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Research article

Improvement of early detection of breast cancer through collaborative multi-country efforts: Observational clinical study

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ABSTRACT

Aim: The aim of this paper is to present baseline imaging data and the improvement that was achieved by the participating centers after applying practice-specific interventions that were identified during the course of a multicentric multinational research coordinated project.

Introduction: The incidence and mortality rates from breast cancer are rising worldwide and particularly rapidly across the countries with limited resources. Due to lack of awareness and screening options it is usually detected at a later stage. Breast cancer screening programs and even clinical services on breast cancer have been neglected in such countries particularly due to lack of available equipment, funds, organizational structure and quality criteria.

Materials and methods: A harmonized form was designed in order to facilitate uniformity of data collection. Baseline data such as type of equipment, number of exams, type and number of biopsy procedures, stage of cancer at detection were collected from 10 centers (9 countries: Bosnia-Herzegovina, Costa Rica, Egypt, India, North Macedonia, Pakistan, Slovenia, Turkey, Uganda) were collected. Local practices were evaluated for good practice and specific interventions such as training of professionals and quality assurance programs were identified. The centers were asked to recapture the data after a 2-year period to identify the impact of the interventions.

Results: The data showed increase in the number of training of relevant professionals, positive changes in the mammography practice and image guided interventions. All the centers achieved higher levels of success in the implementation of the quality assurance procedures.

Conclusion: The study has encountered different levels of breast imaging practice in terms of expertise, financial and human resources, infrastructure and awareness. The most common challenges were the lack of appropriate quality assurance programs and lack of trained skilled personnel and lack of high-quality equipment. The project was able to create higher levels of breast cancer awareness, collaboration amongst participating centers and professionals. It also improved quality, capability and expertise in breast imaging particularly in centers involved diagnostic imaging.

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1. Introduction

Breast cancer is the most prevalent female cancer worldwide. However, it is treatable if detected early which makes it a suitable cancer to screen. Mammography has been the preferred screening modality. Multiple screening trials in the past have shown that population-based breast cancer screening reduces mortality from breast cancer in the screened population [1]. The incidence and mortality from breast cancer are rising worldwide and particularly rapidly across the countries with limited resources [2]. Due to lack of awareness, screening and other early diagnosis options it is usually detected at a later stage. Breast cancer screening programs have not been prioritized in such countries particularly due to lack of funds. Organized screening does not exist in these countries and some opportunistic screening practice is provided in diagnostic centers. The problem gets further compounded by the fact that breast cancer occurs at a younger age in these countries as compared to the affluent nations. Moreover, the availability of mammography facility and skilled radiographers and radiologists is grossly inadequate [3,4].

In high resource countries, there are evidence-based guidelines for the early detection, diagnosis and treatment of breast cancer [5–9]. In the developing world, such guidelines are largely deficient [10]. This leads to a large number of women presenting with breast cancer at a late or advanced stage of the disease, when the likelihood of cure is low resulting to a usually high mortality to incidence ratio [11,12].

There is generally limited expertise in good quality breast diagnostic services, and little or no expertise in formal mammographic screening in many nations [13,14]. There is strong research and service evidence showing that early breast cancer detection and diagnosis, though insufficient in isolation, is essential to reduce the mortality and morbidity from breast cancer. This is because early stage breast cancer has a much higher rate of cure and better survival than late stage breast cancer [15].

X-ray mammography performed under careful quality-controlled process with diagnosis by well-trained radiologists is the only available test repeatedly proven to reduce the mortality rate from breast cancer with provided access to appropriate high-quality imaging, available treatment and care.

In 2012, the International Atomic Energy Agency (IAEA) started a Coordinated Research Project (CRP) in order to enhance the capacity for early detection of breast cancer through imaging. The CRP grouped breast radiologists, medical physicists and radiographers together from 15 different countries with a wide spectrum of established practice. During the 4-year period of the project, many activities were undertaken with the intention to investigate current practices, aiming to improve early detection of breast cancer by strengthening both the clinical component and quality aspects.

The medical physics aspects of this CRP have already been published. Training of medical physicists in QC programs was provided and QC infrastructure was established and strengthened; networking among medical physicists and radiologists was organized and maintained over time. The IAEA Human Health Series publications, Quality Assurance Programme for Digital and Quality Assurance Programme for Film/Screen Mammography provided a uniformed approach to QC measurements [16].

The aim of this paper is to present baseline imaging data and the improvement that was achieved by the participating centers after applying practice-specific interventions that were identified during the course of the CRP.

2. Materials and methods

The study covered the period from 2013 to 2015. The countries were selected upon an open call to the IAEA member states. Initially 15 centers were from 14 countries enrolled in the project, however only 10 centers (Table 1) from 9 countries (Bosnia-Herzegovina, Costa Rica, Egypt, India, North Macedonia, Pakistan, Slovenia, Turkey, Uganda) were able to provide the relevant data. The participating centers varied from regional institutes to organized screening centers (Table 1). Five centers from five countries (Kenya, Mexico, Nigeria, Philippines and Zambia) were excluded. These centers either participated in different work packages of the study or couldn't provide the necessary progress or adequate data during the study period due to administrative and logistic reasons. Three coordination meetings were held during the period of the project to ensure consistent monitoring and evaluation of the progress. National organized screening program did not exist in none of the countries except Slovenia during the study period. One of centers in India and the center from Turkey provided regional organized screening program.

Eligibility criteria for participating centers were defined as below: i: to have radiology service with regular breast imaging workload, ii: to have radiologist and radiographer, both experienced in breast imaging, iii: to have a mammography unit (film-screen or digital mammography machine with appropriate film or digital processing), iv: to have breast ultrasound capability, v: to have image review workstations (mammography viewing lightbox or 5 MP display monitor), vi: to have record keeping and image storage capability, vii: to have local pathology service with capability in breast cytology and histopathology, viii: to have breast surgery service, ix: to have access to medical physics services, x: to have approval from local ethics committee or institutional review board.

The data of 2013 and 2015 were collected from all participants and compiled for comparative analysis. A harmonized form was designed in order to facilitate uniformity of data collection from the participating centers. The key elements in the form included:

1 Number of women undergoing mammography (screening (organized or opportunistic) and diagnostic)

Table 1
Participating countries, institutions and number of procedures.

Center ID	Institution/City/Country	Number of mammograms		Organized Screening: S Oppurtunistic Screening: O Diagnostic: D
		2013	2015	
A	University Clinical Centre of the Republic of Srpska/ Banja Luka/ Bosnia and Herzegovina	1770	3168	O and D
B	Hospital Max Peralta / Cartago / Costa Rica	13498	11882	O and D
C	Women and Fetal Imaging Center / Cairo / Egypt	1130	1403	O and D
D	Rajiv Gandhi Cancer Institute and Research Centre / Delhi/ India	2248	2321	O and D
E	Institute of Nuclear Medicine and Allied Sciences / Delhi / India	1796	2174	S, O and D
F	Public Health Institution Zelezara/Skopje/FYROMacedonia	1261	1171	O and D
G	Multan Institute of Nuclear Medicine and Radiotherapy / Multan / Pakistan	1500	1700	O and D
H	Institute of Oncology-Dora Screening Programme/ Ljubljana / Slovenia	25696	39744	S
I	Memeder Screening Centre/ Istanbul / Turkey	3479	3549	S
J	Mulago National Referral and Teaching Hospital/Kampala/ Uganda	555	400	O and D

2 BI-RADS classification of findings
3 Number of and type of image-guided biopsy procedures
4 Human resources with adequate training
5 Number and type of equipment
6 Quality assurance practices
7 Stage of breast cancer at detection

After the baseline data collection (corresponding to 2013 data) a coordination meeting of all participants was organized, aiming to expose participants to well established breast imaging practices. During the meeting individual local practices were discussed and specific interventions required for each center were identified and common intervention that fit for all centers were set. This meeting also served for enhancing competencies of staff through training activities, such as image guided biopsy techniques for radiologists, mammography positioning for radiographers, performance measurements and dosimetry for medical physicists.

The key interventions that were identified among participants included:

- Full implementation of BI-RADS classification in clinical practice
- Shifting to image guided core biopsies (preferably 14G)
- Implementation of multidisciplinary Breast meetings
- Implementation of QA procedures following IAEA recommendations
- Transition to digital technologies, when feasible
- Initiation of breast cancer awareness campaigns, amongst the general population
- Augment training activities for relevant professionals
- Improvements in data collection process

Participants from all centers (one radiologist and one medical physicist from each center) participated three meetings that were held during the study period. The first meeting was made to collect the baseline data and to set the key interventions that each center should implement which are given above. The second meeting was to train both the medical physicists and radiologists for the execution of these key interventions. The training course in this meeting for the clinical part of the study included: i: positioning and optimization of the exposure parameters, ii: core biopsy procedures and radiologic – histopathologic concordance, iii: fundamentals of BI-RADS iv: multidisciplinary team work in breast imaging v: performance testing of mammography equipment, vi: data collection vii: actions needed for breast cancer awareness. All the centers were asked to make the same interventions. The centers were asked to recapture the data, relevant to the year 2015. The last meeting was to evaluate the progress and collect the data after the interventions. All the centers presented how they made the interventions, the reasons of their success and failure and defined the obstacles they met. These resulting data were analyzed and compared to the baseline data of 2013 to identify the impact of the interventions that have been undertaken. The obstacles and achievements for all centers were noted.

3. Results

The volume of diagnostic and screening mammograms performed by each center during 2013 and 2015 is presented in Table 2.

The major interventions implemented by each participating center are presented in Table 3.

Tables 4a–4c show the results (in BI-RADS scores) for organized, opportunistic and diagnostic mammography practices (Fig. 1). Three centers (E, H, I) had organized screening programs while center H and I exclusively conducted organized screening (Table 4a), (Fig. 1a). Center I and E had recall rates higher than 20% and SL had as low as 3.5%.

Five centers performed an opportunistic screening and diagnostic imaging together (Tables 4b and 4c) (Fig. 1b and c). Two centers performed diagnostic imaging per se. Two centers (centers A and B) were not able to separate the diagnostic and screening mammography results however center B have declared that 90% of their cases were opportunistic screening. Centers F and J performed a very low number of opportunistic screening (Table 2) and did not record their BI-RADS data. The recall rates varied between 1–53.8%.

BI-RADS scores showed vast differences amongst centers (Tables 4a–4c) (Fig. 1). Center H did not use BI-RADS 0 but preferred to give a higher BI-RADS score like 4 or 5 instead. Center G did not record their screening BI-RADS category until after resolving any issues related to BI-RADS 0 leading to a very low recall rate. Centers D and *J* did not use BI-RADS in their reporting and lacked data recording in 2013. These to centers showed an improvement in their results in 2013 after implementation of BI-RADS and data recording.

Two centers introduced image guided core biopsy in their practice as a result of the project and relevant training activities. Image guided biopsy rates increased with a corresponding drop in the rate of FNAB in some of the centers. The distribution of fine needle biopsy, core needle biopsy and stereotaxic biopsy in the centers are given in Fig. 2. Two centers introduced structured reporting system in their practice (Table 4c). Positive predictive values for biopsy (PPV bx) was calculated from relevant data. Centers A, D and E did not provide adequate data for PPV bx. Center J did not have the data recording in 2013 but started a regular data recording system after the intervention. Organized or opportunistic screening centers B, C, G, H and I showed reasonable PPV bx.

Table 5 gives the types of performed surgeries and availability of pre-operative diagnostic work-up in centers with available data. Six centers provided adequate data for 2013 and 2015 where one center (center J) showed an improvement in data management after the intervention and provided their numbers for 2015 (Table 5). Three centers (centers C, H and I) showed an improved proportion between breast conserving surgery and mastectomy rates while other 5 centers presented high rate of mastectomies.

The stages of diagnosed breast cancer were lower in the two centers where organized screening mammography practice was held exclusively. The stages of breast cancers in the centers are given in Fig. 3. Center E was not included in the figure due to non-significant number of cancers (average 6 per year).

The obstacles that each center has met and proposition for a

Table 2
Number and Types of Mammography Performed in 2013 and 2015.

	A		B		C		D		E		F		G		H		I		J	
	2013	2015	2013	2015	2013	2015	2013	2015	2013	2015	2013	2015	2013	2015	2013	2015	2013	2015	2013	2015
Organized	0	0	0	0	0	0	0	0	523	803			0	0	25696	39744	3479	3549		
Opportunistic					745	1027	942	1976	*98*	*102*	160	168	1074	1200					2	26
Diagnostic					385	376	1306	345	1175	1269	1101	1003	426	500					553	374
Opportunistic and diagnostic	1770	3168	13498	11882																
Total	1770	3168	13498	11882	1130	1403	2248	2321	1796	2174	1261	1171	1500	1700	25696	39744	3479	3549	555	400

Table 3
Intervention Actions of Participating Countries.

Interventions	A		B		C		D		E		F		G		H		I		J	
	2013	2015	2013	2015	2013	2015	2013	2015	2013	2015	2013	2015	2013	2015	2013	2015	2013	2015	2013	2015
Implementation of BI-RADS: No (0) Yes (1)	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1
Methodology for data collection: Manual (1), Electronic (2)	1 + 2	1 + 2	1	1	2	2	1	2	2	2	1	1	2	2	2	2	1	1	1	1
Establishment of equipment QC/QA program 0 – No established 1- Provided by manufacturer 2- Provided by external physicist 3- Provided by internal physicist	2	3	2	2	1	3	1	3	3	3	2	2	3	2	2	2	1	2	0	2
Multidisciplinary Breast Meetings: none (0), ad hoc(1), regular(2)	1	2	2	2	1	1	2	2	1	2	1	1	2	2	2	2	1	1	1	1
Number of Community Awareness Programs/Campaigns	0	0	1	1	2	5	3	10	6	10	1	2	6	10	3	5	12	14	0	4
Number of Training courses/events	4	8	3	3	3	6	2	7	2	4	1	1	2	5	9	14	2	4	0	5
Breast counseling: No (0) Yes (1)	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	0	0

Table 4a
Organized Screening Results.

	E		H		I	
	2013	2015	2013	2015	2013	2015
# Mmg	523	803	25696	39744	3479	3549
BI-RADS 0	25.0%	25.9%	0.0%	0.0%	22.9%	22.6%
BI-RADS 1	33.1%	35.7%	65.7%	62.1%	42.0%	42.3%
BI-RADS 2	36.5%	32.6%	30.8%	34.6%	34.4%	34.5%
BI-RADS 3	4.4%	3.2%	0.0%	0.0%	0.5%	0.5%
BI-RADS 4	0.8%	2.1%	3.3%	3.1%	0.1%	0.1%
BI-RADS 5	0.2%	0.4%	0.2%	0.2%	0.1%	0.0%
Recall rate	30.4%	31.6%	3.5%	3.4%	23.6%	23.2%
PPV[a] for Biopsy	n/a	n/a	15%	26%	30%	30%

[a] Positive predictive value.

possible solution were discussed in detail at the last meeting. We tried to classify these, however there was a vast variation amongst the centers about the reasons and priorities. The main problems that were defined and common in all centers were as follows:

- Lack of political will and administrative support
- Insufficient financial resources and infrastructure
- Qualified human resources
- Insufficient resources for data management
- Negligence of culture: This was not a main problem for all centers but was defined by the majority.

4. Discussion

The aim of this IAEA multicentric multinational project has been to identify suitable measures for early breast cancer detection in low-resource countries. The first step was to capture the existing practice for breast cancer detection in the participating institutions. Analysis of data was a challenge due to diversity in practices and mechanisms of data collection from participating centers. Interventions such as enhancing the quality of mammography equipment and professional knowledge and skills were carried out. Finally, the effect of intervention for any change in practice and early detection was analyzed.

The project enhanced awareness about breast cancer and added to the number of mammography examinations being performed e.g. by enhancing workflow efficiency (Table 2). Some general improvements in the participating centers in various countries were noted. However due to the heterogeneity of the practices, each center accomplished different levels of improvement. Breast cancer awareness and education plays an important role in facilitating the detection and diagnosis of early stage breast cancer. Early detection is one of the main factors in decreasing mortality and is cost-effective, with less resource-intensive therapy. However, it only works if it can be followed by prompt therapy. An effective clinical therapeutic approach and early diagnosis are synergistic and reciprocally dependent for the best outcome of the disease. On the other hand, the following diagnostic procedures after early detection and tissue sampling should be well set and simplified and quality measures must be provided. Each country must act according to their national statistics on breast cancer (size, stage, type, treatment, and outcome), available resources and priorities and define their guidelines accordingly [17,18]. This study showed the partial effect of the interventions about implementation of a systemic mammography reading, better tissue sampling and data recording in different centers. Although the improvement was not uniform or involve all centers enhancement of the practices was visible in part of the facilities.

All the centers achieved higher levels of success in the implementation of the QC equipment and procedures [16]. QA is the key issue of screening programs which ensures improving the quality of breast imaging up to a sufficiently high level of quality. Implementation of QA programs showed improvement in clinical mammograms and

Table 4b
Opportunistic Screening Results.

# Mmg	A		B		C		D		E		G	
	1770	3168	13498	11882	745	1027	942	1976	98	102	1074	1200
BI-RADS 0	21.2%	24.2%	31.1%	18.9%	0.0%	0.0%	7.2%	7.5%	31.6%	36.3%	0.0%	0.0%
BI-RADS 1	4.7%	3.8%	41.8%	48.4%	40.9%	30.9%	64.8%	45.5%	22.4%	28.4%	96.3%	95.4%
BI-RADS 2	44.7%	42.4%	26.3%	31.6%	37.0%	55.5%	24.1%	45.7%	35.7%	21.6%	2.9%	3.5%
BI-RADS 3	20.0%	25.0%	0.3%	0.4%	18.7%	12.4%	2.1%	0.6%	6.1%	9.8%	0.7%	0.8%
BI-RADS 4	7.0%	3.8%	0.3%	0.5%	2.1%	1.1%	1.8%	0.6%	3.1%	2.9%	0.1%	0.3%
BI-RADS 5	2.4%	0.8%	0.2%	0.2%	1.2%	0.8%	0.0%	0.2%	1.0%	1.0%	0.1%	0.1%
Recall rate	50.6%	53.8%	31.9%	20.0%	22.0%	14.2%	11.1%	8.8%	41.8%	50.0%	0.8%	1.1%
PPV[a] Biopsy	n/a	n/a	32%	26%	21%	29%	n/a	n/a	3%	8%	40%	39%

[a] Positive predictive value.

Table 4c
Diagnostic Imaging Results.

# Mmg	C		D		E		F		G		J	
	385	376	1306	345	1175	1269	1101	1003	426	500	553	374
BI-RADS 0	50.5%	50.1%	n/a	14.2%	18.5%	27.8%	0.0%	0.0%	0.0%	0.0%	n/a	2.1%
BI-RADS 1	0.0%	0.0%	n/a	9.6%	21.2%	31.7%	0.0%	0.0%	0.0%	0.0%	n/a	48.4%
BI-RADS 2	11.5%	12.9%	n/a	19.1%	34.4%	27.8%	0.0%	0.0%	54.2%	42.8%	n/a	15.8%
BI-RADS 3	17.7%	19.5%	n/a	4.1%	13.4%	5.2%	0.4%	1.1%	2.3%	2.6%	n/a	14.2%
BI-RADS 4	16.3%	10.9%	n/a	12.5%	8.2%	4.6%	1.3%	0.9%	19.7%	20.6%	n/a	20.1%
BI-RADS 5	1.7%	4.0%	n/a	18.0%	3.6%	2.4%	0.0%	0.0%	20.2%	28.6%	n/a	11.2%
BI-RADS6	2.2%	2.5%	n/a	22.6%	0.8%	0.5%	0.0%	0.0%	3.5%	5.4%	n/a	0.8%
Recall rate	86.2%	84.5%	n/a	48.7%	43.7%	40.0%	1.6%	2.0%	42.3%	51.8%	n/a	47.6%
PPV[a] Biopsy	40%	39%	77%	69%	2%	6%	33%	61%	56%	85%	n/a	49%

[a] Positive predictive value.

success in qualifying for national accreditation programs [5,19]. Significant changes in structured reporting of mammograms were observed in centers where BI-RADS was not used before (Tables 4a–4c).

One of the main issues was data recording and analysis. Some centers switched from manual to electronic data recording (Table 3). These centers suffered in retrieving the required data either because of manual recording or due to electronic record scattered among different clinical databases (e.g. HIS, PACS etc.) or lack of coordinated and standardized data recording among departments within the same hospital. The main reasons in negligence of data recording was defined as, lack of IT infrastructure, necessary data collecting software and lacking human resources for data managing. We believe that the availability of a universal, open-source, user-friendly dedicated data software accessible to all the links in the breast-screening chain with data exclusivity will be beneficial. This is particularly true for centers with limited resources or centers with a complex, time-variable internal structure facing large patient workflows as it would allow uniformity of data collecting, monitoring and analyses of the practice along with an improved long-term efficiency of the screening process.

The data showed an increase in the number of trained relevant professionals (Table 3). The collateral effects of training can be seen in the given data, such as the introduction of image guided core needle biopsy practice (with resulting decrease in FNABs) and structured reporting system were achieved. However, availability of free e-learning training modules and webinars for relevant professionals (e.g. radiologists, medical physicists, radiographers) is desirable. Audit visits of multidisciplinary teams to single centers in order to assess the local practice could also be a powerful tool for exchange and improvement of practice both in audited and auditors' centers.

Multiple limitations of the study were identified. First, the duration of the project and observation period was very short to harmonize all the centers to have common practices and observe a clearly positive outcome. Although the standards of good practice have been identified and implemented partially in some centers the impact of outcome cannot be fully substantiated due to the sort period of the study. However quality assurance for mammography was improved and implemented successfully [16]. QA is one of the important pillars of mammography. Even though it is not easy to implement, the existence of concrete IAEA or other guidelines, combined with the procurement of appropriate test tools that took place under this CRP, make its implementation straight forward with relevant resources and can lead to a measurable immediate improvement [16]. On the other hand, good clinical practice is difficult to quantify and significantly prone to the limitation of resources and local practices. However, this project managed to implement basics of BI-RADS and all centers, provided improvement in biopsy practices and raised awareness of quality and good clinical practice among participants. Second, there was no organized screening in the majority of the centers. The data showed higher stages of detected cancers in these centers, as expected (Fig. 3). Screening mammography has to be performed on a large scale of population which makes it resource-intensive. On the contrary, diagnostic mammography can be performed with far fewer resources as it offers significant diagnostic information even in countries where national screening programs are hard to sustain due to low-resources [18]. This kind of service also offers local opportunistic screening which may be a rational solution before starting a national program particularly if supported by awareness campaigns. Third, although BI-RADS is a standard method for uniformization of mammography reporting, interpretation differs widely among participating centers due to local practices [20–24]. In center H, there is a consensus in not using category 0 but instead referring these as 4 or 5. On the other hand, center G used the final determination of the patient as the recorded data due to varied local practices. Although the QC program achieved unified quality measures amongst the centers the training of the participants was not efficient to maintain a better interobserver rapport and data management. Improved training of the participating centers in the use of BI-RADS in order to enhance consistency in reporting will allow improvement of data analysis across multiple sites, ensuring congruency between BI-RADS descriptors and categories and subsequent management.

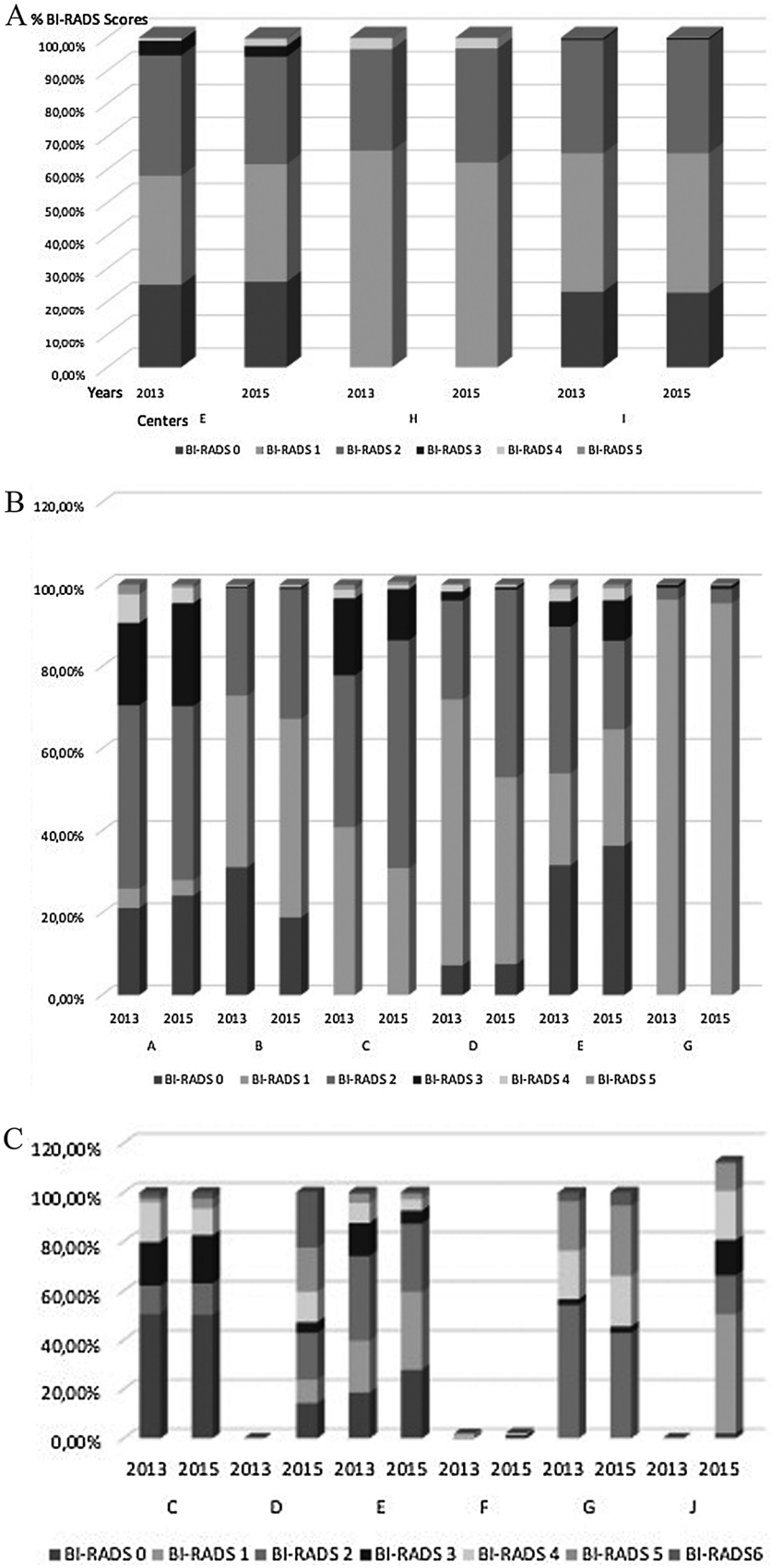

Fig. 1. Distribution of BI-RADS scores a: In organized screening centers, b: In opportunistic screening centers, c: In diagnostic centers.
*FNAB: Fine Needle Aspiration Biopsy, **CB: Core biopsy ***Stx Bx: Stereotactic biopsy.

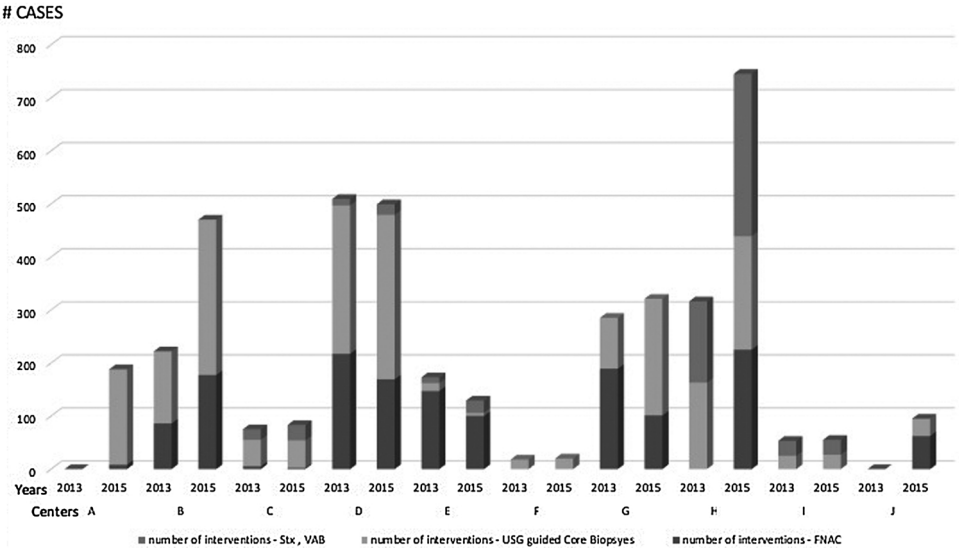

Fig. 2. Number of image guided biopsies according to the centers.

Table 5
Types of performed surgeries and availability of pre-operative diagnostic work-up in centers with available data.

Centers		B		C		D		E		G		H		I		J	
Surgery Preparation	with diagnostic workup	72	125	30	33	526	541	5	8	96	199	48	65	16	17	n/a	171
	without diagnostic workup	0	0	0	0	0	0	0	0	9	3	287	290	0	0	n/a	110
Type of Surgery	BCS[a]	32	78	22	25	117	146	1	1	0	12	207	203	10	13	n/a	5
	Mastectomy	40	46	8	8	409	395	4	7	105	190	59	64	6	4	n/a	164

[a] Breast Conserving Surgery.

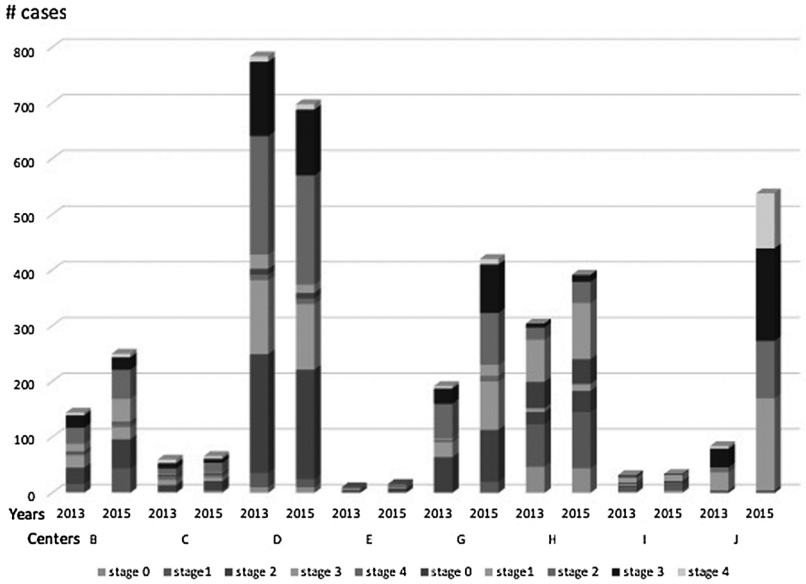

Fig. 3. Percentage of stages of breast cancer in centers.

The practice of mammography for detection of breast cancer is not standardized across the participating centers. The study has encountered different levels of breast imaging practice in terms of expertise, financial and human resources, infrastructure and awareness. The heterogeneity due to these terms was significantly affected by diverse socioeconomic and cultural backgrounds. The most common challenges were the lack of appropriate quality assurance programs and lack of trained skilled personnel other than financial restraints. The knowledge created through the study and results of each center's data highlighted this heterogeneity and diversity. However, the project was able to create higher levels of breast cancer awareness, as well as collaboration amongst participating centers and professionals. It also improved overall quality, capability and expertise in the breast imaging chains.

5. Conclusion

This study highlights that despite the obstacles met due to limited

resources, logistic and administrative problems, some key improvements were partially achieved for good medical practice in breast imaging such as better tissue sampling, structured mammography reporting and basic data management. We conclude that countries or centers with limited resources should specify their deficiencies and priorities for a better outcome in amelioration of their breast health capabilities and further service improvement projects should be concerted to improve breast health practices in countries with limited resources.

Conflicts of interestsstatement

None.

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