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Process indicators from ten centres in the Finnish breast cancer screening programme from 1991 to 2000

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Abstract

The aim of this study was to evaluate the quality of the Finnish mammography programme by assessing process indicators from 10 screening centres using data from the first and subsequent screens. We compared these screen-specific indicators with European standards and results from countries with similar screening protocols. Ten Finnish centres invited approximately 1 000 000 women from 1991–2000. Women were mainly 50–64 years old. Mean compliance amongst this age group was 90% at the first and 93% at subsequent screens. The corresponding recall rates were 4.6% and 2.3%, respectively. The average breast cancer detection rates were 0.44% and 0.36%, respectively. The positive predictive values (PPVs) of mammography at the first and subsequent screens were 10% (range 7–20%) and 16% (range 12–31%), and the corresponding benign to malignant (B:M) biopsy ratios were 1:1 (range 0.5–1.8:1) and 0.4:1 (range 0.3–0.8:1). The PPV of mammography increased significantly during the study period, and the average process indicators fulfilled the criteria of the European community for the most part. However, the variation in PPVs was wide, as has been seen for other European mammography programmes, indicating meaningful differences in diagnostic criteria and potential adverse effects.

Keywords: Epidemiology; Screening; Mammography; Breast cancer; Quality assurance; Effectiveness

1. Introduction

The Finnish population-based breast cancer screening programme started in 1987. Screening centres of the cancer society of Finland (CSF) were then established [1]. The screening programme was introduced gradually. The first women screened in 1987 were those born in the years 1928, 1932 and 1936. Women born in the neighbouring years were used as controls. The group-randomised design was evaluated and the initial follow-up (up to five years) showed a statistically non-significant effect with a 24% reduction in breast cancer mortality amongst those invited [2]. This is close to the reductions observed from the randomised screening trials in Sweden [3]. From Finland and other countries, there is also growing evidence that the non-randomised screening programmes decrease breast cancer mortality [4–6].

There is not much information on the performance of the Finnish programme. Reports from various European countries have suggested differences in the indicators of the screening process [7].

The aim of this study was to evaluate the quality of the Finnish mammography screening, that is run as a public health policy. The study is based on process and performance indicators collected at an individual

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level from 10 screening centres of the CSF from 1991–2000.

2. Materials and methods

The Finnish programme was started using recommendations made by the Finnish National Board of Health in 1986. A Bylaw on public health was passed in 1992. These regulations entitled individual municipalities to decide the organisational details of their breast cancer screening activity. The programme supervised by the screening centres of the CSF covered two thirds of approximately 460 Finnish municipalities during the first five years of the screening programme [2]. The 1992 Bylaw entitled municipalities to offer breast cancer screening to women aged 50–59 years; screenings for 60–69 year old women remained optional. However, since 1987 the CSF has recommended women aged 50–69 years to be screened every second year.

Finnish women who are to be invited to screening are identified from the national population registry. Letters of invitation, usually with an appointment time, are sent personally to each woman. Some of the centres send a reminder to the non-attenders. All of the attenders are informed of the screening results by letter. If there is a need for further examinations, women are advised or provided with an appointment by phone and by letter.

The screening examinations are free of charge for all of the participants. The screening test is a two-view screen film mammography (craniocaudal and mediolateral oblique), which two radiologists interpret independently. If either of these radiologists requires, simultaneous reading is performed. After a simultaneous reading, if either or both of the radiologists requires it, a decision on recall for further examinations is made. Recall examinations include one or several of the following: breast palpation, repeat mammography, breast ultrasound, galactography, pneumocystography, fine-needle aspiration biopsy and, from the late 1990s core biopsy. If a diagnosis of breast cancer cannot be excluded by these examinations, women are referred for surgery. Further surgical and histological confirmation and treatment are undertaken in local or central hospitals, depending on the agreements in place between each municipality and the hospitals. Surgeons, pathologists and radiologists may also arrange feedback meetings, where problematic cancer cases are re-analysed. Exact practices within the CSF screening centres vary, and it is not possible to mention them here with all the details.

Registration of the nationwide breast cancer screening programme is centrally maintained at the mass screening registry of Finland. This was established in 1968 and is part of the Finnish Cancer Registry. Information on screening invitations (personal identifier, year and municipality of invitation), screening attendance, self-reported symptoms, clinical examinations, screening results, recalls, histologically-confirmed findings and treatment are recorded. The invitation files are formed at the mass screening registry by obtaining data on women from the population registry. Data from the screening visits are recorded in each of the screening centres. Screening results are linked with the national population registry and cancer registration by the mass screening registry using the unique personal identifier as a key.

The screening registration is based on the Law and Decree on personal records kept under the health care system, that was passed in 1989. The screening centres of the CSF have registered their data since the beginning of the national programme; other private or municipal screening centres in Finland have increasingly sent their information only since 1994. The screening performance of the Finnish programme in the 1990s could therefore only be studied using data from the screening centres of the CSF.

The 10 CSF screening centres that provided this data covered approximately half of the Finnish breast cancer screening target population from 1991–2000. All 10 centres invited 50–64 year old women. Only one city, Turku, regularly invited 40–49 and 65–74 year old women during this time; 40–49 years old with an interval of one or three years and the women over 64 years biennially. Therefore, the results presented for these two age groups (40–49 years and over 64 years) are mainly data from that one centre.

Data on breast cancer screening parameters were collected individually. The invitation files from 1987–1990 were available and were used to define the number of screening rounds. Data from screening visits before 1991 were incomplete for the recall and detection rates and were therefore excluded. The visit data from 1987–1990 were still used to identify the number of screens. As recommended by the European community [8] results are presented from the first and subsequent screens. We divided the data into three categories; ''first round-first screen'', ''subsequent round-first screen'' and ''subsequent round-subsequent screen''. As some of the centres had not recorded their screening visits (see above), there was the potential of misclassification; therefore, women from the screening category ''subsequent round-first screen'' ($n = 18\,825$) were excluded from the final analysis.

Intermediate indicators process parameters, are developed to help to assess the screening quality and the potential impact of screening on breast cancer mortality, before the actual mortality evaluation is possible [9]. Coverage and attendance to screening indicate the potential effectiveness of the overall programme. Stage distribution of the screen-detected cancers indicates the potential for reduction in the absolute rate of advanced cancers, and the rate of advanced cancers is an early surrogate of mortality reduction. The positive predictive

value (PPV) of mammography represents the percentage of positive mammograms that are ultimately found to be cancer amongst those requiring recall [7]. The PPV of histological confirmation or benign to malignant biopsy ratio (B:M ratio) indicates the ratio of benign to malignant biopsies initiated through screening. Other, frequently reported process indicators are the recall rate, the rate of histological confirmation and the breast cancer detection rate at the first and subsequent screens.

Screening for breast cancer is run as part of the public health policy of several European countries or in defined areas within these countries, including Denmark, Finland, Italy, the Netherlands, Sweden and the United Kingdom. The European community [8] has set criteria for the process indicators of screening, according to which European breast cancer screening programmes are to be evaluated. In Denmark, the Netherlands and Sweden, the screening protocol is similar to that in Finland. In addition to the European standards, we therefore compared the process indicators of the Finnish programme to the actual results in these aforementioned countries. The Swedish studies [10–12] were based on calculations per invitational round, not by individual screening status. The results from Sweden are therefore directly comparable to other studies only at the first screen.

Detection rates in this study were compared with the background incidence from 1980 to 1986, the period preceding the mammography programme in Finland. In addition, average corrections of 32.4% for the first screen and 35.1% for subsequent screens were made based on the annual estimated increase in incidence from 1970 to 1986 and the median year of the first and subsequent screens.

Tumours were classified by stage. The *in situ* cancers represented stage 0. Tumours less than 2 cm in diameter and without regional or distant lymph node metastasis represented stage I. Tumours more than 2 cm in diameter with or without regional lymph node metastasis and/or distant metastasis represented stage II+. Approximately 93% of carcinomas had a pTNM-code.

The performance indicators were calculated by five-year age groups, by each invitational year (period effect), and by screening centres at the first and subsequent screens. To adjust for potential confounders or modifiers, logistic regression analyses were performed for the detection rate parameters, and Poisson regression analyses for the PPVs of mammography and histological confirmation [13]. The statistical analysis of PPV of histological confirmation was considered to describe also the analysis of the B:M biopsy ratio. The Poisson regression person time value for the screen was one.

The age-specific estimates were adjusted by five-year birth cohorts, five-year calendar periods, number of screens (first/subsequent) and screening centres. Comparability within the period and between the screening centres was reached by restricting analyses to 50–64 year old women. The period effect was adjusted by five-year age groups, number of screens and screening centres. The centre-specific indicators were adjusted by five-year calendar periods, five-year age groups and number of screens. We also assessed the influence of annual screening volume and irregular screens on the PPVs in the study.

3. Results

The screening centres in the study sent 1 015 100 invitations and completed 926 500 visits. From 1991, the invitational coverage of the screening programme in women aged 50–59 years was over 90% reached 100% in 2000. Coverage amongst women aged 60–64 years increased up to the beginning of 1990s and then declined rapidly after 1992, when the Bylaw on public health was announced. The annual invitational coverage amongst women less than 50 years and more than 64 years was less than 20% during the 1990s (Fig. 1).

Table 1 shows trends in five-year age groups by number of screens (first/subsequent). The attendance rates were highest amongst women aged 50–59 years and lowest amongst 40–49 year old women. Women aged less than 50 years had the lowest rates of histological confirmation, despite relatively high recall rates compared with the other age groups. This same pattern also existed amongst those 40–49 year old women, who were screened regularly, with an interval of <16 months since the previous screen (data not shown). The adjusted breast cancer detection rate ($P<0.001$), as well as the adjusted PPV of mammography ($P<0.001$) and PPV of histological confirmation ($P=0.02$), increased significantly with increasing age.

The mean participation rates amongst women aged 50–64 years were 90–93%, and 4.6% and 2.3% of the screened women were recalled for further examinations after the first and subsequent screens. The average screen-specific breast cancer detection rates were 0.44% and 0.36%, respectively. The mean PPVs of mammography were 9.6% and 15.8%, respectively. Approximately half of the surgical biopsies revealed breast cancer at the first screen. At the subsequent screen this percentage increased to 70 (Table 2).

The period effect amongst women aged 50–64 years was examined. The annual recall and histological confirmation rates were almost stable or increased slightly. The adjusted breast cancer detection rate increased 18% per five calendar years, and the PPV of mammography by 11%; for both parameters, the *P*-value was <0.001. The adjusted rate of *in situ* cancers was stable, while there was an increase in the adjusted rates of stage I ($P<0.001$) and stage II+ cancers ($P=0.0139$).

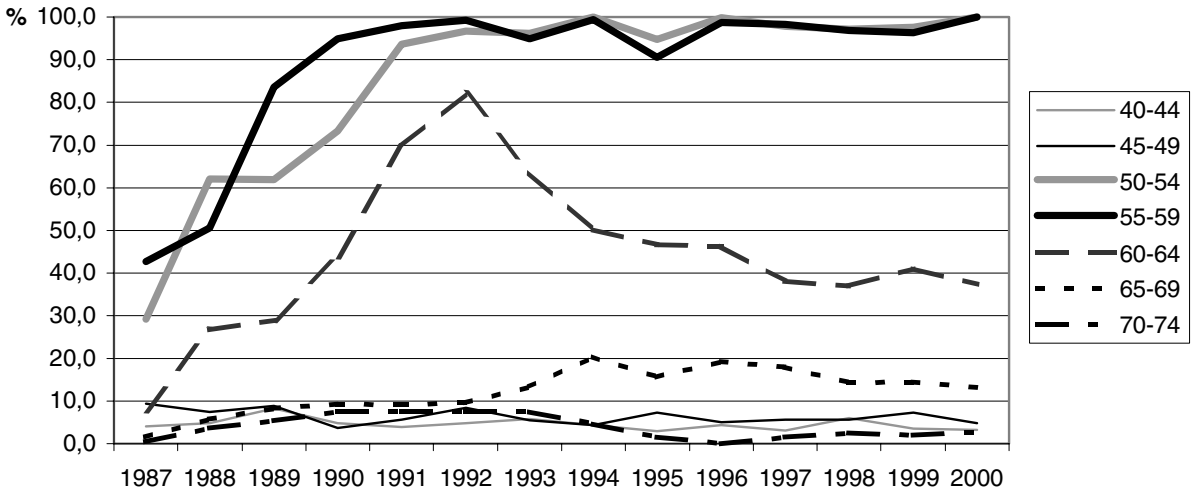

Fig. 1. The estimated coverage of invitations from 1987 to 2000 in five-year age groups: screening centres of the cancer society of Finland (CSF).

The mean annual number of centre-specific invitations in women aged 50–64 years at the first screen was 1900, varying from 1000 to 3500. At subsequent screens the corresponding figure was 6900, varying from 3100 to 14 200. There were clear differences in the process parameters: at the subsequent screens the recall rate varied from 1.0% to 3.6%, the rate of histological confirmation from 0.46% to 0.61%, the breast cancer detection rate from 0.30% to 0.43%, the PPV of mammography from 12% to 31%, and the B:M ratio from 0.25:1 to 0.79:1 (Table 3). The centre-specific differences in PPVs of mammography were statistically highly significant.

The PPV of mammography was 31% smaller ($P<0.001$) in centres with <10 000 annual invitations, compared with centres with a greater average volume. The irregular attendance ($n=68\,780$, screening interval >27 months) at the subsequent screen did not affect the level of PPVs.

Variability in the centre-specific detection rates (Table 3) was mainly attributable to the background (Fig. 2). There were no remarkable differences in the detection rates compared with the background incidence between centres with low or high levels of PPV of mammography.

The average process indicators amongst women aged 50–64 years fulfilled the criteria of the European community [8] (Table 4); the screen-specific participation rates were well above the desired levels, and the recall rates below the limits. In addition, the proportion of screen-detected invasive cancers that were node-negative and the detection rate in comparison with the background incidence rate at subsequent screens satisfied the criteria. At the first screen, the detection rates compared with the background incidence were slightly below the desired level in some of the CSF centres (Fig. 2). In addition, the European community criteria for the proportion of cancers that were stage II+ were not met, and the average B:M biopsy ratios reached only the acceptable level.

4. Discussion

From 1991 to 2000, the 10 CSF centres invited approximately 100 000 women annually. The mean screen-specific compliance amongst women aged 50–64 years was more than 90%, and less than 3% of women were recalled for further assessment(s) at the subsequent screen. The mean breast cancer detection rate at the subsequent screens was 0.36%. The annual detection rate for breast cancer increased, indicating an increase in the background risk. Also, the PPVs of mammography increased significantly during the study period.

The recall rates of women under 50 years were amongst the highest, but their cancer detection rates were low. The breast cancer detection rate and the PPVs increased significantly with age; the amount of breast parenchymal density decreases with age, and the detection of breast cancer has been reported to be more difficult in a dense breast than in a more radiolucent fatty breast [14,15]. Consequently, screening performs different amongst younger women and they are more likely to be recalled for unnecessary further examinations.

A consistently high participation rate over subsequent screens is considered as one of the main intermediate indicators of the success of a screening programme. In this study, the attendance rates amongst women aged 50–64 years were high, 85–95% at the first screen and 90–95% at the subsequent screen, well above the desired levels set by the European community [8], and very favourably also when compared with other programmes. The detection rate in comparison with the background incidence rate at subsequent screens and the proportion of screen-detected invasive cancers

Table 1
Process indicators by five-year age groups from 1991 to 2000; screening centres of the cancer society of Finland (CSF)

Age (in years)	40–44	45–49	50–54	55–59	60–64	65–69	70–74	All
First screen								
Invitations	14229	6317	178267	1216	9046			209075
Visits	11847	4681	160846	1091	7975			186440
Attendance (%)	83.3	74.1	90.2	89.7	88.2			89.2
Recalls	501	183	7532	50	278			8544
Rate (%)	4.2	3.9	4.7	4.6	3.5			4.6
Histological confirmation	59	38	1422	9	84			1612
Rate (%)	0.50	0.81	0.88	0.82	1.05			0.86
Malignant	20	13	690	6	56			785
Rate (%)								
Malignant	0.17	0.28	0.43	0.55	0.70			0.42
In situ	0.02	0.02	0.04	0.09	0.03			0.04
Stage I	0.08	0.13	0.21	0.09	0.44			0.21
Stage II+	0.07	0.09	0.14	0.27	0.20			0.14
PPV mammography(%)[a]	4.0	7.1	9.2	12.0	20.1			9.2
PPV histology (%)[b]	33.9	34.2	48.5	66.7	66.7			48.7
B:M ratio[c]	1.95:1	1.92:1	1.06:1	0.5:1	0.5:1			1.05:1
Subsequent screen								
Invitations	23604	46992	263530	304197	118938	43418	5313	805992
Visits	21199	40872	247517	283534	103959	38135	4787	740003
Attendance (%)	89.8	87.0	93.9	93.2	87.4	87.8	90.1	91.8
Recalls	641	1261	6090	6352	2180	846	119	17489
Rate (%)	3.0	3.1	2.5	2.2	2.1	2.2	2.5	2.4
Histological confirmation	52	161	1231	1512	566	281	43	3846
Rate (%)	0.25	0.39	0.50	0.53	0.54	0.74	0.90	0.52
Malignant	21	89	801	1093	419	221	36	2680
Rate (%)								
Malignant	0.10	0.22	0.32	0.39	0.40	0.58	0.75	0.36
In situ	0.02	0.04	0.03	0.04	0.03	0.06	0.06	0.04
Stage I	0.06	0.11	0.17	0.22	0.27	0.40	0.52	0.21
Stage II+	0.02	0.06	0.10	0.10	0.09	0.11	0.15	0.09
PPV mammography (%)[a]	3.3	7.1	13.2	17.2	19.2	26.1	30.3	15.3
PPV histology (%)[b]	40.4	55.3	65.1	72.3	74.0	78.6	83.7	69.7
B:M ratio[c]	1.47:1	0.81:1	0.54:1	0.38:1	0.35:1	0.27:1	0.19:1	0.44:1

[a] Positive predictive value of mammography.
[b] Positive predictive value of histological confirmation.
[c] Benign to malignant biopsy ratio.

that are node-negative also satisfied the quality assurance criteria. It is, therefore, reasonable to consider that the Finnish mammography programme is sensitive.

Our detection rate in comparison with the background incidence rate at the first screen was below recommendations of the European community (3×IR). However, the recommendations apparently did not include any correction for increase in the background risk. Of note in the present study, the prevalence/incidence ratio at the first screen was 50% higher in the target age group 60–69 years (4.6) compared with 50–59 year olds (3.1) [9].

In the Netherlands, the proportion of stage II+ cancers detected met the European criteria [16,18]. In our data, as observed in Denmark [19], these criteria were not met by our data, and the adjusted annual rates of stage II+ carcinoma increased from 1991 to 2000. If screening programmes are successful in allowing an earlier diagnosis of cancer, an overall reduction in the rates of advanced cancers should be observed in the target

Table 2
Process indicators in 1991 to 2000; screening centres of the Cancer Society of Finland (CSF)

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	All
First screen											
Invitations	39363	10094	13107	15076	16526	19606	19159	19529	17782	18287	188529
Visits	35127	9223	12020	13604	14876	17444	17111	17478	16569	16460	169912
Attendance (%)	89.2	91.4	91.7	90.2	90.0	89.0	89.3	89.5	93.2	90.0	90.1
Recalls	1481	439	604	685	739	841	748	797	768	758	7860
Rate (%)	4.2	4.8	5.0	5.0	5.0	4.8	4.4	4.6	4.6	4.6	4.6
Histological confirmation	319	74	116	133	151	150	138	154	139	141	1515
Rate (%)	0.91	0.80	0.97	0.98	1.02	0.86	0.81	0.88	0.84	0.86	0.89
Malignant	167	33	43	65	59	79	69	78	77	82	752
Rate (%)											
Malignant	0.48	0.36	0.36	0.48	0.40	0.45	0.40	0.45	0.46	0.50	0.44
In situ	0.04	0.05	0.02	0.07	0.03	0.06	0.04	0.03	0.05	0.04	0.04
Stage I	0.24	0.17	0.20	0.23	0.19	0.24	0.20	0.24	0.22	0.24	0.22
Stage II+	0.16	0.10	0.10	0.15	0.14	0.13	0.13	0.16	0.15	0.17	0.15
PPV mammography[a]	11.3	7.5	7.1	9.5	8.0	9.4	9.2	9.8	10.0	10.8	9.6
PPV histology[b]	52.4	44.6	37.1	48.9	39.1	52.7	50.0	50.6	55.4	58.2	49.6
B:M ratio[c]	0.91:1	1.24:1	1.70:1	1.05:1	1.56:1	0.90:1	1.00:1	0.97:1	0.81:1	0.72:1	1.01:1
Subsequent screen											
Invitations	61256	66115	67791	64520	68066	63996	71352	70087	82200	71282	686665
Visits	54451	60675	60205	59385	63884	60699	66869	64851	76421	67570	635010
Attendance (%)	88.9	91.8	88.8	92.0	93.9	94.8	93.7	92.5	93.0	94.8	92.5
Recalls	987	1270	1300	1435	1589	1482	1725	1538	1798	1498	14622
Rate (%)	1.8	2.1	2.2	2.4	2.5	2.4	2.6	2.4	2.4	2.2	2.3
Histological confirmation	222	281	310	319	348	297	398	353	418	363	3309
Rate (%)	0.41	0.46	0.51	0.54	0.54	0.49	0.60	0.54	0.55	0.54	0.52
Malignant	152	201	213	201	236	199	282	242	319	268	2313
Rate (%)											
Malignant	0.28	0.33	0.35	0.34	0.37	0.33	0.42	0.37	0.42	0.40	0.36
In situ	0.02	0.02	0.03	0.04	0.04	0.03	0.06	0.04	0.03	0.03	0.04
Stage I	0.16	0.21	0.19	0.19	0.21	0.17	0.21	0.23	0.25	0.22	0.21
Stage II+	0.08	0.06	0.11	0.09	0.09	0.09	0.13	0.08	0.10	0.12	0.10
PPV mammography (%)[a]	15.4	15.8	16.4	14.0	14.9	13.4	16.3	15.7	17.7	17.9	15.8
PPV histology[b]	68.5	71.5	68.7	63.0	67.8	67.0	70.9	68.6	76.3	73.8	69.9
B:M ratio[c]	0.46:1	0.40:1	0.46:1	0.59:1	0.47:1	0.49:1	0.41:1	0.46:1	0.31:1	0.35:1	0.43:1

Women are 50–64 years old.
[a] Positive predictive value of mammography, (%).
[b] Positive predictive value of histological confirmation, (%).
[c] Benign to malignant biopsy ratio.

population [7]. However, comparisons over time or between countries (or areas) may be difficult in evaluation; borderline cancer cases that previously might have been described as localised with less sophisticated diagnostic techniques may now be diagnosed as advanced [5,7].

The sensitivity of a breast cancer screening programme to detect cancer should be high, but it is also important to achieve a high diagnostic specificity in order to avoid high costs and the morbidity that is associated with unnecessary examinations. Thus, the aim of screening should be both an accurate diagnosis with prompt referral and an accurate diagnosis of benign and involutional changes.

The recall rates in Denmark and Sweden were much higher than in the Netherlands [10–12,16,18–20]. In the

Table 3
Process indicators by screening centres of the Cancer Society of Finland (CSF) from 1991 to 2000

Centre code	1	2	3	4	5	6	7	8	9	10	All
First screen											
Invitations	14247	34851	22378	23520	17001	19844	17408	15936	13766	9578	188529
Visits	12910	29436	20342	21024	15482	18829	15794	14390	12685	9020	169912
Attendance (%)	90.6	84.5	90.9	89.4	91.1	94.9	90.7	90.3	92.1	94.2	90.1
Recalls	457	599	869	1418	1081	869	798	977	246	546	7860
Rate (%)	3.5	2.0	4.3	6.7	7.0	4.6	5.1	6.8	1.9	6.1	4.6
Histological confirmation	97	181	194	215	134	156	140	188	112	98	1515
Rate (%)	0.75	0.61	0.95	1.02	0.87	0.83	0.89	1.31	0.88	1.09	0.89
Malignant	61	121	82	99	92	72	65	67	47	46	752
Rate (%)											
Malignant	0.47	0.41	0.40	0.47	0.59	0.38	0.41	0.47	0.37	0.51	0.44
In situ	0.09	0.04	0.02	0.03	0.09	0.05	0.02	0.03	0.04	0.03	0.04
Stage I	0.26	0.18	0.25	0.31	0.30	0.20	0.18	0.24	0.01	0.31	0.22
Stage II+	0.12	0.19	0.14	0.12	0.20	0.11	0.16	0.19	0.04	0.17	0.15
Unknown	0.01	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.28	0.00	0.03
PPV mammography[a]	13.3	20.2	9.4	7.0	8.5	8.3	8.1	6.9	19.1	8.4	9.6
PPV histology[b]	62.9	66.9	42.3	46.0	68.7	46.2	46.4	35.6	42.0	46.9	49.6
B:M ratio[c]	0.59:1	0.5:1	1.37:1	1.17:1	0.47:1	1.17:1	1.15:1	1.81:1	1.38:1	1.13:1	1.01:1
Subsequent screen											
Invitations	141627	88418	87962	68226	64422	54083	50063	50761	50234	30869	686665
Visits	130758	80439	80767	62090	60610	48897	46794	47791	47781	29083	635010
Attendance (%)	92.3	91.0	91.8	91.0	94.1	90.4	93.5	94.1	95.1	94.2	92.5
Recalls	3142	1047	1533	1614	2152	1343	1321	1147	482	841	14622
Rate (%)	2.4	1.3	1.9	2.6	3.6	2.7	2.8	2.4	1.0	2.9	2.3
Histological confirmation	717	373	453	300	323	248	232	258	229	176	3309
Rate (%)	0.55	0.46	0.56	0.48	0.53	0.51	0.50	0.54	0.48	0.61	0.52
Malignant	519	298	271	224	259	166	170	144	147	115	2313
Rate (%)											
Malignant	0.40	0.37	0.34	0.36	0.43	0.34	0.36	0.30	0.31	0.40	0.36
In situ	0.03	0.04	0.01	0.03	0.08	0.05	0.01	0.03	0.01	0.07	0.04
Stage I	0.26	0.22	0.22	0.20	0.23	0.19	0.21	0.17	0.03	0.23	0.21
Stage II+	0.10	0.11	0.09	0.12	0.11	0.09	0.10	0.10	0.03	0.09	0.10
Unknown	0.01	0.01	0.01	0.01	0.00	0.02	0.04	0.00	0.24	0.00	0.03
PPV mammography[a]	16.5	28.5	17.7	13.9	12.0	12.4	12.9	12.6	30.5	13.7	15.8
PPV histology[b]	72.4	79.9	59.8	74.7	80.2	66.9	73.3	55.8	64.2	65.3	69.9
B:M ratio[c]	0.38:1	0.25:1	0.67:1	0.34:1	0.25:1	0.49:1	0.36:1	0.79:1	0.56:1	0.53:1	0.43:1

Women are 50–64 years old.
[a] Positive predictive value of mammography, (%).
[b] Positive predictive value of histological confirmation, (%).
[c] Benign to malignant biopsy ratio.

CSF centres they were generally below the limits set by the European community [8], even though there was substantial differences between the centres. The screen-specific recall rates (2.0–3.5% and 1.3–2.4%) and the B:M ratios (0.5–0.6:1 and 0.3–0.4:1) were low in the two largest centres, but did not lead to low breast cancer detection rates or PPVs suggesting a good screening sensitivity in these centres. In some centres, the recall and breast cancer detection rates were relatively high compared with the centre-specific back-

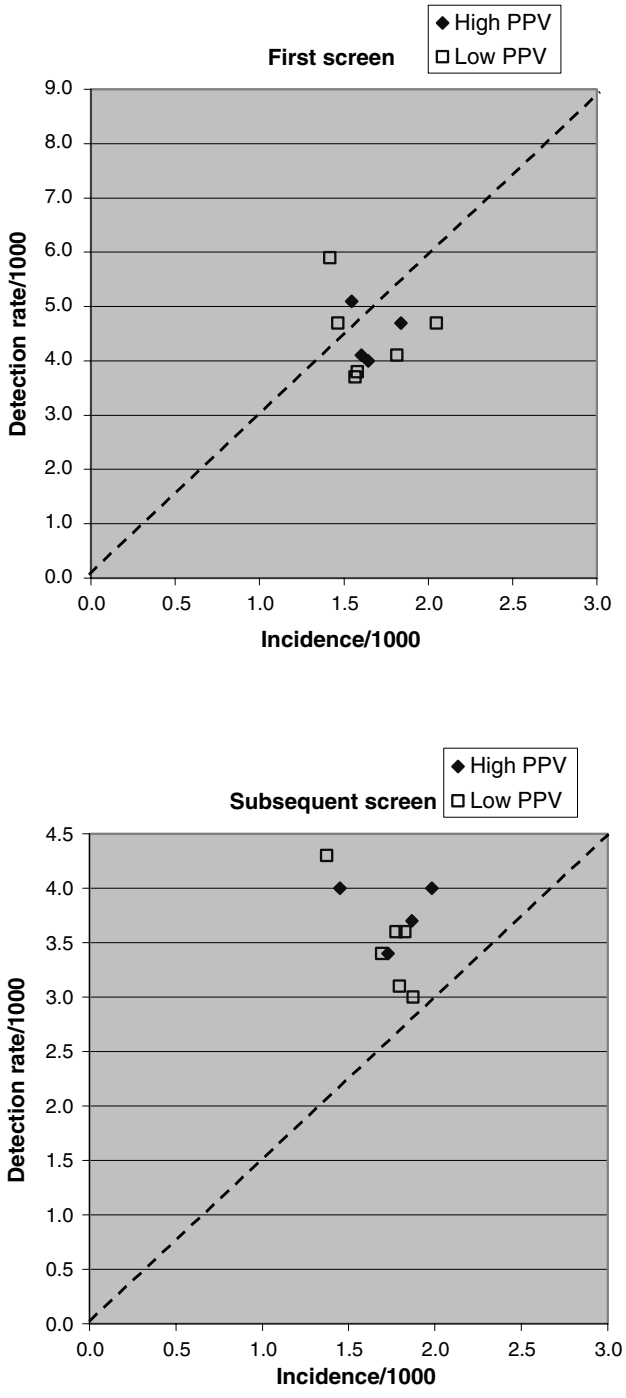

Fig. 2. Detection rates from 1991 to 2000 compared with background incidence amongst women aged 50–64 years at first and subsequent screens in the screening centres of the CSF. Dashed line describes the reference value drawn from the European quality assurance guideline [8]. The centres were divided into two groups based on the levels of the positive predictive values (PPV) of mammography. The screening centres 1–3 and 9 represent high PPVs.

ground incidence, indicating a strong emphasis on test sensitivity.

Overall, the PPV of mammography correlated with the annual volume of screening. Similar results have been reported from the United Kingdom [21]. In addition, the variation in the process parameters reported from the United Kingdom resembles the Finnish estimates, even though comparability is limited because in the UK there is usually a 3-year screening interval [22].

Besides the recall rate, another indicator of good screening specificity is the B:M biopsy ratio, the desirable (acceptable) levels set by the European community [8] are 0.5:1 (1:1) at the first screen and 0.2:1 (1:1) at subsequent screens. In Denmark, Sweden and the Netherlands, the average B:M ratios were 0.4–0.9:1 at the first screen and 0.1–0.8:1 at subsequent screens [10–12,16,18–20]. In our study, the average figures reached acceptable levels, and the relative differences in the histological confirmation rate between centres were considerably smaller than for the recall rate. The women in the finnish data were younger than women in other countries, which probably explains much of the higher B:M ratio.

Differences in recall rates between the Finnish screening centres were larger than the corresponding differences in the cancer detection rates. This suggests that differences in the PPV of mammography between centres were related to the screening criteria rather than to variations in the background risk. Low recall rates, if valid, may decrease costs and the potential adverse effects of screening. Rates in this study were calculated by screen, and variations in lifetime recalls per woman could be large, from 5 to 20. Thus, the differences in the cumulative risk of recall per woman could become even larger than those seen in the screen-specific data.

There is only one previous study on process indicators of the Finnish mammography programme, where data are based on summary tables for the screening centres that were reported to the Radiological Society of Finland [23]. The study precluded detailed analyses of process indicators. Neverthless, the overall levels for the data reported roughly were from 1991–1997 similar to that observed in our study.

One problem with the current guidelines is that most of the reference values are expressed as proportions. This may result in an overestimation of the success of screening e.g., by ignoring overdiagnosis [7]. Comparing prognostic factors as rates per population screened, not as percentages or rates per expectation without screening, would overcome this limitation.

The ultimate goal of breast cancer screening is to reduce breast cancer mortality. There is some evidence on the effectiveness of the non-randomised screening programmes. In Sweden, a non-significant reduction in mortality of 20% amongst women aged 50–69 years was observed [4]. In the Netherlands, a significant 20% reduction was observed in 55–74 year old women [6]. Decreases of 19% to 24% in breast cancer mortality amongst women invited to screening have been reported

Table 4
Results from service screening programmes in Denmark [19,20], Sweden [10–12], the Netherlands [16–18] and Finland compared with the guidelines of the European community [8]

	Desirable level	Denmark 50–69 years	Sweden 40–74 years[b]	Netherlands 50–69 years	Finland 50–64 years[a]
First screen					
Proportion of women invited that attend for screening	>75%	71–84%	69–89%	79%	90% (85–95%)
Proportion of participants recalled for further examinations	<5%	2.8–6.8%	2.1–4.6%	1.3%	4.6% (1.9–7.0%)
Breast cancer detection rate in comparison with the background incidence rate (IR)	>3×IR	4–4.4×IR	Not available	2.95×IR	2.74×IR (2.3–4.2)
Proportion of screen-detected cancers that are carcinoma *in situ*	10–20%	12–14%	11–13%	14%	10% (5–18%)
Proportion of screen-detected cancers that are stage II+	<25%	30–35%	33%	20%	33% (25–46%)
Proportion of screen-detected invasive cancers that are node-negative	>70%	72–81%	79–80%	67%	76% (69–79%)
Benign to malignant biopsy ratio	<0.5:1	0.4–0.9:1	0.4–0.9:1	0.5:1	1:1(0.5–1.8:1)
	Desirable level	Denmark 50–69 years	Sweden 40–69 years[b]	Netherlands 50–69 years	Finland 50–64 years[a]
Subsequent screen					
Proportion of women invited that attend for screening	>75%	70–83%	78–84%	79%	93% (90–95%)
Proportion of participants recalled for further examinations	<3%	1.3–3.2%	5.7%	0.7%	2.3% (1.0–3.6%)
Breast cancer detection rate in comparison with the background incidence rate (IR)	>1.5×IR	1.9–2.0×IR	Not available	1.44×IR	2.1×IR (1.6–3.1)
Proportion of screen-detected cancers that are carcinoma *in situ*	10–20%	11%	15%	14%	10% (4–18%)
Proportion of screen-detected cancers that are stage II+	<20%	27–34%	18%	17%	26% (23–33%)
Proportion of screen-detected invasive cancers that are node-negative	>75%	77–80%	83%	71%	79% (75–81%)
Benign to malignant biopsy ratio	<0.2:1	0.1–0.3:1	0.8:1	0.3:1	0.4:1 (0.3–0.8:1)

[a] Tumours without pTNM classification excluded, range by screening centre in parenthesis.
[b] Results based on calculations per invitational round, not by individual screening status.

in Finland [2,5]. The latest results from the Swedish randomised trials suggest that the advantageous effect of breast cancer screening on breast cancer mortality persists after more than 15 years of follow-up; the reduction in mortality amongst women aged 55–69 years was statistically significant, from 24% to 33% [3].

Setting quality targets for screening programmes is more subjective than setting targets for screening effectiveness. Comparison of recall rates or PPVs are therefore complex, while measures of screening effectiveness in terms of reducing mortality, e.g., compliance, detection rates and stage distribution of screen-detected cancers, can be more readily compared between countries. Screening quality must therefore be evaluated in parallel with estimates of breast cancer mortality reduction [7]. Yet it is not known, in detail, if, or to what degree, differences in process parameters affect mortality. More research is needed in this area, and these issues should be considered directly in the quality assurance guidelines.

5. Concluding remarks

Process indicators of the Finnish screening centres mostly fulfilled the criteria of the European community. Variations in quality indicators were within the same ranges as those reported from Denmark, Sweden and the Netherlands. Wide variability in the recall rates and PPVs suggests differences in diagnostic criteria and potential adverse effects between centres and programmes.

A mortality reduction as a result of the Finnish programme has been previously proposed. Parallel follow-up information on interval cancers and particularly on

the later mortality outcome is required for a continuous evaluation of the programme.

Conflict of interest

None.

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