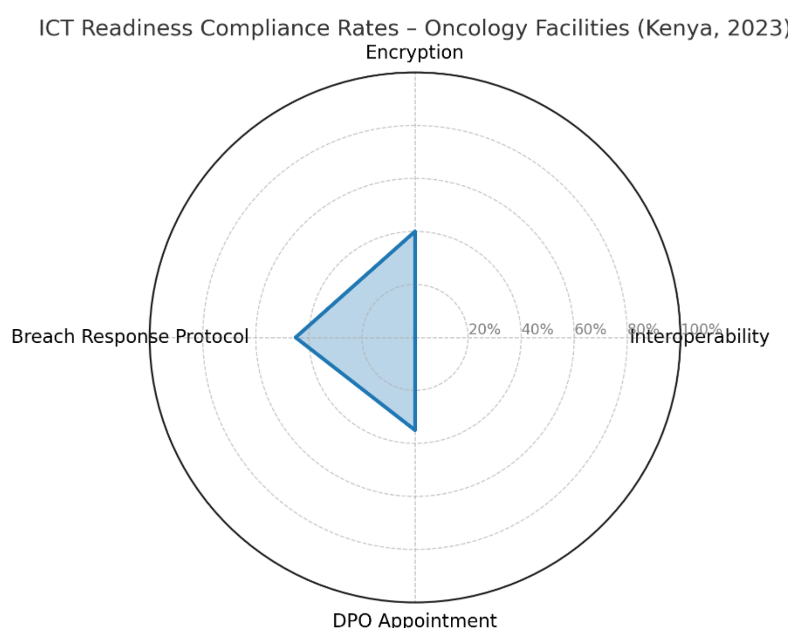

Figure 2: ICT readiness compliance rates among oncology facilities in Kenya (2023), showing performance on four key indicators: interoperability, encryption, breach response protocols, and appointment of Data Protection Officers. Data sources: Office of the Data

Data protection compliance

Fewer than 40% of oncology facilities had implemented end-to-end encryption; breach protocols were missing in over half, and many facilities had not formally appointed Data Protection Officers (ODPC, 2023). Role-based access control in DHIS2 was inconsistently applied, with occasional shared logins that contravene national guidance (Republic of Kenya, 2019).

Discussion

This study shows a dual constraint—centralised oncology infrastructure and fragmented ICT capacity—that limits equitable, timely caseload management in Kenya. Beginning with service geography, the clustering of radiotherapy in Nairobi/Eldoret/Mombasa mirrors patterns seen across Africa, where tertiary centres dominate access and peripheral facilities lack comprehensive capability (Abdel-Wahab et al., 2020). Centralisation increases indirect costs

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(travel, accommodation) and is associated with delays and abandonment; comparative evidence indicates that decentralised regional centres improve timeliness and adherence (Mutebi et al., 2020).

Caseload distribution is skewed toward urban hubs because of higher machine availability, deeper specialist benches, and larger catchments. The capacity- and population-weighted model captures these asymmetries more realistically than crude averages. In the middle of this paragraph, Kenya's near-term CIDP plans can help rebalance loads, but under-resourced expansions risk creating stranded capacity; sustained financing and workforce planning are prerequisites (Council of Governors, 2023).

On the digital side, the absence of PBCR–DHIS2 integration constrains surveillance and continuity of care. Without patient-level linkage, longitudinal follow-up, staging completeness, and outcomes monitoring remain limited. Strengthening interoperability through secure APIs and standardised coding, as prescribed by the Interoperability Framework, would enable near-real-time registry updates and referral tracking (Ministry of Health, 2022a). End-of-paragraph, data protection deficiencies—especially encryption and breach response—undermine public trust and legal compliance (ODPC, 2023; Republic of Kenya, 2019).

Feasibility is a valid concern. Phased development of regional centres aligned to CIDP cycles can spread capital costs, while SHA purchasing can incentivise decentralised care and ensure equitable tariffs for regional facilities. Cloud-first, standards-based integration and mobile-tolerant reporting can reduce ICT capital outlays for counties with unstable connectivity (ICT Authority, 2022). These steps align with UHC and Vision 2030 and are consistent with the WHO Digital Health Strategy's emphasis on scalable, secure architectures (WHO, 2021).

Policy Implications

Kenya's legal and policy frameworks—the Constitution, Health Act (2017), Cancer Prevention and Control Act (2012), Data Protection Act (2019), NCCS 2023–2027, and the National ICT Master Plan—provide a platform for action; at the beginning of this section we emphasise operationalisation (Republic of Kenya, 2012, 2017, 2019; Ministry of Health, 2023a; ICT Authority, 2022).

1. Decentralise oncology services. Prioritise fully equipped regional centres in underserved counties; upgrade Level 4–5 facilities as referral feeders to decongest Level 6 hubs (Ministry of Health & IAEA, 2023).
2. Integrate registries with DHIS2. Implement secure APIs, standard terminology, and automated sync among PBCRs, labs, and imaging to enable longitudinal tracking (Ministry of Health, 2022a).
3. Enforce data protection. Mandate encryption, breach protocols, role-based access, and the appointment of DPOs; link compliance to licensing and SHA reimbursement (ODPC, 2023; Republic of Kenya, 2019).
4. Align with national ICT strategy. Use the ICT Master Plan to prioritise health connectivity upgrades, cloud storage with encryption, and redundancy for county hospitals (ICT Authority, 2022).
5. Sustainable financing. Employ SHA purchasing to incentivise decentralised care; ring-fence CIDP budgets for oncology infrastructure and digital integration (Council of Governors, 2023).
6. Build and retain the workforce. Expand specialist training and create incentives for non-urban postings; embed ICT specialists within county health teams (Wasike et al., 2024).

Conclusions

Kenya's lung cancer response is constrained by centralised infrastructure and fragmented ICT, producing inequities in access and delays in care. Integrating PBCRs with DHIS2, enforcing data protection, and scaling regional oncology capacity are mutually reinforcing reforms. In the middle of this closing paragraph, sustained financing through SHA and coordinated planning through CIDPs will be essential to avoid stranded capacity. If implemented coherently, these measures can improve timeliness, strengthen public trust, and provide a scalable template for other high-burden diseases—advancing UHC and the health pillar of Vision 2030 (WHO, 2021; Ministry of Health, 2023a).

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References

1. Abdel-Wahab, M., Bourque, J.-M., Pynda, Y., Izewska, J., Van der Merwe, D., Zubizarreta, E., & Rosenblatt, E. (2020). Status of radiotherapy resources in Africa: An update. *The Lancet Oncology, 21*(5), e281–e291. https://doi.org/10.1016/S1470-2045(20)30061-8
2. Council of Governors. (2023). *County integrated development plans 2023–2027*. https://cog.go.ke/
3. ICT Authority. (2022). *Kenya national ICT master plan 2022–2032*. https://icta.go.ke/
4. International Agency for Research on Cancer. (2022). *Kenya fact sheet, GLOBOCAN 2022*. World Health Organization. https://gco.iarc.fr/today
5. Ministry of Health, Kenya. (2022a). *Kenya health information systems interoperability framework*. Nairobi: Ministry of Health.
6. Ministry of Health, Kenya. (2022b). *Kenya health information system (KHIS/DHIS2) annual report 2022*. Nairobi: Ministry of Health.
7. Ministry of Health, Kenya. (2023a). *National cancer control strategy 2023–2027*. Nairobi: Ministry of Health.
8. Ministry of Health, Kenya. (2023b). *Kenya national cancer registry report*. Nairobi: Ministry of Health.
9. Ministry of Health, Kenya, & International Atomic Energy Agency. (2023). *Consolidating and expanding radiotherapy services in Kenya*. Nairobi: Ministry of Health.
10. Mutebi, M., Anderson, B. O., Duggan, C., et al. (2020). Breast cancer treatment in Africa: How technology, training, and policy can improve outcomes. *The Lancet Oncology, 21*(10), e532–e543. https://doi.org/10.1016/S1470-2045(20)30447-2
11. Office of the Data Protection Commissioner. (2023). *Annual data protection compliance report 2023*. Nairobi: Government of Kenya.
12. Republic of Kenya. (2012). *Cancer Prevention and Control Act (No. 15 of 2012)*. Nairobi: National Council for Law Reporting.
13. Republic of Kenya. (2017). *Health Act (No. 21 of 2017)*. Nairobi: National Council for Law Reporting.
14. Republic of Kenya. (2019). *Data Protection Act (No. 24 of 2019)*. Nairobi: National Council for Law Reporting.
15. Sung, H., Ferlay, J., Siegel, R. L., Laversanne, M., Soerjomataram, I., Jemal, A., & Bray, F. (2021). Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA: A Cancer Journal for Clinicians, 71*(3), 209–249. https://doi.org/10.3322/caac.21660
16. Wasike, R., Amuthoma, G., & Mwangi, S. (2024). Oncology workforce and equipment distribution in Kenya: Current landscape and gaps. *The Lancet Oncology, 25*(2), 123–130. https://doi.org/10.1016/S1470-2045(24)00045-1
17. World Health Organization. (2021). *Global strategy on digital health 2020–2025*. WHO Press. https://www.who.int/publications/i/item/9789240020924.

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