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Breast cancer awareness, knowledge and self-screening intention among females in Northern Border of Saudi Arabia, Arar City

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Abstract

Background Breast cancer is the most common cancer among females, and early detection plays a crucial role in disease management. This study aimed to assess the knowledge, practices, and barriers related to breast self-examination (BSE) and mammography among Saudi women in Arar City, Saudi Arabia.

Method A cross-sectional observational study was conducted using an online Google Form distributed to women in Arar City. The survey collected sociodemographic data and assessed knowledge, practices, and barriers related to BSE and mammography. Statistical analyses were performed using IBM SPSS Statistics version 27.0.1, with significance set at $p < 0.05$.

Results The study included 385 females, with women aged 19–25 constituting nearly one-third of the population ($n = 118$; 30.6%). Most participants were married ($n = 217$; 56.4%) and held a bachelor's degree ($n = 281$; 73%). While 84.2% ($n = 324$) had heard of BSE and 80% ($n = 308$) demonstrated good knowledge, only 33.5% ($n = 129$) reported performing BSE. Regarding mammography, only 19.5% ($n = 75$) reported undergoing screening, despite 65.1% ($n = 247$) recognizing it as a safe procedure. Educational level ($p = 0.018$), prior knowledge of BSE ($p = 0.009$), and history of breast problems ($p = 0.027$) were significantly associated with higher knowledge scores.

Conclusion While women demonstrated good awareness and knowledge of BSE, its practice remains low, with many unaware of proper techniques, timing, and frequency. Mammography awareness and utilization were also limited, emphasizing the need for targeted educational campaigns to promote early detection and improve screening behaviours.

Keywords Breast cancer, Breast self-examination, Awareness, Mammography, Saudi Arabia

Introduction

Breast cancer (BC) is a multifactorial disease [1]. It is the most common cancer among women worldwide [2], and its incidence rate is higher in developed countries [3]. In 2020, BC ranked as the seventh leading cause of cancer-related death globally, accounting for 685,000 deaths. In Saudi Arabia, there were 3,954 new cases of breast cancer in 2020, accounting for 29% of all cancers reported among women of all ages and 14.2% of all cancers recorded among Saudi citizens [4]. The incidence of breast cancer, expressed as the age-standardized rate per 100,000, varies across different regions of the world:

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more developed regions (74.1), less developed regions (31.3), Western Europe (96.0), Northern America (91.6), Northern Europe (89.4), Australia and New Zealand (85.8), South-Central Asia (28.2), and Eastern Asia (27.0) [5]. Most women are unaware of the risks and protective factors associated with breast cancer, such as gender [6]. The incidence of breast cancer increases with age, peaking during menopause [7].

Factors such as early menarche, late menopause, and prolonged hormone replacement therapy contribute to this increased risk [8]. Conversely, lactation is considered a protective factor [7, 9]. Obesity is linked to breast cancer as it increases estrogen conversion in adipose tissue [10]. Regular physical activity is known to lower the risk of developing breast cancer [11] Additionally, genetic factors and family history also play significant roles in breast cancer risk.

Early diagnosis of breast cancer relies on knowledge about the disease and the use of screening tools, including clinical breast examinations, breast self-examination (BSE), and mammography [12]. Therefore, promoting awareness of regular BSE practice is beneficial. It helps women familiarize themselves with their breast tissue, enabling them to detect any abnormalities as they arise. Furthermore, BSE serves as a valuable screening tool for early diagnosis and improved prognosis of breast cancer [13, 14].

Mammography is an advanced screening method that uses X-rays to detect breast cancer [15]. Numerous randomized controlled trials and meta-analyses have demonstrated that mammography screening significantly reduces breast cancer mortality rates among women [16, 17]. According to the 2015 National Saudi Health Interview Survey, only 1,135 out of 10,735 women underwent breast cancer screenings, indicating a low screening rate [18].

The National Comprehensive Cancer Network recommends annual mammograms for women aged 40 and above. While approximately 6.5% of breast cancer cases are diagnosed in women aged 30 to 40, a significant number occur without a family history. These cases often involve aggressive forms of the disease with poorer prognoses, emphasizing the importance of early detection regardless of family history [19].

Previous studies have shown that emotional factors deter women from participating in breast cancer screenings [20, 21]. Women have cited challenges such as scheduling doctor appointments and concerns about receiving a breast cancer diagnosis [22]. Additionally, limited access to mammography services and the distances required to travel significantly impact women living in rural areas [23].

Despite an expanding body of research on women's awareness, knowledge, and practices regarding breast cancer screening in Saudi Arabia, most studies have predominantly focused on urban centers or select regions, leaving underserved populations underrepresented. Notably, no prior study has comprehensively assessed breast cancer screening awareness, practices, and barriers among the general public in Arar City, located in the Northern Border Region of Saudi Arabia. For instance, a study conducted in Jeddah, KSA revealed that women had low awareness level of BC [24]. The findings from a recent study in Hail, also established that the respondents had average knowledge of BC, risk factors, signs and symptoms. However, they had poor awareness of the practice of BSE [25]. Moreover, poor knowledge and awareness regarding BSE was established among women from Jeddah [26]. Screening methods such as BSE, clinical breast examinations, and mammography play a vital role in the early detection and management of BC. However, low uptake of these practices due to insufficient knowledge, lack of awareness, and cultural or logistical barriers has been widely documented in Saudi Arabia [26]. Studies indicate that although awareness campaigns have increased general knowledge about BC, a significant gap persists between awareness and actionable behavior, such as regular BSE or mammography screening [26]. This gap is particularly pronounced in underserved and remote areas, where healthcare access and educational outreach may be limited [27].

While the findings from studies conducted in different regions of KSA, especially in urban areas of the country highlights existence of poor knowledge and awareness of BSE among women [24–26]. The findings from these regions may fail to represent the population of women from areas where no study have been carried out such as Arar City. Moreover, the evidence from these studies from other regions of KSA, may fail to account for the unique, socioeconomic, cultural and geographical factors affecting BC awareness, knowledge and BSE intentions among women, specifically from Arar City in the Northern Border Region.

Therefore, the presence of this research gap, necessitates the need to conduct a study among women from Arar City to comprehend their awareness, knowledge and intentions toward BSE. This study is important as it fills the gaps on breast cancer (BC) awareness, knowledge, and practicing screening among women in Arar City in Saudi Arabia, which has not been explored before. Breast cancer is the leading malignancy prevalent among women and self-examination (BSE) and mammography help reduce mortality. Yet, in emerging areas such as the Arar City, cultural, physical, and educational barriers may affect the adoption of these practices. This study is

novel one, because it is geographically targeted, providing an extensive assessment of BC screening practices and potential obstacles relevant only to the women living in this region. In doing so, this study provides valuable information on the sociocultural and geographical context of Arar City to inform the planning of targeted public health interventions. These recommendations are expected to contribute to improving early detection, health outcomes, and decreasing BC mortality in the Northern Border Region of Saudi Arabia.

Aim of the study

To determine the awareness, knowledge, attitudes, barriers, and intentions toward breast self-examination (BSE) and mammography among females in the Northern Region of Saudi Arabia, Arar City.

Specific objectives:

1 To assess the awareness of breast self-examination and mammography among females.
2 To evaluate the knowledge of BSE and mammography among females.
3 To explore the attitudes and intentions of females toward BSE and mammography.

Rationale of the study

This study is the first to investigate the awareness, knowledge, attitudes, and barriers related to breast self-examination (BSE) and mammography in the Arar region. Its findings aim to provide evidence for decision-makers to implement targeted screening and educational programs to promote early detection of breast cancer. The results will serve as a foundation for further research in this area and will be disseminated through publication in national and international journals, as well as presentations at scientific conferences, to ensure broad reach and impact.

Materials and methods

This cross-sectional study was conducted over a one-year period from May 2023 to April 2024 in Arar City, Saudi Arabia, targeting the city's population.

Inclusion criteria

- Female Residents of Arar City: Participants were required to be birth-assigned females residing in Arar City, Saudi Arabia. This ensures the study focuses on the target population most relevant to the research objectives.
- Age 18 Years or Older: The study included individuals aged 18 and above, as this age aligns with the legal age of adulthood in Saudi Arabia. This criterion ensured participants have the capacity to provide informed consent independently.
- Informed Consent: Only those who explicitly agreed to participate by completing the consent process were included. The consent form clearly explained the purpose of the study, its voluntary nature, confidentiality assurances, and participants' rights to withdraw at any time.

Exclusion criteria

- Under 18 Years of Age: Females below the age of 18 were excluded to avoid ethical and logistical challenges related to obtaining parental or guardian consent for minors in an online survey.
- Non-Residents of Arar City: Women residing outside Arar City were excluded to ensure the findings are specific to the region under study.
- Declined Consent or Opted Out: Individuals who did not agree to the consent form or chose not to participate were excluded.
- Incomplete or Invalid Responses: Participants who provided incomplete, inconsistent, or otherwise invalid survey responses were excluded during data cleaning to maintain data integrity and reliability.

Sample technique

Participants were selected using a convenience sampling method by distributing the questionnaire online via WhatsApp to local groups targeting adults, including university students, hospital visitors, teachers, and the general public, over a 4-month period (October 2023–January 2024), ensuring accessibility and diversity among 385 participants, while acknowledging the potential biases and limitations associated with this approach.

Sample size estimation

Using the Raosoft sample size formula with a population size of 20,000, a 95% confidence level, a 5% margin of error, and a 50% response distribution, the recommended minimum sample size was calculated to be 384 participants. In this study, we successfully recruited a total of 385 participants, slightly exceeding the required sample size to ensure adequate representation.

The sample size formula used by the Raosoft calculator was as follows:

$$n = \frac{Z^2 \cdot p \cdot (1-p)}{e^2}$$

where:

- n = required sample size,
- Z = Z-score corresponding to the desired confidence level (1.96 for 95% confidence),
- pp = estimated proportion of the population (50% or 0.5 in this case),
- e = margin of error (5% or 0.05).

Substituting the values

$$n = \frac{1.96^2 \cdot 0.5 \cdot (1-0.5)}{0.05^2}$$
$$n = \frac{3.8416 \cdot 0.25}{0.0025} = \frac{0.9604}{0.0025} = 384.16$$

Data collection tool

A cross-sectional survey was conducted in Arar City. An online Google Forms link was distributed to participants who met the inclusion criteria.

Questionnaire distribution

The research questionnaire was distributed online via WhatsApp. Local WhatsApp group links and public messaging groups targeting relevant demographics were identified, and study invitation messages containing the survey link were posted in these groups. Upon clicking the link, participants were directed to a consent form outlining the study purpose, confidentiality, and eligibility criteria. Consent and eligibility screening (e.g., age confirmation) were completed before accessing the anonymous questionnaire. All responses were stored securely in an online database accessible only to the research team.

Instrument validation

The questionnaire was adopted directly from a previously validated survey published in [28], which underwent face validation (expert review of the items) and content validation (systematic examination of survey content). It was used without modifications to ensure its credibility for assessing awareness, knowledge, and barriers. Additionally, the mammography-related questionnaire used in this study was derived from a previously validated survey that employed a self-administered approach. The original study utilized a scoring system to calculate an overall knowledge score by summing responses to the knowledge test, with comparisons between socio-demographic variables and knowledge, attitude, and practice assessed using the Chi-square test, ensuring a robust evaluation of factors influencing mammography practices [29].

Statistical analysis plan

The statistical analyses were conducted using IBM SPSS Statistics version 27, with a significance level set at $p < 0.05$. Descriptive statistics summarized participant characteristics and responses, reporting frequencies and percentages for categorical variables, such as education level and marital status, and medians with interquartile ranges (IQRs) for continuous variables, like knowledge scores, due to their non-normal distribution. Knowledge scores were calculated by assigning 1 point for each correct response and 0 for incorrect ones, resulting in total scores ranging from 0 to 11. Participants were categorized as having good knowledge (scores of 6 or higher) or poor knowledge (scores below 6).

Inferential analyses included the Mann–Whitney U test to compare median knowledge scores between two independent groups, such as married versus unmarried participants, and the Kruskal–Wallis test to compare median scores across three or more groups, such as different educational levels. The Chi-square test was employed to examine associations between categorical variables, such as education level and BSE practice. Additionally, logistic regression analysis was conducted to identify factors influencing key outcomes, including BSE practice and mammography uptake, incorporating independent variables such as age, marital status, education level, and knowledge scores. This approach enabled the identification of significant predictors while accounting for potential confounding effects.

Ethical considerations

Ethical approval for the study was obtained from the Northern Borders IRB under the Northern Borders Health Cluster, Arar, KSA (IRB Log No: NBIRB-023–10–041). Participants were required to provide informed consent before participation, which included clear explanations of the study's purpose, confidentiality measures, and their right to withdraw at any time. To ensure anonymity, all responses were collected via an online survey and securely stored in a password-protected database accessible only to the research team. These measures upheld ethical research standards, ensuring participant rights, data protection, and compliance with institutional guidelines.

Results

Table 1 presents data from 385 females in Arar City, Northern Saudi Arabia, who participated in the study assessing breast cancer knowledge and self-screening intentions. The age distribution varied, with 30.6% of participants aged 19–25 years, 28.3% aged 26–35 years, 19.2% aged 36–45 years, and 21.8% above 45 years. Most participants were Saudi nationals (97.4%), while 2.6% were non-Saudis. In terms of marital status, the distribution was predominantly married (56.4%), followed by single (37.1%), divorced (5.5%), and widowed (1.0%).Regarding education, a significant portion held a

Table 1 Sociodemographic characteristics of participants in the study ($N = 385$)

		N (%)
Age (years)	19–25	118 (30.6%)
	26–35	109 (28.3%)
	36–45	74 (19.2%)
	Above 45	84 (21.8%)
Nationality	Non-Saudi	10 (2.6%)
	Saudi	375 (97.4%)
Marital status	Divorced	21 (5.5%)
	Married	217 (56.4%)
	Single	143 (37.1%)
	Widow	4 (1.0%)
Education Level	Bachelor	281 (73.0%)
	High school	64 (16.6%)
	Less than high school	23 (6.0%)
	Master	13 (3.4%)
	PhD	4 (1.0%)
Occupation	Employee	157 (40.8%)
	Healthcare worker	22 (5.7%)
	Medical student	16 (4.2%)
	Non-employee	142 (36.9%)
	Non-medical student	48 (12.5%)
Family history of Breast cancer	No	302 (78.4%)
	Yes	83 (21.6%)
Having a previous breast problem	No	357 (92.7%)
	Yes	28 (7.3%)

N Frequency, % Percentage

bachelor's degree (73.0%), followed by high school education (16.6%), less than high school (6.0%), a master's degree (3.4%), and a PhD (1.0%).As for occupation, 40.8% were employed, 5.7% were healthcare workers, 4.2% were medical students, 12.5% were non-medical students, and 36.9% were non-employed. Approximately 21.6% of the participants reported a family history of breast cancer, and 7.3% had a previous breast problem.

Table 2 indicates that among the 385 participants, the majority (84.2%) had heard about breast self-examination (BSE), reflecting a high level of awareness within the community. Most participants (93.5%) cited early detection of breast cancer as the primary reason for practicing BSE, while 6.5% were motivated by a family history of breast cancer. Despite this high awareness, only 33.5% of participants reported actually performing BSE. The most common reasons for practicing BSE included routine medical examinations (39.5%), advice from health workers (25.6%), medical reasons (12.4%), noticing a breast lump (11.6%), and a family history of cancer (10.9%). Among those who did not perform BSE (66.5%), responses revealed that many found it inconvenient (5.5%), deemed it unnecessary (15.6%), were too busy (19.1%), felt it was too expensive (2.3%), or provided other unspecified reasons (57.4%).

Figure 1 illustrates the primary barriers hindering the practice of breast self-examination (BSE) among participants. The most significant barrier was a lack of perceived necessity due to not having breast problems (51.9%). Other barriers included not knowing how to perform BSE (19.5%), being too busy (6.2%), and

Table 2 Awareness about practicing breast self-exam

		N (%)
Have you heard about a breast self-exam?	No	61 (15.8%)
	Yes	324 (84.2%)
What are the reasons for practicing breast self-exam?	Breast cancer early detecting	360 (93.5%)
	Presence of family history of Breast cancer	25 (6.5%)
Have you performed a breast self-exam?	No	256 (66.5%)
	Yes	129 (33.5%)
If yes, for what purpose?	Advice from a health worker	33 (25.6%)
	Medical reason	16 (12.4%)
	Noticed abreast lump	15 (11.6%)
	One of my family members had cancer	14 (10.9%)
	Routine medical examination	51 (39.5%)
If not, why?	Not convenient	14 (5.5%)
	Not necessary	40 (15.6%)
	Others	147 (57.4%)
	Too busy	49 (19.1%)
	Too expensive	6 (2.3%)

N Frequency, % Percentage

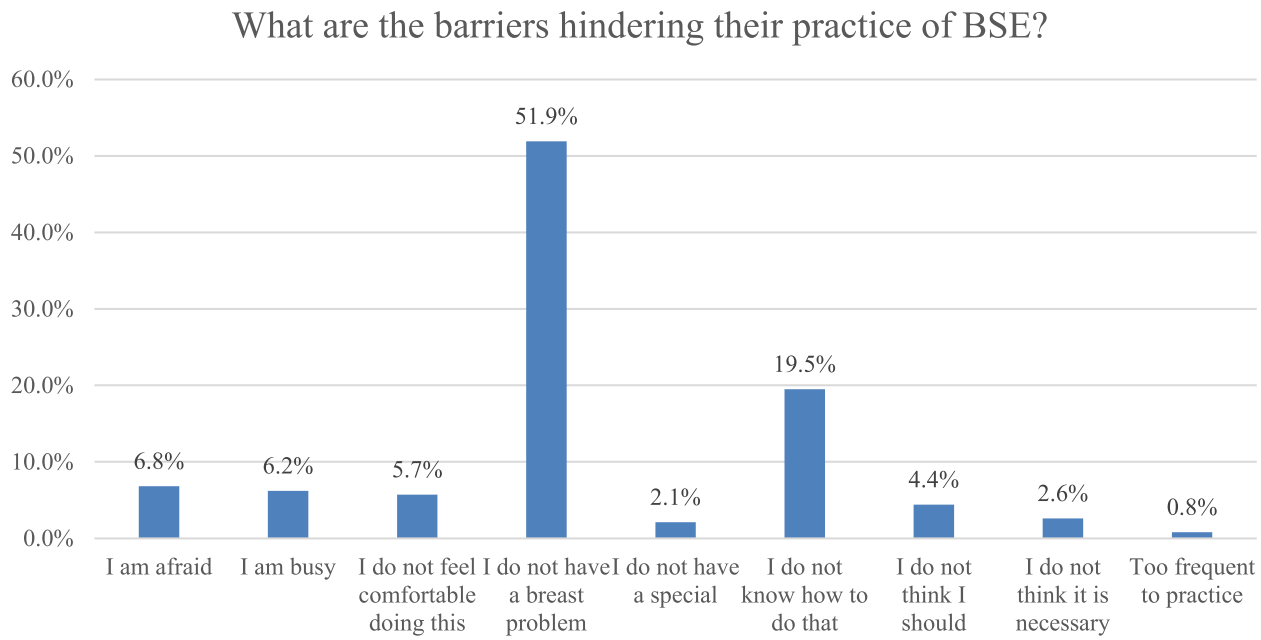

Fig. 1 Barriers hindering the practice of breast self-exam

discomfort with the practice (5.7%). A smaller percentage cited fear (6.8%), the belief that BSE was unnecessary (2.6%), and that it was too frequent to practice (0.8%).

Table 3 indicates that only 10.0% of participants correctly understood that breast self-examination (BSE) involves using fingers around the breasts to detect lumps. Over one-third (34.3%) accurately identified that BSE should be performed monthly; however, a notable 40.0% incorrectly thought it should be done yearly, and 22.1% were unsure. Regarding the timing of BSE, 43.4% correctly identified that it should be performed after menstruation, while 34.5% believed it could be done at any time. Confidence in noticing breast changes was generally low, with only 5.7% feeling highly confident and 47.8% unsure of their ability to detect changes. The vast majority (94.0%) agreed that early detection of breast cancer increases the chance of recovery, and 79.2% believed that women over 20 should practice BSE regularly. Additionally, 94.8% acknowledged the importance of educating females about BSE. However, only 19.5% reported having had a screening mammogram, although 64.2% recognized its significance. While 65.1% acknowledged mammography as safe, 34.9% were unsure or believed it to be unsafe, and 34.3% perceived it as painful. Most participants (83.6%) understood that mammography reduces suffering and death from breast cancer, and 79.5% viewed it as the best choice for screening. Nevertheless, 64.4% did not know the appropriate age to start mammography, with the remaining participants providing varied responses, mostly suggesting ages 29–35 and 46–50.

Figure 2 shows that frequency of breast checks varied, with only 12.5% performing checks monthly, 2.6% weekly, 19.0% at least once in every six months, 31.9% were uncertain, and 34.0% rarely checked.

Figure 3 shows that half of the respondents (50.1%) correctly stated mammography should be done annually, although others suggested intervals ranging from every five years (17.1%) to twice a year (20.5%).

Table 4 shows that the median knowledge scores varied by age, with participants aged 36–45 years achieving the highest median score of 8.0 (IQR: 7.0 – 9.0). However, this difference was not statistically significant. Nationality and marital status did not significantly affect knowledge scores. Educational level had a significant impact on knowledge scores ($p=0.018$). Participants with a PhD had the highest median score of 9.0 (IQR: 8.5 – 9.5), followed by those with a master's degree (8.0, IQR: 6.0 – 9.0). In contrast, participants with less than a high school education had the lowest median score of 6.0 (IQR: 4.0 – 8.0). Occupational status and family history of breast cancer did not significantly influence knowledge scores. However, participants with a previous breast problem had significantly higher knowledge scores (median: 8.0, IQR: 7.0 – 9.0, $p=0.027$) compared to those without such a history (median: 7.0, IQR: 6.0 – 9.0). Additionally, participants who had heard about breast self-examination (BSE) scored significantly higher

Table 3 Knowledge about breast self-exam and mammography

		N (%)
What do you know about the purpose of breast self-exam?	All the above	231 (60.0%)
	Assessment done by doctors/nurses to check for lumps	10 (2.6%)
	BSE is to detect lumps in the breast	105 (27.3%)
	*BSE is using your fingers around your breasts to detect lumps**	39 (10.1%)
How often do you think breast self-exam should be performed?	Daily	6 (1.6%)
	I do not know	85 (22.1%)
	*Monthly**	132 (34.3%)
	Weekly	8 (2.1%)
	Yearly	154 (40.0%)
When do you think is the right time for a woman to perform a breast self-exam?	*After menstruation**	167 (43.4%)
	Any day during menstruation	18 (4.7%)
	Anytime	133 (34.5%)
	Before menstruation	39 (10.1%)
	Middle of menstruation (days 3–5)	28 (7.3%)
How confident are you that you would notice a change in your breasts?	Highly confident	22 (5.7%)
	I Don't Know	184 (47.8%)
	Moderately confident	76 (19.7%)
	Not confident	55 (14.3%)
	Slightly confident	48 (12.5%)
Do you agree that early detection of breast cancer increases the chance of recovery?	*Agree**	362 (94.0%)
	Disagree	4 (1.0%)
	Neutral	19 (4.9%)
Do agree that females more than 20 years old should practice breast self-exams frequently?	*Agree**	305 (79.2%)
	Disagree	11 (2.9%)
	Neutral	69 (17.9%)
Do you agree that females must be educated about breast self-exam?	*Agree**	365 (94.8%)
	Disagree	4 (1.0%)
	Neutral	16 (4.2%)
Have you ever had a screening mammogram?	No	310 (80.5%)
	Yes	75 (19.5%)
Do you know how important that is?	No	138 (35.8%)
	*Yes**	247 (64.2%)
Do you believe Mammography is safe?	No	131 (34.9%)
	*Yes**	244 (65.1%)
Do you believe it is painful?	No	253 (65.7%)
	Yes	132 (34.3%)
Do you believe it reduces suffering and death from breast cancer?	No	63 (16.4%)
	*Yes**	322 (83.6%)
Do you believe mammography is the best choice for screening?	No	79 (20.5%)
	*Yes**	306 (79.5%)
Do you know the age at which you start to have mammography screening ?	No	248 (64.4%)
	Yes	137 (35.6%)
If yes, what is the age range?	29–35	71 (51.8%)
	*36–40**	21 (15.3%)
	41–45	17 (12.4%)
	46–50	28 (20.4%)

N Frequency, % Percentage, * Correct Answer

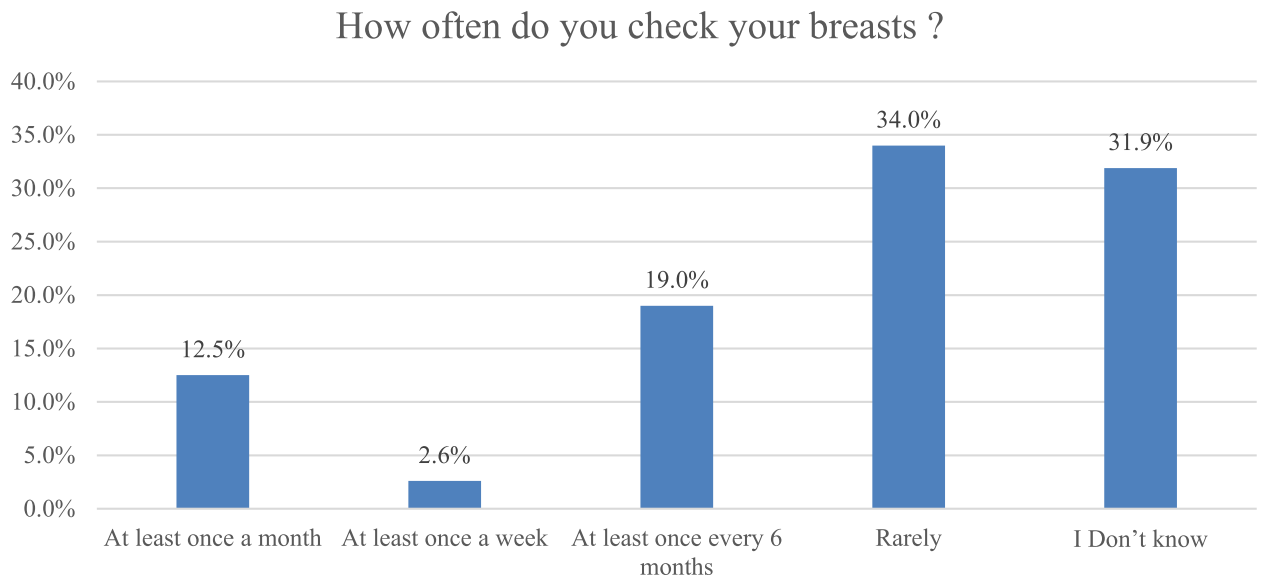

Fig. 2 Participants' response regarding the frequency of breast check-ups

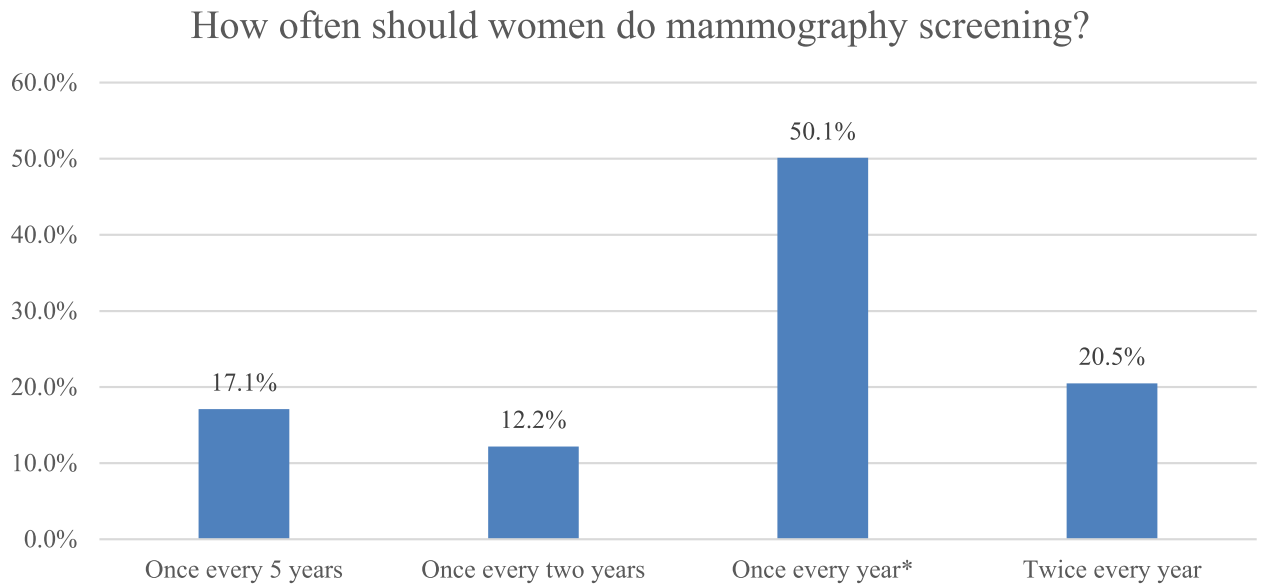

Fig. 3 Participants' response regarding mammography screening

(median: 7.0, IQR: 6.0 – 9.0, $p=0.009$) than those who had not (median: 7.0, IQR: 5.0 – 8.0).

Figure 4 shows that among the 385 total participants, 308 (80.0%) had a good knowledge score (≥6 out of 11), whereas 77 (20.0%) had a poor knowledge score (<6 out of 11).

Discussion

Breast cancer is the most common cancer in women in Saudi Arabia [30]. Health systems face a significant burden due to the rising incidence and increasing mortality rates of the disease. This burden is mainly caused by insufficient awareness, lack of early detection programs,

Table 4 Comparison of Knowledge score among sociodemographic characteristics

		Median (IQR)	Sig.[a]
Age (years)	19–25	7.0 (5.0 – 8.0)	0.097
	26–35	7.0 (6.0 – 8.0)	
	36–45	8.0 (7.0 – 9.0)	
	Above 45	7.0 (6.0 – 9.0)	
Nationality	Non-Saudi	8.0 (7.0 – 9.0)	0.323
	Saudi	7.0 (6.0 – 9.0)	
Marital status	Divorced	8.0 (6.0 – 8.0)	0.564
	Married	7.0 (6.0 – 9.0)	
	Single	7.0 (6.0 – 9.0)	
	Widow	6.5 (6.0 – 7.5)	
Education Level	Bachelor	7.0 (6.0 – 9.0)	**0.018***
	High school	7.0 (6.0 – 8.0)	
	Less than high school	6.0 (4.0 – 8.0)	
	Master	8.0 (6.0 – 9.0)	
	PhD	**9.0 (8.5 – 9.5)**	
Occupation	Employee	7.0 (6.0 – 9.0)	0.583
	Healthcare worker	7.0 (6.0 – 9.0)	
	Medical student	7.5 (6.0 – 8.5)	
	Non-employee	7.0 (6.0 – 8.0)	
	Non-medical student	7.0 (5.0 – 8.5)	
Is there a family history of breast cancer?	No	7.0 (6.0 – 9.0)	0.421
	Yes	8.0 (6.0 – 9.0)	
Have you had a previous breast problem?	No	7.0 (6.0 – 9.0)	**0.027***
	Yes	**8.0 (7.0 – 9.0)**	
Have you heard about breast self-exam?	No	7.0 (5.0 – 8.0)	**0.009***
	Yes	**7.0 (6.0 – 9.0)**	

IQR Interquartile Range, [a] *p*- value, *$p < 0.05$, significant

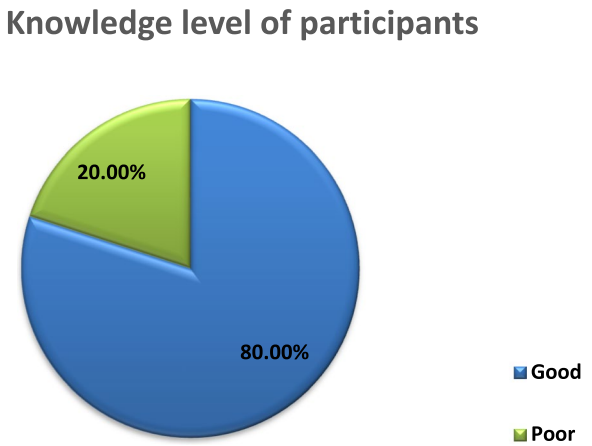

Fig. 4 Knowledge level of participants

and late diagnosis [31, 32].Thus, in this study we assessed the awareness, knowledge and practice of BSE among Saudi women in Arar city, Saudi Arabia.

Awareness and knowledge

This study revealed high levels of awareness about breast self-examination (BSE) among women in Arar City, with 84.2% reporting familiarity with the practice. However, only 33.5% of participants performed BSE regularly, highlighting a significant gap between awareness and practice. This finding aligns with prior studies, such as Jahan et al. [13] and Kharaba et al. [33], which reported BSE practice rates ranging from 18.7% to 46%. The gap between awareness and practice emphasizes the limitations of awareness campaigns that focus primarily on knowledge dissemination without addressing the underlying behavioral, emotional, and psychosocial barriers that inhibit action. Moreover, the revealed discrepancy between awareness and practice indicates that BSE knowledge is superficial for many women, limited to their awareness rather than comprehending the importance of consistent BSE practice. For, instance, while 43.4% of respondents showed awareness of the correct BSE-post-menstruation timing, there was misconceptions regarding the frequency, as 40% believed it should be performed annually instead of

monthly. These highlights the need for educational measures to clarify such important details. In line the present findings, other studies have further revealed better awareness of BC among women, however the practices were suboptimal [34, 35]. Furthermore, the discrepancies between knowledge and practice of BC screening have been attributed to amount of information received by women regarding BC; suggesting the significance of right and correct information in enhancing BC screening practices [36, 37].

Interestingly, 80% of participants in this study demonstrated good knowledge regarding BSE and mammography, which exceeds the findings of Salih et al. [38], where only 35.6% demonstrated good knowledge, and Ibnawadh et al. [39], who reported that 52.1% of female university students had adequate knowledge. These differences may reflect the effectiveness of region-specific educational efforts in Arar City. However, further research is needed to explore how women acquire this knowledge and to identify potential barriers preventing its application. Alqahtani et al. (2019) reported similarly high knowledge levels of BSE in women from the Asir region, with over 90% of the female population demonstrating satisfactory levels of knowledge about the practice [40].

The level of awareness presented in this study is commendably high but this study has also portrayed another vital notion about the nature of awareness. Campaigns entail dissemination of information regarding the practice of BSE and what it entails without much emphasis on why it should be practiced and how to practice it. The gap therefore can be managed by implementing behavioral psychology into awareness strategies since women fail to act due to cognitive biases like optimism bias; assuming one will not be affected by breast cancer [41]. Additionally, this study identified that the respondents had low confidence in detecting breast changes, with only 5.7% being highly confident. This lack of confidence may arise from inadequate training or fear of misdiagnosis, which could prevent women from regular self-examinations. These findings point to the crucial role of healthcare providers in bridging this gap through hands-on demonstrations and workshops that enhance both technical understanding and personal confidence. These findings align with previous studies which identified inadequate confidence and skills related to BSE among women [42, 43].

Barriers to BSE practice

The most reported barrier to practicing BSE was a lack of perceived necessity, with 51.9% of participants indicating they did not perform BSE because they had no breast problems. This finding aligns with Salih et al. [38],who highlighted low perceived risk as a critical deterrent for Saudi women. Many participants associate BSE with the presence of symptoms, such as lumps, rather than recognizing it as a preventive measure. This emphasizes the need for public health initiatives that focus on educating women about the importance of early detection, even in the absence of symptoms.

Moreover, 19.5% of participants reported not knowing how to perform BSE, indicating gaps in practical knowledge despite high levels of awareness. This highlights the need for skill-based workshops or accessible video tutorials to help women feel confident and competent in performing BSE. Addressing these barriers is essential for improving screening practices and empowering women to take proactive steps toward their breast health. Shrestha et al. (2017) examined the knowledge of BSE among female health personnel, reporting that 72.5% had an average level of knowledge, while only 5.6% exhibited good knowledge of the practice [44].

This study's findings further highlight the need for culturally adaptive interventions based on identified barriers. For instance, in Saudi Arabia, societal norms may not allow for open discussions regarding breast health, particularly in conservative communities [45]. Health promotion efforts could counteract this by integrating breast cancer education into broader women's health initiatives, therefore reducing the stigma around the topic and allowing for open discussion. Further, the cited "lack of necessity" reveals an overreliance on symptom-based healthcare seeking. This may be due to limited exposure to preventive health education during the school years. Therefore, a life-course approach could begin with health education in schools and set an enduring pattern of effective preventive behaviors. Gaining support from relevant role models in the community like social media personalities or renowned religious leaders could also be a way of enhancing support for BSE practices in the community [46, 47].

Demographic variations

Consistent with findings by Al-Mulhim et al. [48] and Pilehvarzadeh et al. [49], this study found that higher education levels and prior knowledge of BSE were significantly associated with better knowledge scores. Participants with advanced degrees, such as PhDs, had the highest knowledge scores, emphasizing the importance of formal education in improving health literacy. However, unlike studies by Kharaba et al. [33] and Salih et al. [38], this study did not identify significant associations between age or occupation and BSE knowledge. This difference could be due to regional or cultural differences, as well as variations in sample demographics. Future studies should explore these factors in more depth to

better understand the determinants of BSE knowledge and practice.

Although education was strongly associated with knowledge scores, this study offers a unique opportunity to examine intergenerational influences on health literacy. Participants who are older have fewer formal educational opportunities but may still influence younger women through familial or community roles. The education efforts could be amplified by intergenerational health campaigns that encourage older women to mentor younger generations in health practices such as BSE [50]. Furthermore, the findings reveal no significant associations between age and occupation and knowledge, further underscoring the need for more specific health promotion strategies beyond demographic generalities. For instance, addressing communications to homemakers as a specific audience, which may have limited time due to the responsibilities of being homemakers, may help improve their uptake of health promotions.

Mammography utilization

This study found a low rate of mammography uptake, with only 19.5% of participants undergoing the procedure. This aligns with Al-Dayel et al. [51], who reported a 25% mammography utilization rate among Saudi women. Limited access to mammography services, financial constraints, and a lack of awareness about the recommended age and frequency for screening are likely contributors to this low uptake. Notably, 64.4% of participants were unaware of the appropriate age to start mammography, highlighting a critical knowledge gap. Community-based education programs that focus on the importance of mammography and provide clear guidelines could play a key role in addressing this issue.

Fear of pain and perceptions of mammography safety also emerged as significant barriers. While 65.1% of participants believed mammography was safe, 34.9% expressed uncertainty or perceived it as unsafe, and 34.3% viewed it as painful. These findings align with Mulhim et al. [48], who reported that fear of discomfort deterred women from undergoing mammography. Public health initiatives should address these misconceptions by providing accurate information about the procedure, including testimonials from women who have undergone mammography and detailed explanations of the process. Hence, the low mammography uptake evidenced in this study is not an indication of patient-level factors only, but organizational-level challenges as well. Accessibility remains a significant concern, specifically in areas such as Arar City in a remote or rural setting. As a solution to some of the logistics, the consideration of telehealth services can help women seek pre-screening consultation on whether they require a mammogram before proceeding to a facility [52]. Further, it would be possible to enhance both the accessibility and engagement of screen campaigns by introducing community-based 'screening days' where the healthcare professionals could come to neighborhoods.

Implications for public health

The findings from this study emphasize the need for multifaceted public health interventions to close the gap between awareness and the practice of breast cancer screening. Educational campaigns should aim to reshape women's perceptions of breast cancer risk and highlight the preventive benefits of breast self-examination (BSE) and mammography. These campaigns must also address key barriers such as fear, discomfort, and cultural taboos that prevent engagement.

Skill-development workshops, led by healthcare providers or community leaders, could offer hands-on BSE training, while interactive technologies like mobile apps or online tutorials could provide private, accessible guidance. Community health workers should play a pivotal role in promoting screening, addressing women's concerns, and overcoming logistical challenges in accessing care. Moreover, mobile mammography units could expand access for underserved populations, particularly in remote areas.

Further research is essential to understand the psychological and cultural factors influencing screening behaviors in Saudi Arabia. Qualitative studies could explore the role of family support, healthcare provider recommendations, and religious beliefs in shaping women's attitudes toward breast cancer screening. Longitudinal studies could assess the lasting effects of educational interventions on screening behaviors and clinical outcomes, providing critical insights for future public health strategies.

Limitations

This study has several limitations that should be considered when interpreting the results. First, the use of an online questionnaire may have introduced selection bias, as it limited participation to individuals with internet access and familiarity with the platform, potentially excluding certain populations. Additionally, the study was conducted in a single city (Arar City), which may limit the generalizability of the findings to other regions in Saudi Arabia or beyond. Second, the cross-sectional design of the study does not allow for the establishment of causal relationships between variables. Lastly, the questionnaire did not capture specific familial data on participants reporting a family history of breast cancer, which could influence screening behaviours. These factors may have influenced the study's results and should be considered in future research, which could benefit

from including broader, more diverse populations, utilizing a mixed-methods approach, and collecting detailed familial health history data.

Conclusion

This study found that while most participants were aware of breast self-examination (BSE) and demonstrated good knowledge, many did not practice BSE regularly due to barriers such as lack of time and confidence. Limited awareness of mammography was also observed, highlighting the need for targeted educational campaigns to enhance screening practices. The study's limitations, including convenience sampling and a focus on a single city, may limit the generalizability of the findings. However, the results emphasize critical gaps in screening behaviours and underscore the need for improved public health interventions. Future research should involve larger, more diverse samples and address regional variations to develop more effective interventions. Public health initiatives should focus on bridging the gap between knowledge and practice by overcoming barriers to screening, thereby improving early detection and reducing breast cancer mortality rates.

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Data access statement
All relevant data are within the paper and its Supporting Information files.

Authors' contributions
Waad Alanazi: A. Wrote the main manuscript text (Introduction, Result, Discussion, conclusion) figures, and tables and ethical considerations. GhofranMohamed: B. reviewed and edited the manuscript. Nawaf Alosaimi: C. Study Design and Collected data. Lana Alosaimi: D. sample size and Statistical Analysis. Suliman Elsheekh: Principal investigator; reviewed and edited the manuscript.

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Data availability
Data is provided within the supplementary information files.

Declarations

Ethics approval and consent to participate
This study was conducted in accordance with the ethical standards of the Declaration of Helsinki and was approved by the Northern Borders IRB (H-09-A-051) under the Northern Borders Health Cluster, Arar, KSA (IRB Log No: NB-IRB-023–10-041). Informed consent was obtained from all participants through an online questionnaire, which explained the purpose of the study, ensured confidentiality of responses, and clarified the right to withdraw at any time. All responses were collected anonymously and stored in a secure, password-protected database accessible only to the research team, thereby maintaining participant privacy and data protection.

Consent for publication
Not Applicable.

Competing interests
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