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Health Policy Analysis

Encouraging Mammograms Using Behavioral Economics: A Randomized Controlled Trial in Chile

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ABSTRACT

Objectives: This article illustrates the effect of a direct mail campaign that used insights from behavioral economics and psychology to increase the number of free mammograms in Chilean women aged 50 years or older.

Methods: We hypothesized 4 barriers in obtaining a mammogram based on previous literature and focus group analysis. A behavioral economic approach providing incentives was used to help overcome these barriers. We accessed a unique data set, which comprised 12 000 women 50 years old or older, with private health insurance who have not had a mammogram for 24 or more months. We conducted a randomized controlled trial with 8 treatments, each involving a specific combination of messages.

Results: The intervention overall led to a 167% increase in the use of free mammograms, a 1.13% to 3.03% average increase from the control to treatment groups, respectively. Regarding barriers, we found that all messages were effective, with a slightly larger and persistent effect for the less complex ones in terms of information. This finding illustrates the benefits of keeping the message simple.

Conclusions: Finally, these results suggest a successful public policy for increasing use of free mammography programs. Moreover, they are potentially transferable because the study considered decision-making heuristics that are not specific to one culture or social context.

Keywords: barriers to screening, behavioral economics, mammography, women's health.

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Introduction

Breast cancer is a significantly important disease worldwide. In 2008, there were 12.7 million cancer cases with 7.6 million deaths, of which 23% and 14%, respectively, were breast cancer.[1] In Chile, breast cancer is the most prevalent type of cancer among women[2] and is the second leading cause of death.

There are several ways to detect breast cancer, with mammography being a common method. Although there is some controversy regarding the benefits of this technique generally and based on age, it is still extensively used worldwide. Evidence regarding the benefits of the test is mixed,[3] with some finding that it increased overdetection (defined as the "detection of non-progressive cancers abnormalities that meet the pathological definition of cancer but will never progress to cause symptoms in the patient's lifetime").[4]

Nevertheless, it may be a highly appropriate method for reducing breast cancer mortality, especially when focusing on the 50-69 years age group. Randomized controlled trials (RCTs) that followed population cohorts over their lifetime have found a reduction in breast cancer mortality rates.[5-7] Particularly of note is the study by Nystrom et al[6] (Swedish RCT studies to avoid possible bias ensured that the women had not previously received a diagnosis of breast cancer. We target this, limiting the sample to women who have not had a mammogram in 24 or more months because those with cancer or a history of cancer would undergo frequent screening to evaluate tumor responses to medical treatment.), which studied the screening effects in a Swedish sample of 49-74 years old, finding the largest effects being for the 50-69 years age group. Mandelblatt et al[8] and Weedon-Fekjaer et al[9] found similar results. In Chile, mammography has been a clinical guideline since 2001. There have been advances in screening, but in 2017, only 63.5% of women aged 50 years and older had a mammogram in the last 3 years.[10]

We hypothesized 4 barriers to mammography screening, using behavioral economics concepts from the literature. We based on results from Puschel et al[11] and a focus group used to verify such barriers. The first barrier is "information avoidance," that is, avoiding information because there is a psychological cost associated with knowing such information. For example, patients do not want to receive test results because there may be bad news.[12] A related second barrier is "procrastination," putting off a task because it is undervalued, and doing the said task seems inconvenient or uncomfortable in the present.[13] A third potential barrier

is the "affect heuristic," that individuals may have a fear of detection or fear of the test itself, which are stimuli that influence the decision-making process.[14,15] The final barrier, barrier 4 is "decision fatigue,"[16] given that obtaining a mammogram is complicated because it involves making decisions and is entails taking several step.

Regarding interventions that increase mammography screening, there have been several studies over the past 20 years that have looked at barriers.[2,17-20] Meissner et al[17] offer ways to refine mammography interventions (eg, vouchers or advertising-free tests and mass media campaigns), highlighting the importance of intervention strategies such as those targeting economic barriers. Slater et al[18] tested the efficacy of 2 mailed interventions (mail and mail plus small monetary incentive) on women aged 40-64 years. The study found that "coupling direct mail with an incentive significantly enhances the intervention's effectiveness, concluding that direct mail is quite effective among low-income, medically underserved women." A study by Sohl and Moyer,[19] analyzed the efficacy of personally tailored messages in promoting mammography use.

Puschel et al[11] compared the effects of low- (mail-based) and high-intensity (mail plus phone or in-person contact) interventions on mammogram rates, concluding that a primary care intervention based on mail or brief personal contact could significantly increase mammogram screening rates. Puschel and Thompson[2] provided evidence that the availability of free mammograms was insufficient for increasing screening rates in the population. Finally, Püschel et al[20] performed an RCT in a low-income municipality in Chile. A group of 500 women were divided into 2 groups: one receiving a low-intensity intervention and the other a high-intensity one. Both groups equally increased their rate of using free mammography services, a result indicating that the intervention intensity was not the key to the increase in the rates.

This article estimates the effect of a direct mail campaign that uses insights from behavioral economics on mammography screenings among women aged 50 years or older. Our main contribution was to test several messages based on different behavioral barriers (The behavioral economics provides a framework to understand heuristic behind human behavior, applying psychology into the economic decision-making study. Several studies have reported how a person can be encouraged to behave in a certain way, simply by supplying incentives in a strategic manner to correct biases or address the barriers in the cost-benefit decision problem.).

Although much is already known about barriers to and facilitators of mammography screening among various populations, using a behavioral economic paradigm to consider these barriers and how to overcome them is new (International guidelines provide useful information, but do not include interventions such as those in this study, which attempt to directly respond to barriers described by behavioral economics.). Furthermore, no client-based intervention has been shown to work for all individuals in all settings, and research on population-wide interventions that have the potential to be cost-effective and scalable is lacking.[18] Because this article involved a blind design based on a population-based intervention with a large and non–self-selected sample (drawn from a 17% of the Chilean population covered by private insurance), it can throw some light to these issues. Behavioral economics in an RCT provides many insights for the design of new interventions that are potentially helpful and cost-effective. Moreover, the findings are potentially transferable to multiple populations because this article considers decision-making heuristics that are common to many populations.

Methods

Background

The focus of the study was on women aged 50 and older, with private insurance, living in Santiago. On the one hand, the intervention was administered to those with private insurance because we could observe the longitudinal behavior of these individuals using claims data. Because of data limitations, it was not possible to do so for women with public insurance (80% of the population). An in-depth analysis of the related implications is provided in the Discussion section. On the other hand, approximately 50% of the population lives in Santiago, and it has an abundant supply of mammography machines, thus ruling out a lack of access as a cause of low rates. The large population and high level of access make it a suitable environment to test the behavioral economic interventions.

According to the Chilean Socioeconomic Characterization Survey 2017,[10] only 35% of women aged 50 and older had a mammogram that year, compared with 51% of privately insured women. This shows there is still room for improvement.

In the Chilean health system, after getting a prescription from their doctors, women can choose between 2 options for obtaining a mammogram:

1. The "copay" option. Women use their private insurance coverage to pay for this mammogram, with a copay (typically approximately US $20). Approximately 90% of the women who had mammograms used this option. Although it is available to all public, those without private insurance coverage must make the full payment.
2. The "free" mammogram option. Women can receive a free preventive-care mammogram but only at certain clinics designated by the insurance company. Fewer than 10% of women who have ever had a mammogram in our data have used this option. Because the free mammogram is aimed at overall public welfare and is underused, this is the option that we focus on.

Data

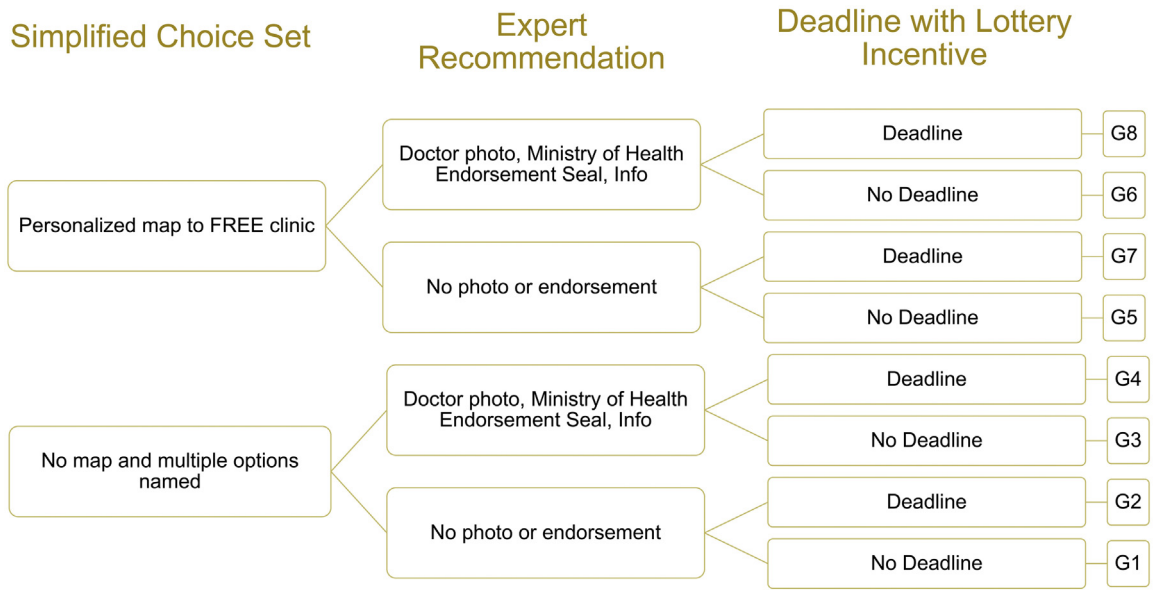
The data used in this study were provided by the Superintendence of Health (the government agency that regulates the private health insurance market) and include all insurance claim records from all private insurance firms in Chile. Approximately 17% of the population has private health insurance, and its data provide the information we need (any mammogram from 2007 onward, age, copayments for mammography screening) and identify the primary care doctor and visits made to them.

The main data set consists of women who have not had a mammogram for at least 24 months, lived in Santiago, and were 50 years old or older (with the oldest woman in the sample being 61 years old). It totaled 42 233 women in June 2015.

Because the intervention (a mail campaign) required an address, which could only be obtained from the insurance company, this further limited the sample. Only 2 large insurance companies were willing to share this information with the Superintendence of Health, leaving a sample of 15 626 (37% of the Chilean private insurance market). Of these, 12 000 women were randomly chosen, with half being assigned to the treatment group.

The treatment group was sent 1 mailer. Within that group, women were divided into 8 equal-sized groups, in a nested $2 \times 2 \times 2$ block design (Fig. 1), that would allow us to apply 8 different types of messages and test different incentive combinations. Appendix A

Figure 1. Summary of proposed mailer messaging.



Note. There were 3 different messages (simplified choice set, expert recommendation, and deadline with lottery incentive) to address different hypothesized barriers. We combined these in a nested 2 × 2 × 2 block design, which resulted in 8 eight types of letters and, consequently, 8 groups within the treatment group.

(in Supplemental Materials found at https://doi.org/10.1016/j.jval.2021.04.1275) provides 2 figures that illustrate the experiment's sampling (Figs. A1 and A2 in Supplemental Materials found at https://doi.org/10.1016/j.jval.2021.04.1275). Appendix B (in Supplemental Materials found at https://doi.org/10.1016/j.jval.2021.04.1275) shows the messages sent and comments about ethical considerations. As shown in Table 1, before treatment, there are no differences between the treatment group and the control group in age or previous mammograms, total health expenditure, or use of health services.

Experimental Strategy

Each type of treatment (message) was designed to address one or more hypothesized barriers. To properly identify these barriers, a series of focus group interviews were conducted to develop and refine the behavioral interventions used. Selected women were recruited via telephone and received a US $50 incentive (gift card). These women were subsequently excluded from the mailer campaign. There were 4 focus groups with 8 participants each and followed a semistructured protocol based on findings from Puschel et al.[11]

The finalized barriers were as follows:

Hypothesized barrier 1: information avoidance

This refers to situations in which a person actively chooses not to obtain knowledge that is freely available via inattention, confirmation bias, and even physical avoidance.[21] There could be immediate benefits if being reminded of the possibility of having breast cancer causes undesirable psychological consequences. Behavioral economics finds that reminders can help address information problems in a variety of contexts.[22-24] Thus, the base intervention was a reminder of mammograms.

Hypothesized barrier 2: procrastination

This concerns self-control and intertemporal decision making. People often have "present-biased" preferences and procrastinate on tasks that involve immediate costs but delayed benefits.[14] For example, women intend to obtain a mammogram soon, but the immediate inconvenience can lead to it constantly being put off, especially because the test has delayed and possibly uncertain benefits. Behavioral economics research has shown that deadlines can help overcome procrastination, and a lottery can take advantage of people's tendency to overweigh small probabilities in making decisions.[25] Thus, half of the mailers gave a deadline with a lottery of Ch $1 million (US $1587) for all women who had mammograms before that date.

Hypothesized barrier 3: affect heuristic

This is related to the problem of fear of detection or of the test. This includes situations when emotions lead to polarized thinking, thereby leading to all-or-nothing choices. This message includes information about how mammograms save lives (and therefore the importance of detection against the fear of finding out one has cancer). A physician recommendation can increase compliance rates for mammography in Chile.[19,26] To study the importance of this behavioral tendency on this barrier, half of the mailers contained a photograph of a physician in a white laboratory coat and an "official endorsement" from the Chilean Ministry of Health. This intervention appeals to the behavioral economic heuristic of deferring to authority,[27] or "expert power."[28] Moreover, we include information regarding how the breast cancer treatment saves lives (and therefore the importance of detection) was included. Essentially, the objective is to lower the level of fear or risk perception of the test or results, with an intention to change individual judgments about the test.

Hypothesized barrier 4: problems from structural barriers and complexity

There are complex structural barriers to accessing the free mammogram. This complexity of the process (having to first make and attend a doctor's visit, then finding and choosing a clinic, and making and attending an appointment there) could be overwhelming, leading to the process being delayed or abandoned. This issue is known as "decision fatigue"[16] and

Table 1. Descriptive statistics by control and treatment groups before the intervention.

	Health expenditure, US dollars	Number of health services	Monthly income, US dollars	Age	Number of dependents
Control	53	96	1482	54.3	0.51
	(64)	(103)	(1013)	(3.3)	(0.50)
Group 1	52	97	1465	54.5	0.49
	(57)	(107)	(1030)	(3.3)	(0.50)
Group 2	51	93	1470	54.3	0.51
	(53)	(123)	(1015)	(3.3)	(0.50)
Group 3	54	106	1470	54.4	0.51
	(54)	(104)	(1034)	(3.3)	(0.50)
Group 4	51	96	1454	54.4	0.53
	(59)	(100)	(1051)	(3.2)	(0.50)
Group 5	52	95	1405	54.6	0.54
	(70)	(92)	(1003)	(3.3)	(0.50)
Group 6	54	93	1460	54.5	0.53
	(58)	(92)	(975)	(3.5)	(0.50)
Group 7	60	93	1483	54.7	0.54
	(98)	(99)	(1029)	(3.4)	(0.50)
Group 8	51	99	1528	54.3	0.49
	(50)	(104)	(1040)	(3.2)	(0.50)
Total	53	96	1474	54.4	0.52
	(64)	(103)	(1018)	(3.3)	(0.50)

Note. Average of each variable between January 2010 and June 2015; standard deviation in parentheses. Author's calculations using Superintendencia's database. US $1 = Ch $650.

illustrates the humans' bounded rationality. The elements that would be influencing to perceive this way are the fact that a woman must make a physician appointment first (to get a prescription to mammography), must choose the clinic where to receive screening, and make all steps compatible with her time and budget constraints. To address this, the message should include preprinted personalized maps and directions to local free mammography clinics to reduce the complexity and decision making. Half of the mailers included this information.

Owing to the randomization, a simple comparison of means across intervention and control[29] arms after treatment was done to test the treatment effectiveness (Because each message is assigned orthogonally to all others, it was designed to not have interactive effects, although there could be random but rare contact between women who received different messages. Therefore, it would not be a source of bias.). Outcomes from the field experiment were monitored 5 months after the intervention letters were mailed. To develop a better understanding of the effects of the different messages, we ran several regressions to control for all possible interactions in a single equation (Appendix C and Table C1 in Supplemental Materials found at https://doi.org/10.1016/j.jval.2021.04.1275). Finally, not all mailers were successfully sent because of women moving (Fig. A1 in Supplemental Materials found at https://doi.org/10.1016/j.jval.2021.04.1275). For example, women may have moved between the time they were selected into the treatment groups and the time the letter was delivered. We addressed the imperfect compliance in Appendix D (in

Table 2. Main results—free mammography.

	Number (%) of mammograms		Difference in the number (%) of mammograms between treatment and control group		
	Control (n = 5731)	Treatment (n = 5745)	Mean	95% CI	*P* value
Before	57 (0.99)	61 (1.06)	4 (0.07)	−17 to 25 (−0.3 to 0.44)	.7212
After	65 (1.13)	174 (3.03)	109 (1.89)	79 to 139 (1.37 to 2.42)	.0000

Note. This is the number (percentage within the group) of women receiving a free mammogram for each group before (July 2015 to October 2015) and after (November 2015 to March 2016) the mailing campaign. These are approximated to natural numbers from the estimated percentage in parentheses. The *P* value is between each treatment group and the control group.
CI indicates confidence interval.

Table 3. Free mammography by treatment groups after treatment.

	N	Number (%) of mammograms after treatment	Difference in the number (%) of mammograms between treatment and control groups		
			Mean	95% CI	*P* value
Group 1	714	28 (3.92)	20 (2.79)	13 to 27 (1.86-3.71)	.0000
Group 2	708	26 (3.67)	18 (2.54)	11 to 24 (1.62-3.46)	.0000
Group 3	719	25 (3.48)	17 (2.34)	10 to 23 (1.43-3.25)	.0000
Group 4	712	25 (3.51)	17 (2.38)	10 to 23 (1.46-3.29)	.0000
Group 5	724	19 (2.62)	11 (1.49)	4 to 17 (0.61-2.37)	.0009
Group 6	723	17 (2.35)	9 (1.22)	3 to 15 (0.35-2.08)	.0059
Group 7	722	18 (2.49)	10 (1.36)	4 to 16 (0.49-2.23)	.0023
Group 8	723	16 (2.21)	8 (1.08)	2 to 14 (0.22-1.94)	.0140
Control	5731	65 (1.13)	-	-	-

Note. This is the number (percentage within the group) of women obtaining a free mammogram after (November 2015 to March 2016) the treatment. These are approximated to natural numbers, from the estimated percentages in parentheses. The *P* value is between each treatment group and the control group.
CI indicates confidence interval.

Supplemental Materials found at https://doi.org/10.1016/j.jval.2021.04.1275), using an instrumental variable (IV) approach in which the first stage of the regression measured if the letter was delivered.[29]

Ethics

All participants gave their written informed consent. The ethics committee of Social Sciences and Humanities of the School of Philosophy and Humanities of the University of Chile approved the study protocol on December 16, 2014.

Results

Mean Analysis

A simple comparison of means across treatment and control groups at the end of the second year of the study was estimated. Table 2 shows almost no change in the number of mammograms in the control group over the 1-year study period. In contrast, mammography uptake substantially increased in the treatment group ex post sending the mailers: a difference of 109 (1.89%). Therefore, the treatment group had a 167% higher free mammography utilization rate than the control group; this difference was statistically significant at the 1% level (with a *P*=.000). Before the treatment, there was no identifiable statistical difference in the uptake between the treatment and control groups (*P*=.7212).

To understand message effectiveness, mammography rates were examined for each of the 8 treatment groups (Table 3). There was an increase in mammograms for all groups compared with the control. The results showed increases from 95% (2.21% vs 1.13%; group 8) to 247% (3.92% vs 1.13%; group 1). Nevertheless, statistically, the treatment effects across the treatment groups did not differ from each other, having *P* values between .000 and .014.

Rather than analyzing each of the groups separately, the data were analyzed by incentive type (deadline, map, or doctor), as shown in Table 4. The estimated effects present statistical differences at a 1% significance level (with *P*=.000 each) between each treatment group and the control group. In particular, the mammogram rates increased from 1.13%, for the control group, to 2.97% for the deadline message, 2.42% for the map message, and 2.88% for the doctor message. As before, there were no large or significant differences across the groups.

Discussion

Results and Public Policy Implications

As shown earlier, all strategies worked, increasing the free mammography use rate. We did not detect statistical differences across the 8 treatment groups (with *P* values at approximately

Table 4. Results by type of incentive after treatment.

	N	Number (%) of mammograms after treatment	Difference in the number (%) of mammograms between treatment and control groups		
			Mean	95% CI	*P* value
Deadline	2865	85 (2.97)	53 (1.83)	36 to 69 (1.25-2.42)	.0000
Map	2892	70 (2.42)	37 (1.29)	21 to 53 (0.73-1.84)	.0000
Doctor	2877	83 (2.88)	50 (1.75)	34 to 67 (1.17-2.33)	.0000
Control	5731	65 (1.13)	-	-	-

Note. This is the number (percentage within the group) of mammograms after the treatment (November 2015 to March 2016). These are approximated to natural numbers from the estimated percentages in parentheses. The *P* value is between each treatment group and the control group.
CI indicates confidence interval.

.0005 each). This evidence suggests that the base message and the base message plus several combinations of the 3 incentives (deadline, map, doctor), without exception, were effective in addressing the different hypothesized barriers.

When analyzing the disaggregated effects, the minimal messages (base message and deadline with lottery) performed somewhat better than the more complex ones, even though additional information would address more barriers and be assumed to have more effect. The evidence we found is consistent with conclusions by Sohl and Moyer[19]; simply using personally tailored reminders did address information avoidance. Meanwhile, creating a deadline, through the raffle, seemed to mitigate procrastination. In addition, even if we interpret the nonmap messages (groups 1-4) as low-intensity treatments and the map messages (groups 5-8) as high-intensity ones, because the latter has more personal information, the treatment intensity does not have an impact (same conclusion was reached in Puschel et al[11]) or could somehow be slightly diminishing the other effects.

We found our results were robust to the IV analyses (Appendix D in Supplemental Materials found at https://doi.org/10.1016/j.jval.2021.04.1275). The regressions shown similar results to the mean test and the regression analysis, leaving no doubts regarding the effectiveness of all messages. Nevertheless, the messages that performed slightly better were the base message and the ones that included doctors' recommendations. Note that we already knew medical authorities have an impact on mammogram rates in Chile. As before, the map messages moderately underperform.

Taking into consideration both the main results and the IV analysis, we suggest implementing simple and personally tailored messages to encourage mammography screening, adding incentives as doctor and/or deadlines according to idiosyncratic attributes of the goal population on an as-needed basis. Map incentives are not out of the question, but it would be pertinent to keep the message minimalist and evaluate how intense it can be perceived according to the culture.

A final point to consider is whether the campaign also affected the take-up rate of "copay" option. In that case, an increase could have attenuated the effects on the number of free mammograms. Appendix F (in Supplemental Materials found at https://doi.org/10.1016/j.jval.2021.04.1275) shows that the campaign had no spillovers into the copay mammography market.

Limitations

One limitation is that only women with private health insurance were included. On average, those women are richer and more educated. In addition, approximately 51% of these women had a mammogram in the past year compared with 34% of publicly insured women.[20] This gap is likely due to increased barriers for public insurance, because of the disadvantage in education and income. Nevertheless, because we focus only on the "free" option available to all, it seems likely that similar messages could be generally affective. The treatment effects that we found may be near the lower bound of the true effects, which argues for a similar public policy intervention.

Another potential limitation is related to the timing effect (Appendix E and Table E1 in Supplemental Materials found at https://doi.org/10.1016/j.jval.2021.04.1275) because mail service complications affected when the messages were sent by a few months. Differential delivery could create a potential attenuation bias on the estimated effects for messages delivered toward the end of the year, because January and February are popular vacation months in Chile.[30]

To study the potential bias by timing differences, we ran a panel event analysis for the 8 groups from November 2015 to March 2016 (Table E2 in Supplemental Materials found at https://doi.org/10.1016/j.jval.2021.04.1275). The results were consistent with the application of the treatments but showed slight differences in last months of the study. We checked the results by message and month to understand the importance of timing relative to the message type, finding that there could be a bias from different messages, but not from the timing.

Cost-Effectiveness Analysis

To our knowledge, there is no other study in Chile that found this type of change in individual behavior regarding mammograms. Because breast cancer has become a significant cause of morbidity and mortality among Chilean women, we did a back-of-the-envelope calculation to determine the cost-effectiveness of the intervention (following Van Hout et al[31] and Johannesson and Meltzer,[32] among others). This cost-effectiveness analysis focused on the costs of a mailer campaign to stimulate demand for already available, free, preventive-care mammograms and the cost of the extra mammograms women got because of the campaign.

To construct the cost-effectiveness ratio, we first estimated an annual mammography rate using the numbers in Table 2, finding a 1.9% effect. Assuming that the results would be similar throughout the year, we extrapolated an annual rate. This resulted in an annual difference of 4.56% between the treatment and control groups. This was then multiplied by the size of the treatment sample and by mortality rates from the literature (10%; Nystrom et al[6] studied the screening effects for the age group 49-74 years. Particularly, for the age group 50-59 years [50-61 years in our study], the mortality rate for the treatment group was 28% vs 38% for the control, that is, an average treatment effect of 10%.). We estimate that 27 lives were saved because of this program, at a total cost of US $15 472 (The total cost of the program was calculated by using the price of a certified letter [US $1.5 approximate ~ Ch $1000] multiplied by the treatment group size plus the cost of the induced number of mammograms, 121 [treatment group-control group] multiplied by the average market price of a mammography in 2014 and 2015 [= US $55].). The cost-effectiveness rate of the intervention is US $573 per life potentially saved, with a confidence interval of US $442 to US $774, a result which is significantly cheaper than other types of interventions that are used worldwide.

Conclusions

This study tested the effects of a series of interventions based on behavioral economics on free mammography use in a developing country. They had a large impact and were successful in terms of increasing free mammography use. Based on the intervention results, we argue that 4 hypothesized barriers are faced for women to screening (information avoidance, procrastination, affect heuristic, and choice fatigue) and that with a simple and low-cost intervention based on behavioral economics and psychology, it is possible to increase the number of mammograms. Particularly, we recommend a mailer campaign, consisting of a minimal and personally tailored reminder with doctor recommendation, deadline, and/or map. A widescale application of these strategies has the potential for improving mammography rates and could complement to increase the effectiveness of free mammogram governmental programs.

Supplemental Material

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.jval.2021.04.1275.

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