ORIGINAL ARTICLE

Mammographic screening programmes in Europe: organization, coverage and participation

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Objectives To summarize participation and coverage rates in population mammographic screening programmes for breast cancer in Europe.

Methods We used the European Network for Information on Cancer (EUNICE), a web-based data warehouse (*EUNICE Breast Cancer Screening Monitoring, EBCSM*) for breast cancer screening, to obtain information on programme characteristics, coverage and participation from its initial application in 10 national and 16 regional programmes in 18 European countries.

Results The total population targeted by the screening programme services covered in the report comprised 26.9 million women predominantly aged 50–69. Most of the collected data relates to 2005, 2006 and/or 2007. The average participation rate across all programmes was 53.4% (range 19.4–88.9% of personally invited); or 66.4% excluding Poland, a large programme that initiated personal invitations in 2007. Thirteen of the 26 programmes achieved the European Union benchmark of acceptable participation (>70%), nine achieved the desirable level (>75%). Despite considerable invitation coverage across all programmes (79.3%, range 50.9–115.2%) only 48.2% (range 28.4–92.1%) of the target population were actually screened. The overall invitation and examination coverage excluding Poland was 70.9% and 50.3%, respectively.

Conclusions The results demonstrate the feasibility of European-wide screening monitoring using the EBCSM data warehouse, although further efforts to refine the system and to harmonize standards and data collection practices will be required, to fully integrate all European countries. The more than three-fold difference in the examination coverage should be taken into account in the evaluation of service screening programmes.

INTRODUCTION

Monitoring early indicators of effectiveness of mammographic breast cancer screening is essential to ensure the quality of all procedures, to optimize the use of resources and ultimately to produce an observable reduction in breast cancer mortality. The fourth edition of the European Guidelines for quality assurance in breast cancer screening and diagnosis defines several performance parameters and indicators that should be monitored in any screening programme, and recommends standards.[1,2] These performance targets address the entire range of activities in screening for and diagnosis of breast cancer, including invitation of the target population, performance of the screening examination, assessment, diagnosis and treatment.

In Europe, most programmes for breast cancer screening have developed their own screening information systems for running day-to-day operations, managing quality, monitoring and evaluating services, and for preparing information for organizations such as local government or ministries, with no explicit priority on promoting an exchange of information between programmes in different countries.

The European Network for Information on Cancer (EUNICE) was a project co-funded by the European Union. A key aim of the project was to produce a monitoring tool capable of calculating a selection of key performance parameters and early impact indicators from the European Guidelines, which could be used to compare screening programmes across Europe on a regular basis. The user-friendly tool facilitates monitoring of screening activity in a standardized format. It enables the uniform, automatic calculation of pre-defined indicators for benchmarking and for comparison between programmes.

This paper describes the design of the tool, with selected programme characteristics, coverage and participation obtained from its initial application in 10 national and 16 regional breast cancer screening programmes in 18 European countries.

METHODS

In 2007 a web-based data warehouse (*EUNICE Breast cancer screening monitoring, EBCSM*) was developed for collection of aggregated data on implementation and performance of breast cancer screening programmes in Europe (www.qtweb.it/eunice).

The database is accessible to authorized users only. It allows data uploading and verification, calculation of screening indicators with standardized algorithms and formats, and comparison between programmes and with benchmarks. The parameters and indicators are shown for the entire age-range and for 5-year age groups. They are generated in the following eight modules:

- Coverage and participation rates
- Number of mammograms performed
- Further assessment, including needle biopsies performed (fine needle aspirations and core biopsies)
- Outcome of further assessment (e.g. number of referrals to surgery)
- Outcome of surgical referral (e.g. number of cancers, benign lesions, ductal carcinoma in situ)
- Number of invasive cancers detected, total and by (TNM) stage
- Size of invasive cancers (1–10 11–20, >20 mm)
- Type of surgery for invasive cancer (number of breast-conserving surgeries, mastectomies)

Each module has two sections, one for routine indicators generated from a minimum set of parameters (standard), and one for optional, more differentiated indicators based on additional parameters (extended). For example, the standard section of the 'participation and coverage' module generates the participation rate by age, whereas the extended version shows the participation rate by age separately for women who were invited to attend screening for the first time.

The online data collection instrument also has a general section, with a questionnaire format, that includes items on programme characteristics, such as the policy on the number of mammographic views or double reading of screening mammograms. The questionnaire and the operational definition of the indicators, as well as a documentation manual (www.qtweb.it/eunice), were prepared by the Eunice Working Group, based on the fourth edition of the European Guidelines.[1,2] Representatives of breast cancer screening programmes from all 27 European Member States plus Norway and Switzerland were invited to join the Group. Two pan-European meetings (Brno, Czech Republic, 2006 and Budapest, Hungary, 2008) were organized to agree the design of the data warehouse, study procedures and data collection.

A survey was then conducted using the EBCSM. The previously identified reference persons from these 29 European countries were asked to provide aggregated data describing service screening activity in the reference year 2005, and supplemental information on programme characteristics in the reference year 2007. Completion of all standard sections was requested, plus the extended sections, where feasible. Checks for internal consistency and completeness were performed on the data received, and detected errors in classification or data entry were corrected. Missing data were reported to participants and completed where possible.

The main outcome measures we report here are coverage and participation, and key organizational and policy characteristics of the programmes. Coverage is defined as the extent to which the screening programme covers the eligible population within the appropriate interval in a given period by invitation (invitation coverage) and the extent to which the screening programme covers the eligible population with screening tests (examination coverage). In practice, coverage has been calculated as the annual number of invitations (or tests) divided by the annual target population, which in turn is represented by the total target population divided by the screening interval in years. Participation is defined as the proportion of women attending screening of those personally invited.

To provide a more detailed picture of the organization of screening services, the extent of invitations and tests performed per screening unit and mammography machine in 2007 were estimated, using data from programme organization in 2007 and the programme performance in earlier years (in most cases 2005 and/or 2006).

RESULTS

Eighteen of the 29 European countries provided aggregated data and information on programme characteristics (Figure 1). National data was provided by 10 countries: Czech Republic, Estonia, Finland, Hungary, Italy, Luxembourg, Norway, Poland, the Netherlands and the United Kingdom (Figure 1). The eight other countries provided data limited to 16 regional programmes: Belgium (Flanders), Denmark (Copenhagen), Germany (pilot projects), Portugal (Centre and North), Republic of Ireland (East), Spain (Asturias, Baleares, Galicia, Navarra, Pais Vasco, Valencia), Sweden (Södermanland, Stockholm, Västmanland) and Switzerland (Fribourg). The results are presented for 26 national or regional programmes. Although the UK also provided national data, we include here only those related to England, as these data are more complete. Performance data from the reference year 2005 were provided by 24 programmes, 10 of which included data from one or two additional reference years. The data from one programme (Germany, pilot projects) referred to the years 2001–2004. The data from Poland referred only to the year 2007.

Policies and organization

Basic information on the programmes is shown in Table 1. Most programmes began in the late 1980s or early 1990s. Exceptions were Belgium (Flanders), Czech Republic, Estonia, Germany (pilot projects in Bremen, Weser-Ems and Wiesbaden), Hungary, Poland, Republic of Ireland and Switzerland (Fribourg), which started more recently.

Women were targeted from age 50 in 17 programmes, while a lower target age was applied in nine programmes. The target age specified in the European Union policy on cancer screening[3] (50–69 years) was adopted in eight programmes, though three others used 50–70 years. In addition to age, gender and geographical area, some

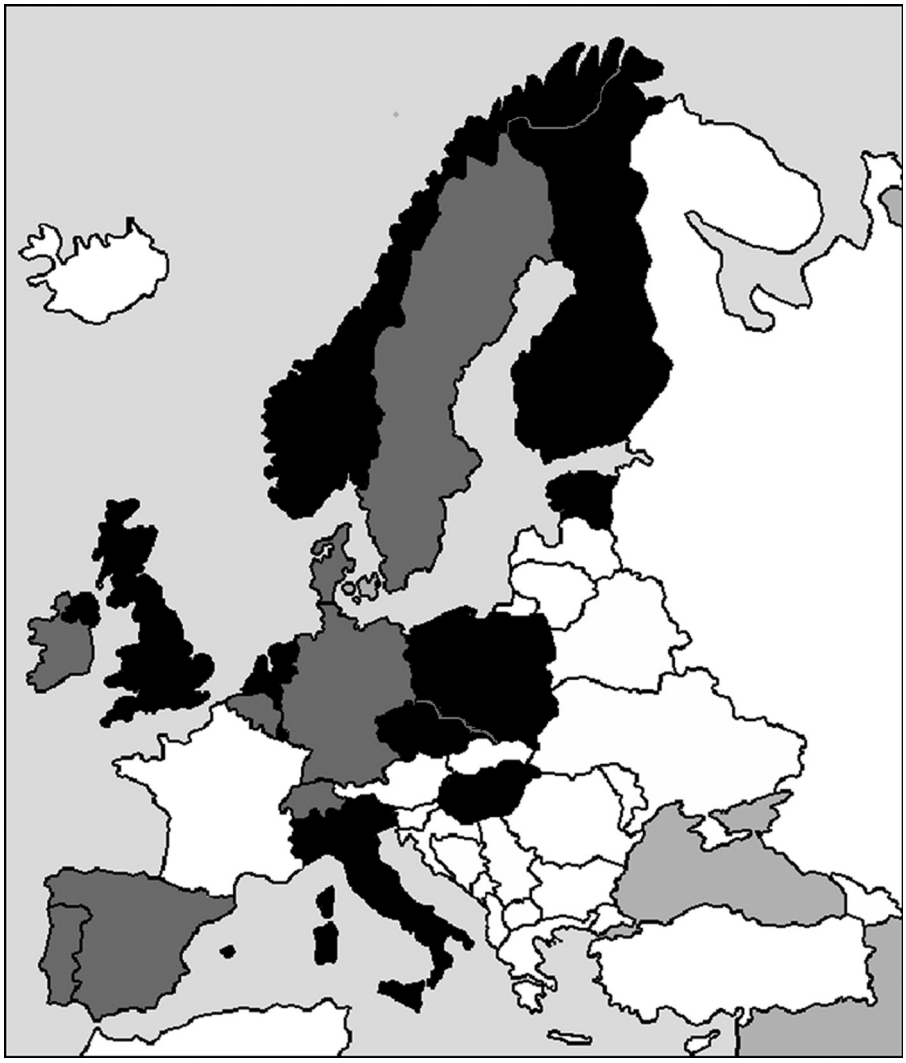

Figure 1 Countries represented in *EUNICE Breast Cancer Screening Monitoring* survey by type of data provided. National data (black): Czech Republic, Estonia, Finland, Hungary, Italy, Luxemburg, Norway, Poland, The Netherlands, United Kingdom; Regional data (grey): Belgium (Flanders), Denmark (Copenhagen), Germany (pilot projects), Portugal (North, Centre) Republic of Ireland (East), Spain (Asturias, Baleares, Galicia, Navarra, Pais Vasco, Valencia), Sweden (Södermanland, Stockholm, Västmanland), Switzerland (Fribourg), Regional and national data: Hungary, Italy, United Kingdom

programmes applied other eligibility criteria, such as exclusion of women with previous breast lesions, previous mastectomies, breast implants, pregnancy or terminal illness. All eligible women received an individual invitation letter, except in the Czech Republic, where women were referred by general practitioners or gynaecologists. Personal invitations were introduced in the Czech Republic on a pilot basis in 2007.

All programmes reported the use of two-view mammography for the initial screening examination; nine programmes used only a single-view at subsequent screening for all or selected groups of women (one missing value). Screening mammograms were read by two independent radiologists in all but five programmes. Mammography was the only screening test performed in 25 programmes. In Hungary, clinical breast examination (BCE) was also used. The screening interval was two years in all programmes except for the United Kingdom (England) where the maximum interval was three years.

In all but two programmes, further assessment was performed on recall. In Spain (Valencia) and the Czech Republic it was possible to perform assessment on the same day as the screening examination. With the exception of the Netherlands, women were recalled for further assessment in units dedicated full or part-time to the screening programme.

Table 2 presents estimates of the annual number of screening tests and the average annual numbers of tests per screening unit, and per mammography machine in 2007 based on the reported programme characteristics in 2007 and volume of tests reported by most programmes in earlier years, assuming that there was no change in volume over time. For most programmes, performance data were provided for the years 2005 and/or 2006. On average, 19 programmes performed less than 10,000 tests per screening unit per year. Ten programmes performed less than 5,000 screening mammograms per machine per year.

Table 1 Breast cancer screening programme features by country or region in 26 European programmes (2007)

Country or region	Start (year)	Target age (years)	Interval (months)	Intermediate mammograms		Mammography views at screening (*N*)*	Double reading (Yes/No)
				After screening (Yes/No)	After further assessment (Yes/No)		
Belgium, Flanders	2001	50–69	24	Yes	No	2	Yes
Czech Republic	2002	45–69	24	Yes	Yes	2	Yes†
Denmark, Copenhagen	1992	50–69	24	No	No	2/1	Yes
Estonia	2002	50–59	24	No	Yes	2	Yes
Finland	1989	50–69	24	NA	NA	NA	Yes
Germany, pilot projects	2001	50–70	24	No	Yes	2	Yes
Hungary	2002	45–65	24	Yes	Yes	2	Yes
Italy	1990	50–69	24	Yes	Yes	2/1	Yes
Luxembourg	1992	50–69	24	Yes	No	2	Yes
Norway	1996	50–69	24	No	No	2	Yes
Poland	2007	50–69	24	Yes	Yes	2	No
Portugal, centre	1990	45–69	24	No	Yes	2	Yes
Portugal, north	1999	45–69	24	No	Yes	2	Yes
Republic of Ireland (East)	2000	50–64	24	No	Yes	2	Yes
Spain, Asturias	1991	50–69	24	No	Yes	2/1	No
Spain, Baleares	1990	50–64	24	Yes	Yes	2	Yes
Spain, Galicia	1992	50–66	24	Yes	Yes	2	Yes
Spain, Navarra	1990	45–69	24	Yes	Yes	2	No
Spain, Pais Vasco	1990	50–64	24	Yes	Yes	2	No
Spain, Valencia	1992	45–69	24	Yes	Yes	2/1	Yes
Sweden, Södermanland	1990	40–74	24	NA	NA	2/1	No
Sweden, Stockholm	1989	40–69	24	NA	NA	2/1	Yes
Sweden, Västmanland	1986	40–69	24	NA	NA	2/1	Yes
Switzerland, Fribourg	2004	50–70	24	No	Yes	2/1	Yes
The Netherlands	1988	50–75	24	NA	NA	2/1	Yes
UK, England	1988	50–70	36	No	Yes	2	Yes

NA, not available
*2/1: two views at first screening, one at subsequent screening
†Performed not in all but in most screened women

Table 2 also shows the availability of full-field digital mammography (FFDM) in 2007. In the 16 programmes using digital mammography, only two relatively small programmes (Estonia and Switzerland, Fribourg) were equipped essentially only with FFDM machines (100% and 95% respectively). In the other programmes FFDM accounted for less than 20% of mammography machines.

Information on breast cancer screening data management and monitoring in 2007 is presented in Table 3, including website addresses from which further information and reports can be obtained. Regional and national monitoring was implemented for 16 programmes in nine countries. Four programmes in three countries used only regional monitoring systems. Monitoring was established only at the national level in five programmes. Most of the programmes used either individual ($n = 8$) or mixed individual and aggregated data ($n = 14$) for monitoring; three programmes used only aggregated data.

Coverage and participation

All 26 programmes completed the standard section of the coverage and participation module. The results shown for most programmes refer to the age group 50–69 years (Table 4). The total number of women in the target population of the 26 programmes used to calculate coverage rates was 26.9 million, and the total number of invitations used to calculate coverage by invitation in the 26 programmes was 13.9 million.

The total number of screening tests in predominantly 50–69-year-old women reported in the 26 programmes and shown in Table 4 (9.16 million) was 7.6% less than the total number performed in women of all ages (9.92 million, Table 2). About 20% of the tests reported in the study were for initial (prevalent) screening, with substantial respective volumes of initial screening reported for the Czech Republic, Estonia and Poland (data not shown).

Coverage by invitation

The coverage by invitation ranged from 50.9% in Italy, to 115.2% in Poland, the latter exceeding 100% as more than 50% of the target population were invited in a single year (i.e. exceeding 100% coverage for a two-year programme) (Table 4). The invitation coverage in Poland was inflated in 2007 due to the initiation of personal invitation in the screening programme in that year. The overall coverage by invitation across all 26 programmes was 79.3%. Excluding Poland, the overall coverage by invitation was 70.9%.

Participation rates

The participation rate varied from 19.4% in Poland to 88.9% in Navarra (Spain) (Table 5). Half of the programmes (13 out

Table 2 Breast cancer screening facilities and estimated annual volume of activity in 26 European programmes (2007)

Country or region	Period (year)	Exams in the period (*N*)*	Screening tests (1 year average) (*N*)*	Screening units (*N*)	Tests per screening unit (1 year average) (*N*)†	Mammography machines (*N*)	Tests per machine (1 year average) (*N*)†	Digital mammography	
								(Y/N)	Proportion of machines (%)
Belgium, Flanders	2005	134,356	134,356	172	781	200	672	Yes	17.4
Czech Republic	2005–2007	1,122,472	374,157	58‡	6451	79‡	4736	Yes	10.3
Denmark, Copenhagen	2005	16,897	16,897	1	16,897	3	5632	No	
Estonia	2005–2006	41,068	20,534	5	4107	5	4107	Yes	100
Finland	2005	211,183	211,183	NA	NA	50	4224	Yes	NA
Germany	2001–2004§	80,388	20,097	4	5024	5	4019	Yes**	NA
Hungary	2005–2007	658,218	219,406	45	4876	NA	NA	Yes††	–
Italy	2005	1,072,357	1,072,357	123	8718	NA	NA	Yes	NA
Luxembourg	2004–2005	28,017	14,009	9	1557	NA	NA	No	–
Norway	2005–2006	370,778	185,389	30	6180	30	6180	Yes	7.7
Poland	2007	935,416	935,416	348	2688	356	2628	Yes	2.0
Portugal, centre	2005	73,182	73,182	10	7318	10	7318	Yes	100
Portugal, north	2005	32,122	32,122	4	8031	4	8031	No	–
Republic of Ireland (East)	2005	59,960	59,960	8	7495	13	4612	Yes	7.8
Spain, Asturias	2005	40,136	40,136	8	5017	10	4014	No	–
Spain, Baleares	2005	13,018	13,018	6	2170	6	2170	Yes	15
Spain, Galicia	2005–2006	172,341	86,170	13	6628	13	6603	No	–
Spain, Navarra	2005–2006	74,087	37,044	2	18,522	3	12,348	No	–
Spain, Pais Vasco	2005	76,229	76,229	9	8470	13	5864	No	–
Spain, Valencia	2005–2006	418,542	209,271	23	9099	23	9099	Yes	9.0
Sweden, Södermanland	2005	21,222	21,222	1	21,222	2	10,611	No	–
Sweden, Stockholm	2005	76,371	76,371	6	12,729	NA	NA	Yes	NA
Sweden, Västmanland	2005	19,617	19,617	2	9809	2	9809	No	–
Switzerland, Fribourg	2005	6886	6886	8	861	8	861	Yes	95
The Netherlands	2005	890,837	890,837	65	13,705	65	13,705	Yes	4.0
UK, England	2005–2007‡‡	3,269,375	1,634,688	83	19,695	202	8093	Yes	3.5
Total		9,915,075	6,480,554§§	1043		1102			

NA, not available

*Estimates for 2007 based on tests performed in all age groups in the period indicated in second column

†Estimates for 2007 based on units/machines reported for 2007 and tests performed in all age groups in the period indicated in second column

‡Data refer to 2006

§July 2001–September 2004 in Bremen and Weisbaden, May 2002–September 2004 in Weser Ems

**Only in subsequent routine screening, not in the pilot projects

††Since2007

‡‡July 2005–June 2007

§§Total does not add up due to rounding of country data to the nearest digit

Table 3 Breast cancer screening data managing and monitoring in 26 European programmes (2007)

Country or region	Regional monitoring (Y/N)	National monitoring (Y/N)	Web site references
Belgium, Flanders	Yes (i)	No	www.zorg-en-gezondheid.be/ziektes/vlaams-bevolkingsonderzoek-naar-borstkanker/
Czech Republic	No	Yes (i)	www.mamo.cz/index-en.php
Denmark, Copenhagen	Yes (i)	No	www.cancer.dk/international/english/Screening+breast+cancer+english/
Estonia	No	Yes (a)	www.cancer.ee/?op=body&id=123
Finland	NA	Yes (i)	www.cancer.fi/syoparekisteri/en/mass-screening-registry/breast_cancer_screening/
Germany	Yes (i)	Yes (i)	www.mammo-programm.de
Hungary	Yes (a)	Yes (a)	NA
Italy	Yes (m)	Yes (a)	www.gisma.it; www.osservatorionazionalescreening.it
Luxembourg	No	Yes (i)	www.mammographie.public.lu/
Norway	Yes (m)	Yes (i)	www.kreftregisteret.no
Poland	No	Yes (m)	NA
Portugal, centre	Yes (i)	No	www.ligacontracancro.pt
Portugal, north	Yes (i)	No	www.ligacontracancro.pt
Republic of Ireland (East)	No	Yes (m)	www.cancerscreening.ie
Spain, Asturias	Yes (i)	Yes (a)	www.cribadocancer.es
Spain, Baleares	Yes (i)	Yes (a)	www.cribadocancer.es
Spain, Galicia	Yes (i)	Yes (a)	www.cribadocancer.es
Spain, Navarra	Yes (NA)	Yes (a)	www.cribadocancer.es
Spain, Pais Vasco	Yes (m)	Yes (a)	www.cribadocancer.es
Spain, Valencia	Yes (m)	Yes (a)	www.cribadocancer.es
Sweden, Södermanland	Yes (m)	Yes (a)	NA
Sweden, Stockholm	Yes (i)	Yes (a)	NA
Sweden, Västmanland	Yes (a)	Yes (a)	NA
Switzerland, Fribourg	Yes (i)	Yes (a)	http://www.liguecancer-fr.ch/fr/; http://www.fgdcs.ch/accueil/index.php
The Netherlands	Yes (i)	Yes (a)	http://www.bevolkingsonderzoekborstkanker.nl/
UK, England	Yes (m)	Yes (a)	www.cancerscreening.nhs.uk

NA, not available
(i) = individual data
(a) = aggregated data
(m) = mixed (individual and aggregated) data

of 26) achieved the acceptable level of participation recommended in the European Union Guidelines (>70%). Nine programmes achieved the higher desirable level specified in the European Union Guidelines (>75%). None of the six programmes that started more recently met the acceptable European Union target; in one of these (Czech Republic) the participation rate was not reported because women access the programme without a personal invitation letter.

The participation rate calculated across all 25 programmes sending personal invitations was 53.4% (Table 5). Excluding Poland, the average participation rate was 66.4%.

Except for two regions in Spain (Baleares and Valencia), the programmes that provided data permitting separate calculation of participation after invitation to attend screening for the first time revealed lower participation rates for initial screening compared with the overall participation rate (initial and subsequent screening combined). The differences ranged from 3 to 33 percentage points (see Table 5, footnote).

Coverage by examination

The coverage by examination ranged from 28.4% in Italy to 92.1% in Navarra, Spain (Table 4). The overall coverage by examination calculated across all 26 programmes was 48.2%.

DISCUSSION

A limited number of publications have presented data on the characteristics and performance of breast cancer screening programmes across Europe and internationally.[4–10] These reports have been instrumental in demonstrating the need for uniform standards of reporting to improve the exchange of information and experience between programmes. The fourth edition of the European Guidelines for quality assurance in breast cancer screening and diagnosis recommends a comprehensive set of performance parameters and indicators for monitoring and evaluating any population-based breast cancer screening programme, but does not provide a means of routinely collecting the requisite data and uniformly generating indicators. The EUNICE data warehouse addresses this important need. This report demonstrates the feasibility of the EBCSM module on coverage and participation, and provides an overview of programme organization in 26 screening programmes in Europe. The results are relevant to the current discussion

Table 4 Coverage by invitation and examination in 26 European breast screening programmes

Country or region	Period (year)	Target population of women (*N*)*	Personal invitations (*N*)*	Examinations (*N*)*	Annual target population (*N*)*,†	Annual invitations (*N*)*,†	Annual examinations (*N*)*,†	Invitation coverage (%)*,†	Examination coverage (%)*,†
[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Belgium, Flanders	2005	717,856	295,150	134,356	358,928	295,150	134,356	82.2	37.4
Czech Republic‡	2005–2007	1,351,706	NA	831,778	675,853	0	277,259		41.0
Denmark, Copenhagen	2005	54,351	17,559	12,678	27,176	17,559	12,678	64.6	46.7
Estonia (50–59)	2005–2006	96,236	75,372	37,667	48,118	37,686	18,834	78.3	39.1
Finland	2005	688,778	242,796	211,183	344,389	242,796	211,183	70.5	61.3
Germany, pilot projects§	2001–2004	153,667	152,371	80,388	76,834	50,571	26,680	65.8	34.7
Hungary (45–65)	2005–2007	1,512,324	1,721,707	658,218	756,162	573,902	219,406	75.9	29.0
Italy	2005	7,240,570	1,843,119	1,027,964	3,620,285	1,843,119	1,027,964	50.9	28.4
Luxembourg	2004–2005	47,870	44,958	28,017	23,935	22,479	14,009	93.9	58.5
Norway	2005–2006	513,998	484,030	370,778	256,999	242,015	185,389	94.2	72.1
Poland	2007	4,747,156	2,734,513	935,416	2,373,578	2,734,513	935,416	115.2	39.4
Portugal, Centre	2005	193,378	94,131	58,447	96,689	94,131	58,447	97.4	60.4
Portugal, North (45–69)	2005	115,308	46,261	31,123	57,654	46,261	31,123	80.2	54.0
Republic of Ireland, East (50–64)	2005–2006	179,910	157,105	123,011	89,955	78,553	61,506	87.3	68.4
Spain, Asturias	2005	134,280	54,905	40,136	67,140	54,905	40,136	81.8	59.8
Spain, Baleares (50–64)	2005	70,642	19,198	13,018	35,321	19,198	13,018	54.4	36.9
Spain, Galicia (50–66)	2005–2006	258,375	218,542	172,341	129,188	109,271	86,171	84.6	66.7
Spain, Navarra	2005–2006	59,574	61,716	54,873	29,787	30,858	27,437	103.6	92.1
Spain, Pais Vasco (50–64)	2005	206,452	98,044	74,636	103,226	98,044	74,636	95.0	72.3
Spain, Valencia	2005–2006	433,368	441,758	320,268	216,684	220,879	160,134	101.9	73.9
Sweden, Södermanland	2005	34,325	14,516	12,192	17,163	14,516	12,192	84.6	71.0
Sweden, Stockholm	2005	215,440	102,887	71,972	107,720	102,887	71,972	95.5	66.8
Sweden, Västmanland	2005	29,424	13,779	12,138	14,712	13,779	12,138	93.7	82.5
Switzerland, Fribourg	2005	29,480	13,073	6886	14,740	13,073	6886	88.7	46.7
The Netherlands	2005	1,861,200	881,862	730,263	930,600	881,862	730,263	94.8	78.5
UK, England**	2005–2007	5,989,817	4,088,143	3,114,205	1,996,606	2,044,072	1,557,103	102.4	78.0
Total		26,935,485	13,917,495	9,163,952	12,469,440††	9,882,079††	6,006,334††	79.3	48.2

NA, not available

*The data and rates in columns [3] to [10] refer to the reference period indicated in column [2] and the age range 50–69 years, unless a different age range is indicated in column [1]

†Calculations: ANNUAL target population [6] = [3]/no. of years in screening interval reported in Table 1; Annual invitations [7] = [4]/no. of years in [2]; Annual examinations [8] = [5]/no. of years in [2]; Invitation coverage [9] = [7]/[6]; Examination coverage [10] = [8]/[6]

‡A pilot study was conducted in 2007–2008 with personal invitation of non-participant women

§Average rates shown are based on data from the first screening round, 07/2001–09/2004 in Bremen and Weisbaden, 05/2002–09/2004 in Weser Ems. Cumulative rates for round 1 are 99.2% (invitation coverage) and 52.3% (examination coverage)

**July 2005–June 2007

††Totals do not add up due to rounding of country data to the nearest digit

Table 5 Participation rates in 25 population-based European breast screening programmes

Country or region	Period (year)	Personal invitations (*N*)*	Examinations (*N*)*,†	Annual invitations (*N*)*,‡	Annual examinations (*N*)*,†,‡	Participation (%)*,‡
[1]	[2]	[3]	[4]	[5]	[6]	[7]
Belgium, Flanders	2005	295,150	111,794	295,150	111,794	37.9
Denmark, Copenhagen	2005	17,559	12,989	17,559	12,989	74.0
Estonia (50–59)	2005–2006	75,372	37,667	37,686	18,834	50.0
Finland	2005	242,796	211,183	242,796	211,183	87.0
Germany, pilot projects§	2001–2004	152,371	80,388	50,571	26,680	52.8
Hungary (45–65)	2005–2007	1,721,707	658,218	573,902	219,406	38.2
Italy	2005	1,843,119	1,044,338	1,843,119	1,044,338	56.7**
Luxembourg	2004–2005	44,958	28,017	22,479	14,009	62.3
Norway	2005–2006	484,030	370,778	242,015	185,389	76.6
Poland	2007	2,734,513	530,300	2,734,513	530,300	19.4
Portugal, Centre	2005	94,131	58,447	94,131	58,447	62.1**
Portugal, North (45–69)	2005	46,261	31,123	46,261	31,123	67.3**
Republic of Ireland, East (50–64)	2005–2006	157,105	123,011	78,553	61,506	78.3
Spain, Asturias	2005	54,905	40,136	54,905	40,136	73.1
Spain, Baleares (50–64)	2005	19,198	13,018	19,198	13,018	67.8**
Spain, Galicia (50–66)	2005–2006	218,542	172,341	109,271	86,171	78.9**
Spain, Navarra	2005–2006	61,716	54,873	30,858	27,437	88.9**
Spain, Pais Vasco (50–64)	2005	98,044	74,636	98,044	74,636	76.1
Spain, Valencia	2005–2006	441,758	320,268	220,879	160,134	72.5**
Sweden, Södermanland	2005	14,516	12,192	14,516	12,192	84.0
Sweden, Stockholm	2005	102,887	71,972	102,887	71,972	70.0
Sweden, Västmanland	2005	13,779	12,138	13,779	12,138	88.1
Switzerland, Fribourg	2005	13,073	5790	13,073	5790	44.3
The Netherlands	2005	881,862	728,151	881,862	728,151	82.6**
UK, England††	2005–2007	4,088,143	3,032,433	2,044,072	1,516,217	74.2**
Total		13,917,495	7,836,201	9,882,079‡‡	5,273,987‡‡	53.4

NA, not available

*The data and rates in columns [3] to [7] refer to the reference period indicated in column [2] and the age range 50–69 years, unless a different age range is indicated in column [1]

†No. of screening examinations reported in column [4] differs from respective number reported in Table 4 for programmes that used invitation cohort method (Belgium, Flanders; Denmark, Copenhagen; Italy; Poland; Switzerland, Fribourg; The Netherlands; UK, England). For explanation see Methods section

‡Calculations: Annual invitations [5] = [3]/no. of years in [2]; Annual examinations [6] = [4]/no. of years in [2]; Participation [7] = [6]/[5]

§Average rates shown are based on data from the first screening round, 07/2001–09/2004 in Weser-Ems

**Participation after invitation to attend screening for the first time: Italy: 40.7%; Portugal centre: 36.4%; Spain, Baleares 72.0%, Galicia: 76.2%, Navarra: 56.4%, Valencia: 80.3%; The Netherlands: 78.7%; UK England: 69.4%

††July 2005–June 2007

‡‡Totals do not add up due to rounding of country data to the nearest digit

of the impact of breast cancer service screening programmes, and to the current preparations to update the first report on the implementation of cancer screening programmes in the European Union.[11]

All of the programmes that participated in this survey are involved in the European Cancer Network (ECN), into which the former European Cancer Screening networks have been consolidated. In addition to collaboration in EUNICE, key projects in the ECN and the former European Union cancer screening networks have been the development and updating of the European Guidelines for quality assurance in breast, cervical and colorectal cancer screening and reporting on the implementation of cancer screening programmes in the European Union.[1,2,11–14]

Although 10 of the 26 European Union Member States with breast screening programmes are not represented in the current survey, the present results are consistent with the findings in the first report on implementation of cancer screening programmes in the European Union. This applies, for example, to the wide consensus in the European Union that breast cancer screening should be conducted in organized, population-based programmes, with personal invitations to each individual in the target population. The results presented here also show that despite wide agreement in Europe on additional policy aspects recommended by the Council of the European Union, such as the screening test (mammography), the target age range (50–69 years) and the screening interval (two years), there are still potentially significant differences in the way screening programmes are organized, particularly with regard to the volume and concentration of services and the size of target populations and screening programmes.

Professionals require a sufficient volume of tests to develop and maintain specialized skills in screening. The larger the testing volume of a screening unit, the shorter the time that will be required to accumulate sufficient data to reliably determine performance indicators, such as the rates of referral to surgery and detection of breast cancer, or the benign-to-malignant biopsy ratio. Delays in detecting potential problems necessarily also delay the time until corrective action can be taken. The present survey reveals a high, 27-fold variation between programmes in the estimated yearly number of examinations per screening unit, and a 20-fold variation in the estimated number of tests performed per mammography machine. This wide variation suggests that programmes with lower unit volumes may

require additional efforts and resources to achieve and maintain appropriate quality.

Very large programmes, with millions of eligible participants, must also ensure the same high level of quality across a large number of screening units and mammography machines. Significant, sustainable resources for uniform, timely reporting of appropriate performance parameters and indicators are essential to reliably and promptly detect differences between screening units that may require further investigation and action.

Decision-makers, programme coordinators and scientists should be aware of the substantial differences in Europe in the extent to which target populations are actually exposed to screening. There is a nearly two-fold difference in the invitation coverage across the 25 programmes included in the survey that routinely sent personal invitations. Furthermore, there is a more than three-fold difference in the examination coverage in the 26 programmes included in the survey (Table 4). The low examination coverage in some programmes may be attributed, to a large extent, to the exclusion criteria in the case of the Hungarian programme (women with a mammogram in the previous 24 months were not eligible to attend), and the incomplete rollout of the very large screening programme in Italy and the pilot projects in Germany during the respective reference periods.

Low examination coverage should not, however, be misinterpreted as a reason to interrupt screening activities of appropriate quality, particularly in the rollout phase of programmes, because potentially high coverage in some regions will be masked by little or no coverage in regions that have not yet initiated or completed rollout. In general, the measureable impact of screening on a target population should be greater in a programme with higher examination coverage. In practice, the relationship between examination coverage and impact may not be proportional, but the importance of the degree to which a target population is actually exposed to the intended screening examination should not be overlooked when evaluating the impact of screening. The lower the examination coverage, the more difficult it will be to distinguish the impact of screening from other trends affecting the burden of breast cancer in the population, particularly when methods of analysis are used that do not distinguish carefully between those women who are exposed to the screening test, and those who are not.

Given the importance of maximizing the benefit of screening, while minimizing the negative effects, professionals responsible for the implementation of breast cancer screening programmes should make every reasonable effort to ensure that the screening examination is available to all eligible women. As pointed out in the European Guidelines, effective communication is crucial to the overall success of these activities.[1,2] Even if 90% of the target population is invited to screening, and the participation rate reaches the 'acceptable ' target recommended in the European Union Guidelines (>70%), 3–4 out of 10 women will not have the mammographic examination during a given round of screening. Careful attention should therefore be paid not only to effective communication, enabling women to make an informed choice about attending screening, but also to technical and administrative aspects which ensure that all eligible women are reliably invited.

The present results show less variation between programmes in invitation coverage than in participation rates. The pronounced differences in participation rates underline the fact that the areas and target populations served by programmes may differ substantially with regard to the health-care environment and the characteristics of the target population. Breast cancer awareness among women and the extent of opportunistic screening can strongly affect participation in population-based screening programmes. Low participation rates should also stimulate careful examination of organizational procedures. For example they may result from preselection of the invited population to only include women with previous tests or invitations. The comparatively low participation rates (<60%) in more recently established breast screening programmes are consistent with previous experience in the ECN, particularly in the initial rounds of programmes in areas with significant opportunistic screening activity. The potential impact of opportunistic screening on participation rates is also quite relevant in some Italian areas, especially in younger women.[15] Facilitating the switch to organized screening when eligible women seek an appointment for mammography outside the programme can help to improve participation. A point which is often overlooked is that organized programmes are usually subject to rigorous quality assurance, whereas opportunistic screening activities may not be. This illustrates the importance of informing general practitioners and office-based gynaecologists and radiologists about the programme, and involving them in communication with women.[1,2]

While this overview of European breast screening programmes provides a useful snapshot of key aspects relevant to monitoring and evaluation, there are also limitations. Data were collected predominantly for the years 2005–2007, but significant changes in policies or performance of some programmes may have occurred subsequently. The use of digital technology, for example, which is now established in a number of programmes, was not yet widespread. The information provided in the report is derived from aggregated data. Though aggregated data permit some useful conclusions they are limited regarding the depth of analysis.

CONCLUSIONS

The feasibility of a web-based data warehouse (*EBCSM*) for standardized data collection, analysis and benchmarking of screening programmes in different countries has been demonstrated. The quality of data collection, and the validity and reliability of the information generated with the EBCSM database, is likely to improve if this resource is used on a regular basis to monitor regional and national programme performance, and to compare results between countries. The results presented here show a substantial difference in the extent to which eligible women are offered and participate in screening in European programmes; this should be taken into account when evaluating the impact of screening.

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