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A REVIEW OF CHALLENGES AND PROSPECTS OF MOBILE MAMMOGRAPHY SCREENING IN DEVELOPING COUNTRIES

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ABSTRACT

Breast cancer is the most common cancer among women worldwide, accounting for approximately 25% of all female cancer cases. Given the increasing impact of breast cancer in developing countries, early detection and timely treatment are crucial in reducing morbidity and mortality associated with the disease. Mammography screening is a well-established method for early detection, as it can identify breast cancer at an early stage when the chances of successful treatment are higher. Mobile mammography screening has the potential to significantly improve early detection and reduce mortality rates associated with breast cancer in developing countries. However, various challenges still impede the full realization of its benefits.

This review article aims to identify and explore the challenges and prospects of implementing mobile mammography screening programs in developing countries, and to provide recommendations on how to overcome these obstacles. Overall, the future of mobile mammography screening in developing countries can be promising, with opportunities for technological advancements, increased global cooperation, and ongoing research to further enhance the effectiveness of these programs. By seizing these opportunities and addressing the challenges related to accessibility, affordability, human resources, cultural and social factors, and infrastructure, mobile mammography screening can make a significant impact on the lives of women in developing countries and contribute to reducing global disparities in breast cancer care. Several successful mobile mammography screening projects in low- and middle-income countries showcase the potential for such programs to improve access to early detection services, raise breast cancer awareness, and ultimately reduce breast cancer mortality rates. By adapting best practices and lessons learned from these projects, other low- and middle-income countries can develop and implement mobile mammography screening programs tailored to their unique contexts and resource constraints.

KEYWORDS: *breast cancer, mammography, breast cancer screening, developing countries, digital breast tomosynthesis, LMICs.*

INTRODUCTION

Breast cancer is the most common cancer among women worldwide, accounting for approximately 25% of all female cancer cases. Globally, about 2.3 million new breast cancer cases have been diagnosed in 2020, with an estimated 685,000 deaths attributed to the disease [*BCFS, 2023*]. By 2040, the number of newly diagnosed breast cancers is projected to grow by over 40%, to about 3

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million cases every year. Similarly, deaths from breast cancer are set out to increase more than 50%, reaching to 1 million in 2040. While the incidence of breast cancer is higher in developed countries, developing countries bear a disproportionate burden in terms of mortality rates. Approximately 50% of breast cancer cases and 58% of related deaths occur in less developed regions [*Arnold M et al., 2022*].

In developing countries, the breast cancer burden is exacerbated by several factors:

- *Late-stage diagnosis:* Women in developing countries are often diagnosed at later stages of the disease, which reduces their chances of successful treatment and survival [*Tfayli A et al., 2010*]. The reasons for this include limited access to healthcare facilities, lack of awareness about the disease and its symptoms, and cultural barriers that hinder timely access to medical care [*Rivera-Franco M, Leon-Rodriguez E, 2018*].
- *Limited healthcare resources:* Healthcare systems in many developing countries are often inadequately equipped to manage the growing burden of breast cancer. This can be attributed to insufficient funding, a lack of specialized healthcare professionals, inadequate infrastructure, and limited access to advanced diagnostic and treatment options [*Al-Sukhun S et al., 2022*].
- *Socioeconomic factors:* Poverty, low literacy rates, and gender inequality are significant barriers to accessing breast cancer care in developing countries. These factors can lead to delayed diagnoses, suboptimal treatment, and poor outcomes [*Lundqvist A et al., 2016; Dreyer M et al., 2018*].

Given the increasing impact of breast cancer in developing countries, early detection and timely treatment are crucial in reducing morbidity and mortality associated with the disease. Mammography screening is a well-established method for early detection, as it can identify breast cancer at an early stage when the chances of successful treatment are higher. According to the WHO Position Paper on Mammography Screening, results from mammography screening programs suggest a reduction in breast cancer mortality by approximately 20% at 11 years of follow up [*WHO, 2023a*]. However, access to mammography services remains limited in many developing countries due to various logistical, financial, and cultural barriers [*Nduka I et al., 2023*].

Mobile mammography screening has emerged as a promising solution to address these challenges and improve early detection rates in resource-constrained settings [*Apffelstaedt J et al., 2014; Guillaume E et al., 2022; van den Bruele A et al., 2022*]. By bringing mammography services closer to communities in remote and underserved areas, mobile mammography has the potential to significantly reduce the burden of breast cancer in developing countries. This review will further explore the challenges and prospects of implementing mobile mammography screening programs in these settings.

Overview of Mammography Screening as a Tool for Early Detection

Mammography is a non-invasive diagnostic imaging technique that uses low-dose X-rays to produce detailed images of the breast tissue. It is widely recognized as the gold standard for early detection of breast cancer, as it can identify tumors and other abnormalities before they can be felt during a physical examination or exhibit noticeable symptoms [*Zubor P et al., 2019*]. By detecting breast cancer at an earlier stage, mammography screening significantly increases the likelihood of successful treatment and improves patient outcomes [*Choi K et al., 2018*] (Fig. 1).

Mammography has a high sensitivity, meaning it can detect a large proportion of breast cancers present in the population. Its specificity, or the ability to correctly identify individuals without breast cancer, is also relatively high. The data from

Figure 1. *Digital Mammography device (National Center of Oncology, Yerevan, Armenia*

the Breast Cancer Surveillance Consortium including about 1.7 million cases, the sensitivity and accuracy of screening mammography were 86.9% and 88.9%, respectively. However, mammography is not perfect, and there is a risk of false-positive results, which can lead to additional testing, anxiety, and potential overdiagnosis [*Dabbous F et al., 2017*]. On the other hand, false-negative results may lead to delayed diagnosis and treatment. In many developed countries, organized population-based mammography screening programs have been implemented to systematically offer mammograms to women within a specific age range (typically 40-74 years). These programs have been shown to reduce breast cancer mortality by 20-30% among women who participate [*Kalager M et al., 2010; Herrmann C et al., 2018*]. Screening guidelines vary across countries and organizations, but most recommend mammography screening every 1-2 years for women aged 50-74 years. Some guidelines also suggest earlier or more frequent screening for women at higher risk of developing breast cancer, such as those with a family history of the disease or known genetic mutations [*Ren W et al., 2022*]. Digital mammography has largely replaced traditional film-based mammography in recent years. Digital mammography offers several advantages, including faster image acquisition, improved image quality, and the ability to adjust images for better visualization of breast tissue. Additionally, newer technologies such as digital breast tomosynthesis and computer-aided detection systems have further improved the accuracy and efficiency of mammography screening [*Fan M et al., 2019*].

Despite the demonstrated effectiveness of mammography screening for early detection of breast cancer, access to these services remains limited in many developing countries [*Tfayli A et al. 2010*]. Mobile mammography screening has the potential to address these disparities by bringing mammography services directly to remote and underserved communities, thereby improving accessibility and early detection rates [*Trivedi U et al., 2022*].

Mobile Mammography Screening and Its Potential Benefits

Mobile mammography screening is an innovative approach that involves utilizing specially designed vehicles equipped with mammography equipment to provide breast cancer screening services in remote and underserved areas (Fig. 2).

Figure 2. *Trailer based mobile mammography complex, National Mammography project, Armenia (courtesy of National Center of Oncology, Ministry of Health, Armenia)*

By bringing mammography services directly to communities with limited access to healthcare facilities, mobile mammography aims to improve early detection rates and reduce the burden of breast cancer in developing countries. The potential benefits of mobile mammography screening include:

- *Increased accessibility:* Mobile mammography units can overcome geographical barriers by reaching rural and remote communities where access to mammography services is limited or nonexistent. This enables more women to undergo screening, increasing early detection rates and the chances of successful treatment [*Brooks S et al., 2013*].
- *Enhanced convenience:* Mobile mammography screening offers convenience to women in targeted communities, as they do not have to travel long distances or incur significant transportation costs to access mammography services. This may encourage more women to participate in regular screening, further improving early detection rates [*Trivedi U et al., 2022*].
- *Cost-effectiveness:* Mobile mammography screening programs can be more cost-effective than establishing permanent mammography facilities in areas with low population densities or limited resources. By sharing the costs of equipment and personnel among multiple communities, mobile mammography units can provide services at a lower cost per exam compared to traditional facilities [*De Mil R et al., 2019*].

- *Tailored outreach and education:* Mobile mammography screening programs can be combined with tailored education and awareness campaigns to promote breast cancer awareness and encourage participation in screening [*Reuben D et al., 2002*]. By addressing local cultural beliefs and misconceptions, these campaigns can help reduce barriers to accessing mammography services and foster a more positive attitude towards breast cancer screening [*Nduka I et al., 2023*].
- *Improved patient follow-up:* Mobile mammography units can facilitate better patient follow-up by maintaining electronic records of screening results and establishing partnerships with local healthcare providers. This can improve the coordination of care and ensure that women with positive screening results receive timely referrals for further evaluation and treatment [*Stanley E et al., 2017*].
- *Capacity building:* Mobile mammography screening programs can contribute to capacity building by providing training and employment opportunities for local healthcare professionals [*Bencivenga M et al., 2008*]. This can help address the shortage of skilled personnel in underserved areas and developing countries and improve the overall quality of breast cancer care.

Overall, mobile mammography screening has the potential to significantly improve early detection and reduce mortality rates associated with breast cancer in developing countries. However, several challenges must be addressed to ensure the successful implementation and sustainability of these programs, including overcoming barriers related to accessibility, affordability, human resources, cultural and social factors, and infrastructure.

Common Challenges of Mobile Mammography Screening in Developing Countries

Accessibility and Affordability

In developing countries, access to mammography screening services is often limited due to a combination of factors, including geographical barriers, lack of trained professionals, high costs and lack of awareness. These challenges hinder the implementation of mobile mammography screening programs and reduce their potential impact on early detection and breast cancer outcomes [*Gutnik L et al., 2016*].

The limited access to healthcare facilities can be related to:

a. Geographical barriers: In many developing countries, healthcare facilities offering mammography screening are concentrated in urban areas, making it difficult for women in rural or remote locations to access these services. Inadequate transportation systems and poor road conditions further exacerbate this challenge. Even in developed countries as the US, limited spatial accessibility to mammography, in addition to socioeconomic barriers, may contribute to suboptimal outcomes of breast cancer detection and treatment among rural women [Hughes A et al. 2020].

b. Insufficient facilities: The demand for mammography services often outweighs the availability of facilities, leading to long waiting times and missed opportunities for early detection. This is particularly true in resource-constrained settings where healthcare infrastructure is limited [*Barrios C, 2022; Newman L, 2022*].

High costs of equipment, maintenance, and screening. Mammography machines are expensive to purchase and maintain, posing a significant financial barrier for healthcare providers in developing countries. The cost of mobile mammography units can also be prohibitive, as they require additional investment in vehicles, equipment, and infrastructure. The costs of maintaining mammography equipment, including regular servicing, repairs, and replacement of parts, fuel costs, can be a substantial financial burden for healthcare providers in resource-limited settings [*De Mil R et al., 2019*]. The fees associated with mammography screening can be a significant barrier for women in low-income households. In some developing countries, the cost of a mammogram can be equivalent to several months' wages, making it unaffordable for a large portion of the population. For example, according to a survey within 2 communities in Nigeria, of 1350 women, only 20.4% could afford annual mammography at the current price, 12.7% at half the price and 19% less than half the price. Nearly half of the respondents (47.9%) could afford nothing [*Arnold M et al., 2022*].

Lack of awareness and understanding among target populations can also be a serious barrier for successful implementation of a mobile mammography screening implementation, in many develop-

ing countries, there is a general lack of awareness about breast cancer, its symptoms, and the importance of early detection [*Dreyer M et al., 2018; Rivera-Franco M, Leon-Rodriguez E, 2018*]. This can lead to low demand for mammography screening services, even when they are available. Misconceptions about mammography, such as fears of radiation exposure or beliefs that the procedure is painful, can discourage women from seeking screening services. Cultural beliefs and taboos may also contribute to the reluctance of some women to undergo mammography. Many women in underserved may not be aware of the availability of mobile mammography services or how to access them. Effective communication and outreach strategies are essential for increasing the uptake of these services [*Nduka I et al., 2023*].

Addressing these challenges related to accessibility and affordability is crucial for the successful implementation and sustainability of mobile mammography screening programs in developing countries. Strategies to improve access may include public-private partnerships, subsidies or sliding scale fees for screening services, and targeted awareness campaigns to inform and encourage women to utilize available resources.

Human Resources and Training

The successful implementation of mobile mammography screening programs in developing countries depends on the availability of skilled healthcare professionals, such as radiologists, radiologic technologists, and nurses. However, many developing countries face challenges related to human resources and training, which can impede the effectiveness of mobile mammography screening initiatives. Many developing countries experience a shortage of healthcare professionals, particularly those with specialized skills in radiology and breast imaging [*Panieri E, 2012, Hricak H et al., 2015; Frija G et al., 2021*]. This shortage can limit the capacity of mobile mammography screening programs to reach their full potential. Beside this, skilled healthcare professionals are often concentrated in urban areas, leaving rural and remote regions underserved. This uneven distribution can further exacerbate the shortage of personnel needed to staff mobile mammography units.

Developing countries may lack comprehensive training programs in mammography and breast imaging, making it difficult for healthcare professionals to acquire the necessary skills and knowledge to provide quality care. Limited access to up-to-date educational materials, textbooks, and training resources can hinder professionals to stay current with advances in mammography technology and techniques [*Li J, Shao Z, 2015*].

Healthcare professionals working in mobile mammography units may face challenging conditions, such as long hours, difficult travel, and limited resources, which can contribute to burnout and high turnover rates. Low salaries, limited opportunities for professional growth, and inadequate recognition can further contribute to high turnover rates among healthcare professionals working in mobile mammography screening programs.

To overcome these challenges, several strategies can be implemented to strengthen human resources and training for mobile mammography screening programs in developing countries: [*Frija G et al., 2021*].

a - Developing comprehensive training programs: Establishing robust training programs in mammography and breast imaging can help ensure that healthcare professionals have the necessary skills and knowledge to provide quality care. These programs should include both theoretical and hands-on components to maximize learning outcomes [*Farria D et al., 2014*].

b - Utilizing e-learning and telemedicine platforms: Leveraging e-learning and telemedicine technologies can help overcome geographic barriers and provide healthcare professionals in remote areas with access to high-quality educational resources and training opportunities [*Chung H, Parikh J, 2020*].

c - Implementing mentorship and apprenticeship models: Encouraging experienced radiologists and technologists to mentor and train younger professionals can help build capacity and expertise within the local workforce. Apprenticeship models, where trainees work under the supervision of experienced professionals, can provide valuable hands-on experience and enhance learning outcomes [*Spacey A et al., 2021*].

d - Improving working conditions and incentives: Ensuring that healthcare professionals working in mobile mammography units have access to adequate resources, support, and opportunities for

professional growth can help reduce turnover rates and improve job satisfaction. Providing competitive salaries, performance-based incentives, and opportunities for career advancement can also help attract and retain skilled professionals in the field [*Agarwal M et al., 2021*].

By addressing the challenges related to human resources and training, developing countries can create a strong foundation for the successful implementation and sustainability of mobile mammography screening programs.

Cultural and Social Barriers

Cultural and social barriers can significantly impact the success of mobile mammography screening programs in developing countries [*Miller B et al., 2019; Tang T et al., 2000; Jaffee K et al., 2021*]. These barriers may influence women's willingness to undergo screening, their understanding of breast cancer, and their ability to access mammography services. Some of the most common cultural and social barriers include:

Stigma and fear associated with breast cancer: In many cultures, breast cancer is associated with a significant amount of fear and stigma, which can discourage women from discussing their concerns, seeking medical help, or participating in screening programs. This can lead to delayed diagnosis and poorer outcomes [*Wang Q et al., 2017*].

Misconceptions about mammography: Some women may have misconceptions about mammography screening, such as fears about radiation exposure, pain during the procedure, or the belief that it is unnecessary if they have no symptoms. These misconceptions can contribute to reluctance in seeking screening services [*Chamot E, Perneger T, 2001*].

Modesty and privacy concerns: In certain cultures, women may feel uncomfortable undressing or exposing their breasts for mammography, particularly if the healthcare providers are male. This can deter women from participating in screening programs, even when mobile mammography units are available [*Jaffee K et al., 2021*].

Gender roles and decision-making: In some societies, women may not have the autonomy to make decisions about their own healthcare, including whether to participate in breast cancer screening. Instead, these decisions may be made by male family members or community leaders, who may not prioritize women's health or understand the importance of early detection [*Rajaram S, Rashidi A, 1999*].

Lack of awareness and education: Limited awareness about breast cancer, its symptoms, risk factors, and the benefits of early detection can result in low demand for mammography services. Low literacy levels and language barriers may also impede women's understanding of breast cancer information and their ability to access screening services [*Miller B et al. 2019; Olasehinde O et al. 2019*].

To address these cultural and social barriers, the following strategies can be employed:

a - Community education and awareness campaigns: Conducting culturally sensitive education and awareness campaigns can help dispel misconceptions about breast cancer and mammography, increase understanding of the benefits of early detection, and promote screening participation.

b - Involving community leaders and influencers: Engaging community leaders, religious leaders, and local influencers can help encourage community acceptance of mammography screening programs and create a supportive environment for women to seek screening services [*McNeill L et al., 2020*].

c - Ensuring culturally sensitive care: Providing culturally sensitive care, including female healthcare providers, private screening environments, and appropriate communication materials, can help address modesty and privacy concerns, making women more comfortable with the screening process [*Rajaram S, Rashidi A, 1999*].

d - Empowering women to make informed decisions: Educating and empowering women to make informed decisions about their own healthcare can help overcome barriers related to gender roles and decision-making. This can be achieved through targeted health education programs and community-based interventions that promote women's autonomy and decision-making power [*Bencivenga M et al., 2008*].

e - Developing targeted communication materials: Designing communication materials that are culturally appropriate, available in local languages, and tailored to the needs of the target population can help overcome literacy and language barriers, ensuring that women have access to accurate and

understandable information about breast cancer and mammography screening [*Nduka I et al., 2023*].

By addressing cultural and social barriers, mobile mammography screening programs in developing countries can significantly improve access to early detection services, leading to better breast cancer outcomes and reduced mortality rates.

Infrastructure and Technological Limitations

Infrastructure and technological limitations can pose significant challenges to the successful implementation of mobile mammography screening programs in developing countries. These challenges can impact the quality and accessibility of mammography services, as well as the sustainability of screening programs. Some of the key infrastructure and technological limitations include:

Limited access to electricity and reliable power sources: Many rural and remote areas in developing countries lack reliable access to electricity, which is essential for operating mammography equipment. Unstable power supplies can lead to equipment malfunction, reduced image quality, and increased downtime, all of which can hinder the effectiveness of mobile mammography screening programs [*Adair-Rohani H et al., 2013*].

Poor road infrastructure and transportation: Inadequate road infrastructure and transportation systems can make it difficult for mobile mammography units to reach remote communities, particularly during inclement weather or natural disasters. This can limit the accessibility of mammography services to the populations that need them the most [*Pape R et al., 2016; Wercholuk A et al., 2022*].

Limited availability of advanced mammography equipment: Developing countries may have limited access to advanced mammography equipment, such as digital mammography systems, digital breast tomosynthesis, or computer-aided detection systems. These technologies can significantly improve the accuracy and efficiency of mammography screening but may be cost-prohibitive or unavailable in many resource-limited settings [*De Mil R et al., 2019*].

Maintenance and repair challenges: The maintenance and repair of mammography equipment can be challenging in developing countries due to a lack of skilled technicians, limited availability of spare parts, and logistical difficulties in transporting equipment to and from repair facilities. This can result in prolonged equipment downtime, reducing the capacity and effectiveness of mobile mammography screening programs [*Frija G et al., 2021*].

Limited telecommunication infrastructure: Inadequate telecommunication infrastructure can hinder the implementation of telemedicine and remote consultation services, which can be valuable for connecting mobile mammography units with radiologists and other specialists in urban centers. This can limit the quality of care provided and impede timely decision-making for follow-up and treatment [*Bali S, 2018*].

To address these infrastructure and technological limitations, several strategies can be implemented, including:

a - Utilizing alternative power sources: Investing in alternative power sources, such as solar panels or generators, can help ensure a reliable power supply for mobile mammography units operating in areas with limited access to electricity [*WHO, 2023b*].

b - Collaborating with local governments and organizations: Collaborating with local governments and organizations to improve road infrastructure and transportation systems can facilitate better access to remote communities and enhance the reach of mobile mammography screening programs.

c - Seeking partnerships and funding opportunities: Establishing partnerships with international organizations, non-governmental organizations, and private companies can help secure funding for the acquisition of advanced mammography equipment and other essential technologies [*Davis M et al., 2018*].

d - Developing local maintenance and repair capacity: Building local capacity for equipment maintenance and repair can help minimize downtime and ensure the sustainability of mobile mammography screening programs. This can involve training local technicians, establishing maintenance facilities, and creating supply chains for spare parts and consumables.

e - Leveraging existing telecommunication infrastructure: Utilizing existing telecommunication infrastructure and exploring innovative solutions, such as satellite or mobile-based connectivity, can

help facilitate telemedicine services and remote consultations for mobile mammography units.

By addressing infrastructure and technological limitations, mobile mammography screening programs can improve the accessibility and quality of mammography services in developing countries, leading to better breast cancer outcomes and reduced mortality rates.

Prospects of Mobile Mammography Screening in Developing Countries

Despite the challenges faced in implementing mobile mammography screening programs in developing countries, there are several promising prospects and opportunities that can contribute to their success and sustainability. Mobile mammography screening has the potential to transform breast cancer detection and management in developing countries, particularly in rural and remote areas with limited access to healthcare facilities. As these programs continue to expand and evolve, several promising prospects can be anticipated:

- *Increased accessibility and early detection:* By bringing mammography services directly to underserved communities, mobile mammography screening can significantly increase accessibility and early detection rates, leading to improved treatment outcomes and reduced breast cancer mortality [*Vang S et al., 2018; Trivedi U et al., 2022*].
- *Enhanced community engagement and awareness:* Mobile mammography screening programs can serve as a platform for tailored community education and awareness campaigns, empowering women with the knowledge and confidence to make informed decisions about their own healthcare and encouraging more women to participate in regular screening [*Rajaram S, Rashidi A, 1999; Avetisyan A, 2023*].
- *Technological advancements and innovations:* The integration of advanced technologies, such as digital mammography, digital breast tomosynthesis, and computer-aided detection systems, can improve the accuracy and efficiency of mobile mammography screening programs [*Chung H, Parikh J, 2020*]. Furthermore, innovations in telemedicine and remote consultation services can help bridge the gap between mobile mammography units and urban-based specialists, improving the quality of care provided in rural and remote settings.
- *Improved capacity building and workforce development:* Mobile mammography screening programs can contribute to capacity building by providing training and employment opportunities for local healthcare professionals [*Farria D et al., 2014*], helping to address the shortage of skilled personnel in developing countries and improve the overall quality of breast cancer care.
- *Cross-sector partnerships and collaboration:* The implementation of mobile mammography screening programs can foster cross-sector partnerships and collaboration between governments, non-governmental organizations, private companies, and local communities. These partnerships can help mobilize resources, share expertise, and leverage existing infrastructure to maximize the impact of mobile mammography screening initiatives [*Davis M et al., 2018*].
- *Scalable and sustainable models:* As mobile mammography screening programs continue to develop, scalable and sustainable models can be refined and adapted to the unique needs of different regions and populations. These models can serve as a blueprint for expanding access to mammography services in other low-resource settings and addressing global disparities in breast cancer care.
- *Leveraging artificial intelligence and machine learning:* The integration of artificial intelligence and machine learning technologies into mobile mammography screening has the potential to improve image analysis and diagnostic accuracy. AI-based tools can aid in detecting subtle abnormalities, reducing false positives, and minimizing the need for unnecessary follow-up exams. This can enhance the overall efficiency and effectiveness of mobile mammography screening programs [*Geras K et al., 2019*].
- *Integration with other health services:* Mobile mammography screening programs can be integrated with other primary healthcare services [*Reed H et al., 2021*], such as COVID-19 testing, smoking cessation, vaccinations, family planning, and cervical cancer screening. This comprehensive approach can help maximize the impact of these programs, improving overall women's health outcomes, and providing more

holistic care in resource-limited settings.

- *Monitoring and evaluation for continuous improvement:* Implementing robust monitoring and evaluation systems can help track the performance and impact of mobile mammography screening programs, allowing for data-driven decision-making and continuous improvement. By identifying best practices and learning from challenges, these programs can be further refined and tailored to the needs of diverse populations and settings.
- *Advocacy and policy support:* Advocacy efforts can help raise awareness of the importance of breast cancer screening and the potential benefits of mobile mammography among policymakers and stakeholders. This can lead to greater policy support and funding for the implementation and scale-up of mobile mammography screening programs in developing countries [*Kizub D et al., 2020*].
- *Portable and low-cost imaging technologies:* The development of portable, low-cost imaging technologies can make breast cancer screening services more accessible and affordable for resource-limited settings [*Tian L. et al., 2022; Ma J et al., 2019*]. Innovations in this area can further expand the reach of mobile mammography screening programs and increase the feasibility of implementing these services in low-income communities.
- *Patient navigation and support services:* Incorporating patient navigation and support services within mobile mammography screening programs can help ensure that women with abnormal screening results receive timely follow-up care and treatment. By connecting patients with the necessary resources and support, these services can improve the continuity of care and enhance patient outcomes [*Tian L et al., 2022*].
- *Monitoring and evaluation of program effectiveness:* Ongoing monitoring and evaluation of mobile mammography screening programs can provide valuable insights into their effectiveness and help identify areas for improvement [*Drake B et al., 2015*]. This can inform the development of best practices and guidelines for implementing and scaling mobile mammography screening initiatives in various settings.
- *Global knowledge sharing and collaboration:* Fostering global collaboration and knowledge sharing can enable countries to learn from each other's experiences and best practices. By sharing resources, expertise, and lessons learned, the global community can work together to address the challenges and maximize the potential of mobile mammography screening in developing countries [*Trivedi U et al., 2022*].

Successful projects of mobile mammography screening in developing countries

There have been several successful real-life mobile mammography screening projects implemented in low- and middle-income countries (LMICs) that serve as examples of effective strategies for increasing access to early detection services and reducing breast cancer mortality. Some notable examples include:

- ***PinkDrive, South Africa:*** PinkDrive is a non-governmental organization in South Africa that operates mobile mammography units to provide breast cancer screening services to women in underserved communities. PinkDrive has successfully increased access to mammography for thousands of women, particularly in rural and remote areas, and has become a valuable resource in raising breast cancer awareness and promoting early detection [*Bateman C, 2012*].
- ***Peru's Mobile Mammography Program in Peru:*** The Ministry of Health launched a mobile mammography screening program that targeted women in rural areas with limited access to healthcare services. The program utilized modern digital mammography equipment and worked closely with local healthcare providers to ensure appropriate follow-up and referrals for women with positive screening results. The program demonstrated the feasibility and effectiveness of mobile mammography screening in a resource-limited setting [*Matsumoto M et al., 2020*].
- ***The Egyptian Breast Cancer Screening Program:*** This program, supported by the Egyptian Ministry of Health and Population, the Breast Cancer Foundation of Egypt, and international partners, utilizes mobile mammography units to provide free breast cancer screening services to women in rural and underserved areas. The program has reached thousands of women, helping

to improve early detection rates and raise awareness about the importance of regular breast cancer screening [*Sallam I et al., 2018*].

- ***National breast cancer screening project of Armenia***: In 2021 a pilot breast screening project was launched by the Ministry of Health, Armenia, in 3 remote provinces the country, for target population of 50-69yo asymptomatic women, funded by a foreign grant, using a mobile 2D mammography machine. During an 18-month period 14 921 (38.43%) women were screened in 2 provinces out of 38 827 target population, with further assessment recall 1006 (6.74%), and 169 (1.13%) newly detected breast cancer cases [*Avetisyan A, 2023*].

These successful mobile mammography screening projects in LMICs showcase the potential for such programs to improve access to early detection services, raise breast cancer awareness, and ultimately reduce breast cancer mortality rates. By adapting best practices and lessons learned from these projects, other LMICs can develop and implement mobile mammography screening programs tailored to their unique contexts and resource constraints.

CONCLUSION

Mobile mammography screening has the potential to address the challenges of early detection and management of breast cancer in developing countries. However, it is essential to address the barriers related to accessibility, affordability, human resources, cultural and social factors, and infrastructure. Overall, the future of mobile mammography screening in developing countries can be promising, with opportunities for technological advancements, increased global cooperation, and ongoing research to further enhance the effectiveness of these programs. By seizing these opportunities and addressing the challenges related to accessibility, affordability, human resources, cultural and social factors, and infrastructure, mobile mammography screening can make a significant impact on the lives of women in developing countries and contribute to reducing global disparities in breast cancer care.

Several successful mobile mammography screening projects in LMICs showcase the potential for such programs to improve access to early detection services, raise breast cancer awareness, and ultimately reduce breast cancer mortality rates. By adapting best practices and lessons learned from these projects, other LMICs can develop and implement mobile mammography screening programs tailored to their unique contexts and resource constraints.

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