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Original Research

Factors Associated With Mammography Screening: An Application of the Health Belief Model and Structural Equation Modeling

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Abstract

Background: Despite the availability of free breast cancer screening services, the use of mammography in Saudi Arabia remains suboptimal. This study examined factors associated with mammography uptake using the Health Belief Model (HBM) and assessed the structural pathways linking health beliefs, intentions, and screening behaviors. **Methods:** This cross-sectional study, conducted in accordance with STROBE guidelines, recruited 385 women aged ≥40 years across Saudi Arabia using an online Arabic-language questionnaire. Seven HBM constructs were assessed alongside mammography uptake within the past 2 years, which served as the primary outcome. Confirmatory factor analysis (CFA), structural equation modelling (SEM), and hierarchical logistic regression analyses were performed. **Results:** Only 25.2% (n = 97) of participants reported recent mammography findings, although 49.9% had undergone screening at some point. The CFA confirmed an excellent model fit (comparative fit index [CFI] = 0.963, root mean square error of approximation [RMSEA] = 0.048, standardized root mean square residual [SRMR] = 0.052). In bivariate analyses, women who underwent screening reported higher levels of triggers for action, self-efficacy, and intention, as well as lower perceived barriers (all $p \leq 0.001$). Logistic regression identified family history of breast cancer as the only factor independently associated with mammography uptake (adjusted odds ratio [aOR] = 3.00, 95% confidence interval [CI]: 1.273–7.059, p = 0.012). SEM identified self-efficacy (β = 0.450), perceived barriers (β = −0.233), and perceived benefits (β = 0.208) as significant predictors of screening intention (all $p < 0.05$). However, intention did not significantly predict mammography uptake (β = 0.163, p = 0.157), indicating an intention–behavior gap. **Conclusions:** Mammography uptake remained low despite high perceived severity and perceived benefits. Structural determinants, including family history, insurance coverage, and urban residence, appeared to outweigh attitudinal pathways in predicting actual screening uptake. Public health interventions should thus integrate psychological and structural approaches to improve participation in mammography screening.

Keywords: breast cancer; mammography uptake; Health Belief Model; structural equation modeling; Saudi Arabia; screening behavior

1. Introduction

Breast cancer is the most commonly diagnosed malignancy in women worldwide and remains the leading cause of cancer-related mortality [1]. According to GLOBOCAN 2020 estimates, breast cancer surpasses lung cancer as the most frequently diagnosed cancer globally, accounting for approximately 2.3 million new cases annually [2]. Despite advances in treatment, survival disparities persist across regions and are largely influenced by stage at diagnosis and access to care [3]. In the Middle East, including Saudi Arabia, breast cancer is often diagnosed at younger ages and more advanced stages, underscoring the need for effective early detection strategies [4].

Breast cancer prevention programs primarily focus on early detection through organized screening initiatives, including mammography, which has been shown to reduce mortality by enabling earlier diagnosis and treatment [5]. Many high-income countries have implemented national screening programs targeting women aged 40–69 years, resulting in improved stage distribution and survival outcomes [6]. In Saudi Arabia, national awareness campaigns and free screening services have been introduced; however, their uptake remains suboptimal compared to global benchmarks [7]. Barriers, such as limited awareness, access inequalities, and sociocultural factors, continue to hinder participation in preventive screening initiatives.

The Health Belief Model (HBM) is a widely used theoretical framework for understanding preventive health behaviors [8,9]. The model posits that individuals are more likely to engage in health-related action when they perceive themselves to be susceptible to a serious condition, believe the condition has significant consequences, perceive benefits in taking action, and identify fewer barriers to action [8,10]. Later studies incorporated self-efficacy and cues for action as additional determinants [11]. Although empirical findings regarding its predictive strength remain mixed across cultural contexts, the HBM has been extensively applied in breast cancer screening research [12,13].

Although mammography is widely recognized as an effective strategy for reducing breast cancer mortality through early detection, screening uptake remains suboptimal in many countries, including Saudi Arabia [14,15]. Prior research in this region has largely focused on descriptive prevalence studies or isolated predictors such as sociodemographic characteristics, knowledge levels, or access-related factors with limited theoretical integration [7,16]. While several studies have applied the HBM to breast cancer screening behaviors globally, findings have been inconsistent regarding which constructs most strongly predict screening uptake [10,17]. Most regional studies have examined HBM constructs using simple regression analyses without testing full structural pathways, mediation effects, or measurement validity through confirmatory factor analysis (CFA) or structural equation modeling (SEM) [7,9,14,15,16]. Consequently, the extent to which health beliefs translate into actual screening behavior—particularly in contexts characterized by structural barriers such as insurance coverage and geographic disparities—remains insufficiently understood. Furthermore, there is limited evidence on the intention-behavior gap in breast cancer screening in Middle Eastern populations. Thus, there is a clear need for theoretically grounded, methodologically rigorous studies that simultaneously evaluate the measurement validity and structural relationships among HBM constructs, intention, and mammography uptake in Saudi women. Addressing this gap can clarify whether psychological or structural factors drive screening behavior and thus inform more targeted public health interventions.

2. Materials and Methods

2.1 Study Design and Setting

This cross-sectional analytical study was conducted to examine factors associated with mammography uptake using the HBM among women aged ≥40 years in the Kingdom of Saudi Arabia. Data were collected between May 2025 and October 2025. This study targeted women residing across multiple regions of the country and assessed the associations between HBM constructs and self-reported mammography screening behavior at a single point in time. This study was conducted according to STROBE guidelines [18].

2.2 Participants and Sampling

A nonprobability convenience sampling approach was used in this study. Eligible women were recruited through an online survey link disseminated through social media platforms and community networks to facilitate nationwide participation.

Inclusion criteria were as follows: (1) women aged ≥40 years; (2) residing in Saudi Arabia during the data collection period; (3) able to read and understand Arabic; and (4) providing informed consent. The exclusion criteria were as follows: (1) previous diagnosis of breast cancer, (2) current diagnostic evaluation for suspected breast cancer, (3) history of bilateral mastectomy, or (4) cognitive or medical impairment preventing questionnaire completion. Eligibility was self-reported at the beginning of the study.

2.3 Data Collection and Measures

Data were collected using a structured, self-administered Arabic questionnaire hosted on a secure online platform. The first page contained an electronic informed consent form. The responses were recorded anonymously and stored in a password-protected database accessible only to the research team. The questionnaire assessed seven HBM constructs: Perceived Susceptibility, Perceived Severity, Perceived Benefits, Perceived Barriers, Self-Efficacy, Cues to Action, and Screening Intention. Each was measured using three items rated on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). The construct scores were calculated as the mean of their respective items. The primary outcome was self-reported mammography scan uptake within the past 2 years (yes/no). The demographic and clinical variables included age, marital status, education, employment, income, residence, insurance coverage, and family history of breast cancer.

The HBM questionnaire used in this study was developed based on established theoretical constructs and later expanded to include self-efficacy and cues to action [10]. Item development was informed by previously validated breast cancer screening instruments, particularly the Champion Health Belief Model Scale (CHBMS), which has been widely applied in mammography research across diverse populations [7,8,9,10,11,12,13,17,19]. Three items were selected or adapted for each construct to ensure conceptual clarity and content validity, while maintaining brevity for online administration. The items were translated into Arabic and reviewed for linguistic appropriateness and cultural relevance before data collection.

2.4 Sample Size Calculation

The required sample size was calculated using a single-proportion formula with a 95% confidence level ($Z = 1.96$), an assumed prevalence of 50%, and a 5% margin of error. The minimum sample size required was 385. A conservative prevalence estimate was used to maximize precision and ensure adequate statistical power. The sample size was initially calculated using a single-proportion formula to estimate the prevalence of mammography screening among women aged ≥40 years in a cross-sectional design. Although the primary calculation was based on prevalence estimation, the final sample size ($n = 385$) also met the recommended requirements for SEM, which typically suggests a minimum of 200 participants or at least 10 observations per estimated parameter to ensure stable parameter estimation. Therefore, the obtained sample size was adequate for both the prevalence assessment and SEM analysis.

2.5 Response Rate, Data Handling, and Bias Control

As recruitment occurred via open online distribution, the exact number of individuals exposed to the survey invitation could not be determined; therefore, the conventional response rate was not calculated. Only the fully completed questionnaires were included in the final analysis. The data were screened for completeness and consistency prior to statistical analysis. To reduce bias, the survey was disseminated nationally to enhance demographic variability (selection bias), utilize standardized HBM-based items (information bias), restrict mammography recall to the past 2 years (recall bias), and ensure anonymity (social desirability bias). However, convenience sampling and self-report measures may have limited the generalizability of the results.

2.6 Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA) and AMOS 26 (IBM Corp., Armonk, NY, USA). Descriptive statistics (means, standard deviations, frequencies, and percentages) were used to summarize participant characteristics and screening prevalence. Prior to conducting parametric analyses, the distribution of continuous variables was assessed using visual inspection of histograms and Quantile-Quantile (Q-Q) plots as well as statistical indicators, including skewness, kurtosis, and the Shapiro-Wilk test. The composite Likert scale scores for the HBM constructs approximated normal distributions, supporting the use of independent-sample *t*-tests for group comparisons. For the sensitivity analysis, equivalent nonparametric tests were also performed, and consistent results were obtained.

Internal consistency reliability was assessed using Cronbach's alpha and composite reliability (CR), with acceptable thresholds set at ≥0.70. Convergent validity was evaluated using average variance extracted (AVE ≥0.50). CFA using maximum likelihood estimation was conducted to evaluate the seven-factor measurement model. Model fit was assessed using multiple indices, including chi-square (χ^2), comparative fit index (CFI ≥0.95), Tucker-Lewis index (TLI ≥0.95), root mean square error of approximation (RMSEA ≤0.06), and standardized root mean square residual (SRMR ≤0.08). Because the measurement items were adapted from previously validated HBM instruments and the latent constructs were theoretically specified, an exploratory factor analysis was not conducted.

Bivariate analyses included independent-sample *t*-tests for continuous variables and chi-square tests for categorical variables. Hierarchical logistic regression was performed to identify variables independently associated with mammography uptake, reporting adjusted odds ratios (aOR) with 95% confidence intervals (CIs). Prior to model estimation, potential multicollinearity among predictors was evaluated using variance inflation factors (VIF) and inspection of correlation matrices; all VIF values were within acceptable limits, indicating no problematic collinearity. Demographic variables were entered based on theoretical relevance and prior evidence, whereas all HBM constructs and screening intentions were entered simultaneously to evaluate the conceptual framework.

SEM was performed using maximum likelihood in AMOS. Mammography uptake was included as an observed binary outcome variable (0 = no screening within the past 2 years, 1 = screening within the past 2 years). Although SEM with maximum likelihood assumes continuous variables, binary outcomes can be incorporated as observed endogenous variables when the sample size is adequate and the model estimation remains stable. In this study, uptake was modeled as a manifest outcome predicted by intention and HBM constructs to evaluate the hypothesized association pathways. Statistical significance was set at $p < 0.05$.

3. Results

3.1 Sociodemographic and Clinical Characteristics of Participants

A total of 385 women aged 40–75 years participated in this study (mean age = 51.9 ± 7.9 years). The largest age group was 50–59 years (43.9%), followed by 40–49 years (40.8%) and ≥60 years (15.3%). Most participants were married (68.8%), and nearly half were homemakers (46.0%). Regarding education, 29.6% held a bachelor's degree, whereas 8.3% had no formal education. Most resided in urban areas (69.9%) and reported a medium household income (46.5%). Health insurance coverage was reported by 55.8% of the participants, and 16.1% had a family history of breast cancer (Table 1).

Overall, 192 women (49.9%) underwent mammography, whereas only 97 (25.2 %) reported undergoing screening within the past 2 years. The screening rates were notably higher among insured women (33.0% vs. 15.3%), urban residents (30.1% vs. 13.8%), those with a family history of breast cancer (46.8% vs. 21.1%), and those with a higher income (33.3%).

3.2 Descriptive Statistics and Reliability of HBM Constructs

Table 2 (Ref. [20,21]) presents the descriptive statistics and internal consistencies of the seven HBM constructs. Perceived Benefits had the highest mean score (Mean [M] = 3.90, standard deviation [SD] = 0.72), followed by Perceived Severity (M = 3.86, SD = 0.62), indicating strong endorsement of the seriousness of breast cancer and the value of early detection. Cues to action (M = 3.47, SD = 1.00) and intention (M = 3.46, SD = 0.75) were rated moderately, while Perceived Barriers (M = 2.28, SD = 0.88) and Perceived Susceptibility (M = 2.67, SD = 0.91) recorded the lowest scores.

CR values ranged from 0.788 to 0.853, and AVE ranged from 0.554 to 0.659, both exceeding the recommended thresholds of 0.70 and 0.50, respectively, confirming convergent validity. Cronbach's alpha was acceptable for Cues to Action (α = 0.727), with the remaining constructs showing CR-supported reliability. The standardized factor loadings across all constructs ranged from 0.727 to 0.854, demonstrating satisfactory item-level reliability.

Table 1. Sociodemographic and clinical characteristics by mammography uptake (past 2 years).

Characteristic	Screened in past 2 years (n = 97)	Not screened in past 2 years (n = 288)	Test statistic	p-value
	n (%)	n (%)		
Age (years)	51.6 ± 7.3	52.0 ± 8.1	t (383) = 0.796	0.454
Age group			χ^2 (2) = 1.748	0.514
40–49 years	43 (44.3%)	114 (39.6%)		
50–59 years	43 (44.3%)	126 (43.8%)		
≥60 years	11 (11.3%)	48 (16.7%)		
Marital status			χ^2 (3) = 0.071	0.995
Divorced	8 (8.2%)	24 (8.3%)		
Married	67 (69.1%)	198 (68.8%)		
Single	8 (8.2%)	22 (7.6%)		
Widowed	14 (14.4%)	44 (15.3%)		
Education level			χ^2 (5) = 6.373	0.272
Bachelor	36 (37.1%)	78 (27.1%)		
Diploma	15 (15.5%)	46 (16.0%)		
No formal education	4 (4.1%)	28 (9.7%)		
Postgraduate	11 (11.3%)	28 (9.7%)		
Primary	11 (11.3%)	32 (11.1%)		
Secondary	20 (20.6%)	76 (26.4%)		
Employment status			χ^2 (3) = 1.328	0.723
Employed	33 (34.0%)	82 (28.5%)		
Homemaker	42 (43.3%)	135 (46.9%)		
Retired	11 (11.3%)	31 (10.8%)		
Unemployed	11 (11.3%)	40 (13.9%)		
Monthly household income			χ^2 (2) = 5.023	0.081
High	24 (24.7%)	48 (16.7%)		
Medium	47 (48.5%)	132 (45.8%)		
Low	26 (26.8%)	108 (37.5%)		
Place of residence			χ^2 (1) = 10.602	0.001**
Rural	16 (16.5%)	100 (34.7%)		
Urban	81 (83.5%)	188 (65.3%)		
Health insurance			χ^2 (1) = 14.906	<0.001***
No	26 (26.8%)	144 (50.0%)		
Yes	71 (73.2%)	144 (50.0%)		
Family history of breast cancer			χ^2 (1) = 16.920	<0.001***
No	68 (70.1%)	255 (88.5%)		
Yes	29 (29.9%)	33 (11.5%)		

Values are presented as frequencies (n) and column percentages (%) within the screening status. Pearson's chi-squared test was used for categorical variables. Independent-sample t-tests were used to analyze continuous age variables. **$p < 0.01$; ***$p < 0.001$.

3.3 Confirmatory Factor Analysis

Confirmatory factor analysis was conducted to evaluate the factorial validity of the seven-factor HBM measurement model (Table 3). The overall model demonstrated a good fit: CFI = 0.963, TLI = 0.951, RMSEA = 0.048 [90% CI: 0.031–0.065], and SRMR = 0.052, all meeting the recommended thresholds (CFI/TLI >0.95; RMSEA <0.06; SRMR <0.08 [22]).

All standardized factor loadings were statistically significant and ranged from 0.727 to 0.854, surpassing the minimum threshold of 0.60, supporting item-level convergent validity. Cues to Action yielded the highest loading range (0.782–0.854), whereas Perceived Severity produced the narrowest range (0.727–0.760). CR values across constructs ranged from 0.788 to 0.853, and AVE ranged from 0.554 to 0.659, all exceeding the recommended cutoffs of 0.70 and 0.50, respectively [23]. Collectively, these results confirm that each construct is well represented by its three indicators and that the measurement model possesses adequate convergent validity and internal consistency prior to structural analysis.

3.4 Bivariate Analysis

Bivariate analyses revealed significant differences across several HBM constructs between the screened and non-screened women (Table 4). Cues to Action was the

Table 2. Descriptive statistics and reliability of HBM constructs.

HBM construct	Items	Mean ± SD	Cronbach's α	Composite reliability (CR)	Average variance extracted (AVE)	Standardized factor loading range (min–max)
Perceived susceptibility	3	2.67 ± 0.91	0.740*	0.806	0.582	0.729–0.801
Perceived severity	3	3.86 ± 0.62	0.710*	0.788	0.554	0.727–0.760
Perceived benefits	3	3.90 ± 0.72	0.781*	0.834	0.626	0.758–0.815
Perceived barriers	3	2.28 ± 0.88	0.865*	0.845	0.645	0.792–0.813
Self-efficacy	3	3.32 ± 0.75	0.812*	0.842	0.639	0.791–0.806
Cues to action	3	3.47 ± 1.00	0.727*	0.853	0.659	0.782–0.854
Intention	3	3.46 ± 0.75	0.811*	0.828	0.616	0.754–0.805
Thresholds (minimum acceptable)	3	1–5	≥0.70	≥0.70	≥0.50	≥0.60

Note. HBM, Health Belief Model; SD, standard deviation. Acceptable thresholds: Cronbach's α ≥0.70 [20]; CR ≥0.70 [21]; AVE ≥0.50 [21]. *Indicates value above recommended threshold.

strongest discriminator (M = 3.82 vs. 3.35; $t(383) = 5.190$, $p < 0.001$), followed by Perceived Barriers, which were significantly lower among screened women (M = 2.04 vs. 2.36; $t(383) = -4.17$, $p < 0.001$), indicating that reduced perceived obstacles were associated with higher uptake. Intention (M = 3.65 vs. 3.40; $t(383) = 3.80$, $p < 0.001$) and Self-Efficacy (M = 3.48 vs. 3.27; $t(383) = 3.28$, $p = 0.001$) were also significantly higher among screened women. Perceived Susceptibility reached borderline significance ($t(383) = 2.03$, $p = 0.044$), whereas Perceived severity and Perceived benefits did not differ significantly between the groups ($p > 0.05$).

Among demographic variables, family history of breast cancer ($\chi^2(1) = 16.92$, $p < 0.001$), health insurance coverage ($\chi^2(1) = 14.91$, $p < 0.001$), and urban residence ($\chi^2(1) = 10.60$, $p = 0.001$) were significantly associated with screening uptake. Age, marital status, education, employment, and income showed no significant bivariate association.

3.5 Multivariable Logistic Regression

Two hierarchical logistic regression models were used to identify independent predictors of mammography uptake (Table 5). Model 1, including demographic variables only, explained 11.3% of variance (Nagelkerke $R^2 = 0.113$), with adequate calibration (Hosmer-Lemeshow $\chi^2 = 11.68$, $p = 0.166$). Three variables were significant: family history of breast cancer (aOR = 3.46, 95% CI: 1.88–6.37, $p < 0.001$), health insurance coverage (aOR = 2.93, 95% CI: 1.71–5.02, $p < 0.001$), and urban residence (aOR = 2.64, 95% CI: 1.43–4.88, $p = 0.002$). Age, marital status, education, employment, and income were not statistically significant.

In Model 2, the addition of all six HBM constructs and intention produced a marginally higher explained variance (Nagelkerke $R^2 = 0.124$), with improved calibration (Hosmer-Lemeshow $\chi^2 = 7.00$, $p = 0.537$). However, none of the HBM constructs reached statistical significance as predictors. Family history of breast cancer remained the sole significant independent predictor (aOR = 2.998, 95% CI: 1.273–7.059, $p = 0.012$), while insurance and residence lost significance after adjusting for HBM constructs, suggesting partial mediation of these structural factors through health beliefs.

3.6 Structural Equation Modelling

A full SEM was estimated using the maximum likelihood to examine the associations among HBM constructs, intention, and mammography screening uptake (Fig. 1), with screening intention specified as a mediator. The measurement model included seven latent constructs, each indicated by three items. The structural model specified direct paths from all HBM constructs to screening intention and uptake, along with a mediating path from intention to uptake. The model demonstrated excellent fit: $\chi^2(182) = 187.33$, $p = 0.378$, $\chi^2/df = 1.03$, CFI = 0.995, TLI = 0.994, RMSEA = 0.009, meeting recommended thresholds and confirming adequacy of the seven-factor structure. Among the six HBM constructs, three were significantly associated with screening intention. Self-efficacy showed the strongest association with screening intention ($\beta = 0.450$, $p < 0.001$), indicating that greater confidence in arranging and undergoing mammography was associated with stronger intention. Perceived Barriers showed a significant negative effect ($\beta = -0.233$, $p = 0.035$), suggesting that higher perceived obstacles reduced screening motivation. Perceived Benefits also positively predicted intention ($\beta = 0.208$, $p = 0.014$). In contrast, Perceived Susceptibility, Perceived Severity, and Cues to Action did not independently predict intention after adjustment. The path from intention to mammography uptake was positive but not statistically significant ($\beta = 0.163$, $p = 0.157$). Although directionally consistent with theory, this finding suggests an attenuation of the intention–behavior relationship, possibly due to structural constraints such as insurance coverage and geographic access.

None of the direct paths from HBM constructs to mammography uptake was statistically significant. Standardized coefficients ranged from $\beta = -0.049$ to $\beta = 0.111$,

Table 3. Confirmatory factor analysis (CFA) results.

Construct	Indicator item	Std. loading (λ)	Error Var.	CR	AVE
Perceived susceptibility	I believe I am at risk of developing breast cancer	0.801	0.358	0.806	0.582
	Compared to other women of my age, my chance of getting breast cancer is high	0.757	0.427		
	It is possible that I could develop breast cancer in the future	0.729	0.469		
Perceived severity	Breast cancer would seriously affect my health	0.727	0.471	0.788	0.554
	Breast cancer would negatively impact my family and daily life	0.760	0.422		
	The consequences of breast cancer can be life-threatening	0.745	0.445		
Perceived benefits	Mammography can detect breast cancer at an early stage	0.815	0.336	0.834	0.626
	Early detection through mammography increases survival chances	0.758	0.425		
	Regular mammography provides reassurance about my health	0.799	0.362		
Perceived barriers	Mammography is uncomfortable or painful	0.813	0.339	0.845	0.645
	It is difficult for me to arrange a mammography appointment	0.792	0.373		
	I feel embarrassed about undergoing mammography	0.804	0.354		
Self-efficacy	I am confident I can schedule a mammography appointment if needed	0.802	0.357	0.842	0.639
	I can overcome obstacles that prevent me from getting screened	0.806	0.350		
	I know where and how to obtain a mammogram	0.791	0.374		
Cues to action	My doctor or healthcare provider has recommended mammography	0.782	0.388	0.853	0.659
	Media or health campaigns remind me to undergo screening	0.797	0.365		
	Family or friends encourage me to get a mammography	0.854	0.271		
Intention	I intend to undergo mammography within the next 6 months	0.794	0.370	0.828	0.616
	I plan to have regular mammography screening as recommended	0.754	0.431		
	I will schedule a mammogram soon	0.805	0.352		
Model fit indices: CFI = 0.963, TLI = 0.951, RMSEA = 0.048 [90% CI: 0.031–0.065], SRMR = 0.052					

Note. λ, standardized factor loading; Error Var., $1 - \lambda^2$; CFI, comparative fit index; RMSEA, root mean square error of approximation; TLI, Tucker–Lewis index; SRMR, standardized root mean square residual. Model fit benchmarks: CFI/TLI >0.95; RMSEA <0.06; SRMR <0.08. The obtained model demonstrated a good-to-excellent fit across all indices.

indicating that belief constructs primarily influenced motivation rather than behavior directly. Bootstrapped mediation analyses (1000 resamples) showed that none of the indirect effects via intention reached statistical significance, as all 95% CIs included zero. The total effects indicated that Self-Efficacy and Perceived Susceptibility demonstrated the largest positive combined association with uptake, while Perceived Barriers showed the

Table 4. Bivariate Comparison of HBM Constructs and Demographic Variables by Mammography Screening Status.

Variable/Characteristic	Screened (n = 97)		Not screened (n = 288)		Test statistic	p-value
	Mean	SD	Mean	SD		
A. HBM construct scores (5-point Likert scale; higher = stronger belief)						
Perceived susceptibility	2.79	0.82	2.63	0.65	t (383) = 2.025	0.044*
Perceived severity	3.88	0.41	3.86	0.42	t (383) = 0.501	0.617
Perceived benefits	3.99	0.48	3.88	0.56	t (383) = 1.869	0.062
Perceived barriers	2.04	0.60	2.36	0.67	t (383) = –4.167	<0.001***
Self-efficacy	3.48	0.52	3.27	0.55	t (383) = 3.279	0.001**
Cues to action	3.82	0.74	3.35	0.79	t (383) = 5.190	<0.001***
Intention	3.65	0.52	3.40	0.55	t (383) = 3.796	<0.001***
B. Demographic & clinical variables (chi-square tests)						
Age (years)	51.6	7.3	52.0	8.1	t (383) = 3.454	0.650
Marital status	—	—	—	—	χ^2 (3) = 0.071	0.995
Education level	—	—	—	—	χ^2 (5) = 6.373	0.272
Employment status	—	—	—	—	χ^2 (3) = 1.328	0.723
Monthly household income	—	—	—	—	χ^2 (2) = 5.023	0.081
Place of residence	—	—	—	—	χ^2 (1) = 10.602	0.001**
Health insurance coverage	—	—	—	—	χ^2(1) = 14.906	<0.001***
Family history of breast cancer	—	—	—	—	χ^2 (1) = 16.920	<0.001***

Note. The HBM construct scores are the means of three Likert items (range: 1–5). A higher score indicates a stronger endorsement of beliefs. Degrees of freedom for all t-tests = 383. *p < 0.05; **p < 0.01; ***p < 0.001.

strongest negative total effect. Overall, the SEM findings indicated that Self-Efficacy, Perceived Barriers, and Perceived Benefits were central determinants of screening intention. However, the absence of significant mediation and the non-significant intention–uptake pathway suggests the presence of an intention–behavior gap, implying that psychological readiness alone may be insufficient to translate into mammography uptake without structural facilitation.

4. Discussion

In this cross-sectional study of Saudi women aged ≥40 years, mammography uptake within the past 2 years was low (25.2%), despite high perceived benefits and severity of breast cancer. Participation in screening was significantly higher among women with a family history of breast cancer, health insurance coverage, and urban residence. Although screened women reported higher cues to action, self-efficacy, and intention, and lower perceived barriers in bivariate analyses, these HBM constructs did not independently predict uptake in fully adjusted models, highlighting the dominance of structural and risk-related factors.

4.1 Screening Uptake in Context

The observed recent mammography uptake (25.2% within the past 2 years) indicates that in this sample of women aged 40–75 years, screening is not yet normalized as a routine preventive behavior, even though almost half of these women reported having undergone mammography (49.9%). This "ever vs. recent" gap is important as it suggests that a substantial proportion of women may have tried mammography once (often opportunistically) but do not maintain repeat screening at recommended intervals—an issue that has been highlighted in mammography behavior research more broadly.

When compared to national and multi-region evidence from Saudi Arabia, the pattern remains consistent with a long-standing challenge of suboptimal screening participation [24,25,26,27,28]. A comprehensive study examining patterns and barriers of mammography use among Saudi women across five regions, based on a convenience sample of women aged ≥40 years, reported 40% ever-use, emphasizing ongoing gaps in knowledge and perceived importance [29]. Although the current sample's "ever" rate is much higher than earlier estimates, the recent screening rate (25.2%) still points to limited adherence to regular screening schedules. More recent national evidence similarly shows persistently modest uptake despite increased awareness activities and service availability. A 2020 national cross-sectional survey examining socioeconomic inequalities in breast cancer screening uptake reported relatively low "ever mammogram" uptake, underscoring how variable estimates can be by sampling frame and recruitment method [30].

4.2 Sociodemographic and Clinical Correlates

The bivariate results showed that urban residence, insurance coverage, and family history of breast cancer were strongly associated with screening in the past 2 years. This aligns with the broader public health literature suggesting that, even in systems with nominally available services, access-enabling resources and healthcare contact remain key drivers of preventive service uptake [31,32]. In the Sa-

Table 5. Multivariable logistic regression predicting mammography uptake in the past 2 years.

Predictor	Model 1: demographic predictors only				Model 2: demographics + HBM constructs				95% CI	*p*-value
	β	SE	aOR	95% CI	*p*-value	β	SE	aOR		
A. Demographic predictors										
Age (years)	0.005	0.016	1.005	0.973–1.037	0.774	0.003	0.017	1.003	0.970–1.036	0.868
Marital status	–0.072	0.155	0.930	0.687–1.259	0.640	–0.073	0.156	0.929	0.684–1.262	0.638
Education level	–0.113	0.065	0.893	0.786–1.014	0.082	–0.098	0.067	0.907	0.795–1.035	0.146
Employment status	–0.098	0.135	0.907	0.696–1.181	0.469	–0.121	0.136	0.886	0.678–1.158	0.376
Monthly household income	–0.247	0.167	0.781	0.563–1.084	0.140	–0.245	0.169	0.783	0.563–1.090	0.147
Place of residence	0.972	0.313	2.643	1.431–4.881	0.002**	0.615	0.375	1.850	0.888–3.855	0.101
Health insurance (ref: No)	1.076	0.274	2.933	1.713–5.023	<0.001***	0.607	0.419	1.835	0.807–4.170	0.147
Family history of BC (ref: No)	1.241	0.311	3.459	1.880–6.366	<0.001***	1.098	0.437	2.998	1.273–7.059	0.012*
B. HBM construct predictors (Model 2 only)										
Perceived susceptibility	—	—	—	—	—	–0.029	0.236	0.970	0.612–1.542	0.901
Perceived severity	—	—	—	—	—	0.139	0.315	1.149	0.620–2.130	0.658
Perceived benefits	—	—	—	—	—	0.113	0.275	1.120	0.653–1.920	0.680
Perceived barriers	—	—	—	—	—	–0.218	0.243	0.804	0.500–1.295	0.370
Self-efficacy	—	—	—	—	—	0.015	0.265	1.016	0.604–1.707	0.954
Cues to action	—	—	—	—	—	0.210	0.245	1.234	0.763–1.994	0.391
Intention	—	—	—	—	—	0.393	0.267	1.481	0.878–2.498	0.141
Model 1 fit: Nagelkerke $R^2 = 0.113$ | Hosmer-Lemeshow: $\chi^2 = 11.675$, $p = 0.166$; Model 2 fit: Nagelkerke $R^2 = 0.124$ | Hosmer-Lemeshow: $\chi^2 = 6.996$, $p = 0.537$										

Note. β, unstandardized logistic regression coefficient; SE, standard error; aOR, adjusted odds ratio; 95% CI, 95% confidence interval; BC, breast cancer. Model 1 included only the demographic predictors. Model 2 included all six HBM constructs and screening intentions. Nagelkerke's R^2 was reported as a pseudo-R^2 effect-size measure. The Hosmer-Lemeshow goodness-of-fit test $p > 0.05$ indicates adequate model calibration. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

udi Health Interview Survey analysis, women who had undergone a routine medical examination in the last 2 years were more likely to have undergone a mammogram in the past 2 years, supporting the idea that “touchpoints” with healthcare systems can move women from awareness to action [33].

The association between urban residence and screening is also consistent with evidence that geography can shape preventive care through service density, appointment availability, and travel burden [34,35,36]. Reviews focused on Saudi women repeatedly document barriers linked to access constraints, including limited facility availability and the practical difficulty of accessing screening services, which plausibly weigh more heavily on rural residents. In addition, provider-side factors (e.g., the degree of organized outreach and systematic reminders) may be more developed in major urban centers, which can widen urban–rural differentials [36,37].

The finding that family history of breast cancer is strongly associated with recent screening is epidemiologically coherent and consistent with evidence [38,39] that family history shapes risk perception and repeat mammography behaviors. In population-based studies, family history has been associated with both higher perceived risk and increased frequency of repeat mammography. Importantly, family history often “legitimizes” screening in the eyes of women and families and may increase the likelihood of provider recommendations (a key “cue to action”), thereby creating multiple reinforcing pathways to uptake [40].

One interesting nuance is that some Saudi studies have reported atypical patterns (e.g., lower uptake among women reporting family history in certain convenience samples), which authors have interpreted as potentially reflecting fear, avoidance, or misconceptions among high-risk women [14,41]. The current results instead support the more commonly observed direction (higher uptake with family history), which may reflect differences in sample composition, awareness, or the way “family history” was operationalized and communicated in the survey.

4.3 Health Belief Profiles and What They Imply

The descriptive patterns across the HBM constructs were notable. Perceived benefits (M = 3.90) and severity (M = 3.86) were high, while perceived susceptibility (M = 2.67) was low. This pattern suggests a form of optimistic bias: women acknowledge the seriousness of breast cancer and the usefulness of mammography, but perceive their personal risk as lower [42,43]. Similar observations have been reported in family-history research, where the absence of family history is often interpreted as “low risk”, potentially leading to underestimation of vulnerability among average-risk women [42,43].

Bivariate comparisons showed that women screened within the past 2 years reported higher cues to action, higher self-efficacy, and higher intention, along with lower perceived barriers. These findings align with the global evidence on HBM constructs and mammography behavior. A systematic review and meta-analysis reported that cue to action was the strongest predictor of screening behavior (mean OR = 1.80). Saudi studies similarly highlight provider recommendation, culturally relevant encouragement, and navigation support as facilitators, while embarrassment, pain concerns, and fear of diagnosis remain common barriers [7,29,37,43]. Together, these findings suggest that knowledge-based persuasion (benefits and severity) may already be relatively saturated, whereas cues to action, self-efficacy, and barrier reduction are critical determinants of screening behavior.

The SEM demonstrated excellent fit (CFI = 0.995, TLI = 0.994, RMSEA = 0.009), supporting the hypothesized HBM structure and consistent with studies from Middle Eastern populations [44,45,46,47]. Self-efficacy showed the strongest association with screening intention (β = 0.450, $p = 0.001$), while perceived barriers were negatively associated with intention (β = −0.233, $p = 0.035$) and perceived benefits showed a positive association (β = 0.208, $p = 0.014$), consistent with prior SEM evidence [44,48]. However, the path from intention to actual screening was positive but non-significant (β = 0.163, $p = 0.157$), reflecting the widely reported intention–behavior gap in preventive health research [49,50,51]. The path from intention to uptake was positive yet non-significant (β = 0.163, $p = 0.157$), reflecting a well-documented intention–behavior gap in preventive health research [46,49,51]. Bootstrapped mediation analysis also revealed no significant indirect effects, as all CIs crossed zero, which is consistent with comparable SEM studies [52,53].

Although attenuation of the residence and insurance effects in the hierarchical logistic regression might appear to reflect indirect associations through health beliefs, the formal SEM mediation analysis did not support significant indirect pathways. This likely reflects the limitations of regression-based mediation inference, where coefficient changes may arise from collinearity or model adjustment, rather than true causal mediation. Overall, these results indicate that structural access factors—such as insurance coverage, geographic location, and family history—play a more direct role in shaping mammography uptake than cognitive belief pathways alone [45,52].

4.4 Implications for Intervention and Policy

Collectively, these results suggest several priorities for improving mammography uptake in Saudi Arabia. Increasing the perceived severity and benefits, while still important, may yield diminishing returns if these beliefs are already firm. Instead, interventions should emphasize (1) cues for action, (2) barrier reduction, and (3) building self-efficacy. Evidence syntheses on Saudi women have consistently identified embarrassment, fear of diagnosis, pain

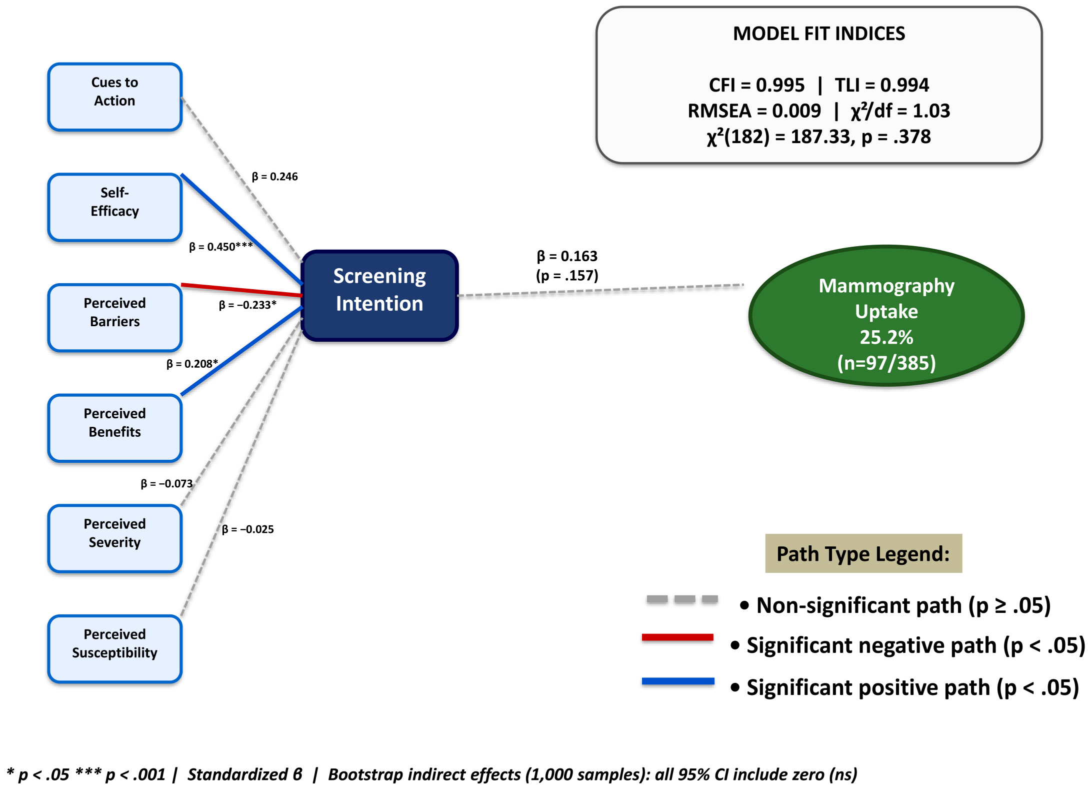

Fig. 1. Structural equation model (SEM) of Health Belief Model predictors of mammography uptake (*n* = 385). Standardized path coefficients are displayed for relationships among Health Belief Model constructs, screening intention, and mammography uptake. Solid lines indicate statistically significant paths ($p < 0.05$), and dashed lines represent non-significant paths. Model fit indices demonstrate excellent fit (CFI = 0.995, TLI = 0.994, RMSEA = 0.009), supporting the adequacy of the proposed seven-factor structure.

concerns, and lack of provider recommendations as common barriers. Therefore, service design and health communication strategies should normalize screening, ensure culturally sensitive privacy conditions, and address fear and procedural concerns through clear explanations and supportive counseling.

Although cues to action significantly differentiated between screened and unscreened women in the bivariate analyses, they did not independently predict screening intention or uptake in the structural model. This finding likely reflects a conceptual overlap with other HBM constructs. In practice, cues—such as physician recommendations or reminders—may operate indirectly by strengthening self-efficacy or reducing perceived barriers rather than exerting a direct behavioral effect. When modeled simultaneously in SEM, the unique contribution of cues diminishes, suggesting that cues primarily function as activation triggers, facilitating existing motivational readiness rather than independent determinants of screening behavior.

Importantly, the findings also indicate that structural access factors may play a stronger role in screening behavior than psychological readiness. Although mammography services are available through national programs, geographical disparities in service distribution, transportation challenges, and a reliance on referral pathways may limit access, particularly for women living in rural areas. Health insurance coverage may facilitate screening by increasing the number of health care contacts and referral opportunities. Consequently, improving mammography uptake in Saudi Arabia will likely require not only behavioral interventions but also system-level strategies that enhance accessibility, organized outreach, and equitable service distribution. Finally, the persistent influence of a family history highlights an opportunity for risk-stratified communication, particularly to correct the misconception that the absence of a family history equates to a low breast cancer risk.

4.5 Strengths and Limitations

A major strength of this study is the integration of psychometric validation using confirmatory factor analysis with behavioral outcome modeling, supporting the reliability and structural validity of the HBM constructs. However, this study has some limitations. The cross-sectional design precludes causal inference and does not establish temporal relationships between health beliefs and screening behaviors. Mammography history was self-reported and may have been subject to recall or social desirability bias. In addition, participants were recruited through social media using a convenience sampling approach, which may have introduced a selection bias by attracting women who were more educated, urban, and engaged in health information. This is reflected in the sample, where most participants were urban residents (69.9%) and over half of the participants reported health insurance coverage (55.8%). Consequently, the observed prevalence of ever undergoing mammography (49.9%) may be higher than the national estimates and should be interpreted cautiously when generalizing to the broader population of Saudi women, particularly those in rural or underserved settings.

Furthermore, the multivariable logistic regression model included several predictors related to the number of screening events ($n = 97$), which may have reduced the statistical power and led to unstable estimates. This may partly explain why the psychosocial constructs that were significant in the bivariate analyses did not remain independent predictors in the adjusted model. Future studies should consider larger samples or more parsimonious models to better evaluate the independent effects of the HBM constructs. Finally, although SEM was used to examine the pathways between beliefs, intention, and behavior, the cross-sectional design means that the SEM results should be interpreted as associative relationships rather than causal mechanisms.

5. Conclusions

This study provides a comprehensive evaluation of mammography uptake among women aged 40 years and above in Saudi Arabia using the HBM. Despite moderate levels of perceived benefits and severity, only one-quarter of the participants reported screening within the past 2 years, indicating persistently low adherence to the recommended guidelines. While self-efficacy, perceived benefits, and perceived barriers significantly influenced screening intentions, these psychological determinants did not translate into actual behavior after adjustment. A family history of breast cancer emerged as the only factor independently associated with screening uptake, highlighting the predominance of perceived risk and clinical prompts over general health beliefs.

These findings suggest the presence of an intention–behavior gap, wherein motivational readiness alone is insufficient to ensure screening participation. Structural factors, including access to healthcare services and insurance coverage, appear to play critical roles. Therefore, public health strategies should integrate behavioral interventions aimed at enhancing self-efficacy and reducing perceived barriers with systemic measures to improve accessibility, outreach, and targeted risk communication.

Future research should employ longitudinal designs to examine how changes in health beliefs influence subsequent mammography screening uptake, as a cross-sectional design does not allow for causal or temporal inferences. Future studies should aim to recruit more geographically and socioeconomically diverse samples, particularly from rural and uninsured populations, to improve the generalizability of the findings across Saudi Arabia. Strengthening both psychological readiness and structural facilitation is essential for improving mammography uptake and advancing early breast cancer detection in Saudi Arabia.

Availability of Data and Materials

The datasets used and/or analyzed in the current study are available from the corresponding author upon reasonable request.

Author Contributions

ASA made a significant contribution to the work reported, including conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; and agreed to be responsible for all aspects of the work.

Ethics Approval and Consent to Participate

This study was approved by the Jazan Health Ethics Committee, Ministry of Health, Saudi Arabia (Approval No. 23106). All the procedures adhered to the principles of the Declaration of Helsinki. Participation was voluntary and informed consent was obtained electronically prior to survey completion.

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Conflicts of Interest

The author declares no conflicts of interest.

Declaration of AI and AI-Assisted Technologies in the Writing Process

During the preparation of this manuscript, the author used ChatGPT to assist with grammar and language editing. After using this tool, the author carefully reviewed and edited the content and takes full responsibility for the final manuscript.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.31083/CEOG51254.

References

[1] Łukasiewicz S, Czeczelewski M, Forma A, Baj J, Sitarz R, Stanisławek A. Breast Cancer-Epidemiology, Risk Factors, Classification, Prognostic Markers, and Current Treatment

Strategies-An Updated Review. Cancers. 2021; 13: 4287. https://doi.org/10.3390/cancers13174287
[2] Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA: a Cancer Journal for Clinicians. 2021; 71: 209–249. https://doi.org/10.3322/caac.21660
[3] Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA: a Cancer Journal for Clinicians. 2018; 68: 394–424. https://doi.org/10.3322/caac.21492
[4] Althubiti MA, Nour Eldein MM. Trends in the incidence and mortality of cancer in Saudi Arabia. Saudi Medical Journal. 2018; 39: 1259–1262. https://doi.org/10.15537/smj.2018.12.23348
[5] Lauby-Secretan B, Scoccianti C, Loomis D, Benbrahim-Tallaa L, Bouvard V, Bianchini F, et al. Breast-cancer screening–viewpoint of the IARC Working Group. The New England Journal of Medicine. 2015; 372: 2353–2358. https://doi.org/10.1056/NEJMsr1504363
[6] Myers ER, Moorman P, Gierisch JM, Havrilesky LJ, Grimm LJ, Ghate S, et al. Benefits and Harms of Breast Cancer Screening: A Systematic Review. JAMA. 2015; 314: 1615–1634. https://doi.org/10.1001/jama.2015.13183
[7] Abolfotouh MA, BaniMustafa AA, Mahfouz AA, Al-Assiri MH, Al-Juhani AF, Alaskar AS. Using the health belief model to predict breast self examination among Saudi women. BMC Public Health. 2015; 15: 1163. https://doi.org/10.1186/s12889-015-2510-y
[8] Rosenstock IM. The health belief model and preventive health behavior. Health Education Monographs. 1974; 2: 354–386.
[9] Alshagrawi SS. Predicting COVID-19 vaccine uptake: Comparing the health belief model and theory of planned behavior. Human Vaccines & Immunotherapeutics. 2024; 20: 2361503. https://doi.org/10.1080/21645515.2024.2361503
[10] Becker MH. The health belief model and personal health behavior. Health Education Monographs. 1974; 2: 324–473.
[11] Champion VL, Skinner CS. The health belief model. In Glanz K, Rimer BK, Viswanath K (eds.) Health behavior and health education: Theory, research, and practice (pp. 45–65). 4th edn. Jossey-Bass/Wiley: Hoboken, NJ, US. 2008.
[12] Garai S, Márton JT, Sipos D, Csima M. Health beliefs and breast self-examination practices among female health science students in Hungary: a health belief model perspective. Frontiers in Public Health. 2025; 13: 1681802. https://doi.org/10.3389/fpubh.2025.1681802
[13] Bhandari D, Shibanuma A, Kiriya J, Hirachan S, Ong KIC, Jimba M. Factors associated with breast cancer screening intention in Kathmandu Valley, Nepal. PloS One. 2021; 16: e0245856. https://doi.org/10.1371/journal.pone.0245856
[14] Alsalamh R, Al-Harbi FA, Alotaibi RT, Al-Harbi ON, Alshahrani N, Alfadhel SM, et al. Barriers to Breast Cancer Screening in Saudi Arabia: A Systematic Review and Meta-Analysis. Cureus. 2024; 16: e65103. https://doi.org/10.7759/cureus.65103
[15] Alanazi WN, Mohamed GM, Alosaimi NS, Alosaimi LM. Breast cancer awareness, knowledge and self-screening intention among females in Northern Border of Saudi Arabia, Arar City. BMC Public Health. 2025; 25: 964. https://doi.org/10.1186/s12889-025-22092-w
[16] Al-Amoudi SM, Abduljabbar HS. Men's knowledge and attitude towards breast cancer in Saudi Arabia. A cross-sectional study. Saudi Medical Journal. 2012; 33: 547–550.
[17] Jones CL, Jensen JD, Scherr CL, Brown NR, Christy K, Weaver J. The Health Belief Model as an explanatory framework in communication research: exploring parallel, serial, and moderated mediation. Health Communication. 2015; 30: 566–576. https://doi.org/10.1080/10410236.2013.873363
[18] Cuschieri S. The STROBE guidelines. Saudi Journal of Anaesthesia. 2019; 13: S31–S34. https://doi.org/10.4103/sja.SJA_543_18
[19] Moreira CB, Dahinten VS, Howard AF, Fernandes AFC. The Revised Champion's Health Belief Model Scale: Predictive Validity Among Brazilian Women. SAGE Open Nursing. 2020; 6: 2377960820940551. https://doi.org/10.1177/2377960820940551
[20] Amusa LB, Hossana T. An empirical comparison of some missing data treatments in PLS-SEM. PloS One. 2024; 19: e0297037. https://doi.org/10.1371/journal.pone.0297037
[21] Laker C, Cella M, Callard F, Wykes T. The impact of ward climate on staff perceptions of barriers to research-driven service changes on mental health wards: A cross-sectional study. Journal of Psychiatric and Mental Health Nursing. 2020; 27: 281–295. https://doi.org/10.1111/jpm.12577
[22] Akiyama Y, Katsuki S, Matoba T, Nakano Y, Takase S, Nakashiro S, et al. Association of Serum Oxysterols with Cholesterol Metabolism Markers and Clinical Factors in Patients with Coronary Artery Disease: A Covariance Structure Analysis. Nutrients. 2023; 15: 2997. https://doi.org/10.3390/nu15132997
[23] Çakıroğlu SS, Caetano A, Costa P. Shared leadership, self-management and perceived team effectiveness in the military context. Military Psychology: the Official Journal of the Division of Military Psychology, American Psychological Association. 2021; 33: 308–319. https://doi.org/10.1080/08995605.2021.1962179
[24] Abdel-Salam DM, Mohamed RA, Alyousef HY, Almasoud WA, Alanzi MB, Mubarak AZ, et al. Perceived Barriers and Awareness of Mammography Screening Among Saudi Women Attending Primary Health Centers. Risk Management and Healthcare Policy. 2020; 13: 2553–2561. https://doi.org/10.2147/RMHP.S277375
[25] Abulkhair OA, Al Tahan FM, Young SE, Musaad SM, Jazieh ARM. The first national public breast cancer screening program in Saudi Arabia. Annals of Saudi Medicine. 2010; 30: 350–357. https://doi.org/10.4103/0256-4947.67078
[26] Abusanad A. Breast Cancer Stage Migration in Saudi Arabia: Examining the Influence of Screening. Global Journal on Quality and Safety in Healthcare. 2022; 5: 24–26. https://doi.org/10.36401/JQSH-21-15
[27] Halabi S, Skinner CS, Samsa GP, Strigo TS, Crawford YS, Rimer BK. Factors associated with repeat mammography screening. The Journal of Family Practice. 2000; 49: 1104–1112.
[28] Burman ML, Taplin SH, Herta DF, Elmore JG. Effect of false-positive mammograms on interval breast cancer screening in a health maintenance organization. Annals of Internal Medicine. 1999; 131: 1–6. https://doi.org/10.7326/0003-4819-131-1-199907060-00002
[29] Al-Wassia RK, Farsi NJ, Merdad LA, Hagi SK. Patterns, knowledge, and barriers of mammography use among women in Saudi Arabia. Saudi Medical Journal. 2017; 38: 913–921. https://doi.org/10.15537/smj.2017.9.20842
[30] Al-Hanawi MK, Hashmi R, Almubark S, Qattan AMN, Pulok MH. Socioeconomic Inequalities in Uptake of Breast Cancer Screening among Saudi Women: A Cross-Sectional Analysis of a National Survey. International Journal of Environmental Research and Public Health. 2020; 17: 2056. https://doi.org/10.3390/ijerph17062056
[31] Sealy-Jefferson S, Roseland ME, Cote ML, Lehman A, Whitsel EA, Mustafaa FN, et al. Rural-Urban Residence and Stage at Breast Cancer Diagnosis Among Postmenopausal Women: The

Women's Health Initiative. Journal of Women's Health (2002). 2019; 28: 276–283. https://doi.org/10.1089/jwh.2017.6884
[32] Odeh A, Feras K, Vincze F, Lakatos K, Pálinkás A, Kőrösi L, et al. Breast cancer screening coverage is severely reduced among women who reside in segregated areas: a cross-sectional investigation in Hungary. Frontiers in Public Health. 2025; 13: 1500098. https://doi.org/10.3389/fpubh.2025.1500098
[33] Healthdata. Saudi Health Interview Survey Results. 2026. Available at: https://www.healthdata.org/sites/default/files/files/Projects/KSA/Saudi-Health-Interview-Survey-Results.pdf (Accessed: 1 January 2026).
[34] Anderson AE, Henry KA, Samadder NJ, Merrill RM, Kinney AY. Rural vs urban residence affects risk-appropriate colorectal cancer screening. Clinical Gastroenterology and Hepatology: the Official Clinical Practice Journal of the American Gastroenterological Association. 2013; 11: 526–533. https://doi.org/10.1016/j.cgh.2012.11.025
[35] Hughes AG, Watanabe-Galloway S, Schnell P, Soliman AS. Rural-Urban Differences in Colorectal Cancer Screening Barriers in Nebraska. Journal of Community Health. 2015; 40: 1065–1074. https://doi.org/10.1007/s10900-015-0032-2
[36] Amin TT, Al Mulhim ARS, Al Meqihwi A. Breast cancer knowledge, risk factors and screening among adult Saudi women in a primary health care setting. Asian Pacific Journal of Cancer Prevention: APJCP. 2009; 10: 133–138.
[37] Abdel-Aziz SB, Amin TT, Al-Gadeeb MB, Alhassar AI, Al-Ramadan A, Al-Helal M, et al. Perceived barriers to breast cancer screening among Saudi women at primary care setting. Journal of Preventive Medicine and Hygiene. 2018; 59: E20–E29. https://doi.org/10.15167/2421-4248/jpmh2018.59.1.689
[38] Haber G, Ahmed NU, Pekovic V. Family history of cancer and its association with breast cancer risk perception and repeat mammography. American Journal of Public Health. 2012; 102: 2322–2329. https://doi.org/10.2105/AJPH.2012.300786
[39] Lerman C, Daly M, Sands C, Balshem A, Lustbader E, Heggan T, et al. Mammography adherence and psychological distress among women at risk for breast cancer. Journal of the National Cancer Institute. 1993; 85: 1074–1080. https://doi.org/10.1093/jnci/85.13.1074
[40] Durham DD, Roberts MC, Khan CP, Abraham LA, Smith RA, Kerlikowske K, et al. Age at initiation of screening mammography by family history of breast cancer in the breast cancer surveillance consortium. Cancer Causes & Control: CCC. 2021; 32: 103–107. https://doi.org/10.1007/s10552-020-01354-5
[41] Basudan AM. Breast Cancer Incidence Patterns in the Saudi Female Population: A 17-Year Retrospective Analysis. Medicina (Kaunas, Lithuania). 2022; 58: 1617. https://doi.org/10.3390/medicina58111617
[42] Facione NC. Perceived risk of breast cancer: influence of heuristic thinking. Cancer Practice. 2002; 10: 256–262. https://doi.org/10.1046/j.1523-5394.2002.105005.x
[43] Aiken LS, Fenaughty AM, West SG, Johnson JJ, Luckett TL. Perceived determinants of risk for breast cancer and the relations among objective risk, perceived risk, and screening behavior over time. Women's Health (Hillsdale, N.J.). 1995; 1: 27–50.
[44] Khazir Z, Morrowati Sharifabad MA, Vaezi AA, Enjezab B, Fallahzadeh H, Yari F. Predictors of mammography based on Health Belief Model in Khorramabad women. Journal of Education and Health Promotion. 2019; 8: 180. https://doi.org/10.4103/jehp.jehp_63_19
[45] 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. Journal of the Egyptian National Cancer Institute. 2022; 34: 50. https://doi.org/10.1186/s43046-022-00150-3
[46] Keshavarzi A, Asadi S, Asadollahi A, Mohammadkhah F, Khani Jeihooni A. Tendency to Breast Cancer Screening Among Rural Women in Southern Iran: A Structural Equation Modeling (SEM) Analysis of Theory of Planned Behavior. Breast Cancer: Basic and Clinical Research. 2022; 16: 11782234221121001. https://doi.org/10.1177/11782234221121001
[47] Firouzbakht M, Hajian-Tilaki K, Bakhtiari A. Comparison of competitive cognitive models in explanation of women breast cancer screening behaviours using structural equation modelling: Health belief model and theory of reasoned action. European Journal of Cancer Care. 2021; 30: e13328. https://doi.org/10.1111/ecc.13328
[48] Noroozi A, Jomand T, Tahmasebi R. Determinants of breast self-examination performance among Iranian women: an application of the health belief model. Journal of Cancer Education: the Official Journal of the American Association for Cancer Education. 2011; 26: 365–374. https://doi.org/10.1007/s13187-010-0158-y
[49] Murphy CC, Vernon SW, Diamond PM, Tiro JA. Competitive testing of health behavior theories: how do benefits, barriers, subjective norm, and intention influence mammography behavior? Annals of Behavioral Medicine: a Publication of the Society of Behavioral Medicine. 2014; 47: 120–129. https://doi.org/10.1007/s12160-013-9528-0
[50] Agide FD, Garmaroudi G, Sadeghi R, Shakibazadeh E, Yaseri M, Koricha ZB. A health belief model-based community health education on mammography screening among reproductive-aged women in Ethiopia: a randomized controlled trial. Frontiers in Public Health. 2024; 12: 1377173. https://doi.org/10.3389/fpubh.2024.1377173
[51] Ritchie D, Van den Broucke S, Van Hal G. The health belief model and theory of planned behavior applied to mammography screening: A systematic review and meta-analysis. Public Health Nursing (Boston, Mass.). 2021; 38: 482–492. https://doi.org/10.1111/phn.12842
[52] Feng GC, Lin Z, Ou W, Su X, Yan Q. A Model-Based Meta-Analysis of Willingness to Participate in Cancer Screening. International Journal of Environmental Research and Public Health. 2021; 18: 2580. https://doi.org/10.3390/ijerph18052580
[53] Salmani F, Moodi M, Yousefi A, Norozi E. Healthy Beliefs regarding Breast Cancer Screening in Iranian Women Health Volunteers: A Path Analysis. Korean Journal of Family Medicine. 2021; 42: 132–139. https://doi.org/10.4082/kjfm.20.0001