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Critical Review

Radiation Therapy for Breast Cancer in Africa

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Purpose: Although radiation therapy is an effective treatment for breast cancer, it has a low rate of use in African countries. A systematic review was undertaken to investigate studies that used radiation therapy as a treatment modality for patients with breast cancer in Africa, focusing on survival outcomes, adverse effects, radiation therapy techniques, fractionation schedules, and effectiveness of radiation therapy.

Methods and Materials: We conducted a comprehensive literature search for studies that treated breast cancer with radiation therapy, using different electronic databases (PubMed, Scopus, and EBSCOhost) up to February 2023. The output was exported to a reference management system for analyses.

Results: The literature search primarily identified 3804 records from Scopus (2427), PubMed (982), and EBSCOhost (395). Based on the inclusion and exclusion criteria, 19 articles were finally included in this systematic review. Most of the studies published were conducted in North Africa (63%), followed by West Africa (21%) and Southeast Africa (16%). Most centers employed external beam radiation therapy to deliver radiation therapy to patients with breast cancer with the standard fractionation size of 50 Gy in 25 fractions. The long-term outcomes with regards to adverse effect suggests that radiation therapy was fairly tolerated among patients with breast cancer.

Conclusions: The reports provide substantial evidence that there are limited number of published studies on the use of radiation therapy for breast cancer treatment in Africa, as well as lower overall survival rate compared with developed countries. To improve breast cancer survivorship, it is necessary for government and other health care planners to provide more radiation therapy resources and implement training programs for personnels.

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Introduction

Breast cancer is the most common neoplasm and the leading cause of cancer death among women globally, with a reported greater rate of mortality in low- and middle-income countries (LMICs).[1,2] In Africa, breast cancer continues to be the most prevalent cancer, and it is the second cause of cancer death in women. According to GLOBOCAN 2018 reports, breast cancer accounted for 27.7% of the total cancer cases in African countries, and the burden of breast cancer is expected to increase by 40% in 2040.[3]

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Although Africa has the lowest breast cancer incidence rates (40.7 per 100,000) compared with countries such as Australia (95.5 per 100,000), North America (89.4 per 100,000), and Europe (69.7 per 100,000), the region reports the greatest mortality rate (19.8 per 100,000). Generally, breast cancer mortality rate is 17% greater in developing countries than developed countries as the result of factors such as lack of education on the causes and treatment of breast cancer, inaccessibility to health care facilities, limited health care resources, financial constraints regarding treatment, fear of breast cancer diagnosis, use of traditional medicines, and in most cases, delay in seeking medical attention.[2]

The treatment of breast cancer can be effective, especially when the disease is diagnosed early. Breast cancer prognosis and treatment depend on the type of breast cancer and tumor stage, using the American Joint Committee on Cancer staging system. For example, early-stage breast cancers (stage I and II) can be treated with a combination of breast-conserving surgery and radiation therapy, whereas locally advanced breast cancer (stage III) is treated with chemotherapy followed by either surgery or radiation therapy or both. Patients with stage IV breast cancer (metastatic breast cancer) are treated predominantly with anticancer medicines such as chemotherapy or hormone therapy alongside radiation therapy, to control the spread of tumor.[4]

In Africa nearly 53% of all women with breast cancer are diagnosed with advanced stages,[5] most are treated by surgical removal combined with hormone therapy or chemotherapy, whereas few receive palliative treatment such as radiation therapy because the tumor is at an advanced stage and inoperable.[6] A study on breast cancer treatment in Sub-Saharan African countries reported that 60% of patients underwent surgery only, 52% received radiation therapy after surgery, and 19% received chemotherapy.[7] The proportion of patients with breast cancer who receive different forms of treatment vary across the continent based on the stage at diagnosis, availability of resources, age at presentation, and the cost involved in treatment.[8]

Radiation therapy is one of the most effective approaches for cancer treatment. with more than one-half of patients requiring radiation therapy during their disease course.[9] However, numerous research conducted over the past 20 years has demonstrated the scarcity of radiation oncology resources in LMICs, including Africa. A recent study on the assessment of radiation therapy resource capacity reported a cumulative shortage of 188 megavoltage machines, 85 brachytherapy afterloaders, and 3363 trained radiation therapy personnels in developing countries.[10] In a previous systematic review on radiation therapy availability in LMICs, Grover et al[11] found that Africa has the fewest radiation therapy resources worldwide. With the increase in cancer incidence in Africa, the lack of radio-oncological health care resources exacerbates the burden of this disease and accentuates a growing public health challenge in the continent. For example, the number of patients with breast cancer in Africa has been projected to increase from 168,690 in 2018 to more than 364,000 cases in 2040.[3,12] Unfortunately, many countries in Africa possess very limited capacity to deal with this disease because of the lack of access to radiation therapy services as a part of comprehensive breast cancer management.[13] Data from the International Atomic Energy Agency indicated that as of March 2020, 28 and 21 of 54 African countries have access to external beam radiation therapy and brachytherapy, respectively. Nonetheless, no African country has sufficient radiation therapy resources that meets the treatment requirement with regards to the increasing cancer incidence in the continent.[14] Radiation therapy resources comprising linear accelerators (linacs), brachytherapy equipment, orthovoltage units, computed tomography simulators, computed tomography scanners, and trained radiation oncology personnel are severely inadequate in Africa.[10]

Previous studies in Western countries suggest that radiation therapy may prolong overall survival as well as achieve local control of the disease.[15] The basis of radiation therapy is the use of ionizing radiation to destroy malignant tumor cells while minimizing damage to normal cells.[16] Radiation therapy plays a vital role in the treatment of breast cancer from the early stages to locally advanced stages and most commonly to alleviate the symptoms associated with metastatic breast cancer.[17] In addition, it is effective in reducing mortality and the risk of recurrence in patients with breast cancer after breast-conserving surgery.[4]

To our knowledge, no systematic review has been conducted to summarize the use of radiation therapy as a treatment modality for breast cancer patients in Africa. An investigation of the use of radiation therapy for breast cancer treatment is imperative, as it could provide a means of increasing survival and quality of life of patients while also providing both physician and patient with real-world data for effective medical decision-making.

This review provides an up-to-date and accurate documentation on radiation therapy for invasive and noninvasive breast cancer treatment in Africa as a whole. Our goals are to (1) identify studies that used radiation therapy as a treatment modality for patients with breast cancer in Africa; (2) assess long-term outcomes such as overall survival and adverse effects associated with radiation therapy for African breast cancer patients; and (3) identify various radiation therapy techniques used for treating breast cancer in Africa.

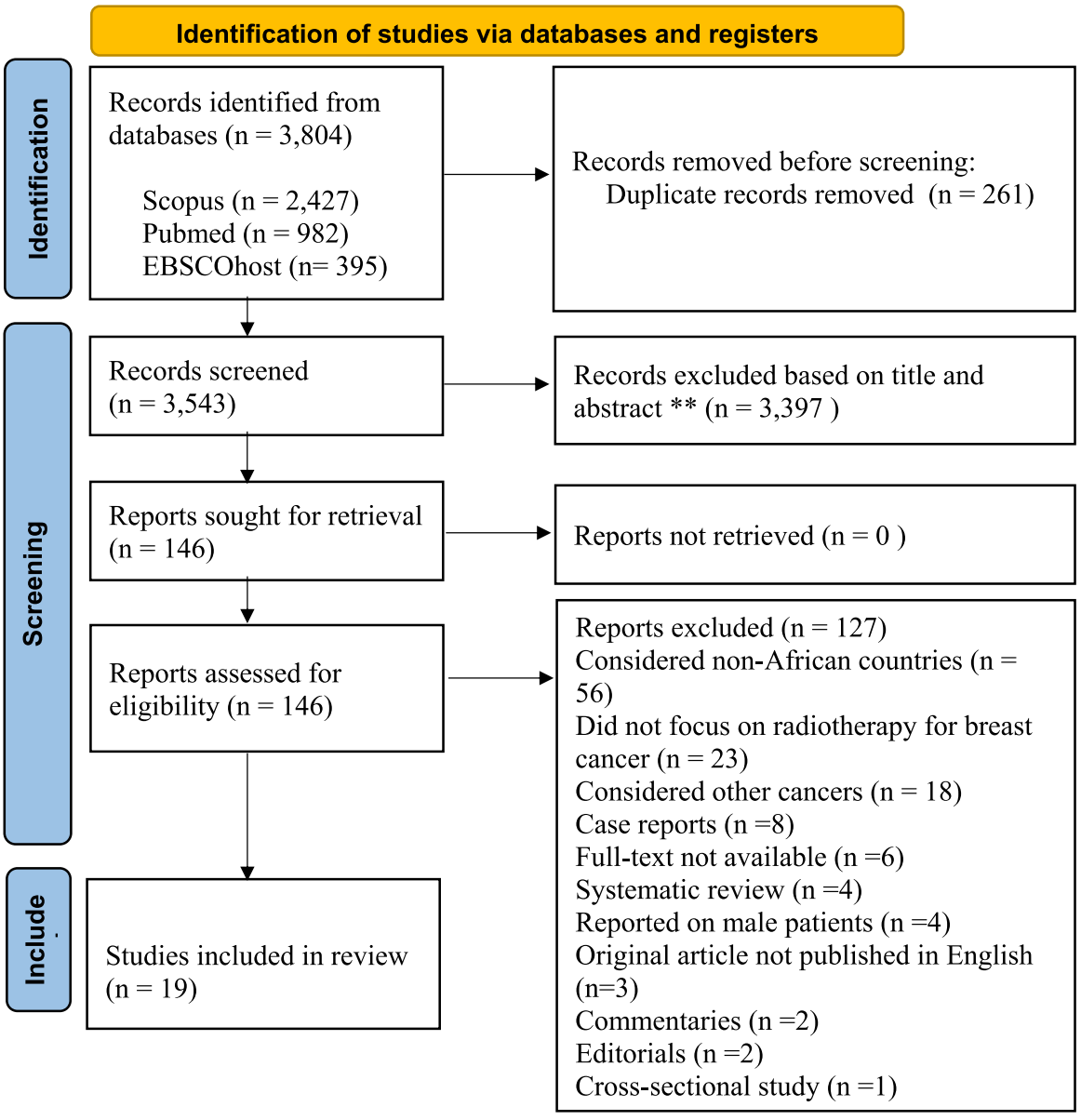

Figure 1 A Preferred Reporting Items for Systematic Reviews and Meta-Analysis diagram showing the studies evaluation process and studies selected for the systematic review. **Upon review of the titles and abstracts of the remaining articles, 3397 articles were found not to have met the scope of study and were excluded from further consideration.

Methods and Materials

Data sources and study selection

This review was conducted in accordance with the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (Fig. 1).[18] A systematic literature search for published articles was conducted via the PubMed, Scopus, and EBSCOhost databases on February 22, 2023. In performing the articles search and retrieval, no date restrictions were applied. Additional hand-searching was made using the search engines Google and Microsoft Bing as well as reference lists of identified relevant studies. Full details of the search terms used for each database are found in the supplementary text.

Inclusion and exclusion criteria

The inclusion criteria for the review included studies:

i. That reported on whole-breast radiation therapy and surgery alone or in combination, with or without systemic therapy;

ii. That reported on radiation therapy−related outcomes, including survival and quality of life in patients with breast cancer;
iii. That were published in the English language;
iv. That were conducted in an African country;
v. In which participants were women of any age with diagnosis of any stage of breast cancer; and
vi. That were randomized controlled trials or cohort study designs.

The exclusion criteria were studies:

i. That reported on other types of cancers;
ii. In which participants included men of any age with diagnosis of any stage of breast cancer;
iii. That were conducted in countries other than African countries;
iv. That were published in languages other than English;
v. That were published as review articles, commentaries, letters to editors, conference proceedings, editorial reports, and case reports; and
vi. That were performed in nonhuman subjects (ie, animal studies).

Quality assessment

Two reviewers independently screened articles obtained from PubMed, Scopus, and EBSCOhost, which were imported into a reference management system (EndNote). Duplicate records were removed. Based on the title and abstract, articles that did not study concurrently breast cancer, radiation therapy, and Africa were removed as irrelevant studies. Studies that met the aforementioned inclusion criteria were selected to be included in the review. A full-text evaluation was conducted among the remaining articles and results obtained from the 2 reviewers were compared. In instances in which there was a lack of agreement, a consensus was reached by further discussion between both reviewers.

Data extraction and synthesis

We used a data-extraction form to collect information from each eligible article obtained by the 2 reviewers. Categories of information included (1) first author and year of publication; (2) country of study; (3) age at diagnosis; (4) sample size; (5) reported stage of breast cancer; (6) study design; and (7) outcomes of interest. The primary outcome of this systematic review is overall survival of patients with breast cancer. Secondary outcomes such as local tumor control, efficacy of treatment, effect on quality of life, and adverse effects are assessed. Data for secondary outcomes are essential to patients and caregivers to guide physicians and policymakers. With respect to the study design, we included randomized controlled trials as well as cohort studies for the evaluation of safety and effectiveness of the treatment.

Results

The literature search primarily identified 3804 records from the databases: Scopus (2427), PubMed (982), and EBSCOhost (395). No article was found by hand-searching using 2 search engines (Google and Microsoft Bing) or from the reference list of identified relevant studies. After the removal of 261 duplicate records, a total of 3543 records were obtained. Upon review of the titles and abstracts of the remaining articles, 3397 articles were found not to be relevant or within the scope of study and were excluded from further consideration. A total of 146 records were assessed for eligibility based on the inclusion and exclusion criteria, and 19 articles were finally included in this systematic review.

Characteristics of included studies

This study included 3 randomized controlled trials,[19-21] 15 retrospective studies,[22-36] and 1 prospective study.[37] No case-control studies using radiation therapy within the period assessed in Africa was identified. In total, the 19 included studies recruited 4100 female patients with breast cancer with sample size ranging from 15 to 434 participants per study. Studies identified were conducted in 6 different African countries, 9 studies were conducted in Egypt, 3 from Nigeria, 3 from Zimbabwe, 2 from Morocco, 1 from Tunisia, and 1 from Ghana. The participants' age ranged from 22 to 95 years, and the average age was 51.1 years (Table 1). Two studies defined neither age range nor mean age.[25,32] Most patients (76.8%) were diagnosed of stage I-III breast cancer and had undergone various forms of surgery before radiation therapy treatment. Radiation therapy was delivered to the chest wall or whole breast for the patients with early-stage breast cancer after breast-conserving surgery and patients with advanced breast cancer were administered radiation therapy in the lymph node region after modified radical mastectomy. None of the patients underwent breast-reconstruction surgery. For all studies except 2, patients received systemic therapies in the form of chemotherapy or hormonal therapy or both, in combination with radiation therapy. Regarding the follow-up time, most studies reported their outcomes in 2, 5, and 7 years.

Based on the eligible studies selected for this review, most of the studies published were conducted in North Africa (63%), followed by West Africa (21%) and South-East Africa (16%) (Fig. 2). We identified 15 different radiation therapy centers across the 6 countries included in

Table 1 Summary of studies with information on authors, country of study, year of publication, Participants' age range/median, study design, breast cancer stage and follow-up period

Study	Country	Year	Sample size	Age range/median, y	Study design	Stage	Follow-up period
Bayoumi et al[19]	Egypt	2014	111	28-81/63.7	Randomized controlled trial	I-III	64 mo
Morsy et al[20]	Egypt	2021	15	34-65/NA	Randomized controlled trial	NA	NA
Mourali et al[21]	Tunisia	1982	112	25-66/45	Randomized controlled trial	III-IV	75 mo
Ismaili et al[22]	Morocco	2010	400	22-95/45	Retrospective study	I-IV	75 mo
Elmore et al[23]	Zimbabwe	2021	351	NA/51	Retrospective study	I-IV	24 mo
El-Sayed et al[24]	Egypt	2012	343	30-69/47	Retrospective study	II-III	48 mo
Ismaili et al[25]	Morocco	2009	244	NA	Retrospective study	I-III	60 mo
El Sharkawi et al[26]	Egypt	1997	272	25-70/44.4	Retrospective study	I-II	15 mo
Abouegylah et al[27]	Egypt	2022	181	NA/51	Retrospective study	I-III	45 mo
Adeneye et al[28]	Nigeria	2021	20	>18/NA	Retrospective study	I-II	NA
Eldeeb et al[29]	Egypt	2012	107	25-67/52.5	Retrospective study	I-III	84 mo
Sekyere et al[30]	Ghana	2019	313	22-95/50.6	Retrospective study	I-IV	25.4 mo
Sayed et al[31]	Egypt	2020	434	NA	Retrospective study	I	60 mo
Mushonga et al[32]	Zimbabwe	2021	351	NA	Retrospective study	I-IV	NA
Makanjuola et al[33]	Nigeria	2014	224	23-85/55	Retrospective study	I-IV	60 mo
Abbas et al[34]	Egypt	2011	267	≥35/49.5	Retrospective study	I-III	30 mo
Aliyu and Kehinde et al[35]	Nigeria	2020	83	60-80/66	Retrospective study	II-III	24 mo
Chipidza et al[36]	Zimbabwe	2021	177	>18/NA	Retrospective study	I-II	11.8 mo
Osman et al[37]	Egypt	2014	75	22-95/52.4	Prospective study	II	54 mo

Abbreviation: NA = not available.

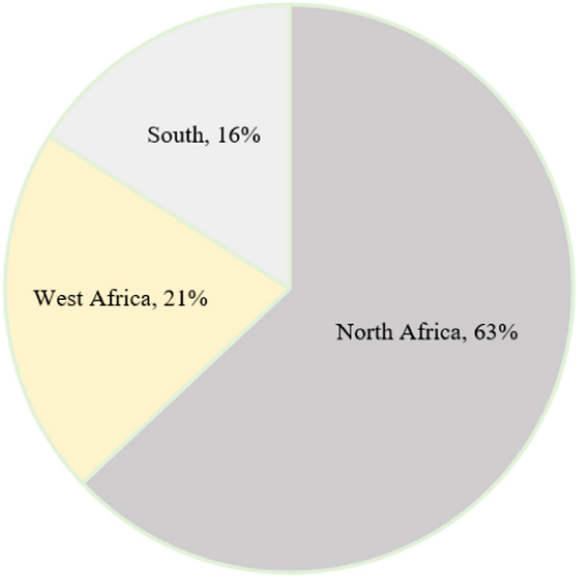

Figure 2 A graphical representation of the distribution of radiation therapy centers in parts of Africa. North Africa with 63%, West Africa with 21%, and Southeast Africa with 16% radiation therapy centers.

this review. Of the 4100 patients with breast cancer, 71% received radiation therapy. Considering the type of radiation therapy machine, 4 studies employed Cobalt-60 teletherapy machine, 4 studies used medical linacs, and the remaining 11 studies provided no information on the type of radiation therapy machine used. Four studies reported a relatively low use of radiation therapy, which was attributed to the prohibitive cost of treatment and limited capacity of radiation therapy machines.[32,33,35,36] Chipidza et al[36] reported that 84% of participants did not have health insurance coverage, which contributed to low use of radiation therapy. In terms of accessibility of radiation therapy, 3 studies[23,32,36] reported on centralization of radiation therapy facilities in capital cities; hence, patients living in remote areas face challenges accessing radiation therapy.

Radiation therapy techniques

Most studies employed an external beam radiation therapy (EBRT) technique to deliver radiation therapy to patients with breast cancer. Considering EBRT technique,

Table 2 Radiation therapy (RT) techniques, fractionation schedules, and radiation therapy boost administered to patients with breast cancer in each study

Study	RT technique(s)	RT schedule	Boost	Evaluation criteria	Adverse outcome
Bayoumi et al[19]	3D-CRT, IMRT	50 Gy	Yes	NA	NA
Morsy et al[20]	3D-CRT and IMRT	50 Gy	No	RTOG	Grade 2 skin toxicity
Mourali et al[21]	N/A	45 Gy	Yes	NA	NA
Ismaili et al[22]	2D	50 Gy	Yes	NA	Hematologic toxicities
Elmore et al[23]	3D, 2D-planning	50 Gy	No	NA	NA
El-Sayed et al[24]	3D or 2D planning	50 Gy, 42.5 Gy, 39 Gy	Yes	RTOG	Skin toxicities and pneumonitis
Ismaili et al[25]	EBRT with 2D planning	50 Gy	Yes	NA	Neutropenia, thrombopenia
El Sharkawi et al[26]	NA	45 Gy	No	NA	Physical toxicities such as fatigue, vomiting, headache, dizziness, anorexia, diarrhea, nausea
Abouegylah et al[27]	3D-CRT, 2D	50 Gy, 40 Gy	Yes	RTOG	Lymphoedema
Adeneye et al[28]	3D-CRT and IMRT	42 Gy and 45 Gy	No	NA	NA
Eldeeb et al[29]	3D, 2D planning	50 Gy, 45 Gy, 40 Gy	No	RTOG	Skin erythema, fibrosis, pain, telangiectasia, arm edema, cellulitis
Sekyere et al[30]	N/A	48-13512 cGray	No	NA	Lymphoedema
Sayed et al[31]	EBRT	50 Gy, 42.5 Gy	Yes	NA	NA
Mushonga et al[32]	EBRT with 3D	30 Gy, 20 Gy, 8 Gy	No	NA	NA
Makanjuola et al[33]	2D	45 Gy, 30 Gy	Yes	NA	NA
Abbas et al[34]	3D and 2D planning	50 Gy	Yes	CTC	Moderate pulmonary toxicity, grade 2 skin toxicity
Aliyu and Kehinde et al[35]	3D or IMRT	50 Gy, 45 Gy	No	CTC	Skin erythema, nausea, vomiting
Chipidza et al[36]	EBRT with 3D	50 Gy, 45 Gy	No	NA	NA
Osman et al[37]	3D-CRT	50 Gy	No	CTC, v.2.0	Lymphedema grade I and II

Abbreviations: 2D = 2-dimensional; 3D = 3-dimensional; 3D-CRT = 3-dimensional conformal radiation therapy; CTC = Common Toxicity Criteria; EBRT = external beam radiation therapy; IMRT = intensity modulated radiation therapy; NA = not available; RTOG = Radiation Therapy Oncology Group.

12 centers used 3-dimensional conformal radiation therapy, 9 used 2-dimensional planning, and 4 used intensity modulated radiation therapy. In 9 studies, a subsequent dose of radiation was delivered to specific areas of the body after the initial course of radiation therapy was completed (Table 2). Many of the studies (47.4%) employed more than 1 radiation therapy technique, and 36.8% used 1 radiation therapy technique only. Approximately, 15.8% of the studies provided no information on the technique used.[21,26,30] The fractionation scheme of radiation therapy administered to participants in all studies was either conventional fractionation or hypofractionation. Of 71% patients with breast cancer who were administered radiation therapy, 57.6% received conventional radiation therapy and 17.8% received a hypofractionated schedule. The remaining 24.6% had no information concerning the radiation therapy schedule received. The dose given to patients in the case of conventional radiation therapy was a total of 50 Gy in 25 fractions over 5 weeks. For hypofractionation, patients were given a total dose ranging from 30 to 45 Gy, in 10 to 18 fractions over 3 weeks. The hypofractionation schedule of 30 Gy in 10 fractions was administered with a palliative intent, whereas 42 Gy in 15 and 45 Gy in 18 fractions were administered with a curative intent. Of the 17.8% who received hypofractionation schedule, 5.8% were administered palliative radiation therapy and 94.2% received curative radiation therapy. The most common fractionation schedule used in majority of the studies was 50 Gy in 25 fractions.

Effect of radiation therapy on survival outcomes

More than one half of the studies (52.6%) provided data on survival benefits of radiation therapy treatment, measured in terms of overall survival (OS), progression-free survival (PFS), and disease-free survival (DFS). OS was calculated from the date of histologic diagnosis or initiation of treatment to the date of death from any cause or to the last follow-up date. In the study of Bayoumi et al,[19] there was a significant difference in the 5-year OS rate of patients who received radiation therapy after surgery (65%) and those that received no radiation therapy (51%). Sayed et al[31] reported a 5-year OS rate of 98.2%, hence a better outcome of patients treated with surgery and radiation therapy than surgery alone. Furthermore, Makanjuola et al[33] demonstrated that patients who received radiation therapy in combination with surgery and systemic therapy had a greater chance of survival compared with those that were treated with surgery and chemotherapy alone. Two studies compared the OS rate of patients with breast cancer treated with conventional radiation therapy and hypofractionated radiation therapy at 2 and 4 years.[24,29] The study of El-Sayed and Abdel-Wanis[24] reported survival rates in terms of DFS of 85.6% for patients treated with hypofractionation schedule and 81% for patients treated with conventional radiation therapy. However, Eldeeb et al[29] reported no significant difference in OS of patients treated with hypofractionated and conventional radiation therapy. In 2 studies, the OS rate was greater than 80% at 5 years, and there was no statistical difference between the 2 groups that were treated concurrently with radiation therapy and systemic therapy.[22,25] One study reported no significant difference in OS regardless of the sequence to which radiation therapy was administered.[35] Considering DFS, 3 studies recorded significant differences in rates of 96.4%, 91.9%, and 83.4% at 2, 5, and 4 years, respectively.[24,31,35] Also, 3 studies reported no significant difference in DFS between patients treated with different schedules or sequences of radiation therapy.[25,29,34] The remaining 13 studies had no information on the DFS of patients treated with radiation therapy.[19-23,26-28,30,32,33,36,37] DFS was measured from the date of enrollment of patients to the date of first event (relapse, progression, or death from any cause) or to the last follow-up date. Based on the study of Osman et al,[37] PFS was calculated from the date of randomization of treatment to relapse, recurrence, or the last follow-up date. They reported that PFS rate at 4 years was 72.5% in patients treated with radiation therapy and 60% in those who received no radiation therapy, hence a 12.5% improvement in PFS. OS, DFS, and PFS were analyzed statistically according to the Kaplan-Meier method. One study estimated the DFS and OS using GraphPad prism program.[24]

Effect of radiation therapy on local recurrence

The rate of local recurrences was calculated from the date of surgery followed by radiation therapy to the date of first relapse or last follow-up date. Data on 2, 4, and 5 years' local recurrences of breast cancer after radiation therapy treatment were extracted from 9 studies.[19,22,24,25,29,34-37] Six of the 9 studies reported on a significant reduction of relapse rate ranging from 5% to 12.5% for patients treated with radiation therapy compared with those who received no radiation therapy.[19,25,34-37] For participants in these 6 studies, the incidence of locoregional recurrence-free survival was reportedly improved, ranging from 88% to 95%. Two studies compared the rate of recurrence of breast cancer in patients who were administered various regimens of radiation therapy[24,29] and reported no significant difference in the local recurrence rate for patients who were given either the conventional or hypofractionated radiation therapy schedule.

Adverse effects

In the present review, we identified various possible adverse effects associated with the use of radiation therapy for breast cancer (Table 2). These adverse effects are grouped into 2 categories, early toxicity and late toxicity. Early toxicity referred to toxicities developed within the first 8 weeks after radiation therapy treatment, and late toxicity was defined as those developed after 8 weeks of treatment completion. Radiation therapy treatment toxicities were assessed based on different grading scales such as Radiation Therapy Oncology Group criteria and Common Toxicity Criteria, version 2.0. We included both hematologic and nonhematologic toxicities such as cardiotoxicity, dermatitis toxicity, and pulmonary toxicity. No study reported cardiac toxicity as an adverse effect. Lymphoedema-related breast cancer was recorded by 3 studies.[27,30,37] Five studies are reported skin toxicities ranging from grade 2 to 4.[20,24,29,34,35] Other studies reported adverse outcomes such as fibrosis, hematologic toxicities, neutropenia, telangiectasia, arm edema, and cellulitis.[25,29] Overall, organs most at risk included the heart, lungs, and skin. Eight studies did not report outcomes of toxicity.[19,21,23,28,31-33,36]

Discussion

We present the results of a comprehensive literature review on the use of radiation therapy as a treatment modality for patients in Africa with breast cancer, taking into consideration radiation therapy techniques and

dosage, survival outcomes, effect on quality of life of patients, and efficacy in treating breast cancer after surgery.

The results of our systematic review showed that 19 breast cancer radiation research studies within the Africa population have been carried out as of February 2023. Considering the substantial increase in breast cancer cases in Africa,[4] the overall count of studies appears to be underwhelming in the continent. Interestingly, most of the studies were performed in North Africa, whereas the southeastern part of the continent had only 3 studies. This observation could be attributed to the scarcity and disparity in the distribution of radiation therapy resources across Africa, with only 23% of the continent having access to radiation services.[14,38] According to a recent report by the International Atomic Energy Agency, most of the radiation therapy facilities are concentrated in North Africa, especially Egypt, whereas other Sub-Saharan countries have very few facilities.[14] It is possible that the unequal distribution of radiation therapy facilities may reflect the increased level of investment and research in breast cancer radiation in North Africa compared with other Sub-Saharan African countries.

The OS rates at 5 years ranged from 65% to 98.2%, which is relatively lower compared with the United States, where OS rates ranged from 86% to 99%. Factors that contribute to this low survival include interruptions during treatment, advanced-stage presentations, patients being lost to follow-up, old age, and prolonged waiting times.[39,40] Our findings correlate with the study on 5-year-survival of patients with breast cancer at Radiation and Isotopes Centre, Khartoum, which reported lower survival rates among Sudanese patients with breast cancer compared with developed countries.[40] The survival rate of patients who were administered chemotherapy while awaiting radiation therapy availability was comparable with those who received chemoradiation concurrently. Our reports contradict previous studies indicating an increased local recurrence rate with an overall decrease in survival of patients who had delayed irradiation to the breast.[41,42] Data on survival rates are difficult to obtain because of loss to follow-up and monitoring of patients with breast cancer over time. The few existing radiation therapy centers are often located in capital cities or big cities, and frequent radiation therapy visits may pose substantial economy burden on patients of low socioeconomic status, leading to their discontinuation of seeking medical attention. Some patients may not continue participating or adhere to the recommended follow-up appointments, making it difficult to gather comprehensive and reliable data on their long-term outcomes. One possible way to ensure proper documentation of patients who undergo radiation therapy is to establish well-defined protocols for follow-up data collection, which includes up-to-date contact information, flexible time frames for follow-up, and provision of incentives.

We recorded an increase in the use of an EBRT technique for breast cancer treatment. The number of 3D conformal radiation therapy techniques used outweighed the number of 2D planning techniques. The 2-dimensional planning technique developed in the 1950s, which employs cobalt-60 as a radiation source,[43] are relatively easier to operate and requires less power.[44] However, this has been replaced by the newer technologies such as 3-dimensional conformal radiation therapy and intensity modulated radiation therapy, which typically use medical linacs as radiation source. These modern radiation therapy techniques are known to deliver an effective dose of radiation to the tumor cells while reducing the amount of radiation exposure to healthy cells around the tumor. This implies an improved quality of life as well as improved survival outcomes.[13] It therefore follows that increased usage of advanced technologies will go a long way toward improving radiation therapy delivery.

Our reported findings depict a high use of conventional schedules, which accounted for 57.6% of all radiation therapy treatments whereas hypofractionation recorded 17.8% usage. This observation could be attributed to the availability of older treatment machines, such as cobalt 60 machines, that are better suited for conventional fractionation in LMICs.[43] Although these machines are affordable and offer ease of treatment delivery and maintenance, the treatment times for conventional schedules are substantially longer.[44] Considering the limited number of radiation therapy machines and facilities in Africa as a whole, treatment techniques that underscore both cost and resource efficiency may be practical for enhancing treatment access and preventing cancer mortality in the region. Hypofractionated radiation therapy is a modern treatment strategy that offers such advantage of both cost- and resource-efficient care to Africa. Unlike conventional radiation therapy, fewer fractions of radiation therapy are administered at larger doses in hypofractionation. This technique does not only reduce the number of visits to the radiation therapy center but also reduce financial cost of treatment and the demand on medical resources as well as enabling clinics to treat more patients in less time.[45-47] Consequently, a wider adoption of hypofractionation for breast cancer in Africa will significantly increase access to life-saving therapies. Ideally, the fraction size of 3 Gy for hypofractionation regimen is considered safe and effective.[48]

Adverse outcomes documented in the current review include blood and skin toxicities, fibrosis, cellulitis, pneumonitis, lymphoedema, arm edema, telangiectasia, and some physical toxicity. A greater proportion of the studies reported different levels of skin toxicities ranging from grade I to II. Possible reasons for this may include an increased dose of hypofractionation regimen, smoking habit of patients, radiation boost, diabetes, body mass index, breast volume, radiation therapy technique, and

genetic factors.[49] We recorded no incidence of cardiac toxicities, which indicates that all radiation therapy doses studied were fairly tolerated. Interestingly, there was no significant difference in the occurrence of early or late toxicities between hypofractionated and conventional radiation therapy groups. This suggests that an increased adoption of hypofractionated schedules is necessary in Africa, as it reduces the length of hospital stay and is relatively safer compared with conventional radiation therapy schedule.

Although the current study provides valuable insights into studies that used radiation therapy for breast cancer treatment in Africa, it is essential to recognize certain limitations. There is an absence of reported percentages of adverse effects in each study. This omission is due to the inherent heterogeneity among the included studies, making it challenging to provide a uniform summary of adverse effects percentages. Despite this limitation, findings presented in this study contribute significantly to the existing literature and provide a foundation for future research.

Conclusion

The current systematic review explored the use of radiation therapy as a treatment option for female patients with breast cancer in Africa. Radiation therapy remains an essential treatment for breast cancer, but the limited number of studies documenting the use of radiation therapy for breast cancer treatment in Africa is a major cause for concern. Radiation dose of 50 Gy in 25 fractions may be inconvenient for patients especially in Africa, and the survival rate of patients with breast cancer is relatively lower compared with developed countries. In view of all considerations, radiation therapy can be a cost-effective treatment for breast cancer if it is adequately planned and used effectively.

Disclosures

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.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.adro.2024.101488.

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