

RESEARCH ARTICLE

Editorial Process: Submission:03/03/2026 Acceptance:06/09/2026 Published:27/09/2026

Prevalence and Predictors of Awareness of the Kuwait National Mammography Screening Program Among Women in Kuwait: A Cross-Sectional Study

Ahmad Salman^{1*}, Fatima Al-Ghadban¹, Ahmad Abbas²

Abstract

Background: Breast cancer is the leading malignancy among women in Kuwait. The Kuwait National Mammography Screening Program (KNMSP), launched in 2014, provides free biennial mammography to asymptomatic women aged 40–69 years; however, participation remains persistently low and awareness is insufficiently characterized. This study aimed to estimate the prevalence of KNMSP awareness and identify its independent predictors across sociodemographic, knowledge, behavioral, and attitudinal domains. **Methods:** A community-based cross-sectional survey was conducted among 458 women aged ≥ 20 years residing across all six governorates of Kuwait between January and April 2025, using convenience sampling via social media and community networks. Of 516 women who accessed the questionnaire, 458 met eligibility criteria and completed all items (response rate 88.7%). Standardized validated instruments assessed breast cancer warning-sign knowledge, risk-factor knowledge, screening beliefs, and perceived barriers. Hierarchical multivariable logistic regression identified independent predictors of KNMSP awareness. **Results:** Overall, 65.3% of participants ($n=299$) reported awareness of the KNMSP. In the final adjusted model (Nagelkerke $R^2=0.355$; AUC=0.798), knowledge of breast self-examination (BSE) was the strongest independent predictor (OR=3.60; 95% CI 1.87–6.93; $p<0.001$). Women aged 20–29 years (OR=0.29), unpartnered women (OR=0.40), and non-Kuwaiti women (OR=0.47) had significantly lower adjusted odds of awareness. Perceived barriers and screening beliefs were not independently associated with awareness. **Conclusions:** Two-thirds of women in Kuwait are aware of the KNMSP; however, substantial gaps persist among younger, unpartnered, and non-Kuwaiti women. Integrating BSE education into outreach initiatives, strengthening primary-care referral, and developing multilingual campaigns targeting high-gap subgroups are priority actions to improve program visibility and, ultimately, screening uptake.

Keywords: Breast cancer screening, Mammography, National screening program, Awareness, Kuwait

Asian Pac J Cancer Prev, 27 (9), 3487-3495

Introduction

Breast cancer is the most commonly diagnosed malignancy among women worldwide, with approximately 2.3 million new cases and 666,000 deaths in 2022 [1]. Early detection substantially improves survival: the five-year survival rate exceeds 99% for localized disease, declining to 86% with regional spread and 31% with distant metastasis [2]. Incidence continues to rise across low- and middle-income countries, driven by demographic transitions, changing reproductive patterns, and lifestyle modifications, and organized mammography screening remains the cornerstone of early detection and mortality reduction [3]. In the Gulf Cooperation Council (GCC) region, breast cancer incidence has increased markedly over recent decades, and awareness campaigns have struggled to translate knowledge into sustained

screening participation [4]. Kuwait is no exception: breast cancer accounted for 38.3% of new cancer cases in 2012, rising sharply to 56.7% by 2019 [5, 6], and currently represents approximately 39.8% of all female cancer diagnoses, yet most cases continue to present at advanced stages, reflecting insufficient utilization of available screening services.

In 2014, the Kuwait Ministry of Health, in collaboration with Memorial Sloan Kettering Cancer Center, launched the KNMSP to provide free digital mammography to asymptomatic women aged 40–69 years [7]. The program achieved a cancer detection rate of 13.6 invasive cancers per 1,000 screened women over its first five years [8]. Despite this technical success, participation has been persistently low: only 7.8% of eligible women were screened over five years far below the 70% coverage target [7, 8]. Program reports have identified lack of awareness as

¹Department of Public Health Practice, College of Public Health, Health Sciences Center, Kuwait University, Kuwait City, Kuwait. ²Nuclear Medicine Department, Farwaniya Hospital, Ministry of Health, Kuwait City, Kuwait. *For Correspondence: ahmad.salman@ku.edu.kw

a primary constraint, noting that the majority of attenders reached the program through healthcare-worker referral rather than self-initiated participation [8].

Awareness of a screening program is a necessary precondition for participation. Kuwait's population includes both nationals and a large expatriate community, with potential disparities in health information exposure and screening norms that may shape program awareness [4]. Qualitative research among Kuwaiti women has identified fear of diagnosis, social stigma, and limited knowledge of available services as deterrents to attendance [9], while a recent cross-sectional study confirmed that fear of pain and appointment constraints remain the most frequently cited barriers to mammography uptake [10]. Across the broader GCC and Arab world, cancer fatalism, embarrassment, and system-level barriers have been documented as persistent deterrents [11]. Studies in Qatar and Saudi Arabia have demonstrated that breast cancer knowledge does not reliably translate into organized screening participation [12, 13], and a Saudi systematic review of 13 studies found that 66.3% of women had low breast cancer awareness and fewer than half performed breast self-examination regularly [14]. Frameworks such as the Health Belief Model posit that perceived susceptibility, severity, benefits, and barriers jointly shape health-seeking decisions [15].

Despite these insights, awareness of the KNMSP as a distinct, investigable outcome has received minimal empirical attention in Kuwait. The present study therefore had two specific aims: (1) to estimate the prevalence of KNMSP awareness among women residing across all six governorates of Kuwait; and (2) to identify independent predictors of KNMSP awareness across sociodemographic, knowledge, behavioral, and attitudinal domains using hierarchical multivariable logistic regression.

Materials and Methods

Study Design and Setting

This cross-sectional survey was conducted between January and April 2025 among women residing across all six governorates of Kuwait. The survey assessed breast cancer awareness, screening behaviors, beliefs, perceived barriers, and KNMSP awareness as the primary outcome. Of 516 women who accessed the online questionnaire, 458 met eligibility criteria and completed all items, yielding a response rate of 88.7%. Data were complete with no missing values across study variables; consequently, no imputation or exclusion procedures were required.

Study Population and Eligibility

Eligible participants were women aged 20 years or older residing in Kuwait who were able to complete the questionnaire in Arabic or English. Broader age inclusion allowed examination of KNMSP awareness across the full adult female population, including younger women who represent a future target cohort for screening promotion. Women were eligible regardless of personal or family history of breast cancer, prior participation in educational programs about breast cancer, or employment status; these variables were treated as measured covariates,

not eligibility criteria. Women who did not provide informed consent, were younger than 20 years, or returned questionnaires with excessive missing data ($\geq 20\%$ of items) were excluded. After data cleaning, 458 complete responses were retained.

Sample Size

Sample size adequacy for the hierarchical logistic regression was confirmed using the events-per-variable (EPV) criterion: with 299 KNMSP-aware participants (events) and 21 predictor degrees of freedom across four blocks, the EPV was 14.2, which exceeds the recommended minimum of 10 EPV for stable logistic regression estimates [16]. The sample therefore provided adequate representation of both outcome groups to support the hierarchical model.

Data Collection

Participants were recruited using convenience sampling. A structured, self-administered questionnaire was distributed in parallel Arabic- and English-language versions through multiple channels to maximize reach across all six governorates. The survey link was disseminated via social-media platforms (WhatsApp, Instagram, Twitter/X), women's health advocacy networks, and institutional mailing lists. In addition, a QR code linking directly to the survey was physically distributed in hospitals, primary health centers, and university campuses across Kuwait to reach women with varying levels of digital access. Community organizations and public health networks were also engaged to recruit participants across diverse age groups, educational levels, and governorates. Participation was voluntary and anonymous. The instrument underwent content validation by three subject-matter experts in public health and oncology, who independently evaluated each item for content relevance, clarity, and cultural appropriateness; expert feedback was incorporated through iterative revisions. The questionnaire was then pilot-tested among 30 Kuwaiti women representing a range of ages (20–60 years) and educational backgrounds, recruited by convenience from community and academic networks and not included in the main study. The pilot assessed clarity, comprehension, and cultural suitability. Minor modifications resulted, including refinement of Arabic wording for two items, simplification of one composite item, and improvement of question flow. No major structural changes were required.

Survey Instrument

The questionnaire comprised 70 items (approximately 10–12 minutes) organized into seven domains: (i): sociodemographic and clinical characteristics, including personal and family history of breast cancer; (ii): breast cancer warning-sign knowledge nine items from the Cancer Awareness Measure (CAM) [17], summed to a total warning-sign score (range 0–9); (iii): breast cancer risk-factor knowledge ten items from the CAM [18], summed to a total risk-factor score (range 0–10); (iv): BSE knowledge and practice history, including clinical breast examination (CBE) history; (v): screening

beliefs thirteen items from the Breast Cancer Screening Beliefs Questionnaire (BCSBQ) [19, 20], summed to a total barrier-belief score; (vi): perceived barriers to help-seeking ten items from the CAM barrier subscale [17], summed to a total barrier score; and (vii): KNMSP awareness, assessed via a single binary item.

Instrument language and translation

CAM-derived items were administered in Arabic following a standard forward-backward translation and cross-cultural adaptation process. Independent bilingual translators (native Arabic, fluent English) produced a forward translation of the English items; a reconciled version was then back-translated into English by an independent translator unaware of the originals; discrepancies were resolved by consensus between the research team and translators. The resulting Arabic version is consistent with the validated transcultural Arabic adaptation of the Breast Cancer Awareness Measure developed by Al-Khasawneh et al. [21], which used formal forward-backward translation and psychometric validation in 972 Arab women. For the BCSBQ, the validated Arabic version developed by Kwok, Endrawes, and Lee [20] was used; that version was formally translated, back-translated, and psychometrically validated in 251 Arabic-speaking women (Cronbach's $\alpha = 0.81-0.93$). The BCSBQ was used for academic, non-commercial research purposes with appropriate citation of the original developers [19, 20].

Primary Outcome

The primary outcome was KNMSP awareness, operationalized as a binary variable: aware (1) vs. not aware/unsure (0). Respondents who answered “don't know” were classified as unaware, consistent with the conceptual definition of awareness as positive knowledge of program existence.

Reliability

Internal consistency was assessed using Cronbach's alpha. The BCSBQ demonstrated acceptable consistency ($\alpha = 0.808$) in this sample, consistent with values reported in prior Arabic-language validation studies ($\alpha = 0.81-0.93$) [20]. CAM warning-sign and risk-factor subscales demonstrated adequate coherence in line with the validated Arabic adaptation ($\alpha \approx 0.80-0.85$) [21]. These values support the suitability of both instruments for use in this Kuwaiti sample.

Statistical Analysis

All analyses were performed using IBM SPSS Statistics, version 29 (IBM Corp., Armonk, NY, USA). Statistical significance was set at $p < 0.05$ (two-tailed). Chi-square tests examined associations between KNMSP awareness and categorical predictors; independent-samples t-tests compared continuous scores between awareness groups. Hierarchical binary logistic regression identified independent predictors, with variables entered in four sequential blocks: (1) sociodemographic factors (age group, nationality, governorate, education, employment status, marital status, personal and family breast cancer

history); (2) knowledge indices (warning-sign score, risk-factor score); (3) behavioral indicators (BSE knowledge, BSE practice history, CBE history); and (4) beliefs and perceived barriers (total barrier-belief score, total barrier score). Adjusted odds ratios (OR) with 95% confidence intervals (CI) are reported for the final model. Model performance was evaluated using the Hosmer-Lemeshow goodness-of-fit test, Nagelkerke R^2 , overall classification accuracy, and AUC. Multicollinearity was assessed via tolerance and variance inflation factor (VIF) diagnostics; all predictors met acceptable thresholds (tolerance > 0.2 ; VIF < 5).

Sensitivity Analysis

To assess robustness, the primary hierarchical regression was repeated in the subsample of Kuwaiti nationals only ($n = 401$). Consistency of effect direction and statistical significance across full-sample and Kuwaiti-only models was used to evaluate generalizability of findings to the national population specifically.

Ethical Approval

The study was reviewed and approved by the Permanent Committee for Coordination of Medical and Health Research, Ministry of Health, Kuwait (Reference No. 1469; Approval Date: 29 August 2024; Study No. 2024/2608), in accordance with Ministerial Resolution No. 232 of 2023 and the Declaration of Helsinki (2013 revision) [22]. All participants provided electronic informed consent prior to questionnaire access. No personally identifying information was collected.

Results

Participant Characteristics

A total of 458 women completed the survey (mean age 36.8 ± 11.4 years; range: 20–65 years). The sample was broadly distributed across the adult age spectrum, with approximately equal representation of women in their twenties (27.9%, $n = 128$), thirties (28.4%, $n = 130$), and forties (28.6%, $n = 131$), while women aged 50 years or older constituted 15.1% ($n = 69$). The large majority were Kuwaiti nationals (87.6%, $n = 401$), most held at least a bachelor's degree (66.2%, $n = 303$), and most were employed (63.5%, $n = 291$). In terms of marital status, 60.3% ($n = 276$) were partnered and 39.7% ($n = 182$) were unpartnered. A personal history of breast cancer was reported by 6.1% ($n = 28$) and a family history by 3.1% ($n = 14$). Geographically, Hawally was the most represented governorate (28.4%, $n = 130$), followed by Al Asimah (20.5%, $n = 94$), Mubarak Al Kabeer (19.9%, $n = 91$), Al Farwaniya (18.3%, $n = 84$), Al Ahmadi (7.2%, $n = 33$), and Al Jahra (5.7%, $n = 26$). Full characteristics are presented in Table 1.

Breast Cancer Warning-Sign and Risk-Factor Knowledge

The most frequently recognized breast cancer warning signs were a change in the appearance of a mole (67.9%), an unexplained lump or swelling (64.6%), and unexplained bleeding (55.5%). Persistent pain (47.8%), unexplained weight loss (47.4%), and a non-healing sore

Table 1. Sociodemographic and Clinical Characteristics of Participants (n=458)

Variable	n	%
Age group (years)		
20–29	128	27.9
30–39	130	28.4
40–49	131	28.6
50+	69	15.1
Nationality		
Kuwaiti	401	87.6
Non-Kuwaiti	57	12.4
Governorate		
Hawally	130	28.4
Al Asimah	94	20.5
Mubarak Al Kabeer	91	19.9
Al Farwaniya	84	18.3
Al Ahmadi	33	7.2
Al Jahra	26	5.7
Educational attainment		
Less than bachelor's degree	155	33.8
Bachelor's degree or higher	303	66.2
Employment status		
Employed	291	63.5
Unemployed / Homemaker	98	21.4
Retired	69	15.1
Marital status		
Partnered (married)	276	60.3
Unpartnered (single/divorced/widowed)	182	39.7
Personal history of breast cancer		
Yes	28	6.1
No	430	93.9
Family history of breast cancer		
Yes	14	3.1
No	444	96.9

Note: Percentages may not sum to 100.0% due to rounding.

(35.4%) were recognized by fewer participants. Mean warning-sign scores were significantly higher among aware women than among unaware women (4.16 ± 2.69 vs. 3.58 ± 2.50 ; $t = -2.24$; $p = 0.025$). For risk-factor knowledge, smoking was the most widely recognized factor (73.6%), followed by having a close relative with cancer (59.6%) and passive smoking exposure (54.8%). Mean risk-factor scores did not differ significantly between awareness groups ($p = 0.705$). BSE knowledge

Table 2. KNMSP Awareness: Program Information Sources, Scheduling, and Outreach Preferences (n=458)

Variable	n	%
KNMSP awareness (n=458)		
Yes - aware	299	65.3
No - not aware	76	16.6
Don't know / unsure	83	18.1
Source of KNMSP information (n=299)		
Online search	118	39.5
Healthcare professional	89	29.8
Family or friend	69	23.1
Sahel application	23	7.7
Is booking an appointment with KNMSP easy? (n=299)		
Yes	154	51.5
No	29	9.7
Don't know	116	38.8
How do you schedule a KNMSP appointment? (n=299)		
Hospital	102	34.1
Sahel application	70	23.4
Phone	64	21.4
q8Seha application	55	18.4
Email	8	2.7
Should there be a KNMSP? (n=159, unaware group)		
Yes	151	95.0
No	8	5.0
Preferred outreach strategies (n=458, multiple selection)		
In-person education and training	310	67.7
Professional social media campaign	300	65.5
Online education and training	260	56.8
Posting educational materials	256	55.9

Note: Multiple selection permitted for outreach strategies; percentages sum to >100%. KNMSP=Kuwait National Mammography Screening Program.

was reported by 260 women (56.8%); 225 (49.1%) had ever performed BSE, of whom 49.3% had received formal training. Clinical breast examination (CBE) had been received by 181 women (39.5%).

KNMSP Awareness and Bivariate Associations

Overall, 299 women (65.3%) were aware of the KNMSP, 76 (16.6%) were not aware, and 83 (18.1%) were unsure. Among those aware, the most common information source was online search (39.5%), followed by healthcare professionals (29.8%), family or friends (23.1%), and the Sahel digital health application (7.7%). Only 51.5%

Table 3. Bivariate associations between Candidate Predictors and KNMSP Awareness (n=458)

3A. Continuous Variables

Score	Aware Mean $\pm$ SD	Unaware Mean $\pm$ SD	t	p-value
Warning-sign knowledge score (range 0–9)	4.16 ± 2.69	3.58 ± 2.50	-2.24	0.025
Risk-factor knowledge score (range 0–10)	4.03 ± 2.83	4.14 ± 2.81	0.38	0.705
Help-seeking barrier score (range 0–10)	4.74 ± 2.71	4.94 ± 2.86	0.74	0.459

Note: Independent-samples t-tests; $df = 456$; two-tailed p-values reported. Warning-sign score and help-seeking barrier score from the Cancer Awareness Measure (CAM) [17,18]; barrier-belief score from the BCSBQ [19,20].

Table 3. Bivariate associations between Candidate Predictors and KNMSP Awareness (n=458)

3B. Categorical Variables

Variable	Aware n (%)	Unaware n (%)	χ^2	p-value
Age group			77.2	<0.001
20–29 years	44 (34.4%)	84 (65.6%)		
30–39 years	94 (72.3%)	36 (27.7%)		
40–49 years	105 (80.2%)	26 (19.8%)		
50+ years	56 (81.2%)	13 (18.8%)		
Nationality			9.2	0.002
Kuwaiti	272 (67.8%)	129 (32.2%)		
Non-Kuwaiti	27 (47.4%)	30 (52.6%)		
Governorate			17.7	0.003
Hawally	96 (73.8%)	34 (26.2%)		
Al Asimah	66 (70.2%)	28 (29.8%)		
Mubarak Al Kabeer	63 (69.2%)	28 (30.8%)		
Al Farwaniya	42 (50.0%)	42 (50.0%)		
Al Ahmadi	18 (54.5%)	15 (45.5%)		
Al Jahra	14 (53.8%)	12 (46.2%)		
Educational attainment			1.2	0.282
Less than bachelor's degree	96 (61.9%)	59 (38.1%)		
Bachelor's degree or higher	203 (67.0%)	100 (33.0%)		
Employment status			39.8	<0.001
Employed	203 (69.8%)	88 (30.2%)		
Unemployed / Homemaker	39 (39.8%)	59 (60.2%)		
Retired	57 (82.6%)	12 (17.4%)		
Marital status			51.6	<0.001
Partnered	216 (78.3%)	60 (21.7%)		
Unpartnered	83 (45.6%)	99 (54.4%)		
Personal history of breast cancer			0.9	0.35
Yes	16 (57.1%)	12 (42.9%)		
No	283 (65.8%)	147 (34.2%)		
Family history of breast cancer			1.1	0.289
Yes	11 (78.6%)	3 (21.4%)		
No	288 (64.9%)	156 (35.1%)		
BSE knowledge			6.0	0.014
Yes	183 (70.4%)	77 (29.6%)		
No	116 (58.6%)	82 (41.4%)		

Note: BSE, breast self-examination. Bold group headers indicate significant association ($p < 0.05$) based on Pearson chi-square test.

of aware women found booking an appointment easy, while 38.8% were unsure. Among the 159 women who were unaware, 95.0% (n=151) nonetheless supported the existence of a national screening program. When asked how the KNMSP could better reach the public, the most preferred strategies were in-person education and training (67.7%), professional social media campaigns (65.5%), online education (56.8%), and posting educational materials (55.9%). Full KNMSP awareness details are presented in Table 2.

Regarding bivariate associations with KNMSP awareness: awareness increased markedly with age: 34.4% among women aged 20–29 years, 72.3% among those aged 30–39, 80.2% among those aged 40–49, and

81.2% among those aged ≥ 50 years ($\chi^2 = 77.2$; $df = 3$; $p < 0.001$). Kuwaiti nationals showed higher awareness (67.8%) than non-Kuwaiti women (47.4%; $\chi^2 = 9.2$; $p = 0.002$). Partnered women had markedly higher awareness (78.3%) than unpartnered women (45.6%; $\chi^2 = 51.6$; $p < 0.001$). Awareness also differed significantly by employment status ($\chi^2 = 39.8$; $p < 0.001$) and by governorate of residence ($\chi^2 = 17.7$; $df = 5$; $p = 0.003$). BSE knowledge was significantly associated with awareness: 70.4% of women with BSE knowledge were aware of the KNMSP compared with 58.6% of those without ($\chi^2 = 6.0$; $p = 0.014$). Education level, personal breast cancer history, and family history were not significantly associated with awareness at the bivariate level (all $p > 0.28$). Full bivariate

Table 4. Perceived Barriers to Seeking Medical Advice (n=458)

Item	Yes n (%)	No n (%)	Don't know n (%)
I would be too scared to see a doctor	330 (72.1%)	112 (24.5%)	16 (3.5%)
I would be too embarrassed	321 (70.1%)	112 (24.5%)	25 (5.5%)
I would be worried about what the doctor might find	320 (69.9%)	121 (26.4%)	17 (3.7%)
I have too many other things to worry about	259 (56.6%)	171 (37.3%)	28 (6.1%)
I would be too busy to make time	248 (54.1%)	190 (41.5%)	20 (4.4%)
I wouldn't feel confident talking about my symptoms	176 (38.4%)	255 (55.7%)	27 (5.9%)
It would be difficult to make an appointment	180 (39.3%)	246 (53.7%)	32 (7.0%)
My doctor would be difficult to talk to	163 (35.6%)	268 (58.5%)	27 (5.9%)
I would be worried about wasting the doctor's time	120 (26.2%)	310 (67.7%)	28 (6.1%)
It would be difficult for me to arrange transport	87 (19.0%)	334 (72.9%)	37 (8.1%)

Note: Items derived from the Cancer Awareness Measure (CAM) help-seeking barriers subscale [17]. Responses reflect proportions of 458 participants endorsing each barrier category.

results are presented in Table 3.

Perceived Barriers to Help-Seeking

Emotional and psychological barriers were the most

commonly reported deterrents. Fear of seeing a doctor was endorsed by 72.1% of participants, embarrassment by 70.1%, and worry about what a doctor might find by 69.9%. Competing priorities were common: 56.6%

Table 5. Hierarchical Binary Logistic Regression: Independent Predictors of KNMSP Awareness (n=458)

Variable	Adjusted OR	95% CI	p-value
Block 1: Sociodemographic variables			
Age group (reference: ≥ 50 years)			
20–29 years	0.29	0.09–0.95	0.040
30–39 years	0.95	0.31–2.91	0.921
40–49 years	1.17	0.42–3.23	0.765
Nationality (reference: Kuwaiti)			
Non-Kuwaiti	0.47	0.23–0.93	0.029
Governorate (reference: Al Jahra)			
Overall (5 df)	—	—	0.106
Educational attainment (reference: bachelor's degree or higher)			
Less than bachelor's degree	1.91	1.08–3.40	0.027
Employment status (reference: Retired)			
Overall (2 df)	—	—	0.509
Marital status (reference: Partnered)			
Unpartnered	0.40	0.23–0.70	0.001
Personal history of breast cancer (reference: Yes)			
No personal history	4.18	1.60–10.95	0.004
Family history of breast cancer (reference: Yes)			
No family history	0.39	0.09–1.65	0.199
Block 2: Knowledge indices			
Warning-sign knowledge score (continuous)	1.10	0.99–1.22	0.069
Risk-factor knowledge score (continuous)	0.99	0.91–1.08	0.855
Block 3: Behavioral indicators			
BSE knowledge (Yes vs. No)	3.60	1.87–6.93	<0.001
BSE practice history (Yes vs. No)	0.86	0.44–1.71	0.674
Clinical breast examination history (Yes vs. No)	0.67	0.37–1.24	0.202
Block 4: Beliefs and perceived barriers			
Total barrier-belief score (continuous)	0.96	0.87–1.05	0.366
Total help-seeking barrier score (continuous)	1.04	0.95–1.14	0.405

Note: Model fit (Block 4): Nagelkerke R^2 , 0.355; Hosmer–Lemeshow χ^2 , 5.43; df, 8; p, 0.711; AUC, 0.798; overall classification accuracy, 78.6%. OR, odds ratio; CI, confidence interval; BSE, breast self-examination. Bold, statistically significant at $p < 0.05$.

reported having too many other concerns and 54.1% reported being too busy. Help-seeking barrier scores did not differ significantly between awareness groups ($p=0.459$), consistent with the null finding in the adjusted model. Healthcare communication barriers were also present: 38.4% lacked confidence discussing symptoms and 35.6% felt their doctor would be difficult to talk to. Logistical barriers were less prevalent; only 19.0% reported difficulty arranging transportation. Full item-level barrier data are presented in Table 4.

Hierarchical Logistic Regression: Independent Predictors of KNMSP Awareness

The final four-block model was statistically significant overall ($p<0.001$) and explained 35.5% of the variance in KNMSP awareness (Nagelkerke $R^2=0.355$). The Hosmer - Lemeshow goodness-of-fit test was non-significant ($\chi^2=5.43$; $df=8$; $p=0.711$), indicating adequate model calibration. The model correctly classified 78.6% of cases overall (sensitivity=89.6%; specificity=57.9%; AUC=0.798).

Six predictors were independently significant in the final adjusted model. BSE knowledge was the strongest predictor: women who knew how to perform BSE were 3.6 times more likely to be aware of the KNMSP than those who did not (OR=3.60; 95% CI 1.87–6.93; $p<0.001$), after adjusting for all other variables. Women without a personal history of breast cancer had higher adjusted odds of awareness (OR=4.18; 95% CI 1.60–10.95; $p=0.004$); the wide confidence interval indicates a statistically imprecise estimate warranting cautious interpretation. Women with less than a bachelor's degree had higher adjusted odds (OR=1.91; 95% CI 1.08–3.40; $p=0.027$), consistent with suppression by age. Unpartnered women had significantly lower adjusted odds (OR=0.40; 95% CI 0.23–0.70; $p=0.001$). Non-Kuwaiti women had lower adjusted odds (OR=0.47; 95% CI 0.23–0.93; $p=0.029$). Women aged 20–29 years had significantly lower odds (OR=0.29; 95% CI 0.09–0.95; $p=0.040$). Full regression results are presented in Table 5.

Sensitivity Analysis

The primary model was repeated restricting the analysis to Kuwaiti nationals ($n=401$). Results were consistent with the full-sample analysis (Nagelkerke $R^2=0.345$; Hosmer-Lemeshow $\chi^2=3.88$; $df=8$; $p=0.868$). The direction and significance of key predictors younger age, unpartnered status, and BSE knowledge were preserved, supporting robustness of findings in the Kuwaiti-national population.

Discussion

This study provides the first nationwide Kuwaiti analysis using hierarchical logistic regression to disentangle sociodemographic, knowledge, behavioral, and attitudinal contributions to KNMSP awareness as a distinct outcome. Overall, 65.3% of women were aware of the program, representing a meaningful improvement on earlier Kuwaiti estimates: Saeed et al. previously found that only 48.6% of Kuwaiti women were aware of

mammography, and only 22.2% understood diagnostic procedures [23]. This level of program-specific awareness is also notably higher than general breast cancer awareness patterns observed in neighboring countries: a systematic review of 13 Saudi studies ($n=7,562$ women) found that 66.3% of women had low breast cancer awareness and only 20.2% had high awareness [14], and a recent Kuwait study among 490 employed women found only moderate awareness of breast cancer symptoms and risk factors [24]. However, direct comparisons are limited by differences in outcome measurement, and the online convenience sample likely over-represents digitally engaged and health-aware women. More than one-third of women remain unaware of a free, nationally available service, and the awareness gap is widest among women aged 20–29 years, unpartnered women, and non-Kuwaiti residents.

BSE knowledge was the strongest independent predictor of KNMSP awareness (OR=3.60), outperforming all demographic and attitudinal variables in the fully adjusted model, and this association persisted after controlling for actual BSE practice, confirming that cognitive familiarity not behavior itself carries independent predictive value. Within the Health Belief Model, BSE knowledge functions as a self-efficacy and cue-to-action marker [15]. This aligns with regional evidence from Qatar [12] and Saudi Arabia where BSE knowledge was consistently associated with higher breast cancer awareness across 13 studies [14]. The large proportion of untrained women who expressed interest in future BSE education represents an immediately reachable cohort; BSE sessions that explicitly incorporate KNMSP branding and referral pathways could efficiently strengthen both constructs simultaneously.

The age gradient (20–29 years OR=0.29) is partly attributable to the KNMSP's eligibility age of 40–69 years; 'know now, act later' messaging via universities and social media could establish program familiarity before eligibility and create a primed cohort [15]. This age pattern mirrors Saudi and UAE data where older married women consistently show higher breast cancer awareness [14, 25]. The nationality gap (non-Kuwaiti OR=0.47) reflects language, health-system unfamiliarity, and access uncertainty for non-citizens [7, 8]; multilingual outreach as demonstrated in the UAE context [25] is a clear priority. The association between unpartnered status and lower awareness (OR=0.40) corroborates GCC evidence [12, 15] and is likely mediated by reduced exposure to household health-information networks.

Neither the help-seeking barrier score nor the barrier-belief score significantly predicted KNMSP awareness. This null finding is conceptually coherent: barriers plausibly operate at the stage of uptake conversion rather than at the stage of awareness itself. This sequencing is consistent with GCC evidence showing that fear, embarrassment, and logistical constraints primarily influence attendance among already-aware women [11, 12], and with the finding of AlMutawah et al. [24] that pain concern is the dominant post-awareness barrier in Kuwait.

A notable structural finding is that only 51.5% of KNMSP-aware women found booking an appointment easy, and the most common scheduling routes were hospital attendance (34.1%), the Sahel digital health

application (23.4%), and telephone (21.4%). While Kuwait has increasingly adopted digital tools including the Sahel and q8Seha applications for health communication and service access, this shift toward technology may inadvertently widen disparities. Digital access tends to be higher among younger, educated, and urban women, while older women and those with lower educational attainment may be excluded from digital-first outreach [26]. Participants overwhelmingly favored in-person education and training (67.7%) and professional social media campaigns (65.5%) as outreach strategies, reinforcing that multi-modal communication is essential for equitable program reach [27]. Encouragingly, 95.0% of women who were unaware of the KNMSP nonetheless supported the existence of a national screening program.

Strengths and Limitations

This study has several strengths. It is the first nationwide Kuwaiti analysis to use a four-block hierarchical regression design to disentangle sociodemographic, knowledge, behavioral, and attitudinal contributions to KNMSP awareness as a distinct outcome. Geographic coverage of all six governorates enhances representativeness relative to hospital-based or single-governorate samples. Use of validated instruments the Arabic Cancer Awareness Measure [21] and the Arabic BCSBQ [20] supports construct validity and regional comparability. The Kuwaiti-only sensitivity analysis ($n=401$; Nagelkerke $R^2=0.345$; Hosmer–Lemeshow $p=0.868$) confirmed robustness.

Several limitations should be acknowledged. First, the cross-sectional design precludes causal inference; the BSE–KNMSP association may be bidirectional. Second, online convenience recruitment may over-represent digitally engaged and health-conscious women as evidenced by the high educational attainment (66.2% bachelor's degree or higher) potentially inflating the 65.3% awareness estimate relative to the broader Kuwaiti female population. Third, the non-Kuwaiti subsample ($n=57$) and history-positive cell ($n=28$) are small, producing imprecise estimates. Fourth, all data are self-reported, introducing social-desirability and recall bias. Fifth, this study measured awareness rather than actual mammographic uptake. Sixth, absence of a sampling frame precluded calculation of a formal response rate for the broader population.

In conclusion, approximately two-thirds of women in Kuwait are aware of the KNMSP, yet substantial gaps persist among younger, unpartnered, and non-Kuwaiti women. BSE knowledge is the most robust and actionable independent predictor. Priority interventions should fuse BSE education with KNMSP promotion, strengthen structured primary-care referral supported by GCC evidence for provider-initiated engagement [11] and develop multilingual, expatriate-inclusive campaigns that address language and access barriers. Longitudinal and quasi-experimental research is needed to establish whether targeted awareness strategies translate into measurable improvements in mammographic uptake.

Author Contribution Statement

Ahmad Salman conceptualized the study, developed the methodological and analytical framework, conducted data cleaning and recoding, performed the formal statistical analysis, interpreted the results, and drafted the full manuscript. Fatima Al-Ghadban and Ahmad Abbas contributed to data collection and critically reviewed the manuscript for intellectual content. All authors contributed to writing – review and editing, approved the final version, and agreed to be accountable for all aspects of the work.

Acknowledgements

The authors thank all women who participated in the survey and the health authorities across all six Kuwaiti governorates who facilitated data collection.

Availability of Data and Materials

The anonymized dataset analyzed during the current study is available from the corresponding author on reasonable request, along with a detailed codebook, variable definitions, and SPSS syntax files used in the analysis.

Ethics Approval and Consent to Participate

This study was reviewed and approved by the Permanent Committee for Coordination of Medical and Health Research, Ministry of Health, Kuwait (Reference No. 1469; Approval Date: 29 August 2024; Study No. 2024/2608), in accordance with the Declaration of Helsinki (2013 revision). All participants provided electronic informed consent before completing the questionnaire. Participation was voluntary, anonymous, and confidential.

AI Disclosure

An AI language tool (ChatGPT, OpenAI) was used to support proofreading and language editing during manuscript preparation; all intellectual content, analysis, interpretation, and conclusions are those of the authors alone.

References

1. Bray F, Laversanne M, Sung H, Ferlay J, Siegel RL, Soerjomataram I, et al. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin.* 2024;74(3):229-63. <https://doi.org/10.3322/caac.21834>.
2. Weiss A, Chavez-MacGregor M, Lichtensztajn DY, Yi M, Tadros A, Hortobagyi GN, et al. Validation study of the American Joint Committee on Cancer eighth edition prognostic stage compared with the anatomic stage in breast cancer. *JAMA Oncol.* 2018;4(2):203-9. <https://doi.org/10.1001/jamaoncol.2017.4298>.
3. Lim YX, Lim ZL, Ho PJ, Li J. Breast cancer in Asia: Incidence, mortality, early detection, mammography programs, and risk-based screening initiatives. *Cancers (Basel).* 2022;14(17):4218. <https://doi.org/10.3390/cancers14174218>.
4. Chaabna K, Ladumor H, Cheema S. Ecological study of breast

- cancer incidence among nationals and non-nationals in the Gulf Cooperation Council countries. *East Mediterr Health J*. 2023;29(1):40-8. <https://doi.org/10.26719/emhj.23.005>.
5. Al Ramadhan MA. Eradicating breast cancer: Longevity impact on Kuwaiti women. *Asian Pac J Cancer Prev*. 2017;18(3):803-9. <https://doi.org/10.22034/apjcp.2017.18.3.803>.
 6. Kuwait Cancer Registry. Kuwait Cancer Registry annual report 2010–2019. Kuwait: Ministry of Health; 2023. Available from: <https://www.moh.gov.kw/UserGuides/Cancer%20Registry%20Book%202019.pdf>.
 7. Mango VL, Al-Khawari H, Dershaw DD, Ashkanani MH, Pennisi B, Turner P, et al. Initiating a national mammographic screening program: The Kuwait experience training with a US Cancer Center. *J Am Coll Radiol*. 2019;16(2):202-7. <https://doi.org/10.1016/j.jacr.2018.07.025>.
 8. Alkhawari HA, Asbeutah AM, Almajran AA, AlKandari LA. Kuwait National Mammography Screening Program: Outcomes of 5 years of screening in Kuwaiti women. *Ann Saudi Med*. 2021;41(5):257-67. <https://doi.org/10.5144/0256-4947.2021.257>.
 9. Marzouq Muhanna A, Floyd MJ. A qualitative study to determine Kuwaiti women's knowledge of breast cancer and barriers deterring attendance at mammography screening. *Radiography (Lond)*. 2019;25(1):65-71. <https://doi.org/10.1016/j.radi.2018.10.003>.
 10. Alfaiakawi O, Alostath H, Aldubian A, Alsaleh AG, Alsughayer G, Alshamran A, et al. Barriers and limitations for undergoing mammography screenings among Kuwaiti Women (aged 40-69) attending primary health care centers. *BMC Prim Care*. 2025;26(1):295. <https://doi.org/10.1186/s12875-025-02971-2>.
 11. Alhomoud S, Al-Othman S, Al-Madoudj A, Homsy MA, AlSaleh K, Balaraj K, et al. Progress and remaining challenges for cancer control in the Gulf Cooperation Council. *Lancet Oncol*. 2022;23(11):e493-e501. [https://doi.org/10.1016/s1470-2045\(22\)00488-0](https://doi.org/10.1016/s1470-2045(22)00488-0).
 12. Donnelly TT, Al Khater AH, Al-Bader SB, Al Kuwari MG, Al-Meer N, Malik M, et al. Beliefs and attitudes about breast cancer and screening practices among Arab Women living in Qatar: A cross-sectional study. *BMC Womens Health*. 2013;13:49. <https://doi.org/10.1186/1472-6874-13-49>.
 13. Alqahtani T, Alqahtani AM, Alshahrani SM, Orayj K, Almanasef M, Alamri AH, et al. Assessment of knowledge and practice of mammography and breast self-examination among the general female population in Asir Region of KSA. *Eur Rev Med Pharmacol Sci*. 2021;25(23):7231-7. https://doi.org/10.26355/eurrev_202112_27416.
 14. AlRajhi B, Aljadani FF, Almarwan SR, Alzahrani AA, Sindi MHM, Kano A, et al. Breast cancer awareness among women in Saudi Arabia: A systematic review. *Breast Cancer (Dove Med Press)*. 2023;15:913-24. <https://doi.org/10.2147/BCTT.S426079>.
 15. Bahri N, Mardani F, Sharifi N, Dashti S. Predicting factors for breast cancer screening in Middle Eastern Women based on Health Belief Model: A systematic review. *J Egypt Natl Canc Inst*. 2022;34(1):50. <https://doi.org/10.1186/s43046-022-00150-3>.
 16. Peduzzi P, Concato J, Kemper E, Holford TR, Feinstein AR. A simulation study of the number of events per variable in logistic regression analysis. *J Clin Epidemiol*. 1996;49(12):1373-9. [https://doi.org/10.1016/s0895-4356\(96\)00236-3](https://doi.org/10.1016/s0895-4356(96)00236-3).
 17. Linsell L, Forbes LJ, Burgess C, Kapari M, Thurnham A, Ramirez AJ. Validation of a measurement tool to assess awareness of breast cancer. *Eur J Cancer*. 2010;46(8):1374-81. <https://doi.org/10.1016/j.ejca.2010.02.034>.
 18. Forbes LJ, Atkins L, Thurnham A, Layburn J, Haste F, Ramirez AJ. Breast cancer awareness and barriers to symptomatic presentation among women from different ethnic groups in East London. *Br J Cancer*. 2011;105(10):1474-9. <https://doi.org/10.1038/bjc.2011.406>.
 19. Kwok C, Fethney J, White K. Chinese breast cancer screening beliefs questionnaire: development and psychometric testing with Chinese-Australian Women. *J Adv Nurs*. 2010;66(1):191-200. <https://doi.org/10.1111/j.1365-2648.2009.05177.x>.
 20. Kwok C, Endrawes G, Lee CF. Breast cancer screening beliefs questionnaire: psychometric properties assessment of the Arabic Version. *Eur J Oncol Nurs*. 2016;20:42-8. <https://doi.org/10.1016/j.ejon.2015.08.003>.
 21. Al-Khasawneh EM, Leocadio M, Seshan V, Siddiqui ST, Khan AN, Al-Manaseer MM. Transcultural adaptation of the Breast Cancer Awareness Measure. *Int Nurs Rev*. 2016;63(3):445-54. <https://doi.org/10.1111/inr.12265>.
 22. World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects. *JAMA*. 2013;310(20):2191-4. <https://doi.org/10.1001/jama.2013.281053>.
 23. Saeed RS, Bakir YY, Ali LM. Are women in Kuwait aware of breast cancer and its diagnostic procedures? *Asian Pac J Cancer Prev*. 2014;15(15):6307-13. <https://doi.org/10.7314/apjcp.2014.15.15.6307>.
 24. AlMutawah K, Taqi G, Radhwan S, AlMutairi A, AlHussainan A, Faraj M, et al. Knowledge and awareness of breast cancer symptoms, risk factors, and screening barriers among women in Kuwait: A cross-sectional study. *BMC Womens Health*. 2025;25(1):448. <https://doi.org/10.1186/s12905-025-03994-8>.
 25. Abdulla RA, Kareem NA, Assadi RA, Sanaullah AAR, Nandagopal S, Wazil SM, et al. Impact of breast cancer awareness program on breast screening utilization among women in the United Arab Emirates: A cross-sectional study. *BMC Public Health*. 2025;25(1):578. <https://doi.org/10.1186/s12889-025-21512-1>.
 26. Chen AM. Digital disparities in healthcare: A tale of the haves and have-nots? *J Patient Exp*. 2025;12:23743735251343585. <https://doi.org/10.1177/23743735251343585>.
 27. Causio FA, Fakhfakh M, Kaur J, Sert B, Gandolfi S, Di Pumo M, De Angelis L, et al. Digital health interventions' impact on health literacy: a systematic review. *Eur J Public Health*. 2024;34(Suppl 3):ckae144.1201. <https://doi.org/10.1093/eurpub/ckae144.1201>.



This work is licensed under a Creative Commons Attribution-Non Commercial 4.0 International License.