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Preference-Based Assessments

Demand for Cancer Screening Services: Results From Randomized Controlled Discrete Choice Experiments

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ABSTRACT

Objectives: Low uptake of cancer screening services is a global concern. Our aim was to understand factors that influence the screening decision, including screening and treatment subsidies and a gain-frame message designed to present screening as a win–win.

Methods: We analyzed preferences for mammography and Pap smear among women in Singapore by means of discrete choice experiments while randomly exposing half of respondents to a gain-framed public health message promoting the benefits of screening.

Results: Results showed that the message did not influence stated uptake, and given the levels shown, respondents were influenced more by treatment attributes, including effectiveness and out-of-pocket cost should they test positive, than by screening attributes, including the offer of a monetary incentive for screening. Respondents also underestimated the survival chances of screen-detected breast and cervical cancers.

Conclusions: Combined, these findings suggest that correcting misconceptions about screen-detected cancer prognosis or providing greater financial protection for those who test positive could be more effective and more cost-effective than subsidizing screening directly in increasing screening uptakes.

Keywords: breast cancer, cancer screening, cervical cancer, discrete choice experiments, uptake simulation.

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Introduction

Cancer is a leading cause of morbidity and mortality worldwide. In 2018, more than 18.1 million people were diagnosed with cancer and more than 9.6 million cancer deaths were reported.[1] The likelihood of complete recovery is greatest for those diagnosed at earlier stages, whereas survival drops markedly for those diagnosed in later stages when cancer has progressed.[2-4] The rationale for screening is to identify and treat cancers before they progress.

Mammography and Pap smear are the two most common screening services for women. In Singapore, the focus of this study, the Health Promotion Board (HPB) recommends women aged 50 to 69 to screen every 2 years, and women aged 40 to 49 with higher cancer risk to screen every year.[5] HPB further recommends Pap smears for women aged 25 to 69 who have ever had sexual intercourse to screen every 3 years.[5] Despite the HPB recommendations, screening rates for both services are low. In 2016, only 38.6% of women aged 50 to 69 underwent mammography screening within the last 2 years and 50.7% of eligible women aged 25 to 69 underwent Pap smear screening within the last 3 years.[6] Incomplete screening uptake is not unique to Singapore, although some countries screen at much higher rates.[7,8] These cross-country differences suggest opportunities to increase rates above current levels in Singapore.

A large body of literature has used discrete choice experiments (DCEs) to understand preferences for cancer screening services and to identify strategies to increase screening uptake.[9,10] DCEs ask respondents to choose between hypothetical alternatives (eg, different health services) described through a set of attributes (eg, cost, quality, safety) that vary according to predefined levels. They are appealing to study health screenings because only limited market data exist to estimate their demand and the factors that influence it.

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Prior DCEs concerning screening uptake have mainly focused on the features of the screening services (eg, procedure, accuracy, cost). Other factors, however, such as costs associated with treatment, might be equally or even more salient.[11-13] The DCEs we employ are novel in that they combine traditional screening attributes with treatment attributes that have also been posited to influence the screening decision.

Our first objective was to determine which factors matter most in the decision to undergo cancer screening, with special emphasis on the comparison between screening and treatment outcome attributes and whether a monetary incentive to encourage screening would increase stated uptake. Our second objective was to test the effectiveness of a gain-frame message on the benefits of screening that mimics current public health information campaigns in Singapore. Given that our DCEs mirror the responses of informed respondents in terms of screening attributes and treatment outcomes (as these are presented in the DCE task), the question we asked is whether there is still a role for targeted messaging to influence uptake. A third objective is to simulate the effect of 2 strategies aimed at increasing screening uptake. The first aims to quantify the effect on uptake of correcting respondents' large misconceptions for screen-detected cancer survival rates. The second strategy is a budget-neutral reallocation of screening subsidies towards lower treatment costs for the subset of screened patients who test positive, as the latter might be a more effective use of public money than subsidizing screening itself in settings with high copayment rates.

To conduct these analyses, we employed 2 randomized controlled DCEs: one for mammography and another for Pap smear, with nationally representative samples of working age women living in Singapore aged 40 to 64 and 25 to 64. To assess the effectiveness of messaging, we randomly allocated half the respondents to a group that we subjected to the message and half to a control group with no message.

Methods

Selection of the Attributes and Levels for the DCE

We based attribute selection on both a systematic literature review of DCEs on preferences for cancer screening (see Appendix Table 1 in Supplemental Materials found at https://doi.org/10.1016/j.jval.2020.06.004) and on 8 focus group interviews of 8 women each.[14] We used the literature review to identify the most frequently included attributes in past DCEs. We shortlisted the following attributes based on their frequency: accuracy, frequency of screening, screening cost, effectiveness, pain or discomfort incurred during procedure, travel time, and sex of the health practitioner. The most prominent theme that we identified in our focus groups was the fear of screening. We identified 2 broad categories of fear: fear of the screening procedure and fear related to a cancer diagnosis. We further broke down the latter category into three subthemes that we grouped as follows: (1) fear of death, (2) fear of side effects from treatment, and (3) fear of financial burden from treatment. To address fear of dying, we included an attribute indicating the survival rate if cancer were to be diagnosed. To address fear of adverse effects, we included 2 attributes: the fear of losing one's breast (mammography DCE) and of infertility (cervical cancer DCE). We also included an attribute focusing on treatment costs conditional on a positive diagnosis. We presented this cost in dollars as opposed to percentage reductions as done in the prior DCE, as many women have no idea of the actual costs of treatment and there is a wide range depending on the approach taken. We also including a level with a monetary incentive (ie, payment) for attending the screening to see the impact of a cash payment on stated uptake.

We excluded screening frequency from the attribute list because our aim was to analyze the preferences for screening according to established guidelines. We also excluded travel time because this factor was neither mentioned in our focus groups nor likely to be relevant in a small city-state like Singapore. To further reduce the number of attributes, we mapped pain (for mammography) and sex of health practitioner (for Pap smear) to the fear of screening procedure, and screening effectiveness to the fear of dying. We confirmed our attribute selection and determined preliminary levels by means of 20 cognitive interviews. Each cognitive interview took around 1 hour for the respondents to complete either the breast or cervical cancer screening surveys. Table 1 presents the 6 selected attributes along with their levels. We finalized the attribute levels after conducting quantitative pilots to ensure a sufficient degree of trading off between

Table 1. Cancer screening attributes and levels: mammography and Pap smear.

Attributes	Levels			
	1	2	3	4
Mammography				
Discomfort or pain during mammography	Discomfort	Pain		
Chance of false cancer diagnosis	5%	15%	30%	
Out-of-pocket payment or reward for screening	Receive $50	Free-of-charge	Pay $50	Pay $200
Chance of surviving breast cancer	25%	50%	65%	90%
Permanent changes to breast	None	Change in feel and appearance of breast	Lose an entire breast	
Total out-of-pocket cost of treatment	$0	$50 000	$150 000	$250 000
Pap Smear				
Choice of practitioner's sex	Choice	No choice		
Chance of false cancer diagnosis	5%	15%	30%	
Out-of-pocket payment or reward for screening	Receive $50	Free-of-charge	Pay $50	Pay $200
Chance of surviving cervical cancer	25%	50%	65%	90%
Permanent sexual or reproductive problems	None	Sexual difficulties	Infertility	
Total out-of-pocket cost of treatment	$0	$50 000	$150 000	$250 000

Figure 1. Example of choice-task for mammography screening.

	WHICH ONE WOULD YOU CHOOSE?	
	For the next time you screen…	**For the next time you screen…**
Discomfort or pain during mammography	Discomfort	Pain
chance of false cancer diagnosis	15% chance of false diagnosis	15% chance of false diagnosis
out-of-pocket payment or reward	Receive $50	Pay $200
	IF breast cancer is found and you undergo treatment…	**IF breast cancer is found and you undergo treatment…**
Chance of surviving breast cancer	50% survival	50% survival
permanent change to breast	Lose an entire breast	No change
Total out-of-pocket cost of treatment	$150,000	$150,000

a	Out of these 2 scenarios, **which one do you prefer?** Scenario A Scenario B
b	How likely would you be to screen according to guidelines given all 6 aspects of **your preferred scenario**? Definitely Likely Unlikely Definitely not

attributes. For chance of survival, we used a wide range of levels consistent with the respondents' beliefs regarding cancer survival.

Design of the Survey and the DCE

The surveys started by giving background information on mammography or Pap smear screening. This was followed by questions on past experience and perception of the cancer screening services. We then asked respondents their beliefs about screening costs and accuracy, cancer survival, the probability of suffering from permanent side effects, and out-of-pocket treatment costs. Participants were also asked about their opinion on how painful mammography screening is and how important it is to be able to choose the sex of the staff performing the Pap smear. These questions were asked before the DCE. The attributes and levels were then introduced to the respondents, followed by the health promotion message for the treatment group.

Several focus group participants conveyed that screening is a lose–lose proposition: a negative test is a waste of time and money, whereas a positive test uncovers a life-threatening health problem. In efforts to alter this perception and address the fear of a positive diagnosis, we randomly selected one-half of the respondents to be subjected to the following public health promotion message: "Cancer screening according to guidelines is a WIN-WIN. A negative test result gives peace of mind and early detection saves lives."

We presented 2 alternative screening scenarios per choice-task. To maximize the information collected from each choice-task, we used a 2-part question format. The first part was a forced comparison between the 2 alternative scenarios, and the second part asked for the likelihood of screening under the preferred scenario. Responses "likely" and "definitely" were grouped to indicate screening uptake in the main estimates and assumed that only those who said "definitely would screen" were tested in a sensitivity analysis. Figure 1 shows an example choice task for mammography. Note that we clearly divided the attributes into screening characteristics (first 3 attributes) and consequences of being diagnosed with cancer (last 3 attributes).

We used SAS macros to generate D-efficient designs for our model specifications,[15] notably accounting for the interaction terms between cancer survival and permanent adverse effects. We included these interaction terms, as respondents might value survival less if they were to suffer from permanent adverse effects. Prior parameter values were all set to zero when generating the designs. We obtained 72 choice tasks, which we divided into 9 blocks of 8 choice tasks to reduce the respondent burden. We then randomly assigned an equal number of respondents to each block. We also added 2 choice tasks in each block to test the transitivity of the stated preferences.[16,17] Transitivity requires that if Scenario A is preferred to Scenario B and Scenario B is preferred to Scenario C, then Scenario A should also be preferred to Scenario C. This is one of the fundamental axioms of economic utility theory and a requirement for rational preference.[18]

After administering the DCE, questions were asked on perceived susceptibility and vulnerability to breast and cervical cancer, health behaviors and attitudes, opinions regarding potential public policies aimed at increasing screening uptake, health status, and socio-demographics. Some of this information was jointly analyzed with the focus group data in mixed-methods exercises and published elsewhere.[14] Before fielding, pilot surveys were administrated to 40 eligible respondents. Because no additional concerns were raised, we did not make any further revisions. The average survey took about 30 minutes to complete.

Data Collection

To determine an acceptable sample size for each DCE, we used Orme's rule-of-thumb equation.[19] This suggested we need at least 375 respondents for each DCE, which we rounded up to 400. The sampling frames are nationally representative of the population of households that include at least 1 Singapore resident who is aged between 40 and 65 for mammography screening, and between 25 and 65 for Pap smear screening. Each sampling frame contained 1000 addresses to account for invalid addresses, ineligible households, nonresponses, and other issues that may arise during data collection. For households with multiple eligible women, a Kish grid was used to select a respondent.[20] The surveys were administered by trained interviewers using computer tablets between September 2014 and June 2015. Appendix A (in Supplemental Materials found at https://doi.org/10.1016/j.jval.2020.06.004) gives a detailed description of the model specification and estimation method used.

Results

Table 2 presents the characteristics of the mammography and Pap smear respondents according to their past screening experience following the guidelines of every 2 years for mammography and every 3 years for Pap smear. Mixed logit estimation parameters are presented in Appendix Tables 2 and 3 (in Supplemental Materials found at https://doi.org/10.1016/j.jval.2020.06.004) for mammography and Pap smear screening, respectively. We found that screening cost was not statistically significant for mammography ($P = .25$) or Pap smear ($P = .67$). Permanent adverse effects were also not statistically significant for Pap smear at the 5% level. In contrast, we found that all other attributes were statistically significant for both screening services (all $P < .01$). All interaction terms involving messaging equal to zero cannot be rejected (P value of .11 for mammography and .34 for Pap smear). This means that the message failed at significantly altering the choices made by the respondents in the DCEs. The same statistical test conducted for the income variable is strongly rejected for mammography ($P < .01$) but cannot be rejected for Pap smear ($P = .13$). The same statistical test also shows that past screening experiences following the guidelines do not significantly affect screening decisions in the DCEs (P value of .59 for mammography and P value of .25 for Pap smear).

Tables 3 and 4 present changes in screening uptake according to changes in attribute levels for mammography and Pap smear, respectively. The uptake for mammography and Pap smear when the attributes are set to their worst levels are 63.7% and 57.1%, respectively. For both surveys, screening service attributes (experience, accuracy, and cost) have the lowest effect sizes. Improving mammography screening experience from painful to having discomfort would increase uptake by 1.2 percentage points (1.9%), whereas giving Pap smear respondents the choice of the health practitioner's sex would increase uptake by 2.5 percentage points (4.4%). Decreasing the chance of a false diagnosis from 30% to 5% would increase screening uptake by 1.4 percentage points (2.1%) for mammography and by 0.7 percentage point (1.2%) for Pap smear. Even replacing the $200 screening cost by a $50 monetary incentive would increase screening uptake by only 1 percentage point for both mammography and Pap smear.

Tables 3 and 4 reveal that, given the levels shown, treatment outcomes in the case of a cancer diagnosis is what mattered most to respondents. For both cancers, survival was the most important attribute. Improving survival chances from 25% to 90%, an admittedly large range but consistent with the difference between early and late diagnosis, would increase mammography and Pap smear screening uptake by 14.5 and 20.4 percentage points, respectively—relative increases of 22.8% and 35.7%. Out-of-pocket treatment cost was nearly as important to respondents. Reducing costs from $250 000 to $0, as would occur with Universal Health Coverage, would increase mammography and Pap smear screening uptake by 14.3 and 19.3 percentage points, respectively, which corresponds to an increase of 22.4% and 33.8%. Not losing a breast would increase mammography screening uptake by 4.8 percentage points (7.5%), whereas avoiding infertility would increase Pap smear screening uptake by 4.7 percentage points (8.2%).

For both screening services, there was no noticeable difference in attribute effect between the respondents who were subjected to messaging and those who were not. For mammography, those with lower income were relatively less concerned by cancer survival and permanent adverse effects but relatively more concerned about treatment costs ($P < .05$), as reported in Appendix Table 2 (in Supplemental Materials found at https://doi.org/10.1016/j.jval.2020.06.004). For Pap smear, those with lower income were relatively less concerned about screening accuracy ($P < .05$) but income did not have a statistically significant effect on concerns related to survival or treatment cost, as shown in Appendix Table 3 (in Supplemental Materials found at https://doi.org/10.1016/j.jval.2020.06.004). Past screening experiences also did not have any statistically significant moderating effect.

In Table 5, we present the respondents' opinions and beliefs on the cancer screening attributes that were included in the DCEs. What stands out is that respondents vastly underestimate survival for screen-detected breast and cervical cancer. In our mammography sample, 94.4% of non-screeners and 87.1% of screeners reported that they believe the screen-detected breast cancer survival rate is lower than 90%. In total, 82.2% of nonscreeners and 66.0% of screeners in our Pap smear sample believe that the screen-detected cervical cancer survival rate is lower than 75%. These are low compared with the survival estimates using the age-standardized relative survival rates per cancer stage in Singapore[21] and the data on the stage distribution of screen-detected breast and cervical cancers.[22,23] These calculations yielded a survival rate of 93% for screen-detected breast cancer and 86% for screen-detected cervical cancer.

We simulated the effect of a fully successful information campaign, focusing on survival conditional on early detection/treatment, on cancer screening uptake. To do so, we first predicted the uptake of each respondent by setting the attributes at their believed levels. We then substituted the believed cancer survivals with the actual survival and recalculated uptake. This simulation found that, if misconceptions were corrected, mammography screening would increase by 4.6 percentage points and Pap smear screening would increase by 6.5 percentage points. On the other hand, 79.5% of the mammography sample and 75.0% of the Pap smear sample believed that they would suffer from permanent adverse effects from cancer treatment. These beliefs were not significantly different between screeners and non-screeners in the mammography sample. However, among the Pap smear respondents, a larger proportion of those who believe they would have both sexual difficulties and inability to have children are from the screener group. Therefore, correcting these misperceptions may not translate into higher screening rates in the real world.

Lastly, Tables 3 and 4 show that fully subsidizing a $200 screening service would only increase uptake by 2.3 and 5.6 percentage points for mammography and Pap smear, respectively. We calculated the increase in uptake that would correspond to distributing the same total amount in subsidies to lower the treatment cost of those diagnosed with cancer. To do this, we first tested polynomial specifications for treatment cost, chance of false diagnosis, and chance of cancer survival, and

Table 2. Respondent characteristics according to past screening experience.

	Mammography		Pap Smear	
	Screened according to guidelines (n = 142)	Did not screen according to guidelines* (n = 258)	Screened according to guidelines (n = 206)	Did not screen according to guidelines† (n = 195)
Citizenship (%)				
Singapore citizen	92.3	86.4	81.1	79.0
Singapore permanent resident	7.8	13.6	18.9	21.0
Age, mean [SD]	52.9 [6.6]	51.7 [7.7]	42.5 [9.6]	43.6 [12.5]
Ethnicity (%)				
Chinese	73.9	74.0	68.5	62.1
Malay	11.3	12.4	16.0	19.0
Indian	10.6	9.7	11.2	12.3
Other	4.2	3.9	4.4	6.7
Marital status‡				
Never married	3.5	9.3	3.9	21.0
Married	85.9	81.0	92.2	71.8
Widowed/divorced/separated	9.2	7.8	3.4	5.1
Prefer not to say	1.4	1.9	0.5	2.1
Highest educational attainment‡,§				
No formal education/primary	21.1	27.1	8.3	17.4
Secondary/vocational/ITE	38.7	46.1	34.0	37.4
JC/poly/diploma/university and above	40.1	26.7	57.8	45.1
Employment status (%)				
Working full-time	40.9	34.1	56.8	47.7
Working part-time	18.3	17.8	13.1	14.4
Homemaker/retired or not working	40.9	48.1	30.1	38.0
Household total income per month, (%)‡,§				
< $1500	11.3	15.5	5.3	16.4
$1500-$3499	15.5	24.0	23.3	24.6
$3500-$11 499	37.3	28.3	45.2	27.2
> $11 500	10.6	2.7	8.3	3.1
Refused/don't know	25.4	29.5	18.0	28.7
Housing type‡,§				
HDB‖ 1-3 room, (%)	20.4	20.2	18.5	30.8
HDB‖ 4 room	33.8	48.5	37.4	34.4
HDB‖ > = 5 room	26.8	22.9	29.6	25.1
Condo/private flat/bungalow/semiD/ Terrace/other	19.0	8.5	14.6	9.7
Current health status (%)				
Excellent	6.3	3.5	4.4	3.1
Very good	17.6	12.8	17.0	19.0
Good	49.3	53.9	59.2	59.5
Fair	24.7	28.3	19.4	18.0
Poor	2.1	1.6	0.0	0.5
Ever been diagnosed for cancer, (%)§	9.2	3.1	4.4	2.1
Go for regular check-up at least once in every 2 years, (%)‡,§	88.0	55.8	86.9	46.2

HDB indicates Housing and Development Board, which offers public housing in Singapore.
*Did not screen according to guidelines includes those who never screened and those who screened at least once but had their last mammography more than 2 years ago.
†Did not screen according to guidelines includes those who never screened and those who screened at least once but had their last Pap smear more than 3 years ago.
‡Statistically significant difference at the 5% level between screeners and non-screeners for Pap smear.
§Statistically significant difference at the 5% level between screeners and non-screeners for mammography.
‖HDB stands for Housing and Development Board which offers public housing in Singapore.

selected a quadratic function for treatment cost and a linear function for false diagnosis and cancer survival. Results from these estimates are presented in Appendix Tables 4 and 5. Linearizing our uptake effects on the range of treatment costs considered, we found that uptake would increase by 0.7 and 2.3 percentage points for each $1000 reduction in treatment cost. Given that the chance of testing positive during a mammography or Pap smear amounts to 7.9[24] and 0.4[25] per 1000 screeners, respectively, a screening subsidy of $200 would correspond to $200/0.0079 = $25 253 and $200/0.0004 = $540 541 treatment subsidy for each screen-detected breast and cervical cancer patient, respectively. In the case of cervical cancer, our calculated subsidy of $540 541 is more than the highest cost level of $250 000 in our DCE. Thus, cervical cancer

Table 3. Change in mammography screening uptake according to changes in attribute levels (in percentage points).[*,†]

Attribute level	All women	Messaging		Income[‡]		Screened according to guidelines	
		No	Yes	Lower	Higher	No	Yes
Reference scenario[§]	63.7[‖]	67.1[‖]	61.2[‖]	61.9[‖]	67.7[‖]	59.6[‖]	69.4[‖]
	[55.9-70.8]	[58.3-75.8]	[52.5-69.5]	[53.8-69.5]	[58.3-77.5]	[51.0-67.8]	[60.1-77.9]
Discomfort during screening (ref: pain)	1.2	1.2	1.4	1.1	1.2	1.4[‖]	0.9
	[0-2.8]	[0-3.0]	[0-3.3]	[0-2.9]	[0-3.3]	[0.1-3.0]	[−0.3 to 2.6]
Chance of false diagnosis (ref: 30%)							
5%	1.4	1.2	1.5	0.4	2.9[‖]	1.6	1.1
	[0-3.5]	[−0.8 to 3.5]	[−0.3 to 3.9]	[−1.8 to 2.3]	[0.8-5.8]	[0-4.3]	[−1.1 to 3.5]
15%	0.6	0.2	1.1	1	−0.2	0.8	0.3
	[−0.8 to 2.3]	[−2.0 to 2.3]	[−1.0 to 3.6]	[−0.8 to 3.3]	[−2.5 to 2.0]	[−1.0 to 3.0]	[−2.0 to 2.8]
Screening cost (ref: pay $200)							
Receive $50	0.9	1.1	0.5	1.5	−0.1	1.3	0.1
	[−0.5 to 2.8]	[−0.8 to 3.5]	[−1.3 to 2.8]	[0-3.8]	[−2.5 to 2.3]	[−0.5 to 3.8]	[−2.3 to 2.3]
Free-of-charge	2.3[‖]	2.6[‖]	1.9	2.8[‖]	1.4	2.5[‖]	1.9
	[0.8-4.3]	[0.5-5.1]	[0-4.5]	[0.9-5.5]	[−0.3 to 3.8]	[0.8-4.8]	[0-4.3]
Pay $50	1.6[‖]	2.1[‖]	1	1.6	1.6	1.5	1.8
	[0.3-3.5]	[0.3-4.3]	[−0.5 to 3]	[0-3.8]	[0-3.8]	[0-3.5]	[0-4.0]
Chance of cancer survival (ref: 25%)							
90%	14.5[‖]	14.3[‖]	15[‖]	14.1[‖]	15.4[‖]	15.4[‖]	13[‖]
	[9.5-20]	[9.3-19.8]	[9.8-20.8]	[9.1-19.4]	[10.0-21.3]	[10.3-21.0]	[8.0-18.6]
65%	9.9[‖]	8.9[‖]	10.8[‖]	10[‖]	10[‖]	10.2[‖]	9.1[‖]
	[6-14.5]	[5.3-13.5]	[6.8-15.6]	[6.3-14.4]	[6.0-14.9]	[6.0-14.8]	[4.8-13.5]
50%	9.3[‖]	9.6[‖]	9.3[‖]	9.4[‖]	9.1[‖]	10[‖]	8.4[‖]
	[5.5-13.8]	[5.5-14.3]	[5.3-13.8]	[5.4-13.6]	[5.0-14.3]	[5.8-14.5]	[4.3-12.5]
Permanent side-effect (ref: loss of an entire breast)							
None	4.8[‖]	6.3[‖]	3.1	2.5	8.1[‖]	4.7[‖]	4.9[‖]
	[1.8-8.5]	[2.8-10.4]	[0-6.8]	[−0.3 to 6]	[4.3-12.3]	[1.3-8.6]	[1.5-8.8]
Change in feel and appearance	2.1	2.7	1.8	0.5	4.6[‖]	1.7	2.4
	[−0.3 to 5]	[−0.1 to 6.3]	[−1.0 to 5.3]	[−2.3 to 3.5]	[1.0-8.5]	[−1.3 to 5.3]	[−0.3 to 5.8]
Out-of-pocket treatment cost (ref: $250 000)							
$0	14.3[‖]	13.8[‖]	14.7[‖]	16.2[‖]	11.6[‖]	16.1[‖]	11.6[‖]
	[10.1-19.1]	[9.3-19.3]	[10.5-20.3]	[11.8-21.8]	[7.3-17.1]	[11.3-21.5]	[7.5-16.8]
$50 000	10.3[‖]	10.9[‖]	9.4[‖]	11.2[‖]	9[‖]	11.3[‖]	8.5[‖]
	[6.8-14]	[7.3-15.3]	[5.8-13.8]	[7.5-15.6]	[5.5-13.3]	[7.3-15.8]	[5.1-12.8]
$150 000	4.3[‖]	4.5[‖]	4[‖]	4.7[‖]	4[‖]	4.1[‖]	4.6[‖]
	[2.0-7.0]	[2.0-7.6]	[1.5-7.3]	[2.0-7.8]	[1.3-7.0]	[1.8-7.1]	[1.8-7.9]

Note. N = 400 respondents.
*The incremental effects of each attribute were calculated by setting all other attributes at their reference level.
[†]Squared brackets indicate 95% simulated nonparametric confidence intervals.
[‡]Owing to the large proportion of missing income values, lower income was proxied by living in a HDB of 4 rooms or less, and higher income proxied by living in HDB of 5 rooms or more, private flat, condo, or landed property.
[§]The reference scenario takes the worst level of all the attributes: pain, 30% chance of false diagnosis, $200 screening cost, 25% survival rate, lose an entire breast, $250K OOP cost of treatment.
[‖]Indicates statistical significance at the 5% level.

treatment was fully subsidized, whereas breast cancer treatment was only partially subsidized in our simulations. The resulting increase in uptake would be 17.7 percentage points for mammography and 19.3 percentage points for Pap smear. The much larger effect for Pap smear is due to the relatively lower cervical cancer detection rate.

Discussion

Our DCEs revealed that respondents were far more concerned about cancer treatment outcomes than they were about screening service features, including screening cost, given the range of levels shown. For instance, although screening subsidies had a negligible

Table 4. Change in Pap smear screening uptake according to changes in attribute levels (in percentage points).*,†

Attribute level	All women	Messaging		Income[‡]		Screened according to guidelines	
		No	Yes	Lower	Higher	No	Yes
Reference scenario[§]	57.1[‖]	54.1[‖]	59.4[‖]	61.4[‖]	52.8[‖]	54[‖]	60.7[‖]
	[48.6-65.6]	[43.3-64.8]	[47.9-68.8]	[51.3-70.1]	[41.4-63.5]	[43.8-64.1]	[49.8-70.0]
Choice of practitioner's gender (ref: no)	2.5	3.7	1.4	2.4	2.1	3.5*	1.7
	[0-5.3]	[0.5-6.8]	[−1.8 to 4.3]	[−0.3 to 5.3]	[−0.8 to 5.3]	[0.3-6.8]	[−1.3 to 4.8]
Chance of false diagnosis (ref: 30%)							
5%	0.7	1.5	−0.1	−0.3	2.3	1.3	-0.2
	[−1.8 to 3.3]	[−1.5 to 4.8]	[−3.0 to 3.3]	[−3.0 to 2.3]	[−1.0 to 6.0]	[−1.8 to 4.6]	[−3.3 to 2.8]
15%	1.2	1.8	0.4	0.2	2.8	1.2	1.1
	[−1.0 to 3.8]	[−1.3 to 5.3]	[−2.5 to 3.8]	[−2.5 to 3.0]	[−0.3 to 6.8]	[−1.8 to 4.8]	[−1.9 to 4.5]
Screening cost (ref: pay $200)							
Receive $50	1	1.6	0.4	−0.7	3.2	0.5	1.1
	[−1.0 to 3.8]	[−1.5 to 5.0]	[−2.8 to 3.8]	[−3.8 to 2.0]	[0-7.0]	[−2.8 to 4.0]	[−2.0 to 4.4]
Free-of-charge	5.6[‖]	6.2[‖]	5.1[‖]	3.5[‖]	8.2[‖]	5[‖]	6.1[‖]
	[2.5-9.0]	[2.5-10.0]	[2.0-9.0]	[0.8-6.8]	[4.3-12.5]	[1.5-8.8]	[2.8-10.0]
Pay $50	3[‖]	2.9[‖]	3.1[‖]	1.6	5[‖]	2.7[‖]	3.3[‖]
	[0.8-5.8]	[0.3-5.8]	[0.5-6.3]	[−0.6 to 4.0]	[2.0-8.5]	[0.3-5.5]	[0.8-6.5]
Chance of cancer survival (ref: 25%)							
90%	20.4[‖]	19.7[‖]	21.1[‖]	17.6[‖]	23.4[‖]	19.5[‖]	21.1[‖]
	[14.6-27.4]	[13.3-26.6]	[13.8-28.6]	[11.3-24.5]	[16.4-31.0]	[13.0-26.4]	[14.0-28.5]
65%	14.5[‖]	14.7[‖]	14.4[‖]	12.8[‖]	15.3[‖]	12.7[‖]	16.2[‖]
	[9.5-20.3]	[9.0-20.5]	[8.8-20.9]	[7.8-18.8]	[9.5-21.6]	[7.3-18.8]	[10.3-22.5]
50%	11.6[‖]	11.4[‖]	11.6[‖]	9.8[‖]	13.6[‖]	10.9[‖]	12.2[‖]
	[6.8-17.3]	[6.0-17.5]	[5.9-17.6]	[4.8-15.5]	[8.0-20.3]	[5.8-16.8]	[6.8-18.5]
Permanent side-effect (ref: infertility)							
None	4.7[‖]	3.9	5.4[‖]	4.9[‖]	4	4.7[‖]	4.4
	[0.5-9.8]	[−0.3 to 9.3]	[0.8-10.9]	[0.5-9.8]	[−0.5 to 9.8]	[0.3-10.1]	[0-9.8]
Sexual difficulties	1.9	0	3.7	2	0.9	1.4	2.4
	[−2.1 to 6.3]	[−5.3 to 5.4]	[−0.5 to 9.0]	[−2.0 to 6.8]	[−4.5 to 6.3]	[−3.3 to 6.5]	[−2.0 to 7.3]
Out-of-pocket treatment cost (ref: $250k)							
$0	19.3[‖]	20.3[‖]	18.6[‖]	18.2[‖]	18.7[‖]	19.3[‖]	19[‖]
	[14.5-25.1]	[14.5-26.9]	[12.8-25.1]	[13.3-24.4]	[13.0-25.5]	[13.6-25.9]	[13.4-25.8]
$50k	15.7[‖]	14.4[‖]	16.8[‖]	13.5[‖]	16.6[‖]	14.8[‖]	15.9[‖]
	[11.3-21.3]	[9.8-19.8]	[11.5-22.6]	[9.0-18.5]	[11.8-22.5]	[9.8-20.0]	[11.0-21.5]
$150k	6.5[‖]	5.4[‖]	7.6[‖]	5.1[‖]	8.2[‖]	6.2[‖]	6.6[‖]
	[3.5-9.8]	[2.0-9.4]	[3.8-11.8]	[2.0-8.5]	[4.3-12.8]	[2.8-10.3]	[2.8-10.8]

Note. N = 401 respondents.
*The incremental effects of each attribute were calculated by setting all other attributes at their reference level.
†Squared brackets indicate 95% simulated nonparametric confidence intervals.
‡Owing to the large proportion of missing income values, lower income was proxied by living in a HDB of 4 rooms or less, and higher income proxied by living in HDB of 5 rooms or more, private flat, condo, or landed property.
§The reference scenario takes the worst level of all the attributes: pain, 30% chance of false diagnosis, $200 screening cost, 25% survival rate, lose an entire breast, $250 000 out-of-pocket cost of treatment.
‖Indicates statistical significance at the 5% level.

influence on uptake, an increase in perceived cancer survival rate from 25% to 90% led to increases in predicted uptakes in mammography and Pap smear of 23% and 36%, respectively. Although public health agencies cannot directly influence the survival rate, they can address misconceptions about survival, which our results suggest would have a positive influence on screening uptake. Likewise, a decrease in treatment costs from $250 000 to $0 led to similar increases in predicted uptakes. These results occur because women greatly fear the costs of treatment conditional on a positive diagnosis. Therefore, insulating women from these costs has a large effect. Although such a strategy sounds expensive, it is potentially less expensive than screening subsidies because screening leads to few positive diagnoses, especially for Pap smear.[25]

We expected our gain-framed message to partially address women's fears about screening. Even though this message was based on prior research conducted in Singapore, the message failed to improve screening uptake. While this message was tested using stated preferences, its lack of effectiveness on intent to screen makes it even less likely to work in the real world.

Table 5. Respondent opinions and beliefs on real cancer screening attributes.

	Mammography		Pap smear	
	Screened according to guidelines (n = 142)	Did not screen according to guidelines* (n = 258)	Screened according to guidelines (n = 206)	Did not screen according to guidelines† (n = 195)
Perception of pain during mammography, (%)	33.8	34.1		
Will never get a pap smear if it is not done by a healthcare professional of my preferred gender, (%)			15.2	22.6
Chance of false diagnosis, (%)				
<10%	44.1	43.8	52.7	41.1
10-25%	29.7	25.0	25.8	29.8
>25%	26.2	31.3	21.5	29.0
Screening cost, (%)‡,§				
Free	19.1	15.3	10.8	8.9
<$25-49	44.9	22.2	56.0	21.8
$50-$99	23.8	12.5	16.6	4.0
$100-$199	5.9	4.9	7.2	8.1
>$200	0.8	1.4	0.4	0.8
Never heard of mammography/ pap smear	0.0	22.2	0.0	41.9
Don't know	5.5	21.5	9.0	14.5
Chance of survival‡,§				
<10%	7.0	12.5	10.5	11.3
10-25%	7.8	5.6	10.1	9.7
25-50%	13.7	22.2	15.5	22.6
50-75%	32.0	38.9	30.0	38.7
75-90%	26.6	15.3	22.4	12.1
>90%	12.9	5.6	11.6	5.7
Permanent changes to breast after cancer treatment, (%)				
No change	20.7	20.1		
Change in the appearance and feel	39.8	39.6		
Lose an entire breast	39.5	40.3		
Permanent changes after cervical cancer treatment, (%)				
No change			25.6	25.0
Sexual difficulties			7.6	4.8
Unable to have children			27.4	39.5
Both sexual and reproductive difficulties			39.4	30.7
OOP cost of treatment, (%)				
$5000	46.9	45.8	34.3	40.3
$5,000-$19,999	21.5	27.8	27.4	32.3
$20,000-$49,999	15.2	15.3	21.3	16.9
>$50,000	16.4	11.1	17.0	10.5

*Did not screen according to guidelines includes those who never screened and those who screened at least once but had their last mammography more than 2 years ago.
†Did not screen according to guidelines includes those who never screened and those who screened at least once but had their last Pap smear more than 3 years ago.
‡Statistically significant difference at the 5% level between screeners and non-screeners for mammography.
§Statistically significant difference at the 5% level between screeners and non-screeners for Pap smear.

Although other messages may work better, our results suggest that a very general message on survival may not be as effective as properly informing women on actual cancer treatment outcomes conditional on an early diagnosis. This is especially true in Singapore, where respondents widely underestimated screen-detected cancer prognosis. We estimated that correcting misbeliefs on screen-detected cancer prognosis has the potential to increase mammography and Pap smear screening uptake by 4.6 and 6.5 percentage points, respectively. Another health promotion strategy we propose is subsidizing treatment costs contingent on screening according to guidelines. Our results show that this strategy would be more effective than subsidizing screening costs. Therefore, we propose limiting screening subsidies but ensuring that cancer treatments are priced lower for those who screen according to guidelines. Some screening subsidies may still be needed, but these could be means-tested instead of being broadly distributed.

A methodological point that we would like to highlight is that DCEs do not require respondents to calculate expected utilities accurately. DCEs merely require that respondents have a utility associated with each attribute level and consistently tradeoff between them. When assessing the utility of treatment attributes, the respondents were reminded that these were conditional on testing positive for cancer, and rigorous pretesting made sure that respondents were aware of this assumption. It is true that the respondents' utilities for treatment attributes implicitly includes an assessment of the probability of testing positive for cancer. However, this probability does not have to be accurate. According to prospect theory,[26] it is the probability perceived by the respondents, not the actual probability, that determines the choices they make in reality.

As for limitations, DCEs have been criticized for their cognitive burden and design matters such as framing, realism, and interpretation of the opt-out parameter.[27,28] We mitigated these limitations through pretesting and by including choice-tasks to check for violations of axioms of preference theory. Results show that the full sample and subsample of those who passed these tests yielded similar results (see Appendix Tables 6 and 7 in Supplemental Materials found at https://doi.org/10.1016/j.jval.2020.06.004). Further, it may be argued that by asking about both screening and treatment outcomes simultaneously, our DCE designs brought increased complexity and cognitive burden and more attention to cancer treatment outcomes than many women consider in reality. Whereas this may be true, the decision of whether or not to undergo a screening exam is multifaceted, and our focus group data clearly show that women consider both screening and treatment attributes in deciding whether or not to undergo a screening exam. Although we admit that framing likely influenced responses, this is not unique to DCEs because real world decisions are also subject to influence based on how information is presented. This is why our proposed policy strategies involve increasing the salience of factors that might not be salient enough in reality—but as we know from our DCEs, greatly matter to women when they are paying attention. In other words, we recognize that framing matters and propose to take advantage of this to increase uptake in the real world. Other limitations are that, based on the pretesting results, the respondents struggled with trading off between attributes when survival was expressed as 5-year survival rates; hence, survival was presented as "not dying as a result of the disease" in the final DCE. This may have created a slight discrepancy from the information available on actual (5-year) survival rates. Another concern is that, despite using attribute levels for chance of survival that are close to the respondents' beliefs, we recognize that the range of survival rate options presented in the DCE might have magnified the importance of this attribute, and thus the relative importance of treatment versus screening. It is also worth noting that although our experimental design made the gain-frame salient only to those respondents in the treatment group, it is possible that some control group respondents were exposed to gain-frame messaging before the study and that some of them remembered it. Therefore, the generalizability of the lack of effect with gain-frame messaging should be considered limited to settings in which gain-frame messaging is already in place. Lastly, this analysis took place in Singapore, where participants are used to large out-of-pocket expenses. Some results may not generalize to countries where citizens are insulated from the costs of treatment.

Future research could entail developing and empirically testing health promotion interventions according to the strategies we propose above. Messaging on the fear of being diagnosed with cancer could be included into letters inviting people to take part in screening programs. Advertisements featuring screen-detected cancer survivors sharing their treatment experience could also be used to convey these messages. Regarding screening-contingent cancer treatment subsidies, these could be implemented as a special type of financial incentive for health behavior change and tested in the framework of a randomized controlled trial.[29] There are numerous possibilities to test or implement our findings that, ultimately, cancer screening is not solely about screening, but also about the costs and benefits of treatment.

Supplemental Material

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.jval.2020.06.004.

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