Preventive Medicine 91 (2016) 250–263

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

Presence, characteristics and equity of access to breast cancer screening programmes in 27 European countries in 2010 and 2014. Results from an international survey

S. Deandrea [a,*,1], A. Molina-Barceló [b,1], A. Uluturk [a], J. Moreno [b], L. Neamtiu [a], R. Peiró-Pérez [b,c], Z. Saz-Parkinson [a], J. Lopez-Alcalde [c,d,e], D. Lerda [a,2], D. Salas [b,f,2]

[a] European Commission, Directorate General Joint Research Centre (JRC), Directorate F – Health, Consumers and Reference Materials, Ispra, VA, Italy
[b] Área de Investigación en Cáncer y Salud Pública. Fundación para el Fomento de la Investigación Sanitaria y Biomédica (FISABIO)-Salud Pública Área de Investigación en Cáncer y Salud Pública, Valencia, Spain
[c] CIBER Epidemiología y Salud Pública (CIBERESP), Madrid, Spain
[d] Unidad de bioestadística clínica, Hospital Universitario Ramón y Cajal (IRYCIS), Madrid, Spain
[e] Faculty of Medicine, Universidad Francisco de Vitoria (UFV) Madrid, Madrid, Spain
[f] Dirección General de Salud Pública. Conselleria de Sanitat Universal i Salut Pública. G. Valenciana, Valencia, Spain

ARTICLE INFO

Article history:
Received 5 May 2016
Received in revised form 11 July 2016
Accepted 12 August 2016
Available online 13 August 2016

Keywords:
Early detection of cancer
Breast neoplasms
Socioeconomic factors
Europe

ABSTRACT

The European Union Council Recommendation of 2 December 2003 on cancer screening suggests the implementation of organised, population-based breast cancer screening programmes based on mammography every other year for women aged 50 to 69 years, ensuring equal access to screening, taking into account potential needs for targeting particular socioeconomic groups. A European survey on coverage and participation, and key organisational and policy characteristics of the programmes, targeting years 2010 and 2014, was undertaken in 2014. Overall, 27 countries contributed to this survey, 26 of the 28 European Union member states (92.9%) plus Norway. In 2014, 25 countries reported an ongoing population-based programme, one country reported a pilot programme and another was planning a pilot. In eight countries, the target age range was broader than that proposed by the Council Recommendation, and in three countries the full range was not covered. Fifteen countries reported not reaching some vulnerable populations, such as immigrants, prisoners and people without health insurance, while 22 reported that participation was periodically monitored by socioeconomic variables (*e.g.* age and territory). Organised, population-based breast cancer screening programmes based on routine mammograms are in place in most EU member states. However, there are still differences in the way screening programmes are implemented, and participation by vulnerable populations should be encouraged.

© 2016 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

1. Introduction

Breast cancer screening programmes in Europe have been in place since the late 1980s, since results of trials on their effectiveness became available (Shapiro, 1977; Tabár et al., 1985; Andersson et al., 1988; Roberts et al., 1990; Tabár et al., 1992). Surveys conducted in subsequent years (Jensen et al., 1990; Shapiro et al., 1998; Klabunde et al., 2002; Lynge et al., 2003; Yankaskas et al., 2004; Broeders et al., 2005; Klabunde and Ballard-Barbash, 2007) reported a gradual implementation of programmes, sometimes applying different policies, and heterogeneous compliance. At European Union level, the Council Recommendation of 2 December 2003 (Council of the European Union, 2003) (OJ L 327, 16.12.2003, p. 34.) set a list of requirements for the implementation of organised, population-based breast cancer screening programmes; it represents a shared commitment by member states to implement cancer screening programmes. The Council Recommendation also recommended a breast cancer screening protocol 'foreseeing mammography screening for breast cancer in women aged 50 to 69 in accordance with European guidelines for quality assurance in mammography'.

The expected outcome of cancer screening programmes is a decrease in mortality rates for some types of cancer (von Karsa et al.,

Abbreviations: DG SANTE, European Commission Directorate-General for Health and Food Safety; ECN, European Cancer Network; EHIS, Eurostat European health interview survey; EUNICE, European Network for Information on Cancer; EPAAC, European Partnership for Action Against Cancer; FISABIO, Fundación para el Fomento de la Investigación Sanitaria y Biomédica de la Comunitat Valenciana; JRC, European Commission's Joint Research Centre.

* Corresponding author at: European Commission, Directorate General Joint Research Centre (JRC), Directorate F – Health, Consumers and Reference Materials, Via E. Fermi 2749, 21027 Ispra, VA, Italy.
E-mail address: silvia.deandrea@ec.europa.eu (S. Deandrea).

[1] SD and AM equally contributed to this manuscript.
[2] DS and DL equally contributed to this manuscript.

http://dx.doi.org/10.1016/j.ypmed.2016.08.021
0091-7435/© 2016 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

2008); however, participation in such programmes is key to attaining the expected outcomes. The different barriers to participation include: organisational aspects of the screening programmes; people's knowledge, beliefs and attitudes about the disease and the programmes; and lack of screening opportunities in some regions of Europe (Bastos et al., 2010). Together, these barriers are shaping inequalities in cancer care.

Social inequalities in cancer imply health inequities spanning the full cancer continuum and cover social inequalities in the prevention, incidence, prevalence, detection and treatment, survival, mortality, and burden of cancer and other cancer-related health conditions and behaviours (Krieger, 2005). Population-based screening programmes assure more equity in access in comparison with other health initiatives such as opportunistic screening programmes (Palència et al., 2010). However, social inequalities in access can still be observed in population-based programmes (Spadea et al., 2010), as shown by the fact that vulnerable populations – those who "because of shared social characteristics are at higher risk of risks" (Frohlich and Potvin, 2008) — participate less in breast cancer screening programmes. These groups include those with lower socioeconomic status, and those pertaining to minority ethnic groups (von Euler-Chelpin et al., 2008; Szczepura et al., 2008). Equity aspects are considered in the Council Recommendation, which ask for 'action to be taken to ensure equal access to screening, taking due account of the possible need to target particular socioeconomic groups' (Council of the European Union, 2003).

In 2008, a first report of the implementation of the Council Recommendation was issued (von Karsa et al., 2008) (hereinafter *Implementation Report*). It was based on a written survey involving the EU member states, conducted by the European Commission's Directorate-General for Health and Food Safety (DG SANTE) in the second half of 2007, and complemented by information obtained from two European projects (European Cancer Network – ECN, and European Network for Information on Cancer – EUNICE). The *Implementation Report* stated that most member states had followed the Council Recommendation, and that most of them intended to undertake future actions. Data collected through EUNICE, also published by Giordano et al. (Giordano et al., 2012) in 2012, referred mostly to 2005, 2006 and 2007. In 2010, the first wave of the Eurostat European health interview survey (EHIS) (Eurostat, 2010) asked for few variables related to cancer screening (percentage of women who had undergone a mammography and, if a woman had undergone a mammography, what her reasons for doing so were); most countries reported data up to 2008 or 2009. While a second Implementation Report is in preparation (DG SANTE Grant Agreement 2011 53 03), no consistent data were available after 2010. In 2014 a new survey was undertaken in order to provide bridging on some general indicators on breast cancer screening programmes in Europe, and to provide original data on equity of access to those programmes.

2. Methods

Contacts within each member state were derived from two independent surveys conducted by the European Commission's Joint Research Centre (JRC) in 2012 (European Commission Initiative on Breast Cancer, 2015; Lerda et al., 2014), and the *Fundación para el Fomento de la Investigación Sanitaria y Biomédica de la Comunitat Valenciana* (FISABIO) within the European Partnership for Action Against Cancer (EPAAC) framework. Further details on those surveys are reported in Appendix A.

2.1. Data collection

Contributors to the two previous surveys received a joint communication from the JRC and FISABIO in July 2014, asking if they were interested in providing data for the publication of a common research paper. Each country was asked to provide a unique contact person and the names of up to two additional contributors (with the exception of countries with regional screening programmes, which were allowed more contributors). These persons were held responsible for checking and integrating the information reported in the past two survey(s) they had contributed to, according to standardised definitions provided in a new questionnaire. Definitions from the EUNICE project (EUNICE, 2012) and the *Implementation Report* (von Karsa et al., 2008) were applied when relevant. All countries except one that had participated in previous surveys agreed to contribute to the new paper.

2.2. Data analysis

A descriptive study of the main variables included in the questionnaire was performed. Calculations for the total number of women in the eligible population, total number of women invited and total number of women screened only considered the data available for the countries/regions providing information. Coverage by invitation, coverage by test, and participation rate were computed using EUNICE's formulas for an annual period (EUNICE, 2012). Coverage was 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). Coverage by invitation was calculated as the annual number of invitations divided by the annual target population; coverage by test was calculated as the annual number of women screened divided by the annual target population. Participation is defined as the proportion of women personally invited for screening who actually attended, and was calculated by dividing the annual number of women screened by the annual number of invitations.

3. Results

3.1. Respondents

Twenty-seven countries contributed to this survey, 26 of the 28 member states (92.9%) (no data from Greece or Slovakia) plus Norway. Data covering the whole state was provided by all the surveyed states, with the exception of United Kingdom (England only), Portugal (four regions out of seven), and Spain (15 regions out of 19). All the countries contributed both information for 2010 and 2014 about the screening organisation and protocol; regarding performance indicators, 20 countries contributed with 2014 data, three with 2013, three with 2012 and one with 2011. On inequality issues, all countries reported data for the 2010–2014 period except Romania (its programme began in 2014). Information on interventions to tackle inequalities was provided separately for the 2007–2012 and 2012–2014 periods.

3.2. General characteristics

General information on screening policy is reported in Table 1, Table 2 and Fig. 1. Most screening programmes started in the first decade of this century, with the exception of Sweden (1985), Finland (1987), England (1988), the Netherlands (1990), Denmark (1992), Luxembourg (1992), Norway (1996) and more recently Austria (2010) and Bulgaria (2013) [data not shown]. By 2010, 20 countries had rolled-out a population-based programme (in Portugal only for the Central Region, Alentejo and Algarve); in 3 countries (Malta, Poland and Slovenia), as well as for the Northern Region of Portugal, the rollout was ongoing. In three countries the programme was in its pilot (Austria, Czech Republic) or planning (Bulgaria) phase. In 2014, Malta and Poland completed the rollout, Bulgaria started a pilot and Romania initiated planning, which corresponds to 24 countries having a fully implemented population-based breast cancer screening programme. In 2014, a national programme or a regional programme with national coordination (Denmark, Portugal) was present in all countries; only Belgium

Table 1
Breast cancer screening programmes in 2010 and 2014.
Programme type:
NP = Non-programme screening. Examinations for early detection of breast cancer performed in a diagnostic or clinical setting, independent from the public screening policy
P = Programme screening. Examinations financed by public sources performed in the context of a public screening policy documented in a law, or an official regulation, decision, directive or recommendation, and where the policy defines, at minimum: the screening test, the examination intervals, group of persons eligible to be screened
O = Organised screening. Programme screening where other procedures (*e.g.* standard operating procedures) are specified and where a team at national or regional level is responsible for implementing the policy
PB = Population-based screening. Programme screening where in each round of the screening the persons in the eligible target area served by the programme are individually identified and personally invited
NA = Not applicable
Coordination: NS = National screening programme; R/NC = Regional screening programme, nationally coordinated; R = Regional screening programme; L, N/RC = Local screening programme, regional/national coordinated; L = Local screening programme; NA = Not applicable
Implementation: Planning phase (PL); Pilot phase (PI); Rollout on-going (RO); Rollout completed (RC)
Type of Test: M = Mammography; CBE = Clinical Breast Examination.

Country	Update period	Programme type	Coordination	Implementation status	Type of test	Age range	Interval (months)	Notes
Austria	2010	PB	L, N/RC	PI	M	Three pilot regions: 50–69, two pilot regions: 40–69	12/24 months (depending on pilot project, age or BIRADS)	
	2014	PB	NS	RC	M (digital)	Personally invited: 45–69; Via Opt-In – Serviceline (telephone) or online (website): 40–44 and 70+	Fixed interval: 24 months; BIRADS III: early rescreen after 6 or 12 months possible	
Belgium	2010	PB	R	RC	M	50–69	24	Important parallel opportunistic activity ongoing
	2014	PB	R	RC	M	50–69	24	
Bulgaria	2010	NP PB	– NS	– PL	M	NP: over 50 PB: 50–69	NP: 24 PB: 36	NP: funded by the National Health Insurance fund Some regional oncological centres offer prophylactic mammographies paid by the municipalities
	2014	NP PB	– NS	– PI	M	NP: over 50 PB: 50–69	NP: 24 PB: 36	
Croatia	2010	O PB	NS	RC	M	50–69	24	
	2014	O PB	NS	RC	M	50–69	24	
Cyprus	2010	PB	NS	RC	M	50–69	24	
	2014	PB	NS	RC	M (digital)	50–69	24	
Czech Republic	2010	O PB	NS	RC (O, NS) PI (PB, NS)	M	Over 45	24	PB (centralised invitation), as currently implemented it is aimed at women not attending the screening programme during the previous three years. The individuals in the target population are therefore covered either by invitation or actual screening examination
	2014	PB	NS	RC	M (digital)	Over 45[a]	24	
Denmark	2010	PB	R/NC	RC	M (digital)	50–69	24	Mammography screening started in Copenhagen Municipality in 1991 followed by the County of Funen in 1993 and subsequent by three other counties in 1994–2004. Rollout to rest of the country took place between 2007 and 2010
	2014	PB	R/NC	RC	M (digital)	50–69	24	
Estonia	2010	PB	NS	RC	M	50–62	24	
	2014	PB	NS	RC	M	50–62	24	
Finland	2010	PB	NS	RC	M (digital)	50-69[b]	24[c]	The responsibility to organise actual breast cancer screening is given to local municipalities (226 in 2012; 320 in 2013)
	2014	PB	NS	RC	M (digital)	50–69[b]	24	
France	2010	PB	NS	RC	M + CBE	50–74	24	
	2014	PB	NS	RC	M + CBE	50–74	24	
Germany	2010	PB	NS	RC	M	50–69	24	
	2014	PB	NS	RC	M (digital)	50–69	24	

Table 1 (*continued*)

Country	Update period	Programme type	Coordination	Implementation status	Type of test	Age range	Interval (months)	Notes
Hungary	2010	PB	NS	RC	M	45–65	24	
	2014	PB	NS	RC	M	45–65	24	
Ireland	2010	PB	NS	RC	M	50–64	24	From 2015 Ireland will commence extending breast screening from 65 to 69 year olds. This will be completed by 2021
	2014	PB	NS	RC	M	50–64	24	
Italy	2010	PB	NS	RC	M	50–69	24	
	2014	PB	NS	RC	M	50–69 standard protocol 45/49–69[d] 50–74[e]	24 12 for 45–49 years old	
Latvia	2010	PB	NS	RC	M	50–69	24	
	2014	PB	NS	RC	M	50–69	24	
Lithuania	2010	PB	NS	RC	M	50–69	24	The pilot programme started in 1999, it was expanded to the whole country in 2005
	2014	PB	NS	RC	M	50–69	24	
Luxembourg	2010	PB	NS	RC	M	50–69	24	
	2014	PB	NS	RC	M (digital)	50–69	24	
Malta	2010	PB	NS	RO	M	52–60	36	
	2014	PB	NS	RC	M	50–60	36	
Netherlands	2010	PB	NS	RC	M	50–75	24	
	2014	PB	NS	RC	M	50–75	24	
Norway	2010	PB	NS	RC	M (digital)	50–69	24	
	2014	PB	NS	RC	M (digital)	50–69	24	
Poland	2010	PB	NS	RO[f]	M	50–69	24	Population based pilot phase of screening was performed in 2006
	2014	PB	NS	RC	M (screen-film and digital)	50–69	24	
Portugal	2010	PB	R/NC	Central region, Alentejo and Algarve: RC North Region: RO	M (digital)[g]	45-69[g] 50-69[h]	24	Four regions contributed to the survey: Alentejo, Algarve, Central Region, Norte
	2014	PB	R/NC	Central region, Alentejo and Algarve: RC North Region: RO	M (digital)[g]	45-69[g] 50-69[h]	24	
Romania	2010	Not present in 2010	–	–	–	–	–	Breast Cancer Screening pilot was finally signed to be financed by Ministry of Health within R0 19 Norwegian Funds in December 2014
	2014	O	R	PL	M	50–69	24	
Slovenia	2010	O PB	NS	RO	M	50–69	24	In 2010 coexistence of organised and opportunistic screening
	2014	O PB	NS	RO	M	50–69	24	
Spain	2010	PB	R	RC	M (screen-film and digital)	45-69[i] 50-69[j]	24	Information for Spain refers to 19 regions
	2014	PB	R	RC	M (digital)	45-69[i] 50-69[j]	24	
Sweden	2010	PB	NS	RC	M	40–74	18–21–24 depending on age and area[k]	
	2014	PB	NS	RC	M	40–74	18–21–24 depending on age and area[k]	
United Kingdom	2010	PB	NS	RC	M	50–70	36	Data referring to England only
	2014	PB	NS	RC	M	50–70	36	

Table 2
Breast cancer screening programmes in 2010 and 2014, aggregated characteristics.

		2010	2014
		N (%)	N (%)
Programme type	Population-based only	22 (81.5)	23 (85.2)
	Organised	0 (0.0)	1 (3.7)
	Population-based and organised cohexisting	3 (11.1)	2 (7.4)
	Population-based and non programme cohexisting	1 (3.7)	1 (3.7)
	Not applicable	1 (3.7)	0 (0.0)
Coordination	National	21 (77.8)	22 (81.5)
	Regional/National coordinated	2 (7.4)	2 (7.4)
	Regional	2 (7.4)	3 (11.1)
	Local/Regional-National coordinated	1 (3.7)	0 (0.0)
	Not applicable	1 (3.7)	0 (0.0)
Implementation status	Planning	1 (3.7)	1 (3.7)
	Pilot	1 (3.7)	1 (3.7)
	Rollout ongoing	3 (11.1)	1 (3.7)
	Rollout completed	19 (70.4)	23 (85.2)
	Other	1 (3.7)	1 (3.7)
	Not applicable	2 (7.4)	0 (0.0)
Type of test	Mammography	25 (92.6)	26 (96.3)
	Mammography + Clinical breast examination	1 (3.7)	1 (3.7)
	Not applicable	1 (3.7)	0 (0.0)
Age range covered[a]	50–69[b]	23	24
Interval (months)	24	21 (77.8)	21 (77.8)
	36	3 (11.1)	3 (11.1)
	Depending on other variables (site, age, BIRADS, *etc.*)	2 (7.4)	3 (11.1)
	Not applicable	1 (3.7)	0 (0.0)

[a] The sum is higher than 27 because each single screening protocol is counted once.
[b] 50–70 approximated to 50–69.

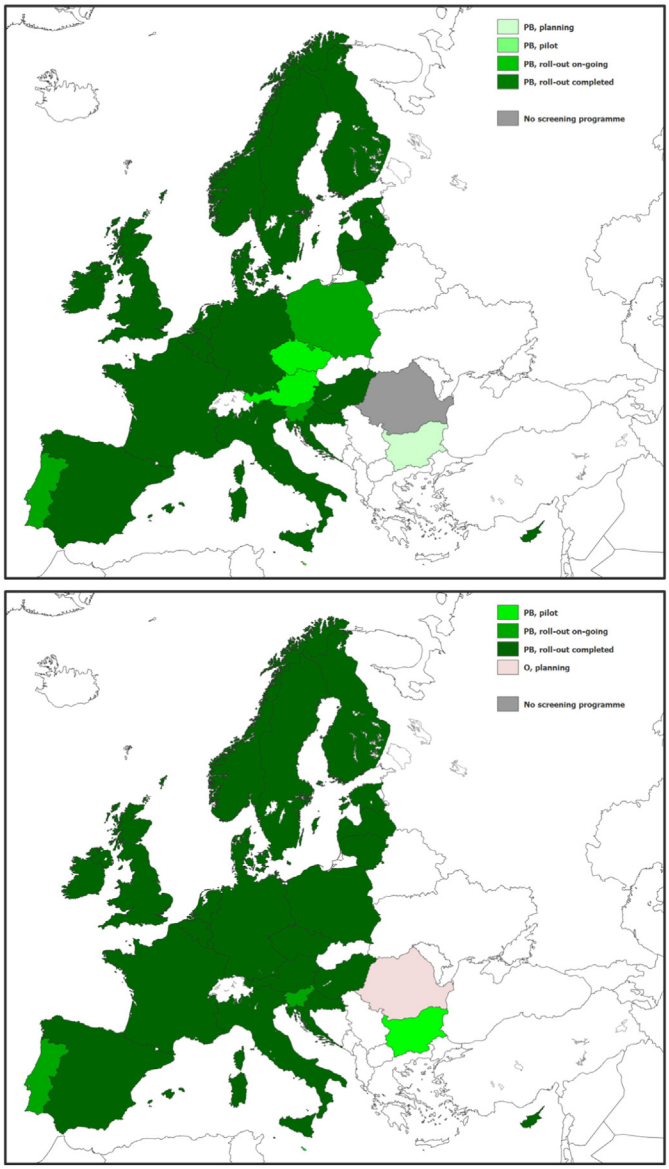

Fig. 1. Breast cancer screening programmes in 2010 and 2014.

(whose performance data are reported separately for Brussels, Flanders and Wallonia) and Spain had regional screening programmes in place. The planned project in Romania has regional coordination; Austria switched from local/national or regional coordination to national coordination between 2010 and 2014. National and regional websites are listed in Appendix B.

3.3. Screening protocol

The screening method used most often (Table 1 and Table 2) is mammography alone, with the exception of France, which implements mammography plus clinical breast examination. A specific question on analogic vs. digital mammography was not included in the survey, but this information was voluntarily reported by some countries. Regarding the target age, Portugal, Austria, Spain and Italy have different protocols according to the region. Women have been targeted from at least age 50 in all countries with active programmes since 2010 but Malta; a lower target age was applied in 7 countries/regions either in 2010 or 2014 (from age 40 or 45 according to the specific protocol). In 2010, three countries (France, the Netherlands, Sweden) were inviting the over 70s for screening, a number that increased to five countries in 2014 with the inclusion of some regions in Italy and Austria. Overall, the target age specified in the Council Recommendation (50–69 years) was

Notes to Table 1:
[a] Invitation up to 70.
[b] Both in years 2010 and 2014 the implementation phase for older ages was ongoing (almost complete in 2014). During years 1987–2006 screening was offered for women aged 50–59 years. However, according to Government Decree on Screening, since the beginning of year 2007 the upper age of screening was increased to 69 years for those women born on year 1947 or after that. Thus there has been a gradual implementation of this programme in older age groups and the full coverage of the programme will be reached by 2016 (for all women aged 50–69 years).
[c] 20–26 months interval reported in the Government Decree on Screening.
[d] Piedmont and Emilia Romagna regions.
[e] Several programmes.
[f] Lower Silesia only.
[g] Alentejo, Central Region, Norte.
[h] Algarve.
[i] Valenciana, Castilla-La Mancha, Castilla y León, Ceuta, Melilla, Navarra, La Rioja.
[j] Andalucía, Aragón, Asturias, Baleares, Canarias, Cantabria, Cataluña, Extremadura, Galicia, Madrid, Murcia, País Vasco.
[k] In most places in Sweden younger women are invited with 18 months interval and older women with 24 months interval. But in counties where you have to use mobile units, such as the northern part of Sweden, it is not possible to come back for the 18 and 24 months interval so all women are invited with 24 months interval. In the western part of Sweden all women are invited in an interval of 21 months. In Stockholm, since January 2015, all women in the age group between 40 and 74 will be invited in a 24 months interval.

adopted as such in 18 countries/regions in 2010 and 2014; in four countries (Estonia, Hungary, Ireland, Malta) the target age range was not completely covered in either 2010 or 2014. In 2014 the Irish Government announced plans to extend its breast cancer screening programme to women aged 65–69, commencing in 2015. The screening interval is two years in most countries except for Bulgaria, England and

Table 3
Breast cancer screening programmes in 2010 and last update: coverage by test, coverage by invitation, participation rate.
Coverage by invitation: annual number of invitations divided by the annual target population.
Coverage by test: the annual number of women screened divided by the annual target population.
Participation: annual number of women screened divided by the annual number of invitations.

Country	Update period	Annual eligible population	Number of invitations	Number of women screened	Coverage by invitation (%)	Coverage by test (%)	Participation rate (%)
Austria	2010	200,000	200,000	27,000	100.0	13.5	13.5
	2014	1,500,000	1,500,000	600,000	100.0	40.0	40.0
Belgium	2010	52,000	57,802	6194	111.2	12.0	10.7
Brussels	2014	52,000	55,029	5791	105.8	11.1	10.5
Belgium	2010	380,317	370,016	183,384	97.3	48.2	48.2
Flemish	2014	Not available	Not available	204,082	Not available	Not available	Not available
Belgium	2010	Not available	218,412	18,161	Not available	Not available	8.3
Walloon	2014	Not available	238,637	19,012	Not available	Not available	8.0
Bulgaria	2010	1,633,000	Not available	Not available	Not available	Not available	Not available
	2013–2014	1,057,000	123,647	10,392	11.7	1.0	8.4
Croatia	2010	334,543	334,543	147,525	100.0	45.0	57.0
	2014	329,988	301,395	131,455	91.0	44.0	60.1
Cyprus	2010	36,193	35,923	16,286	99.3	45.3	45.3
	2014	38,908	42,123	17,326	108.2	44.5	41.1
Czech	2010	879,496	Not applicable	477,413	Not applicable	54.3	Not applicable
Republic	2013	878,576	521,187[a]	538,997	28.7[a]	61.3	13.4[a]
Denmark	2010	Not available	310,000	251,000	Not available	Not available	81.0
	2014	Not available	324,000	266,000	Not available	Not available	82.1
Estonia	2010	63,800	53,500	33,502	83.9	52.5	62.6
	2014	65,534	60,399	34,089	92.1	52.0	56.4
Finland[b]	2010	736,262	316,535	268,314	85.7	72.6	84.8
	2012	750,813	342,816	284,433	90.9	75.5	83.0
France	2010	4,545,415[c]	4,545,415	2,361,548	100.0	52.0	52.0
	2014	4,834,417[c]	4,834,417	2,520,980	100.0	52.1	52.1
Germany[d]	2010	5,233,114	4,888,368	2,624,669	93.4	50.2	53.7
	2011	5,242,172	4,864,574	2,718,225	92.8	51.9	55.9
Hungary	2010	Not available	475,000	Not available	Not available	Not available	Not available
	–	Not available	Not available	Not available	Not available	Not available	Not available
Ireland	2010	368,967	167,088	120,730	45.3	32.7	72.3
	2014	395,416	181,922	138,770	43.5	32.9	75.6
Italy	2010	3,611,500	2,495,599	1,382,450	69.1	38.3	55.4
	2013	3,644,000	2,696,888	1,543,889	74.0	42.4	57.2
Lithuania	2010	214,000	63,769	60,925	Not applicable[e]	28.5	Not applicable[e]
	2013	234,228	80,826	80,348	Not applicable[e]	34.3	Not applicable[e]
Luxembourg	2010	26,550	26,019	16,122	98.0	60.7	62.0
	2014	30,274	29,668	18,362	98.0	60.6	61.9
Latvia	2010	203,336	196,578	38,148	96.7	18.8	19.4
	2014	159,223	142,168	51,060	89.3	32.1	35.9
Malta	2010	Not available	11,864	6,456	Not available	Not available	54.4
	2014	Not available	15,625	9,329	Not available	Not available	59.7
Netherlands	2010	1,250,000	1,193,347	961,765	95.5	76.9	80.8
	2012	1,299,000	1,266,555	1,007,966	97.5	77.6	80.0
Norway	2010	282,000	270,000	201,000	95.7	71.3	74.4
	2014	300,000	289,000	213,000	96.3	71.0	73.7
Poland	2010	2,522,421	2,419,459	945,283	95.9	37.5	39.1
	2014	2,668,119	2,749,919	1,207,214	103.1	45.2	43.9
Portugal[f]	2010	359,217	352,268	181,801	98.1	50.6	51.6
	2014	441,531	434,151	263,244	98.3	59.6	60.6
Romania	–	–	–	–	–	–	–
	–	–	–	–	–	–	–
Sweden	2010	900,000	900,000	720,000	100.0	80.0	80.0
	2014	900,000	900,000	720,000	100.0	80.0	80.0
Slovenia	2010	130,000[g]	12,754[h]	10,299[h]	9.8[g]	7.9[g]	80.8[h]
		22,000[h]			58.0[h]	46.4[h]	
	2014	135,000[g]	38,175	30,405[h]	28.3[g]	22.5[g]	79.6[h]
		49,000[h]			77.9[h]	62.1[h]	
Spain[i]	2010 (from 15 regions	1,911,410	1,911,410	1,365,344	100.0	71.4	71.4
	2012 (from 14 regions)	1,907,507	1,907,507	1,411,819	100.0	74.0	74.0
United	2010	2,124,038	2,302,886	1,728,671	108.4	81.4	75.1
Kingdom	2014	2,276,200	2,276,200	1,770,435	100.0	77.8	77.8
England							
TOTAL[j]	2010	27,880,370	24,123,792	14,153,224	–	–	–
	Latest update	29,020,899	26,217,196	15,816,366	–	–	–

Malta, where it is three years. Two countries adopt a different protocol according to individual risk: Austria allows early rescreening for BIRADS III (American College of Radiology, 2013), while some Italian regions invite women between the ages of 45 and 49 every 12 months, and in Sweden women are invited every 18–21-24 months according to age and area of residence.

3.4. Coverage by invitation

Table 3 shows the number of women invited and tested each year per country, as well as the calculated coverage by invitation and participation rate, and coverage by test. The number of people invited per year depended mostly on the country's population and the programmes' coverage — ranging from 11864 (Malta, rollout ongoing in 2010) to ~4.800,000 in France and in Germany. The total number of women in the overall target population that was used to calculate coverage rates was 28 million in 2010 (data from 23 countries, plus two regions of Belgium) and 29 million in 2012–2014 (latest annual update from 23 countries, plus one region of Belgium). The total number of invitations was 24 million in 2010 (data from 24 countries) and 26 million in 2012–2014 (latest annual update from 24 countries, plus two regions of Belgium). Finally, the number of women screened was 14 million in 2010 (data from 24 countries) and 16 million in 2012–2014 (latest annual update from 25 countries). For some countries the invitation strategy does not include an individual letter and the rates were not computed in the same way as for the others: in the Czech Republic, women previously accessed the programme without a personal invitation letter and those who had not previously attended were only invited to do so from 2014; in Lithuania the invitation is sent by the general practitioner and is registered only when the mammography test is carried out; for Finland, annual coverage by invitation and by test are approximated, as some municipalities use different invitation schedules over the two-year round. Coverage by invitation was higher than 90% in 17 countries, both in 2010 and in 2014.

Comparing coverage by invitation in 2014 with that in 2010, the greatest increase is observed in countries implementing the rollout within this period (2010–2014) as opposed to countries that had already implemented screening before 2010. Significant increases were seen in: Estonia, from 83.9% to 92.1%; Malta, from 55.5% to 100.0%; Slovenia: from 9.8% to 28.3%. However, differences among countries and between 2010 and 2014 may be due to differences in the timing of invitations in individual countries.

3.5. Participation rate

As regards the participation rate, in 2010 six countries/regions (Denmark, England, Finland, the Netherlands, Sweden and Slovenia) reported a rate above 75%, which is the desirable threshold for the corresponding indicator in the *European Guidelines for quality assurance in breast cancer screening and diagnosis* (hereinafter *European Guidelines*) (Perry et al., 2006). In general, no major differences in individual countries' participation rates were observed between 2010 and 2014 for most of those countries where the rollout had already been completed in 2010. Another three countries (Ireland, Norway and Spain) report a rate above 70%, which was an acceptable level according to the *European Guidelines*. Therefore, there are nine countries with a better than acceptable level of participation. The latest corresponding figure is comparable, with Ireland reaching >75% in 2014. As for the invitations, differences between countries, and between 2010 and 2014 for individual countries, may be due to differences in the timing of invitations and registration of test uptake.

3.6. Coverage by test

Finally, coverage by test, which depends on the previous indicators, ranged from 7.9% in 2010 (Slovenia, rollout ongoing) to 81.4% (England) in 2010 and from 1.0% (Bulgaria, pilot) to 80.0% (Sweden) in 2014.

3.7. Equity and access

Inequalities in access were identified. Although accessing most of the programmes is free of charge (Table 4) (with the exception of Norway), 16 have programmes that do not cover certain social groups — most frequently women without health insurance, women without residence permits, and women in prison. Some 16 programmes do however have specific objectives to reduce inequalities. These objectives are general (both general and targeted) in seven countries, targeted in four countries, and complementary in five countries.

To monitor participation (Fig. 2), most countries use socioeconomic variables. All countries monitor participation by age and territory, and half of them also include other variables, such as socio-economic level, educational level and/or ethnicity/nationality. Moreover, 13 countries have identified vulnerable populations that participate to a lesser extent in their programmes (Fig. 2), with the deprived population and migrant/ethnic minority groups being the population groups most commonly identified, followed by older women and those with a lower level of education. On the other hand, 18 countries identified barriers to participation (Fig. 2), with beliefs, knowledge and accessibility being the barriers most commonly detected. Finally, 17 countries have acted to tackle inequalities in participation. The majority of such interventions were performed in the period 2007–2012 — nine countries performed no such intervention in 2012–2014 (Table 5). Interventions directed to the general population were the most frequent. Examples of interventions (Table 5) are: information strategies (*e.g.*: general information campaigns, informative materials adapted to the needs of specific population groups, information sessions, community courses); organisational changes (*e.g.*: establishment of population-based screening programmes); accessibility improvements (*e.g.*: decrease in transport barriers, removal of fees, facilitation of out-of-hours appointments, establishing mobile units in rural areas and targeting ethnic communities); invitation strategies (*e.g.*: follow-up calls to non-attendants); social participation mechanisms and empowerment (*e.g.*:

Notes to Table 3:

[a] Women previously not attending individually invited Jan–Dec 2014, coverage computed for total target population 45–70 (entire population targeted in 2014).

[b] In Finland, some municipalities invite women aged 51–69 years every two years, others invite women aged 50–68 years every two years. Therefore, the coverage of invitations and visits (or tests) must be calculated over a two year period. Thus the coverage of invitation calculated using numbers from the year 2010 would not give a real picture on the invitational coverage of the national programme in age group 50–69 in 2010. Additionally, the programme expands gradually in ages 60–69 until 2016.

[c] Non-adjusted target population.

[d] The presented data refer to the target population and are derived from the statistical offices of the federal states without adjustment for eligibility. Women with one of the following criteria are not eligible and excluded temporarily: women with mammogram within the last 12 months, women with symptoms for breast cancer and women with breast cancer and in breast cancer care. Exact adjustment for eligibility as well as complete access to the target population is not possible due to very strict data protection regulations.

[e] There is no systematic personal invitation system through population register, but via GP's. The invitation is registered and paid by National Health Insurance Fund (NHIF) only when the mammography test is done. That is why the numbers of invitations coincide with the numbers of screening tests.

[f] Information from 4 regions out of 7 – regional data available on request.

[g] All country.

[h] Screening areas.

[i] Information from 15 regions out of 19 – regional data available on request.

[j] These figures only include the sum of the numbers available in each of the cells above.

Table 4
Inequalities in access to breast cancer screening programmes: individual cost, vulnerable populations not covered by the programme, objectives to tackle social inequalities in participation (2010–2014).

Country	Is the participation in the programme free of charge?	Is there any vulnerable population not covered by the programme?		Does the programme include objectives to tackle social inequalities in participation?		
	Yes/No	Yes/No	Type of vulnerable population	Yes/No	Type of approach	Content
Austria	Yes	No		No		
Belgium[a] (3/3)	Yes (3/3)	Yes (3/3)	Not health insured	No (3/3)		
Bulgaria	Yes	Yes	Not health insured	Not reported		
Croatia	Yes	Yes	Without residence permits	Yes[b]	General	Arise knowledge of target population by more educational activities
Cyprus	Yes	Yes	Without residence permits Prisoners	No		
Czech Republic	Yes	Yes	Without residence permits	Yes	General	To decrease inequalities in screening coverage across age groups and regions by implementing individual invitations and implement quality assurance mechanisms
Denmark	Yes	No		No		
Estonia	Yes	Yes	Not health insured	Yes	Targeted	To reduce inequalities we have to include to screenings also those groups who do not have insurance
Finland	Yes	No		Yes	General	To reduce social inequality inviting by a personal letter
France	Yes	No		Yes	Complementary	1) To inform GPs, physicians and medical staff working in prisons, local and national social organisations, immigrant groups and NGOs. 2) To improve accessibility by mobile screening bus
Germany	Yes	Yes	Without residence permits	Yes	General	To send personal written invitation based on the data provided by population registries
Hungary	Yes	No		No		
Ireland	Yes	No		Yes	Complementary	To inform "hard to reach" target populations and to address barriers of specific subgroups to increase accessibility. Some of the initiatives include: information sessions, community courses and the development of information leaflets in different formats and languages
Italy	Yes	Yes	Without residence permits Prisoners Not registered in the basic municipal register	Yes[b]	Targeted	To involve disadvantaged groups (included in the Local Health Plan)
Latvia	Yes	Yes	Without residence permits Prisoners Undergoing treatment at least 3 months at mental hospital	No		
Lithuania	Yes	Yes	Not health insured Without residence permits Prisoners	No		
Luxembourg	Yes	No		No		
Malta	Yes	No		Yes	General	The invitation includes an appointment date and time for a mammogram
Netherlands	Yes	Yes	Not registered in the basic municipal register	Yes	Complementary	To regularly test and evaluate education and communication materials also among low SES groups
Norway	No	No		No		
Poland	Yes	Yes	Not health insured Without residence permits Prisoners Not registered in the basic municipal register	Yes	General	To improve participation inviting by a personal letter, and educate the target population about cancer and screening
Portugal[a] (4/7)	Yes (4/4)	Yes (2/4)	Not health insured	No (4/4)		
Romania[b]	Yes	No		Yes	Targeted	To achieve access of Roma population and other disadvantaged groups from rural and isolated areas
Sweden	Yes	Yes	Without residence permits	Yes	General	To invite every woman in the right age group with a residence permit
Slovenia	Yes	Yes	Not health insured	Yes	Targeted	To screen women with no health insurance, too
Spain[a] (15/19)	Yes (15/15)	Yes (4/15)	Without public health card Prisoners	Yes (8/15)	Complementary	Free access and diagnosis, also for those who are not entitled to assistance in the public health system
UK[a] (England)	Yes	No		Yes	Complementary	The objective to tackle inequalities in screening comes from the Public Health Outcome Framework of the National Health System: "To improve and protect the nation's health and wellbeing, and improve the health of the poorest fastest"

[a] Response elaborated with regional data (number of regions responding/total of regions).
[b] Data available only for 2014.

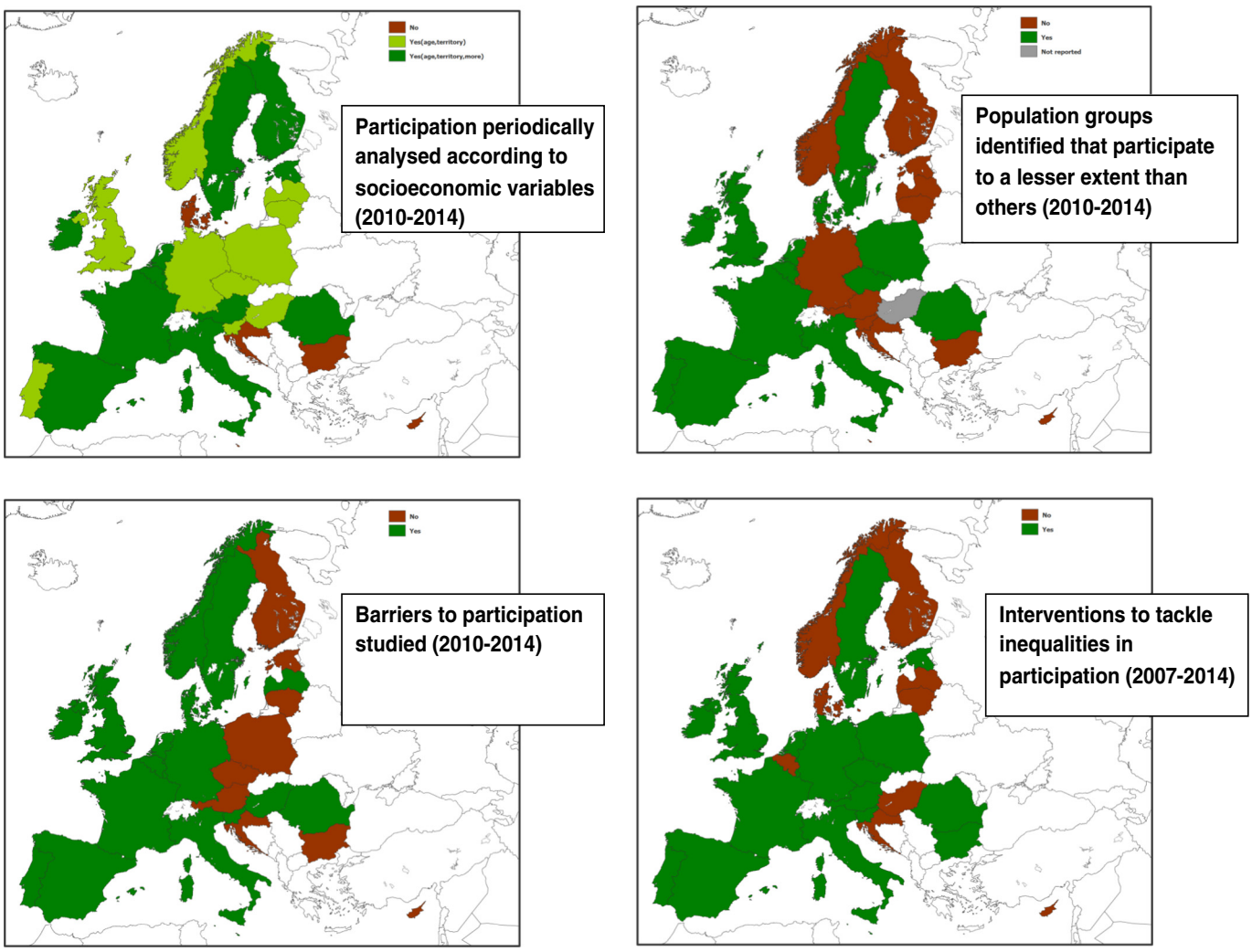

Fig. 2. Monitoring, evaluating and tackling inequalities in participation (2007–2014).

training health agents from local ethnic groups, social inclusion work); monitoring and research (*e.g.*: participation monitoring in specific geographic locations, studies of reasons for non-attendance).

4. Discussion

Population-based breast cancer screening is now in place in nearly all EU member states. By 2014, in 23 out of 28 member states, the rollout of an organised or population-based programme was complete (82.1%), in 2 the rollout was ongoing (7.1% — Slovenia and Northern Region of Portugal), 1 country was piloting a programme (Bulgaria), and another was planning to pilot a programme (Romania). For the two remaining countries (Greece and Slovakia), for which no data were provided, the most recent international source of information on screening programmes (von Karsa et al., 2008; Lerda et al., 2014) provided no evidence that an organised breast cancer screening programme was in place or planned, although some evidence exists for Greece (Simou et al., 2011; Trigoni et al., 2008; Trigoni et al., 2011; Tsounis et al., 2014). The present results are consistent with the findings in the *Implementation Report* (von Karsa et al., 2008). They show a positive trend towards compliance with the Council Recommendation and are encouraging, especially when considered together with the recent data on organised breast cancer screening in non-EU Mediterranean countries (Giordano et al., 2016), where such programmes are rare and do not meet international recommendations. In particular, only 4 out of the 25 countries with a programme in place do not cover the 50–69 age group, whilst the eligible age in 7 countries extends above or below this age threshold. It is worth noting the recent IARC viewpoint (Lauby-Secretan et al., 2015), which suggests there is sufficient evidence of mortality reduction for women aged 70–74, whilst for women aged 45–49 the evidence is limited. Moreover, three countries employ a different invitation schedule, using baseline risk as defined by breast density and/or specific age groups. In the *Implementation Report* there was no evidence of tailored screening protocols in place in organised programmes, which may reflect that research activity on tailored screening is still ongoing (Paci and Giorgi Rossi, 2010).

Taking into account the overall results of the 20 countries/regions that provided complete data for 2010 and 2014 (see Table 3, *i.e.* Austria, Belgium — Brussels, Croatia, Cyprus, Estonia, Finland, France, Germany, Ireland, Italy, Luxembourg, Latvia, the Netherlands, Norway, Poland, Portugal, Spain, Sweden, Slovenia, England), mean coverage by invitation increased by 3% (86.8% to 90.1%), and coverage by test by 4% (48.3% to 52.6%). This increase seems to be mainly due to progress or completion of rollout in Austria, Latvia, Italy, and Slovenia. Globally, coverage by invitation and by test still seems to be improving slightly, despite the austerity measures implemented in Europe over the last five years. However, the large range observed for the indicators in different countries (*e.g.* participation rate ranging from 8.3% to 84.8% in 2010 and

Table 5
Interventions to reduce inequalities in participation performed in the periods 2007–2012 and 2012–2014.

Country	Objective	Target Population	Type of intervention	Description of the intervention	Outcomes
Austria					
2007–2012	To increase participation and inform the women in the target population	General population	Information	General campaigns	Not evaluated
2012–2014	To implement the population-based screening programme	General population	Information	Campaigns of general information in 4 languages	Evaluation ongoing
Bulgaria					
2007–2012	No	No	No	No	No
2012–2014	Not reported	Not reported	Not reported	Not reported	Not reported
Czech Republic					
2007–2012	To increase participation and inform the women in the target population	General population	Information	General campaigns	Continuous increase in coverage by examination
2012–2014	To reduce inequalities in participation	General population: 45–70	Organisational changes	Implemented a population-based screening (by individual invitations)	13.4% participation in previously unscreened women, overall decrease inequalities to be evaluated
Estonia					
2007–2012	To increase participation	General population	Accessibility improvement	Decrease of transport barriers: make the timetables mammography buses more intense	Participation rise 15%
2012–2014	No	No		No	No
France					
2007–2012	To reduce inequalities and increase participation	Vulnerable population and Health professionals: GPs medical, staff in prisons, immigration NGO, low income population	Information, social participation mechanism, empowerment	Local initiatives and National campaigns: actions in the National Cancer Plans (2009–2013 and 2014–2019) were dedicated to reduction of inequalities in breast cancer screening	Increase of participation in the targeted population
2012–2014	Continuity	Continuity		Continuity	Continuity
Germany					
2007–2012	To implement the population based screening programme	General population	Information	General campaigns	Since 2009 fully implemented programme, plenty of information material, regular invitation of the entire target population
2012–2014	Change in communication and information strategies towards enabling informed decision rather than increasing participation	General population	Information	Revision of most information material, introduction of new information material: video statements, information films, graphics, new internet presence with specific portals for different users-women, physicians, media, ….	Nothing measured
Ireland					
2007–2012	1) To inform about early detection, prevention and screening; 2) To address barriers of specific subgroups to increase accessibility; 3) To advocate on behalf of all service users to ensure an equitable service	General and vulnerable population and Health professionals: community, voluntary organisations, statutory bodies, health professionals and other relevant agencies, specific 'hard to reach' target populations	Information, empowerment	General campaigns and specific initiatives for 'hard to reach' targeted populations: information sessions, community courses, health fairs and staffed displays. Examples of social inclusion work include, developing a language tool for use by radiographers, organising language and sign interpreters, the development of materials in other languages and formats	Specific 'hard to reach' targeted populations have been directly reached by health promotion teams. Key messages on early detection and prevention have been developed. Our social inclusion work ensures that these groups are given every opportunity to access our services and their specific needs understood and responded to. The development of low literacy materials *e.g.* Breast Check pictorial leaflet. On-going work and initiatives with minority groups in training community health workers, appointment support for women and low literacy support *etc.*
2012–2014	Identification of groups with low participation rates	Vulnerable population: specific geographical area	Monitoring and research, empowerment	Monitoring of participation rates in specific geographical locations Various initiatives introduced for reduced participation rates in this locations	Health professionals such as Primary Care Teams including General Practitioners, Practice Nurses and Public Health Nurses and also community groups are asked to provide support in creating awareness of the Breast Screening Programme among their patient population and encourage women to attend for screening where low rates of participation exist

(continued on next page)

Table 5 (*continued*)

Country	Objective	Target Population	Type of intervention	Description of the intervention	Outcomes
Italy					
2007–2012	1) To analyse participation by sub- groups (ethnic, socio-economic groups). 2) To reduce barriers to informed choice	Vulnerable population: Ethnics/immigrants groups	Research and studies, information	Study of barriers to design an intervention	A National survey specific for People coming from Countries with high migration pressure has been carried out. Several programmes have carried out analysis of participation by socio-economic status. Several programmes adopt leaflets translated into principal languages of Countries with high migration pressure
2012–2014	No	No		No	No
Luxembourg					
2007–2012	To increase participation rate	General population	Information	General campaigns	Difficult to measure.
2012–2014	No	No		No	No
Malta					
2007–2012	To implement the population based screening programme	General population	Invitation strategies	General campaign.	Roll out of the national screening programme
2012–2014	To increase the participation rate	General population	Information Empowerment	1. Some projects have looked at motives for non-attendance, by telephone surveys and follow up calls; 2. data sets have been cleaned up, and demographic information made more reliable	Increase in attendance rate
Netherland					
2007–2012	To raise informed decision making of target population	General and Vulnerable population: specific geographical area and specific socioeconomic level groups	Information, monitoring and research	1) Specific information for some groups 2) Monitoring of reasons for non-participation	Continuous improvement of education materials. Regular monitoring of reasons for non-participation acting upon that
2012–2014	No	No		No	No
Portugal					
2007–2012	To promote participation, analyse and reduce existing barriers	General and vulnerable population	Information, accessibility improvement	1) General campaigns 2) Provide transportation to women with limited resources	Higher participation rate
2012–2014	No	No		No	No
Poland					
2007–2012	To promote participation	General population	Information, invitation strategies	1) General campaigns, information material, lectures, and educational events 2) Personal invitation by letter	Difficult to measure
2012–2014	Continuity	Continuity		Continuity	Continuity
Romania					
2012–2014	1)To improve accessibility 2) To increase participation	Vulnerable population: Roma and other disadvantaged groups	Information, accessibility improvement	Regional information campaign with mobile units and sanitary mediators	Expected Outcome: Up to 5000 tests in disadvantaged groups in rural and ethnic communities up to April 2016, end of Project implementation
Sweden					
2007–2012	1) To increase participation 2) To facilitate rebooking 3) To increase participation	General and vulnerable population	Accessibility improvement, Invitation Strategies, Information	1) Political decision to take away the fee 2) Second invitation within one – two weeks if they did not attend. 3) Specific information in several languages focused on lower socio-economic level; different phrasing in invitation letter	Outcome: Increased participation especially in areas with low participation and among younger women
2012–2014	No	No		No	No
Slovenia					
2007–2012	To rise participation rate among no respondent women	General population: non-respondents	Invitation strategies	Second and third invitation if they did not attend	Third invitation with fixed appointment term not efficient. Since then we send only one additional invitation
2012–2014	To rise screening participation rate	General population: Women who did not attend subsequent screening interval after being screened at least once.	Monitoring and research	Non-attendance questionnaire, still on-going	It is effective to remind women about screening after few years of being no respondent – with motivation letter, not with fixed appointment for screening
Spain					

Table 5 (*continued*)

Country	Objective	Target Population	Type of intervention	Description of the intervention	Outcomes
2007–2012	1)To improve accessibility 2) To empower population in cancer prevention 3) To increase participation and informed decision making	General and vulnerable population: 1) 1.1.rural and remote population; 1.2. psychiatric patients in hospitals 2) Ethnic groups in high vulnerable areas, immigrant population 3) 3.1. general population; 3.2. vulnerable population	Accessibility improvement, Information, Empowerment	1) 1.1.Mobile units, free transportation; 1.2.Accessibility for psychiatric patients admitted in Hospitals 2) Training health agents from local ethnic groups, action-participative research 3) 3.1.General campaigns, 3.2.Meetings with vulnerable population	1.1) Increase participation/participation rates unchanged 1.2) Identification of specific needs 2) Community empowerment/Not assessed 3) Improvement of informed participation
2012–2014	No	No		No	No
UK (England)					
2007–2012	To increase participation	General population	Accessibility improvement	Offer of out of hours appointment	The highest attendance was observed in the group offered an initial office hour appointment with the option to change to out-of-hours (76.1% vs 73.3% for standard office hour, P^2 0.001), with 7% of invitation
2012–2014	No	No		No	No

from 8.0% to 83.0% in 2014) suggests variation in performance between European screening programmes — an issue that must be taken into consideration by policy-makers.

It is widely accepted that European health care policies, such as 'universal' national health systems and 'population-based' cancer screening programmes, promote equity. However, vulnerable populations have been identified as being excluded from the target population (*e.g.*: women without health insurance, women without residence permits, and women in prison). According to the definition of target population included in the *European Guidelines* (Perry et al., 2006), 'all women eligible to attend for screening on the basis of age and geographic location (dictated by screening policy)' shall be invited. This definition also specifies that 'special groups such as institutionalised or minority groups' should be included. It would therefore be advisable for European breast cancer screening programmes to ensure that the definition of their target population is in accordance with the *European Guidelines*, including that for vulnerable populations.

Monitoring participation is another quality indicator recommended in the *European Guidelines* (Perry et al., 2006). Age and territory are the most common variables used to analyse participation, but effort is needed to also include variables related with ethnicity and socioeconomic level in cancer screening registries. This study identified inequalities in participation, with socially vulnerable groups showing a lower participation rate. These results are consistent with those of other studies (Palència et al., 2010; Euler-Chelpin et al., 2008; Dolansky, 2006; Maheswaran et al., 2006). Reducing social inequalities in cancer could be achieved with different approaches, both general and targeted. The general approach takes into account the whole population, and seeks to reduce the difference in health between high, middle and low-income groups by providing health opportunities equally across all socioeconomic strata. The targeted approach focuses only on people in the poverty stratum. Both approaches are complementary and interdependent (Whitehead and Dahlgren, 2006). Interventions to tackle inequalities with general and targeted approaches are therefore needed.

This study reports the implementation status of breast cancer screening programmes in most EU countries. However, as the Council Recommendation invited to maximise benefits and minimise harms of screening and to comply with quality assurance guidelines, our study is limited to some extent by a lack of information on the quality of the service actually provided by those countries. This is important, particularly in view of the debate on the undesirable effects of mammography screening, such as overdiagnosis.

Despite continuous improvement in the implementation of breast cancer screening programmes, it may be challenging in future to maintain the coverage achieved despite austerity, to reduce inequalities in access, and to maximise the risk-benefit ratio. Moreover, strategies to reduce inequalities in cancer screening must be implemented. For this to happen, the unequal distribution of barriers limiting access to screening among different socioeconomic and cultural groups must be further analysed so that suitable interventions that improve access to good quality screening may be developed.

5. Conclusion

Organised, population-based breast cancer screening programmes based on routine mammograms are in place in most EU member states. However, there are still differences in the way breast cancer screening programmes are implemented which could translate into cancer inequalities. Offering universal and free access to breast cancer screening and implementing interventions to encourage participation by vulnerable populations through information and invitation strategies as well as social participation and empowerment mechanisms will be needed. In the future, studies on the quality of the services provided will also be necessary.

Contributing authors

Austria: Alexandra Ramssl-Sauer and Alexander Gollmer, Austrian Federal Institute for Quality Assurance in Health Care, Vienna. Magdalena Arrouas, Austrian Federal Ministry of Health, Vienna. **Belgium**: Saskia Van den Bogaert, Federal Public Service Health, Food Chain Safety and Environment, Brussels. Marc Van den Bulcke, Scientific Institute of Public Health, Brussels. **Bulgaria**: Constanta Timcheva, Medical Oncology Clinic, MHAT "Nadezhda, Sofia. Nadya Dimitrova, Bulgarian National Cancer Registry, National Hospital of Oncology, Sofia. Savelina Popovska, Department of Clinical Pathology Medical University Hospital, Pleven. Ivan Gavrilov, Thoracic surgery department, National Hospital of Oncology, Sofia. **Croatia**: Nataša Antoljak, Croatian Institute of Public Health and University Zagreb, Medical School, Zagreb. Andrea Šupe Parun, Croatian Institute of Public Health, Zagreb. Melita Jelavić,

Institute of Public Health "Dr Andrija Štampar", Zagreb. **Cyprus**: Stala Kioupi and Despina Ioannou, National Screening Programmes, Cyprus Ministry of Health, Nicosia. Anna Demetriou, Health Monitoring Unit, Cyprus Ministry of Health, Nicosia. **Czech Republic**: Ondrej Majek and Ladislav Dusek, a) Institute of Biostatistics and Analyses, Faculty of Medicine, Masaryk University, Brno b) Institute of Health Information and Statistics of the Czech Republic, Prague. Jan Danes, Clinic of Radiology of 1st Faculty of Medicine, Charles University in Prague and General University Hospital in Prague, Prague. **Denmark**: Ilse Vejborg, Department of Radiology, University Hospital of Copenhagen Rigshospitalet, Copenhagen. My von Euler-Chelpin, Department of Public Health, University of Copenhagen, Copenhagen. Berit Andersen, Department of Public Health Programs, Randers Regional Hospital, Central Denmark Region, Randers. **Estonia**: Katrin Kuusemäe, Estonian Cancer Screening Foundation, Tallinn. Ülle Iles, National Institute for Health Development, Tallinn. **Finland**: Ahti Anttila and Tytti Sarkeala, Finnish Cancer Registry, Helsinki. Liisa Pylkkänen, Finnish Cancer Society, Helsinki. **France**: Emmanuelle Salines, French Ministry of health, Paris. Agnes Rogel and Dimitri Lastier, French Institute for Public Health Surveillance, Saint-Maurice. **Germany**: Vanessa Kääb-Sanyal and Daniela Malek, Evaluation and Quality Management, Mammography Cooperative, Berlin. **Hungary**: Mátrai Zoltán, National Institute of Oncology, Budapest. **Ireland**: Michael Conroy and Keith Comiskey, Department of Health, Dublin. **Italy**: Antonio Federici, Ministry of Health – Direction of Prevention, Rome. Marco Zappa, National Screening Centre – Institute For Study and Prevention of Cancer (ISPO), Florence. **Lithuania**: Elona Juozaityte, Oncology institute, Lithuanian University of Health Sciences, Kaunas. Rugile Ivanauskiene, Health Research Institute, Lithuanian University of Health Sciences, Kaunas. **Luxembourg**: Astrid Scharpantgen and Claire Dillenbourg, Ministry of Health, Luxembourg. **Latvia**: Alise Laivina and Liga Gaigala, The National Health Service, Riga. **Malta**: Stephanie Xuereb and Joseph V Psaila, National Screening Programmes, Valletta. Miriam Dalmas, Ministry for Health, Valletta. **Netherlands**: Nynke De Jong, RIVM – Centre for Population Studies, Bilthoven. Tineke Kleefkens, Ministry of Health, Welfare and Sport, The Hague. **Norway**: Solveig Hofvind, Silje Sagstad and Anne-Kathrin Olsen Ertzaas, Cancer Registry of Norway, Oslo. **Poland**: Rafał Matkowski, a) Department of Oncology and Surgical Oncology, Wroclaw Medical University, Wrocław b) Lower Silesian Oncology Centre, Wrocław. Jolanta Kotowska and Dawid Błaszczyk, Lower Silesian Oncology Centre, Wrocław. **Portugal**: Tereza Sequeira Lopes, Vitor Veloso, Ana T. Aguiar and Miguel Pina, Portuguese League Against Cancer. Maria J. Bento, Instituto Português de Oncologia, Epidemiology Unit. Vitor Rodrigues, Coimbra University Medical School. Maria Filomena Horta Correia, Diana Ferrinho and Ricardo Pereira, Algarve Breast Cancer Screening Programme, Faro. **Romania**: Florian Nicula, Oncology Institute "Prof. Dr. Ion Chiricuta", Cluj-Napoca. **Spain**: Rosario Fernandez Echegaray, Consejería de Salud y Asuntos Sociales, Andalucía. Miguel A. Prieto García, Consejería de Sanidad, Asturias. Carmen Sánchez-Contador Escudero, Direcció General de Salut Pública i Consum. Conselleria de Salut, Illes Balears. Mariola de la Vega Prieto, Servicio Canario de la Salud, Canarias. Mar Sanchez Movellán, Dirección General de Salud Pública. Consejería de Sanidad y Servicios Sociales, Cantabria. Rosa Arizmendi, Consejeria de Sanidad, Castilla-La Mancha. Josep Alfons Espinàs, Catalan Cancer Strategy, Cataluña. Jose María Sánchez Romero, Consejería de Sanidad y Consumo, Ceuta. Josefa Miranda García, Consellería Sanitat, DG Salud Pública, Comunidad Valenciana. Raquel Zubizarreta Alberdi, Consellería de Sanidade da Xunta de Galicia, Galicia. Araceli Baroja Mazo, Fundación Rioja Salud-Servicio Riojano de Salud, La Rioja. Francisco Pérez-Riquelme, Dirección General de Salud Pública. Consejería de Sanidad, Murcia. Instituto Murciano de Investigaciones Biomédicas (IMIB). Nieves Ascunce and Juana Vidan Alli, Instituto de Salud Pública y Laboral de Navarra, Navarra. Garbiñe Sarriugarte Osakidetza, Dirección General. Servicio Vasco de Salud, País Vasco. **Sweden**: Karin Leifland, Medical Imaging, The South General Hospital, Stockholm. **Slovenia**: Katja Jarm, Mateja Krajc and Maja Primic Žakelj, Epidemiology and Cancer Registry, Institute of Oncology, Ljubljana. **United Kingdom (England)**: Julietta Patnick, Cancer Epidemiology Unit, University of Oxford, Oxford.

Transparency document

The Transparency document associated with this article can be found, in online version.

Acknowledgments

This study was co-financed by the European Partnership for Action Against Cancer (Grant Agreement number 2010 2202).

Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.ypmed.2016.08.021.

References

American College of Radiology, 2013. ACR BI-RADS mammography. ACR Breast Imaging Reporting and Database System, Breast Imaging Atlas, 5th ed. American College of Radiology, Reston, Va.

Andersson, I., Aspegren, K., Janzon, L., Landberg, T., Lindholm, K., Linell, F., Ljungberg, O., Ranstam, J., Sigfússon, B., 1988. Mammographic screening and mortality from breast cancer: the Malmo mammographic screening trial. BMJ 297, 943–948.

Eurostat, 2010. http://ec.europa.eu/eurostat/statistics-explained/index.php/Breast_cancer_screening_statistics [Accessed on 11 July 2016]

EUNICE, 2012. http://www.qtweb.it/eunice/EUNICE_documentation_v2.doc [Accessed on 11 July 2016]

Bastos, J., Peleteiro, B., Gouveia, J., Coleman, M.P., Lunet, N., 2010. The state of the art of cancer control in 30 European countries in 2008. Int. J. Cancer 126, 2700–2715.

Broeders, M.J., Scharpantgen, A., Ascunce, N., Gairard, B., Olsen, A.H., Mantellini, P., Mota, T.C., Van Limbergen, E., Séradour, B., Ponti, A., Trejo, L.S., Nyström, L., Network, E.B.C., 2005. Comparison of early performance indicators for screening projects within the European breast cancer network: 1989–2000. Eur. J. Cancer Prev. 14, 107–116.

Council of the European Union, 2003. Council Recommendation of 2 December 2003 on Cancer Screening 2003/878/EC). OJ L 327. 16.12. p. 34.

Dolansky, H., 2006. Mammography for elderly women. Prakt. Lek. 86, 578–582.

Euler-Chelpin, M., Olsen, A.H., Njor, S., Vejborg, I., Schwartz, W., Lynge, E., 2008. Socio-demographic determinants of participation in mammography screening. Int. J. Cancer 122, 418–423.

European Commission Initiative on Breast Cancer, 2015. Concept Document. Publications Office of the European Union, Luxembourg.

Frohlich, K.L., Potvin, L., 2008. Transcending the known in public health practice: the inequality paradox: the population approach and vulnerable populations. Am. J. Public Health 98, 216–221.

Giordano, L., Bisanti, L., Salamina, G., Ancelle Park, R., Sancho-Garnier, H., Espinas, J., Berling, C., Rennert, G., Castagno, R., Dotti, M., Jaramillo, L., Segnan, N., 2016. The Euromed Cancer network: state-of-art of cancer screening programmes in non-EU Mediterranean countries. Eur. J. Pub. Health 26, 83–89.

Giordano, L., von Karsa, L., Tomatis, M., Majek, O., de Wolf, C., Lancucki, L., Hofvind, S., Nyström, L., Segnan, N., Ponti, A., Eunice Working Group, Van Hal, G., Martens, P., Májek, O., Danes, J., von Euler-Chelpin, M., Aasmaa, A., Anttila, A., Becker, N., Péntek, Z., Budai, A., Mádai, S., Fitzpatrick, P., Mooney, T., Zappa, M., Ventura, L., Scharpantgen, A., Seroczynski, P., Morais, A., Rodrigues, V., MJ, B., de Carvalho J, G., Natal, C., Prieto, M., Sánchez-Contador Escudero, C., Zubizarreta Alberti, R., Fernández Llanes, S.B., Ascunce, N., Ederra Sanza, M., Sarriugarte Irigoien, G., Salas Trejo, D., Ibáñez Cabanell, J., Wiege, M., Ohlsson, G., Törnberg, S., Korzeniewska, M., de Wolf, C., Fracheboud, J., Patnick, J., Lancucki, L., Ducarroz, S., Suonio, E., 2012. Mammographic screening programmes in Europe: organization, coverage and participation. J. Med. Screen. 19 (Suppl1), 2–82.

Jensen, O., Estéve, J., Miller, H., Renard, H., 1990. Cancer in the European Community and its member states. Eur. J. Cancer 26, 1167–1256.

Klabunde, C.N., Ballard-Barbash, R., 2007. For the International Breast Cancer Screening Network. Evaluating population-based screening mammography programs internationally. Semin. Breast Dis. 10, 102–107.

Klabunde, C.N., Sancho-Garnier, H., Taplin, S., Thoresen, S., Ohuchi, N., Ballard-Barbash, R., 2002. Quality assurance in follow-up and initial treatment for screening mammography programs in 22 countries. Int. J. Qual. Health Care 14, 449–461.

Krieger, N., 2005. Defining and investigating social disparities in cancer: critical issues. Cancer Causes Control 16, 5–14.

Lauby-Secretan, B., Scoccianti, C., Loomis, D., Benbrahim-Tallaa, L., Bouvard, V., Bianchini, F., Straif, K., 2015. Breast-cancer screening — viewpoint of the IARC working group. N. Engl. J. Med. 372, 2353–2358.

Lerda, D., Deandrea, S., Freeman, C., López-Alcalde, J., Neamtiu, L., Nicholl, C., Nicholson, N., Uluturk, A., Villanueva, S., 2014. Report of a European Survey on the Organisation of Breast Cancer Care Services. Publications Office of the European Union, Luxembourg.

Lynge, E., Olsen, A.H., Fracheboud, J., Patnick, J., 2003. Reporting of performance indicators of mammography screening in Europe. Eur. J. Cancer Prev. 12, 213–222.

Maheswaran, R., Pearson, T., Jordan, H., Black, D., 2006. Socioeconomic deprivation, travel distance, location of service, and uptake of breast cancer screening in north Derbyshire, UK. J. Epidemiol. Community Health 60, 208–212.

Paci, E., Giorgi Rossi, P., 2010. Tailored screening for breast cancer in premenopausal women: not just looking at sensitivity, but aiming to reduce burden. Women's Health (Lond. Engl.) 6, 477–479.

Palència, L., Espelt, A., Rodríguez-Sanz, M., Puigpinós, R., Pons-Vigués, M., Pasarín, M.I., Spadea, T., Kunst, A.E., Borrell, C., 2010. Socio-economic inequalities in breast and cervical cancer screening practices in Europe: influence of the type of screening program. Int. J. Epidemiol. 39, 757–765.

Perry, N., Broeders, M., de Wolf, C., Törnberg, S., Holland, R., von Karsa, L. (Eds.), 2006. European Guidelines for Quality Assurance in Breast Cancer Screening and Diagnosis, 4th ed. European Commission, Office for Official Publications of the European Communities, Luxembourg.

Roberts, M.M., Alexander, F.E., Anderson, T.J., Chetty, U., Donnan, P.T., Forrest, P., Hepburn, W., Huggins, A., Kirkpatrick, A.E., Lamb, J., 1990. Edinburgh trial of screening for breast cancer: mortality at seven years. Lancet 335, 241–246.

Shapiro, S., 1977. Evidence on screening for breast cancer from a randomized trial. Cancer 39, 2772–2782.

Shapiro, S., Coleman, E.A., Broeders, M., Codd, M., de Koning, H., Fracheboud, J., Moss, S., Paci, E., Stachenko, S., Ballard-Barbash, R., 1998. Breast cancer screening programmes in 22 countries: current policies, administration and guidelines. International breast cancer screening network (IBSN) and the European network of pilot projects for breast cancer screening. Int. J. Epidemiol. 27, 735–742.

Simou, E., Tsimitselis, D., Tsopanlioti, M., Anastasakis, I., Papatheodorou, D., Kourlaba, G., Gerasimos, P., Maniadakis, N., 2011. Early evaluation of an organised mammography screening program in Greece 2004–2009. Cancer Epidemiol. 35, 375–380.

Spadea, T., Bellini, S., Kunst, A., Stirbu, I., Costa, G., 2010. The impact of interventions to improve attendance in female cancer screening among lower socioeconomic groups: a review. Prev. Med. 50, 159–164.

Szczepura, A., Price, C., Gumber, A., 2008. Breast and bowel cancer screening uptake patterns over 15 years for UK south Asian ethnic minority populations, corrected for differences in socio-demographic characteristics. BMC Public Health 8, 346.

Tabár, L., Fagerberg, G., Duffy, S.W., Day, N.E., Gad, A., Gröntoft, O., 1992. Update of the Swedish two-county program of mammographic screening for breast cancer. Radiol. Clin. N. Am. 30, 187–210.

Tabár, L., Gad, A., Holmberg, L., Ljungquist, U., 1985. Significant reduction in advanced breast cancer. Results of the first seven years of mammography screening in Kopparberg, Sweden. Diagn. Imaging Clin. Med. 54, 158–164.

Trigoni, M., Griffiths, F., Tsiftsis, D., Koumantakis, E., Green, E., Lionis, C., 2008. Mammography screening: views from women and primary care physicians in Crete. BMC Womens Health 7 (8), 20.

Trigoni, M., Mahoney, M.C., Moschandreas, J., Tsiftsis, D., Koumantakis, E., Lionis, C., 2011. Approaches to breast cancer screening among primary care physicians in rural areas of Crete, Greece. J. Cancer Educ. 26, 490–496.

Tsounis, A., Sarafis, P., Alexopoulos, E.C., 2014. Austerity and its consequences on cancer screening in Greece. Lancet 384, 2110.

von Euler-Chelpin, M., Olsen, A.H., Njor, S., Vejborg, I., Schwartz, W., Lynge, E., 2008. Socio-demographic determinants of participation in mammography screening. Int. J. Cancer 122, 418–423.

von Karsa, L., Anttila, A., Ronco, G., Ponti, A., Malila, N., Arbyn, M., Segnan, N., Castillo-Beltran, M., Boniol, M., Ferlay, J., Hery, C., Sauvaget, C., Voti, L., Autier, P., 2008. Cancer screening in the European Union. Report on the Implementation of the Council Recommendation on Cancer Screening – First Report. European Commission, Luxembourg.

Whitehead, M., Dahlgren, G., 2006. Levelling Up, Part 1: Concepts and Principles for Tackling Social Inequalities in Health. World Health Organization, Copenhagen.

Yankaskas, B.C., Klabunde, C.N., Ancelle-Park, R., Renner, G., Wang, H., Fracheboud, J., Pou, G., Bulliard, J.L., Network, I.B.C.S., 2004. International comparison of performance measures for screening mammography: can it be done? J. Med. Screen. 11, 187–193.