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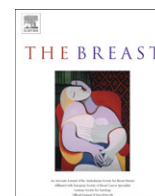
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Original article

The low uptake of breast screening in cities is a major public health issue and may be due to organisational factors: A Census-based record linkage study

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ABSTRACT

Background: Cancer screening uptake is generally lower in UK cities but quantifying city-level effects from causes due to population composition that comprise cities is hampered by data limitations.

Methods: A unique data linkage project combining a 2001 Census-based longitudinal study in Northern Ireland with the NHS Breast Screening Program. Validated uptake in the three years following the Census for Belfast Metropolitan Urban Area was compared against the rest of the country with adjustment for cohort attributes defined at Census.

Results: Belfast Metropolitan Urban Area contained 34.8% of invited women but a greater proportion who rented their accommodation (40.3%) or who did not have a car (47.1%). After full adjustment for demographic and socio-economic factors, Belfast Metropolitan Urban Area uptake was lower for first and subsequent screen (Odds ratio (OR) 0.72; 95% CIs 0.66, 0.78 and OR 0.58; 95% CIs 0.55, 0.62 respectively). There were no significant interactions between patient characteristics and area of residence indicating that all residents in Belfast Metropolitan Urban Area are equally affected.

Conclusion: The reduced uptake of screening in cities is a major public health issue; the effects are large and a large proportion of the population are affected, organisational factors appear to be the primary cause. Strategies to correct this imbalance might help reduce inequalities in health.

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Introduction

One of the best ways to increase the rates of early cancer detection is through National screening strategies¹ and early diagnosis through the NHS Breast Screening Program (NHSBSP) is considered to have contributed significantly to the overall reduction in breast cancer mortality in the UK over the past 20 years.^{2,3,4} The effectiveness of screening programmes depends on rates of participation but routine information on variations in uptake rates is limited and a recent systematic review of studies on inequalities in access to cancer services reported that there was a dearth of information about the factors related to screening uptake in the UK.⁵ The need for more detailed information on the sources of variation in uptake of screening services has been highlighted in the final report of the Equalities Review⁶ and the National Screening Programmes Information Strategy.⁷ A further shortcoming highlighted by the systematic review was that in most UK studies problems of uptake were seen as emanating from the target

groups themselves, and the systems effects, such as configuration of the screening services, administrative procedures were rarely seen as determinants worth investigating.

Perhaps one of the most obvious signs that there may be difficulties arising from the organisation of screening services is when there is significant variation across geographical areas. Such variation is apparent in the UK where the acceptance rate for first invitation to breast screening is currently about 75% but varies by Region, and is particularly low in London (~65%).⁸ The lower uptake rates in the larger cities in the UK have been noted previously^{8,9,10,11} and is a particular concern given the increasing proportion of populations living in these areas. The reasons for this are not entirely clear. It is difficult to conclude that there are (contextual) factors operating at the city level without first controlling for variations in the population (composition). Cities have a greater proportion of people who are deprived and higher concentrations of people from an ethnic minority or for whom English is not their primary language; all factors are associated with lower screening uptake. Methodologically, the separation of context and compositional factors requires data that includes sufficient information to enable adjustment for individual characteristics but also sufficient numbers to produce robust estimates of

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area-level effects and this has not been available to date. For example, in the largest UK study published to date,¹² aggregated data from nine rounds of the National Statistics Omnibus Survey (2005–7) to obtain very detailed socio-demographic information on 3185 respondents but the sample size was too small to confirm the recognized lower uptake in London.

The aim of this study is to use a record linkage approach to circumvent these difficulties and to quantify the variations in screening uptake across Metropolitan areas in Northern Ireland after making adjustment for variation in the types of people living in these areas.

Methods

The data for this study were created by linking data from the National Breast Screening System (NBSS) to the Northern Ireland Longitudinal Study (NILS). The NBSS holds information about eligibility and uptake of breast screening in Northern Ireland and the data extracted excluded early rescreens, technical repeats and women who had been referred for investigations and/or treatment. Uptake rates were calculated as the total number of women who attended, within an extra 6 months included for delayed attendance, divided by the total number of women invited during the three year screening cycle. NILS is a representative sample of nearly 500,000 people (approx 28% of the Northern Ireland population), formed by the linkage of the GP registration system and the 2001 Census (Northern Ireland Longitudinal Study).¹³ The core NILS dataset includes the cohort member's Census record and contextual information relating to characteristics of the area of residence. It also contains the Health and Care number, a unique Health Service identifier that enables linkage to other Health Service datasets. The data were anonymised and held in a secure setting by the Registrar General for Northern Ireland. The screening and NILS data were linked using the encrypted Health Service identifier as the matching field; a process carried out jointly by the respective data custodians within the secure setting in the Northern Ireland Statistics and Research Agency (NISRA) so that at no time were patient identifiable data available to the research team. The matching field was subsequently removed and the resultant research dataset, without identifiers such as date of birth, address

and so was entirely anonymous. The study was approved by the local ethics committee (07/NIR01/90) and has conformed to the principles laid out in the Declaration of Helsinki; individual patient consent was not required.

The linkage produced 11,931 women aged 48–52 who had been invited for their first routine screen, 25,128 women aged 53–64 who had been invited for a subsequent screen during this time. All characteristics of women in the cohort were as recorded on the Census form and selected as factors shown in other UK studies to be associated with screening uptake. Age was included as 5-year bands (≤ 49 , 50–54, 55–59, 60–64); marital status was categorised as married, never married, and a final group combining the widowed, separated or divorced. It was not possible to include ethnicity as less than 1% of women in this age group were from an ethnic minority. Three Census-based indicators of socio-economic status were included: the National Statistics Socio-Economic Classification (NS-SEC)¹⁴ (a measure of social class categorised as Higher/Lower Professional/Managerial, Intermediate, Own account workers, Lower supervisory, routine and unemployed), household car availability (categorized as two or more cars, one only and no car access) and housing tenure (categorised as owner occupier, private renter and social renter). Education has not been included as it was not shown to be independently associated with screening uptake either in this or in other UK studies.^{9,12,15} A Census-based measure of self reported morbidity was also included; general health (GH) in the preceding year with three responses – good, fairly good and not good.

Defining urban/rural areas

There is no universally agreed definition of what constitutes an 'urban' or 'rural' area¹⁶ but in the UK, an approach based on population size and density and access to services has been used to produce an official classification of settlement bands.¹⁷ In Northern Ireland, there are eight settlement bands – ranging from the largest, the Metropolitan Area of Belfast, the Capital City (encompasses about 580,000 people, 34.3% of the population); to the smallest representing settlements of less than 1000 people and open countryside. The Belfast Metropolitan Urban Area includes more than the tight administrative boundaries of the City and

Table 1
Demographic and socio-economic characteristics of women invited for any screen during 2001 and 2004.

		Rest of Northern Ireland		Belfast Metropolitan Area	
		No invited (%cohort)	No attended (%uptake)	No invited (%cohort)	No attended (%uptake)
Age at census	<50	2857 (11.8)	2063 (72.2)	1392 (10.8)	915 (65.7)
	50–54	8567 (35.4)	6954 (81.2)	4335 (33.7)	3121 (72.0)
	55–59	7622 (31.5)	6122 (80.3)	4266 (33.1)	2962 (69.4)
	60–64	5132 (21.2)	3880 (75.6)	2888 (22.4)	1804 (62.5)
Marital status	Married	18,103 (74.9)	14,631 (80.8)	8864 (68.8)	6398 (72.2)
	Never married	1696 (7.0)	1191 (70.2)	1078 (8.4)	660 (61.2)
	Sep/Wid/Div	4379 (18.1)	3197 (73.0)	2939 (22.8)	1744 (59.3)
General Health	Good	12,764 (52.8)	10,263 (80.4)	6337 (49.2)	4563 (72.0)
	Fairly good	7053 (29.2)	5557 (78.8)	3563 (27.7)	2437 (68.4)
	Not good	4361 (18.0)	3199 (73.4)	2981 (23.1)	1802 (60.5)
Housing tenure	Owner	19,989 (82.7)	16,189 (81.0)	10,055 (78.1)	7257 (72.2)
	Private rent	953 (3.9)	668 (70.1)	387 (3.0)	229 (59.2)
	Social rent	3236 (13.4)	2162 (66.8)	2439 (18.9)	1316 (54.0)
Car access	2 or more	11,572 (47.9)	9524 (82.3)	4544 (35.3)	3424 (75.4)
	1 car	9701 (40.1)	7609 (78.4)	5741 (44.6)	3958 (68.9)
Social Class	No car	2905 (12.0)	1886 (64.9)	2590 (20.2)	1420 (54.7)
	H/L Prof/Man	5874 (24.3)	4717 (80.3)	3324 (25.8)	2407 (72.4)
	Intermediate	3276 (13.6)	2646 (80.8)	2279 (17.7)	1651 (72.4)
	Own account	1511 (6.3)	1224 (81.0)	447 (3.5)	303 (67.8)
	Lower supervisory	1354 (5.6)	1076 (79.5)	704 (5.5)	481 (68.3)
	Routine	10,364 (42.9)	8108 (78.2)	5411 (42.0)	3600 (66.5)
	Not working	1799 (7.4)	12,481 (69.4)	716 (5.6)	360 (50.3)

incorporates those areas in the proximate hinterland that would reasonably be included as part of the City. The analysis presented here compares Belfast to the rest of the country, as initial analysis showed that there were no significant differences between the smaller conurbations. In addition, the analysis was repeated using only the smaller Local Authority definition to test if our conclusions depended on the geographical definition of city and essentially very similar results were found (available on request). NILS includes the place of residence on Census day and this was used to allocate cohort members to Settlement Band areas.

Multivariate logistic regression using STATA version 10 was used to explore the relationship between uptake of breast screening and the area-level variables while adjusting for variations in the demographic and socio-economic characteristics of the residents. Interactions between these demographic and socio-economic factors and area of residence were also tested using the Likelihood Ratio test in STATA to see if the differences in uptake around the city were more pronounced for some types of residents.

Results

Table 1 shows that the composition of Belfast Metropolitan Urban Area differs somewhat from the rest of the country with over one third of women who are invited to screening living in the Belfast Metropolitan Area despite similarity in age distributions. It encompasses a greater proportion of women who are separated/widowed/divorced (22.8% compared to 18.1% for the rest of Northern Ireland).. It also has a greater proportion of women who are in rented accommodation (40.3%), who do not have access to a car (47.1%), or who's general health was 'not good' (40.6%). All of these factors are associated with lower crude uptake rates in both Belfast Metropolitan Urban Area and in the rest of the country, though for each variable the uptake is lower in Belfast; for example although people who own their home were more likely to attend for a subsequent screen than those who rent, home owners in Belfast had lower attendance than those in the rest of the country (72.2% vs 81.0% respectively).

During the study period 70.3% of those in the Belfast Metropolitan Urban Area attended first screen and 67.4% attended for subsequent screen; the equivalent figures for rest of Northern Ireland were 77.6% and 79.2% respectively. Logistic regression confirmed the well attested relationship between attendance and demographic and socio-economic factors.¹² In the fully adjusted models, with non-attendance at any screen as the dependent variable, women who were never married were less likely to attend than their peers who were married (Odds ratio (OR) 0.74; 95% CIs 0.68, 0.81), and those with poor general health in the preceding year were about 20% less likely than those with good health to attend (OR 0.81; %5CIs 0.76, 0.86). Attendance was lower for those who rented rather than owned their accommodation (OR 0.67; 95% CIs 0.62, 0.72) and for those who lived in household without access to a car, compared to those with access to two or more (OR 0.63; 95% CIs 0.58, 0.69).

Table 2 shows that women in Belfast were about one third less likely to attend first screening (OR 0.68; 95% CIs 0.63, 0.75) and

about one-half as likely to attend for a subsequent screen (OR 0.55; 95% CIs 0.51, 0.58) compared to women in the rest of the country. These odds ratios were only a little attenuated with further adjustment for variations in age, marital and health status, and indicators of socio-economic status. Further analysis demonstrated that there were no significant interactions between marital status, housing tenure, car access or social class and area of residence.

Discussion

This study has clearly demonstrated that uptake around a major Metropolitan area is substantially lower than in other parts of the country. This is not attributable to the variations in population composition as the difference persists after adjustment for all demographic and socio-economic factors shown in previous UK studies to be associated with variations in screening uptake. Residual confounding is therefore unlikely. Differences in ethnicity mix however, were not included in the analysis as they comprised less than 1% of the population at the time of the Census and even if entirely concentrated in Belfast Metropolitan Urban Area could not explain the differences. The absence of significant interactions between these demographic factors and area of residence suggests that the lower uptake for the City as a whole is not because of marked effects of one particular group. The data in Table 1 showing the crude uptake rates across the various socio-demographic characteristics confirms this.

That all residents within a city are affected indicates a systemic effect and though it is possible that city dwellers have a different attitude to health protection, problems relating to the organisation of services is a more compelling explanation. Screening for the majority of women takes place at one static screening unit in the heart of the City and is well served by public transport, so geographical access is unlikely to be the main explanation.

An alternative explanation, and one that is more easily identified and possibly rectified, is that a proportion of women do not attend because they do not receive their invitation letter as the address used in the call-recall system is incorrect. This is a recognized problem with centralized GP registers^{18,19,20} and is known to be particularly difficult in large conurbations. Address inaccuracies have been shown to contribute to the lower uptake of cervical screening in cities²¹ and for the lower uptake of breast screening amongst Asian women.²² As the National Screening Programmes Information Strategy⁷ states, "a key information requirement...is for accurate and timely identification of individuals to be offered screening, this includes identification of target group individuals not already identified through normal procedures".

This study has some significant strengths and possible limitations that should be mentioned. The use of data linkage has enabled two very powerful datasets to be combined to produce the largest and most representative study of factors associated with breast screening uptake in the UK to date. We have been able to adjust for a very wide array of socio-demographic factors known to be associated with screening uptake. It is unlikely that any important demographic factors have been omitted. However, the results relate to only one City in Northern Ireland and it is possible that other

Table 2
Likelihood of women attending first or subsequent breast screen in the Belfast Metropolitan Urban Area compared to their peers in the rest of the country. Data represent Odds Ratios (OR) and (95% confidence intervals), unadjusted and after further adjusted for other demographic and socio-economic factors.

	First screen	Subsequent screen	Any screen
Unadjusted	0.68 (0.63, 0.75)	0.55 (0.51, 0.58)	0.59 (0.56, 0.61)
Adjusted for age and marital status	0.70 (0.64, 0.77)	0.56 (0.53, 0.60)	0.60 (0.57, 0.63)
+ adjustment for health status	0.71 (0.65, 0.77)	0.57 (0.53, 0.60)	0.61 (0.58, 0.64)
+ adjustment for socio-economic status ^a	0.72 (0.66, 0.78)	0.58 (0.55, 0.62)	0.62 (0.59, 0.65)

^a Socio-economic status includes housing tenure, car availability and social class (NS-SEC).

factors related to population composition may operate in other UK cities. We suggest that equivalent Census-based longitudinal studies in other parts of the country^{23,24} are utilised in a similar fashion to test the findings presented here.

The conclusion of this study is that tackling the reduced uptake of screening for breast (and probably other cancers) in cities should be a major public health concern. This is because the size of the effect is large and because a great proportion of the population is affected. In Northern Ireland, 34.8% of women in the breast screening age live in and around the capital city; for the UK as a whole it is estimated that approximately 32.4% of the population live in the ten most populous urban areas.²⁵ Finally, it should be noted that a disproportionate number of those who are deprived live in cities; in the current study almost half of public sector renters and those without access to a car live in or around Belfast. Therefore, any changes that would result in increasing the uptake in cities may help reduce socio-economic inequalities in cancer screening, which is a priority for both the Cancer Reform Strategy²⁶ and the Strategic Review of Health Inequalities in England Post 2010 (Marmot Review).²⁷

Competing interests

None.

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