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The Influence of Environmental Factors on Prehospital Care Delivery: A Literature Review

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Abstract

Prehospital care is a vital component of emergency medical services (EMS) that significantly influences patient outcomes. This literature review investigates the impact of various environmental factors on prehospital care delivery, encompassing geographical, socio-economic, and infrastructural elements. The review synthesizes findings from 45 studies, revealing that geographical disparities, particularly between urban and rural areas, lead to longer response times and limited access to EMS, adversely affecting patient care. Socio-economic factors, including community health status and cultural attitudes towards healthcare, further complicate access and responsiveness to emergencies. Additionally, infrastructure quality, such as transportation and communication systems, plays a crucial role in facilitating effective prehospital interventions. The analysis highlights significant gaps in the current literature, particularly regarding the interplay of these factors and the lack of longitudinal studies that track changes over time. Recommendations for future research include the need for standardized measures to assess environmental influences, interdisciplinary approaches to explore complex interactions, and investigations into the role of technology in mitigating environmental challenges.

Keywords*: prehospital care, emergency medical services, environmental factors, socio-economic influences, infrastructure.*

INTRODUCTION

Recent data from the National Cancer Institute (INCA) in Brazil highlights breast cancer as the most common form of cancer among women in the country, accounting for 29.7% of all new cases in 2023, totaling 76,210 cases (INCA, 2023)[1]. Mammography is widely recognized as the primary screening method for asymptomatic breast cancer in average-risk women around the world. Evidence shows that organized screening programs can decrease mortality rates by up to 40% for women who regularly participate[2, 3]

However, medical organizations and experts continue to debate the best mammography screening recommendations for women with average breast cancer risk. Determining guidelines involves carefully weighing the benefits and risks of screening. The US Preventive Services Task Force recommends biennial mammography for women aged 50-74 while suggesting that women aged 40-49 make personalized decisions[4]. In contrast, the American College of Radiology recommends annual mammography starting at age 40, with no upper age limit[5]. Meanwhile, the European Commission Initiative on Breast Cancer recommends mammography every two years for women aged 50-69 and 2-3 years for women aged 45-49 and 70-74[6]. Ultimately, the decision to undergo mammography screening should be based on individual values, preferences, and risk factors and involve a discussion with a healthcare provider.

Breast cancer screening recommendations in Brazil vary depending on the source. The Brazilian Ministry of Health (MS) and the National Cancer Institute (INCA) recommend biennial mammography for women aged 50-69 and annual clinical breast exams for women aged 40 and above[7]. Mammography screening for women under 50 is personalized, considering individual risk factors, such as

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family history. These guidelines align with the World Health Organization's recommendations for breast cancer screening, which target age groups with the highest disease incidence.

However, the Brazilian Society of Mastology (SBM), Brazilian Federation of Gynecology and Obstetrics (FEBRASGO), and Brazilian College of Radiology (CBR) recommend annual mammography for all women aged 40 and above up to 75 years old, based on the Canadian National Breast Screening Study (CNBSS)[8]. For women aged 75 or older, mammography is personalized, based on health status and life expectancy, with those with a life expectancy of more than 7 years being recommended for screening[8]. These recommendations focus not only on age groups with the highest incidence of the disease but also on age groups where the disease tends to be more aggressive and potentially lethal.

The varying recommendations highlight the controversy surrounding mammography screening for breast cancer among different agencies and medical societies. Ultimately, the decision to undergo mammography screening should be based on individual risk factors and a discussion with a healthcare provider. As breast cancer screening guidelines are frequently updated, healthcare providers must stay informed about the latest evidence-based recommendations to provide the best care for their patients.

According to the Brazilian demographic census of 2010, women make up about 51% of the population, with approximately 16.1% between 40 and 75 years old and 8.3% between 50 and 69 years old, the recommended age groups for screening by the Ministry of Health[9]. This data shows that the number of Brazilian women screened can double or be halved depending on the screening method chosen. Therefore, it is essential to evaluate the sensitivity of these protocols in early detection of breast cancer, especially in the population not within the screening recommendations, i.e., from 40 to 49 years old and 70 to 75 years old. This evaluation can justify why Brazil adopts these two screening methods and weigh their advantages and disadvantages.

The main objective of this research is to compare the sensitivity of breast cancer screening recommended by the Brazilian Ministry of Health with that recommended by the Brazilian Society of Mastology, the Brazilian Federation of Gynecology and Obstetrics, and the Brazilian College of Radiology, in order to justify the advantages and disadvantages of each.

Methods

This is an ecological observational study based on retrospective data on mammographic screening programs in Brazil. A National Screening Database (DATASUS - Cancer Information System) publicly available for download was used as the data source. Exams performed between 2014 and 2021 for screening purposes in women with no personal or family risk for breast cancer were selected. Diagnostic exams and those without all the collected information, as well as those outside the specified age range, were excluded. The analyzed variables were age group, which is predetermined by the system (40 to 75 years with 5-year intervals), BIRADS™ results, and exam frequency (biannual, annual, triennial, or quadrennial). To compare the two breast cancer screening protocols, two groups were created: the MS group, comprising exams performed according to the Ministry of Health's guidelines (50 to 69 years), and the SBM group, comprising exams performed according to the Brazilian Society of Mastology's guidelines (40 to 75 years). Data were tabulated using Microsoft Excel, and descriptive analyses, statistical significance calculations ($p < 0.05$), Odds Ratio, Chi-Square Test, Sensitivity, Specificity, Prevalence Ratio, Accuracy, Positive Predictive Value, and Negative Predictive Value were performed. For this study, a significance level of 0.05 (5%) was established, and all confidence intervals were constructed with 95% statistical confidence, using the SBM group as the base for calculations.

Results

Between 2014 and 2021, 19,114,091 mammography exams were performed in Brazil, of which 99.80% were on women and 0.20% were on men. Of these exams, 97.46% were performed exclusively for screening purposes, while 2.35% were diagnostic exams. Within the target population, 91.13% of women received mammograms. Of these women, 4.6% had a family history of breast cancer, and 1.53% had a personal history of the disease. A total of 16,622,571 mammograms were performed on women within the age range specified in the study (40 to 75 years), while 2,006,986 were performed on women outside of this range. These data are summarized in Table 1

The mammograms performed were grouped based on the two types of screenings available in Brazil, the MS Group representing the Ministry of Health screening and the SBM Group representing the screening recommended by SBM, CBR, and FEBRASGO.

In the MS Group, a total of 11,246,186 (58.83%) mammograms were performed, while in the SBM Group, 16,631,571 (86.96%) mammograms were performed, representing a difference of 5,385,385 (28.13%) exams (Table 1). When comparing only the exams performed for screening, there is a difference of 7,017,372 more exams in the SBM Group compared to the MS Group, which resulted in 52,708 more suspicious exams (BIRADS™ 4 and BIRADS™ 5) compared to the MS Group. This increase indicates that for every 100,000 screening mammograms, 751 more suspected cases of breast cancer were found, and this reflects statistical significance.

Among the exams performed for screening, high rates of normal results were observed, i.e., with BIRADS™ 1 (B1) and BIRADS™ 2 (B2) results in both groups, corresponding to 85.86% of reports in the SBM Group and 86.15% of reports in the MS Group (Table 2).

The prevalence of altered results, that is, with BIRADS™ 4 (B4) and/or BIRADS™ 5 (B5) results and normal results (B1+B2) were compared between the two studied groups,

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taking the SBM group as the reference for calculating the Prevalence Ratio. It was observed that there was a statistically significant difference in the prevalence of altered results between the MS and SBM groups in all analyses. Furthermore, in all cases, the prevalence of altered results in the SBM group was higher than that in the MS group (Table 3).

When comparing the repetition of mammography exams in both groups, crossing altered (B4+B5) and normal (B1+B2) results, it was observed that the prevalence of altered results was higher in the SBM group than in the MS group when the periodicity was annual, as recommended by the Brazilian Society of Mastology (p 0.000), as well as when the periodicity was biennial, as recommended by the Ministry of Health (p 0.001). Furthermore, it was observed that accuracy, specificity, and positive predictive value were higher when mammography exams were performed annually. However, sensitivity was higher when the exam was performed every three years, which diverges from the two Brazilian recommendations (Table 4).

Regarding the adherence of patients to the recommended periodicity of the exam for both groups, that is, adherence of the SBM and MS groups to perform mammography in the same year when the exam result is BIRADS™ 0 or 3 and annually when BIRADS™ 1 or 2 in the SBM group and every two years for these same results in the MS group, it was observed that adherence is higher in the SBM group compared to the MS group with statistical significance (Table 5).

Table 1 - Distribution of mammograms performed in Brazil from 2014 to 2021

	Mamografias (N)	%
Total exams	19.114.091	100,00
Women	19.076.833	99,80
Men	37.258	0,20
Type of Exam		
Screening	18.629.557	97,46
Diagnostic	450.276	2,45
Type of Pop		
Target Population	17.457.690	91,13
Family History	878.713	4,60
Previous History of Breast Cancer	293.131	1,53
Age Groups		
20 to 24 years	16.108	0,08
25 to 29 years	18.295	0,10
30 to 34 years	55.844	0,29
35 to 39 years	401.915	2,10
40 to 44 years	2.125.348	11,12
45 to 49 years	2.654.972	13,89
50 to 54 years	3.800.178	19,88
55 to 59 years	3.262.931	17,07
60 to 64 years	2.542.090	13,30
65 to 69 years	1.640.987	8,59
70 to 74 years	596.065	3,12
75 to 79 years	245.933	1,29
Above 79 years	97.024	0,51

Source: DATASUS - SISCAN access 03/01/2022.

Table 2 - Prevalence of mammogram results by BIRADS™ by studied group

	SBM		MS		p-valor
	N	%	N	%	
BIRADS™ 0	1.877.626	11,30%	1.050.117	10,93%	<0,001
BIRADS™ 1	6.201.473	37,31%	3.477.238	36,20%	<0,001
BIRADS™ 2	8.070.466	48,55%	4.797.564	49,95%	<0,001
BIRADS™ 3	353.596	2,13%	213.581	2,22%	<0,001
BIRADS™ 4	102.217	0,61%	57.108	0,59%	<0,001
BIRADS™ 5	17.190	0,10%	9.591	0,10%	0,006
Total	16.622.571		9.605.199		

Note: BIRADS™ stands for Breast Imaging Reporting and Data System, which is a standardized system used to report mammogram results. The percentages shown in the table represent the prevalence of each BIRADS™ result in the SBM and MS groups.

Table 3 - Comparison between the overall prevalence of positive mammography with cases of normal results

		Altered	Normal	P-valor	Prevalence	RP	Accuracy	Sensitivity	Specificity	PPV	NPV
BIRADS™ 4	MS	57.108	8.274.802	<0,001	0,685%	0,964 (0,954 a 0,974)	63,11%	35,84%	63,30%	0,69%	99,29%
	SBM	102.217	14.271.939		0,711%						

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BIRADS™ 5	MS	9.591	8.274.802	0,003	0,116%	0,962 (0,939 a 0,987)	63,27%	35,81%	63,30%	0,12%	99,88%
	SBM	17.190	14.271.939		0,120%						
BIRADS™ 4+5	MS	66.699	8.274.802	<0,001	0,800%	0,964 (0,955 a 0,973)	63,07%	35,84%	63,30%	0,80%	99,17%
	SBM	119.407	14.271.939		0,830%						

Table 4 - Comparison between the prevalence of positive and normal results by exam periodicity.

		Altered	Normal	P-valor	Prevalence	RP	Accuracy	Sensitivity	Specificity	PPV	NPV
Same year.	MS	5.615	231.973	0,001	2,363%	0,945 (0,915 a 0,976)	62,37%	35,62%	63,04%	2,36%	97,50%
	SBM	10.147	395.696		2,500%						
1 year	MS	21.753	2.539.437	0,000	0,849%	0,951 (0,935 a 0,967)	61,84%	36,74%	62,06%	0,85%	99,11%
	SBM	37.449	4.154.467		0,893%						
2 years	MS	13.129	2.077.051	0,001	0,628%	0,965 (0,945 a 0,986)	61,47%	37,54%	61,63%	0,63%	99,35%
	SBM	21.849	3.335.655		0,651%						
3 years	MS	5.167	774.786	0,233	0,662%	0,979 (0,946 a 1,014)	61,52%	37,82%	61,69%	0,66%	99,32%
	SBM	8.496	1.247.370		0,677%						
4 years +	MS	5.701	741.746	0,003	0,763%	0,951 (0,921 a 0,983)	61,57%	37,05%	61,77%	0,76%	99,20%
	SBM	9.686	1.198.414		0,802%						
Ignored.	MS	15.334	1.909.809	0,648	0,797%	0,996 (0,977 a 1,015)	67,08%	32,55%	67,35%	0,80%	99,20%
	SBM	31.780	3.940.337		0,800%						

Tabela 1 - Comparação entre a prevalência da aderência a periodicidade correta entre os grupos

Aderência	SBM		MS				Total	
	N	%	N	%	RP	P-valor	SBM	MS
BIRADS™ 0	70.863	5,13%	40.592	4,95%	1,04	<0,001	1.380.275	819.665
BIRADS™ 1	1.708.696	40,48%	825.673	32,20%	1,26	<0,001	4.220.615	2.563.846
BIRADS™ 2	2.445.771	40,02%	1.251.378	32,92%	1,22	<0,001	6.110.987	3.801.147
BIRADS™ 3	27.248	9,59%	16.221	9,15%	1,05	<0,001	284.264	177.295

Discussion

Screening for any disease can be carried out through two main approaches: opportunistic and organized. Opportunistic screening occurs when a patient seeks health care for any reason and the health care professional takes the opportunity to screen for a disease or risk factor. This results in a portion of the screenable population being lost, and therefore fewer screening tests are performed than planned. On the other hand, organized screening occurs when the health care institution is committed and responsible for systematically providing means for the population within the screening area to carry out screening, as well as proceed with diagnosis and treatment if necessary. This type of screening is the most effective, but it is not replicable in large territories like Brazil[10]

In Brazil, many screening mammograms are performed every year to detect breast cancer early. However, there is no consensus on which screening protocol to adopt, as both currently in use in the country are effective for their intended purpose. Regardless of the protocol followed, screening is opportunistic, meaning it depends on the patient seeking medical attention, and it is up to the healthcare provider, together with the patient, to choose the age range to be screened and the frequency of the exam.

Anders, Carey K et al. (2008) conducted a study in the United States to evaluate the relationship between a breast cancer patient's age at diagnosis and their prognosis, concluding that younger patients have a worse prognosis[11]. This is because younger patients are more likely to have genetic mutations such as those in the BRCA genes[12]. In addition, these patients commonly have a worse biological tumor profile (lacking hormone receptors, expressing the HER 2 receptor, and having a higher nuclear grade), resulting in a later diagnosis and a higher risk of recurrence and cancer-related death for younger patients[12-14].

The combination of the results from the North American study and those found in the present study, specifically the increase of over 700 suspected cases per 100,000 mammograms performed under the screening protocol proposed by the SBM, justifies the earlier initiation of screening. Additionally, the SBM protocol's recommendation

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for annual screening may contribute to greater patient adherence.

On the other hand, increasing the age range for screening leads to a higher cost for the screening program proposed by the SBM. Based on the reimbursement value of US$ 4,50 per mammogram established by the SUS table in 2022, screening more patients as proposed by the SBM generated an additional cost of approximately US$ 28,707,430.90 to detect only 751 more cases per 100,000 mammograms performed. In the context of public health, this cost increase can have an impact on other health policies, including those related to breast cancer treatment[15].

Furthermore, a 17-year follow-up study conducted in the United Kingdom showed that there was no decrease in mortality rates when screening was conducted from the age of 40, but rather a postponement of deaths from the disease. This suggests an increase in the years spent in treatment, as well as the number of years, lived without the disease. Such information supports the legitimacy of the screening protocol recommended by the Brazilian Ministry of Health[16].

When we compare Brazilian screening protocols with those performed around the world, we see the same lack of consensus regarding the best way to screen for breast cancer. According to the recommendation of the American College of Obstetricians and Gynecologists (ACOG), breast cancer screening in women at average risk for the disease is opportunistic, involving clinical breast examination and annual or biennial mammography starting at age 40 and continuing until at least age 75[17]. The recommendation from the National Health Service (NHS) in England is that organized screening should be performed with mammography between 50 and 70 years of age every 3 years, and women over 70 who wish to undergo screening can request a mammogram at their local health unit every 3 years[18] .

In Sweden, breast cancer screening is recommended using mammography in women aged 40-54 every 18 months and in women aged 55-69 every 24 months. However, it is up to each municipality to decide whether to offer organized screening to the age group deemed most appropriate by the local health authority, resulting in differing age groups for screening within the country[2].

Breast cancer screening in Canada is opportunistic and based mainly on joint decision-making between the physician and patient after discussion of the risks and benefits of screening. Therefore, even in the absence of a recommendation, a patient may request screening, and in the presence of a recommendation, a patient may refuse. According to the Canadian Task Force on Preventive Health Care, there is no recommendation for screening between the ages of 40 and 49, and mammography is recommended every 2 or 3 years between the ages of 50 and 74[19].

Despite the lack of unanimity regarding the age range for screening, periodic breast cancer screening is performed worldwide due to the high number of cases of the disease, as well as the significant investment required to provide care for patients with breast cancer.

Conclusions

In conclusion, while there is no consensus regarding the optimal age range and screening frequency for mammography, it is clear that medical expertise, patient preferences, and common sense are crucial in selecting an appropriate screening protocol for breast cancer. Our findings suggest that the screening program recommended by the Brazilian Society of Mastology, Brazilian Federation of Gynecology and Obstetrics, and Brazilian College of Radiology (annual between 40-75 years old) may offer superior sensitivity for detecting suspicious breast lesions, although the economic feasibility of this approach should be taken into consideration. Ultimately, individualized screening strategies based on patient risk factors and preferences may offer the best outcomes in breast cancer detection and management.

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