RESEARCH ARTICLE

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The Trade-Offs that Vietnamese Women Make in Early Detection Services for Breast Cancer: Insights from a Discrete Choice Experiment Using a Latent Class Model

Vinh-Quang Tran[1], Viet Cuong Le Dang[1], Phuong Anh Ta Ngoc[2], Thanh Van Phan Nguyen[3], Yen Nhi Ngo Hoang[4], Toi Lam Phung[5], Anh Tuan Ho Nguyen[3], Trung Quang Vo[1]*

Abstract

Introduction: Delays in diagnosis and treatment are common among Vietnamese breast cancer (BC) patients. This study analyzed women's preferences regarding breast cancer screening (BCS) programs and mammography screening to support the government in implementing population-based BCS. **Methods:** We conducted literature reviews, focus group discussions, and qualitative interviews to develop the attributes and levels of a discrete choice experiment (DCE) involving [breast cancer screening (BCS) programs and mammography screening. The BCS program included] seven attributes (screening test staff's gender, method of invitation, free breast self-exam course, waiting time, combined screening test, screening location, and cost), and mammography screening included five attributes (comfort level, screening test staff's gender, false positives, overdiagnosis, and cost). The choice data were analyzed using a latent class model. Uptake was predicted, and policy scenarios were formulated. **Results:** A total of 1,023 women, with an average age of 33.4 years, completed the DCE survey. In the BCS scenario, respondents in all classes preferred a combination of screening tests and lower costs, except for the smallest class of participants. Screening location and waiting time were influential components in decision-making for all women. Most participants were sensitive to organizational characteristics and costs. In the mammography screening scenario, respondents' preferences were strongly influenced by the gender of screening test personnel, false positives, and costs across all classes. **Conclusion:** Women in Vietnam exhibit heterogeneous preferences for breast cancer screening (BCS) programs and mammography screening. This study provides supporting evidence related to Vietnamese women's preferences for BCS, which may be valuable for public health authorities.

Keywords: breast cancer- consumer engagement- mammography- screening- Vietnam

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Introduction

A report released by the Global Cancer Observatory showed that in 2020, BC surpassed lung cancer as the most commonly occurring cancer worldwide, accounting for 11.9% of total cancers, having 2.3 million new cases, and resulting in 685,000 deaths (one in six deaths) [1]. An estimated 3.0 million new female BC cases are projected to occur globally in 2040 - a 31% increase from the aforementioned 2.3 million cases [2]. BC incidence rates vary by nearly fourfold across areas identified by the World Health Organization (WHO). The highest incidence rates (per 100,000) have been found in Australia/New Zealand (95.5), Western Europe (90.7), and Northern America (89.4), while the lowest rates have been identified in South-Central Asia (26.2), Middle and Eastern Africa (33), and Central America (39.5) [2]. In Vietnam, BC accounted for 21,555 cases (11.8%) of the total cancers occurring in the country and caused 9,345 deaths in 2020 [3]. The five-year probability of survival from the disease is also lower in Vietnam than in countries with similar distributions of cancer stages at diagnosis [4].

Screening for BC is an effective way to detect early-stage disease and improve the survival rates of patients [5]. Population-based breast cancer screening (BCS) programs have been implemented in many developed countries over

*[1]Faculty of Pharmacy, Pham Ngoc Thach University of Medicine, Ho Chi Minh City 700000, Vietnam. [2]Social, Economic and Administrative Pharmacy (SEAP) Graduate Program, Faculty of Pharmacy, Mahidol University, Bangkok 10400, Thailand. [3]Faculty of Basic Medical Science, Pham Ngoc Thach University of Medicine, Ho Chi Minh City 700000, Vietnam. [4]Department of Office, Ministry of Health, Hanoi 100000, Vietnam. [5]University of Medicine and Pharmacy, Vietnam National University, Hanoi 100000, Vietnam. *For Correspondence: voquangtrungdk@gmail.com. Quang Vinh Tran, Cuong Dang Viet Le and Anh Ngoc Phuong Ta have equal contribution in this study.*

the last few decades, thereby contributing to the reduction of mortality and advanced cancer rates [5]. Mammography, which has been successful in reducing mortality, is recommended as the primary screening modality for women at average risk of developing BC, according to 23 international guidelines [5]. Mammography screening has been suggested by the WHO and other international cancer networks as successfully reducing mortality, and it remains the gold standard for BCS [6]. This observation is supported by a systematic review of 23 international guidelines issued by developed countries, with the review indicating that most of these standards advise annual or biennial mammographic screening between the ages of 40 and 74 years for average-risk populations and annual mammography or annual magnetic resonance imaging starting from younger ages for high-risk populations [5]. In Vietnam, mammography for the early diagnosis of BC is recommended every one to two years for women aged 40 years and the elderly or high-risk populations [7].

BC patients in low- and middle-income countries (LMICs) are typically diagnosed at a later stage, possibly because of a lack of screening capacity for early detection, which is seen as essential to lowering public health burdens and cancer mortality rates [6]. Although mammography screening is consider the most effective screening method and a cost-effective strategy for LMICs [6], its use is relatively low compared with breast self-examination (BSE) and clinical breast examination [8]. In Vietnam, delays in diagnosis and treatment are common among BC patients [9]. For example, in-person surveys administered to 462 women in North Vietnam showed that 31.5% of patients experience moderate delays (3-8 months), and 17.5% experience serious delays (≥9 months) [9]. Such delays in diagnosis and treatment are related to psychological and financial barriers as well as lack of knowledge [9]. A study revealed that Vietnamese BC patients diagnosed at later stages incur higher expenses compared to those diagnosed early and this highlights the importance of early detection through screening programs [10]. In Vietnam, there are no national BCS guidelines at population-based level or programs implemented. Although BCS screening service is available in Vietnam's central/tertiary hospitals and some private hospitals, screening costs are not covered by the country's national health insurance system [11]. The first objective was to assess women's preferences for a BCS program focusing on organizational characteristics rather than the screening technique; and the second objective was to evaluate their preferences for mammography screening using discrete choice experiment (DCE), which is an attractive method for supporting research and policymaking, as it offers a flexible methodology with which to estimate the attributes that are important in decision-making on the issue of interest [12].

Materials and Methods

Study design and sampling method

A cross-sectional survey was conducted in Vietnam from July 2022 to December 2024. The inclusion criteria were women who were ≥18 years old, had no history of and were not suffering from BC at the time of the study. To develop a DCE and perform a pilot study, we followed the guidelines released by the Conjoint Analysis Task Force of the International Society for Pharmacoeconomics and Outcomes Research for good research practices [13]. This study also followed the DIRECT Checklist for Reporting Discrete Choice Experiments in Health to ensure comprehensive and transparent reporting.

Development of DCE attributes and levels

We developed attributes and levels for the DCE design for BCS program and mammography screening based on Helter and Boehler's [14] four-stage process: raw data collection, data reduction, the removal of inappropriate attributes, and the wording of attributes. The BCS program aims to assess organizational characteristics, while mammography screening focuses on features that highlight its importance.

Raw data collection and data reduction

The first two stages involved reviewing the literature on DCEs related to preferences for BCS and conducting semi-structured interviews to identify potential attributes for DCEs. The review, based on PubMed up to July 2022, included 720 studies, which were narrowed down to five after screening titles and abstracts. Attributes and levels were extracted from these studies by two researchers (QVT and ANPT). Twenty-eight potential attributes were categorized into two scenarios: BCS (25 attributes) and mammography screening (26 attributes), and were grouped under themes like cost, health information, and time. These themes formed the basis for the interview guide. The semi-structured interviews addressed four issues: ranking of attributes, personal BCS experiences, perceived pros and cons of BCS, and other decision factors. The 20 key informants recruited for these interviews included 6 healthcare staff members with experience in oncology (2 doctors and 4 pharmacists) and 14 eligible women from the target age group (40–70 years). Findings revealed that key preferences were cost and out-of-pocket expenses for BCS. Fear of screening procedures was the main concern for mammography, leading to the inclusion of emotional aspects in the DCE. Additionally, some respondents had difficulty understanding false positives and overdiagnosis, prompting the creation of an explanatory poster.

Removing inappropriate attributes and wording attributes

After the two previous steps, a complete list of attributes and levels was prepared. A key issue in the design of DCEs revolves around determining a suitable quantity of attributes and levels, as an insufficient number can diminish the validity of the outcomes. At the same time, however, an extensive list of attributes and levels complicates a DCE design, leading to an elevated response burden and an increased likelihood of non-engagement with a task. Therefore, interviews with stakeholders (two general practitioners, a nurse, and a pharmacist) were held to discuss the DCE attributes, levels, and questionnaire. Attributes were retained or removed based on three explicit criteria: (1) importance: attributes consistently ranked as low-priority by the target population during the

initial interviews were excluded; (2) relevance: attributes deemed clinically irrelevant or impractical for the Vietnamese healthcare context by the expert panel were removed; and (3) redundancy: attributes that overlapped conceptually with others were merged or eliminated to prevent multicollinearity.

The research team discussed the results of the interviews until a consensus was reached. In mammography sreening, a plausible and clinically applicable range of levels for overdiagnosis and false positives is determined on the basis of real data on Asian countries [15]. As BCS expenses are not reimbursed in Vietnam, we incorporated out-of-pocket costs into both scenarios. To accurately reflect the issue of affordability, the cost levels employed were grounded in actual BCS screening expenses at hospitals in Vietnam. The final DCE questionnaire consisted of seven attributes for the BCS program and five attributes for the mammography screening (Table 1).

Construction of tasks and elicitation of preferences

A DCE consists of a set of choice tasks, and each set contains three profiles that encompass two alternative screening scenarios and an opt-out choice representing a "no screening" program. This format effectively mimics the decisions that women face in real life and enables accounting for nondemanders of BCS. We applied generic labels (programs A and B) to the design of the tasks to reduce the effects of bias against a particular BCS program [16]. To maximize the information collected from each choice task, we used a two-part question format. The first part was a forced comparison between the two alternativess, and the second involved asking the respondents for the likelihood of screening under their preferred scenarios ("yes", "no").

Experimental design

In BCS program and mammography screenin, fractional factorial designs were used to reduce the number of choices available to the participants and minimize the burden imposed on them [13]. To avoid imposing a high cognitive load on the respondents, we implemented a block design, attribute level overlap, and color coding. The DCE questionnaire consisted of a total of 48 choice tasks, divided into four blocks of 12 choice tasks each. The BCS program contained 13 items, one of which was a within-set monotonicity test. Overlapping attribute levels and color coding were also applied in the questionnaire to reduce the complexity of the choices and the perceived burden on the respondents as well as to reduce the drop-out rate, increase choice consistency, and avoid problems with attribute nonattendance [17, 18]. Three out of the BCS program attributes and two out of the five mammography screening attributes were constrained; that is, they were presented at the same level. Color coding was also applied to non-overlapping attribute levels. The experimental design was created using the Bayesian D-efficiency design in SAS (Statistical Analysis Software) and its value was 95% [19].

Subsequently, a pilot study involving 30 participants was carried out to develop the necessary Dpriors-efficient design, which assumes fixed and specific values and directions for the parameters of interest [19]. The pilot phase enabled us to refine the attribute levels and generate preliminary estimates of the parameters associated with these levels. SAS allowed to determine the superior attribute level and minimize the over prioritization of certain attribute level pairs in the questionnaire, thereby encouraging the participants to consider other attributes. During the pilot phase, as well, the entire questionnaire was tested to assess the accuracy of the wording and the comprehension of the attributes, levels, information, and choice tasks by the target population. By incorporating a Dpriors-efficient design, we created a unified DCE design that guaranteed both statistical identification and optimal statistical efficiency for respondents who may have had varied preference structures. Tables S1 show example choice tasks for the BCS programs and mammography screening.

Instrument design

The questionnaire had two sections: the first covered demographics (11 items) and consent, while the second included a public health message on BC risks, BCS importance, and attribute descriptions. It also featured the DCE questionnaire (25 items), with 13 for the BCS program and 12 for mammography screening. Participants received completion instructions and were randomly assigned to a design block. Half were randomly exposed to the promotional message, given the low awareness and practice of early BC detection [20, 21].

Validity and reliability of the designs

Content validity refers to the extent to which findings are aligned with priori hypotheses. First, we developed attributes and levels through qualitative methods, including semi-structured interviews, and quantitative approaches, such as literature reviews, to increase the likelihood of including attributes and levels important to the majority of respondents. Second, pilot test was conducted to check by examining the direction of the preference estimates.

Choice validity ensures that respondents engage in a task based on expected behavior. The concept of monotonicity, which states that people will not prefer 'worse' levels of an attribute to 'better' levels, was applied. Two types of monotonicity were tested: within-set monotonicity and across-set monotonicity. The within-set monotonicity test was conducted by adding a dominant choice task to all versions of the design in BCS scenario. This task presented a choice where all attribute levels were superior to those of its paired alternative. The across-set monotonicity test examined whether people consistently chose the preferred choice profile when one profile dominated across choice tasks [14]. To increase the validity of the results, we excluded respondents who failed two test.

Sampling and data collection

Convenience sampling was performed, and the minimum sample size (N) was calculated using the equation $N>500c/ta$, where t is the number of choice tasks, a denotes the number of alternatives, and c represents the

Table 1. Attributes and Levels for the BCS Program and for the Mammography Screening

	Attributes	Definition	Levels
Attributes and levels for the BCS program			
1	Screening test staffs' gender	Gender of the healthcare worker who performs breast cancer screening	Male Female
2	Way of invitation	The approach a woman prefers to be invited to screening	Personalized invitation letter Telephone call Referral doctor
3	Free breast self-exam course	Women will receive free instruction on performing breast self-exams	Yes No
4	Waiting time (minutes)	Waiting time in healthcare facility during the screening visit	30 60 90 120
5	Combined screening test	Breast cancer screening can be combined with other cancer screenings such as cervical cancer,...	Yes No
6	Screening place	Location of breast cancer screening program	Provincial and central hospitals District and commune hospitals
7	Cost (USD)	Out-of-pocket costs for breast cancer screening	0 4.2 20.8 41.7 62.5
Attributes and levels for the mammography screening			
1	Feeling	The feeling of taking a mammography	Uncomfortable Pain
2	Screening test staffs' gender	Gender of the practitioner who performs breast cancer screening	Male Female
3	False positive (%)	A false-positive is defined as a positive screening mammography result in a woman who is cancer free	5 10 20 30
4	Overdiagnosis (%)	Overdiagnosis is defined as the detection of tumors at screening that might never have progressed to become symptomatic or life-threatening in the absence of screening.	1 5 10 15
5	Cost (USD)	Out-of-pocket costs for mammogram not covered by health insurance	4.2 20.8 41.7 62.5

1 USD, 25,304 VND (Source: The state bank of Vietnam - Exchange rate for foreign currencies in March 2024).

largest number of levels for any of two attributes [22]. This survey included 48 choice tasks with two alternatives and an opt-out option for both scenarios. The largest number of levels for any of the two attributes was five in BCS scenario and four in mamography scenario. Therefore, this questionnaire required at least 70 respondents (500*5/12*3=69.4) for BCS programs and 56 respondents (500*4/12*3=55.6) for mammography screening. Since four blocks were included in the design, at least 280 respondents were needed for BCS programs and 224 for mammography screening. Google Forms were used to collect data because they enabled easy administration and fast data collection, were inexpensive, covered a wide population, and ensured good data quality with few overall data errors and missing items [23]. The form includes content arranged in the order described in the instrument design section. The survey invitation, shared via social media, included a Google Forms link and a cover letter outlining the study's title, objectives, and confidentiality assurances. Respondents provided electronic informed consent before starting the questionnaire. The authors had no direct contact with participants. Google Forms automatically collected and anonymized responses, which were later downloaded into a Microsoft Excel file.

Outcomes

In the BCS program and mammography screening, the primary outcome was the preference parameters, encompassing each latent class, all women, the message reception group, and the message non-reception group. The first secondary outcome was the relative importance, which represents the maximum effect for each attribute;

these were compared across attributes and rescaled to sum to 1 within each latent class. Moreover, the second secondary outcome included the estimated choice probabilities for different policy scenarios in the BCS program.In mammography screening, the second secondary outcome involved estimating the probability of choosing screening over no screening to simulate how uptake varies with changes in the levels of cost, false positives, and overdiagnosis.

Statistical analysis

Descriptive statistical analysis was performed using the Statistical Package for Social Sciences (version 20) to summarize the detailed numbers and proportions of respondents corresponding to each level of demographic variables. A latent class model (LCM) and policy scenarios were constructed using Latent GOLD® (version 6.0).

An LCM assumes that the attributes of alternatives can have heterogeneous effects on choices across a finite number of groups or classes of respondents. To account for this heterogeneity, the model also assumes that there are classes or segments within a sample, such that each class has preference weights that are identical within the class but are systematically different from the preference weights in other classes. The optimal number of latent classes was determined based on a combination of statistical goodness-of-fit criteria and model interpretability. Within each class, the preference weights are estimated using conditional logit analysis [24]. Choice probability is defined in an LCM, where π_q is a class-probability function indicating the probability of being in each of the different classes, and β_q represents individual-specific preference weight parameters. The class-probability function is a specific multinomial logit function that can include only a constant term or can encompass explanatory variables related to the probability of class membership based on respondent characteristics [24]: $Pr(choice = 1)\sum_q Pr\ (choice=i|\beta_q)\pi_q$. Three-step latent class analysis, which was modified to account for non-invariance [25], was conducted to examine the relationship between the classes and independent variables used in this work. The independent variables were age, residence, education, occupation, and breastfeeding experience in the BCS programs and age and residence in the mammography screening.

We designed five policy scenarios based on real-world situations or five other alternatives that were not utilized in the original choice experiment for BCS program. These include: (1) the existing BCS initiatives, (2) the existing BCS initiatives with female screening test staff, (3) the existing BCS initiatives with out-of-pocket screening costs, (4) the pilot BCS program at provincial and central hospitals, (5) the pilot BCS program at district and commune hospital.

There were four additional choice tasks and each consisting of "the existing BCS program" alternative, a "no screening" program alternative, and sequentially one of the remaining four alternatives. The estimated choice probabilities P_p (a | x) in a set of three alternatives was estimated and probabilities for three alternatives within choice task are 100%, where a denote a level of the attribute p, Ap its total number of levels, $\eta_{(a|xp)}$ the utility associated with level a for latent class x [26].

$$P_p(a|x) = \frac{\exp(\eta_{a|xp})}{\sum_{a'=1}^{A} \exp(\eta_{a'|xp})}$$

Vietnam does not currently have a nationwide screening program for BC. However, there are some BC screening initiatives that have been launched by hospitals and the Ministry of Health, which include awareness campaigns and some free screening programs at provincial and central hospitals in urban areas. These are referred to as 'the existing BCS initiatives' in the policy scenario analysis. The second and third scenarios were created based on the attribute levels of the scenario featuring existing BCS initiatives. The second scenario involves a change from male to female screening test personnel, and the third entails changes in cost from free to US$20.8. The pilot BCS program at provincial and central hospitals consists of private services provided by central hospitals, which also means prolonged waiting as well as travel (e.g., 90 minutes) along with expensive screening (US$62.5). The pilot BCS program offered at district or commune hospitals with improvements, such as the employment of female screening test personnel, referral by doctors, free breast self-exam courses, shorter waiting times (e.g., 30 minutes), and lower costs than those BCS program at provincial and central hospitals (Table S2).

In mammography screening, to evaluate variations in uptake among different classes and to understand how changes in levels of cost, false positives, and overdiagnosis might affect uptake, the probability of choosing screening (Pi) over no screening was determined as follows:

$$P_i = \frac{e^{V_i}}{e^{V_i} + e^{V_j}} = \frac{e^{(\beta_1 Gender + \beta_2 Feeling + \beta_3 False\ positive + \beta_4 Overdiagnosis + \beta_5 Cost)}}{e^{(\beta_1 Gender + \beta_2 Feeling + \beta_3 False\ positive + Overdiagnosis + \beta_5 Cost)} + e^{\beta_{none}}}$$

where the utility of screening and non-screening options is represented by V_i and V_j, respectively. The assumption was grounded in the best-case scenario. For instance, when estimating uptake based on cost, the assumption included attribute levels such as discomfort, female screening test personnel, a 5% false positive rate, and a 1% overdiagnosis rate.

Results

Participants

The final analysis included 1,023 out of 1,034 participants (Table 3). Only 11 participants (approximately 1.1%) were excluded for failing monotonicity tests (10 within-set and 1 across-set); this low failure rate indicates high data quality and respondent engagement. The average age was 33.4 years. Most women lived in urban areas (59.9%), had graduate education (49.5%), earned 4.5 to <10.5 million VND/month (50.4%), were nonmedical workers (75.1%), and were married or cohabiting (61.1%). Additionally, 94.7% had menstruation, 90.8% had no relatives with breast cancer, 81.9% were unaware of BSE, and 54.3% had breastfed. Most had never undergone

Table 2. Demographic Characteristics of the Sample (n = 1,023)

Baseline characteristics	N (%)	Baseline characteristics	N (%)
Age		Married	
Mean (SD)	33.41 (0.5)	Unmarried	365 (35.7)
Range (Min-Max)	55.0 (18-73)	Married/Cohabitation	625 (61.1)
Median	32.0	Widow/Divorce/Separation	33 (3.2)
IQR (Q1-Q3)	15.0 (24-39)	Nutritional status (*)	
BMI (kg/m^2)		Underweight (BMI < 18.5)	195 (19.1)
Mean (SD)	20.4 (2.3)	Normal weight (BMI 18.5 - < 23.0)	693 (67.7)
Range (Min-Max)	(15.4-33.9)	Pre-obesity (BMI 23.0 - < 25.0)	96 (9.4)
Median	20.0	Obesity (BMI ≥ 25.0)	39 (3.8)
IQR (Q1-Q3)	2.8 (18.8-21.6)	Have you ever breastfed a baby?	
Residence		Yes	556 (54.3)
Urban	613 (59.9)	No	467 (45.7)
Rural	410 (40.1)	Have relative(s) with breast cancer	
Education		Yes	94 (9.2)
High school and lower	480 (46.9)	No	929 (90.8)
Graduate	506 (49.5)	Have you ever heard about breast self-examination?	
Postgraduate	37 (3.6)	Yes	185 (18.1)
Occupation		No	838 (81.9)
Non-medical workers	768 (75.1)	Have you ever taken a mammogram?	
Healthcare workers	60 (5.9)	Yes	51 (5.0)
Student	195 (19.0)	No	972 (95.0)
Menopausal status		Have you been screened for breast cancer within the last 12 months?	
Menstruation	969 (94.7)	Yes	61 (6.0)
Menopause	54 (5.3)	No	962 (94.0)
Income (million VND) (a)		Have you self-examined your breasts in the past month?	
< 4.5	276 (27.0)	Yes	123 (12.0)
4.5 - <10.5	516 (50.4)	No	900 (88.0)
≥ 10.5	231 (22.6)		

Notes: BMI, Body mass index; SD, standard deviation; IQR, Interquartile range; VND, Viet Nam Dong; (*), World Health Organization (2000); 1 USD, 25,304 VND (Source: The state bank of Vietnam - Exchange rate for foreign currencies in March 2024).

mammography (95.0%), were not screened in the past year (94.0%), and did not perform self-exams in the last month (88.0%) (Table 2).

Preferences regarding breast cancer screening program

There were five classes, with Class 1 being the largest (40%). Overall, most respondents preferred combined screening tests and lower costs, with the exception of the smallest class. Similarly, most respondents preferred female screening personne, except the class 2. Class 1 was labeled the 'Quality-Driven' group, favoring programs with female staff, invitation letters, 60-minute waiting times, and services at provincial or central hospitals. Class 2 was labeled the 'Indifferent' group, characterized by a low inclination to participate in screening (indicated by a non-significant opt-out coefficient) and a lack of preference regarding the gender of the screening staff. Moreover, they favored programs with 90-minute waiting times and services at provincial or central hospitals. Class 3, labeled the 'Local service' group, preferred screening programs with female staff, invitations via doctor referral, 90-minute waiting times, and services provided at district and commune hospitals. Class 4 was labeled the 'Gender-sensitive' group, sharing similar characteristics with Class 1 but distinguished by a substantially higher coefficient for the gender attribute, which was the most important factor for this class. Additionally, participants in this group displayed a consistent preference for all waiting time intervals (30, 60, or 90 minutes) over the 120-minute reference. Class 5 was labeled the 'Time-conscious' group, characterized by a preference for 30-minute waiting times, female staff, invitations via doctor referral, and services at provincial or central hospitals. Three classes were primarily rural residents. Message exposure had little impact those unexposed were largely indifferent to attributes except for combined tests and low cost, while both groups preferred screening (Table 3 and Figure S1).

Compared to the existing BCS initiatives and no screening option, the women showed a higher probability of choosing the existing BCS initiatives with female screening test staff and a lower probability of the existing BCS initiatives with out-of-pocket screening costs. Even if organizational characteristics improved, high costs significantly reduced the likelihood of selection: 17% for

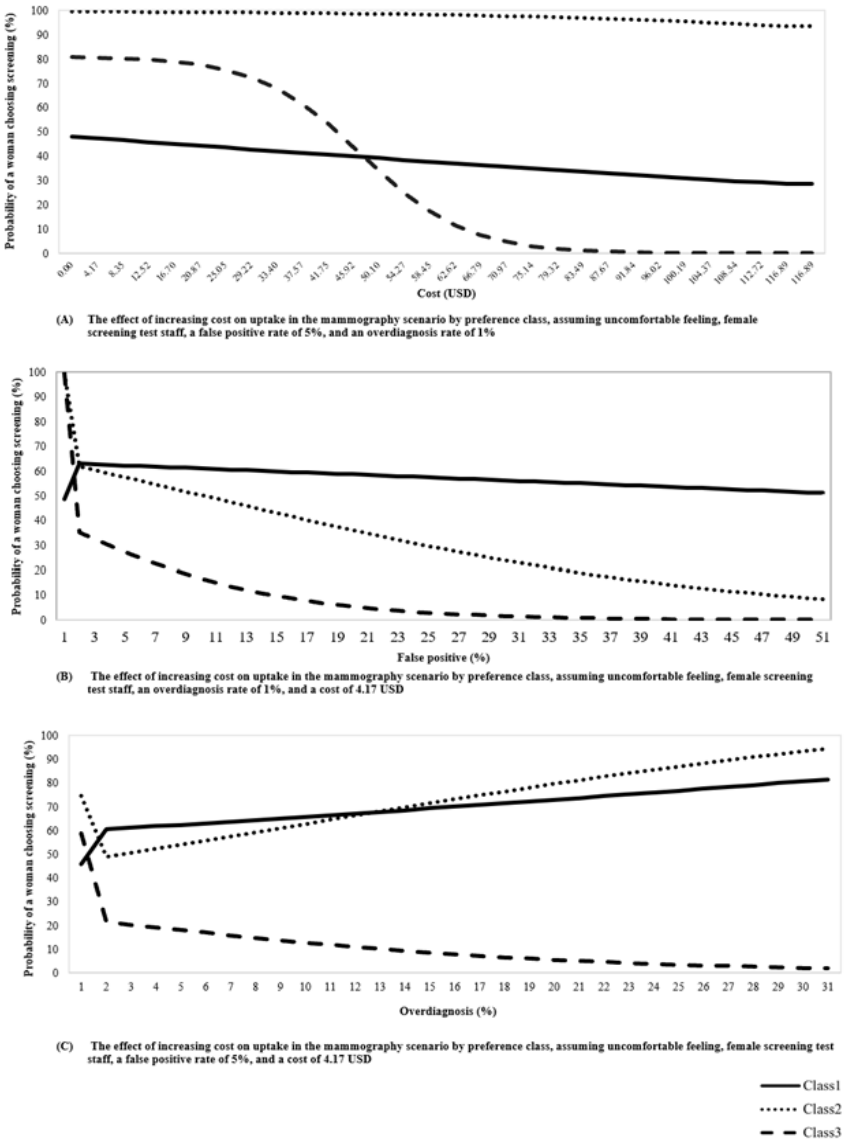

Figure 1. Effects of Increasing Cost, False Positives, and Overdiagnosis on Uptake in the Mammography Screening

the scenario with an existing BCS program at provincial and central hospitals, and 16% for the scenario featuring a pilot BCS program at district and commune hospitals (Figure S2 and Table S2).

Preferences for mammography screening

There were four classes, with Class 1 being the largest (42%). Cost was the most important attribute, and respondents preferred higher costs, female healthcare staff, low false positives, and discomfort during mammography, mainly residing in urban areas. Class 2 (41%) prioritized low false positives and preferred lower costs, female staff, discomfort, and high overdiagnosis. Class 3 (17%) valued cost the most, favoring lower costs, female staff, low false positives, lower overdiagnosis, and discomfort. Overdiagnosis did not influence Classes 1 and 2 (Table 4 and Figure S3). In terms of message, overdiagnosis was seen as controversial by the two groups, while others exhibited the same trend (i.e., were affected by uncomfortable feelings, female practitioners, lower false positives, and lower costs). Both groups preferred to undergo screening.

In the best-case scenario, the decrease in costs and false positives was proportional to the probability of selection in three classes. The decrease in overdiagnosis was proportional to the probability of choosing screening, except in Classes 1 and 2 (Figure 1).

Discussion

It is critical need for BCS programs that promote early diagnosis. By adopting policies that encourage earlier detection of BC, healthcare costs can be minimized, reducing the economic strain on patients and enhancing both the availability and the effectiveness of treatments. According to the HTA Core Model® of the European Network for Health Technology Assessment, the crucial elements of healthcare are those related to patient and social aspects [27]. Patient preferences can be informative for health technology assessment and payer decision-making, and DCEs can quantify personal preferences, allow for statistical analysis, and possibly

Table 3. LCM Results for the BCS Program (n = 1,023)

	Class 1			Class 2			Class 3			Class 4			Class 5			All women			Message reception			Message non-reception		
	Coef.	SE	Z	Coef.	SE	Z	Coef.	SE	Z	Coef.	SE	Z	Coef.	SE	Z	Coef.	SE	Z	Coef.	SE	Z	Coef.	SE	Z
Screening test staffs' gender (ref: Male)																								
Female	0.52#	0.07	7.19	0.13	0.07	1.85	0.48#	0.08	5.81	4.95#	0.31	15.79	0.87#	0.28	3.09	0.39#	0.03	13.02	0.12#	0.04	2.81	-0.01	0.04	-0.27
Way of invitation (ref: Referral doctor)																								
Telephone call	0.11	0.11	1.00	-0.14	0.09	-1.59	-0.39#	0.11	-3.45	0.48	0.25	1.88	-0.79#	0.30	-2.62	-0.09#	0.04	-2.05	-0.07	0.06	-1.09	-0.10	0.06	-1.71
Personalized invitation letter	0.27#	0.11	2.44	0.04	0.09	0.46	0.00	0.12	0.03	0.27	0.24	1.08	-1.35#	0.35	-3.81	0.06	0.04	1.52	0.09	0.07	1.26	-0.02	0.05	-0.41
Free breast self-exam course (ref: No)																								
Yes	0.04	0.08	0.48	-0.09	0.07	-1.33	0.35#	0.09	4.00	-0.18	0.17	-1.07	0.22	0.27	0.84	0.01	0.03	0.42	0.06	0.05	1.36	0.02	0.04	0.55
Waiting time (ref: 120 mins)																								
30 mins	0.06	0.11	0.55	-0.09	0.10	-0.88	0.23	0.13	1.80	1.01#	0.24	4.26	0.93*	0.44	2.10	-0.01	0.05	-0.2	-0.06	0.06	-1.06	-0.04	0.08	-0.55
60 mins	0.45#	0.13	3.38	0.16	0.10	1.49	0.07	0.14	0.53	1.06#	0.24	4.37	0.46	0.48	0.96	-0.14#	0.05	2.86	-0.03	0.07	-0.39	-0.06	0.07	-0.79
90 mins	0.14	0.10	1.38	0.37#	0.09	4.07	1.13#	0.12	9.02	0.99#	0.22	4.41	0.77	0.43	1.80	0.12#	0.04	2.77	0.21#	0.06	3.23	-0.04	0.06	-0.67
Combined screening test (ref: No)																								
Yes	2.19#	0.09	23.32	0.32#	0.06	5.03	0.65#	0.07	9.50	0.78#	0.15	5.14	-0.06	0.26	-0.23	0.71#	0.03	24.99	0.06	0.03	1.67	0.17#	0.05	3.68
Place (ref: District and commune hospitals)																								
Provincial and central hospitals	1.19#	0.08	15.26	0.18#	0.07	2.57	-0.17*	0.08	-2.12	0.89#	0.18	4.99	1.34#	0.28	4.73	-0.36#	0.03	12.38	-0.16#	0.04	-3.55	0.01	0.04	0.32
Cost	-1.69#	0.06	-26.34	-0.09*	0.03	-3.11	-0.08#	0.03	-2.39	-1.12#	0.09	-12.29	-0.15	0.11	-1.36	-0.43#	0.01	-38.75	-0.05#	0.02	-2.87	0.02	0.02	1.16
Opt out	-7.67#	0.28	-26.97	0.04	0.11	0.35	-4.31#	0.35	-12.28	-2.29#	0.29	-7.78	-2.68#	0.37	-7.29	1.79#	0.04	43.43	0.83#	0.06	14.05	0.26#	0.06	4.47
Preferences covariates																								
Age	-0.03	0.02	-1.93	0.01	0.02	0.46	-0.05	0.02	-1.92	-0.12#	0.03	-4.30	-	-	-	-	-	-						
Residence (ref: Rural)																								
Urban	-1.56#	0.38	-4.10	-0.09	0.41	-0.22	-1.50#	0.42	-3.58	-1.12#	0.48	-2.34	-	-	-	-	-	-						
Education	1.20#	0.30	3.99	0.34	0.33	1.03	0.80#	0.34	2.34	1.36#	0.36	3.77	-	-	-	-	-	-						
Occupation (ref: Student)																								
Non-medical worker	-0.72	0.53	-1.35	-0.93	0.53	-1.76	-1.33#	0.54	-2.46	-0.10	0.55	-0.19	-	-	-	-	-	-						
Healthcare staff	-1.19	0.76	-1.56	-0.84	0.73	-1.14	-0.66	0.73	-0.90	-1.37	0.96	-1.43	-	-	-	-	-	-						
Previous breastfeeding experience (ref: No)																								
Yes	1.48#	0.37	4.05	-0.06	0.39	-0.17	0.49	0.44	1.10	0.04	0.45	0.09	-	-	-	-	-	-						
Average class probability	0.40			0.24			0.11			0.11			0.07			-	-	-						

Notes: Coef., coefficient; SE, standard errors; Z, Z-value; Age, education, cost is continuous variables; *P<0.05; #P<0.01

detect preference heterogeneity among individuals. In this study, DCE involved latent class modeling, which revealed that the participating women's preferences regarding BCS program and mammography screening were highly heterogeneous, with five and three distinct preference classes arising, respectively.

In BCS program, this study demonstrated that all the classes of respondents preferred a combination of screening and low testing costs, except for the smallest class. In a DCE study conducted in Belarus to assess women's preferences for BCS programs, all the classes were sensitive to cost [28]. In research on the reasons for and barriers to delays in the diagnosis and treatment of BC in Vietnam, financial barriers were stronger among participants living in rural areas (OR = 9.14; 95% CI: 3.69–22.64) [9]. An initiative for the early detection of BC and cervical cancer in women was implemented in Hanoi between 2012 and 2014, with 50,000 screened women reporting that the lack of health insurance reimbursement for screening services is one of the factors affecting their outcomes [11]. In the present study, the analysis of policy scenarios based on the actual situation of BCS program in Vietnam showed that the women had the highest preference for the existing BCS initiatives with female screening test staff , telephone calls as referral sources, long waiting times, screening at provincial and central hospitals, and free screening cost. However, even if the existing BCS initiatives 's characteristics improved, high costs would result in a low probability of selection. The high cost of screening may become a significant issue when expanding from pilot programs to a nationwide scale.

Moreover, the Vietnamese women were sensitive to the organizational characteristics of screening, including referral source (i.e., doctors), the possibility of combining various cancer screening tests, screening location (i.e., provincial and central hospitals), and the acquisition of detailed information on BSE in BCS program. These issues can become a concern when screening is extrapolated from pilot initiatives to a nationwide level. With respect to screening location, the rural-based participants preferred to undergo BSC in provincial and central hospitals. Although screening centers are easily accessible in cities, access to health facilities for rural inhabitants is more restricted and can decrease attendance rates among the most deprived individuals, who also happen to be at a higher risk of BC mortality [29]. Vietnam remains a largely rural country (65%), but the majority of BCS initiatives or services hold screening activities in large cities, perhaps exacerbating inequality in access between rural and urban areas [30]. As regards referral source, the women preferred invitations to undergo screening from doctors or personalized letters. A study in Vietnam identified the factors associated with mammography screening behaviors among rural Vietnamese women and found that receiving recommendations from physicians increased the likelihood of participants undergoing BCS [31]. Moreover, a systematic review revealed that tailored group education delivered by either healthcare workers, lay health advisors, or trained volunteers significantly increases the rate of mammography use [8]. Therefore,

Table 4. LCM Results for Respondent Preferences Regarding Mammography Screening (n = 1,023)

	Class 1			Class 2			Class 3			All women			Message reception			Message non-reception		
	Coef.	SE	Z	Coef.	SE	Z	Coef.	SE	Z	Coef.	SE	Z	Coef.	SE	Z	Coef.	SE	Z
Feeling (ref Uncomfortable)																		
Pain	-0.128#	0.049	-2,606	-0.442#	0.042	-10,505	0.147	0.104	1,407	0.18#	0.03	6.77	0.11#	0.04	3.10	0.07	0.04	1.79
Screening test staffs' gender (ref: Male)																		
Female	0.436#	0.051	8,519	0.195#	0.044	4,480	0.251*	0.100	2,509	0.22#	0.03	7.99	0.49#	0.04	12.73	0.00	0.04	-0.06
False positive	-0.010#	0.004	-2,817	-0.058#	0.004	-16,567	-0.125#	0.009	-14,090	-0.04#	0.00	-18.67	-0.19#	0.02	-8.88	-0.47#	0.03	-17.39
Overdiagnosis	0.004	0.006	0.749	-0.001	0.006	-0.252	-0.096#	0.013	-7,661	-0.01	0.00	-1.92	0.10#	0.02	4.79	-0.14#	0.02	-5.87
Cost	0.000#	0.000	-5,526	-0.001#	0.000	-16,981	-0.005#	0.000	-16,517	-0.09#	0.00	-28.96	-0.28#	0.02	-15.01	-0.68#	0.03	-27.29
Opt out	0.597#	0.105	5,674	-5.118#	0.194	-26,337	-6.184#	0.357	-17,304	-1.46#	0.06	-26.14	-1.27#	0.10	-12.19	-3.09#	0.13	-23.05
Preferences covariates																		
Age	-0.002	0.009	-0.243	-0.019*	0.009	-2,279	-	-	-	-	-	-	-	-	-	-	-	-
Residence (ref: Rural)																		
Urban	1,350	0.213	6,349	0.128	0.200	0.640	-	-	-	-	-	-	-	-	-	-	-	-
Average class probability	0.42			0.41			0.17			-	-	-	-	-	-	-	-	-

Notes: Coef., coefficient; SE, standard errors; Z, Z-value; VND, Viet Nam Dong; false positive, overdiagnosis, cost and age is continuity variables; *, P<0.05; #, P<0.01.

group education delivered by healthcare workers should be developed to disseminate information to individuals to encourage them to seek recommended screening.

For the mammography screening, our DCE revealed that the respondents were far more concerned about screening experience, false positives, and costs than overdiagnosis and practitioners' genders. For instance, the women preferred uncomfortable feelings over pain, low false positives, and low costs. A considerable decrease in costs led to an increased uptake. Women earning all levels of income were influenced by the cost of mammography. Likewise, a study in Singapore reported that a decrease in treatment costs to zero motivates similar increases in the predicted uptake of mammography [29]. In the current research, screening experience affected all three classes, and the respondents preferred having discomfort over pain. An investigation of preferences for mammography among women in Singapore indicated that improving the mammography screening experience from pain to discomfort would increase uptake [29]. Furthermore, the present study showed that the women were sensitive to harms from screening, including overdiagnosis and false positive mammography results. The women in all the three classes were affected by perceived low false sensitivity to the text, consistent with previous DCE studies in various screening contexts [29, 32]. However, preferences related to overdiagnosis differed between classes, even though this concept was defined and explained through a poster before questionnaire administration. This phenomenon can be attributed to the low awareness of overdiagnosis among the participants. A DCE study provided evidence that overdiagnosis extensively affected women's decision to undergo mammography [32]. The present work uncovered that the respondents had low awareness of BSE and that 94% had not been tested for BC in the previous 12 months. In the future, therefore, strategies should be formulated to inform the public and patients about overdiagnosis and awareness programs should be developed and disseminated through various channels, such as mass media and other campaign avenues to increase the practice of mammography screening among women.

In this study, as well, the genders of health workers were important to the women's choices in both scenarios. The availability of female practitioners potentially affected the respondents' decision to seek BCS services. A study reported that women prefer to be seen by a woman in clinical breast exams because they would feel shy and embarrassed if a man attends to them [33]. In both scenarios in the present research, the women were highly sensitive to the costs of tests, favoring those that are affordable. As indicated in a systematic review, the reduction in client out-of-pocket expenses and the elimination of structural barriers, as is achieved through the provision of discounts on mammography costs, the use of mobile mammography vans, and the provision of mammography navigation assistance, contribute to increased rates of mammography use [8].

We expected the promotional message to partially address the women's fears about screening. This message was based on prior research conducted in Singapore, which showed that messages do not influence uptake [29]. Our findings illustrated that no apparent disparity was found between the two groups in the BCS program scenario. Specifically, the group shielded from the message was not sensitive to almost all the attributes, except for the combined screening test and cost. Additionally, both groups preferred to undergo screening. For the mammography screening, overdiagnosis was seen as controversial by the two groups, while others exhibited the same trend (i.e., were affected by uncomfortable feelings, female practitioners, low false positives, and low costs). Both groups also preferred to undergo screening. These findings might have stemmed from the general nature of the content of the message or the possibility that it was ignored by the participants given that the survey was administered online. Measuring the effectiveness of a message or its impact requires long-term exposure to a communication intervention and a baseline of behavioral measures.

Strengths and limitations

This study is the first to explore women's preferences for BCS programs and mammography screening while proposing strategies to improve screening rates. Latent class modeling was used to categorize respondents into subgroups based on their choices, helping to identify preference heterogeneity and align initiatives accordingly. However, DCEs have limitations, including cognitive burden and design challenges such as framing and realism [29]. A potential sign of hypothetical bias in our data was the presence of women with extreme preferences, particularly in Class 2, who favored high overdiagnosis in mammography. This may result from misunderstanding, as overdiagnosis is a complex medical issue often difficult to grasp [32].

Future research

Future studies could focus on improving interventions, like cost vouchers, to reduce out-of-pocket costs and structural barriers. There are small differences among women, such as rural respondents preferring BSC in provincial hospitals and those with lower education favoring shorter waiting times. Women of all income levels were influenced by mammography costs, while older women were unaffected by overdiagnosis. Researchers should explore why preferences vary based on socioeconomic background and health status and how they relate to information and healthcare access.

In conclusion, Vietnamese women have diverse preferences for BCS and mammography. They favor affordable tests, female practitioners, and convenience but are unwilling to trade convenience for costlier, higher-quality screening. Concerns include screening experience, accuracy, and overdiagnosis, with mixed views across groups. These findings can inform public health programs, health technology assessments, and healthcare professionals in aligning BCS services with women's preferences.

Author Contribution Statement

Study conception and design: QVT, CDVL, ANPT, TQV, VNTP, NHYN, TLP, THAN; Data collection: CLDV, QVT, TVQ; Analysis and interpretation of results: CLDV, QVT, ANPT; Draft manuscript preparation: CLDV, QVT, ANPT, NHYN, TQV. All authors reviewed the results and approved the final version of the manuscript.

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Data Availability Statement

The datasets generated and analyzed during the current study are not publicly available due to privacy and ethical restrictions but are available from the corresponding author on reasonable request. Any data shared will be anonymized to protect the confidentiality of the study participants.

Ethical Declaration

This study's protocol was approved by the Human Research Ethics Committee of Pham Ngoc Thach University of Medicine, Ho Chi Minh City, Vietnam (No. 847/TDHYKPNT-HDDD). All participants provided informed consent prior to their inclusion in the study. Participation was voluntary, and confidentiality of personal data was maintained throughout the research. This study involved no interventions on human subjects and was not a clinical trial; therefore, a clinical trial registration number is not applicable.

Conflict of Interests

The authors declare that the research was carried out in the absence of any potential conflicts of interest. Consent to publish declaration: not applicable. This study did not receive any external financial funding.

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