

# Do Appalachian Women Attending a Mobile Mammography Program Differ from Those Visiting a Stationary Mammography Facility?

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Published online: 17 March 2013  
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**Abstract** To compare the characteristics (demographic, access to care, health-related behavioral, self and family medical history, psychosocial) of women aged 40 years and above who utilize a mobile mammography unit with those women aged 40 years and above who obtain mammography screening at a stationary facility. A cross-sectional study design was used with participant cohorts comprised of women age 40 years and above throughout West Virginia (WV) who utilized mobile mammography unit to get mammogram and those who had mammography screening at the stationary facility and completed the Mammography

Screening and Preventive Care Survey. A total of 1,161 women who utilized the mobile mammography unit and 1,104 women who utilized stationary facility were included in the analysis. In logistic regression after adjusting for all the variables, women who utilized mobile mammography unit were more likely to be in age group 40–49, with lower income, with no health insurance coverage, not visit doctor or obstetrician/gynecologist (OB/GYN) in the past year, not adherent to clinical breast exam and mammography screening guidelines, with lower perceived five-year risk of developing breast cancer and with high knowledge about mammography screening. Women who utilize mobile unit are not adherent to mammography screening guidelines thereby suggesting that the mobile mammography unit is indeed reaching a rural vulnerable population who may not routinely access preventive health services. Financial and insurance constraints, as well as access to medical care, restricted WV women from receiving mammography screening from the stationary screening facilities.

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**Keywords** Mammography screening · Stationary mammography facility · Mobile mammography unit

## Introduction

Mammography screening is considered to be effective at detecting breast cancer (BC) early and reducing mortality among women at an average risk [1, 2]. Several clinical trials have shown that mammography screening reduces BC-related mortality by 20–35 % in women age 40–69 years of age [3–7]. Thus, utilization and adherence to mammography screening guidelines should be fostered in women age 40 years and above to reduce BC-related mortality.

West Virginia (WV) lies entirely within Appalachia and 34 out of its 55 counties are categorized as rural [8]. Moreover, 48 of WV's 55 counties are wholly or partially designated as Medically Underserved Areas by the Health Resource and Services Administration [9]. Appalachia is a predominantly rural and medically underserved region in the United States characterized by high poverty rates, low levels of education, high rates of chronic disease, and poor health behaviors [10–13]. WV has a lower incidence but higher rates of advanced and unstaged BC [14–19], which has been attributed to lower mammography screening rates in women in WV [15–20]. In 2010, WV was ranked 48th among all the states in the US for proportion of women having had mammography screening within the past 2 years [21]. A study on screening using the Behavioral Risk Factor Surveillance System self-reported data indicated that 74.5 % of WV women had a mammogram in the past 2 years compared to 76.6 % women nationally [20]. However, a recent study about mammography screening in WV Medicaid fee-for-service women indicated that less than 40 % of women had a mammogram related billing in 2007–2008 within the previous 2 years although mammography screening service is covered by WV Medicaid [22]. Thus, these studies highlight the need for increasing mammography screening rates among women in WV.

Mobile mammography is one way to provide better access to women for mammography screening. Mobile mammography programs have been in use for more than two decades to overcome barriers to mammography screening and increase screening rates in rural and hard-to-reach populations [23]. However, there have been very few studies about the effectiveness of mobile mammography to reach these remote populations. One recent study described women who utilized mobile mammography units and what factors influence their adherence to mammography screening guidelines [24]. Yet, this study did not determine how women who utilize mobile mammography units for screening may be different from women who get their routine screening performed at a stationary facility. Understanding the characteristics of women who utilize a mobile mammography unit compared to women who utilize a stationary facility, can help identify the determinant characteristics of these women to facilitate the development of specific targeted educational programs and interventions to increase mammography screening rates among such hard-to-reach populations. Hence, the objectives of this research study were to compare the characteristics of women aged 40 years and above who utilize a mobile mammography unit with those women aged 40 years and above who obtain mammography screening at a stationary facility.

## Methods

### Settings

The 'Bonnie Wells Wilson Mobile Mammography Program' (Bonnie's Bus) was set up in 2009 with the aim to increase persistence of mammography screening in underserved and rural WV women, especially to those with limited or no access to screening mammography. It is a program of the Mary Babb Randolph Cancer Center (MBRCC) in partnership with West Virginia University Healthcare.

Before Bonnie's Bus was established, women in WV typically utilized mammography screening services from the stationary facilities such as the Betty Puskar Breast Care Center (BPBCC), Montgomery General Hospital, Advanced Women's Imaging by Saint Francis Hospital and a few other such facilities located throughout WV. BPBCC, the largest mammogram and BC treatment facility in WV, is housed at the MBRCC that launched and operates Bonnie's Bus. The BPBCC provides a comprehensive program for breast care, offering the best available expertise, educational tools, and technology aimed at the early detection of BC. The center sees approximately 10,000–12,000 women every year.

The BPBCC was chosen as a representative stationary facility for comparing the Bonnie's Bus women because it is the largest mammography screening stationary facility in the state, and 60 % of its coverage area overlaps with the Bonnie's Bus coverage area.

### Study Design and Participants

This research study used a cross-sectional study design. Participant cohorts were comprised of women throughout WV who utilized mammography screening on Bonnie's Bus in 2009–2011 or those who had mammography screening at the BPBCC at least once in the past 10 years and completed the study survey.

Out of a total of 2,447 women who utilized Bonnie's Bus mammography services, 1,313 women consented to participate in the survey. Out of these 1,313 women, six women did not report age, seven women did not report time since last mammogram, and seventy-nine women already had a mammogram on Bonnie's Bus prior to the documented visit and hence were not included in the sample. Sixty women were under the age of 40 years and were not included in the study to be consistent with average risk mammography screening guidelines, which recommends mammography screening in women age 40 years and above [25–27]. Therefore, the final sample size for the Bonnie's Bus cohort was 1,161 (50.6 %).

Out of a total of 16,687 women who utilized BPBCC to get a screening mammogram and did not need further evaluation, 2,505 women were randomly selected and invited to participate in the study and complete the survey. As the data was not being collected at the time of the mammography screening visit but after the visit, women who had additional evaluation following their screening may have attitudes and knowledge that may be significantly different as a result of that screening test and therefore were excluded. Out of these 2,505 women contacted, 246 women did not receive the survey due to improper address, and four women died during the ten-year period. Thus, these women were not included in the study. Hence, a total of 2,255 women were presumed to have received the survey. Out of these, 1,104 women (49.0 %) completed and returned the survey which comprised the final size for the BPBCC cohort.

### Survey Instrument

Data were collected using the West Virginia University Institutional Review Board (WVU-IRB) approved Mammography Screening and Preventive Care Survey from women who utilized Bonnie's Bus and those who utilized the BPBCC to get a mammogram. The details about the survey development and its validation are explained elsewhere [24].

### Survey Administration and Data Collection

Women who utilized Bonnie's Bus to get a mammogram were provided study information and were asked to participate in the research survey. Women agreeing to participate were required to sign a consent and Health Insurance Portability and Accountability Act form before completing the survey. The consent form was used to seek their consent to use their survey data for research, and also contact them, if necessary, for the current or any other study for which they may be eligible in the future.

A survey, a cover letter, and a prepaid business reply envelope from the Medical Director of BPBCC were sent to the 2,505 randomly selected women who had been screened at the BPBCC at least once in the previous 10 years. After 3 weeks, a second mailing of the survey was sent to those who had not responded to the first mailing to maximize response rate. Those who completed and returned the survey were assumed to have given their consent to participate in the study. A \$5 gift-card was mailed to all women who completed and returned the survey to acknowledge their participation and time.

### Dependent Variable—Type of Mammography Screening Facility

The main outcome of interest was the type of mammography screening facility used by women age 40 years and above to get a mammogram. It was dichotomized into mobile mammography unit (Bonnie's Bus) and stationary screening facility (BPBCC).

### Independent Variables

Adherence to mammography screening guidelines, categorized as adherent and non-adherent, was used for both study cohorts. Various socio-demographic variables included age, education level, and employment status; and health-related variables included body mass index (BMI), smoking status, and alcohol consumption. Several variables such as household income, health insurance, visit to physician in the past year, visit to an OB/GYN in the past year, and delay in medical care due to transportation were also utilized. Variables related to health and medical history such as family history of BC, breast problems in the past, breast biopsy in the past, adherence to CBE, adherence to Pap test, and adherence to routine screening tests such as blood glucose test, bone mineral density test, cholesterol test, high blood pressure test were also included. A woman was considered adherent to CBE if she had CBE in the previous year and adherent to Pap test if she had Pap test within previous 2 years [27]. A woman who had all the four routine screening tests in the past 2 years was given a score of 4 while a woman who had not had any test in the past 2 years was given a score of 0. Perceived five-year risk and perceived lifetime risk of developing BC; views towards mammography screening; and knowledge about BC and mammography screening were assessed as well. The details of the assessment of perceived risk of developing BC, positive and negative views towards mammography screening, and knowledge about BC and mammography screening are described elsewhere [24]. Internal consistency for positive and negative views statements was evaluated using Cronbach's alpha co-efficient. For the Bonnie's Bus cohort, the Cronbach's alpha was 0.76 for the set of positive views and 0.71 for the set of negative views which indicated sufficient internal consistency. For the BPBCC cohort, the Cronbach's alpha was 0.76 for the set of positive views and 0.68 for the set of negative views, which indicated sufficient internal consistency.

### Non-Response Bias Assessment

To determine whether or not women who did not participate in the study were different from women who participated, non-response bias was assessed in both the study cohorts.

The basic information on age, marital status, employment status, and health insurance coverage, BMI and if it was their first mammogram were collected from all women who utilized Bonnie's Bus. These data were used to compare responders to non-responders of the survey. The survey response rate for the Bonnie's Bus was 50.6 %. Non-respondents were significantly older (64.4 % in age group  $\geq 65$  years,  $p < 0.0001$ ), were single/widowed (53.9 %,  $p = 0.002$ ), were unemployed (52.2 %,  $p = 0.001$ ), were overweight and morbidly obese (54.0 and 51.2 % respectively,  $p < 0.0001$ ) and had some kind of insurance coverage (51.7,  $p = 0.007$ ) (data not shown in tabular form).

The survey response rate for the BPBCC study sample was 49.0 %. From those who did not complete and return the survey, 400 women were randomly selected and mailed a WVU-IRB approved, brief, non-response bias assessment survey. This brief survey was developed by selecting key questions from the Mammography Screening and Preventive Care Survey. These included possible reasons for non-participation, time since last mammogram, a positive view statement about mammography screening, a knowledge item about mammography screening, and selected demographic and access related questions. Of those mailed the non-response survey, a total of 100 women completed and returned this survey. Twenty-eight women said that they misplaced the survey, and 26 % mentioned that they do not respond to mail surveys in general. Another 12 % of women indicated that they had no time to complete and mail back the survey, while 9 % mentioned other reasons for not participating in the study. Survey respondents were compared to non-respondents on the key information collected using the non-response bias assessment survey. Non-respondents were significantly more likely to be unemployed (54.0 %,  $p = 0.026$ ) and had less than college-level education (51.0 %,  $p = 0.013$ ) (data not shown in the tabular form).

#### Statistical Analyses

Chi square statistics for categorical variables and  $t$  tests for continuous variables were used to determine significant differences between the types of mammography facility used by women age 40 years and above to get a mammogram. Logistic regressions were also performed to analyze the relationship between types of mammography facility with all the independent variables. 'Stationary mammography facility (BPBCC)' was the reference group for the dependent variable. Resulting odds ratios and their corresponding 95 % confidence intervals are reported. The findings that are significant with  $p$  values  $< 0.05$  levels are discussed. SAS 9.3 software program was used for the statistical analyses.

## Results

### Results of Bivariate Analyses

The right panel of Table 1 describes the independent variables that were significantly different between women who utilized mobile mammography and the stationary mammography facility to get a mammogram. Approximately 48 % of women who utilized mobile mammography reported to be adherent to mammography screening guidelines as compared to an overwhelming 92 % among those who utilized the stationary mammography facility ( $\chi^2 = 522.057$ ,  $p < 0.0001$ ). The average age of women who utilized mobile mammography unit was 54.5 years while that of women who utilized the stationary mammography facility was 57.8 years ( $F = -8.67$ ,  $p < 0.0001$ ). All the independent variables except adherence to Pap test were significant at 0.05 % level for the type of mammography facility. Women who utilized mobile mammography unit were in age group 40–49 years ( $\chi^2 = 71.129$ ,  $p < 0.0001$ ), with less than college level education ( $\chi^2 = 230.069$ ,  $p < 0.0001$ ), unemployed ( $\chi^2 = 20.298$ ,  $p < 0.0001$ ), obese to morbidly obese ( $\chi^2 = 103.743$ ,  $p < 0.0001$ ), current smokers ( $\chi^2 = 94.519$ ,  $p < 0.0001$ ), did not consume alcohol ( $\chi^2 = 129.249$ ,  $p < 0.0001$ ), and with annual household income of less than \$25,000 ( $\chi^2 = 593.366$ ,  $p < 0.0001$ ). Also women who utilized mobile mammography unit did not have health insurance ( $\chi^2 = 442.507$ ,  $p < 0.0001$ ), did not visit doctor ( $\chi^2 = 57.004$ ,  $p < 0.0001$ ) and OB/GYN ( $\chi^2 = 73.199$ ,  $p < 0.0001$ ) in the past year, did not report family history of BC ( $\chi^2 = 3.939$ ,  $p = 0.0472$ ), had any kind of breast problems ( $\chi^2 = 40.955$ ,  $p < 0.0001$ ) and breast biopsy in the past ( $\chi^2 = 64.978$ ,  $p < 0.0001$ ), were not adherent to CBE ( $\chi^2 = 57.164$ ,  $p < 0.0001$ ) and did not have all the four routine screenings ( $\chi^2 = 106.243$ ,  $p < 0.0001$ ). Moreover, women who utilized mobile mammography unit had lower perceived five-year risk ( $\chi^2 = 19.363$ ,  $p < 0.0001$ ) and lower perceived lifetime risk ( $\chi^2 = 15.768$ ,  $p = 0.0004$ ) of developing BC, higher knowledge about BC ( $\chi^2 = 60.347$ ,  $p < 0.0001$ ) and stronger agreement with the positive views ( $F = -4.780$ ,  $p < 0.0001$ ) and weaker disagreement with the negative views about BC ( $F = -5.330$ ,  $p < 0.0001$ ).

### Results of Multivariable Analyses

Table 2 indicated the adjusted odds ratios (AOR) and 95 % confidence intervals (CI) of all the variables which predicted women's utilization of mobile mammography unit to get a mammogram. Women who got screened at the mobile mammography unit were less likely to be in age groups 50–64 years and 65 years and above as compared to women in age group 40–49 years. The adjusted odds ratio (AOR) were 0.465 (95 % CI = 0.347–0.624) and 0.232

**Table 1** Description of the study samples of WV women age 40 and above by the type of mammography screening facility

	Mobile unit		Stationary facility		Chisqr/t-test	<i>p</i> value	Sig
	<i>N</i> (1,161)	%	<i>N</i> (1,104)	%			
Adherence					522.057	< 0.0001	***
Yes	559	48.15	1,019	92.30			
No	602	51.85	85	7.70			
Age					71.129	< 0.0001	***
40–49	361	31.09	217	19.66			
50–64	662	57.02	630	57.07			
65 & above	138	11.89	257	23.28			
Mean	54.469		57.799		–8.67	< 0.0001	***
Median	54		57				
Range	(40, 88)		(40, 80)				
Education					230.069	< 0.0001	***
Less than HS	43	3.70	15	1.36			
Some HS/HS grad	522	44.96	273	24.73			
GED/tech	247	21.27	135	12.23			
Some college/graduate	349	30.06	681	61.68			
Employment status					20.298	< 0.0001	***
Employed	558	48.06	635	57.52			
Unemployed	603	51.94	469	42.48			
Body mass index					103.743	< 0.0001	***
Underweight/normal weight	205	17.66	351	31.79			
Overweight	280	24.12	327	29.62			
Obese	393	33.85	214	19.38			
Extremely obese	163	14.04	126	11.41			
Morbidly obese	120	10.34	86	7.79			
Smoking status					94.519	< 0.0001	***
Never	630	54.26	729	66.03			
Former	236	20.33	267	24.18			
Current	295	25.41	108	9.78			
Alcohol consumption					129.249	< 0.0001	***
Yes	287	24.72	526	47.64			
No	874	75.28	578	52.36			
Household Income					593.366	< 0.0001	***
Less than \$25,000	777	66.93	232	21.01			
\$25,000–\$50,000	242	20.84	270	24.46			
\$50,000–\$75,000	83	7.15	220	19.93			
More than \$75,000	59	5.08	382	34.60			
Health insurance					442.507	< 0.0001	***
Yes	660	56.85	1,048	94.93			
No	501	43.15	56	5.07			
Visit to doctor in past year					57.004	< 0.0001	***
Yes	671	57.80	805	72.92			
No	490	42.20	299	27.08			
Visit to OB/GYN in past year					73.199	< 0.0001	***
Yes	405	34.88	582	52.72			
No	756	65.12	522	47.28			
Delayed care due to transportation problem					5.331	0.0209	*
Yes	58	5.00	34	3.08			
No	1,103	95.00	1,070	96.92			

**Table 1** continued

	Mobile unit		Stationary facility		Chisqr/t-test	p value	Sig
	N (1,161)	%	N (1,104)	%			
Family History of BC					3.939	0.0472	*
Yes	190	16.37	216	19.57			
No	971	83.63	888	80.43			
Breast problems					40.955	< 0.0001	***
Yes	152	13.09	259	23.46			
No	1,009	86.91	845	76.54			
Breast biopsy in past					64.978	< 0.0001	***
Yes	215	18.52	368	33.33			
No	946	81.48	736	66.67			
Adherence to CBE					57.164	< 0.0001	***
Yes	544	46.86	692	62.68			
No	617	53.14	412	37.32			
Adherence to PAP test					0.504	0.4779	
Yes	798	68.73	774	70.11			
No	363	31.27	330	29.89			
Total score of screenings					106.243	< 0.0001	***
0–3	1,002	86.30	753	68.21			
4	159	13.70	351	31.79			
Perceived 5 year risk					19.363	< 0.0001	***
Lower	513	44.19	391	35.42			
Similar	508	43.76	541	49.00			
Higher	140	12.06	172	15.58			
Perceived lifetime risk					15.768	0.0004	***
Lower	440	37.90	337	30.53			
Similar	560	48.23	571	51.72			
Higher	161	13.87	196	17.75			
Knowledge score					60.347	< 0.0001	***
0–2	73	6.29	75	6.79			
3–4	541	46.60	683	61.87			
5–6	547	47.11	346	31.34			
Views							
Positive views							
Mean	1.741		1.975		–4.780	< 0.0001	***
Negative views							
Mean	5.509		5.822		–5.330	< 0.0001	***

HS high school, OB/GYN obstetrician/gynecologist, CBE clinical breast exam, Chisqr chi square, Sig significance. For views, score 1 is equal to strongly agree and score 7 is equal to strongly disagree on the scale of 1 to 7

\*\*\*  $p < 0.001$ ; \*\*  $0.001 \leq p < 0.01$ ; \*  $0.01 \leq p < 0.05$

(95 % CI = 0.154–0.349), respectively. Also women who got mammography screening at the mobile mammography unit were 1.78 times more likely to be current smokers than those who never smoked (AOR = 1.776, 95 % CI = 1.280–2.466). Women who utilized mobile mammography unit to get a mammogram were 46 % less likely to consume alcohol than those who did not consume alcohol (AOR = 0.537, 95 % CI = 0.414–0.698). Women who utilized mobile mammography unit were significantly less likely to have higher annual household income. The

AORs were 0.399 (95 % CI = 0.300–0.532), 0.210 (95 % CI = 0.145–0.303) and 0.092 (0.062–0.137) for income range of \$25,001–\$50,000, \$50,001–\$75,000 and more than \$75,000 respectively. Moreover, women who got mammography screening at the mobile mammography unit were 6.1 times more likely not to have health insurance coverage (AOR = 6.097, 95 % CI = 4.285–8.675). Women who utilized mobile mammography unit to get a mammogram were more likely not to have visited a doctor or OB/GYN in the past year. The AOR were 1.381, 95 %

**Table 2** Adjusted odds ratios and 95 % confidence interval from logistic regression of attending mobile mammography facility

	Mobile unit			
	AOR	95 % CI	<i>p</i> value	Sig
Age				
40–49	1			
50–64	0.465	[0.347, 0.624]	<0.0001	***
65 & above	0.232	[0.154, 0.349]	<0.0001	***
Education				
Less than HS	1			
Some HS/HS grad	0.878	[0.409, 1.882]	0.7376	
GED/Tech	0.881	[0.400, 1.938]	0.7522	
Some college/Graduate	0.462	[0.213, 1.001]	0.0504	
Employment status				
Employed	1			
Unemployed	1.004	[0.771, 1.307]	0.9748	
Body mass index				
Underweight/Normal weight	1			
Overweight	1.195	[0.855, 1.670]	0.2973	
Obese	1.876	[1.342, 2.623]	0.0002	***
Extremely obese	1.183	[0.783, 1.787]	0.4251	
Morbidly obese	1.310	[0.834, 2.058]	0.2407	
Smoking status				
Never	1			
Former	1.075	[0.805, 1.434]	0.6252	
Current	1.776	[1.280, 2.466]	0.0006	***
Alcohol consumption				
Yes	0.537	[0.414, 0.698]	<0.0001	***
No	1			
Household income				
Less than \$25,000	1			
\$25,000–\$50,000	0.399	[0.300, 0.532]	<0.0001	***
\$50,000–\$75,000	0.210	[0.145, 0.303]	<0.0001	***
More than \$75,000	0.092	[0.062, 0.137]	<0.0001	***
Health insurance				
Yes	1			
No	6.097	[4.285, 8.675]	<0.0001	***
Visit to doctor in past year				
Yes	1			
No	1.381	[1.063, 1.794]	0.0157	*
Visit to OB/GYN in past year				
Yes	1			
No	1.734	[1.349, 2.231]	<0.0001	***
Delayed care due to transportation problem				
Yes	0.497	[0.282, 0.879]	0.0161	*
No	1			
Family history of BC				
Yes	0.942	[0.685, 1.295]	0.7114	
No	1			

**Table 2** continued

	Mobile unit			
	AOR	95 % CI	<i>p</i> value	Sig
Breast problems				
Yes	0.525	[0.373, 0.739]	0.0002	***
No	1			
Breast biopsy in past				
Yes	0.609	[0.453, 0.819]	0.0010	**
No	1			
Adherence to CBE				
Yes	1			
No	1.377	[1.054, 1.797]	0.0188	*
Adherence to PAP test				
Yes	1			
No	0.704	[0.537, 0.925]	0.0116	*
Total score of screenings				
0–3	1.599	[1.203, 2.125]	0.0012	**
4	1			
Perceived 5 year risk				
Lower	1			
Similar	0.725	[0.496, 1.059]	0.0963	
Higher	0.483	[0.260, 0.895]	0.0208	*
Perceived lifetime risk				
Lower	1			
Similar	1.039	[0.704, 1.533]	0.8475	
Higher	1.113	[0.613, 2.022]	0.7240	
Knowledge				
0–2	0.256	[0.160, 0.407]	<0.0001	***
3–4	0.303	[0.236, 0.389]	<0.0001	***
5–6	1			
Views				
Positive views	0.825	[0.748, 0.909]	0.0001	***
Negative views	0.896	[0.822, 0.977]	0.0127	*

The regressions also include intercept terms and parameter estimates for other variables controlled are not presented. Asterisks represent statistically significant group differences compared to the reference group. “Stationary mammography facility” is the reference group for the dependent variable

*HS* high school, *OB/GYN* obstetrician/gynecologist, *CBE* clinical breast exam, *CI* confidence interval, *Sig* significance. For views, score 1 is equal to strongly agree and score 7 is equal to strongly disagree on the scale of 1–7

\*\*\*  $p < 0.001$ ; \*\*  $0.001 \leq p < 0.01$ ; \*  $0.01 \leq p < 0.05$

CI = 1.063–1.794 and 1.734, 95 % CI = 1.349–2.231, respectively. Women who got mammography screening at the mobile mammography unit were 50 % less likely to report delayed care due to transportation problem. In addition, women who utilized mobile mammography unit were less likely to have had breast problems in the past (AOR = 0.525, 95 % CI = 0.373–0.739) or have had breast biopsy in the past (AOR = 0.609, 95 % CI = 0.453–0.819).

Women who utilized mobile mammography unit were 1.4 times less likely to be adherent to CBE (AOR = 1.377, 95 % CI = 1.054–1.797), 30 % less likely to be non-adherent to Pap test (AOR = 0.704, 95 % CI = 0.537–0.925), and 1.6 times more likely not to have all the four routine screenings in the past 2 years (AOR = 1.599, 95 % CI = 1.203–2.125). In addition, women who utilized mobile mammography unit were 51 % less likely to have higher perceived 5-year risk of developing BC (AOR = 0.483, 95 % CI = 0.260–0.895). Women who utilized mobile mammography unit had lower likelihood of having low to moderate knowledge about mammography screening and BC. The AORs were 0.256 (95 % CI = 0.160–0.407) and 0.303 (95 % CI = 0.236–0.389), respectively. Also, women who got screened at the mobile mammography unit were 17 % less likely to have reduced level of agreement towards positive statements about mammography screening (AOR = 0.825, 95 % CI = 0.748–0.909). Besides, women who utilized mobile mammography unit were 10 % less likely to have reduced level of agreement towards negative statements about mammography screening (AOR = 0.896, 95 % CI = 0.822–0.977). Women who utilized mobile mammography unit were 91 % less likely to be adherent to mammography screening guidelines as compared to those who utilized stationary mammography facility (data not shown).

## Discussion

In this study, the characteristics of women age 40 years and above who utilized a mobile mammography service were compared to those who utilized a stationary mammography facility. Among women who utilized mobile mammography unit, only 48.2 % were adherent to mammography screening guidelines as compared to 92.3 % among those who utilized stationary mammography facility. Adherence to mammography screening for women who utilized mobile unit is significantly below the national Healthy People 2010 goals for mammography screening [28], WV screening rate of 72.3 % [29] and the national screening rate of 75.4 % in 2010 [29]. As suggested by previous studies, mobile mammography program may be more likely to provide mammography screening to those women who were never ever screened or who were long overdue (more than 2 years) to undergo mammography screening [30, 31]. By providing mammography screening at no cost or low cost to these women, mobile mammography programs such as Bonnie's Bus can eliminate some of the barriers to mammography screening typically experienced by lower income women residing in underserved areas. Thus, mobile mammography is useful to underserved women who may not go to a medical facility to get screened due to lack of insurance coverage or other issues,

and so are at a greater risk of an advanced stage BC detection if diagnosed. Furthermore, the high mammography screening rate among women who utilized stationary facility suggests that these women may have overcome the potential barriers to mammography screening.

Consistent with the previous studies, the findings indicated that mobile mammography units typically attract younger women age 40–49 years, who are not adherent to mammography screening guidelines, with lower annual household income, and no health insurance coverage [30, 31]. Women who utilized mobile mammography did not visit their doctor or OB/GYN in the past year, and were adherent to Pap test but not adherent to CBE and routine screenings. This indicates that younger women age 40–49 years may be more concerned about the Pap test than mammography screening or CBE or other routine screenings. In addition, women with higher knowledge about mammography screening were more likely to get screening at the mobile mammography unit. This indicates that though these women have higher knowledge concerning the importance of mammography screenings, they may not get screened at the stationary facility due to lack of health insurance coverage and other financial constraints. Interventions around mobile mammography unit, targeted at women age 50 and above who have financial and insurance problems, and have no access to a provider may be beneficial to increase mammography screening in the rural and underserved women in WV.

There are several limitations of the study. One limitation is the response rate; 49 % of women who utilized mobile mammography unit and 51 % of women who utilized stationary mammography facility did not complete surveys. A non-respondents analysis indicated that, compared to respondents, non-respondents for mobile mammography unit were more likely to be older, and more likely to be single/widowed, morbidly obese, as well as have insurance coverage. Moreover, non-respondents analysis for women who utilized stationary facility indicated that, compared to respondents, non-respondents were more likely to be unemployed and to have lower levels of education. Hence, these should be taken into consideration while extrapolating the findings of the study, particularly when attempting to generalize outside of WV.

## Conclusions

High proportion of women who utilize mobile unit are not adherent to mammography screening guidelines thereby suggesting that the mobile mammography unit is indeed reaching a rural vulnerable population who may not routinely access preventive health services. Financial and insurance constraints, as well as access to medical care, restricted WV

women from receiving mammography screening from the stationary screening facilities. In contrast, the mobile mammography unit served the rural and underserved women in WV by offering low-cost or free-of-cost services.

**Acknowledgments** This research study is partially funded by Susan G. Komen For the Cure, Claude Worthington Benedum Foundation, and AHRQ Grant # R24HS018622-02.

**Conflict of interests** No competing financial interests exist.

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