7-2004

Individual and Regional Determinants of Mammography Uptake

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INDIVIDUAL AND REGIONAL DETERMINANTS OF MAMMOGRAPHY UPTAKE

Running Title: **Determinants of Mammography Uptake**

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ABSTRACT

Background: Analysis of mammography utilisation has traditionally been performed from an individual level perspective. The purpose of this study was to explore the combined influence of individual and regional level determinants of mammography utilisation.

Methods: Logistic hierarchical multilevel modelling was used to investigate the influences of region of residence and individual characteristics on mammography utilisation. Socioeconomic status information about health planning regions was derived from the 1996 Canadian Census. Individual level information was extracted from the 1996 National Population Health Survey.

Results: After controlling for individual level education, regions with fewer high school graduates had lower levels of mammography utilisation. A cross-level interaction between regional level education and individual level social involvement was found. Other individual level variables associated with screening confirmed previous literature findings.

Conclusion: Higher levels of participation in social activities modifies the detrimental influence of living in a less educated region on mammography utilisation. The study findings challenge the current research perspective on mammography screening focussed on individual level determinants of uptake. For program planners, the study highlights the importance of multilevel, synergistic strategies to possibly achieve higher levels of screening.

Key Words: Multilevel; Context; Health Region; Public Health; Mammography; Canada

Acknowledgements

Kothari would like to acknowledge the financial support, by way of doctoral fellowships, provided by The Canadian Institute for Health Research and the Centre for Health Economics and Policy Analysis during the development of this study. Additional support was provided by Drs. G. Browman, C. Charles and G. Norman.

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INTRODUCTION

Mammography screening is an effective strategy for the early detection of breast cancer in women of particular age groups.[1] In Ontario, mammography is available through self-refer, or through physician referral, to a publicly-managed Ontario Breast Screening Program (OBSP) site. Alternatively, privately-managed screening sites can be accessed by physician referral. It has been reported that the OBSP needs to screen 70% of women older than 50 years of age to achieve a 40% reduction in breast cancer mortality.[2] However, in 2000/01 the OBSP screening participation rate for Ontario women, age 50 – 69, was 19.6%.[3] Previous research has identified several factors associated with higher mammography uptake: higher socio-economic status in terms of education, employment and income; speaking English, or of Caucasian background; age 50-69; involvement in social networks; other preventive health behaviours, such as obtaining Pap smears or conducting self-breast exams; having had a previous mammogram; having a regular physician; and having health insurance coverage.[4-10] In terms of barriers to screening, women from rural areas; those with low self-esteem; low sense of control; and those who smoke are less likely to utilise mammography screening.[5,8,11] Missing from these analyses is consideration of the role of contextual characteristics on mammography utilisation, and on the relationship between individual level factors and mammography utilisation. Consequently, efforts to recruit women to screening sites rely on behavioural interventions but potentially miss broader level determinants of utilisation.

The purpose of this study was to analyse the combined influence of individual and regional level determinants of lifetime mammography uptake. One motivation for such an

approach can be traced to the determinants of health literature, which questions the narrow, often medically-focussed interventions enlisted to achieve better health outcomes. Broader frameworks draw attention to the social, physical and economic influences on health and health related behaviours.[12] A second motivation comes from empirical work in other areas that incorporate contextual influences including studies on smoking, drinking, low birthweight, cardiovascular disease, and health status.[13-18] An understanding of the multilevel and cross-level influences on mammography screening can assist in the development of more effective interventions to encourage program participation.

METHODS

Data Sources and Sampling

Individual and regional data were required for this multilevel study. Statistic Canada's 1996 National Population Health Survey (NPHS) was used to obtain all individual level data of interest.[19] The Ontario portion of the NPHS is available as a separate datafile; permission to use this file was granted to the first author by the Ontario Ministry of Health and Long-Term Care. All Ontario women age 50-69 were selected from the 1996/97 Ontario Health Survey Datafile (n = 4,773).

The 1996 Canadian Census was used to obtain regional level variables to correspond with responses in the 1996 NPHS. The regions selected for the analysis reflected the provinces' public health agency boundaries (n = 23), as mammography screening education and recruitment are mandatory responsibilities of these agencies in Ontario.[20] Recent studies have demonstrated area-level socio-economic effects on health outcomes,[13,16,18] prompting us to select socio-economic status information about each census division in Ontario (n = 60). Statistics Canada

provided data to manually link the census divisions to the public health/health planning regions; census divisions belonged to one and only one region.

The selected sample from the NPHS ranged from a high of 464 to a low of 143 women per region, with an average of 207 women per region (unweighted). This is in-line with the recommendation that 25 units in each of 25 groups are desirable for sufficient variation at each level of data for the multi-level analysis.[21]

Variables

The dependent variable in this analysis was the dichotomous response to the question: "Have you ever had a mammogram, that is, a breast x-ray?" in the 1996 NPHS. Non-responders were included in the "no" category. Information on screening in the last two years, a period that conforms to current Ontario guidelines for mammography screening, would have been preferable. Although a question on screening in the last two years was asked in the NPHS, the numbers of women responding yes to this question were too small in some regions to provide the basis for reliable estimations.

The variables used to explain variations in the incidence of mammography utilisation were: marital status, Canadian born or years since immigration, education level, ever having had one's blood pressure taken, frequency of physical activity, smoking, alcohol consumption, ever having had a Pap smear, conducting breast self-examinations, having a regular physician, number of consultations with a health professional in the past year, perceived social support, social involvement, self-rated health and age. Age, had a dual purpose: to represent an established risk factor for breast cancer, and to adjust for the greater number of years in the age group for which mammography considered appropriate. All variables had valid responses for at

least 95% of the sample. Non-responders were excluded from the analysis. Income was excluded because of a low response rate and resulting variance and confidentiality issues. Most variables had multiple response categories; the most frequent response for each variable was coded as zero and absorbed into the intercept.

Two indicators of regional socio-economic status were used to reflect potentially different dimensions of the construct; the employment-population ratio, among adults; and the percentage of the adult population without a secondary school graduation certificate. These variables were centred from the sample mean value, which was absorbed into the intercept.[22]

Statistical Analysis

A preliminary analysis using logistic regression established the significant individual-level determinants of mammography uptake. Subsequent analyses were conducted with logistic hierarchical multilevel modeling (MLM), a statistical technique that supports the exploration of effects arising from individual and contextual levels (as well as cross-level effects) on the outcome. The technique allows for a detailed examination of the *variability* of effects among individuals and across contexts, in contrast to a simple aggregate summary measure of such effects.[22]

First, the individual level variables were incorporated into the model to confirm their influence on mammography uptake. The model estimated average individual-level effects on the outcome across all regions (variance components model). The intercept represents having had a mammogram by a woman 59 years old, married, did not finish secondary school, not an immigrant, non-smoker, had a regular physician had a moderate social involvement score (2 on

scale of 0 to 4), had a Pap smear and conducted breast self-examination (the 'baseline' case). Significant variables were retained in the model, as was age.

The two regional-level variables were modelled separately with the significant individual variables (i.e., regional employment with individual variables – Model A, and regional education with individual variables – Model B) . Separate models were developed because the two regional-level variables were moderately correlated.

Finally interaction effects between regional and individual level variables were estimated. This step explored the conditional nature of health determinants, as variables may have more or less pronounced effects in the presence of other variables.[23]

The multilevel software used for this analysis, MLWin 1.10, contained a defect that prevented the usual incorporation of weights on a sample selected via stratification. Consequently, standard errors may be slightly less conservative than obtained using weighted data. The MLWin software relies on a linear approximation based on a Taylor series expansion for an iterative generalised least squares estimation. [24]

RESULTS

Nearly 80% of the study sample (Ontario women between the ages of 50 - 69 years in NPHS) reported having had a mammogram in their lifetime. Table I presents the distribution of the individual and regional level characteristics in the sample.

The individual-level variables that demonstrated statistical significance ($p \leq 0.05$) are identified in Table II. Age failed to demonstrate significance but was retained to adjust for increased opportunities to have had a mammogram. Having a college or university degree was

also retained to guard against the claim that estimated regional level education effects are the result of a misspecified individual level model. The intercept value, 0.86, represents the estimated proportion of baseline women who reported having had a mammogram in Ontario, across all regions. The overall model was significant using the Wald joint chi-squared test .[25]

Table III presents the findings of Models A and B. Introduction of regional-level variables had little effect on the estimated coefficients for the intercepts and independent variables (only regional coefficients for regional variables are shown in Table III). Model A failed to detect a significant influence of regional employment on mammography uptake. On the other hand, Model B, which considered the region=s educational level, was significantly associated with mammography uptake. Regions with fewer high school graduates have lower levels of mammography utilisation, after controlling for variation in individual-level characteristics. This indicates that individual level education and regional level education had independent associations with mammogram uptake.

Model B was used to examine possible interaction effects. A statistically significant cross-level interaction between regional level education and individual level social involvement was found (Table IV). Moreover, adding the interaction changed the fixed effect of regional-level education from -0.05 (Table III) to -0.11. This suggests that the overall impact of a lower high school graduation rate in a region was two-fold: a direct, downward influence on mammography uptake (fixed effect), and a combined, upward influence on the relationship between social involvement and uptake (cross-level interaction effect).

DISCUSSION

The findings demonstrated that both individual and regional level factors influenced lifetime mammography uptake. Individual level factors associated with mammography uptake were consistent with previous research. Of note was the synergistic, cross-level interaction effect between regional education and social involvement. This implies that the influence of a woman=s increased participation in volunteer activities, associations and religious services modifies the detrimental influence of living in a less educated region on mammography uptake. Other studies have also demonstrated a protective effect attributable to social involvement.[26]

How social involvement and regional education might interact was not specifically investigated in this study. Additional theoretical development and confirmatory work is required on this front. For instance, are social information channels particularly valuable sources of information within less educated regions? If so, is the information 'scientific' or anecdotal? Frohlich and colleagues suggest the need for determining the meaning of the interactions between social structure and behaviour for individuals.[27] In this case, however, it is questionable whether a woman would even know that her region is more or less educated, in spite of her social participation.

Regional socio-economic influences might "work" by limiting or enhancing the choices available for a woman to support good health and health behaviours. This study supports this general concept as advantaged areas positively influenced mammography uptake after controlling for individual (or compositional) differences in regional populations. In effect, these findings challenge the current theoretical perspective on mammography screening focussed on individual level accounts of uptake. Public health researchers might now be stimulated to broaden the conceptualisation of the issue to include the effects of community level social and political structures on participation in mammography programs. By under-appreciating the

circumstances in which behaviours take place, researchers might overestimate the success of interventions.

This study might point to future directions for mammography program planners. The analysis underlined some "pressure points" that could be used to increase levels of screening (the individual and contextual-level variables discussed earlier). For greater applicability, however, future research might aim to replicate the findings using contextual variables derived directly from public health boundaries (rather than census boundaries). What is salient, however, is the idea that an intervention that integrates multilevel, synergistic strategies might be required to achieve higher levels of screening.

The main contributions of this study are two fold. First a multilevel modelling approach has been used to explore the separate influences of individual and contextual-level determinants of utilisation as well as interactions between these determinants. Second, unlike many multilevel studies that were confined to using administrative geographic units with little relevance to policy problems, policy-relevant geographic boundaries – health planning regions – were employed as the contextual level.

There are, however, limitations to using the NPHS as a data source. First, the data are subject to biases common to self-reported surveys, including recall bias and social desirability bias. In principle this could be overcome by linking population health surveys with utilisation databases. Second, responses may have included mammograms performed for diagnostic purposes (i.e., in response to symptoms) and hence overestimated the rate of screening in populations. These problems could also be addressed in future research by linking population health surveys with utilisation databases. Third, as described above, the relatively low rates of reporting mammogram use in the last two years in some regions restricted the analysis to

considering lifetime incidence of mammogram use. More policy-informing research would therefore require larger data sets than used here.

In conclusion, the research reported here has shown that analyses focused exclusively on individual-level data may fail to identify important determinants of utilisation, both in terms of direct contextual-level influences on utilisation as well as contextually-driven variations in individual-level relationships. This broader understanding can help public health researchers re-configure their approaches to understanding participation rates in mammography screening programs and considering interventions to change those rates.

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Table I: Individual and Regional Characteristics of Study Sample (n =4,773, N=23)

Type of Variable	Variable	% of Study Sample
Dependent	Ever Had a Mammogram	
	Yes	79.2
	No	20.8
	Missing Responses	2.5
Individual	Marital Status	
	Married, Common-law, Partner	61.4
	Single, Divorced, Separated, or Widowed	38.0
	Missing Responses	0.5
	Years Since Immigration	
	Recent Immigrant (0-9 yrs)	1.4
	Established Immigrant (10 years +)	24.8
	Not an Immigrant	73.6
	Missing Responses	0.8
	Education Level	
	Less Than Secondary School	31.6
	Secondary School	21.0
	Other Post-Secondary School	17.3
	College/University	28.6
	Missing Responses	1.5
	Smoker	
	Daily	20.4
	Occasionally	2.3
	Not at All	77.1
	Missing Responses	0.2
	Had a Pap Smear	
	Yes	90.4
	No	6.4
	Missing Responses	3.1
	Conducted Breast Self-Exam	
	Yes	79.8
	No	16.9
	Missing Responses	3.2
	Derived Social Involvement Score	
	0	27.7
	1	14.9

	2	29.8
	3	6.4
	4 (most social)	18.8
	Missing Responses	2.5
	Has a Regular Physician	
	Yes	96.5
	No	3.5
	Missing Responses	0
	Age	59.00 (mean)
Regional	Employment-Population Ratio	59.63 (mean)
	Percentage Without Secondary School Diploma	19.22 (mean)
	Median Family Income	50,787 (mean)

Table II: Significant Individual Level Determinants of Mammography Uptake (Log-Odds Estimates)

Determinant	Coefficient	S.E.*
Intercept	1.82	0.09
Age (Differential)	0.01	0.01
College	0.18	0.09
Daily smoker	-0.42	0.09
No doctor	-1.46	0.18
>0' social involvement score	-0.21	0.09
>3' social involvement score	0.54	0.20
>4' social involvement score	0.46	0.12
No pap smear	-1.62	0.13
No breast self- exam	-0.54	0.10

* S.E. refers to standard error of the coefficient estimate

Table III: Regional Determinants of Mammography Uptake (Log-Odds Estimates)

Model	Regional Determinant	Coefficient	S.E.*
A	Employment-population ratio	0.01	0.01
B†	Percentage without a secondary school graduation certificate	-0.05	0.02
	College	0.16	0.10

* S.E. refers to standard error of the coefficient estimate
† Statistically significant at $p<0.05$

Table IV: Interaction Between Regional Percentage Without Graduation Certificate and High Social Involvement Score (Log-Odds Estimates)

Determinant	Coefficient	S.E.*
>4' social involvement score	0.43	0.13
Regional percentage without graduation certificate	-0.11	0.03
>4' social x Regional percentage without grad.	0.18	0.05

* S.E. refers to standard error of the coefficient estimate