Available online at *www.ujpronline.com*
Universal Journal of Pharmaceutical Research
An International Peer Reviewed Journal
ISSN: 2831-5235 (Print); 2456-8058 (Electronic)

REVIEW ARTICLE

BREAST CANCER AND FERTILITY: WHO FRAMEWORK FOR REPRODUCTIVE COUNSELING IN YOUNG AFRICAN PATIENTS

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Article Info:

Article History:
Received: 3 February 2026
Reviewed: 12 March 2026
Accepted: 13 April 2026
Published: 15 May 2026

Cite this article:
Obeagu EI, Leshoele MA. Breast cancer and fertility: WHO framework for reproductive counseling in young African patients. Universal Journal of Pharmaceutical Research 2026; 11(2): 105-111.
http://doi.org/10.22270/ujpr.v11i2.1540

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Abstract

Breast cancer is becoming more acknowledged as a major health issue for young women in Africa, where it is frequently identified at more advanced stages and at a younger age than the worldwide averages. The convergence of breast cancer and fertility creates distinct clinical and psychosocial difficulties, as numerous patients are in their childbearing years and confront the dual pressure of a life-threatening illness and the possible loss of fertility from treatment. Thus, tackling fertility preservation is an essential aspect of holistic cancer treatment for young African women. The World Health Organization (WHO) created a framework to incorporate reproductive counseling into cancer treatment, highlighting early assessment of fertility risks, education for patients, culturally appropriate counseling, and availability of fertility preservation services. Nonetheless, the execution in African contexts is still restricted because of resource limitations, absence of specialized services, socio-cultural obstacles, and inadequate awareness among providers. These difficulties emphasize the necessity for customized approaches that take into account the local health system and cultural environment.

Keywords: Breast cancer, fertility preservation, reproductive counseling, WHO guidelines.

INTRODUCTION

Breast cancer continues to be the most prevalent cancer impacting women globally, with increasing rates in low- and middle-income countries, including numerous African countries[1,2]. In contrast to high-income areas, where breast cancer mainly impacts postmenopausal women, a significant number of breast cancer patients in Africa are diagnosed at younger ages, frequently before 40 years old. This younger group encounters unique clinical issues, especially related to their reproductive health and potential fertility, which are often neglected in cancer treatment guidelines[3,4]. The identification of breast cancer in a woman's reproductive years can greatly alter her life path, impacting not only her survival but also her capacity to conceive and have children later on. Fertility issues are particularly meaningful in African cultures where being a mother carries deep social and family importance. The possible decline in fertility from gonadotoxic cancer treatments like chemotherapy, radiation, and hormonal therapies brings forth significant psychosocial concerns, affecting treatment choices and quality of life results[5,6].

Even with improvements in cancer care, fertility preservation continues to be a neglected concern in numerous African healthcare environments. Restricted availability of fertility preservation options, lack of proper patient guidance, and poor collaboration between oncology and reproductive health services lead to less than ideal care for young breast cancer patients. The lack of structured guidelines designed for African contexts makes it even more difficult to assist patients in making informed reproductive decisions while undergoing cancer treatment[7-9]. Acknowledging these difficulties, the World Health Organization (WHO) has created an extensive framework to enhance reproductive counseling in cancer treatment, highlig-hting a multidisciplinary approach that honors cultural sensitivities and prioritizes patient autonomy[10-12]. This framework is designed to assist healthcare professionals in identifying fertility risks at an early stage, providing information on possible reproductive choices, and enabling access to fertility preservation strategies when possible. Applying this model in Africa may close

current gaps and enhance comprehensive care for young breast cancer survivors.

The epidemiology of breast cancer in Africa, marked by late-stage diagnosis and aggressive tumor biology, highlights the necessity of incorporating fertility counseling into clinical practice. Numerous young women contend with not just the physical impact of cancer but also emotional anguish associated with concerns over infertility and its societal effects. Consequently, reproductive counseling is not just a clinical supplement but a vital part of patient-focused oncology care that fosters mental well-being and enables women in making choices[13,14]. This review seeks to clarify how breast cancer treatments affect fertility, assess the relevance of the WHO reproductive counseling framework in African settings, and recognize obstacles and prospects for successful implementation.

This review aims to examine the intersection of breast cancer and fertility in young African women, highlighting the implications of cancer treatment on reproductive health.

Epidemiology of breast cancer in young African women

Breast cancer is becoming a significant public health issue in sub-Saharan Africa, with incidence rates increasing consistently over the past few decades. In contrast to trends seen in high-income nations, a notable percentage of breast cancer cases in Africa are identified in women under 40 years old. Epidemiological research shows that about 25–35% of breast cancer patients in African populations are in this younger age category, while around 5–7% are in Western nations. This unique demographic distribution carries significant clinical and psychosocial consequences, especially regarding fertility and survivorship matters[16,17]. Multiple elements lead to the comparatively younger age at which African women are diagnosed. Genetic factors, including the increased occurrence of aggressive molecular variants like triple-negative breast cancer, could be a contributing factor. Moreover, reproductive and environmental elements like early onset of menstruation, multiple pregnancies, breastfeeding habits, and exposure to pathogens interact in intricate ways to affect risk profiles. Diagnosis at later stages is still frequent, often because of restricted access to screening and diagnostic resources, cultural stigma, and postponements in pursuing medical attention[18].

The aggressive tumor biology frequently observed in young African women, coupled with limited treatment resources, results in poorer prognosis and higher mortality rates compared to counterparts in more developed regions. This adverse clinical landscape underscores the urgency of addressing fertility preservation as part of comprehensive cancer management, since many patients face the dual threat of life-threatening disease and potential loss of reproductive capacity[18]. Moreover, the socio-cultural context amplifies the impact of breast cancer on young African women. Fertility and childbearing are deeply embedded in social identity, marital stability, and community standing. Infertility resulting from cancer treatment can lead to significant psychological distress, marital discord, and social isolation. Thus, epidemiological data underscore the need for integrating fertility counseling and preservation strategies into breast cancer care protocols that are adapted to local realities[19].

Impact of breast cancer treatment on fertility

Breast cancer treatment poses significant risks to fertility, particularly for young women who have not yet completed childbearing. The primary modalities used in breast cancer management chemotherapy, radiotherapy, and hormonal therapy can adversely affect ovarian function, leading to temporary or permanent infertility[20]. Chemotherapy, especially regimens containing alkylating agents like cyclophosphamide, is the most common cause of gonadotoxicity in breast cancer patients. These agents induce DNA damage in oocytes and disrupt ovarian follicles, potentially leading to premature ovarian insufficiency (POI). The risk of chemotherapy-induced infertility depends on factors such as patient age, chemotherapy type, dose, and treatment duration. Younger women generally have a higher ovarian reserve and greater resilience; however, even in this group, the risk of amenorrhea and infertility can be substantial[21].

Radiationtherapy can also compromise fertility, particularly when pelvic or abdominal fields are involved. While breast radiotherapy primarily targets the chest, incidental exposure or treatment involving lymph nodes near the ovaries can damage ovarian tissue or disrupt the hypothalamic-pituitary-gonadal axis. Additionally, radiation may affect the uterus, reducing its capacity to support pregnancy by impairing endometrial receptivity and vascular-iz-ation[22]. Hormonal therapies, such as tamoxifen and aromatase inhibitors, present unique fertility challenges. These treatments are typically administered for extended periods (5–10 years) to reduce recurrence risk, effectively delaying pregnancy attempts. While not directly gonadotoxic, hormonal therapies necessitate prolonged contraception or treatment interruption, which may complicate family planning. Furthermore, tamoxifen is contraindicated in pregnancy due to teratogenicity[23].

In many African healthcare settings, limited access to fertility preservation technologies and specialized reproductive counseling exacerbates the impact of treatment on fertility. The absence of early fertility risk assessment and the lack of multidisciplinary care contribute to missed opportunities for intervention. Furthermore, socio-economic constraints and cultural factors may limit patients' ability to pursue fertility preservation, making pre-treatment counseling and education even more vital (Table 1)[24].

WHO's framework for reproductive counseling in cancer care

The World Health Organization (WHO) recognizes reproductive health as a fundamental human right and has underscored the importance of integrating fertility counseling into comprehensive cancer care, particularly for young patients at risk of treatment-induced infertility.

Table 1: Impact of breast cancer treatment on fertility.

Treatment Modality	Mechanism of fertility impact	Clinical consequences	Key Considerations in young African patients
Chemotherapy (e.g., cyclophosphamide, anthracyclines, taxanes)	Direct ovarian follicle depletion; DNA damage to oocytes and granulosa cells	Premature ovarian insufficiency (POI), amenorrhea, reduced ovarian reserve	Often used in advanced-stage disease requiring urgent initiation; limited access to fertility preservation before treatment
Endocrine Therapy (tamoxifen, aromatase inhibitors + ovarian suppression)	Ovarian suppression or altered hormonal signaling; long treatment duration (5–10 years)	Treatment delays childbearing; may cause irregular menses and subfertility	Long treatment periods conflict with reproductive timelines in cultures valuing early motherhood
Radiotherapy (breast, chest wall, supraclavicular nodes)	Indirect HPG-axis disruption; thyroid dysfunction from neck irradiation	Possible menstrual irregularities; reduced fertility potential	Many centers lack shielding technology or precise dosing equipment
Surgery (mastectomy, lumpectomy)	No direct effect on fertility	Psychological distress may affect sexual and reproductive decisions	Body image issues may reduce desire for future pregnancy
Targeted Therapy (HER2 inhibitors: trastuzumab, pertuzumab)	Minimal direct gonadotoxicity; potential for cardiotoxicity	Pregnancy contraindicated during treatment; requires washout period	Awareness of safe conception timing is low, leading to unplanned pregnancies
Ovarian Suppression with GnRH agonists during chemotherapy	Temporary ovarian quiescence reduces follicle exposure to cytotoxic damage	May reduce risk of POI; not a replacement for cryopreservation	Often the only feasible fertility-protection method in resource-limited settings
Cancer-Related physiological stress (before treatment)	Systemic inflammation, malnutrition, and hormonal imbalance	Irregular menstruation, transient anovulation	Many patients present with pre-existing cycle disruptions due to late diagnosis

In response to the growing need for patient-centered oncological services, WHO developed a framework that provides guidance to healthcare providers on how to address fertility concerns systematically and ethically throughout the cancer treatment continuum[25]. At the core of the WHO framework is the principle of early and proactive fertility risk assessment. Patients diagnosed with cancers that may impair reproductive function such as breast cancer should be promptly evaluated to identify potential fertility threats associated with planned treatments. This early assessment facilitates timely discussions about risks, fertility preservation options, and informed decision-making before initiating therapy, thereby maximizing the chances of preserving reproductive potential[26].

Another key element is comprehensive patient education and counseling. WHO emphasizes that healthcare providers must communicate clearly and compassionately about the impact of cancer treatments on fertility, available preservation techniques, and potential outcomes. Counseling should be individualized, considering the patient's age, cancer subtype, treatment plan, reproductive goals, and socio-cultural background. This approach promotes shared decision-making, respects patient autonomy, and addresses emotional and psychological dimensions related to fertility loss[27]. The framework also advocates for equitable access to fertility preservation services, even in resource-limited settings. While advanced technologies like oocyte or embryo cryopreservation may be limited in some African contexts, WHO encourages the use of feasible interventions such as ovarian tissue preservation or temporary ovarian suppression with gonadotropin-releasing hormone analogs. Integration of these services into existing oncology and reproductive health infrastructure is encouraged to reduce barriers and enhance multidisciplinary collaboration[28].

Cultural sensitivity and ethical considerations form another pillar of WHO's framework. Fertility and childbearing hold diverse meanings across societies, and counseling must be tailored to respect cultural values, religious beliefs, and individual patient preferences. This culturally informed approach helps to overcome stigma, misinformation, and social barriers that often hinder fertility discussions in African settings[29]. WHO highlights the importance of multidisciplinary coordination, involving oncologists, reproductive endocrinologists, psychologists, social workers, and patient advocates. Such teamwork ensures holistic care, addressing not only the medical but also the psychological and social needs of young cancer patients. Effective referral systems and communication pathways between oncology and fertility services are essential components of this integrated care model (Table 2)[30].

Challenges to implementation in African contexts

Implementing effective fertility counseling and preservation services for young breast cancer patients in Africa faces numerous complex challenges, many of which are rooted in systemic, socio-cultural, and economic factors unique to the region. These barriers must be carefully addressed to ensure that reproductive health becomes an integral component of cancer care[31,32].

Resource constraints and infrastructure limitations:

Many healthcare systems in Africa operate under significant resource limitations, including shortages of specialized medical personnel, lack of fertility preservation technologies, and inadequate laboratory infrastructure.

Table 2: WHO's framework for reproductive counseling in cancer care.

WHO Framework Component	Description	Application in breast cancer care	Relevance to young African patients
1. Rights-based approach	Emphasizes autonomy, informed decision-making, and non-discrimination in reproductive health	Ensures patients receive full information on fertility risks and options before treatment	Protects vulnerable young women facing cultural pressure and limited decision-making autonomy
2. Integrated service delivery	Reproductive health should be integrated across all medical specialties	Encourages oncology units to collaborate with fertility clinics, gynecologists, and mental health teams	Overcomes fragmented health systems and improves referral pathways
3. Quality and safety of care	High standards of counseling, documentation, and evidence-based practice	Ensures consistent fertility risk assessment, safe timing of conception, and standardized counseling	Addresses variability in provider knowledge across African centers
4. Equity and accessibility	Promotes universal access to reproductive services regardless of socioeconomic status	Supports developing low-cost fertility preservation pathways and subsidized care	Critical in regions with financial barriers and limited ART infrastructure
5. Culturally appropriate communication	Counseling should consider local norms, beliefs, language, and family roles	Encourages tailored messaging, shared decision-making, and culturally-sensitive materials	Helps navigate stigma, gender norms, and misconceptions about cancer treatment and fertility
6. Health workforce competence	Training of providers in SRHR, counseling, and patient-centered communication	Oncologists and nurses trained to initiate fertility discussions early and accurately	Addresses knowledge gaps and lack of formal training in African oncology units
7. Adolescent and Young Adult (AYA) protection	Ensures privacy, confidentiality, and specific support for young patients	Guarantees age-appropriate counseling for women aged 15–39	Important in societies where young women rely heavily on family or spouses for decisions
8. Monitoring and evaluation	Data collection to track service quality, outcomes, and access	Encourages fertility counseling documentation and reproductive outcome tracking	Supports development of national policies and cancer registries

Facilities equipped for advanced reproductive interventions such as oocyte or embryo cryopreservation are sparse and often concentrated in urban centers, making access difficult for rural populations. This infrastructural gap restricts the availability of fertility preservation options and limits timely counseling[33].

Limited awareness and training among healthcare providers

A pervasive lack of awareness about oncofertility among oncology professionals and primary healthcare workers contributes to inadequate fertility risk assessment and counseling. Training opportunities focused on reproductive health in cancer care are scarce, leading to inconsistent or delayed communication with patients regarding fertility implications of treatment. This knowledge gap undermines patient empowerment and informed decision-making[34].

Socio-cultural barriers and stigma

Cultural beliefs and societal norms play a significant role in shaping attitudes toward cancer, fertility, and reproductive choices. In many African communities, infertility can carry profound social consequences, including marital instability and stigmatization. Paradoxically, cultural taboos surrounding discussions of sexuality and reproduction may inhibit open conversations about fertility risks and preservation options. Additionally, misconceptions and myths about cancer and fertility preservation can discourage patients from seeking or accepting these services[35].

Economic challenges and cost barriers

The financial burden associated with fertility preservation procedures is a significant obstacle for many patients. Without insurance coverage or subsidized care, the high out-of-pocket costs for technologies such as cryopreservation are often prohibitive. In countries where healthcare financing relies heavily on direct payments, economic inequities exacerbate disparities in access to fertility preservation[36].

Fragmented healthcare systems and referral pathways

Poor coordination between oncology services and reproductive health specialists impedes seamless integration of fertility counseling into cancer care. Fragmented health systems with weak referral mechanisms result in missed opportunities for timely fertility risk assessment and intervention. This disjointed approach compromises the continuity and quality of patient care[37].

Limited data and research

The paucity of region-specific data on fertility outcomes, patient preferences, and effective preservation methods hampers evidence-based policy and program development. Without robust research, interventions may not be appropriately tailored to the needs of African breast cancer patients, limiting their efficacy and sustainability. Addressing these challenges requires a concerted effort from governments, healthcare providers, communities, and international partners. Overcoming systemic, cultural, and economic barriers is essential to realizing WHO's vision for comprehensive reproductive counseling and fertility preservation in cancer care, thereby improving survivorship and quality of life for young African women with breast cancer[38,39].

Strategies to improve fertility counseling and preservation

Enhancing fertility counseling and preservation services for young African breast cancer patients requires a multifaceted approach tailored to the unique socio-economic and cultural realities of the region. Addressing existing barriers involves strengthening healthcare systems, building provider capacity, and fostering patient empowerment through education and supportive policies[40-42].

1. Capacity building and provider training:

One of the most critical steps is equipping healthcare providers with the knowledge and skills necessary to discuss fertility risks and preservation options confidently and empathetically. Training programs should be integrated into oncology, gynecology, and primary care curricula, focusing on oncofertility principles, counseling techniques, and the use of available preservation methods. Continuous professional development and mentorship can further sustain provider competence and motivation[43,44].

2. Development of national and institutional policies:

Policy frameworks that formally recognize fertility preservation as an essential component of cancer care are vital. National cancer control plans should incorporate guidelines aligned with WHO recommendations, ensuring standardized fertility risk assessment and counseling practices across healthcare facilities. Policies can also address financial coverage for fertility preservation procedures, reducing economic barriers that disproportionately affect patients in low-resource settings[45,46].

3. Infrastructure enhancement and service integration:

Establishing or expanding fertility preservation services within existing healthcare facilities is crucial. This includes investing in affordable technologies such as ovarian tissue cryopreservation and promoting referral networks between oncology and reproductive health specialists. Integrating fertility counseling into routine cancer care pathways fosters timely interventions and reduces fragmentation of services[47,48].

4. Culturally sensitive patient education and community engagement:

Patient-centered educational materials, delivered in local languages and sensitive to cultural beliefs, can demystify fertility preservation and reduce stigma. Community health workers and patient advocates play key roles in raising awareness, encouraging early medical consultation, and supporting adherence to fertility preservation plans. Engagement with religious and community leaders can further facilitate acceptance and dissemination of accurate information[49].

5. Research and data collection:

Building a robust evidence base through local research is essential for understanding fertility preservation needs, outcomes, and barriers in African populations. Collecting epidemiological and clinical data can guide resource allocation, policy formulation, and the development of context-appropriate interventions[50].

6. Psychological support and counseling services:

Addressing the emotional and psychological impact of potential infertility is integral to comprehensive care. Incorporating mental health professionals into oncology teams provides patients with coping strategies, supports decision-making, and mitigates distress related to fertility loss[51].

7. Leveraging international collaboration and funding:

Partnerships with international organizations, academic institutions, and funding bodies can provide technical expertise, training, and financial resources. Such collaborations can accelerate the introduction of innovative fertility preservation techniques and capacity-building initiatives in African healthcare systems[44].

CONCLUSIONS

Breast cancer in young African women presents unique challenges that extend beyond oncological management to encompass vital reproductive health concerns. The potential impact of cancer treatments on fertility underscores the need for integrating comprehensive reproductive counseling and fertility preservation services into routine cancer care. The World Health Organization's framework offers a valuable, culturally sensitive model for addressing these needs through early risk assessment, patient education, multidisciplinary collaboration, and equitable access to fertility preservation options. However, the successful implementation of this framework in African contexts is hindered by resource limitations, healthcare system fragmentation, socio-cultural barriers, and economic constraints. Overcoming these obstacles demands strategic investments in healthcare infrastructure, and community engagement to ensure that fertility preservation becomes an accessible and integral part of breast cancer care.

ACKNOWLEDGEMENTS

The authors express their gratitude to Africa University, Mutare, Zimbabwe to provide necessary facilities for this work.

AUTHOR'S CONTRIBUTION

Obeagu EI: conceived the idea, writing the manuscript, literature survey. **Leshoele MA:** formal analysis, data processing. Final manuscript was checked and approved by both authors.

DATA AVAILABILITY

The empirical data used to support the study's conclusions are available upon request from the corresponding author.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

1. Łukasiewicz S, Czeczelewski M, Forma A, *et al*. Breast cancer-epidemiology, risk factors, classification, prognostic markers, and current treatment strategies-An updated review. Cancers (Basel) 2021;13(17):4287. *https://doi.org/10.3390/cancers13174287*
2. Francies FZ, Hull R, Khanyile R, Dlamini Z. Breast cancer in low-middle income countries: abnormality in splicing and lack of targeted treatment options. Am J Cancer Res 2020;10(5):1568-1591.
3. Obeagu EI. N2 neutrophils and tumor progression in breast cancer: Molecular pathways and implications. Breast Cancer 2025; 17:639-651. *https://doi.org/10.2147/BCTT.S542787*
4. Obeagu EI, Obeagu GU. Exploring the profound link: Breastfeeding's impact on alleviating the burden of breast cancer - A review. Medicine (Baltimore) 2024;103(15): e37695. *https://doi.org/10.1097/MD.0000000000037695*
5. Chen M, Wang X, Lan N, *et al*. Prevalence and impact of fertility preservation among young women with breast cancer. Sci Rep 2025;15(1):7549. *https://doi.org/10.1038/s41598-025-91197-4*
6. Mordenfeld Kozlovsky N, Partridge AH, Sella T. Pregnancy after breast cancer: Latest evidence and practical considerations. Ther Adv Med Oncol 2025; 17:17588359251346648. *https://doi.org/10.1177/17588359251346648*
7. Odhiambo M, Muteshi C. Bridging the gap: An outlook of oncofertility care in Africa. Int J Gynaecol Obstet 2025;169(3):908-912. *https://doi.org/10.1002/ijgo.16175*
8. Flink DM, Sheeder J, Kondapalli LA. A review of the oncology patient's challenges for utilizing fertility preservation services. J Adolesc Young Adult Oncol 2017;6(1):31-44. *https://doi.org/10.1089/jayao.2015.0065*
9. Obeagu EI, Obeagu GU. Exploring the profound link: Breastfeeding's impact on alleviating the burden of breast cancer-A review. Medicine 2024;103(15): e37695. *https://doi.org/10.1097/MD.0000000000037695*
10. Liao S, Tian X, Liu Z, *et al*. Decision-making about fertility preservation after cancer diagnosis: A qualitative study of patients' experiences and perspectives. Cancer Manag Res 2025; 17:2403-2415. *https://doi.org/10.2147/CMAR.S543626*
11. Hira V, Palnati SR, Bhakta S. Understanding the Influence of culture on end-of-life, palliative, and hospice care: A narrative review. Cureus 2025;17(7): e87960. *https://doi.org/10.7759/cureus.87960*
12. Obeagu EI, Obeagu GU. Lymphocyte infiltration in breast cancer: A promising prognostic indicator. Medicine 2024;103(49):e40845. *https://doi.org/10.1097/MD.0000000000040845*
13. Obeagu EI, Obeagu GU. Breast cancer: A review of risk factors and diagnosis. Medicine 2024;103(3): e36905. *https://doi.org/10.1097/MD.0000000000036905*
14. Assi HA, Khoury KE, Dbouk H, *et al*. Epidemiology and prognosis of breast cancer in young women. J Thorac Dis 2013 Jun;5 Suppl 1(Suppl 1): S2-8. *https://doi.org/10.3978/j.issn.2072-1439.2013.05.24*
15. Murugan N, Dickens C, Pisa PT, *et al*. Down-staging of breast cancer in the pre-screening era: Experiences from Chris Hani Baragwanath Academic Hospital, Soweto, South Africa. S Afr Med J 2014;104(5):380. *https://doi.org/10.7196/SAMJ.8243*
16. Anyigba CA, Awandare GA, Paemka L. Breast cancer in sub-Saharan Africa: The current state and uncertain future. Exp Biol Med (Maywood) 2021;246(12):1377-1387. *https://doi.org/10.1177/15353702211006047*
17. Azubuike SO, Muirhead C, Hayes L, McNally R. Rising global burden of breast cancer: The case of sub-Saharan Africa (with emphasis on Nigeria) and implications for regional development: a review. World J Surg Oncol 2018;16(1):63. *https://doi.org/10.1186/s12957-018-1345-2*
18. Łukasiewicz S, Czeczelewski M, Forma A, *et al*. Breast cancer-epidemiology, risk factors, classification, prognostic markers, and current treatment strategies-An updated review. Cancers (Basel) 2021 Aug 25;13(17):4287. *https://doi.org/10.3390/cancers13174287*
19. Obeagu EI. Breast cancer cells under oxygen stress: Adaptation and survival mechanisms. Universal J Pharm Res 2025; 10(5): 73-79. *http://doi.org/10.22270/ujpr.v10i5.1427*
20. Tetteh DA, Faulkner SL. Sociocultural factors and breast cancer in sub-Saharan Africa: implications for diagnosis and management. Womens Health (Lond) 2016;12(1):147-56. *https://doi.org/10.2217/whe.15.76*
21. Hulvat MC, Jeruss JS. Maintaining fertility in young women with breast cancer. Curr Treat Options Oncol 2009 Dec;10(5-6):308-17. *https://doi.org/10.1007/s11864-010-0116-2*
22. Mauri D, Gazouli I, Zarkavelis G, *et al*. Chemotherapy associated ovarian failure. Front Endocrinol (Lausanne) 2020;11:572388. *https://doi.org/10.3389/fendo.2020.572388*
23. Wo JY, Viswanathan AN. Impact of radiotherapy on fertility, pregnancy, and neonatal outcomes in female cancer patients. Int J Radiat Oncol Biol Phys 2009;73(5):1304-12. *https://doi.org/10.1016/j.ijrobp.2008.12.016*
24. Shandley LM, Spencer JB, Fothergill A, *et al*. Impact of tamoxifen therapy on fertility in breast cancer survivors. Fertil Steril 2017;107(1):243-252.e5. *https://doi.org/10.1016/j.fertnstert.2016.10.020*
25. Whittaker A, Gerrits T, Hammarberg K, Manderson L. Access to assisted reproductive technologies in sub-Saharan Africa: Fertility professionals' views. Sex Reprod Health Matters 2024;32(1):2355790. *https://doi.org/10.1080/26410397.2024.2355790*
26. Redig AJ, Brannigan R, Stryker SJ, *et al*. Incorporating fertility preservation into the care of young oncologypatients.Cancer.2011;117(1):4-10. *https://doi.org/10.1002/cncr.25398*
27. Ruddy KJ, Gelber SI, Tamimi RM, *et al*. Prospective study of fertility concerns and preservation strategies in young women with breast cancer. J Clin Oncol 2014;32(11):1151-6. *https://doi.org/10.1200/JCO.2013.52.8877*
28. Obeagu EI, Mahmoud SA. Mentzer index in early breast cancer: A low-cost diagnostic insight into anemia patterns. Universal J Pharm Res 2026; 11(1): 67-73. *http://doi.org/10.22270/ujpr.v11i1.1492*
29. Liao S, Tian X, Liu Z, Liu X, Chen O. Decision-making about fertility preservation after cancer diagnosis: A Qualitative Study of Patients' Experiences and Perspectives. Cancer Manag Res 2025; 17:2403-2415. *https://doi.org/10.2147/CMAR.S543626*
30. Purandare N, Ruiloba F, Nguyen-Hoang L, *et al*. FIGO committee on the impact of pregnancy on long-term health and the FIGO Division of Maternal and Newborn Health and in collaboration with the FIGO committee on women's cancer and the FIGO committee on reproductive medicine, endocrinology and infertility. Cancer and fertility management: FIGO best practice advice. Int J Gynaecol Obstet 2025;171(1):32-44. *https://doi.org/10.1002/ijgo.70426*
31. Bobel MC, Al Hinai A, Roslani AC. Cultural sensitivity and ethical considerations. Clin Colon Rectal Surg 2022;35(5): 371-375. *https://doi.org/10.1055/s-0042-1746186*
32. Taberna M, Gil Moncayo F, Jané-Salas E, *et al*. The Multidisciplinary Team (MDT) approach and quality of care. Front Oncol. 2020; 10:85. *https://doi.org/10.3389/fonc.2020.00085*
33. Sefogah PE, Attah DA, Swarray-Deen A, *et al*. Perspectives on fertility preservation among women living with breast cancer in Ghana. BMC Womens Health 2025;25(1):409. *https://doi.org/10.1186/s12905-025-03963-1*
34. Obeagu EI, Obeagu GU. Exploring neutrophil functionality in breast cancer progression: A review. Medicine (Baltimore). 2024;103(13):e37654. *https://doi.org/10.1097/MD.0000000000037654*
35. Oleribe OO, Momoh J, Uzochukwu BS, *et al*. Identifying key challenges facing healthcare systems in Africa and potential solutions. Int J Gen Med 2019; 12:395-403. *https://doi.org/10.2147/IJGM.S223882*
36. Ranjith S, Dave A. Filling the gaps in oncofertility care by addressing challenges faced by patients and providers. Cureus 2023;15(12):e50219. *https://doi.org/10.7759/cureus.50219*
37. Obeagu EI. Oxygen deprivation in breast cancer: Mechanisms, pathways, and implications. Annals of Medicine Surgery 2025;87(6):3635-3659. *https://doi.org/10.1097/MS9.0000000000003334*
38. Ekpor E, Brobbey SS, Kumah CY, Akyirem S. Experience of infertility-related stigma in Africa: A systematic review and mixed methods meta-synthesis. Int Health 2025;17(6):903-913. *https://doi.org/10.1093/inthealth/ihaf060*

39. Sauerbrun-Cutler MT, Rollo A, Gadson A, Eaton JL. The status of fertility preservation insurance mandates and their impact on utilization and access to care. J Clin Med 2024;13(4):1072. *https://doi.org/10.3390/jcm13041072*
40. Flink DM, Sheeder J, Kondapalli LA. A Review of the oncology patient's challenges for utilizing fertility preservation services. J Adolesc Young Adult Oncol 2017;6(1):31-44. *https://doi.org/10.1089/jayao.2015.0065*
41. Obeagu EI, Ngwoke AO, Malunga G. Iron chelators in breast cancer therapy: mechanisms and clinical applications: A narrative review. Annals of Medicine and Surgery. 2025;87(6):3556-3565. *https://doi.org/10.1097/MS9.0000000000003173*
42. Musa SM, Haruna UA, Manirambona E, *et al*. Paucity of health data in Africa: An obstacle to digital health implementation and evidence-based practice. Public Health Rev 2023;44:1605821. *https://doi.org/10.3389/phrs.2023.1605821*
43. Dorfman CS, Stalls JM, Mills C, *et al*. Addressing barriers to fertility preservation for cancer patients: The role of oncofertility patient navigation. J Oncol Navig Surviv 2021;12(10):332-348.
44. Hussien SMM, Zoromba MA, El-Gazar HE, *et al*. Fertility-preservation knowledge, perceived barriers, and tokophobia among female oncology patients: The moderating role of psychological capital. SAGE Open Nurs 2025;11:23779608251376079. *https://doi.org/10.1177/23779608251376079*
45. Obeagu EI, Obeagu GU. Exploring neutrophil functionality in breast cancer progression: A review. Medicine 2024;103(13): e37654. *https://doi.org/10.1097/MD.0000000000037654*
46. Michaeli J, Erb M, Savic M, Greenblatt EM. Fertility preservation by ovarian tissue transportation and centralized cryobanking for a 20-year-old woman with Hodgkin lymphoma. Canadian Med Assoc J 2025;197(39):E1307-E1310. *https://doi.org/10.1503/cmaj.250519*
47. Bohren MA, Vazquez Corona M, Odiase OJ, *et al*. Strategies to reduce stigma and discrimination in sexual and reproductive healthcare settings: A mixed-methods systematic review. PLOS Glob Public Health 2022;2(6): e0000582. *https://doi.org/10.1371/journal.pgph.0000582*
48. Munakampe MN, Haaland MESH, Zulu JM, Michelo C. From science to sustainable systems: Evidence based-decision making for adolescent fertility in Zambia. Health Policy Open 2021;2:100046. *https://doi.org/10.1016/j.hpopen.2021.100046*
49. Patel A, Sharma PSVN, Kumar P. Role of mental health practitioner in infertility clinics: A review on past, present and future directions. J Hum Reprod Sci 2018;11(3):219-228. *https://doi.org/10.4103/jhrs.JHRS_41_18*
50. Obeagu EI, Obeagu GU. Predictive models and biomarkers for survival in stage III breast cancer: a review of clinical applications and future directions. Annals Med Surg 2024;86(10):5980-5987. *https://doi.org/10.1097/MS9.0000000000002517*
51. Doble A, Sheridan Z, Razavi A, Wilson A, Okereke E. The role of international support programmes in global health security capacity building: A scoping review. PLOS Glob Public Health 2023;3(4): e0001763. *https://doi.org/10.1371/journal.pgph.0001763*