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The use of breast screening services in NSW: are we moving towards greater equity?

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Introduction: Since 1991 State and Federal Governments, under the auspices of BreastScreen Australia, have been providing mammography services free at the point of delivery to women aged 40 and over. One of the stated aims of the program is to provide equitable access to all women in the target group.

Methods: Data on self-reported utilisation of breast screening services came from the 1997/98 and 2002/04 NSW Health Surveys. Probit regression analysis was used to examine the relationship between income and breast screening behaviour of women in NSW aged 50 to 69.

Results: The results for 2002 and 2004 show that income has a positive and significant impact on the likelihood that a woman chooses to screen for breast cancer at regular intervals. The role of income was consistent across most regions. Women born overseas have a lower likelihood of screening regularly. Results from the pooled dataset show that the income gradient appears to be steeper in 2002/04 compared to 1997/98.

Conclusions: These results indicate that the current program has not ensured equitable take-up of mammography services and that further research and investment is needed to meet program objectives.

Introduction

Breast cancer is the most common cancer and a leading cause of death among women. There is strong evidence that the early detection and treatment of breast cancer has a positive impact on survival. Therefore, many countries have introduced national programs to encourage women to undertake regular breast screens. The aim of such programs is to reduce the mortality and overall burden of disease attributable to breast cancer.

In Australia, a national breast screening program was introduced in 1991. Under the program, all women aged 40 and over are eligible to be screened every two years either at zero or at minimal cost to women[1]. The program is particularly targeted at women in the 50-69 year age group. It aims to increase coverage of breast screening among women in this age group and targets these women through additional recruitment strategies such as sending them promotional materials and letters of invitation to encourage attendance. Such recruitment strategies inform, emphasise and remind women about the importance and timeliness of screening and are aimed at changing the perception or expectation of benefits associated with service utilization. No referral by a physician is required but, if she consents, a woman's general practitioner is provided with the results of the screen.

The BreastScreen Australia program is jointly funded by the Federal and State and Territory governments. The eight State and Territory Government are responsible for operational and implementation matters and the federal government coordinates policy and standards and oversees accreditation of services. Under the auspices of national program, BreastScreen NSW manages and provides mammography services in 132 local government areas (out of 172) via a mixture of fixed, relocatable and mobile screening units covering both densely populated metropolitan populations and more scattered rural and remote populations. The first screening units became operational in 1989 and state-wide coverage was achieved in 1995.

Each state's and territory's breast screen service abides by a set of nationally determined program objectives and measures (Australian Institute of Health and Welfare 2000). Two

[1] The program does not offer mammography services for diagnostic purposes. Diagnostic mammograms are usually provided in the private sector and subsidised by the Medicare program

program objectives are relevant in the context of participation. Firstly, the program aims to achieve a participation rate of 70% amongst women aged 50 to 69 years. Secondly, the national policy states that the program selects women for screening on the basis of age alone[2]. This implies that participation rates should not be systematically related to any ethnic, economic or geographic factors. This paper provides a new analysis of how the BreastScreen program has performed against this second objective using pooled data from the 1997/98, 2002 and 2004 New South Wales Population Health Survey (NSW Population Health Survey (HOIST) 2002/04). Before turning to this analysis we will first review Australia's overall performance in terms of participation in breast screening.

Breast screening participation in Australia: a review

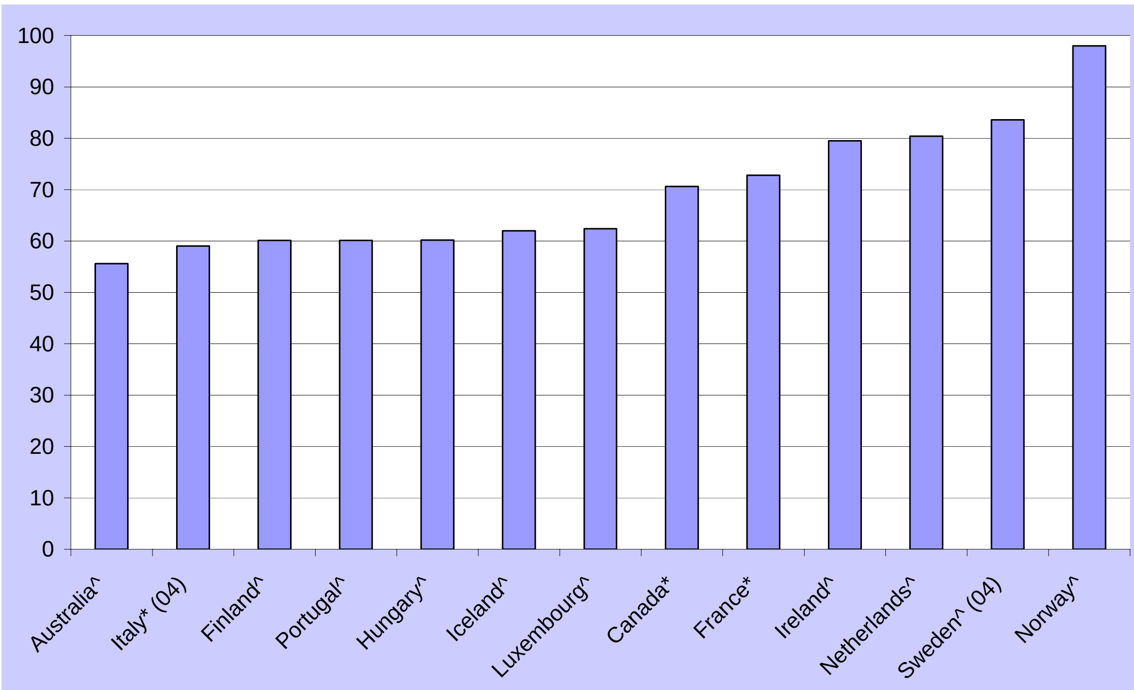
As part of the BreastScreen Australia program, services collect administrative data on participation and these are reported bi-annually by the Australian Institute for Health and Welfare (AIHW). The trend amongst women in the target age group between 1996 and 2002 was positive with participation rates improving from 50.4% to 57.1% - still well short of 70% policy target. More concerning is that since 2002 there has been a downward trend with the most recent data showing that participation rates fell to 55.6% in Australia (Australian Institute of Health and Welfare 2007). Compared to the national average, screening rates in NSW have been consistently lower but have exhibited similar trends over time. The latest figures show a participation rate of 50.1% for 2003-04, after having reached 53% in 2001-02.

By international standards, Australia's breast screening participation rates appear to be low. To enable direct comparison, we selected OECD countries on the basis of (1) having data for either 2003 and 2004 and, as far as we can tell, having similar methods of analysing these data (i.e. the numerator is given by the number of women in the target age range who screened in the last two years). The denominator is the total number of women in the age group. Figure 1 shows that Australia ranks at the bottom of the list with 55.6% participation rate whereas the corresponding

[2] From an epidemiological perspective, important variations in risk may occur within the target-age group related to hereditary or other factors. However, the program was not concerned with identifying and implementing priority groups within this target age group. Instead, the program's objectives and policies imply that each woman in the age group is deemed to be of equal priority

figure in Norway is 98%. It should be noted that three of the countries listed use survey data to compile participation rates (Italy, Canada, and France). Survey data have historically shown higher participation rates than program data (King, E. S., Rimer, B. K. et al. 1990; Gordon, N. P., Hiatt, R. A. et al. 1993).

Figure 1: Percentage of women participation in breast screening program (target age group) 2003 - selected OECD countries

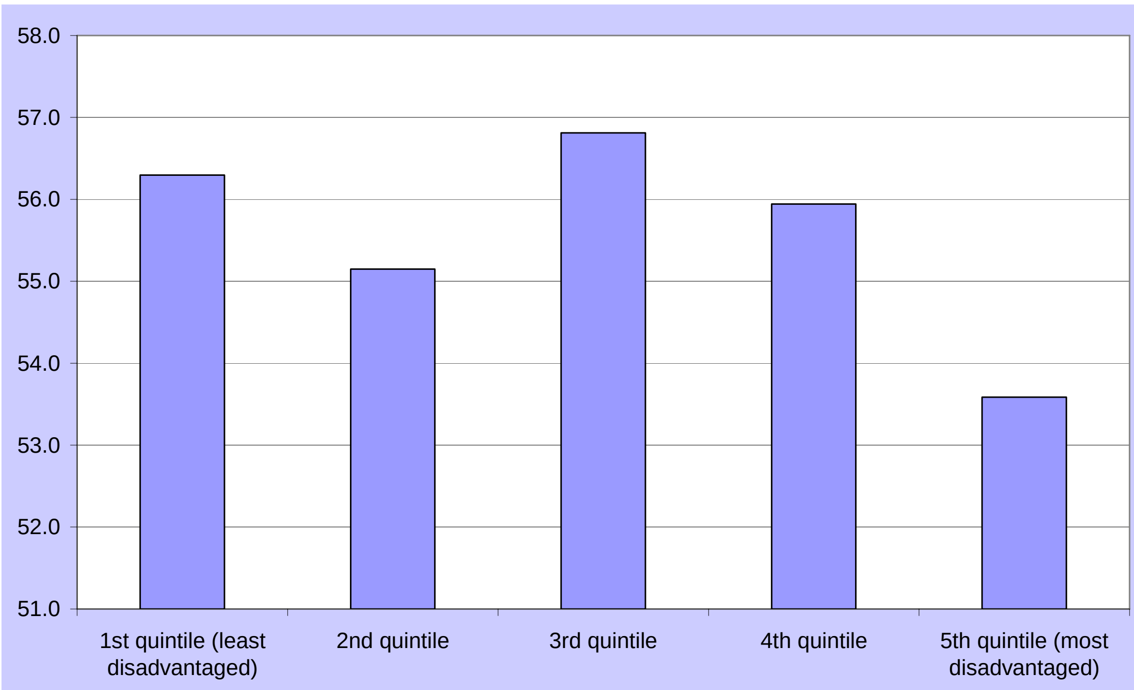


^program data; * survey data. Source:(OECD 2007)

As far as the second participation objective is concerned, program data from 2003 and 2004 shows significant variation in participation amongst women. Participation varies depending on which type of region a women lives (e.g. metropolitan, rural, remote etc) as well as the socio-economic status of the area. Furthermore, non-English speaking women and women from Aboriginal and Torres Straight Islander backgrounds are far less likely to screen (Australian Institute of Health and Welfare 2007).

Using program data (Figure 2), the AIHW reports significant variation in participation rates between socio-economic groups but there is no discernable pattern. In 2003-04, women living in the most disadvantaged areas were least likely to screen whereas women in the third quintile were the most likely to screen. Furthermore there is no discernable difference between the least disadvantaged (Q1) and the second most disadvantaged group (Q4).

Figure 2: Percentage of women participating in BreastScreen Australia program amongst 50-69 year olds by socioeconomic status, 2003–2004



Source: (Australian Institute of Health and Welfare 2007)

A previous analysis of the 1997/98 NSW Health Survey data, using women's self-reported breast screening participation, revealed a more discernable pattern. This analysis showed that socio-economic status, measured by imputed income, was positively and significantly related to the likelihood of screening (Birch, S., Haas, M., Savage, E. and Van Gool, K., 2007). By contrast, Taylor et al (2003), found that amongst women aged 50-69, high income earners were more likely to have never screened. However, this result may be confounded by the fact that younger women in the cohort are more likely to have never used mammography and may also have higher incomes. Taylor et al (2003) also found that women with annual household income of $40,000 or higher were less likely to regularly screen through the BreastScreen NSW program (compared to those on less than $40,000). However, this group was more likely to use mammography services outside of the BreastScreen NSW program (i.e. Medicare funded private services).

Previous studies have some important limitations. Results based on program data are limited by (1) the use of ecological socio-economic status (SES) assigned to women participating in the program (as opposed to personal data on household income); (2) the practice of reporting results in broad categories (quintiles of SES) thereby reducing potential variation in the variable of interest and (3) only reporting one-way analysis (as opposed to multivariate analysis) thereby not taking account of other factors (e.g. regional characteristics) that may bias the results. The study by Birch et al (2007) was restricted by the lack of income data in the 1997/98 NSW Health Surveys – which the authors attempted to overcome by imputation, using available socio-economic variables. The study by Taylor et al (2003) only contained two income brackets (more or less than $40k annual household income). Furthermore, the result showing that high income earners were less likely to screen through the BreastScreen program was negated by their greater use of Medicare funded services – although the extent to which this affects the results is not clear.

The next section of this paper will investigate the presence of systematic variation amongst various sub-populations within the target-age group (aged 50-69). In particular, this analysis investigates (1) the role of income (2) the effect of living in metropolitan, rural and remote areas and (3) the importance of being born overseas on the probability that a woman is a regular screener. We also investigate whether the role of income in predicting utilisation in 2002/04 has changed since 1997/98. As part of our analysis we used the NSW Population Health survey because it contains individual unit data on mammography participation, socio-economic status – including household income - and locality (NSW Population Health Survey (HOIST) 2002/04).

Methods

Analytical model: Suppose that an individual will choose to screen if utility is greater with screening than without. Let V_1^* be the difference between utility with screening and without. This difference is not observed, but is assumed to arise from the model

$$V_1^* = \beta' \mathrm{X} + \varepsilon$$

where $\varepsilon \sim N(0,1)$, β is a $k \times 1$ vector ($\beta_1 \; \beta_2 \ldots \beta_k$) of parameter estimates and X is $k \times 1$ vector ($x_1 \; x_2 \ldots x_k$) of explanatory variables, also suppose that V_1^* may be influenced by X.

What is observed however is whether an individual screens or not, that is

$$S = \begin{cases} 1 & if \; V_1^* > 0 \\ 0 & if \; V_1^* \leq 0 \end{cases}$$

This gives rise to the probit model which is specifically suited for limited dependent variables. The probit model estimates a model using maximum likelihood based on the above unobservable utility index V_1^*. The probability of a positive response – an individual chooses to screen is given by

$$\text{Prob}(S = 1 \mid x_1 \ldots x_k) = \Phi(\beta' \text{X})$$

where $\Phi(\cdot)$ denotes the standard normal cumulative distribution function.

An estimated probit coefficient (β_i) indicates how a unit change in the explanatory variable will impact on the probit index measured in units of standard deviations. The results are more easily interpreted in terms of marginal effects. Marginal effects are the change in predicted probability associated with changes in the explanatory variables. For continuous explanatory variables, the marginal effect indicates the impact on the probability of being screened associated with a unit difference in x_i when all other variables are set to their baseline values. When x_i is continuous,

$$ME(x_i) = \frac{\partial \text{Prob}(S = 1 \mid x_1 \ldots x_k)}{\partial x_i} = \frac{\partial \Phi(\beta' \text{X})}{\partial x_i} = \beta_i f(\beta' \text{X})$$

where $f(\cdot)$ is the standard normal probability density function.

Where categorical data are entered using simple 0 -1 indicator variables, the marginal effect is the difference in probability of screening from changing x_i from 0 to 1, holding all other variables at their baseline values. When x_i is a dummy

$$ME(x_i) = \frac{\Delta \text{Prob}(S = 1 \mid x_1 \ldots x_k)}{\Delta x_i} = \Phi[\beta' \text{X} + \beta_i(1)] - \Phi[\beta' \text{X} + \beta_i(0)] = \Phi(\beta' \text{X} + \beta_i) - \Phi(\beta' \text{X})$$

where $\Phi(\cdot)$ is the standard normal cumulative distribution function.

Data: The 2002 and 2004 NSW Population Health Surveys were the main source of data. The NSW Population Health Survey is an ongoing annual health surveys which use computer-assisted telephone interviewing (CATI) to study a random sample of residents in every health district (Area Health Service) in NSW aged 16 years and over living in households with private telephones. In addition, we also used the Centre for Epidemiology and Research's Health Surveys from 1997 and 1998. These surveys were a precursor to the Population Health Surveys. Questions in the survey covered a wide range of topics relating to health and illness, health risks and health care utilisation together with background information relating to social and demographic characteristics.

The 1997, 1998, 2002 and 2004 surveys asked women aged 40 to 79 questions relating to (1) whether they ever had a mammogram; (2) time since last mammogram; (3) the reason for the last mammogram; and (4) whether they have mammograms regularly. Responses to these questions were used to create the dependent variable of women who were regular screeners. All women aged 50 to 69 were included in our analysis except those who indicated that their last mammography was for diagnostic purposes[3]. A woman was defined as a regular screener if her last mammogram was less than two years ago. In addition, we classified women as regular screeners if they had their last mammogram between two and three years ago and also reported that they had a mammogram regularly.

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[3] Women who undergo a mammogram for diagnostic purposes are eligible for subsidies under the Medicare but not the BreastScreen Australia program. Mammograms were classified as diagnostic if the respondent stated their last mammogram was because of (1) history of breast cancer, and/or (2) breast problems or symptoms at the time the mammogram is taken.

For the 2002 and 2004 surveys, a continuous household income variable was generated by taking the midpoints of six household income ranges from the survey expressed in terms of thousands and transformed into logarithms. Our decision to use Income-log was to allow for non-linearity in the association between utilisation and income. Women who reported that they did not know which household income group they were in or refused to disclose their household income (22% of women) were dropped from the analysis.

As stated previously, the 1997/98 surveys did not ask respondents to state their household income and therefore imputed income was used. For further information on how income was imputed see Birch et al (2007).

To ensure greatest possible consistency between the 1997/98 and 2002/04 income data, we categorised the imputed income variable into six groups. Women were allocated according to matching household income groups and distributed proportionally into corresponding 2002/04 income categories. Identical procedures for the 2002/04 income data were then applied to the 1997/98 survey.

The type of region women resided in was included in the analysis using the accessibility/remoteness index of Australia (ARIA). The ARIA variable allocates individuals into one of five categorical groups with higher quintile values assigned to those women living in less accessible areas. See Table I for variable definitions.

Analysis: Three probit models predicting the probability of having a regular screening mammogram for women in the target-age group were estimated. Model 1a and Model 1b both used the 2002/04 survey data. The independent variables in model 1a were a continuous log-income variable, a categorical variable on whether a woman was born overseas and five categorical variables on the place of residence based on ARIA quintiles. The equation was re-estimated with five interaction terms consisting of ARIA quintile and household income (Model 1b). Model 2 used a pooled data set (2002/04 and 1997/98 surveys), commensurate with Model 1a as well as having survey year dummies interacted with household income. Classification tables were then used to report the frequencies with which the models correctly predict whether a woman regularly screens or not, as well as the proportion of overall correct predictions which, when expressed as a percentage, is a measure of goodness-of-fit.

The coefficients in the probit models, once transformed to marginal effects, estimate the impact of the explanatory variable on the probability of utilisation compared to the base case. For all models the base is a woman born in Australia with a household income equal to the mean of all women in the 50-69 age group ($35,500 per year for the 2002/04 survey and $31,500 for the 1997/98 survey) and living in ARIA quintile 1 (highly accessible). The comparison is made in terms of the separate impacts of an extra $1,000 per year of household income, not being born in Australia and living in a less accessible ARIA quintile compared to quintile 1

The specific research questions addressed in this paper are as follows:

Does household income, being born overseas or locality explain variation in reported use of regular breast screening?

The null hypothesis was that the impact of the variables of interest is not significantly different from zero. Rejection of the null would indicate that age is not the only determinant of participation. Furthermore a positive and significant coefficient for income would provide evidence of systematic inequity in the use of breast screening services.

Does the association between utilisation and household income vary among geographical divisions?

This question was considered by introducing interactions between ARIA quintiles and household income into the previous model. A Wald test was used to determine whether any of the interacting terms are equal to each other. The null hypothesis was that the interaction terms are statistically equal to each other. Rejection of the null hypothesis would indicate that the importance of household income varies depending on region.

Does the association between utilisation and household income vary through time?

This question was considered by pooling 1997/98 and 2002/04 surveys and introducing two interaction terms to the basic model (Model 1a): income log variable interacted with a 97/98 and

02/04 survey year dummy. A Wald test was used to determine whether the two interaction terms are equal to each other. The null hypothesis was that over time income has become either less or no more important in predicting utilisation. Rejection of the null hypothesis would indicate that the household income gradient has become steeper over time and therefore income has become more important in explaining utilisation.

Results

Table 2 shows the mean and standard deviation for each variable for women in the target-age group for the 2002/04 and 1997/98 pooled surveys respectively.

Tables 3 to 5 shows the coefficient and marginal effects for model 1a, 1b and model 2 respectively. Coefficients and marginal effects significant at the 5% level are indicated. Standard errors for the marginal effects were obtained by the Delta Method (Anderson, S. and Newell, R. G. 2003). Table 6 reports the proportion of correct classifications for each model[4]. :

Does household income, being born overseas or locality explain variation in reported use of regular breast screening?

In model 1a (see Table 3) the coefficient for income log was positive and significant ($p < 0.01$). At the mean household income level ($35,450) an extra $1,000 increased the probability of screening by 0.11%. The set of ARIA quintiles variables were not significantly different from zero. However, being born outside Australia significantly reduces the probability of regular screening by 8.4%. We therefore reject the null hypothesis but there is evidence that under the ARIA quintile definition of region, a woman's place of residence had no impact on the probability of her screening regularly.

Does the association between utilisation and household income vary among geographical divisions?

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[4] We chose threshold values $\tau_{97/98} = 0.67$ and $\tau_{02/04} = 0.74$ such that the predicted probability of screening regularly $\tilde{y} = 1$ when $\Phi(\beta' \mathrm{X}) > \tau$ and $\tilde{y} = 0$ when $\Phi(\beta' \mathrm{X}) \leq \tau$. These threshold values was chosen because the rates for regular screening for the two pooled survey is 67.2% and 73.7% respectively and we want of the fraction of $\tilde{y} = 1$ in the sample to be the same, or very close to, $\bar{y}$.

The ARIA quintiles and income interaction terms were added to the model and their coefficients reported in Table 4 (Model 1b). A joint test of the interaction terms reveals that the null hypotheses can be rejected and that the role of income varies by ARIA ($p < 0.05$). However, the fifth ARIA quintile (very remote)
is the only region where income played a significantly different role than in ARIA quintile 1 – the role of income in all other ARIA quintiles was not different. Given the lack of significance of the interaction terms, no marginal effects were calculated for this model.

Does the association between utilisation and household income vary through time?
Table 5 shows the results for Model 2. The coefficients and marginal effects for both the income-log 97/98 and income-log 02/04 variables were significant and positive, indicating systematic inequity in participation rates. The Wald test showed that these coefficients were significantly different from each other ($p<0.01$), and as indicated by the relative size of the marginal effect, the income gradient was steeper in 2002/04. This latter result provides evidence of greater inequity over time and therefore we can not reject the null hypothesis.

In terms of model performance, Model 1b performs slightly better than model 1a with a higher pseudo R^2 (0.0127 compared to 0.009), with Model 2 having a pseudo R^2 of 0.0122. The percentage correctly predicted by the models is consistent for all 3 models (see Table 6).

Discussion

This paper utilised unit record data (including self-reported household income) to analyse systematic variation in screening mammography participation. It found that in 2002/04, income was positively related to the likelihood of a woman regularly screening, people born overseas were less likely to screen and that the region type in which a woman resides has no impact on her probability of screening. Furthermore, the role of income does not seem to differ according to which region a woman lives in, apart from those living in very remote parts of the state. These findings re-affirm our previous research using 1997 and 1998 survey data. Furthermore, there is some evidence that the role of income in predicting participation was more important in 02/04 than in 97/98, suggesting greater income related inequality over time.

Of note is the is that the participation rates based on program data (and as reported in Figure 2) are considerably lower than those reported in the NSW Health survey – based on self-reported use (55.6% versus 73.7%). There may be several explanations for this apparent discrepancy. Firstly, survey data may be capturing mammograms provided under the Medicare program in addition to those provided by BreastScreen Australia. In 2003 and 2004 Medicare subsidised over 650,000 mammograms to Australian women and it is feasible that a proportion of these may be reported in the survey data. Secondly, women's recall of whether their last mammogram occurred in the last two years may be imprecise and thirdly, respondents may be over-stating their mammography use. It is of course also possible that the program data are imprecise. Given the large discrepancies in participation rates between program and survey data care should be taken in judging performance on overall participation rates.

Despite the difference in participation rates between self-reported and program data, survey data may still be valid for use in analysing potential systematic variation in participation as long as there was no systematic variation in over (or under reporting) amongst sub-populations. A study by Zapka et al (1996) compared self-reported mammography use with program data and found no biases in self-reporting accuracy amongst women of various age, income or education. This supports the use of survey data for current purposes.

It should also be noted that when comparing the role of income between the 1997/98 to 2002/04 datasets we were reliant on imputed income for the former dataset. Adjustments were made to make the two income variables as comparable as possible. Nevertheless, the imputed income data may differ from self-reported household income. Finally, the use of ARIA quintiles is a broadly defined variable of region. There may well be significant variation within ARIA quintiles that are not captured in the models.

On economic grounds, there are two potential reasons that could explain the systematic variation in women's use of screening mammography found in our study. Firstly, the opportunity cost of screening may differ across regions and socio-economic groups. Even though price at the point of delivery is zero, this only removes one barrier to access and other aspects of the opportunity cost (or shadow price) of utilisation remain unaffected. For example, the opportunity cost of travelling to (and waiting at) the point of delivery may be greater among some population groups and/or in some regions. As a result, utilisation may be influenced by non-price factors, which determine the opportunity cost (or shadow price) of utilisation.

Secondly, women's perceptions of the utility (and disutility) of screening may differ. Women with relatives or friends with breast cancer may be more motivated to screen than those who do not have any direct experience of the disease. Alternatively, women's preferences over the short-term inconvenience and the long term benefits may also be different. Such factors may explain why some women screen and others do not. However, it does not explain why we observe systematic variation amongst certain groups. For systematic variation to occur on the basis of differences in preference a second condition needs to be met. That is, there would need to be some homogeneity of preferences amongst similar (socio-economic) groups and heterogeneity of preferences amongst different groups. For example, women in lower socio-economic groups may place a higher weight on the short term disutility of screening compared to those in higher socio-economic groups.

If inequities in service use are to be reduced, the appropriate policy response will depend on the underlying reason for the systematic variation. If the first reason (opportunity cost) is a cause of systematic variation, the policy response should aim to standardise such costs including travel and waiting times. On the other hand if the reason for inequity is women's preferences the appropriate response will include targeted information about the benefits of the program, recruitment and follow-up activities to specific population groups who are known to under utilise services[5].

The international literature provides decision makers with evidence about which policies are effective in raising overall participation and reducing inequities. In a systematic review of the literature, Legler et al (2002) showed that a*ccess enhancing* interventions (e.g. mobile vans, same-day appointments and removal of financial barriers) increased participation on average by

[5] To increase overall participation rates (rather than remove systematic variation), the policy response would be to reduce opportunity costs and to increase awareness and recruitment activities for all women.

18.8% and *individual directed* interventions (e.g. physician recommendations, counselling, reminders and bilingual program materials) improved participation by 17.6%. Interventions that combined elements of both interventions improved participation rates by 26.9% (Legler, J., Meissner, H. I. et al. 2002).

A US study analysed the impact of an access enhancing intervention (mobile van) in addition to an education program compared to an education only program. The overall results show participation rates for the access and education versus education only of 55% versus 40% (P<0.001), respectively. Importantly, the difference was significant amongst those with incomes of less than $20,000 (55% versus 36%; p<0.002) but not for those on more than $20,000 (Reuben, D. B., Bassett, L. W. et al. 2002). This suggests that access enhancing interventions may be particularly effective for low income women.

However, it should be noted that these results were usually achieved alongside a ‘do-nothing’ alternative. A recent paper by Page et al (2006) found that substantial improvements in participation rates may be more difficult to achieve in the presence of an existing program. Furthermore, the additional costs associated with introducing interventions aimed at increasing participation have to be compared with the potential benefits foregone.

This paper has shown that the BreastScreen program is faced by a dual challenge. Firstly, on the basis of program data, the participation rate is well below the program target of 70% amongst women aged 50 to 69. Furthermore, more recent data suggest that participation rates are declining. Secondly, on the basis of survey data, there is systematic variation in participation rates amongst women born overseas (compared to those born in Australia) and there is evidence of a positive relationship between income and regular breast screen participation. However, the program can claim some success in eradicating systematic variation across ARIA quintiles – a noteworthy achievement in a large state such as NSW. Further research is needed to aid future decisions about the most effective and efficient methods to fulfil the program’s aims.

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Table 1: Variables and definitions used in the study

Variable	**Definition**
Regular Screener	1 = At least one mammogram obtained for screening purposes in the last 3 years on a regular basis. 0 = Women who never had a mammogram or who screened more than 3 years ago
Income–log	Household income per year in logarithmic form. Individual's approximate household income are allocated in the following ranges: Less than $10,000 (midpoint : 5) $10,000 to $20,000 (midpoint : 15) $20,000 to $40,000 (midpoint : 30) $40,000 to $60,000 (midpoint : 50) $60,000 to $80,000 (midpoint : 70) More than $80,000 (midpoint : 95)
non Australian–born	1 = Women who were not born in Australia. 0 = Women who were born in Australia
ariaQ1	1 = Remoteness Quintile 1 : Highly accessible – relatively unrestricted accessibility to a wide range of goods and services and opportunities for social interaction. 0 = Otherwise.
ariaQ2	1 = Remoteness Quintile 2 : Accessible – some restrictions to accessibility of some goods, services and opportunities for social interaction. 0 = Otherwise.
AriaQ3	1 = Remoteness Quintile 3 : Moderately accessible – significantly restricted accessibility of goods, services and opportunities for social interaction. 0 = Otherwise.
ariaQ4	1 = Remoteness Quintile 4 : Remote – very restricted accessibility of goods, services and opportunities for social interaction. 0 = Otherwise.
ariaQ5	1 = Remoteness Quintile 5 : Very remote - very little accessibility of goods, services and opportunities for social interaction. 0 = Otherwise.
income9798_log	1997/98 year dummy interacted Income-log
Income0204_log	2002/04 year dummy interacted Income-log
ariaQ1xinc	Remoteness Quintile 1 interacted with Income-log
ariaQ2xinc	Remoteness Quintile 2 interacted with Income-log
ariaQ3xinc	Remoteness Quintile 3 interacted with Income-log
ariaQ4xinc	Remoteness Quintile 4 interacted with Income-log
ariaQ5xinc	Remoteness Quintile 5 interacted with Income-log

Table 2: Means and standard deviation of variables

	2002/04 (age 50 - 69)		1997/98 (age 50 - 69)	
	Mean	**StDev**	**Mean**	**StDev**
Regular Screeners	73.73%	44.01%	67.19%	46.56%
Household Income ($'000 p.a.)	35.49	27.08	31.54	24.97
Non-Australian Born	18.97%	39.21%	20.35%	40.26%
Aria Quintile 1	46.44%	49.88%	59.68%	49.06%
Aria Quintile 2	29.63%	45.67%	28.53%	45.16%
Aria Quintile 3	17.12%	37.67%	9.00%	28.61%
Aria Quintile 4	6.21%	24.14%	1.98%	13.93%
Aria Quintile 5	0.61%	7.793%	0.82%	9.02%
Observations	3,605		5,248	

Table 3: **Model 1a**

Variable	Coefficient	Base case/mean	mfx dy/dx
income_log	0.117 *	35.45	0.0011 #
ariaQ2	0.052	0	0.0162
ariaQ3	0.034	0	-0.0108
ariaQ4	-0.071	0	-0.0233
ariaQ5	-0.021	0	-0.0067
Non Aust born	-0.244 *	0	-0.0837 #
_cons	0.292 *	1	

Log *L*	-2055.3437
Observations	3,605
Pseudo R^2	0.0099

Notes: * Coefficient significant at the 5% level

Marginal effect significant at the 5% level

Table 4: **Model 1b**

Variable	**Coefficient**
income_log	0.109 *
ariaQ2	0.146
ariaQ3	-0.178
ariaQ4	-0.598
ariaQ5	3.673
Non Aust born	-0.245 *
ariaQ2xinc	-0.030
ariaQ3xinc	0.067
ariaQ4xinc	0.177
ariaQ5xinc	-1.128 *
_cons	0.319 *

Log *L*	-2049.6262
Observations	3605
Pseudo R2	0.0127

Notes: * Coefficient significant at the 5% level

Table 5: **Model 2**

Variable	Coefficient	Base case/mean	mfx dy/dx
income9798_log	0.089 *	31.54	0.0007 #
income0204_log	0.145 *	35.49	0.0010 #
Non Aust born	-0.207 *	0	-0.0550 #
ariaQ2	-0.088	0	-0.0221
ariaQ3	-0.101	0	-0.0256
ariaQ4	-0.15	0	-0.0388
ariaQ5	-0.149	0	-0.0387
_cons	0.257 *	1	

Log *L*	-5352.9866
Observations	8853
Pseudo R2	0.0122

Table 6: **Classification tables**

	Model 1a		Model 1b		Model 2	
	$\hat{y}=0$	$\hat{y}=1$	$\hat{y}=0$	$\hat{y}=1$	$\hat{y}=0$	$\hat{y}=1$
$y=0$	465	1050	501	1128	1360	2487
$y=1$	482	1608	446	1530	1309	3697
Proportion of correct classification	$\frac{465+1{,}608}{3{,}605}=0.575$		$\frac{501+1{,}530}{3{,}605}=0.563$		$\frac{1{,}360+3{,}697}{8{,}853}=0.571$	