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Characteristics of US Counties with No Mammography Capacity

Lucy A. Peipins,
Division of Cancer Prevention and Control, Centers for Disease Prevention and Control, Atlanta, GA, USA. Epidemiology and Applied Research Branch, DCPC, CDC, 4770 Buford Highway, NE, Mailstop K55, Atlanta, GA 30341-3717, USA

Jacqueline Miller,
Division of Cancer Prevention and Control, Centers for Disease Prevention and Control, Atlanta, GA, USA

Thomas B. Richards,
Division of Cancer Prevention and Control, Centers for Disease Prevention and Control, Atlanta, GA, USA

Janet Kay Bobo,
Battelle Centers for Public Health Research and Evaluation, Seattle, WA, USA

Ta Liu,
Battelle Centers for Public Health Research and Evaluation, Seattle, WA, USA

Mary C. White,
Division of Cancer Prevention and Control, Centers for Disease Prevention and Control, Atlanta, GA, USA

Djenaba Joseph,
Division of Cancer Prevention and Control, Centers for Disease Prevention and Control, Atlanta, GA, USA

Florence Tangka, and
Division of Cancer Prevention and Control, Centers for Disease Prevention and Control, Atlanta, GA, USA

Donatus U. Ekwueme
Division of Cancer Prevention and Control, Centers for Disease Prevention and Control, Atlanta, GA, USA

Abstract

Access to screening mammography may be limited by the availability of facilities and machines, and nationwide mammography capacity has been declining. We assessed nationwide capacity at state and county levels from 2003 to 2009, the most recent year for which complete data were available. Using mammography facility certification and inspection data from the Food and Drug Administration, we geocoded all mammography facilities in the United States and determined the total number of fully accredited mammography machines in each US County. We categorized mammography capacity as counties with zero capacity (i.e., 0 machines) or counties with capacity (i.e.,≥1 machines), and then compared those two categories by sociodemographic, health care, and geographic characteristics. We found that mammography capacity was not distributed equally across counties within states and that more than 27 % of counties had zero capacity. Although the number of mammography facilities and machines decreased slightly from 2003 to 2009, the percentage of counties with zero capacity changed little. In adjusted analyses, having zero mammography capacity was most strongly associated with low population density (OR = 11.0; 95 % CI 7.7–15.9), low primary care physician density (OR = 8.9; 95 % CI 6.8–11.7), and a low percentage of insured residents (OR = 3.3; 95 % CI 2.5–4.3) when compared with counties having at least one mammography machine. Mammography capacity has been and remains a concern for a portion of the US population—a population that is mostly but not entirely rural.

Keywords

Mammography; Access; Breast cancer; Screening

Introduction

Screening mammography is currently the most effective way to detect breast abnormalities and has led to an estimated 10–25 % mortality reduction from breast cancer [1, 2]. Even as mammography use has reached a plateau in recent years [3], mammography usage varies by state [4] and a significant proportion of women are not up-to-date with screening, especially low-income women, those who are uninsured [5, 6] and those without usual source of care [7]. In November 2009, the US Preventive Services Task Force (USPSTF) recommended that women aged 50 and older undergo routine screening mammography every 2 years [8]. Earlier USPSTF recommendations and those of the American Cancer Society and the American College of Radiology recommended beginning annual screening for women 40 years of age and older [9, 10].

Among the barriers to screening that have been detailed in the literature is access to mammography facilities [11–15]. The conceptual framework describing access to medical services includes a number of related characteristics: availability or supply of services, accessibility or distance to those services, how accommodating and acceptable the services are to individuals, and the affordability of the services [16]. The availability of mammography machines, defined as mammography capacity, is a key component of access. In 2006, the US Government Accountability Office (GAO) issued a report regarding nationwide capacity for mammography from 2001 to 2004 indicating that mammography capacity decreased by 6 %. Although the capacity was judged to be nationally adequate, one-fourth of counties had no mammography capacity [17]. Additional research has shown that the lack of imaging resources in the US may be a barrier to screening [18] as well as being associated with a later breast cancer stage at diagnosis [19].

For this analysis, we updated the GAO 2006 report and provided a more detailed examination of state- and county-level mammography capacity from 2003 to 2009, the most recent years for which complete data were available. Because a relatively large proportion of counties have no capacity, we further sought to describe and compare the sociodemographic and geographic characteristics of counties with zero mammography capacity (no machines) with those counties having capacity (at least one machine) in order to better understand the factors that underlie disparities in access to mammography.

Methods

Mammography Facilities

To determine the location of all certified mammography facilities in US counties during 2003–2009, we obtained data from the mammography program reporting and information system (MPRIS), which is managed by the Food and Drug Administration (FDA) [20]. The FDA requires all US mammography facilities (including those in US territories and overseas military facilities) to undergo annual inspections and triennial accreditation and certification in order to comply with the Mammography Quality Standards Act (MQSA) of 1992 (42 U.S.C. 263b, reauthorized 1998 and 2004). For each year in our study interval, we identified all facilities certified on October 1st of that year. Using the facility ID codes, we linked each certification record to the corresponding annual inspection record, which contained the address data used for the on-site inspections and findings from those inspections.

After excluding facilities with an address in a US territory or an overseas location, we used all available street address, city, state and ZIP code data to determine the county where the facility was located. Using a variety of geocoding resources [ESRI Street Map Premium, 2008 NAVTEQ streets, Caliper TransCAD, and ESRI Data DVD 9.3 with ArcGIS software (Version 9.3, ESRI, Redlands, CA)], we geocoded 97 % of the facilities to the street level and the remaining 3 % to the zip code level. In most instances in which facilities were geocoded only to the zip code level, the entire zip code area fell within a county boundary. If the zip code spanned more than one county, but 95 % of the population in that zip code resided in one county, we assigned the facility to that county. We also used web mapping tools (Superpages.com and Google Maps) or information from facility staff to determine the county in which a facility was located. County boundaries in all states were based on 2007 data.

To estimate annual county-level mammography capacity, we aggregated inspection record data across all county facilities to determine the total number of available fully accredited mammography units in each county, including all full field digital, computed radiography, film screen and mobile units. We then classified counties as either having or not having at least one mammography unit. Next, we derived year-specific mammography capacity ratios for each county by dividing the number of mammograms that theoretically could be performed in the county by the number of women in the county 40 years of age and older. We estimated the number of mammograms that theoretically could be performed by multiplying the number of mammography machines in the county by 6,000 (the number of mammograms that the GAO estimated that a single mammography machine can perform per year) [17]. A capacity to population ratio ≥1 indicates that capacity fully meets the population needs for that year. Ratios below 1.0 suggest the county would not be able to provide a mammogram to all female county residents 40 years of age and older in that year. We used an age cutoff of 40 for our analyses because most screening guidelines during the study period recommended that mammography screening begin at age 40, and results of a

2006–2007 survey of US primary care physicians showed that virtually all were recommending that their patients begin annual mammography screening at age 40 [21].

County Characteristics

We used the most recent county-level sociodemographic data available from a number of sources. We obtained annual population data from the US Bureau of the Census [22]; county-level estimates of the number of residents in poverty from the Bureau of the Census' Small Area Income Poverty Estimates (SAIPE) 2009 file [23]; the percentage of residents in each county who had health insurance from 2007 Small Health Area Insurance Estimates (SAHIE) data; and the percentage of the employed civilian labor force, aged 16 years or older, who were in management, professional, and related occupations, and the percentage who were in sales and office occupations from the 2000 Census of Population and Housing Demographic Profile, included in the Health Resources and Services Administration 2009–2010 Area Resource File (ARF) [24]. In addition, we used data from Census 2000 Summary File 3 to calculate the household income inequality ratio for each county. The household income inequality ratio is the ratio of the number of households with high household income in 1999 (the upper fifth or ≥$75,000) divided by the number of households with low household income (lowest fifth or ≤$19,000 or less). Census 2000 Summary File 3 provided the number of households in 16 county-level household income categories. The total household income for each category was estimated by multiplying the number of households in each category by the mid-point of the range of income for each category.

We also used data from the 2009–2010 ARF to determine county-level numbers of non-federal primary care physicians (i.e., physicians specializing in family medicine, general practice, general internal medicine, and general obstetrics-gynecology). We then calculated the primary care physician density per 100,000 county residents by dividing the number of primary care physicians in each county by that county's population estimate and multiplying by 100,000.

Rural/Urban Classification of Counties

We divided counties into three population categories based on rural/urban continuum (RUCC) codes developed in 2003 by the US Department of Agriculture [25]. The RUCC codes divide counties into nine groups based on their population and their adjacency to a metropolitan county. We distinguished between metropolitan counties (codes 1–3), suburban/small town counties (codes 4–7) and rural counties (codes 8–9) in our analyses.

Statistical Analyses

We used SAS version 9.2 (SAS Institute Inc., Cary, North Carolina) to compare zero capacity counties to counties with at least one mammography machine by their urban–rural classification and by the selected socio-demographic characteristics and health care variables described above. Using ArcGIS 10 software (ESRI, Redlands WA), we constructed a map showing the location of counties with no mammography capacity.

We then examined the relationship between mammography capacity (zero capacity vs. any capacity) and total population density, percent insured, percent poverty, household income inequality ratio, and primary care physician density using multivariate logistic regression to calculate adjusted odds ratios (ORs) and 95 % confidence intervals (CIs). The values of each of the independent variables were divided into tertiles. Regression analyses were performed using SAS software version 9.2 (SAS Institute Inc., Cary, North Carolina).

Results

From 2003 to 2009, the number of US, mammography facilities decreased by roughly 5 % (from 8,936 to 8,505) and the number of mammography machines decreased by roughly 10 % (from 13,400 to 12,098) (Table 1). If one assumes that each machine has the potential to perform 6,000 mammograms per year, this means that the maximum annual number of mammograms that could be performed in the United States decreased by 7.8 million during this period. The number of digital machines increased almost 19-fold (from 350 to 6,572), and the proportion of all machines that were digital increased from 2.6 to 54.3 %. The number of counties with no machines, or zero capacity, remained between 27 and 28 % throughout the study period. In 2009, 3.4 % of US women aged 40 years or older, or slightly more than 2.5 million women, resided in counties with no mammography capacity. However, the proportion of women in zero-capacity counties varied substantially by region: 0.2 % in the Northeast region, 1.2 % in the West region, 3.9 % in the Midwest region, and 6.1 % in the South region (data not shown). As shown in Fig. 1, zero-capacity counties were concentrated in a wide swath from west Texas–North Dakota as well as in several southern states.

At the state level (Table 2), the capacity to population ratio ranged from 0.78 in Maryland to 2.14 in North Dakota. Although most states had an adequate number of mammography machines overall, 84 % of states had one or more counties with no machines. In 2009, Texas, Virginia, Georgia, Missouri, and Nebraska had the largest number of zero-capacity counties, and South Dakota, North Dakota, Texas, Alaska, and Idaho had the highest percentage of zero-capacity counties. All but 8 states had fewer machines in 2009 than in 2003, with the largest decreases occurring in New York, Pennsylvania, Indiana, Texas, and Illinois.

In 2009, the proportion of mammography machines that were digital ranged from 31 % in Wyoming to 81 % in Vermont; California, Texas, New York, Florida, and Pennsylvania had the largest number of digital machines (together accounting for 34 % of the national total) (Table 2). Of all digital machines, 86.1 % were in metropolitan counties, 13.3 % in suburban/small town counties, and 0.6 % in rural counties (data not shown).

Of the 12,098 mammography machines reported for 2009, 225 were mobile machines. Furthermore, 86 % (194/225) of the mobile machines were in metro counties. Only 3 mobile mammography machines were in completely rural counties (RUCC codes 8–9) (data not shown).

Most zero-capacity counties were classified as “rural” (Table 3). Rural counties were eight times more likely to have zero capacity than were counties classified as “metropolitan” (data not shown). Among women 40 years of age and older who resided in rural counties, more than half of the women resided in counties with no mammography machines whereas only around 2 % of those in metropolitan counties had no such access. In addition, the 2009 population density in zero-capacity counties was less than that in counties with at least one mammography machine even among counties with the same urban–rural classification. However, the mean population density in both suburban/small town and rural zero-capacity counties was considerably less than that in metropolitan zero-capacity counties, which suggests that population density does not, by itself, account for the number of mammography machines. Overall, there was about 6 % difference in the percent insured among the various rural–urban categories, with the lowest percent insured seen in zero capacity non-metropolitan rural counties.

The proportion of residents with incomes below the poverty level averaged 13.9 % in urban counties, 17.7 % in suburban/small town counties, and 17.4 % in rural counties (Table 3). The highest percentage of poverty (20.3 %) was in zero-capacity suburban/small town counties. Overall, the household income inequality ratio in metropolitan counties was about 2.5 times higher than that in suburban/small town counties and about 3.0 times higher than that in rural counties. Although the income inequality ratios for metropolitan and suburban/small town counties were substantially higher in counties with mammography capacity than in counties with no capacity (15.4 vs. 8.5 and 5.7 vs. 3.9, respectively), the ratios for rural counties differed little by mammography capacity status (4.2 vs. 4.1). Among counties with mammography capacity, primary care physician density was higher in those classified as metropolitan than in those classified as suburban/small town or rural. Among zero-capacity counties, physician density was highest in those classified as suburban/small town, and physician density in counties classified as rural was similar to that in counties classified as metropolitan.

Results of our unadjusted analysis of the relationship between the absence of mammography machines and county characteristics showed that the likelihood of a county having zero capacity was positively associated with the percentage of the population below the poverty level and negatively associated with population density, percentage of the population with health insurance, household income inequality ratio, and primary care physician density (Table 4). Although each of these associations remained significant in our adjusted analyses, zero capacity was most strongly associated with low population density (OR = 11.0; 95 % CI 7.7, 15.9), low primary care physician density (OR = 8.9; 95 % CI 6.8, 11.7), and a low percentage of insured residents (OR = 3.3; 95 % CI 2.5, 4.3).

Discussion and Conclusions

For the majority of states in the US, the number of mammography machines appears adequate for the population as a whole, but analyses by state do not capture geographic disparities within the state. Similar to an earlier examination of national mammography capacity, our findings indicate that capacity is not distributed equally across counties [18] and that 870 (27.7 %) counties have zero capacity. Although the number of mammography facilities and machines decreased slightly between 2003 and 2009, the percentage of zero-capacity counties remained fairly consistent. According to 2009 census data, almost 2.5 million women 40 years of age and older lived in these zero-capacity counties. In general, zero-capacity counties had a lower population density, a higher percentage of residents in poverty, a lower prevalence of insurance coverage, and a lower primary care physician density than did counties with at least one mammography machine.

We also found that, in metropolitan and suburban/small town counties, the likelihood of having a least one mammography machine was positively associated with income inequality. The magnitude of differences across the income spectrum and concentrated wealth or poverty represent different kinds of inequalities that can operate differently at individual, community or larger geographic levels [26]. Income inequality has been associated with health disparities [27] but the pathways through which inequality operates are not fully understood [28] [29]. A higher income inequality ratio indicates a wider range of incomes and higher incomes suggest higher demand and ability to pay for services requiring more resources to meet that demand [30]. This may be especially true for the growth of a new technology such as digital mammography. Higher income inequalities were seen in metropolitan and suburban/small town counties compared with rural counties and in metropolitan capacity versus metropolitan zero-capacity counties. Income inequality, mammography capacity, and the proportion of digital machines were largest for the metropolitan counties. While services may be present in metropolitan counties with high income inequalities as demanded by high income groups, these services may not be accessible to the lowest income groups within that county whose dependence on public transportation may limit access [31]. Household income inequality ratio was the same for rural capacity and zero-capacity counties. Rural counties with capacity have higher population density, lower poverty and higher physician density than rural counties with zero capacity.

The results of our multivariate regression analysis showed that population density, primary care physician density, and insurance prevalence were the factors most strongly associated with a county's mammography capacity status. Within all three of our urban–rural categories, zero-capacity counties had a lower primary care physician density than did counties with at least one mammography machine. The metropolitan zero capacity counties had a physician density almost equal to the zero capacity rural areas despite the higher population density of the metropolitan area counties. Although most of these counties were classified as metropolitan due in some degree to their adjacency to large metropolitan counties, they are not rural. Clearly medical service shortage is not strictly a phenomenon of rural areas.

Technology is an important consideration with respect to the geographic allocation of medical resources. More advanced technology would typically be seen in locations that can support such technology, both in terms of trained personnel, specialized facilities or other resources, and this is true for digital mammography capacity located primarily in metropolitan areas. While the percent of digital mammography machines has increased substantially over this time period, the vast majority are located in metropolitan areas (86 % in metropolitan counties vs. 0.6 % in rural counties (data not shown). These areas are also areas of greatest income inequality and of demand and ability to pay for new technologies. However, because digital mammography machines produce images that can be transmitted electronically to off-site locations for interpretation, digital machines may be especially

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appropriate technology for rural areas, the areas least likely to have them. A potential barrier is the increased cost associated with digital mammography [32]. Even as digital machines allow facilities to increase exam workload [33] and produce records that are easily accessible thereby improving efficiency and productivity, savings may be offset by the cost of the equipment as well as costs associated with image archiving and printing [34].

Our facility numbers do not exactly match those found on the FDA Website Scorecard Statistics which presents commonly requested national statistics on the MQSA program [35]. This is due to several factors. First, the FDA counts all facilities that are certified, including military facilities outside the US We included only facilities within US counties. Second, the FDA summary statistics are based upon certification records where addresses may not be actual facility addresses but may refer to administrative offices. In contrast, we merged certification information with inspection records in order to obtain the actual addresses used by inspectors when they go onsite to inspect the facilities. Despite these differences, we obtained an overall facility percentage match of 97–98 % for the years 2003–2009.

One limitation is that capacity assessments at the state or county levels do not indicate whether people in a specific area within a state or county have access to mammography services within that area. For example, we found that North Dakota had a large number of zero-capacity counties even though it had an overall capacity to population ratio >1, indicating adequate capacity at the state level. Similarly, the assignment of uniform sociodemographic characteristics at the county level can conceal considerable variation in the distribution of these characteristics at the community level, a variation which our results do not reflect. Furthermore, US counties differ substantially in size and population density, and county residents are not distributed evenly within counties. We took population density into account in our assessment of the relationship between county sociodemographic characteristics and absence of mammography machines. Another potential limitation is that women in zero capacity counties may have obtained mammograms from a neighboring county or from a mobile mammography machine from an adjacent county. Since the locations of mobile mammography machines were assigned to the county of its home facility, their areas of service were unknown. Although the number of mobile machines is low, resulting in little impact on overall capacity, some zero capacity counties may be served by these mobile machines from another county. Another limitation is that we almost certainly overestimated mammography capacity because we assumed that all machines were fully functional at all times.

Several studies comparing screening prevalence to availability of mammography facilities using data from the Behavioral Risk Factor Surveillance System (BRFSS) found that unavailability of mammography facilities may be a barrier to screening [18, 36]. We could not provide a direct assessment of the relationship between screening utilization as reported in the BRFSS and the availability of screening facilities from the FDA because of BRFSS data limitations. BRFSS samples are designed to provide reliable national and state-level estimates on risk factors and health-related behavior. Many of our zero capacity counties had relatively small populations, and the number of BRFSS respondents in those counties was too small to provide a reliable county level estimate.

Our results show that mammography capacity has been and remains a concern for a portion of the US population—a population that is mostly but not entirely rural. Increasing the age at which mammography is initiated from 40 to 50 years of age would reduce the total number of mammography machines needed on a national basis, would have no effect on zero capacity counties. In the current economic environment, the efficient allocation of resources where need is greatest assumes an even greater importance. This investigation of capacity is one step in assessing that need. Also suggested by this research is the need to allocate resources where the need is greatest or likely to increase. Digital mammography can facilitate remote screening services which may help to address chronic deficits in medical services, despite increased cost. Furthermore, changes in the age distribution of the population and changes in insurance coverage that would decrease cost-sharing would be expected to create greater demand in certain locations [37]. A countervailing trend however, is a potential for decline in capacity due to financial constraints brought on by the recent economic downturn. These changes suggest a need to monitor capacity in the future. A focus on the distribution of mammography services and on the effects of technological advances may inform our efforts to address disparities in access to mammography.

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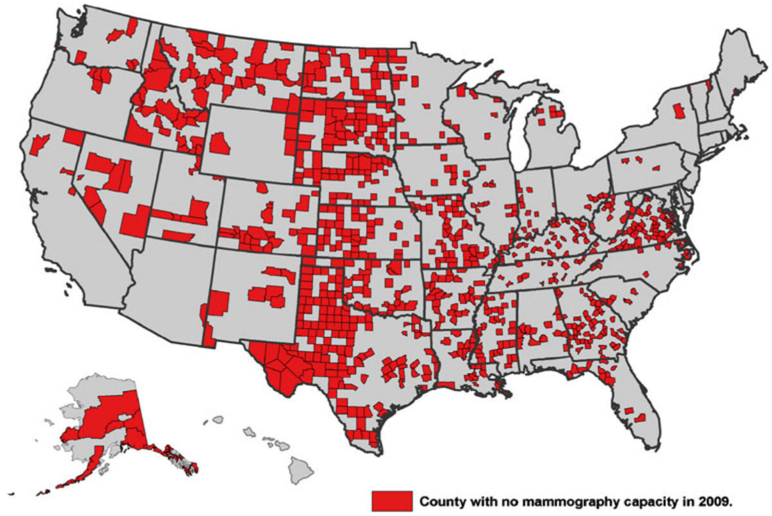

Fig. 1.
Counties with no mammography capacity (n = 870), Mammography Program Reporting and Information System Data, 2009

Table 1

US mammography capacity by year, 2003–2009

	Facilities	Mammography machines, total[a]	Counties with no machines	Digital machines[c]	Mobile units	Counties with at least 1 mobile unit
Year	N	N	N (%[b])	N (% total)	N	%
2003	8,936	13,400	866 (27.6)	350 (2.6)	305	6.2
2004	8,827	13,408	852 (27.1)	544 (4.1)	262	5.6
2005	8,704	13,394	852 (27.2)	860 (6.4)	215	4.4
2006	8,655	13,314	860 (27.4)	1,437 (10.8)	180	3.5
2007	8,647	12,993	857 (27.3)	2,595 (20.0	155	3.1
2008	8,616	12,548	856 (27.3)	4,662 (37.2)	160	3.0
2009	8,505	12,098	870 (27.7)	6,572 (54.3)	225	4.7

[a] Sum of number of film screen units, full field digital units, and computed radiology units

[b] Percentage of all 3,141 US counties

[c] Full field digital units or computed radiology units

Table 2

Ratio of mammography capacity[a] to population, percentage of mammography machines that were digital, and percentage of counties with no machines, by state, 2009

State	Women age ≥40 in state n	Mammography machines, total n	Ratio of mammography capacity to population	Digital machines % total	Counties total n	Counties with no machines, n
Alabama	1,176,528	182	0.93	49.5	67	13
Alaska	140,231	41	1.75	46.3	27	13
Arizona	1,483,090	228	0.92	57.0	15	1
Arkansas	708,169	121	1.03	37.2	75	27
California	8,216,521	1,153	0.84	48.8	58	4
Colorado	1,131,576	174	0.92	57.5	64	24
Connecticut	922,806	175	1.14	77.1	8	0
Delaware	226,121	39	1.03	79.5	3	0
District of Columbia	139,335	31	1.33	54.8	1	0
Florida	4,909,256	706	0.86	59.1	67	12
Georgia	2,207,221	380	1.03	46.3	159	54
Hawaii	315,686	54	1.03	46.3	5	1
Idaho	337,673	58	1.03	55.2	44	21
Illinois	3,054,825	542	1.06	48.7	102	20
Indiana	1,544,152	266	1.03	62.8	92	14
Iowa	749,565	165	1.32	50.3	99	12
Kansas	663,398	144	1.30	44.4	105	40
Kentucky	1,069,830	213	1.19	45.5	120	36
Louisiana	1,068,133	191	1.07	63.9	64	20
Maine	368,684	71	1.16	71.8	16	1
Maryland	1,430,231	186	0.78	54.8	24	0
Massachusetts	1,704,729	280	0.99	75.4	14	0
Michigan	2,511,989	442	1.06	51.8	83	6
Minnesota	1,265,852	254	1.20	53.9	87	15
Mississippi	699,601	116	0.99	39.7	82	32
Missouri	1,488,323	256	1.03	51.2	115	49
Montana	245,333	48	1.17	72.9	56	26

State	Women age ≥40 in state n	Mammography machines, total n	Ratio of mammography capacity to population	Digital machines % total	Counties total n	Counties with no machines, n
Nebraska	422,397	100	1.42	48.0	93	41
Nevada	577,862	84	0.87	40.5	17	7
New Hampshire	348,651	61	1.05	73.8	10	0
New Jersey	2,234,204	312	0.84	63.1	21	0
New Mexico	472,167	66	0.84	39.4	33	7
New York	4,953,347	782	0.95	60.1	62	1
North Carolina	2,278,237	332	0.87	59.6	100	14
North Dakota	154,521	55	2.14	32.7	53	29
Ohio	2,938,639	554	1.13	33.8	88	5
Oklahoma	873,491	140	0.96	58.6	77	29
Oregon	941,112	141	0.90	63.8	36	4
Pennsylvania	3,354,948	537	0.96	52.1	67	3
Rhode Island	276,735	57	1.24	66.7	5	0
South Carolina	1,143,013	175	0.92	62.9	46	5
South Dakota	195,378	57	1.75	47.4	66	39
Tennessee	1,566,259	260	1.00	50.0	95	19
Texas	5,197,900	776	0.90	62.1	254	126
Utah	488,381	67	0.82	53.7	29	8
Vermont	167,611	26	0.93	80.8	14	2
Virginia	1,908,689	309	0.97	61.5	134	60
Washington	1,577,522	219	0.83	64.8	39	6
West Virginia	486,822	90	1.11	37.8	55	13
Wisconsin	1,398,103	353	1.51	45.0	72	7
Wyoming	124,265	29	1.40	31.0	23	4
US total	73,859,112	12,098	0.98	54.3	3,141	870

[a] Ratio of capacity to population = 6000

[*] Number of machines/number of women 40 years of age or older

Table 3

Selected characteristics of residents in US counties by rural–urban categories[a] and by mammography capacity (0 machines vs.≥1 machine) in 2009

County rural–urban category and number	Counties	Women age ≥40 years 2009	Population density, 2009[b]		Percent white collar, 2000		Percent insured, 2007		Percent below poverty level, 2007		Household income inequality ratio, 2000[c]		Primary care physician density, 2008[d]	
Mammography machines	n	n	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Metropolitan														
0 machines	195	1,034,399	137.3	39.4	49.7	0.5	79.7	0.4	15.2	0.4	8.5	0.7	25.7	2.9
≥1 machine	895	59,749,194	746	97.5	57.5	0.3	83.3	0.2	13.6	0.2	15.4	0.6	67.4	1.3
Suburban/small town														
0 machines	198	651,460	47.3	11.8	46.5	0.4	79.3	0.5	20.3	0.5	3.9	0.2	37.5	2.5
≥1 machine	1,183	10,981,934	60	3.2	49.4	0.2	82.8	0.2	17.3	0.2	5.7	0.2	53.9	0.9
Rural														
0 machines	477	824,823	12.5	0.7	50.2	0.3	77.8	0.3	17.8	0.3	4.1	0.1	27.6	1.6
≥1 machine	193	617,302	21.4	1.4	49.6	0.4	81.3	0.3	16.6	0.4	4.2	0.2	55.3	3.3
All counties by mammography machine status														
0 machines	870	2,510,682	48.4	9.4	49.2	0.2	78.6	0.2	17.8	0.2	5.0	0.2	29.4	1.3
≥1 machine	2,271	71,348,430	327.1	39.1	52.6	0.2	82.9	0.1	15.8	0.1	9.4	0.3	59.3	0.8
All counties by population category														
Metropolitan	1,090	60,783,593	637.1	80.6	56.1	0.3	82.7	0.2	13.9	0.2	14.2	0.5	59.9	1.3
Suburban/small town	1,381	11,633,394	58.2	3.2	49.0	0.2	82.3	0.2	17.7	0.2	5.4	0.1	51.5	0.8
Rural	670	1,442,125	15.1	0.7	50.0	0.3	78.8	0.2	17.4	0.3	4.1	0.1	35.6	1.6

[a] RUCC codes are the US Department of Agriculture 2003 Rural–Urban Continuum Codes [1–9] where Metropolitan counties are RUCC 1–3; suburban/small town (excluding rural) counties are RUCC 4–7; and Rural counties are RUCC 8–9

[b] Per square mile

[c] Average annual income among households in highest income quintile/average annual income among households in lowest income quintile

[d] Per 100,000 population

Table 4

Relationship between county sociodemographic characteristics and absence of mammography machines, 2009

	Unadjusted			Adjusted[a]		
	Odds ratio	95 % CI	*p* value	Odds ratio	95 % CI	*p* value
Population density						
Highest	1.0			1.0		
Middle	5.6	(4.1, 7.6)	< .0001	2.9	(2.1, 4.1)	< .0001
Lowest	21.2	(15.9, 28.9)	< .0001	11.0	(7.7, 15.9)	< .0001
Percent insured						
Highest	1.0			1.0		
Middle	2.6	(2.1, 1.3)	< .0001	1.7	(1.3, 2.3)	< .0001
Lowest	5.7	(4.6, 7.1)	< .0001	3.3	(2.5, 4.3)	< .0001
Percent in poverty						
Highest	1.0			1.0		
Middle	0.6	(0.5, 0.7)	< .0001	1.0	(0.8, 1.3)	NS
Lowest	0.6	(0.5, 0.7)	< .0001	1.3	(1.0, 1.8)	NS
Household income inequality						
Highest	1.0			1.0		
Middle	2.6	(2.0, 3.2)	< .0001	1.0	(0.7, 1.4)	NS
Lowest	6.1	(4.9, 7.7)	< .0001	1.6	(1.1, 2.3)	0.01
Primary care physician density						
Highest	1.0			1.0		
Middle	1.9	(1.4, 2.4)	< .0001	1.8	(1.3, 2.4)	< .0001
Lowest	11.5	(9.1, 14.6)	< .0001	8.9	(6.8, 11.7)	< .0001

[a] Values for each variable adjusted for all other variables in table