Artificial intelligence in radiotherapy: a bibliometric assessment of Nigeria's contribution within the African and global research landscape

Abstract

Background: Artificial intelligence (AI) is increasingly investigated across radiotherapy workflows, but the geographical distribution of African contributions remains unclear.

Objective: To quantify Nigeria's contribution to Scopus-indexed AI-in-radiotherapy publications within African and global research output.

Methods: A descriptive bibliometric analysis of Scopus records published from 2017 to 15 October 2026 was undertaken. Radiotherapy- and AI-related terms were searched in titles, abstracts and keywords. Publication types, annual output, country and institutional affiliations, and collaboration patterns were summarized using descriptive statistics. MATLAB software was used for the analysis.

Results: The search identified 10,854 publications, including 8,010 articles (73.8%), 1,659 reviews (15.3%) and 1,185 conference papers (10.9%). Of these, 224 (2.06%) included an African affiliation, and 74 were exclusively Africa-affiliated. Nigeria was affiliated with 25 publications (0.23% of the global total); four had exclusively Nigerian affiliations, whereas 21 (84.0%) involved institutions outside Nigeria. Global annual output increased from 269 publications in 2018 to 2,162 in 2025.

Conclusion: African representation in indexed AI-radiotherapy research remains limited, and Nigeria's output is predominantly internationally collaborative. Locally led multidisciplinary studies, representative datasets and external validation are priorities for clinically relevant research.

Keywords: artificial intelligence; bibliometrics; radiotherapy; Nigeria; Africa; research collaboration

Introduction

Radiotherapy is an essential component of modern cancer care, providing treatment for a wide range of malignancies [1,2]. Advancements in imaging, treatment planning, image guidance, and radiation delivery have improved radiotherapy treatment precision but have also increased the complexity and volume of clinical, imaging, and treatment-related data generated across the radiotherapy pathway. These developments have created opportunities for computational approaches to support clinical decision-making, automate routine tasks, and facilitate personalized treatment [3,4]. Consequently, artificial intelligence (AI), including machine learning, deep learning, and radiomics, has become an important area of research in radiation oncology. Several studies have explored AI applications across multiple stages of radiotherapy, including medical image analysis, automated segmentation, image registration, treatment planning, adaptive radiotherapy, treatment response prediction, quality assurance, and clinical decision support [5,3,4].

However, the development and translation of AI in radiotherapy depend on more than algorithmic performance. High-quality datasets, computational infrastructure, technical expertise, appropriate validation, interoperability, and clinical oversight are important for developing reliable and generalizable applications. Challenges related to data quality, generalizability, interpretability, reproducibility, and integration into clinical workflows remain important considerations in the advancement of AI-driven radiotherapy [5,4]. These requirements may contribute to differences in research productivity and technological development across countries and regions, particularly where infrastructure, funding, expertise, and scientific collaboration are limited. Such disparities are especially relevant in Africa, where a substantial cancer burden coexists with persistent limitations in radiotherapy infrastructure, specialist workforce, treatment capacity, and research resources [6].

Although bibliometric studies have examined AI in selected applications, the geographical distribution of African research and Nigeria's institutional participation remain poorly characterized. A previous bibliometric analysis of 615 Web of Science records covering 2003–2023 identified increasing activity and substantial contributions from the United States and China [9]. However, database choice, search

scope and study period influence bibliometric counts, making comparisons between studies descriptive rather than directly equivalent.

This study therefore quantifies Scopus-indexed publications on AI radiotherapy between 2017 and 15 October 2026, emphasizing Africa-affiliated output, Nigeria-affiliated publications, institutional collaboration, and geographical representation. The analysis describes publication patterns rather than clinical performance or adoption of AI technologies.

Materials and Methods

A descriptive bibliometric analysis of Scopus-indexed records related to artificial intelligence (AI) in radiotherapy was conducted. Records were retrieved on 15 October 2026 for publications dated from 2017 through the search date.

Search strategy and eligibility criteria

The Scopus TITLE-ABS-KEY search combined radiotherapy-related terms with AI-related terms using "OR" within concepts and "AND" between concepts (Table 1). Publication years were restricted by PUBYEAR > 2016 AND PUBYEAR < 2027. Original articles, reviews, and conference papers were included, while book chapters and letters were excluded. No language or geographic filter was applied. Records indexed after 15 October 2026 were not captured.

Table 1. Search terms and Boolean strategy

Search concept	Search terms	Boolean operator
Radiotherapy	"radiotherapy"; "radiation therapy"; "radiation oncology"; "radiation treatment"	OR
Artificial intelligence	"Artificial intelligence"; "machine learning"; "deep learning"; "neural network*"; "radiomics"	OR
Combined search	Radiotherapy terms AND artificial intelligence terms	AND
Publication period	2017–2026	PUBYEAR > 2016 AND PUBYEAR < 2027
Search fields	Title, abstract and keywords	TITLE-ABS-KEY

Data extraction and geographical classification

Scopus records were exported with publication year, document type, institutional affiliation and country information. Publications were classified as global (all eligible records); Africa-affiliated (at least one African-affiliation); Africa-only (exclusively African affiliations); Nigeria-affiliated (at least one Nigerian affiliation); Nigeria–Africa collaboration (Nigerian and other African affiliations); and Nigeria-only (exclusively Nigerian affiliations). These overlapping categories were not summed. Each record was counted once per applicable category. Countries and institutions in co-authored records may contribute to multiple affiliation counts. Definitions were applied at the institutional-affiliation level, not the nationality of authors.

Statistical analysis

Descriptive counts, percentages and annual publication trends were calculated in MATLAB (MathWorks, Natick, MA, USA). Geographic and institutional distributions were visualized using frequency plots. The denominators for reported percentages were defined explicitly, and no hypothesis

testing was undertaken. Because 2026 records were retrieved on 15 October, the 2026 annual total was treated as incomplete.

Results

The search identified 10,854 Scopus-indexed records: 8,010 original articles (73.8%), 1,659 reviews (15.3%) and 1,185 conference papers (10.9%). Of these, 224 (2.06%) had at least one African institutional affiliation, and 74 (0.68% of records; 33.0% of Africa-affiliated records) had exclusively African affiliations. Twenty-five records (0.23% globally; 11.2% of Africa-affiliated records) had at least one Nigerian affiliation, including 14 original articles, 10 reviews and one conference paper. Four of these 25 records (16.0%) had exclusively Nigerian affiliations; the remaining 21 (84.0%) involved at least one non-Nigerian affiliation. Five records included both Nigerian and other African affiliations. Country and institutional totals require confirmation against the exported affiliation-level dataset (Table 2).

Global annual publication output increased from 269 records in 2018 to 2,162 in 2025; 2,086 records had been indexed for 2026 by the search date (Figure 1). China (n = 3,420) and the United States (n = 3,104) led the global country counts (Figure 2a). In the Africa-only country chart, Morocco (n = 21), Egypt (n = 17), and South Africa (n = 10) ranked highest; Nigeria was one of four countries with five records (Figure 2b). These Africa-only country counts must not be interpreted as the total Nigeria-affiliated output of 25.

The network of countries and institutions co-affiliated with Nigerian research is shown in Figure 3, while Nigerian institutions are shown in Figure 4. Among the 25 Nigeria-affiliated records, 21 (84.0%) involved institutions outside Nigeria. Network links may exceed the number of unique publications because a single publication can contain affiliations from several countries or institutions.

Table 2: Distribution of publications on AI in radiotherapy by document type and geographical affiliation

Geographical category	Articles	Reviews	Conference papers	Total	Countries	Institutions
Global	8,010	1,659	1,185	10,854	123	160
Africa–Global	138	55	31	224	89	160
Africa-Only	37	19	18	74	11	148
Nigeria–Africa	3	1	1	5	2	10
Nigeria–Global	14	10	1	25	33	160
Nigeria-Only	3	0	1	4	1	8

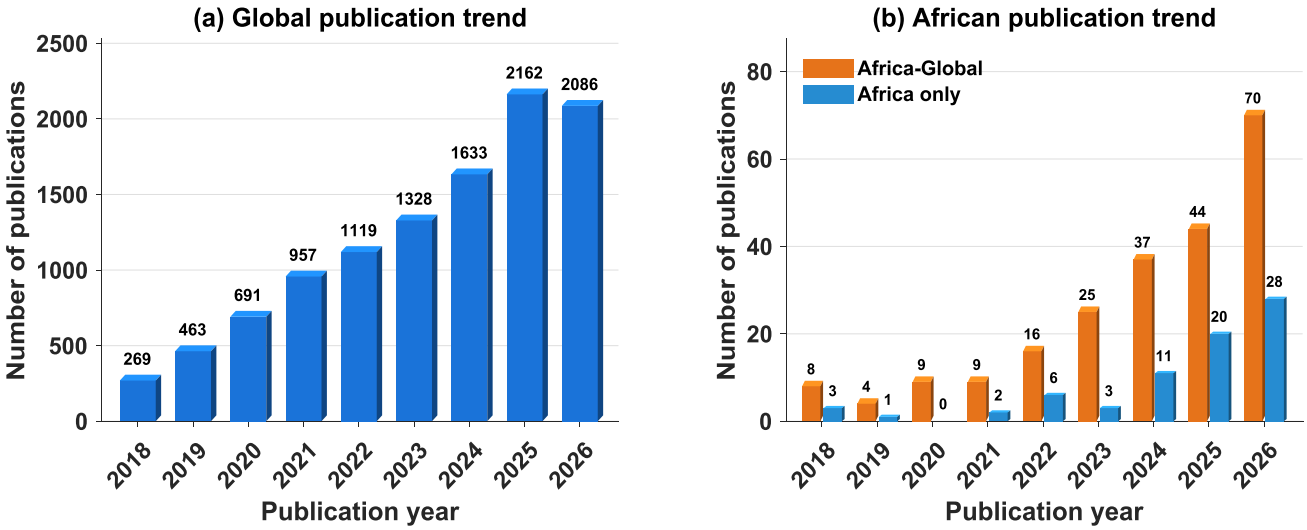


Fig. 1: The distribution of publication trends globally (a) and in Africa (b)

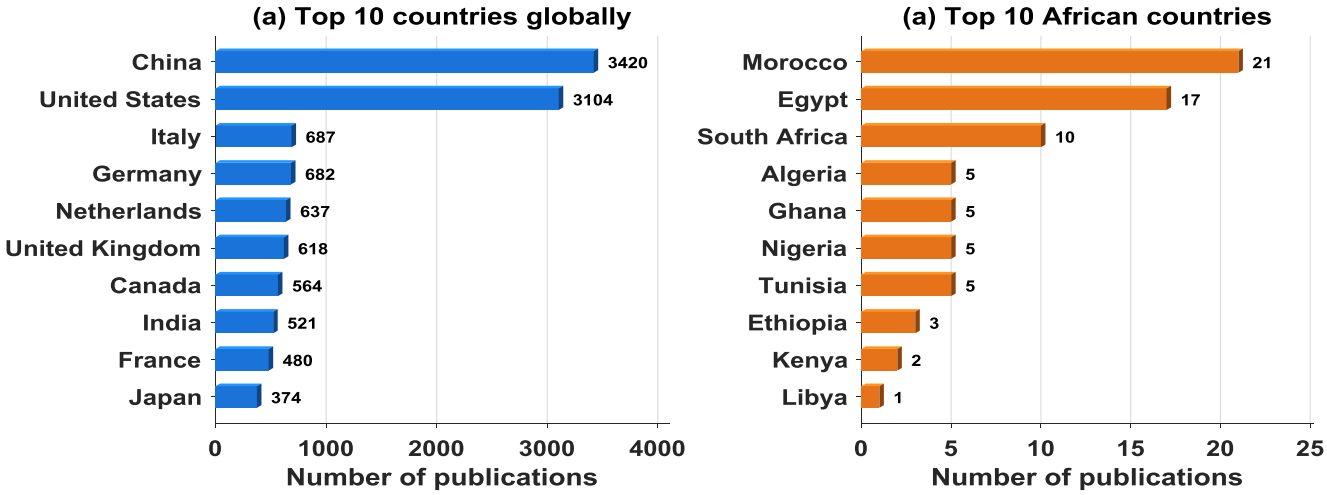


Fig. 2. Distribution of the top 10 countries contributing to AI research in radiotherapy globally (a) and within Africa (b).

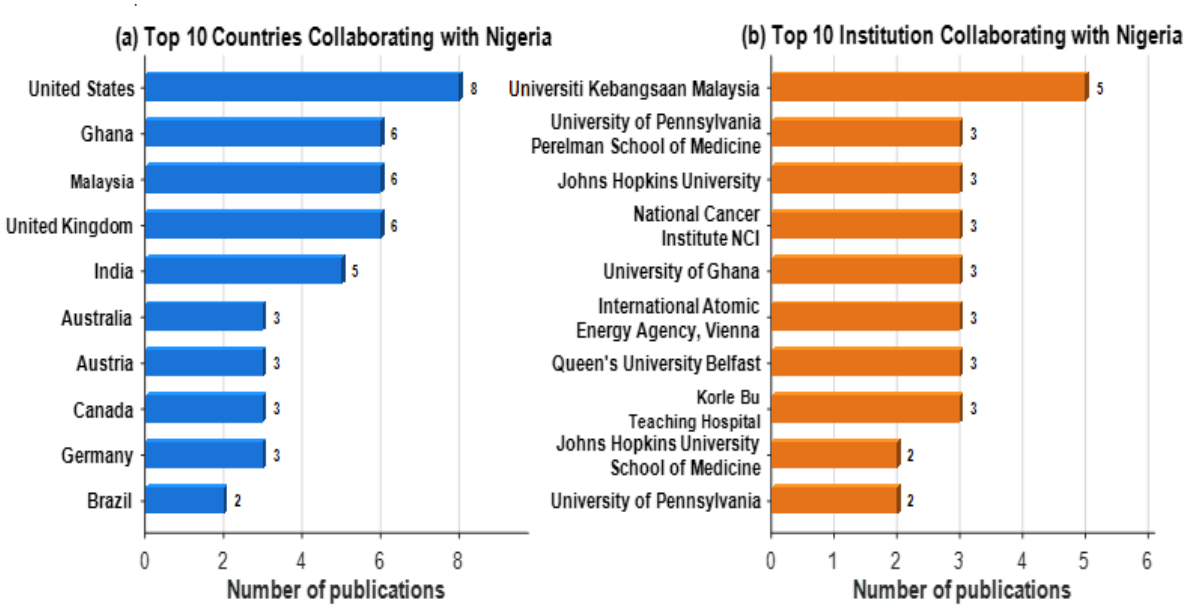


Fig. 3. Distribution of the top 10 countries (a) and institutions (b) collaborating with Nigeria on AI

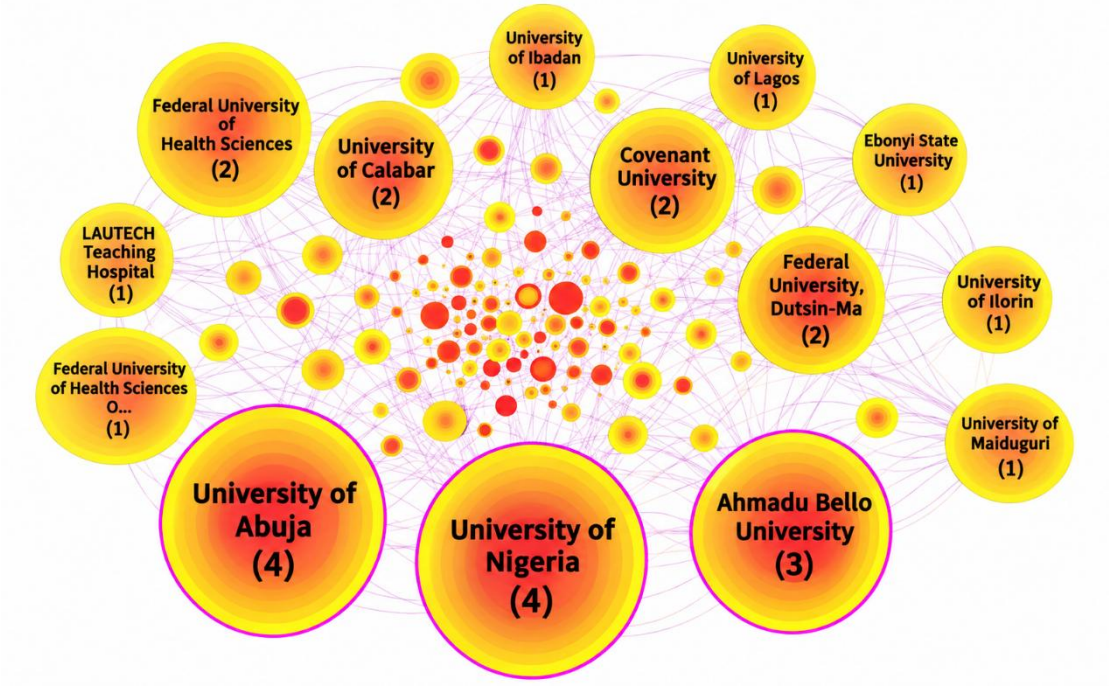


Fig. 4: Distribution of Nigerian institutions with AI in radiotherapy publications

Discussion

Principal findings and significance

This bibliometric analysis identified 10,854 Scopus-indexed publications on AI in radiotherapy, with growth from 269 records in 2018 to 2,162 in 2025. China and the United States dominated country-

level output, while Africa-affiliated publications represented 2.06% of global records. These results establish a marked geographical imbalance in indexed research activity, but they do not measure AI implementation, methodological quality or effects on patient outcomes [9,16–18]. The increase in publications broadly agrees with Lv et al. [9], who analysed 615 Web of Science publications from 2003 to 2023 and reported growth after 2017, with the United States and China as major contributors. Differences in database coverage, search, terminology, document types and observation periods prevent direct comparison of absolute counts. The 2,086 records retrieved for 2026 represent an incomplete year and should not be interpreted as evidence of a decline or increase relative to the full 2025 total.

Africa's contribution to global AI-radiotherapy research

Only 224 records (2.06% of the global set) had an African institutional affiliation, and 74 of these (33.0%) had exclusively African affiliations. These overlapping classifications distinguish participation in international research from output confined to African institutions. In the Africa-only country distribution, Morocco, Egypt, and South Africa recorded the largest counts, whereas Nigeria was among several countries tied at five records. Differences in publication output may be associated with research capacity, investment, and collaboration networks, but these explanatory factors were not directly assessed and cannot be inferred from publication counts alone.

The limited African representation must be interpreted alongside persistent inequities in access to radiotherapy. The IAEA and WHO reported in 2022 that‒radiotherapy was generally unavailable to populations in nearly 70% of African countries [19]. Such infrastructure limitations provide context for research prioritization, but this study did not test an association between equipment availability and AI publication output. AI-based segmentation, planning and quality-assurance tools may improve selected workflows; they cannot substitute for functioning treatment equipment, qualified personnel and reliable clinical systems [16–18].

A practical research agenda should prioritize reproducible, locally relevant use cases: structured extraction of radiotherapy data, auto-segmentation validation, treatment-planning support, treatment interruption analytics and outcome prediction. Multicentre datasets, standardized annotations, transparent reporting, external validation and monitoring after deployment are essential before clinical adoption. Joint ESTRO–AAPM guidance emphasizes appropriate development, reporting and clinical validation of AI models in radiotherapy [18]. These recommendations are priorities proposed from the present findings, not applications measured by the bibliometric analysis.

Nigeria's contribution and the role of international collaboration

Nigeria contributed 25 publications with at least one Nigerian institutional affiliation (0.23% of the global set and 11.2% of Africa-affiliated records). Only four records (16.0%) were affiliated exclusively with Nigerian institutions, whereas 21 (84.0%) included non-Nigerian institutions. Five involved other African countries. Importantly, the five Nigeria records in the Africa-only country figure refer to a different geographical subset from the 25 Nigeria-affiliated records. Affiliation-based participation should not be conflated with Nigerian authorship, first-author leadership, or domestic research capacity. International co-authorship may facilitate access to multidisciplinary expertise, computational methods, and geographically diverse datasets. Nevertheless, 84.0% international collaboration is a descriptive characteristic of the retrieved corpus, not evidence that Nigerian institutions cannot undertake independent research. Future assessments should measure first and corresponding authorship, funding, data stewardship, local model development, and sustained research programmes to determine whether participation translates into institutional research leadership.

Research priorities and opportunities for future investigation

Three priorities emerge. First, content analysis should classify clinical applications and AI techniques, rather than assuming that all retrieved papers address the same radiotherapy tasks. Second, affiliation networks should be complemented by authorship-position and funding analyses to describe Nigerian leadership. Third, clinical evidence reviews should assess external validation, reproducibility,

workflow impact and prospective benefit in African settings, consistent with implementation and quality-assurance recommendations [17,18].

Limitations of the study

The analysis is limited to records indexed in Scopus –and –captured by the selected keywords and document-type filters on 15 October 2026; publications outside scope were not assessed. The 2026 data represent a partial calendar year. Broad terms such as “radiomics” can retrieve studies with heterogeneous AI relevance, and false-positive or missed records may occur unless the search is manually screened. Multiple institutional affiliations can inflate aggregated country or institution frequencies relative to unique publication totals. Publication counts and citation metrics cannot establish technical quality, clinical validity, equitable leadership or real-world uptake. The original search export and country-classification rules should be audited before final numerical claims are submitted.

Conclusion

This bibliometric study demonstrates rapid growth and substantial geographical concentration of Scopus-indexed AI research in radiotherapy. Africa-affiliated studies constituted 2.06% of global records, while 84.0% of Nigeria-affiliated publications included international institutional partners. These findings support targeted efforts to strengthen locally led, multicentre research, standardized data resources and externally validated AI applications responsive to clinical needs.

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