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Portuguese Breast Screening: Triennial Results in Portugal, from 2017

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ABSTRACT

Introduction: Breast cancer represents the most frequently diagnosed cancer and the leading cause of cancer death among Portuguese women. In recent decades, industrialized countries have registered an increase in breast cancer incidence and prevalence, as a result of the introduction of population-based screening and advances in therapy. This work aimed to evaluate the impact of breast cancer screening on the incidence and prevalence of this neoplasm in a three-year series (2017 to 2019). For this purpose, in an observational cross-sectional study, data from three indicators present in the "Portuguese Primary Health Care - Identity Card" platform were collected, their growth dynamics were studied and their performances correlated, from the national figures, down to the lowest administrative levels, the Health Centre Clusters, to also evaluate inequities at regional levels.

Material and Methods: Three indicators were selected from the Primary Health Care Indicators matrix online platform: 2013.044.01 FL, MORB.243.01 FL e MORB.218.01 FL. For each one of them, the results existing on December 31st for 2017, 2018 and 2019 were studied by the National level, Regional Health Administrations level, and within these, by the Health Centre Clusters level.

Results: The total proportion of enrolled women screened increased from 52.06% in 2017, to 56.41% in 2019. Breast cancer incidence and prevalence in enrolled women followed this trend, with an increase of 0.03 ‰ and 0.08%, respectively. For 2019, the analysis by region identified a statistically significant difference ($p < 0.01$) in the proportion of enrolled women screened.

Discussion: Some asymmetries were found in the analysis by region for the three indicators. The proportion of enrolled women screened was generally higher in the northern areas of Portugal when compared to the southern ones. On the other hand, the incidence of breast cancer was higher in the south, while in north, the highest growth dynamics for this indicator were observed. The prevalence followed the same pattern of the incidence, except for Algarve, where the lowest values of all were reported.

Conclusion: The increase in the proportion of enrolled women screened was less than desirable. Incidence and prevalence can depend on factors other than screening. Nevertheless, this preventive work must be carried on and even incremented. Monitoring work should be continued with the available data to correct regional asymmetries and implement measures to raise awareness among women, regarding the importance of breast cancer screening. Modifying the indicators, creating age groups categories, will be important to better understand their results.

Keywords: “Breast Neoplasms”; “Screening”; “Mammography”; “Incidence”; “Prevalence”; “Primary Health Care”.

RESUMO

Introdução: O cancro da mama representa a neoplasia mais frequentemente diagnosticada, e a principal causa de morte por cancro entre as mulheres portuguesas. Nas últimas décadas os países industrializados registaram um aumento na sua incidência e prevalência, fruto da introdução dos rastreios de base populacional e avanços na terapêutica. O presente trabalho teve como objetivo avaliar o impacto do rastreio do cancro da mama na incidência e prevalência desta neoplasia, numa série trienal (2017 a 2019). Para tal, num estudo transversal observacional, os dados de três indicadores constantes na plataforma "Bilhete de Identidade dos Cuidados de Saúde Primários" foram colhidos, as suas dinâmicas de crescimento foram estudadas, e os seus desempenhos correlacionados, desde o total nacional, até ao nível administrativo mais baixo, os Agrupamentos de Centros de Saúde, para identificar também iniquidades a nível regional.

Material e Métodos: Foram selecionados três indicadores constantes na plataforma online da Matriz de Indicadores dos Cuidados de Saúde Primários: 2013.044.01 FL, MORB.243.01 FL e MORB.218.01 FL. Para cada um deles, estudaram-se os resultados existentes à data de 31 de dezembro de 2017, 2018 e 2019, por total nacional, Administração Regional de Saúde e dentro destas, por Agrupamentos de Centros de Saúde.

Resultados: A proporção total de mulheres inscritas rastreadas aumentou de 52.06% em 2017, para 56.41% em 2019. A incidência e prevalência do cancro da mama acompanharam esta tendência, com um aumento de 0.03‰ e 0.08% respetivamente. Para o ano de 2019, na análise por região identificou-se uma diferença estatisticamente significativa ($p<0.01$) na proporção de mulheres inscritas rastreadas.

Discussão: Foram encontradas algumas assimetrias entre regiões para os três indicadores. A proporção de mulheres inscritas rastreadas foi de um modo geral mais alta a norte quando comparada com as regiões mais a sul de Portugal. Já a incidência do cancro da mama foi mais alta a sul, enquanto que a norte se verificaram as dinâmicas de crescimento mais elevadas para este indicador. A prevalência seguiu o mesmo padrão da incidência, excetuando no Algarve, que apresentou os valores mais baixos de todos.

Conclusão: O aumento da proporção de mulheres rastreadas ficou aquém do desejável. A incidência e prevalência dependerão de outros fatores além do rastreio. Apesar disso, este trabalho preventivo deve ser continuado e inclusive incrementado. Dever-se-á continuar a monitorização dos rastreios por forma a corrigir assimetrias regionais, bem como implementar medidas de sensibilização na população feminina relativas à importância do rastreio de cancro

da mama. A correção dos indicadores, criando neles grupos etários, será importante para melhor compreender os seus resultados.

Palavras-chave: “Neoplasias da mama”; “Rastreio”; “Mamografia”; “Incidência”; ”Prevalência”; “Cuidados de Saúde Primários”

ABBREVIATIONS

BC - Breast Cancer

EU - European Union

HCCs - Health Centre Clusters

LTV - Lisbon and Tagus Valley

NHS - National Health Service

PBS - Population-based Screening

PHC - Primary Health Care

PHC-IC - Primary Health Care - Identity Card

RHAs - Regional Health Administrations

INTRODUCTION

Worldwide and for both sexes combined, female breast cancer (BC) is currently the second most diagnosed neoplasm and the fifth leading cause of cancer death. Among women, it represents the most frequent diagnosis of neoplasia and the main cause of death from malignant disease.[1] In fact, this global pattern seems to be transposed in a similar way to the Portuguese female population, thus highlighting the importance of this neoplasm in the national context.[2]

In 2018, 2 088 849 new cases of female BC were recorded, of which 522 513 were identified in Europe, making it the most incident neoplasia in this continent.[3,4] In the same year, 6 974 new cases of female BC were identified in Portugal, which represented 12% of all new diagnoses due to cancer.[2]

Regarding mortality from female BC, Portugal remains one of the European Union (EU) countries with the lowest rates,[4–6] with an estimated age-adjusted mortality rate of 16.6 per 100 000 inhabitants for 2018.[4] According to a recent report published by the Organization for Economic Cooperation and Development, it is estimated that for 2020 Portugal will have the fifth-lowest mortality rate from BC.[6] As for the 5-years prevalence, in 2018, 26 329 cases were registered in Portugal, corresponding to a proportion per 100 000 inhabitants of 485.77.[2]

In the last decades, there has been an increase in the incidence of female BC in industrialized countries;[7,8] however, its mortality rate has shown the opposite behaviour, with a sustained decline,[4,9–11] which can be justified by the increased usage of mammography as a screening method,[11–13] and by the constant scientific advances in therapeutics.[14,15]

The development of recommendations for population-based screening (PBS) in BC is based on several assumptions: the prevalence of the disease in the screened population, the effectiveness in reducing the mortality rate, and possible risks associated with screening. The answer to these questions subsequently allows the selection of the most effective screening modalities.[13]

Several studies have already shown that mammography is the only screening method associated with a reduction in the BC mortality rate. Some of these have shown a 30% reduction or more. Nevertheless, this may happen at the expense of some risks, being the overdiagnosis and subsequent overtreatment of tumours that might otherwise not be progressive, a particular concern.[8,13,16–19]

Given that tumour stage at diagnosis remains one of the most crucial aspects in woman's BC prognosis,[20–23] the main goal of PBS is to detect the disease at an early stage,[24,25] meaning asymptomatic and non-palpable, so that subsequent treatments can more effectively change its course and improve long-term prognosis.[7,25,26] Before the widespread use of mammography, the diagnosis of ductal carcinoma in situ was rare. Nowadays, it accounts for approximately 25% of all breast cancer cases, most of them only detected by imaging.[24,27]

Secondary prevention centred on PBS using mammography thus remains the most practical and effective intervention in the average risk female population, after weighed its harms and benefits.[28,29]

In 2016, out of the 28 EU member states, 25 already had pilot-projects or PBS programmes underway.[30] In Portugal, PBS for female BC was initially introduced in the Centre region in 1990, by the Portuguese League Against Cancer ("Liga Portuguesa Contra o Cancro"). Since then, it has progressively evolved with an increase in geographical coverage, number of screened women and adherence rate.[19] By 2014, Portugal already had the highest rate of mammograms performed, with 84.2%, well above the European average which was 62.8%.[19,31]

Following scientific evidence and the European guidelines for the quality assurance of BC screening and diagnosis,[32] in Portugal, it is recommended to perform every two years, a mammogram with a blinded double reading, in women without exclusion criteria aged 50 to 69 years.[33]

For mainland Portugal, data from 2016 shows a geographical coverage by the screening programme of 80% and a participation rate of 61%. The number of screened women was below the number of women invited, which has been systematically the trend over the last years.[19]

The Primary Health Care - Identity Card (PHC – IC) is a platform integrated into the National Health Service (NHS) website. Available since 2017, it includes information that enables the characterization and monitorization of all Primary Health Care (PHC) Units, assessing their performance in an integrated and multidimensional way.

The Portuguese NHS is divided into 5 Regional Health Administrations (RHAs), each subdivided in Health Centre Clusters (HCCs), associating all PHC Units, caring for the Portuguese population.

This work aimed to understand the impact of PBS in BC incidence and prevalence in a three-year series (2017 to 2019). For this purpose, three indicators present in the PHC - IC platform were used, their growth dynamics were studied, and their performances were correlated with each other. In an observational cross-sectional study, we analysed data regarding three indicators related with breast cancer screening, incidence and prevalence, in women enrolled in primary health care, down to the level of Health Centre Clusters, to evaluate inequities at national and regional levels.

It was hypothesised that the growth dynamics were positive with a difference (∆) ≥5% between each year for the indicator "*Proportion of women among [50; 70[years old, with a mammography recorded in the last two years",* and were lower for the indicator *"Proportion of users with a new diagnosis of 'malignant neoplasm of the female breast'"*. Being ∆ ≥2% and <5% for the indicator *"Proportion of users with the diagnosis of 'malignant neoplasm of the female breast'"*.

MATERIAL AND METHODS:

Bibliographic research

Bibliographic research was carried out through the PubMed and Embase databases, associating multiple keywords: “Breast Neoplasms”; "Screening"; "Portugal"; "Mammography"; "Early Detection of Cancer"; "Epidemiology"; "Trends"; "Incidence"; "Prevalence"; "Mortality".

Additional filters were selected: Case Reports; Guideline; Observational Study; Practice Guideline; Meta-Analysis; Review; Systematic Review; Humans; English; Portuguese; Female; Cancer; Middle Aged + Aged: 45+ years.

Relevant documents and reports were also selected from the Global Cancer Observatory, Directorate-General for Health, Central Administration of the Health System, European Commission, Organization for Economic Cooperation and Development, National Institute of Statistics and Regional Health Administrations websites.

Data collection

Data from the present work were collected from the PHC – IC Matrix of Indicators platform, available in the NHS website. This is a public platform responsible for collecting data on all indicators defined by the Central Administration of the Health System, and for their integration at a national level, by RHAs, HCCs and by type of PHC Unit.

The extracted data refer to the following indicators under study: “*Proportion of women among [50; 70[years old, with a mammography recorded in the last two years”* (2013.044.01 FL), *“Proportion of users with a new diagnosis of ‘malignant neoplasm of the female breast’"* (MORB.243.01 FL), and *“Proportion of users with the diagnosis of ‘malignant neoplasm of the female breast’"* (MORB.218.01 FL).

For each indicator and for all registered users, data corresponding to different levels were extracted for the three years under study (2017 to 2019): National, RHAs and HCCs. At the RHA level, data were collected for the five health regions of mainland Portugal: North, Centre, Lisbon and Tagus Valley (LTV), Alentejo and Algarve.

As for the HCCs, as a representative sample of each region, two-thirds of the HCCs of each region were randomly studied, chosen according to their numbering in reverse alphabetical order. The following HCCs were analysed:

1. **North RHA:** Tâmega II - Vale do Sousa Sul**;** Tâmega I - Baixo Tâmega**;** Matosinhos**;** Grande Porto VIII - Espinho/Gaia**;** Grande Porto VI - Porto Oriental**;** Grande Porto V - Porto Ocidental**;** Grande Porto II – Gondomar**;** Grande Porto I - Santo Tirso / Trofa**;** Douro II - Douro Sul**;** Douro I - Marão e Douro Norte**;** Cávado III - Barcelos/Esposende**;** Cávado II - Gerês/Cabreira**;** Ave/Famalicão**;** Alto Trás-os-Montes – Nordeste**;** Alto Trás-os-Montes - Alto Tâmega e Barroso**;** Alto Minho.

2. **Centre RHA:** Pinhal Litoral**;** Pinhal Interior Sul; Pinhal Interior Norte; Guarda; Dão Lafões; Baixo Mondego.

3. **LTV RHA:** Sintra; Oeste Sul; Oeste Norte; Loures/Odivelas; Estuário do Tejo; Cascais; Arrábida; Arco Ribeirinho; Amadora; Almada/Seixal.

4. **Alentejo RHA:** Baixo Alentejo; Alentejo Central; Alentejo Litoral.

5. **Algarve RHA:** Algarve II - Algarve Barlavento; Algarve I - Algarve Central.

Description of the indicators

2013.044.01 FL

The Indicator 2013.044.01 FL expresses the proportion between women with a mammography recorded in the last two years, and women aged between 50 and 69 years.

For its calculus, in the numerator are considered all women between 50 and 69 years old with at least one mammography result in the previous two years. As for the denominator, all women in the age group under study, who have an active enrolment in the Health Unit at the indicators reference date, are eligible. The result is reported as a percentage.

MORB.243.01 FL

The indicator MORB.243.01 FL expresses the proportion of users, among the enrolled population, with a new diagnosis of “malignant neoplasm of the female breast” in the last year.

The numerator includes registered users who have a female breast cancer diagnosis in the list of problems with an “active” status at the reference date of the indicator and starting in the last 12 months. The denominator corresponds to all registered users. The result is expressed in the form of permillage.

MORB.218.01 FL

The indicator MORB.218.01 FL expresses the proportion of users with “malignant neoplasm of the female breast” identified in the enrolled population.

The numerator comprises registered users who have a female breast cancer diagnosis registered in the list of problems. The denominator corresponds to the number of registered users.

Data analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) software, version 25.

Kruskal-Wallis nonparametric statistic was used to assess differences between regions for each one of the indicators in the three years under study. We considered a value of $p < 0.01$ statistically significant.

The growth dynamics between 2017 and 2019 were calculated for each region and for the national total, by subtracting the values of 2017 from the values obtained for 2019, then dividing the result obtained by the value of 2017. Growth dynamics between each year (2017-2018 and 2018-2019) were also calculated using the same method.

RESULTS:

Distribution:

None of the calculated distributions of the indicators for the three years under study (2017 to 2019) followed a normal distribution, by the Kolmogorov Smirnov one-sample test: P-value of 0.024 for 2013.044.01 FL indicator, p-value of 0.200 for MORB.243.01 FL indicator, and p-value of 0.200 for MORB.218.01 FL indicator.

In line with the results, Kruskal-Wallis nonparametric statistic was used.

Analysis by Region:

We found no statistically significant differences between regions, for the years 2017 **(Table 1)** and 2018 **(Table 2)**.

Table 1. Analysis by Health Region for the Year 2017

	2013.044.01 FL	**MORB.243.01 FL**	**MORB.218.01 FL**
Chi-Square	10,044	1,929	3,619
df	4	4	4
Asymp. Sig.	0.040	0.749	0.460

a. Kruskal-Wallis Test

b. Grouping Variable: Health Region

Table 2. Analysis by Health Region for the Year 2018

	2013.044.01 FL	**MORB.243.01 FL**	**MORB.218.01 FL**
Chi-Square	9,385	5,644	2,587
df	4	4	4
Asymp. Sig.	0.052	0.227	0.629

a. Kruskal-Wallis Test

b. Grouping Variable: Health Region

For the year 2019, in the analysis by Health Region through the Kruskal-Wallis test, a statistically significant difference ($p<0.01$) for the indicator 2013.044.01 FL was found **(Table 3)**.

Table 3. Analysis by Health Region for the Year 2019

	2013.044.01 FL	MORB.243.01 FL	MORB.218.01 FL
Chi-Square	16,815	2,108	3,476
df	4	4	4
Asymp. Sig.	**0.002**	0.716	0.481

a. Kruskal-Wallis Test

b. Grouping Variable: Health Region

Table 4. Calculated values for 2019 referring to the 2013.044.01 FL indicator

		North	Centre	LTV	Alentejo	Algarve
N	Valid	16	6	10	3	2
	Missing	0	0	0	0	0
Mean		62.01	59.85	48.68	58.70	24.45
Median		65.33	62.28	46.76	58.08	24.45
Mode		44.14[a]	48.48[a]	41.59[a]	57.39[a]	22.61[a]
Std. Deviation		9.84	6.66	6.44	1.71	2.60
Minimum		44.14	48.48	41.59	57.39	22.61
Maximum		77.63	66.66	63.88	60.63	26.29

a. There are several modal values. The lowest value is shown.

Table 5. Indicators by Year and Health Region from PHC-IC online platform

Region	2013.044.01 FL			MORB.243.01 FL			MORB.218.01 FL		
	2017	2018	2019	2017	2018	2019	2017	2018	2019
North	54.94	55.85	62.53	0.79	0.81	0.88	0.80	0.85	0.89
Centre	59.46	61.37	63.32	0.79	0.81	0.83	0.84	0.90	0.93
LTV	48.39	49.69	49.37	0.88	0.97	0.87	0.88	0.92	0.96
Alentejo	56.96	59.19	60.63	0.88	0.85	0.85	0.84	0.89	0.92
Algarve	20.57	22.43	27.99	0.85	0.81	0.83	0.70	0.74	0.76
National total	**52.06**	**53.36**	**56.41**	**0.83**	**0.87**	**0.86**	**0.84**	**0.88**	**0.92**

2013.044.01 FL - "*Proportion of women among [50; 70[years old, with a mammography recorded in the last two years"*; MORB.243.01 FL - *"Proportion of users with a new diagnosis of 'malignant neoplasm of the female breast'"*; MORB.218.01 FL - *"Proportion of users with the diagnosis of 'malignant neoplasm of the female breast'"*

Table 6. Calculated growth dynamics between 2017 and 2019

Region	2013.044.01 FL	MORB.243.01 FL	MORB.218.01 FL
North	0.14	0.11	0.11
Centre	0.06	0.05	0.11
LTV	0.02	-0.02	0.09
Alentejo	0.06	-0.03	0.09
Algarve	0.36	-0.03	0.09
National total	**0.08**	**0.04**	**0.10**

2013.044.01 FL - "*Proportion of women among [50; 70[years old, with a mammography recorded in the last two years"*; MORB.243.01 FL - *"Proportion of users with a new diagnosis of 'malignant neoplasm of the female breast'"*; MORB.218.01 FL - *"Proportion of users with the diagnosis of 'malignant neoplasm of the female breast'"*

DISCUSSION

By using an official online platform that aggregates anonymized data related to PHC, the present study assessed the implementation status of BC screening in mainland Portugal, and its impact on the incidence and prevalence of this neoplasm.

Looking at the results obtained from the PHC-IC online platform concerning the 2013.044.01 FL indicator, it is worth highlighting the positive evolution of the total national number of women in the age group eligible for BC screening and enrolled in PHC, that have been effectively screened: 52.06%, 53.36% and 56.41% for 2017, 2018 and 2019 respectively (Table 5), with a growth dynamic of 0.08 (Table 6).

These results reflect the efforts made in recent years by the various RHAs to improve the coverage and quality of PBS and are in line with the National Programme for Oncological Diseases activity plan, which outlined as a target for 2020, an expansion to the entire national territory of the various screening programmes, including for BC, in order to achieve 100% geographic coverage rate for all of them.[5,19]

Nevertheless, despite the noteworthy increase of 4.35% in the proportion of enrolled women screened from 2017 to 2019, this figure may fall short of what would be desirable. The existing difficulties in achieving full geographical coverage, and the influence of women's adherence to the screening programme, may appear as possible explanations.

For 2018, the target projected by the National Programme for Oncological Diseases for the geographic coverage rate by HCCs was 90%, but the rate verified was only 84.4%. On the other hand, the adherence rate did not suffer significant changes between 2017 and 2018, despite the increasing number of women invited, and 2018 ended with a 63.5% adherence rate.[34] Over the past decade, the adherence rate has remained relatively stable, with only slight increases,[19] but always below the “acceptable level” of 70% defined by European recommendations.[32]

It should also be noted that our initial null hypothesis for this indicator was not verified, with no $\Delta \geq 5\%$, regarding the growth dynamics between each of the three years under study, and therefore, the obtained growth was different from what was initially determined as an adequate growth.

As expected, it was possible to identify some asymmetries in the proportion of screened users between RHAs.

It was in the Centre RHA that, for the three years under study, the highest proportion of enrolled women screened was systematically verified (Table 5). Such result was already expected, as it is in this region that the screening programme is most consolidated, having been operating continuously since 1990, and being implemented in 100% of the HCCs, and within these, in all Health Centres and Functional Units.[19,35] Furthermore, it is also in the Centre region that the highest adherence rates for mainland Portugal have been reported,[19] having presented for 2018 a rate of 64.5%.[35]

In contrast to the Centre region, it was in the Algarve RHA that the lowest results for this indicator were obtained for the three years under study (Table 5), despite having the highest growth dynamic between 2017 and 2019, with 0.36 (Table 6).

According to the Algarve RHA activities report, in 2017 the adherence rate was 57%, well below the 63% that had been set as a target for that same year and region,[36] increasing to 61% in 2018.[37] This fact may justify the low proportions of women screened and the positive growth dynamic found. Furthermore, it is also in the south of mainland Portugal, particularly in Algarve, that the highest percentages of mammography non-use and underuse have been verified.[38] According to the 2014 National Health Survey, for mainland Portugal, it was in Algarve that the lowest proportion of the female resident population aged between 50 and 69 years old, who reported having performed a mammogram in the 2 years prior to the interview was registered.[39] A fact remaining in 2019, according to data from that year's survey.[40]

As for the Lisbon and Tagus Valley RHA, we must note that 2018 ended with a coverage rate of just 27%, referring to only 4 of the 15 HCCs in this region, with 43 645 women invited, of which only 28 309 were screened.[41] Only by the end of 2019 was signed a protocol between this RHA and the Portuguese League Against Cancer, in order to extend the screening programme to the entire region from 2020 on,[42] expecting to cover an annual target population of 229 418 women.[41] Taking this into account, and given the results found for the 2013.044.01 FL indicator (Table 5), it can be inferred that a significant proportion of women in Lisbon and Tagus Valley RHA, will have been screened outside the PBS programme.

The analysis by health region for 2019 showed a statistically significant difference ($p < 0.01$) for the 2013.044.01 FL indicator (Table 3), with two health regions, LTV and Algarve, with median values far lower than the rest of the health regions (Table 4), reflecting these asymmetries.

Regarding the MORB.243.01 FL indicator, there was an increase of 0.03 ‰ in the total proportion of new cases of female BC from 2017 to 2019 (Table 5), representing a positive

growth dynamic of 0.04 (Table 6). This positive evolution is in line with the growing trend observed in the incidence of cancer in Portugal,[5] and in this particular case, female BC.[43–45]

Furthermore, it also matches what was predictable given the positive growth in the total proportion of users screened (Table 5 and 6). This correlation between screening and incidence has already been demonstrated in several studies and justified the increasing incidence of this neoplasia in industrialized countries over the last decades.[6,11] Nevertheless, it should be noted that this increase in BC incidence was not transversal to all studied regions (Table 6), with some important asymmetries described below.

It was in the south of mainland Portugal that this trend was reversed, with Lisbon and Tagus Valley, Alentejo and Algarve regions showing a negative growth dynamic between 2017 and 2019, even though that, for all three regions, the growth dynamics between those same years have been positive for the 2013.044.01 FL indicator (Table 6). This finding seems to contradict the projections that demonstrate an increase in the incidence for all regions of Portugal.[46]

Despite that, it was in the south that the highest incidences were observed, with emphasis on Lisbon and Tagus Valley RHA, which presented the highest proportion of new cases for 2017 and 2018, being only surpassed by the North region in 2019 (Table 5). Other studies had previously demonstrated a similar pattern of incidence.[45,46] The existence of an association between a high socioeconomic status, urbanity and education level with an increased risk of developing breast cancer,[8,47,48] might justify the results found, as this region is the one with the highest income[49] and educational levels[50] in Portugal. Furthermore, although the growth dynamic was negative between 2017 and 2019 (Table 6), there was an important fluctuation in the incidence between the three years, with a peak in 2018 (Table 5), which may possibly be justified by the absence of a consolidated PBS programme in most HCCs in the Lisbon and Tagus Valley region.[41]

In contrast, the North region presented the highest growth dynamic regarding this indicator, with a value of 0.11 between 2017 and 2019 (Table 6), surpassing the proportion of new cases in enrolled women of the southern regions in this last year. This marked increase in the incidence of BC, which had already been predicted by another study,[46] is in line with the evolution of the 2013.044.01 FL indicator, since it was also in the North region that the second-highest growth dynamic was found, concerning the number of enrolled women screened (Table 6).

North region introduced population-based screening in 2009, being the last to do so in mainland Portugal.[19] Thus, this more marked increase in the incidence of BC could be due to

the so-called "prevalent wave effect",[51] especially in recent years as there has been an increase in the adherence and geographical coverage rates, with all the HCCs and all their respective Health Centres covered by the programme since 2017.[5,19]

Centre region also showed an increase in the proportion of new cases; however, this increase was lower when compared to the North region, perhaps because the Centre region has a longer-established screening programme.[19]

Notwithstanding the previously mentioned asymmetries, it should be noted that, for this indicator, no statistically significant differences were found between the different RHAs, for each of the three years under study (Tables 1 to 3).

It should also be noted that these data refer exclusively to women who, being enrolled in PHC Units, have an active registry. It is possible that an unknown proportion of women carried out the studies in question, without their results having come to the knowledge of their family doctors, and therefore were not recorded. Furthermore, it is also known that the southernmost regions of mainland Portugal have a lower percentage of enrolled users with a family doctor assigned, by comparison with the North and Centre Regions.[42] As a retrospective study, it was dependent on the presence of data in medical records, and data quality was dependent on the thoroughness of its registry. These might be possible limitations to the approach taken into account in the present work.

Finally, as to the results obtained for the MORB.218.01 FL indicator, an increase of 0.08% in the national prevalence between 2017 and 2019 was registered (Table 5), following the increase also seen for the MORB.243.01 FL indicator, in relation to the proportion of new cases of BC identified in the same period.

In addition to the evolution seen in the PBS programmes, national and European trends in BC mortality[5,6] constitute a concurrent factor for this increase in BC prevalence. From 2010 to 2015, we observed a sustained decline in the female BC standardized mortality rates,[5] and according to data from Health at a Glance 2020, Portugal showed an 87.6% 5-year survival rate for BC, in women diagnosed between 2010 and 2014, being only surpassed by Finland, and being 4.6 percentage points above the European average.[6]

This increase was transversal to all regions under study; however, it was in the North and Centre regions that the greatest growth was found in terms of the BC prevalence in the female enrolled population, following what happened for the MORB.243.01 FL indicator, since these were also the regions that showed the highest growth in terms of incidence. Furthermore,

data from recent years shows that North and Centre RHAs had the lowest standardized mortality rates.[45,52]

It is in Lisbon and Tagus Valley RHA that the highest proportion of BC cases was registered, partially explained by the fact that it is also the region where the highest incidence was found (Table 5).

On the contrary, the Algarve RHA, despite the incidences recorded, had the lowest prevalences over the three years under study. It was also in this region that for the 2013.044.01 FL indicator, the lowest numbers of enrolled women screened were found (Table 5).

It is known that PBS allows the identification of neoplasms in early and preclinical stages, so a lower rate of screening may be related to later diagnoses, in clinical stages, and therefore with a more unfavourable prognosis in terms of survival,[6,53] thus decreasing the prevalence. A recent study, which analysed data from 2002 to 2013, found that, for mainland Portugal, Algarve had the second-highest adjusted mortality rate for BC, after Lisbon and Tagus Valley region.[54] Data from 2017 shows the Algarve region as having the highest standardized mortality rate due to female BC.[52] Therefore, it can be concluded that these factors may partly be responsible for the results obtained for BC prevalence in this region.

Regarding this indicator, our null hypothesis was also not confirmed, as the growth dynamic between 2017 and 2018 was higher than expected. The same occurred for BC incidence, as its growth dynamic was also above the expected between those same years.

Factors other than screening, that influence BC incidence and prevalence, may be the cause.

CONCLUSION

The population-based BC screening programme is gradually expanding, to increase the number of women screened, and cover the missing geographical areas. The obtained results reflect these same efforts, carried out in recent years.

Even so, despite the fact that in 2019 the proportion of enrolled women screened was 56.41%, and that there was an increase in this proportion compared to previous years, this might be below the desirable values. Although geographic coverage is close to being completed, more efforts should be made to raise the awareness of the female population about the importance and the role of organized screening, in order to increase the levels of adherence.

The knowledge of regional asymmetries regarding the proportion of eligible women who actually perform the screening, as evidenced in this study, could be an important factor to understand any flaws or difficulties in the implementation of screening programmes, and thus, allow a better allocation of resources.

At a national level, the assisted growth for the screening was also followed by an increase in the incidence and prevalence, as would be expected, although this aspect was not transversal for all regions. Despite not part of this work, some of these differences could also be due to socio-demographic factors, lifestyle, habits, and access to health care, which should form the basis for future studies, in order to customize measures aimed at the needs of each region.

The studied indicators reflect data from women aged 50 to 70 years old. Such large interval makes it difficult to know who is being screened the most, and at what array of age there is a higher incidence, and consequently prevalence. A change in the indicators, creating age groups categories, will be important, allowing stratification of the results according to age, and therefore, a better understanding of the relation between the results from the different indicators.

Finally, it should be emphasized the importance of public platforms with anonymized data, that allow the development of scientific production, in order to evaluate the PHC activity in the context of screening implementation, and also the need for an updated registration of data by family doctors.

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APPENDICES

Appendix I. Calculated growth dynamics between 2017 and 2018

Region	2013.044.01 FL	MORB.243.01 FL	MORB.218.01 FL
North	0.02	0.02	0.05
Centre	0.03	0.03	0.06
LTV	0.03	0.09	0.05
Alentejo	0.04	-0.03	0.06
Algarve	0.09	-0.05	0.05
National total	**0.02**	**0.05**	**0.05**

2013.044.01 FL - "*Proportion of women among [50; 70[years old, with a mammography recorded in the last two years"*; MORB.243.01 FL - *"Proportion of users with a new diagnosis of 'malignant neoplasm of the female breast'"*; MORB.218.01 FL - *"Proportion of users with the diagnosis of 'malignant neoplasm of the female breast'"*

Appendix II. Calculated growth dynamics between 2018 and 2019

Region	2013.044.01 FL	MORB.243.01 FL	MORB.218.01 FL
North	0.12	0.09	0.06
Centre	0.03	0.01	0.04
LTV	-0.01	-0.10	0.04
Alentejo	0.02	0.00	0.04
Algarve	0.25	0.02	0.03
National total	**0.06**	**-0.01**	**0.04**

2013.044.01 FL - "*Proportion of women among [50; 70[years old, with a mammography recorded in the last two years"*; MORB.243.01 FL - *"Proportion of users with a new diagnosis of 'malignant neoplasm of the female breast'"*; MORB.218.01 FL - *"Proportion of users with the diagnosis of 'malignant neoplasm of the female breast'"*

Appendix III. Data obtained from the PHC-IC platform for the indicator 2013.044.01 FL

HCCs	Screening 2017	Screening 2018	Screening 2019
1 - ACES Tâmega II - Vale do Sousa Sul	69.78	77.16	74.92
2 - ACES Tâmega I - Baixo Tâmega	42.75	62.87	67.38
3 - ACES Matosinhos	45.04	47.30	51.88
4 - ACES Grande Porto VIII - Espinho / Gaia	57.53	63.78	66.58
5 - ACES Grande Porto VI - Porto Oriental	45.53	43.88	49.68
6 - ACES Grande Porto V - Porto Ocidental	44.11	45.34	44.14
7 - ACES Grande Porto II – Gondomar	43.33	35.94	56.60
8 - ACES Grande Porto I - Santo Tirso / Trofa	69.00	59.96	69.18
9 - ACES Douro II - Douro Sul	65.62	42.79	64.23
10 - ACES Douro I - Marão e Douro Norte	38.12	66.44	51.64
11 - ACES Cávado III - Barcelos / Esposende	58.95	57.72	77.63
12 - ACES Cávado II - Gerês / Cabreira	59.10	30.38	72.49
13 - ACES Ave / Famalicão	59.51	65.30	57.07
14 - ACES Alto Trás-os-Montes – Nordeste	64.98	52.53	67.15
15 - ACES Alto Trás-os-Montes - Alto Tâmega e Barroso	55.46	39.24	66.42
16 - ACES Alto Minho	54.77	60.54	55.24
17 - ACES Pinhal Litoral	60.17	64.53	61.87
18 - ACES Pinhal Interior Sul	40.01	51.48	48.48
19 - ACES Pinhal Interior Norte	51.65	48.20	63.81
20 - ACES Guarda	53.59	48.38	55.60
21 - ACES Dão Lafões	66.18	71.44	66.66
22 - ACES Baixo Mondego	56.54	57.62	62.68
23 - ACES Sintra	45.31	45.70	45.31
24 - ACES Oeste Sul	52.52	54.41	53.83
25 - ACES Oeste Norte	50.88	58.85	63.88
26 - ACES Loures / Odivelas	48.43	48.92	48.02
27 - ACES Estuário do Tejo	46.95	45.91	48.29
28 - ACES Cascais	42.88	42.47	41.59
29 - ACES Arrábida	47.27	45.75	44.16
30 - ACES Arco Ribeirinho	45.19	45.29	45.50
31 - ACES Amadora	46.73	45.30	44.75
32 - ACES Almada / Seixal	52.36	53.70	51.45
33 - ACES Baixo Alentejo	62.84	63.48	58.08
34 - ACES Alentejo Central	55.09	55.35	60.63
35 - ACES Alentejo Litoral	52.95	56.58	57.39
36 - ACES Algarve II - Algarve Barlavento	12.39	17.94	22.61
37 - ACES Algarve I - Algarve Central	22.80	26.72	26.29

Appendix IV. Data obtained from the PHC-IC platform for the indicator MORB.243.01 FL

HCCs	Incidence 2017	Incidence 2018	Incidence 2019
1 - ACES Tâmega II - Vale do Sousa Sul	0.60	0.80	0.74
2 - ACES Tâmega I - Baixo Tâmega	0.70	0.71	0.66
3 - ACES Matosinhos	0.65	0.82	0.99
4 - ACES Grande Porto VIII - Espinho / Gaia	0.92	0.87	0.94
5 - ACES Grande Porto VI - Porto Oriental	1.02	0.96	1.05
6 - ACES Grande Porto V - Porto Ocidental	0.97	0.87	0.92
7 - ACES Grande Porto II – Gondomar	0.92	0.88	1.07
8 - ACES Grande Porto I - Santo Tirso / Trofa	0.84	0.92	0.84
9 - ACES Douro II - Douro Sul	0.90	0.62	0.83
10 - ACES Douro I - Marão e Douro Norte	0.69	0.94	0.79
11 - ACES Cávado III - Barcelos / Esposende	0.74	0.71	0.79
12 - ACES Cávado II - Gerês / Cabreira	0.64	0.57	1.13
13 - ACES Ave / Famalicão	0.82	0.93	0.96
14 - ACES Alto Trás-os-Montes – Nordeste	0.67	0.74	0.90
15 - ACES Alto Trás-os-Montes - Alto Tâmega e Barroso	0.96	0.75	0.87
16 - ACES Alto Minho	0.67	0.77	0.76
17 - ACES Pinhal Litoral	0.77	0.77	0.72
18 - ACES Pinhal Interior Sul	0.59	0.82	0.81
19 - ACES Pinhal Interior Norte	0.70	0.97	1.03
20 - ACES Guarda	0.58	0.79	0.71
21 - ACES Dão Lafões	0.83	0.74	0.72
22 - ACES Baixo Mondego	1.05	0.92	1.06
23 - ACES Sintra	0.75	0.77	0.74
24 - ACES Oeste Sul	0.89	1.14	0.97
25 - ACES Oeste Norte	0.68	0.92	0.71
26 - ACES Loures / Odivelas	0.80	0.91	0.81
27 - ACES Estuário do Tejo	0.79	1.00	0.90
28 - ACES Cascais	1.15	1.18	1.03
29 - ACES Arrábida	0.88	0.88	0.78
30 - ACES Arco Ribeirinho	0.80	0.78	0.87
31 - ACES Amadora	0.83	0.91	0.86
32 - ACES Almada / Seixal	0.92	1.04	0.93
33 - ACES Baixo Alentejo	0.89	0.55	0.85
34 - ACES Alentejo Central	0.73	0.91	0.92
35 - ACES Alentejo Litoral	0.90	1.23	0.69
36 - ACES Algarve II - Algarve Barlavento	0.82	0.96	0.84
37 - ACES Algarve I - Algarve Central	0.82	0.74	0.75

Appendix V. Data obtained from the PHC-IC platform for the indicator MORB.218.01 FL

HCCs	Prevalence 2017	Prevalence 2018	Prevalence 2019
1 - ACES Tâmega II - Vale do Sousa Sul	0.62	0.67	0.71
2 - ACES Tâmega I - Baixo Tâmega	0.59	0.64	0.68
3 - ACES Matosinhos	0.97	1.02	1.07
4 - ACES Grande Porto VIII - Espinho / Gaia	0.92	0.97	1.01
5 - ACES Grande Porto VI - Porto Oriental	1.11	1.15	1.19
6 - ACES Grande Porto V - Porto Ocidental	1.07	1.10	1.11
7 - ACES Grande Porto II – Gondomar	0.98	1.02	1.09
8 - ACES Grande Porto I - Santo Tirso / Trofa	0.82	0.89	0.95
9 - ACES Douro II - Douro Sul	0.80	0.85	0.89
10 - ACES Douro I - Marão e Douro Norte	0.80	0.86	0.90
11 - ACES Cávado III - Barcelos / Esposende	0.66	0.70	0.75
12 - ACES Cávado II - Gerês / Cabreira	0.59	0.62	0.71
13 - ACES Ave / Famalicão	0.81	0.88	0.94
14 - ACES Alto Trás-os-Montes – Nordeste	0.75	0.79	0.84
15 - ACES Alto Trás-os-Montes - Alto Tâmega e Barroso	0.93	0.95	0.99
16 - ACES Alto Minho	0.75	0.78	0.82
17 - ACES Pinhal Litoral	0.82	0.85	0.87
18 - ACES Pinhal Interior Sul	0.83	0.88	0.92
19 - ACES Pinhal Interior Norte	0.77	0.84	0.91
20 - ACES Guarda	0.82	0.87	0.90
21 - ACES Dão Lafões	0.80	0.87	0.91
22 - ACES Baixo Mondego	0.94	1.01	1.05
23 - ACES Sintra	0.72	0.75	0.78
24 - ACES Oeste Sul	0.81	0.88	0.94
25 - ACES Oeste Norte	0.89	0.94	0.97
26 - ACES Loures / Odivelas	0.82	0.86	0.89
27 - ACES Estuário do Tejo	0.71	0.79	0.83
28 - ACES Cascais	0.98	1.03	1.06
29 - ACES Arrábida	0.82	0.86	0.89
30 - ACES Arco Ribeirinho	0.74	0.78	0.82
31 - ACES Amadora	0.87	0.88	0.91
32 - ACES Almada / Seixal	0.93	0.98	1.02
33 - ACES Baixo Alentejo	0.83	0.84	0.85
34 - ACES Alentejo Central	0.85	0.91	0.96
35 - ACES Alentejo Litoral	0.86	0.94	0.95
36 - ACES Algarve II - Algarve Barlavento	0.74	0.79	0.81
37 - ACES Algarve I - Algarve Central	0.69	0.71	0.73