Dave M, Dovalés ACM, Veiga LHS, Peixoto JE, Pearce MS. [Trends in mammography use in the Brazilian public healthcare system](#). *Journal of Cancer Policy* 2018, 16, 43-48.

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DOI link to article:

<https://doi.org/10.1016/j.jcpo.2018.04.002>

Date deposited:

17/05/2018

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Trends in mammography use in the Brazilian public healthcare system

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Abstract

Background: Although breast cancer mortality rates are declining in many developed countries, recent trends in Brazil reveal increasing mortality rates. As mammography is an important tool in the early diagnosis and improved prognosis for breast cancer, we aimed to explore recent trends of mammography in the Brazilian public healthcare system (SUS).

Methods: We extracted a range of data from the DATASUS and SISMAMA online databases for the period 2010-2013, for Brazil and all of its regions, to explore patterns and trends in mammography within SUS across Brazil.

Results: On average, over 2010-2013, 18% and 14% of SUS-dependent Brazilian women aged 50-59 and 60-69 years respectively, were given a screening mammogram. Screening and diagnostic mammograms were recorded for females outside of this age range. The South and South-East had greater rates of screening and diagnostic mammograms respectively, than other regions. Most screening and diagnostic mammograms were categorised as BI-RADS category 1 ('negative') or 2 ('benign'). There was an average annual increase in numbers of machines in use, machines available to SUS and machine usage within SUS in each region.

Conclusions: Screening mammography rates were much lower than recommended in target age groups for mammography in Brazil and both types of mammograms were recorded for women younger than usually recommended. More appropriate use of mammography and better use of resources, will likely improve the outcomes of breast cancer in Brazilian women in a country with wide socio-economic differences, as well as minimise the potential risks associated with mammography in younger women.

Keywords: Breast cancer, Mammography, Early detection, Breast screening rates, BI-RADS, Brazil

Introduction

In Brazil, there were an estimated 67,316 new cases of [1] and 13,591 deaths from [2] female breast cancer in 2012, corresponding to standardised incidence and mortality rates of 59.5 and 12.0 per 100,000 respectively [1, 2]. As Brazil continues to move through the demographic transition and its ageing population grows [3], the burden of breast cancer in Brazilian women is predicted to increase over time [1].

Breast cancer incidence rates are reported to be higher in the more developed regions (South-East and South), compared to the less developed regions (North and North-East) of Brazil [4]. Although many countries in Northern and Western Europe are also experiencing increasing breast cancer incidence, mortality rates from the disease are declining [5], highlighting positive developments in its detection and treatment. In comparison, the world standardised mortality rate for breast cancer in Brazil increased from 8.61 to 12.66 per 100,000 women between 1979 and 2013 [2]. Studies exploring trends over time suggest the more developed regions are experiencing a stabilisation or decline in breast cancer mortality, whilst less developed regions are experiencing an increase [6-8].

Brazil's healthcare system has both public and private systems. Approximately 75% of the population depend solely upon the public subsector- the 'Sistema Único de Saúde' (SUS), providing free and universal health coverage to its population [3, 9]. The National Institute of Cancer in Brazil (INCA), recommends screening by mammography in women aged 50-69 years at average risk of breast cancer with a maximum of 2 years between mammograms, and annual mammograms in women from 35 years if at high risk for breast cancer [10]. However, Brazil does not have a national breast screening programme and responsibility lies with local health authorities to organise and implement such programmes [11].

As breast cancer mortality rates continue to increase in Brazil, there is a need for information on screening for breast cancer in Brazilian women, particularly in those dependent upon SUS, who are

most likely vulnerable to inequalities in the diagnosis and treatment of breast cancer. Therefore, this paper aims to explore recent trends and patterns in mammography among SUS-dependent women in Brazil.

Methods

The Informatics Department of SUS (Departamento de Informática do SUS, DATASUS) online database holds a wide range of extractable data on healthcare in Brazil [12]. From here, we went on to extract the annual number of mammograms funded by SUS from the Outpatient Information System (Sistema de Informações Ambulatoriais do SUS, SIA/SUS) [13]. Mammograms were classified by clinical indication as either 'screening' or 'diagnostic' examinations which were those conducted in women presenting without or with the signs or symptoms of breast cancer respectively. Specifically, examinations were defined as bilateral screening mammograms (Mamografia Bilateral Para Rastreamento, the examination of both breasts in one woman) or unilateral diagnostic mammograms (Mamografia) [13]. For the latter, the examination of one woman usually results in two recorded approved procedures, as one woman usually gets both breasts examined [14]. Therefore we halved the number of diagnostic mammograms for our analysis. We also extracted mammography machine and population data from DATASUS [12]. Numbers of machines in use (all public and private scanners in operation) and available to SUS (available to use by the public healthcare system) were obtained for each month of the study period and were subsequently averaged by year [15]. Population data were obtained from either census/inter-census estimates [16] or population projections for 2013 [17].

We extracted the annual number of mammograms by mammography result from the SISMAMA database [18]. Mammography results were classified using the 'Breast Imaging Reporting and Data System' (BI-RADS, categories 0-6) developed by The American College of Radiology (ACR) [19]. BI-RADS categories range from category 1- 'negative' to category 5- 'highly suggestive of malignancy'

with category 0 indicating an 'incomplete' examination and category 6, a 'known biopsy-proven malignancy' [19].

Data from both databases were restricted to females, for the period 2010-2013, for Brazil and for each of its geographical regions: North, North-East, South-East, South and Mid-West. This study period was chosen as nationwide implementation of SISMAMA occurred in 2009 [20] with likely limited data entry for that year. Data for 2014 were still likely to be entering the system and data for later years were not complete at the time of analysis.

We extracted data for private health insurance coverage for women living in Brazil and its regions (Table 2) from The National Agency of Complementary Healthcare (Agência Nacional de Saúde Suplementar, ANS) website [21] by age and for each year of the study period. Data are updated quarterly and at time of analysis, only data from September of each year were available- which we used [21].

The population of women mainly dependent on SUS was estimated as the proportion of the population within each age band (10-14, 15-19, 20-29, 30-39, 40-49, 50-59, 60-69, 70-79 and ≥ 80 years) [16, 17, 21] that did not have private health insurance coverage. The total SUS- dependent population for Brazil and each region was considered as the sum of their respective SUS-dependent populations within each age band.

Crude mammography rates were calculated as the annual number of mammograms per 100,000 SUS dependent women, according to clinical indication, for Brazil and each geographical region for each year of the study period and were subsequently averaged. Age-standardized mammography rates for Brazil's regions were obtained using the 2010 Brazilian SUS-dependent female population as a standard. Rates were calculated by multiplying the crude age-specific mammography rates by the respective proportion of each age group in the standard population which were then summed for

each region. We also calculated the average number and proportion of mammograms per BI-RADS category by clinical indication for the period 2010-2013 for Brazil and its geographical regions.

For Brazil and its regions, for each year of the study period, we calculated the number of machines in use per million population of females and machines available to SUS per million SUS-dependent females. Rates of mammograms performed per machine available to SUS were calculated using the annual number of mammograms (both screening and diagnostic) and the number of SUS-available machines.

The compound annual growth rate (CAGR) over the study period was calculated using the following equation: $CAGR = [(N_f/N_i)^{1/(Y_f-Y_i)}] - 1$ [22]

where N_f = Number in final year, N_i = Number in initial year, Y_f = Final year, Y_i = Initial year.

Results

Screening mammograms increased and diagnostic mammograms decreased for Brazil from 2010-2013 (Table 1). Age standardisation revealed screening mammography rates in the South were 3% greater than in the South-East, but over 3.5 times greater than in the North (Table 2). Diagnostic mammography rates in the South-East were 31% higher than in the South, but over 2.5 times greater than the North (Table 2).

Overall, screening and diagnostic mammography rates were highest in those aged 50-59 years. Both types of mammograms were recorded for women outside of this age range (Table 2). On average, 18% and 14% of SUS-dependent women aged 50-59 and 60-69 years respectively, were given a screening mammogram and less than 1% of 50-59 and 60-69 year old women were given a diagnostic mammogram in Brazil between 2010 and 2013. Most screening and diagnostic mammograms in each region of Brazil were classified as BI-RADS category 1 or 2 (Table 3).

The rate of machines in use and available to SUS as well as machine usage rates are shown in Table

4. All geographic regions experienced an average annual increase in all of these rates.

Discussion

Screening and diagnostic mammography rates were highest in 50-59 year olds, but many mammograms were recorded outside of this age range. Age standardisation highlighted regional differences, with the South and South-East having higher rates of mammograms than any other region. Most mammograms were classified as 'negative' or 'benign' [19]. All regions experienced average annual increases for machines in use, machines available to SUS and machine usage rates over the study period.

On average, screening rates in target age groups for Brazil (18% of 50-59 and 14% of 60-69 year olds) were much lower than the target of 60% coverage proposed by the Brazilian Ministry of Health [23] or 70% coverage of women aged 50-69 years, screened every 2 years, set as an indicator parameter by the SUS Performance Index (IDSUS) [24]- even if we had assumed all women had a screening mammogram biennially and that screening cycles did not overlap (35% of 50-59 and 29% of 60-69 year olds). In comparison, the UK's National Health Service (NHS) Breast Screening Programme has set a minimum coverage target of 70% [25] and achieved 75.9% coverage of 53-70 year olds by March 2014 [25], whilst the USA achieved 71.4% coverage of 50-64 year olds in 2013 [26].

High rates of mammography were also seen in 40-49 year olds, in some regions, exceeding rates in 60-69 year olds. Several Brazilian medical societies have recommended annual mammography for women aged 40-69 years at average risk for breast cancer [27]. With most mammograms within SUS being opportunistic, it is likely that medical professionals are following these recommendations, rather than those made by INCA of mammography in 50-69 year old women [10]. In addition, better response to media campaigns on the importance of early diagnosis by younger women, may be contributing to more frequent medical visits and hence mammography within this group [28].

Indeed, increasing numbers of medical visits have been previously shown to be positively associated with having a mammogram in Brazil [29].

We found regional variation in coverage rates, with the highest rates of screening mammograms in 50-69 year olds found in the South compared to lowest rates in the North. Differences in screening rates may be attributed to regional differences in the distribution of breast cancer across Brazil, with early detection measures being concentrated and driven in those regions with highest breast cancer incidence and mortality rates. However, breast screening services need to adapt to the increasing breast cancer incidence and mortality rates facing less developed regions [6-8] as they experience demographic changes.

Regional variation can also be linked to development levels. The South-East only makes up 11% of Brazil's geography, yet accounts for 56% of Brazil's gross domestic product (GDP) [9] in comparison to the North and North-East which are the poorest regions of Brazil [9]. Greater investment into outpatient services can be made by more developed regions.

We found that Brazil had 45.5 mammography machines in use per million women and 27.3 machines available to SUS per million SUS-dependent women, in 2013. This was greater than the 1 per every 240,000 inhabitants recommended by Brazilian health authorities in 2002 [30]. Therefore, it would seem that Brazil has an adequate number of mammography machines for SUS and for its population of women overall. However, the distribution of mammography machines within each geographic region is quite heterogeneous and has previously been documented [31]. Similarly in our study, rates of mammography machines in use and available to SUS in 2013 were lowest in the North and North-East although the proportion of women dependent upon SUS was greatest in these regions [16, 17, 21]. Average annual growth rates however, were greatest in the North-East followed by the North for machines in use, and in the North-East for machines available to SUS. This may be a result of saturation of mammography units in more developed regions of the country, with more growth in areas of need.

All regions experienced average annual increases in screening mammograms which largely contributed to the increase in machine usage rates seen. Mammography rates found in our study were lower than those found in previous population based studies of mammography in Brazil [32-34], as we focussed on mammography in SUS-dependent women only. It is well documented that mammography coverage rates in Brazil are much higher in women with private health insurance [29, 32].

We found both diagnostic and screening mammograms recorded for women younger than usually recommended. Mammography in young women may be even more frequent in the private sector. Indeed, it has been reported that the median age of women having their first mammogram was lower in private (40.2 years) compared to public (46.8 years) services [35]. Of those who had undergone a previous mammogram, the majority of private service users (64.7%) had between 2 and 6 previous mammograms compared to only 1 previous mammogram for the majority (51.2%) of public service users [35]. Although less common, breast cancer in young women does occur with approximately 6.6% of all cases diagnosed in <40 years, 2.4% in <35 years and 1% in <30 years [36]. In Brazil, approximately 19% of female breast cancers occur in women aged <45 years [1], almost twice that in the USA (11%) and the UK (10%) [1]. Potential reasons for this have been discussed elsewhere [37]. Therefore, performance of diagnostic mammograms in young women experiencing the signs and symptoms of breast cancer is important. However, age is still an important risk factor for the development of breast cancer, with incidence increasing with age [38]. In addition, exposure to ionising radiation is a risk factor for cancer induction [39, 40]. It has also been suggested that age at exposure is a risk factor for breast cancer induction, with those exposed at younger ages at a higher risk [40-43]. Screening mammography of young asymptomatic women in the absence of breast cancer risk factors, can unnecessarily expose them to these potential harms and is therefore not recommended [44]. Furthermore, mammographic performance in young women is known to be poor [45]. Importantly, despite the potential risks, radiation doses from mammography are very low in comparison to other imaging modalities such as computed tomography (CT) [46] and the benefits

of mammography in terms of reduction in relative risk of breast cancer mortality, for women aged 50-70 years, have been identified [47].

The majority of cases of breast cancer in Brazil occur in older women. Therefore, in a country with wide socio-economic differences [3], which lacks a population based screening programme [11] and has limited healthcare resources [9], it is essential to achieve efficient use of mammographic screening in target age groups in order to minimise the potential problems and risks of mammography in young women and reduce the wastage of resources, incurred by screening young women.

A strength of this study was the use of the SIA/SUS and SISMAMA databases [13] [48] which collate information on mammograms conducted within Brazil's public health system [13] [49]. This enabled us to explore mammography within SUS and women dependent upon SUS unlike previous studies [32-34]. Additionally, initial analysis of the preliminary findings from the SISMAMA database [20] did not report detailed age specific mammography rates- as in our study.

We found that the number of mammograms reported within the SIA/SUS database were higher than that in the SISMAMA database, reflecting underreporting within the SISMAMA database. Therefore, we extracted mammography data from the SIA/SUS database, but used SISMAMA for data on BI-RADS categorisation of mammograms as the SIA/SUS database did not record this. Therefore, the results reported in our study on the BI-RADS categorisation of mammograms recorded within SISMAMA were likely to be underestimates. The data used to obtain our results were from a limited time period- 2010-2013, however, the study period chosen was likely to have the most complete data for the SISMAMA database.

Diagnostic mammograms recorded in women outside of those aged 40-69 years could partly be explained by inaccuracies in recording data within the SIA/SUS database. We halved the number of diagnostic procedures recorded within the SIA/SUS database for our study as the diagnostic

examination of one woman would result in two records within the system. We must consider that there would be some cases in which only one breast was examined, for example, within a woman who has had a previous mastectomy, however, this information was not available.

Although INCA recommends a maximum of 2 years between screening mammograms for women aged 50-69 years at average risk of breast cancer [10], we did not halve the population of SUS-dependent women for calculation of mammography rates in our study. This was because data on time between mammograms was not available within the SIA/SUS database, in addition to taking into consideration the overlapping of the female population between screening cycles. Had we done so, screening rates would be approximately twice that reported in our study and therefore, our rates could be considered underestimates. However, when taking into account information from the SISMAMA database about time since the last mammogram, there is evidence to suggest that many Brazilian women undergo annual mammograms. For those mammograms recorded for women within the SISMAMA database, the time since the last mammogram was 1 year for 27%, 28%, 29% and 27% of diagnostic mammograms and 23%, 23%, 22% and 21% of screening mammograms in 2010, 2011, 2012 and 2013 respectively [18]. These proportions were greater than the proportion of women who had their last mammogram <1 year, 2 years, 3 years or ≥ 4 years previously [18].

A further limitation was the assumption that all mammograms recorded within the databases used, were on women solely dependent upon SUS, as women with private health insurance are also able to access mammography through SUS. Although roughly three-quarters of Brazilian women do not have private health insurance [3, 21], coverage varies greatly and in some cities, the proportion of women with private health insurance is much greater, for example in Rio de Janeiro and São Paulo in which 38.9% and 45.4% of women respectively had private health insurance in 2013 [21]. This may have resulted in some overestimation of mammography rates in SUS, availability of machines to SUS and rates of machine usage within SUS. However, the limitations of universal healthcare systems like SUS, such as long waiting times and limited resources [50], mean that those with private health

insurance would likely use private services over public ones [50]. Therefore, the impact of this on our results is likely to be minimal.

Overall, although Brazil seems to have an adequate number of mammography units, their use seems to be largely inappropriate, reflected both in poor levels of coverage of the target age range for mammography- women aged 50-69 years, and in the use of mammography in young women. The latter is worrying, especially due to the potential harms of poor mammographic performance and risk of breast cancer induction at young ages. Regional differences in mammography rates in the correct age groups and the number of mammography units highlights inequalities which need to be addressed in order to tackle morbidity and mortality from breast cancer, which is likely to grow in less developed regions of Brazil undergoing demographic changes.

Ethical approval

This study used anonymised data and therefore did not require ethical approval.

Funding

This work was partially supported by the Brazilian Federal Agency for the Support and Evaluation of Graduate Education (CAPES), AUXP 138/2013.

Declarations of interest

The authors declare there are no conflicts of interest.

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Table 1: Number of mammograms by type for Brazil and its regions, 2010-2013

Diagnostic mammograms^a					
Region	2010	2011	2012	2013	CAGR^b
Brazil	230,036.0	196,385.5	190,982.5	187,140.0	-6.6%
North	10,857.0	8,181.0	6,830.0	4,038.5	-28.1%
North-East	40,167.0	37,888.5	40,324.5	34,851.5	-4.6%
South-East	134,786.5	105,353.5	97,804.5	94,388.5	-11.2%
South	32,276.5	32,266.0	34,736.0	36,742.5	4.4%
Mid-West	11,949.0	12,696.5	11,287.5	17,119.0	12.7%
Screening mammograms					
Region	2010	2011	2012	2013	CAGR^b
Brazil	3,039,269	3,560,007	3,979,956	4,287,889	12.2%
North	67,478	81,832	107,503	124,580	22.7%
North-East	562,579	702,567	895,594	942,284	18.8%
South-East	1,569,134	1,840,372	1,987,840	2,166,180	11.3%
South	722,207	807,677	838,976	892,355	7.3%
Mid-West	117,871	127,559	150,043	162,490	11.3%

^a=Half the number of diagnostic mammograms extracted from the SIA database.

^bCAGR= Compound annual growth rate.

Table 2: Crude and standardised rates of mammography by type per 100,000 SUS-dependent females for Brazil and its regions, 2010-2013

Diagnostic mammography rates per 100,000 SUS-dependent females						
Age group (Years)	Brazil	North	North-East	South-East	South	Mid-West
10-14	0.5	0.3	0.2	0.5	1.5	0.3
15-19	4.8	2.8	1.5	5.0	15.7	2.7
20-29	22.5	13.6	7.7	23.3	72.7	12.4
30-39	150.0	77.2	88.0	193.8	280.8	93.2
40-49	642.8	375.3	501.0	846.1	578.1	604.2
50-59	883.8	488.7	560.9	1,205	836.7	814.4
60-69	819.9	375.3	438.1	1,196	817.4	704.9
70-79	590.2	203.5	276.5	919.1	571.9	476.9
≥80	295.9	83.0	116.3	523.9	254.6	186.4
Total	271.6	104.4	157.6	415.5	319.7	223.3
Standardised Rate ^a	270.6	141.0	171.5	372.9	285.2	235.7
Screening mammography rates per 100,000 SUS-dependent females						
Age group	Brazil	North	North-East	South-East	South	Mid-West
10-14	0.0	0.0	0.0	0.0	0.0	0.0
15-19	0.0	0.0	0.0	0.0	0.0	0.0
20-29	0.0	0.0	0.0	0.0	0.0	0.0
30-39	1,609	407.2	1,135	2,184	2,854	617.2
40-49	14,417	5,457	10,395	18,955	19,494	7,141
50-59	17,740	6,695	12,622	22,446	23,167	9,087
60-69	14,464	4,978	9,647	18,885	18,937	7,039
70-79	7,278	2,474	4,270	10,047	9,226	3,681
≥80	2,271	870.5	1,293	3,441	2,434	1,259
Total	5,016	1,321	3,186	7,271	7,665	2,350
Standardised Rate ^a	4,986	1,815	3,486	6,497	6,691	2,469
Proportion of women with private health insurance coverage (%) ^b						
	Brazil	North	North-East	South-East	South	Mid-West
% coverage	25.0	11.0	12.0	38.0	25.0	18.0

^aCrude mammography rates were standardised to the 2010 female SUS-dependent population of Brazil

^bAverage private health insurance coverage over the study period (2010-2013) extracted from the ANS website [21].

Table 3: Average number (%) of diagnostic and screening mammograms classified as BI-RADS categories 0-6 between 2010 and 2013

Average number (%) of diagnostic mammograms classified as BI-RADS categories 0-6						
BI-RADS Category	Brazil	North	North-East	South-East	South	Mid-West
0	9,526 (10.4)	436 (11.0)	2,522 (14.4)	4,699 (9.0)	1,135 (10.6)	734 (10.7)
1	32,679 (35.8)	2,515 (63.5)	8,977 (51.2)	13,516 (25.9)	4,373 (40.7)	3,298 (47.9)
2	33,373 (36.6)	710 (17.9)	3,828 (21.8)	22,493 (43.2)	4,052 (37.7)	2,290 (33.3)
3	9,411 (10.3)	159 (4.0)	1,271 (7.2)	6,970 (13.4)	698 (6.5)	313 (4.5)
4	3,882 (4.3)	91 (2.3)	614 (3.5)	2,691 (5.2)	351 (3.3)	136 (2.0)
5	654 (0.7)	14 (0.3)	82 (0.5)	475 (0.9)	48 (0.4)	35 (0.5)
6	1,703 (1.9)	36 (0.9)	247 (1.4)	1,249 (2.4)	90 (0.8)	81 (1.2)
Total	91,227 (100.0)	3,960 (100.0)	17,541 (100.0)	52,092 (100.0)	10,748 (100.0)	6,887 (100.0)
Average number (%) of screening mammograms classified as BI-RADS categories 0-6						
BI-RADS Category	Brazil	North	North-East	South-East	South	Mid-West
0	314,215 (11.0)	8,227 (9.7)	73,490 (12.8)	170,455 (10.9)	44,077 (8.9)	17,966 (13.2)
1	1,202,897 (42.2)	43,107 (50.7)	294,916 (51.3)	580,411 (37.2)	224,851 (45.6)	59,612 (43.7)
2	1,229,755 (43.2)	31,508 (37.1)	189,473 (32.9)	747,895 (48.0)	207,616 (42.1)	53,264 (39.1)
3	67,351 (2.4)	1,311 (1.5)	10,107 (1.8)	41,671 (2.7)	10,693 (2.2)	3,570 (2.6)
4	30,542 (1.1)	710 (0.8)	6,413 (1.1)	16,463 (1.1)	5,354 (1.1)	1,602 (1.2)
5	4,020 (0.1)	130 (0.2)	784 (0.1)	2,174 (0.1)	677 (0.1)	256 (0.2)
6	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Total	2,848,780 (100.0)	84,993 (100.0)	575,182 (100.0)	1,559,068 (100.0)	493,268 (100.0)	136,269 (100.0)

Table 4: Trends of mammography machines in use, machines available to SUS and machine usage in Brazil and its regions, 2010-2013

Number of machines in use per 1,000,000 population of females					
Region	2010	2011	2012	2013	CAGR ^a
Brazil	41.2	43.5	43.8	45.5	3.3%
North	21.8	24.6	24.3	25.2	5.0%
North-East	26.6	28.9	30.5	33.2	7.6%
South-East	52.1	53.9	53.8	55.3	2.0%
South	45.0	48.1	48.5	49.5	3.2%
Mid-West	48.6	50.9	49.5	51.0	1.6%
Number of machines available to SUS per 1,000,000 SUS-dependent females					
Region	2010	2011	2012	2013	CAGR ^a
Brazil	24.2	25.9	25.6	27.3	4.1%
North	14.2	15.9	14.8	15.0	1.7%
North-East	16.4	18.0	18.7	21.5	9.4%
South-East	31.2	32.2	30.8	32.5	1.4%
South	31.7	35.1	34.9	36.1	4.4%
Mid-West	23.9	27.0	26.8	27.9	5.4%
Number of mammograms conducted per machine available to SUS ^b					
Region	2010	2011	2012	2013	CAGR ^a
Brazil	1,831.8	1,958.0	2,205.1	2,195.0	6.2%
North	776.9	793.1	1,069.4	1,164.8	14.5%
North-East	1,520.8	1,702.5	2,056.2	1,844.8	6.6%
South-East	2,102.3	2,315.4	2,604.6	2,683.4	8.5%
South	2,250.0	2,273.7	2,356.1	2,386.9	2.0%
Mid-West	915.8	874.8	1,022.2	1,075.5	5.5%

^aCAGR= Compound annual growth rate.

^bIncludes both screening and diagnostic mammograms.