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Imaging-based Breast Cancer Screening: A Comparative Study of Screening Pathways in Three Healthcare Facilities in Libya

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A B S T R A C T

The problem of breast cancer is very significant in the contemporary world, as it represents one of the most common causes of death among women due to late diagnoses. Therefore, early diagnosis is necessary to improve the prognosis of the disease and select the optimal treatment. The main imaging technique used to diagnose breast cancer is mammography that detects even slight changes in tissues. However, its effectiveness decreases in women with dense breasts since it reduces the sensitivity of the test and increases the risk of missing certain abnormalities. In this case, ultrasonography is used as a complementary diagnostic technique to improve the results.

Although clinical examination, imaging, and biopsy are standard practices used in all countries for breast cancer detection, the sequence of the procedures differs, especially concerning imaging techniques. Therefore, a comparison of the existing techniques was needed to develop a unified national program. Thus, a retrospective cross-sectional study was conducted on the records of 1150 female patients with an average age of 47 years, ranging between 15 and 65 who had been exposed to ultrasound and mammography in three Libyan medical centers during the year 2021.

The records from three centers revealed that cases were referred to mammography units straightaway after self and physical examination in 713 cases (62%), while in 437 (38%) cases, patients were referred to physicians after ultrasound imaging. From the findings of the questionnaires, it was discovered that almost all mammography pictures taken were from Automatic Exposure Control (AEC), and the radiographers used dose-saving programs by manufacturers (99%). Nevertheless, the majority of the radiographers were not well-informed with regard to guidelines in performing the procedure; they just followed the instructions of the equipment manufacturers. There was also no data on how often the equipment was calibrated. Moreover, the quality management process involved was not well-documented since there were unanswered questions in all the questionnaires returned. This shows that there is a need for an evidence-based study in this particular topic to ensure accuracy and reliability.

Keywords:
Mammography, Radiographer, Quality control, Mammography screening, Breast cancer

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Introduction

Worldwide, breast cancer is regarded as the most common type of cancer in females, accounting for up to 23% of cancer cases (1). It is responsible for 10-18% of cancer- related mortalities, being the leading cause of death due to cancer in developed countries while occupying the third place in developing countries (1,3). Breast cancer cases are on the rise worldwide; however, there is some geographical variation in breast cancer incidence, ranging from that varies from very low cancer incidence, observed in Japan and many countries across Asia, Latin America, and Africa, to countries with a higher breast cancer incidence such as the United States, Western Europe, Northern Europe and Australia (1-,5).

A Libyan study conducted in 2006 (6) provided evidence of an increasing trend in breast cancer in western Libya. This can be attributed to improvements in healthcare, especially with regard to diagnosis. According to Boder et al. (2011), the breast cancer incidence in Libya over a period of four years (2002 –2006) was 18.9 per 100,000 females. Even though this figure is far less than what is seen in Europe or the US, there is a dire need for more advanced diagnostic techniques. This means that it is imperative to keep oneself abreast of the current trends in the diagnosis technologies and also the diagnostic criteria because, at the moment, it seems that the diagnostic criteria are heavily practitioner-dependent. Since there is no national system for regulating the diagnostic processes in all national cancer centers, this research aims to establish national mammographic criteria and a standardized diagnostic pathway to reduce the expected prevalence of breast cancer throughout Libya. On the other hand, mammography has not necessarily increased the frequency of early diagnosis. Some studies have indicated problems with early mammographic diagnosis of breast cancer before menopause. Other studies attempt to determine the variables that can make mammography a reliable and efficient diagnostic procedure. There are certain factors that can affect whether or not a woman undergoes mammogram screening regularly, including whether she lives in a rural area or an urban area, accessibility to mammography, geographical distance from the nearest mammography facility, age, ethnicity/race, and knowledge about the costs associated with mammograms, socioeconomic status (income), and education levels (7-13).

Screening Programs for Breast Cancer in Libya

Due to the complex nature of this issue, some international health organizations prepare specific recommendations for the implementation of screening programs. At present, there are three major forms of breast cancer screening: mammography,clinical breast examination (CBE), and BSE with subsequent biopsy verification. Even though the resulting images from mammography are a well-known, recognized, and effective method for diagnosing breast cancer in the international context, some authors argue that this screening approach might prove inadequate for breast cancer reduction (14). The controversy regarding mammograms is broader than mere benefits; it involves negative consequences as well, such as those related to overdiagnosis. Overdiagnosis involves the detection of malignant tumors through screening which would never cause any symptoms or threat to women's lives if they had not been discovered during screening. This is a clear case of harm from screenings since the absence of markers to distinguish

between benign and threatening overdiagnoses implies that both types of cancers require treatment, exposing patients to unnecessary harm from treatments while deriving no benefit. In addition to false positive mammograms, which occur because of the differing levels of sensitivity and specificity in breast cancer identification (15, 16), there is a risk of encountering such an issue as an interval cancer, which occurs during the interval between a negative screening mammogram and the next scheduled screening round (19). Some researchers suggest that this type of cancer either has not been detected earlier or represents rapidly developing cancer. False-positive screening is a condition that leads to many women being exposed to biopsies and even having unnecessary lumpectomies (16, 17); moreover, a study suggests that women's psychological state deteriorates after receiving the results of the test (18).

Research Objectives

- Indicate the relevance of using the resulting images from mammography in order to diagnose a disease at an early stage.
- Highlight the distinctive features of different diagnostic methods that are used in various medical diagnostic centers.
- Demonstrate the role played by public health education in raising awareness about breast cancer.
- Identify clinical factors that may be overlooked by healthcare practitioners during care delivery.

Methodology

The methodology adopted for this study involved the use of a retrospective analysis of the data available from three national cancer centers in Libya (the National Institute for Cancer Treatment in Misurata, the Tumor Center of Sabratha, and the Sebha Medical Center). This included the examination of the records of cases treated in 2021 and the analysis of data obtained from two questionnaires administered to healthcare professionals in these three centers to examine the differences in protocols used at these three centers. Within this framework, the study concentrates on examining the correlation between the use of mammography as a primary diagnostic technique and the use of ultrasound as an alternative or complementary method for certain cases.

The empirical approach was also applied in order to promote objectivity and reduce personal bias when making this evaluation. This was achieved through the distribution of questionnaires to various medical professionals, such as doctors, technicians, and heads of departments operating within these centers.

Statistical Analysis

The collected data from patient records and the results of the two questionnaires were statistically analyzed using the SPSS version 16.0 for Windows program. This computation was used to find the frequencies and distribution of breast cancer cases from three national medical centers (Misurata, Sabratha, and Sebha) within the year 2021. The focus was put on the number of cases under examination, thereby identifying the center that had the most patients and analyzing the possible reason(s). The output was applied for comparison purposes with other centers in terms of the sequence followed to make the right diagnosis.

Data from questionnaires were to be analyzed qualitatively to find out what practices existed among the medical personnel and to analyze whether mammography devices can be adopted easily. However, it is unfortunate that no

inferential statistics could be done in this regard due to the observational nature of the questionnaires and collected data.

Results and Discussion

High-quality diagnostic practices are necessary for the early detection of cancers. Therefore, this study examined the diagnostic process for breast cancer among three medical facilities in Libya, namely Misurata, Sabratha, and Sebha. The study compared two different diagnostic practices that are used to detect breast cancer among women, namely Exam → Mammo and US → Mammo. Specifically, the study will focus on examining the rates of malignancies among the two diagnostic paths as well as among the different medical centers.

For the purpose of this study, data was collected from three different medical facilities in Libya: 234 cases from Misurata (20%), 343 cases from Sabratha (29.8%), and 573 cases from Sebha (49.8%). Each case was categorized according to its diagnostic practice, namely Exam → Mammo or US → Mammo, and whether the final diagnosis was malignant or not. Statistical analysis involved determining the rates of malignancy of cases under either of the two diagnostic practices. To determine significant differences in malignancy rates, the chi-square test of independence was carried out for three comparisons, namely malignancy rate between the two practices and malignancy rates among the different medical facilities for the Exam → Mammo and US → Mammo practices ($\chi^2 = 63.86$, p-value = 1.3355e-15) and ($\chi^2 = 0.32$, p-value = 0.85327), meaning that there are no significant differences in malignancy rates among all centers.

Graphical visualizations were created to represent the detection rates of malignancy and the number of cases per center and pathway.

Case Distribution in 2021

Observations of the distribution of cases across the three national centers in 2021. The data revealed the following, as summarized in Table 1 and visually represented in Figure (1):

Table (1): Total Breast Cancer Cases by Medical Center (2021)

Center	(No)Total Cases (2021)
Misurata	234
Sabratha	343
Sebha	573

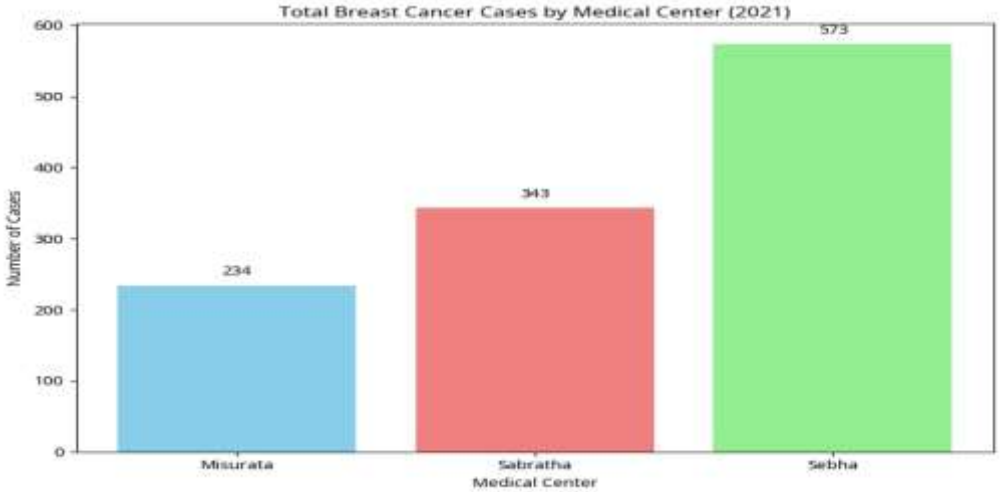

Figure (1): Total Breast Cancer Cases by Medical Center (2021)

The number of suspected cases at Misurata Cancer Center was 234. This can be considered normal given the size of the population in Misurata, taking into account that the cancer center was out of service during the first four months of the year. It should also be noted that the city of Misurata received patients from all parts of the country.

The monthly distribution of suspected cases at Misurata revealed an increase in the number of cases, probably due to growing awareness regarding the availability of the center, as illustrated in Figure (2).

Table 2: Monthly Breast Diagnoses in Misurata Cancer Center (2021)

Month	No of cases diagnoses
January	0
February	0
March	0
April	0
May	11
June	22
July	15
August	24
September	30
October	41
November	44
December	47

This table represents a total of 234 diagnoses, which aligns with the Misurata data.

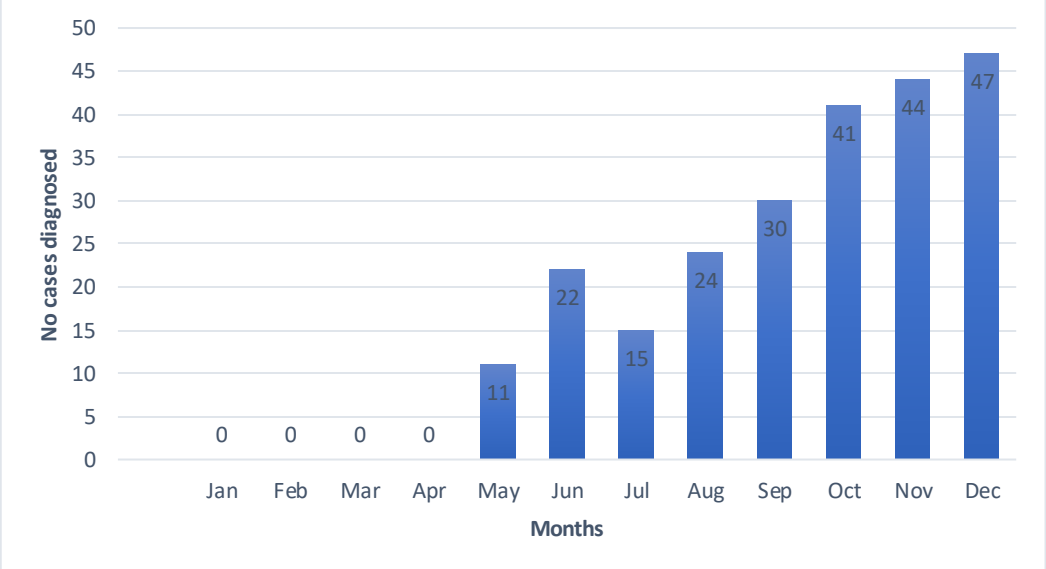

Figure 2: Monthly Breast Diagnoses in Misurata Cancer Center (2021)

In addition to that, the number of suspicious cases were (573) at Sebha Medical Center, which is higher than that of Misurata (234) and Sabratha (343). This is because Sebha Medical Center operates all year round as illustrated in the table (3). In addition to that, breast cancer campaigns made a great difference since 273 cases of breast cancer were diagnosed in the month of October only as illustrated in the figure (3) and this number is more than the total number of cases in Misurata for the whole year. This proves the great effect that both national and international campaigns can have in raising awareness about breast diseases, which has been demonstrated by the research conducted by Fatima Alsharif et al. on the frequency of breast disease in Tripoli (26).

Table (3) Monthly Breast Diagnoses in Sebha medical Center (2021)

Month	No of cases diagnoses
January	23
February	31
March	19
April	71
May	52
June	9
July	27
August	16
September	22
October	273
November	11
December	19

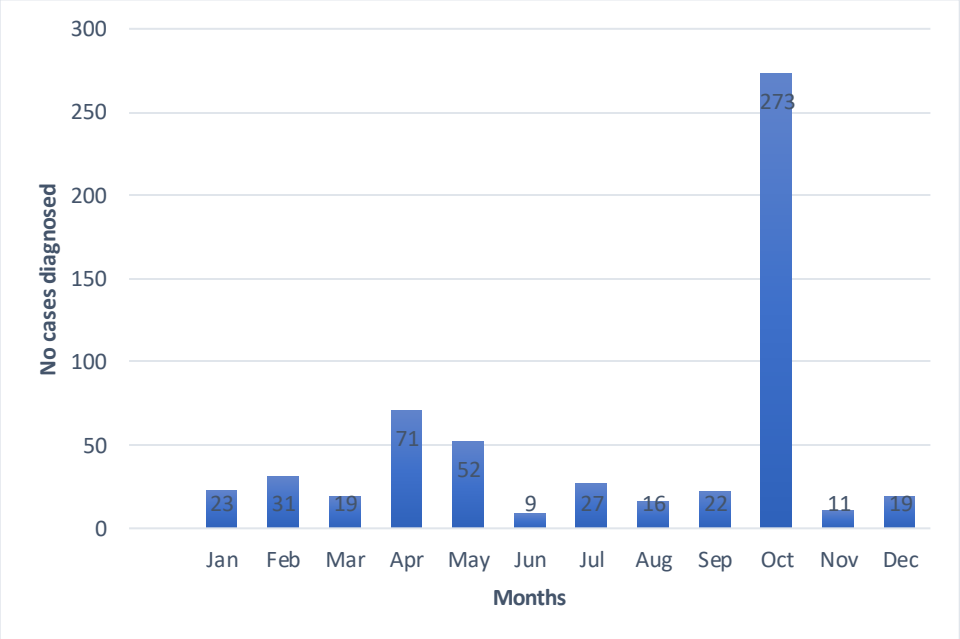

Figure 3: Monthly Breast Diagnoses in Sebha medical Center (2021)

On the other hand, Sabratha Cancer Center diagnosed 343 cases as showen in Table (4). The monthly distribution in Sabratha showed fluctuations, and unlike Sebha, there was no increase in cases during October, as shown in Figure (4).

Table (4) Monthly Breast Diagnoses in Sabratha Cancer Center (2021)

Month	No of cases diagnoses
Jan	23
Feb	19
Mar	42
Apr	27
May	27
Jun	37
Jul	33
Aug	31
Sep	24
Oct	22
Nov	32
Dec	26

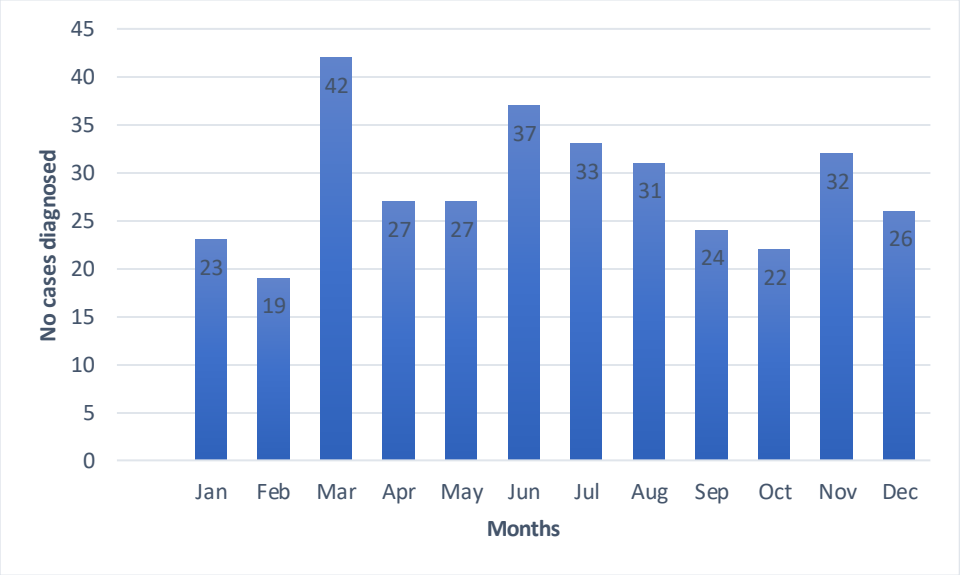

Figure (4) Monthly Breast Diagnoses in Sabratha cancer Center (2021)

Key Results

Overall Pathways Comparison

The findings of the study suggest that there are no significant differences in the use of mammography in the three national health centers.

Table (5) shows that the overall statistical significance of malignancy between 'Exam → Mammo' and 'US → Mammo' pathways was evident (Chi2=63.86, p-value=1.3355e-15). It can be deduced from these results that there is a significant difference in the rate of malignant diagnoses in cases where mammography is done

after an external exam and **in cases where** mammography is done after the ultrasound.

Table (5) differences in malignancies rate in all centers

Center	Misurata	Sabratha	Sebha	sum
(No) cases	234(20%)	343(29.8%)	573(49.8%)	1150
Exam+Mammography	186(79.4%)	227(66.37%)	300(52.3%)	713(62%)
Malignant	74(39.78%)	93(40.9%)	127(42%)	294(41.2%)
Benign	112(60.2%)	134(59.03%)	173(57.6%)	419(58.7%)
US+Mammography	48(20.5%)	116(33.9%)	273(47.6%)	437(38%)
Malignant	34(70.8%)	109(93.9%)	214(78.3%)	357(81.6%)
Benign	14(29.1%)	7(6.03%)	59(21.6%)	80(18.3%)

Between Centers for 'Exam → Mammo' Pathway

No statistically significant differences between the centers in terms of malignancy rates for the 'Exam → Mammo' pathway were observed (Chi2=0.32, p-value=0.85327). This means that the ratio of patients who have been diagnosed as having malignant cancer using this pathway is fairly equal for all three centers—Misurata, Sabratha, and Sebha.

Between Centers for 'US → Mammo' Pathway

However, the 'US → Mammo' pathway has yielded highly statistically significant differences between the centers regarding malignancy (Chi2=17.46, p-value=1.6158e-04).

Table (6) Malignancy Rates by Center and Pathway

Center	Exam -> Mammo Malignancy Rate	US -> Mammo Malignancy Rate
Misurata	0.602	0.708
Sabratha	0.590	0.940
Sebha	0.577	0.784

From Table (6), it can be seen that the highest malignancy ratio in the 'US → Mammo' pathway belongs to Sabratha, with a ratio of 0.940. This is significantly higher than the malignancy ratio in the 'Exam → Mammo' pathway of 0.590, as well as the 'US → Mammo' ratios of Misurata (0.708) and Sebha (0.784). The malignancy ratios of Misurata and Sebha in the 'Exam → Mammo' pathway are similar.

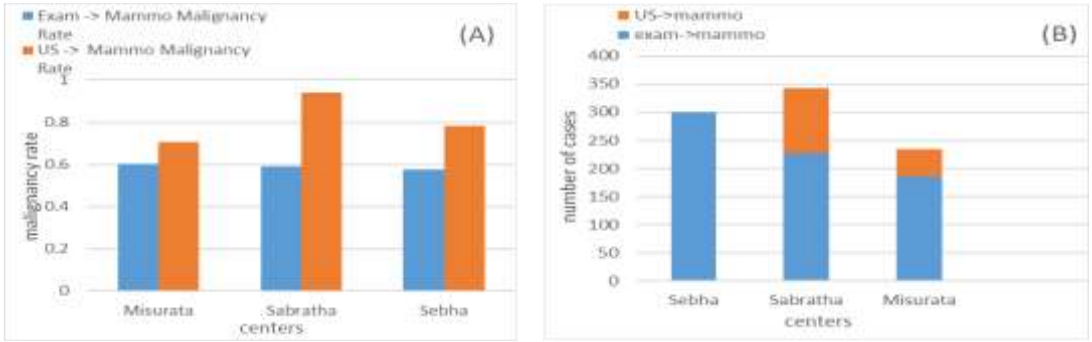

Figure (5) (A)malignancy detection rate by diagnostic pathway
(B)the volume of cases by diagnostic pathway

This graph demonstrates the number of cases for each pathway across the different centers. Sebha received the highest number of cases in total, but a relatively large proportion followed the 'US → Mammo' pathway. Misurata had a lower overall volume of cases, and fewer cases followed the 'US → Mammo' pathway than the 'Exam → Mammo' pathway. An intermediate volume of cases was observed at the Sabratha Cancer Center; however, a notable number of cases followed both pathways.

Discussion

Regarding the outcome of the respondents, the study is based on a moderate-sized sample population, involving only three major national medical centers, which limits the generalizability of the research results. Unlike mammography, ultrasound procedures are operator-dependent, and hence different techniques could have an impact on diagnosis. In favor of the mammogram procedure, however, its low sensitivity rate when diagnosing dense breasts means that ultrasound should be added to the test.

It becomes clear that a considerable difference was noted between the two pathways 'Exam → Mammo' and 'US → Mammo' as shown in the literature, due to their specific role in breast cancer detection (1). The 'US → Mammo' pathway, in which ultrasound preceded mammography, resulted in a relatively high malignancy rate among certain centers, such as Sabratha. This trend was found because there were some reports showing that ultrasound was able to find more cancers among women with dense breast tissue compared to mammography (2,3). As already mentioned above, breast cancer patients in Libya tend to be younger, their average age being about 46 years old (4,5).

The absence of statistical significance in the difference in malignancy rates between centers in the 'Exam → Mammo' pathway points towards the relatively equal use of this diagnostic pathway or similar patient populations selected for this pathway in the centers studied. Such a pattern may be related to the standardization of initial diagnostic tests or to equal patient populations selected for external examination and mammography. The presence of a very significant difference in malignancy rates between centers in the 'US → Mammo' pathway reflects possible differences in clinical protocols used, patient selection criteria, or breast disease pathology at the centers. As seen from the data provided, a much higher malignancy rate of 0.940 at Sabratha in the 'US → Mammo' pathway might suggest a tendency for this center to employ this pathway for patients with high suspicion of cancer after an ultrasound test. This would translate into a higher pre-test probability of malignancy being higher than at other centers. Differences in radiologist expertise, diagnostic ultrasound criteria, or the patient cases referred to this pathway may contribute to the differences in question (1).

All specialists from each center suggested a diagnostic protocol of ultrasound and then mammography followed by biopsy confirmation as the most effective one. Sometimes this was violated because some patients had already undergone mammography as schedule without ultrasound first. Among the participating physicians, mammography was commonly regarded as one of the most accurate diagnostic tools currently in use, which explains its preference for diagnosing older age categories. For patients under 30 years old, ultrasound was suggested because

of the denser structure of the breast tissue. Also in foreign clinics, they confirm the fact that the use of breast ultrasound alongside mammography as a complementary diagnostic tool helps improve the results of testing especially in dense-breast cases (20, 21). According to the Austrian investigation, adding ultrasound tests to mammography helped raise the rate of detection from 3.5/1000 to 4/1000 in the general population, while in dense-breast cases it increased from 1.8/1000 to 2.4/1000(29). Also, there are well-known limitations to conventional mammography, described in the works of Amisha J. Shah et al. (22) and Bussières, André E et al. (23).

Nonetheless, it is imperative to state that variability in mammogram readings affects case reporting. Scientists have been searching for the sources of variability in order to design better screening programs, with reduced numbers of false-positive results without affecting the cancer diagnosis rate (24). It is important to mention that the false-positive results have been reported to range from 1.5% to 24.1% (25).

It should be mentioned that all medical centers in this study used different versions of mammography machines. However, there were some differences because some of the machines were relatively new; for example, the Senographe Prestina machine at Misurata Cancer Center, one of the two Sophil machines at Sebha Medical Center and Radmex. Nevertheless, the mammography machine at Sabratha Cancer Center was relatively old. The parameters concerning the amount of radiation dose were determined by technologists, following the instructions provided by the manufacturers.

Limitations

The current study has limitations regarding the aggregation of the data collected, which does not permit patient-level analysis or adjustment for confounders, such as breast density, or other characteristics. Moreover, the results of this study cannot be generalized to explain on the rationale behind the use of one diagnostic approach versus another. Additionally, the lack of information on the false-positive and false-negative rates associated with the different pathways hinders a comprehensive assessment of their diagnostic value as some of them have not yet been confirmed yet. Also, the lack of data on the characteristics of the tumors decreases the value of the research.

Conclusion

The study demonstrates that the selection of the diagnostic pathway influences breast cancer malignancy detection, with the 'US → Mammo' pathway yielding a higher malignancy detection rate. There are substantial variations between centers, especially in terms of the 'US → Mammo' pathway. Further studies may shed light on the rationale behind these variations and improve the breast cancer diagnosis protocol in Libya.

Recommendations

The following recommendations, based on the above findings of the study**,** are proposed:

- Increased Emphasis on BSE and the Development of National Mammography Programs: In light of the findings, it is necessary to emphasize breast self-examination and gradually adopt national mammography programs in Libya.

Ideally, the programs should be promoted through the media with strong backing from the government.

- Standardization of National Breast Diagnostic Tests: It is necessary to standardize national breast diagnostic tests, including the target age groups.
- Need for Further Studies on Mammography and Ultrasound: Additional studies must be conducted to examine the roles of both mammography and ultrasound as tools for breast cancer diagnosis.
- Public Education for Early Cancer Detection: Increased public awareness campaigns will serve as reminders to the public to get screened for cancer.
- Epidemiological/Etiological Studies: Further epidemiological/etiological studies will aid in identifying some of the causative factors responsible for breast cancer trends in Libya, specifically in southern Libya. This is in light of the fact that the bulk of the literature on cancer incidence trends in Libya focuses on the eastern and western parts of Libya (27–31)

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Conflict of Interest

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- No ☐√

Data Availability

- Yes ☐
- No √☐

Authors' Contributions

N.	Author Name and Emai and ORCID link	Study Conception / Idea	Data Collection or Contribution to Data Collection	Contribution to Previous Studies / Literature Review	Study Methodology	Conducting Analyses (Practical Aspect)	Data Analysis	Interpretation and Discussion of Results	Approval of Final Version
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2									
3									