BMJ Open   Mammograms on-the-go—predictors of repeat visits to mobile mammography vans in St Louis, Missouri, USA: a case–control study

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ABSTRACT

Objectives: Among women, breast cancer is the most common non-cutaneous cancer and second most common cause of cancer-related death. The purpose of this study was to determine the extent to which women use mobile mammography vans for breast cancer screening and what factors are associated with repeat visits to these vans.

Design: A case–control study. Cases are women who had a repeat visit to the mammography van. (n=2134).

Participants: Women who received a mammogram as part of Siteman Cancer Center's Breast Health Outreach Program responded to surveys and provided access to their clinical records (N=8450). Only visits from 2006 to 2014 to the mammography van were included.

Outcome measures: The main outcome is having a repeat visit to the mammography van. Among the participants, 25.3% (N=2134) had multiple visits to the mobile mammography van. Data were analysed using χ^2 tests, logistic regression and negative binomial regression.

Results: Women who were aged 50–65, uninsured, or African-American had higher odds of a repeat visit to the mobile mammography van compared with women who were aged 40–50, insured, or Caucasian (OR=1.135, 95% CI 1.013 to 1.271; OR=1.302, 95% CI 1.146 to 1.479; OR=1.281, 95% CI 1.125 to 1.457), respectively. However, the odds of having a repeat visit to the van were lower among women who reported a rural ZIP code or were unemployed compared with women who provided a suburban ZIP code or were employed (OR=0.503, 95% CI 0.411 to 0.616; OR=.868, 95% CI 0.774 to 0.972), respectively.

Conclusion: This study has identified key characteristics of women who are either more or less likely to use mobile mammography vans as their primary source of medical care for breast cancer screening and have repeat visits.

INTRODUCTION

In the USA, one in eight women develop an invasive form of breast cancer in their

Strengths and limitations of this study

- This study has identified key characteristics of women who are either more or less likely to use mobile mammography vans as their primary source of medical care for breast cancer screening and have repeat visits.
- These data can be generalisable to other mobile units that service urban, suburban and rural environments with a similar population.
- The present research study adds insight into a new strategy that uses mobile mammography as an outreach strategy for repeat screening in minority and medically underserved communities.
- Owing to differences in breast cancer screening guidelines, our use of American Cancer Society (ACS) mammography guidelines is not generalisable to populations whose screening guidelines differ.
- The reasons why women missed routine screening were not investigated in our study.
- It is possible that women in our study had a repeat mammogram at another facility that is not captured in our data, and thus were adherent to screening guidelines by using multiple points of service.

lifetime, making it the most common cancer after skin cancer among women.[1] There were 232 640 new cases of invasive breast cancer diagnosed in addition to 62 570 cases of non-invasive breast cancer in 2014.[1] Although breast cancer is the second leading cause of cancer death in women, the mortality rate has been on the decline since the late 1980s.[1] The decreases in mortality rate due to breast cancer can be attributed to mammography screening, increased awareness and advancements in treatment.[1 2]

Mammography screening is a tool used to detect breast cancer in its earliest stages so that treatment can be initiated promptly, and it has led to improved survival rates among

women older than 40 years of age but most significantly in those over the age of 50 years.[2–4] According to the American Cancer Society (ACS), women who are in good health and at least 40 years old should get a mammogram annually.[1] Mammography screening rates have remained at 67% over the past several years[5] with the repeat screening rate in the overall population in the US at 46%.[6] However, screening rates among uninsured women are dramatically lower at 31.5% in 2010.[5] Women who are not being screened regularly tend to be a part of underserved populations and are disproportionately affected by breast cancer.[7]

In order to improve screening rates, particularly among women who underuse mammography screening, many areas, rural and urban, have introduced mobile mammography. In a study conducted by Brooks et al,[8] the rate of detection of breast tumours by mobile mammography was significantly higher than the age-adjusted rate of the general population, and 68% of those diagnosed by mobile mammography were uninsured. This suggests that mobile mammography may be detecting many tumours that otherwise could have gone undiscovered. Even further, mobile mammography has been shown to be accurate and accessible,[9 10] thereby increasing participation rates and improving equity of care.[11] Interestingly, in a study conducted by Lee and Yao[12], 21.3% of the women surveyed preferred mobile mammography for screening while 7.6% favoured a hospital setting.

With the increasing presence of mobile mammography, several studies have assessed self-reported adherence to screening guidelines at the time of participation in mobile mammography. Brooks et al[8] found that 29% of the women participating in the mobile mammography screenings had either never been screened or not screened within the past 5 years while Vyas et al[13] discovered that 46.2% of the women obtaining a mobile mammogram had a screening mammogram in the past 2 years. Mobile mammography is reaching higher risk women who are taking advantage of the increased opportunities for screening. However, there is a lack of research in determining if women are using mobile mammography for multiple or consecutive screening visits.

The Alvin J Siteman Cancer Center (SCC) at Barnes-Jewish Hospital and Washington University School of Medicine in St Louis, Missouri, has offered mammograms at little or no cost for women through their mobile mammography van (MMV) service for the past 10 years.[14] The rate of mammography screening in Missouri exceeds national estimates at 72.9%, but women earning less than $25 000 annually had significantly fewer mammograms than women whose annual income is at least $25 000.[15] Even further, for women earning less than $25 000 per year in Missouri, over one-third are without healthcare coverage, making it difficult for them to seek primary care and obtain screening.[15] In 2006, the Mammography Outreach Registry was created and any woman who qualified for financial assistance to obtain a mammogram at the Joanne Knight

Breast Health Center or at the MMV was included. Participation in the registry was not required for receipt of services, but the vast majority of women (approximately 99%) who qualified for the programme agreed to participate. The purpose of this study was to use data from the Mammography Outreach Registry to determine the extent to which women use MMVs for breast cancer screening and what factors are associated with repeat visits to these vans.

METHODS
Study sample
This study used a Mammography Outreach Registry that collected patient and questionnaire data from women who have utilised the mammography services provided on the SCC MMV. Participants provided consent and questionnaires were administered by a research technician to all women who receive financial assistance for a mammogram on the van prior to receiving a mammogram. This analysis included women who had at least one screening visit on the van between April 2006 and March 2014 (N=9480). Since the overwhelming majority of the SCC MMV population were African-American and Caucasian (89.26%), we excluded women of other races. Our study sample included 8450 respondents who met our inclusion criteria. No follow-up data are presented in this analysis.

Variable definitions
A repeat visit was defined as the number of times a woman returned to the SCC MMV after her initial visit. Repeat visits were assessed as a dichotomous variable: those with only one visit (no repeat) and those with two or more visits (repeat). The number of visits ranged from 1 to 7. Demographic variables were collected from the survey administered at the time of the screening and the women's health records. Covariates selected for analyses included insurance status (insured vs non-insured), age (<40, 40–50, 50–65, 65+), race (Caucasian vs African-American), marital status (married vs not married) and employment status (employed vs not employed). The ZIP code of each participant was used to determine urban status. Urban status was divided into three categories (urban, suburban and rural). ZIP codes from St Louis city were classified as urban, ZIP codes from St Louis County were classified as suburban, and rural was classified as ZIP codes coming from the Bootheel region of Missouri. On the questionnaire (administered at the time of each visit), participants were asked about the quality of their mammography experience. Response options were Very Bad, Okay, Good and Great. The response to this question from each participant's first visit was used in the analysis.

Statistical analysis
Bivariate analyses were conducted using the two outcome measures (discrete and dichotomous repeat

visits) separately and comparing them to all of the demographic factors of interest. Logistic regression was used for the dichotomous outcome (repeat visit vs no repeat visit) to model the likelihood of a woman having a repeat visit on the SCC MMV according to potential predictors. ORs were calculated for each of the significant predictors. Statistical analysis was conducted using SAS software (V.9.4, SAS Institute, Cary, North Carolina, USA); significance was assessed at $\alpha<0.05$. To determine if we could isolate predictive factors for increased number of visits, we employed a negative binomial regression model using the number of repeat visits as the outcome. A negative binomial model was used because the outcome was count data and the majority of participants had no repeat visits.[16] Missing data were minimal. In total, 8.35% of data were missing for Models 1 and 2. Per cent missing for each variable is shown in table 1.

In subanalyses, we calculated the number of consecutive visits among women with repeat visits. Variables were added into the logistic and negative binomial models if they retained a significance at the $\alpha<0.1$ level in bivariate analyses. In both models, we controlled for the varying length of time that women could potentially have had a repeat visit by controlling for year of first visit.

RESULTS
Among the 8450 study participants, 25% (N=2101) had multiple visits to the MMV and of these women, 41% always had consecutive visits. The mean number of repeat visits was 2.5. Descriptive statistics and χ^2 analyses are reported in table 1. There was a significant difference between women with no repeat visits versus women with repeat visits by urban status, insurance coverage,

Table 1 Characteristics of 8450 women who had or did not have repeat visits related to mobile mammography van

	No repeats (n=6349)		Repeats (n=2101)		
	n	per cent	n	per cent	p Value
Mean repeat visits	–	–	2.49	–	–
Consecutive visits					
Always	–	–	865	41.17	
Sometimes	–	–	392	18.66	
Never	–	–	844	40.17	
Urban status					<0.0001*
Urban	2776	43.72	1012	48.17	
Suburban	2483	39.11	881	41.93	
Rural	975	15.36	196	9.33	
Missing	115	1.81	12	0.57	
Insurance coverage					<0.0002*
Yes	2130	33.55	610	29.03	
No	4218	66.44	1487	70.78	
Missing	1	0.02	4	0.19	
Age group					0.0023*
Under 40	68	1.07	7	0.33	
40–50	2668	42.02	833	39.65	
50–65	3098	48.80	1081	51.45	
Over 65	513	8.08	180	8.57	
Missing	2	0.03	0	0.00	
Race					<0.0001*
Caucasian	2556	40.26	638	30.37	
African-American	3793	59.74	1463	69.93	
Marital status					<0.0001*
Not currently married	4338	68.33	1606	76.44	
Married	1580	24.89	450	21.42	
Missing	431	6.79	45	2.14	
Baseline mammography experience					0.0036*
Very bad	19	0.30	14	0.67	
Okay	492	7.75	185	8.81	
Good	3547	55.87	1205	57.35	
Great	2196	34.59	656	31.22	
Missing	95	1.50	41	1.95	
Employed					0.0003*
Yes	2074	32.67	776	36.93	
No/missing	4275	67.33	1325	63.07	

*Significant at $\alpha=0.05$.

Table 2 Logistic regression model

	Model 1*			Model 2†		
	OR	95% CI	p Value	OR	95% CI	p Value
Urban status						
Suburban	Ref	–	–	Ref	–	–
Urban	1.027	0.925 to 1.142	0.6142	1.116	0.995 to 1.142	0.0610
Rural	0.567	0.477 to 0.673	<0.0001	0.488	0.398 to 0.598	<0.0001
Insurance coverage						
Yes	Ref	–	–	Ref	–	–
No	1.231	1.102 to 1.371	0.0002	1.319	1.160 to 1.500	<0.0001
Age group						
Under 40	0.330	0.151 to 0.721	0.0054	0.335	0.149 to 0.752	0.0080
40–50	Ref	–	–	Ref	–	–
50–65	1.118	1.007 to 1.240	0.0364	1.150	1.026 to 1.289	0.0163
Over 65	1.124	0.932 to 1.355	<0.0001	1.160	0.925 to 1.454	0.1980
Race						
Caucasian	Ref	–	–	Ref	–	–
African-American	1.545	1.390 to 1.717	<0.0001	1.261	1.108 to 1.436	0.0005
Marital status						
Married	Ref	–	–	Ref	–	–
Not currently married	1.300	1.154 to 1.465	<0.0001	1.105	0.968 to 1.262	0.1379
Baseline mammography experience						
Very bad	2.171	1.085 to 4.343	0.0284	1.544	0.739 to 3.224	0.2475
Okay	1.107	0.923 to 1.327	0.2723	0.948	0.780 to 1.152	0.5907
Good	Ref	–	–	Ref	–	–
Great	0.879	0.789 to 0.987	0.0207	0.974	0.866 to 1.096	0.6652
Employed						
Yes	Ref	–	–	Ref	–	–
No	0.828	0.747 to 0.918	0.0003	0.857	0.765 to 0.961	0.0084
Year at first screening	0.681	0.661 to 0.703	<0.0001	0.664	0.643 to 0.687	<0.0001

*Unadjusted Model.
†Adjusted Model.

age group, race, marital status, baseline mammography experience and employment.

In the logistic regression model (table 2), women who were aged 50–65, uninsured, or African-American had higher odds of a repeat visit to the MMV compared with women who were aged 40–50, insured, or Caucasian, respectively (OR=1.150, 95% CI 1.026 to 1.289; OR=1.319, 95% CI 1.160 to 1.500; OR=1.261, 95% CI 1.108 to 1.436). However, the odds of having a repeat visit to the van was lower among women who reside in a rural ZIP code, were under 40 years old, or were unemployed, compared with women who reside in a suburban ZIP code, were aged 40–50, or were employed, respectively (OR=0.488, 95% CI 0.398 to 0.598; OR=0.335, 95% CI 0.149 to 0.752; OR=0.857, 95% CI 0.765 to 0.961).

Results from negative binomial regression analyses (table 3) suggest that women who were 50–65 years old, uninsured, or African-American had a statistically significant higher number of repeat visits to the MMV compared with those 40–50 years old, insured, or Caucasian, respectively (β=0.15, 95% CI 0.06 to 0.24; β=0.17, 95% CI 0.07 to 0.27; β=0.21, 95% CI 0.10 to 0.31). On the other hand, residing in a rural ZIP code, being under 40 years old, or being unemployed were statistically

significant predictors of a lower number of repeat visits to the MMV compared with residing in a suburban ZIP code, being 40–50 years old, or being employed, respectively (β−0.6180, 95% CI −0.7871 to −0.4489; β−0.9125, 95% CI −1.6180 to −0.2070; β−0.1638, 95% CI −0.2545 to −0.0731).

To determine whether women with a repeat mammography were following up an abnormal mammography result, the investigators conducted the same analyses only among women with a negative mammography result (Breast Imaging Reporting and Database System (BI-RAD)=1) and the results were similar to what is presented here. These results are not shown.

DISCUSSION

Of the women who have had repeat visits to the MMV, 41% had all of their visits within 1 year of each other, adhering to ACS recommended screening guidelines. Women who are aged 50–65, uninsured, or African-American are more likely to undergo a repeat visit to the MMV whereas those less likely to have a repeat visit are unemployed or reside in a rural ZIP code.

The findings demonstrate that the MMV has had considerable success servicing more than half of its

Table 3 Negative binomial regression model

	Model 1*			Model 2†		
	Coefficient	95% CI	p Value	Coefficient	95% CI	p Value
Urban status						
Suburban	Ref	–	–	Ref	–	–
Urban	−0.0087	−0.1030 to 0.0856	0.8567	0.0659	−0.0250 to 0.1569	0.1552
Rural	−0.5804	−0.7374 to −0.4235	<0.0001	−0.6180	−0.7871 to −0.4489	<0.0001
Insurance coverage						
Yes	Ref	–	–	Ref	–	–
No	0.1292	0.0321 to 0.2263	0.0091	0.1700	0.0667 to 0.2732	0.0012
Age group						
Under 40	−1.0512	−1.7712 to −0.3312	0.0042	−0.9125	−1.6180 to 0.2070	0.0112
40–50	Ref	–	–	Ref	–	–
50–65	0.1367	0.0422 to 0.2313	0.0046	0.1521	0.0605 to 0.2437	0.0011
Over 65	0.1628	−0.0049 to 0.3306	0.0571	0.1784	−0.0004 to 0.3571	0.0506
Race						
Caucasian	Ref	–	–	Ref	–	–
African-American	0.4370	0.3411 to 0.5329	<0.0001	0.2095	0.1045 to 0.3144	<0.0001
Marital status						
Married	Ref	–	–	Ref	–	–
Not currently married	0.2468	0.1392 to 0.3544	<0.0001	0.0859	−0.0215 to 0.1933	0.1168
Baseline mammography experience						
Very bad	0.4834	−0.1440 to 1.1109	0.1310	0.1455	−0.4104 to 0.7014	0.6080
Okay	0.1535	−0.0084 to 0.3154	0.0631	−0.0033	−0.1543 to 0.1476	0.9655
Good	Ref	–	–	Ref	–	–
Great	−0.0840	−0.1828 to 0.0147	0.0954	0.0128	−0.0816 to 0.1072	0.7897
Employed						
Yes	Ref	–	–	Ref	–	–
No	−0.2147	−0.3074 to −0.1219	<0.0001	−0.1638	−0.2545 to −0.0731	0.0004
Year at first screening	−0.3961	−0.4234 to −0.3688	<0.0001	−0.4017	−0.4298 to −0.3737	<0.0001

*Unadjusted Model.
†Adjusted Model.

vulnerable patient population on a repeat basis. Demographic characteristics of women who are either more or less likely to use mobile mammography services were identified. It is important that mobile mammography is maintained and remains easily accessible to women who continuously use the service.

Although not focused on mobile mammography, previous studies have discovered similar findings in regard to repeat mammography. This study is among the first to assess predictors of repeat screening visits using only mobile mammography. Ulcickas Yood et al[17] found that among women 50–74 years old with a normal mammogram, 66% received another mammogram within 2 years of the initial screening and 88% did so within 5 years. Even further, Gjelsvik et al[18] demonstrated that low use of mammography is quite prevalent among the uninsured; identifying these women better informs development and structuring of a mobile mammography intervention. The results of their analysis suggest that being 55–80 years old, having a primary care doctor and earning an annual income of $75 000 or more makes a woman more likely to have repeat screening.[18] In Halabi et al's[19] study, they concluded that about 50% of the women in their sample were either categorised as off schedule for screening or never screened in the past.

Off-schedule women may be the most interesting to further investigate because they, in fact, may belong to the group least knowledgeable about screening guidelines but perhaps more likely to return to routine screening.[19] Although our large sample size may drive some of the statistically significant associations reported here, its public health relevance to mobile mammography programmes is relevant. Our study suggests that women identified as being less likely to have repeat or routine screening in previous studies are significantly more likely to have repeat visits using mobile mammography.

There are limitations to the study. In general, it is difficult to assess repeat mammography rates because they are defined differently among recommended guidelines.[5 6 20] Second, the reasons why some women missed routine screening were not investigated in our study and it is possible that those women had a mammogram at another facility that is not captured in our data, and thus were adherent to screening guidelines by using multiple points of service. Related to this is that we only assessed mammography screening that occurred on the MMV and women may have had a repeat or consecutive visit on-site instead of at the mobile unit. Finally, generalisability is limited because the sample does not

proportionally represent all women at risk for breast cancer. However, this sample is representative of the SCC mammography outreach population. In addition, these data can be generalisable to other mobile units that service urban, suburban and rural environments with a similar population.

Further research should uncover ways to make mobile mammography a more effective resource for women who are more likely to use it for routine screening. Future work should also examine how community partnerships and development of a regular van schedule contribute to successful outreach efforts. Mobile mammography users should be surveyed about other factors such as primary care access and social support. Beyond looking at age, race and insurance status as predictors of repeat mammography, several studies have noted other reasons that may explain increased motivation to undergo repeat mammography. Researchers have discussed the importance of social support and integration as well as social networks in encouraging women to seek screening for breast cancer.[21] [22] Other studies have also determined that if women have a primary care doctor or other healthcare professional who can provide recommendations or scheduling assistance, they will be more likely to follow screening guidelines.[18] [23]

The present research study adds insight into a new strategy that uses mobile mammography as an outreach strategy for repeat screening in minority and medically underserved communities. We now have a better understanding of who is using mobile mammography to adhere to recommended screening guidelines and can begin to find ways to reach these populations more effectively, which will ultimately impact disparities in stage at diagnosis.

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