Acceptance of artificial intelligence (AI)-based screening for breast health in urban slums of central Karnataka, India – SWOC analysis

Shubha B. Davalagi¹, Balu S. Palicheralu¹, Sanjana S Narasimha Murthy², Shalini Hurlihal¹

¹Department of Community Medicine, JJM Medical College, Davangere, Karnataka, ²Medical Affairs, Eka Care, Orbi Health Pvt Ltd, Bangalore, Karnataka, India

ABSTRACT

Background: Artificial intelligence-based imaging is a low-cost, radiation-free solution for the breast imaging process that uses infrared radiation emitted by the body. This is a novel procedure that, when feasible, could be a better solution, particularly in underprivileged communities having low access to breast health care. **Aims:** To assess the acceptance and explore challenges for an artificial intelligence-based screening solution for breast health among the urban slum population. **Settings and Design:** A mixed-method study was conducted in urban slums of central Karnataka, India. **Material and Methods:** The study was carried out for a period of two years in 2019–21 among women in the reproductive age group in urban slums of central Karnataka to understand the acceptance of an artificial intelligence-based imaging solution for screening breast health. In-depth interviews were conducted to identify the strength, weaknesses, opportunities, and challenges (SWOC) screening for breast health. **Statistical Analysis Used:** Quantitative data were analysed using Statistical Package for the Social Sciences (SPSS) v16.0, and for qualitative data, manual descriptive content analysis was carried out, and the sub-themes were generated. **Results:** A total of 768 women accessed the thermalytix ® breast imaging services, the majority of them in the age group 31–40 years (35%), belonging to the Muslim religion (68.5%) with a mean monthly family income of Rs. 11,950.67/-. SWOC analysis identified reduced cost for the screening services and involvement of female self-help groups (SHGs) as strengths. Weaknesses included poor breast health awareness among women and the stigma associated with breast cancer. **Conclusions:** Artificial intelligence-based screening is a feasible solution for breast health in low-income, low health access areas like urban slums. Engagement of the local community and active involvement of the health system is of paramount importance for the sustainability of any novel strategy.

Keywords: Acceptance, artificial intelligence, breast, urban slum

Introduction

Globally, cancer is the leading cause of death, next only to cardiovascular diseases, and 70% of these deaths are from low and middle-income countries.[1] Breast cancer accounts for 25% of all cancers in women, and its incidence varies from 27 per 100,000 women in underdeveloped countries of middle Africa and eastern Asia to 92 per 100,000 women in developed countries of North America.[2-4] In India, gynaecological cancers, including breast cancer, account for over half of all cancers in women. A recent report of the hospital-based cancer registries says that breast cancer accounted for more than a quarter of the cases diagnosed (25.4%), followed by cervical cancer (15.2%).[5] Breast cancer accounts for 14% of cancers in Indian women.[6] It is reported that every four

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minutes, an Indian woman is diagnosed with breast cancer.[7,8] Breast cancer is on the rise, both in rural and urban India. Breast cancer replaced cervical cancer as the common cause of morbidity and mortality among women in India for the 1st time in 2012, and this trend is most likely to continue in the face of changing dietary habits and child-bearing practices in India.[9,10]

In a developing country like India, where a painless breast lump is often ignored, early detection for improved survival remains to be an important strategy as also promoted by the Government of India's comprehensive primary care package for women's health.[10-12]

Thermography, a non-contact, non-invasive, and safe procedure, can detect cancer much earlier than the standard methods.[13] The latest thermal cameras are capable of measuring breast surface temperature differences of even 0.05°C and can be used to detect high thermal changes resulting from cancer cells that have high metabolic activity and those induced by neo-angiogenesis.[14] Though thermography as a screening tool was introduced in the 19th century, it was not widely accepted then as the manual interpretation of thermograms is highly complex and subjective.[15] With recent advancements in high-resolution thermal cameras, breast thermography is re-emerging as a screening method. When thermography is combined with artificial intelligence (AI) or machine learning for automated analysis, the results are quantitative and consistent.[14-16] In resource-constrained settings such as in low and middle-income countries (LMICs), where the radiologist to population ratio is as low as 1:100,000, technology-assisted solutions can be scalable and pave the way forward. AI-powered algorithms for screening breast health conditions could reduce the need for unnecessary referrals, increase continuity with patients and enhance mastery for primary care physicians.[14]

Thermalytix ® is an artificial intelligence (AI)-based thermal imaging solution which uses machine learning and image processing techniques to generate an automated interpretation report of thermal breast images.[13] It basically uses automated scoring and image annotations of potential malignancies and vascularity, assists the clinician in better decision making, and improves the quality of care in an affordable and radiation-free manner.[15]

With this background, a study was conducted to evaluate the feasibility and acceptance of the AI-based imaging solution for breast health among women in the reproductive age group in urban slums of central Karnataka. The centre was established in the urban health training centre of a tertiary care teaching hospital and the same services were later expanded to rural field practice areas. The findings discussed below account for the authors' experience in urban slums.

Material and Methods

Ethical clearance was taken from Institutional Ethical Committee, and data was collected after obtaining informed written consent from the study participants.

Study design: An exploratory sequential mixed-methods study.

Study duration: Two years from September 1st, 2019, to August 31st, 2021.

Study setting: The study was carried out in central Karnataka, with an estimated population of around 4,95,519 and with an urban slum population of approx. 59,990.[17]

Study population:

For Quantitative component: Women above 20 years accessing the artificial intelligence-based screening centre for breast health.

For Qualitative component: All the stakeholders involved-members of women self-help groups (SHG), women accessing the screening centre, medico-social workers counselling the women at the screening centre.

Overview of the imaging solution used: Thermalytix© is a computer-aided diagnosis solution to automate the detection of potential malignancy from thermal images. The software consists of novel computer algorithms based on artificial Intelligence and machine learning that analyse thermal images and generate quantitative interpretation. The software enables a low-cost, easy-to-use, portable solution for detecting breast cancer which is effective for all ages of women and does not require expert skills to operate the system. The solution consists of a Food and Drug Administration (FDA) 510(k) cleared Forward-Looking InfraRed (FLIR) A and E Series thermal cameras and Thermalytix software to generate a Thermal Analysis report and interpretation result automatically that a radiologist can review before making a final observation on the patient.[13]

Data collection:

In phase I, a community-based awareness program was conducted in the months of August–September 2019 in urban slums to create awareness among women on breast health. The awareness program included street plays by undergraduate medical students and visits to the female SHG meetings for sensitisation on breast health by the research team.

In phase II, quantitative data and qualitative data were collected.

Quantitative data was collected using a pre-tested semi-structured questionnaire by interview method among women accessing the AI-based imaging centre for breast health. The information collected was on sociodemographic details, obstetric history, and awareness and treatment-seeking behaviour on breast health.

Qualitative data collection involved focus group discussions (FGD) among members of SHGs, in-depth interviews (IDIs) among women accessing the thermal imaging centre, and medico-social workers counselling the women at the imaging centre.

Participants were interviewed using a semi-structured interview guide prepared after the pilot study and consultation with all the stakeholders. The final guide covered the following domains:
1. Knowledge of breast health
2. Histories of breast health-seeking behaviour
3. Experiences of accessing, utilising breast health care centre in Urban Health Training Centre (UHTC)
4. Important promoters and inhibiting factors related to access, utilisation of breast healthcare services

For the purpose of privacy protection, participants were coded during the interview and were encouraged to share their past experiences in accessing any services for breast health in accordance with but not limited to the core topics. Women were encouraged to share any other interesting stories related to breast health. It was made clear to the participants that they could refuse to answer any topics or questions they were not interested in or felt uncomfortable with, and they could also quit the interview at any time. The leading author together with trained notetakers, carried out all interviews and group discussions. Every interview lasted for an hour and was conducted in private rooms at the urban health training centre (UHTC).

Procedure of screening: This was a no-touch, no-radiation, and non-invasive technique, where the woman enters a temperature-controlled room equipped with thermographic imaging solution and undergoes screening under the guidance of skilled paramedic technicians. The procedure is carried out with complete privacy. Five images of the woman are captured for (a) frontal (b) left-lateral (c) left-oblique (d) Right-lateral and (e) Right-oblique views. Figures 1-3 give a few samples of subject images for various types of breast abnormalities.

The Thermalytix ® assesses areas of high thermal activity from the captured thermal images and generates a quantitative interpretation report, with the suggestions of needing further evaluation or not, based on artificial intelligence and machine learning algorithms.[14]

Data analysis:

Quantitative: Data collected was analysed using the Statistical Package for the Social Sciences (SPSS) version 16.0 and is presented with appropriate tables and figures wherever necessary.
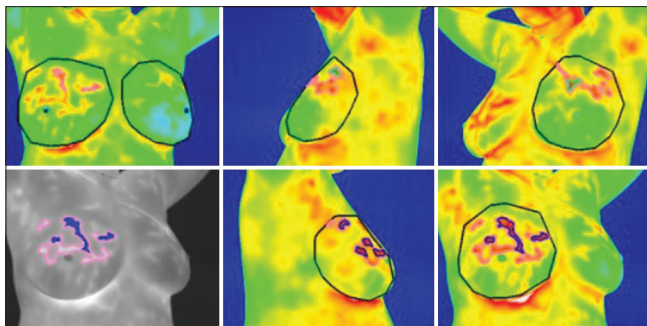
Figure 1: Thermal images of a subject with BIRADS IV Fibroadenoma in the right breast

Qualitative: Discussions and interviews were audio-recorded with the permission of the participants. The transcripts and audio recordings were fully transcribed verbatim by the researchers independently before the Strengths, Weaknesses, Opportunities, and Challenges (SWOC) analysis. For the SWOC analysis, the strategy aimed at summarising and developing themes and subthemes by the generation of keywords, phrases, opinions, thoughts, and attitudes of the participants towards external and internal factors affecting access and utilisation of breast imaging centre. Finally, descriptive content analysis was carried out by the authors, and the sub-themes generated were manually organised into a matrix of strengths, weaknesses, opportunities, and challenges.

Results

Quantitative component: A total of 768 women accessed the screening centre for breast health during the study period. Among them, 129 (35%) women belonged to the age group 31 to 40 years, with the mean age of beneficiaries being 39.9 ± 10.8 years, and of them, 452 (68.5%) women belonged to the Muslim religion. The majority of the study population belonged to Class IV socio-economic class (33.4%) as per the modified BG Prasad socioeconomic classification,[18] with a mean monthly per capita income of Rs. 2,238/- [Table 1]

Qualitative component: A total of five FGDs and sixteen semi-structured in-depth interviews were conducted. The SWOC analysis was carried out to synthesize and organize themes referring to external and internal components related to the AI-based screening solution for breast health.

SWOC analysis matrix includes external factors, which are strengths and weaknesses, whereas opportunities and challenges are internal factors.

Table 1: Sociodemographic profile of beneficiaries accessing AI-based imaging centre for breast health		
	Frequency (*n*=768)	**Percentage**
Age (Years)		
≤20	72	1.6
21-30	150	22.8
31-40	199	35.1
41-50	163	26.4
51-60	108	11.4
≥61	76	2.7
Religion		
Hindu	116	31.5
Muslim	252	68.5
Socioeconomic class		
Class I	8	2.2
Class II	46	12.5
Class III	84	22.8
Class IV	123	33.4
Class V	107	29.1
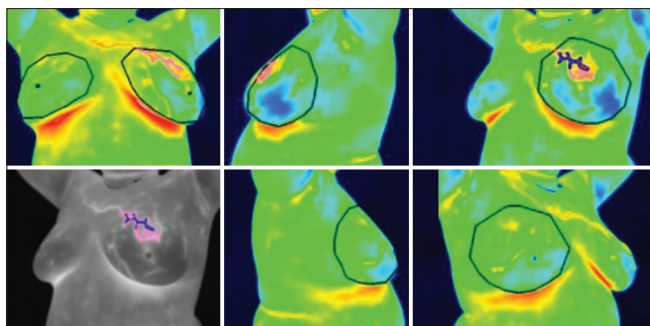
Figure 2: Thermal images of a subject with BIRADS IV Fibrocystic disease of the left breast

Figure 3: Thermal images of a subject with BIRADS V Malignancy B-5 category in the right breast

External factor: Strengths

i. Political attention and support from local healthcare workers helped in planning and implementing this novel program.
ii. Health education materials that were simple, easy to understand, and translated into local languages (Kannada and Urdu) were used for creating awareness during SHG meetings.
iii. The presence of public health nurses and medico-social workers from the same community helped in the reduction of stigma and encouraged women to disclose their health issues freely.
iv. It was an all-women run screening centre as the technicians and medico-social workers were all women, and thus privacy was not a factor of concern.
v. Ultrasound (USG) guided Fine Needle Aspiration Cytology (FNAC), referral, and further management were conducted free of cost as part of encouraging the women to access the services and to remove the stigma associated with breast health.
vi. Readily available screening test results to help decide the future course of action.
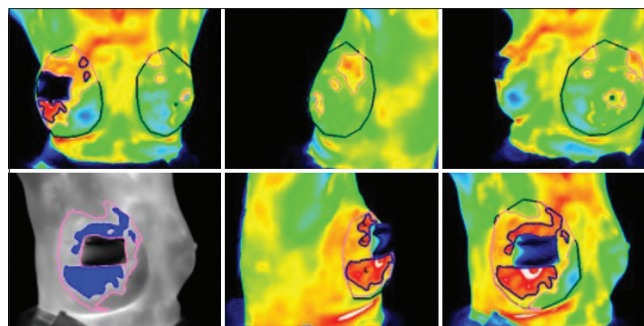
Some of the feedback received is mentioned below:

"It was helpful that you had come to our community and explained this in simple language and cleared our doubts".

"Some of my friends in sthree-shakti sangha encouraged me to undergo this procedure".

External factor: Weaknesses

i. Poor breast health awareness among women.
ii. Women diagnosed with changes and referred for further follow-up were reluctant as some of them did not have any signs/symptoms of breast changes.
iii. The non-availability of USG/USG-guided FNAC at the thermal screening centre was also a barrier.
iv. The cost associated with travel to the tertiary care centre was also one of the barriers.
v. Lack of volunteers for house-to-house visits for screening women/motivating them to access the services and follow-up after the screening.

Some of the feedback received is mentioned below:

"I do not have any lump/pain in the breast, so I do not want to undergo any evaluations."

"I would have undergone further evaluation if it is available in UHTC."

"Will incur a loss of today's pay if I have to visit the college hospital."

Internal factor: Opportunities

i. Community engagement and people-centred approach: The street plays and involving the local SHGs increased the awareness regarding the importance of breast health and thus improved the utilisation of the services.
ii. Human resource: In resource-constrained settings such as in low and middle-income countries (LMICs), where the radiologist to population ratio is as low as 1:100,000, such technology-assisted solutions can be scalable and pave the way forward.
iii. Cost: While a 2D mammogram costs 350,000 USD, a good thermal camera can be procured at 10,000 USD.
iv. Other conditions apart from breast cancer could also be detected (primary breast tuberculosis (TB)).

Internal factor: Challenges

i. Fear of results prevented women from accessing the thermalytix services.
ii. Loss of daily wage: as the majority of the urban slum populace were daily wage workers.

Some of the feedback received is mentioned below:

"It would help if all the services are available at the screening centre, as I do not want to take another day off from work".

Discussion

Data has shown that community-based screening for breast health is virtually non-existent in the majority of the developing countries.[19] Also, the low accessibility and utilisation of health services is one of the major barriers seen in the slum population.[11] A study conducted in a hospital in India found that only 5% of females presented in stage 1,[20] which is comparatively

higher than 4% presenting in tobacco cessation centres as per hospital-based cancer registry.[21] A community-based cancer screening program conducted in Kerala found 22% of females with stage 1 breast cancer, which emphasises the need for strengthening the early case detection for effective treatment and in turn, improves prognosis.[22]

The government of India, in its population-based screening, recommends breast screening for women from 30 years onwards with a clinical breast examination.[12] In our study, we promoted a no-touch, no-radiation exposure, and complete privacy ensured thermalytix screening solution for breast screening among women from 20 years onwards as this initiative was not only for early detection of the breast changes but also to improve breast health awareness, promote breast healthcare access and remove the stigma associated with breast cancer among women. This was promoted as an all-women initiative as the staff nurses and counsellors were all women at the screening centre to encourage active utilisation of services by the women, and a similar experience was also seen in the community-based screening programme of Kerala.[22]

We did not recruit any volunteers from the community, but some of the studies conducted in Mumbai,[23] Kerala,[22] and Sudan[24] have demonstrated volunteers from the community doing a door-to-door screening of the women and referral had resulted in improved utilisation of services and detection of breast cancer in early stages.

Around 47% of the women referred for further investigations and management to the tertiary care centre did not follow up; the reasons were multifactorial; the majority of the women who were lost-to-follow-up were asymptomatic (70%), other reasons included fear/inhibition/stigma associated with breast cancer (10%), and few women (10%) did not consider their breast health requires further evaluation. Few women (10%) also said the cost of travel and loss of pay incurred as a result of visiting the tertiary care hospital, which was around 2–3 km from the screening centre. This was in spite of pre-screening and post-screening counselling for all the women undergoing thermalytix-based screening by the medico-social workers. This was also similar to a multisite study conducted in Bangalore, where thermalytix®-based screening solution was able to detect changes in the majority of the asymptomatic women.[16]

Conclusion and Recommendations

This solution can assist the clinicians, especially primary care physicians providing health care services in remote areas, in better decision making and improve the quality of care in an affordable and radiation-free manner. Also, the AI-based digital tools like thermalytix solutions for breast health are a feasible option for improving healthcare access and utilisation among underserved populations and resource-poor settings like urban slums and rural areas. Engagement of the community through the involvement of local healthcare workers and members of self-help groups will improve the accessibility. Counselling services before and after the screening test would play an important role in improving

the compliance for further evaluation and management. Thus, a comprehensive approach to health awareness, low-cost solutions like AI-based thermalytix imaging, and increased stakeholder participation could be the key to sustainability, and in turn, it could also be implemented in resource constraint areas like urban slums and/or rural areas. An extended study needs to be conducted among women from different strata and among primary care physicians to understand their perspective of the imaging solution.

Implications

This study provides an understanding of why women accept a novel AI-based screening solution for breast health from their perspective. Further, these findings could provide useful information for the policymakers, stakeholders, and other researchers in the related field.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient (s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published, and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Key Messages

Artificial intelligence-based screening solution for breast health is feasible and could be an appropriate solution for resource-constrained settings like urban slums and rural areas with the active involvement of the community.

Conflicts of interest

There are no conflicts of interest.

References

1. Top 10 causes of death. Available from: https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death. [Last accessed on 2021 Dec 25].
2. Cancer. Available from: https://www.who.int/news-room/fact-sheets/detail/cancer. [Last accessed on 2021 Dec 25].

3. Breast cancer. Available from: https://www.wcrf.org/dietandcancer/breast-cancer#:~:text=Breast%20cancer%20is%20the%20most, per%20100%2C000%20in%20Northern%20America. [Last accessed on 2021 Dec 26].

4. Cancer fact sheets. Globocan 2020. Available from: https://gco.iarc.fr/today/data/factsheets/cancers/39-All-cancers-fact-sheet.pdf. [Last accessed on 2021 Dec 26].

5. Clinicopathological profile of cancers in India: A Report of the Hospital Based Cancer Registries, 2021. Available from: https://ncdirindia.org/All_Reports/HBCR_2021/. [Last accessed on 2022 Apr 06].

6. Cancer Statistics. Available from: http://cancerindia.org.in/cancer-statistics/. [Last accessed on 2022 Apr 08].

7. Asthana S, Chauhan S, Labani S. Breast and cervical cancer risk in India: An update. Indian J Public Health 2014;58:5–10.

8. Dikshit R, Gupta PC, Ramasundarahettige C, Gajalakshmi V, Aleksandrowicz L, Badwe R, *et al*. Cancer mortality in India: A nationally representative survey. Lancet 2012;379:1807–16.

9. Babu GR, Lakshmi SB, Thiyagarajan JA. Epidemiological correlates of breast cancer in South India. Asian Pac J Cancer Prev 2013;14:507783.

10. Crochet P, Molinari N, Darmon JC, Cutuli B, Serin D. Followup of patients treated for pT1aN0M0 breast cancer: 10 year survival and prognostic factors. Breast J 2016;22:3635.

11. Shulman LN, Willett W, Sievers A, Knaul FM. Breast cancer in developing countries: Opportunities for improved survival. J Oncol 2010;2010:595167.

12. Operational guidelines -prevention, screening and control of common non communicable diseases -hypertension, diabetes and common cancers. Available from: https://main.mohfw.gov.in/sites/default/files/Operational%20Guidelines%20of%20NPCDCS%20%28Revised%20-%202013-17%29_1.pdf. [Last accessed on 2021 Dec 26].

13. Thermalytix. Available from: https://www.niramai.com/. [Last accessed on 2021 Dec 25].

14. Sudhakar S, Manjunath G, Kakileti ST, Madhu H. Thermalytix: An advanced artificial intelligence based solution for non-contact breast screening. World academy of science, engineering and technology. Int J Med Health Sci 2018;12:2.

15. Singh A, Bhat V, Sudhakar S, Namachivayam A, Gangadharan C, Pulchan C, *et al*. Multicentric study to evaluate the effectiveness of Thermalytix as compared with standard screening modalities in subjects who show possible symptoms of suspected breast cancer. BMJ Open 2021;11:e052098. doi: 10.1136/bmjopen-2021-052098.

16. Kakileti ST, Madhu HJ, Krishnan L, Manjunath G, Sampangi S, Ramprakash HV. Observational study to evaluate the clinical efficacy of thermalytix for detecting breast cancer in symptomatic and asymptomatic women. JCO Glob Oncol 2020;6:1472-80.

17. Davangere city population. Available from: https://www.indiacensus.net/district/davanagere. [Last accessed on 2022 Apr 08].

18. Sharma R. Online interactive calculator for real-time update of the Prasad's social classification. Available from: www.prasadscaleupdate.weebly.com. [Last accessed on 2021 Dec 25].

19. Singh S, Shrivastava JP, Dwivedi A. Breast cancer screening existence in India: A non-existing reality. Indian J Med Paediatr Oncol 2015;36:2079.

20. Agarwal G, Ramakant P. Breast cancer care in India: The current scenario and the challenges for the future. Breast Care (Basel) 2008;3:217.

21. Hospital Based Cancer RegistryAnnual report 2013. Available from: http://www.mcc.kerala.gov.in/dept_CanReg/HBCR_AnnualReport2013.pdf. [Last accessed on 2021 Dec 30].

22. Parambil NA, Philip S, Tripathy JP, Philip PM, Duraisamy K, Balasubramanian S. Community engaged breast cancer screening program in Kannur District, Kerala, India: A ray of hope for early diagnosis and treatment. Indian J Cancer 2019;56:222-7.

23. Kulkarni VS, Mishra AG, Dusane RR. Determinants of compliance to breast cancer screening and referral in low socio-economic regions of Urban India. Int J Prev Med 2019;10:84.

24. Abuidris DO, Elsheikh A, Ali M, Musa H, Elgaili E, Ahmed AO, *et al*. Breastcancer screening with trained volunteers in a rural area of Sudan: A pilot study. Lancet Oncol 2013;14:36370.