

Service screening mammography reduces breast cancer mortality among elderly women in Turku

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Objectives The aim of this study was to assess the effects of service screening mammography on breast carcinoma incidence and refined mortality among women aged 55-69 at entry in three cities employing different screening policies.

Methods Since 1987, the city of Turku, Finland, has provided service screening mammography for women aged 55-69 at entry (in 1987), and Tampere provided screening for women aged 55-59 at entry, whereas Helsinki did not screen any of these age groups. The incidence of breast carcinoma during the screening period 1987-97 in women born in 1918-32 (1918-22, 1923-27, 1928-32) was compared with incidence during the pre-screening period 1976-86 in women born in 1907-21 (1907-11, 1912-16, 1917-21) in each city. The follow-up for mortality was four years longer.

Results Breast carcinoma incidence was 31-38% higher in the screening period in all three cities irrespective of screening. In breast carcinoma mortality, no significant changes were seen in Helsinki or Tampere. In Turku, a 36% mortality reduction (relative risk [RR] 0.64; 95% confidence interval [CI] 0.47-0.88; $P=0.007$) in the whole study population and a 47% reduction in women aged 65-69 at entry (RR 0.53; 95% CI 0.28-0.99; $P=0.047$) were seen.

Conclusions The incidence of breast carcinoma increased in all study cities irrespective of screening. The comprehensive screening programme in Turku including women aged 55-69 at entry was associated with a significant reduction in breast carcinoma mortality. The pronounced decrease in mortality in the oldest age group (65-69 years at entry) also indicated that women of this age group greatly benefit from mammography screening.

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INTRODUCTION

The promising results of randomized controlled trials showing a reduction in breast cancer mortality in association with mammography screening led to the launching of population-based service screening programmes in several countries in the late 1980s and early 1990s.¹ Breast cancer is a long-term disease, and several years of follow-up are needed to determine the ultimate effects of breast cancer mammography screening. However, currently available reports suggest a reduction in breast cancer mortality in conjunction with service mammography screening.²⁻⁷

In published reports, the reduction of mortality has been assessed by comparing mortality rates before and after the initialization of screening,^{4,6,7} or comparing ever-invited with never-invited women during the screening period,^{2,8} or even comparing incidence and mortality changes among women exposed to mammography screening gradually over the years.³ When interpreting results, one should consider factors that may affect breast cancer mortality, such as age and changes in treatment modalities over the years.⁷ A theoretical but controversial issue is the possibility of finding an increasing number of cancers that would never harm the subjects (i.e. overdiagnosis of breast cancer) which should also be considered when interpreting results.⁹

Assessment of the effectiveness of mammography screening in elderly birth cohorts is of prime importance, as the incidence of breast cancer and breast cancer-refined mortality in elderly birth cohorts are high, and incidence

has also been increasing in older age groups.^{10,11} In the elderly population treatment modalities are often limited owing to other diseases and conditions, and elderly patients may therefore not receive all benefits of new and effective breast cancer treatments, which underlines the importance of early diagnosis in this group. In Finland, the average life expectancy of women is 82 years,¹² which also justifies the assessment of the benefit of service mammography screening in the elderly population.

A population-based service mammography screening programme was introduced in Finland in 1987. The nationwide screening programme covered women aged 50-59 years, who were to be screened every second year with recommended continuation until the age of 69.² The differences in the screening policy between the three large cities (Turku, Helsinki, and Tampere) prompted us to investigate the effects of mammography screening on breast cancer incidence and mortality, with a particular interest in the elderly population.

METHODS

Study population

The study population of the screening period (1987-97) consisted of women aged 55-69 years at screening entry (i.e. birth cohorts 1928-32 [women aged 55-59], 1923-27 [women aged 60-64], and 1918-22 [women aged 65-69]), and the study population in the pre-screening period (1976-86) consisted of birth cohorts 1917-21 (women aged

55–59 in 1976), 1912–16 (women aged 60–64), and 1907–11 (women aged 65–69). Helsinki (539,363 inhabitants, 53.9% of whom were women at year-end 1997), Tampere (188,726, 52.8%), and Turku (168,772, 53.4%) were selected as they are among the five most populated cities in Finland, and their female populations have a similar type of age and ethnic structure, socioeconomic situation, health and living standard status, and habits. All cities are located in the relatively densely populated southern part of the country.

Information on screening invitation and participation was obtained from the three cities. Data on new invasive breast carcinomas and breast cancer deaths were obtained from the Finnish Cancer Registry, which registers the municipality of residence reflecting the time of diagnosis (1 January of the year of diagnosis).

The studied birth cohorts were defined in such a way that it was possible to compare breast cancer incidence and mortality in women at the same age before and after the start of the screening programme. The birth cohorts were differently screened in the three cities during the screening period. The screening effect was evaluated by comparing the incidence of breast carcinoma in 1987–97 (*screening period*, 11 years) in birth cohorts 1828–32, 1923–27, and 1918–22 with incidence in 1976–86 (*pre-screening period*, 11 years) in birth cohorts 1917–21, 1912–16 and 1907–11. Mortality was followed for four additional years after both periods. Mortality rates due to new carcinomas (refined mortality) were compared for the same birth cohorts in 15-year periods 1987–2001 and 1976–91, respectively. In comparing incidence rates new carcinomas diagnosed before the age of 75 years and in comparing mortality rates breast cancer deaths occurring before age 85 years, were taken into account.

Table 1 shows how the screening programmes were carried out. In Turku, women in birth cohorts 1918–22 were invited an average of three times when aged 67–74, those in birth cohorts 1923–27 were invited an average of four times when aged 61–70, and those in birth cohorts 1928–32 were invited 5–6 times when aged 55–69. Tampere only screened women aged 55–59 at entry (birth cohorts 1928–32), but no older birth cohorts. Helsinki did not screen any of the above birth cohorts.

Statistical analyses

The statistical comparisons on breast cancer incidence were done for 11-year periods (pre-screening and screening periods). Breast cancer mortality data were analysed for 15-year periods (11+4 following years), only considering those new breast cancer cases in which the patient died of breast cancer diagnosed during the 11-year incidence period mentioned above (refined mortality). Each death was recorded only for the period (1976–86 or 1987–97) during which the incident cancer case was detected.

Incidence and mortality rates in the population were calculated per 100,000 women-years. For a given age, the number of women years was calculated by summing the number of women of each year during the study period 1987–97 using the mid-year number of women at that age. This is based on the assumption that the same number of women of that age survived the entire year.

Relative risks with 95% confidence intervals (CI) were computed using Poisson regression analysis. To evaluate developments in background risk, routine trends in the general population in 1970–86 (i.e. before screening) were computed for women aged 55–74 (breast cancer incidence) and 55–84 (breast cancer mortality). A log-linear assumption for a temporal trend was assumed and the trend was calculated per 10 years of time and adjusted for five-year age groups. Statistical computations were done with the GENMOD procedure of the SAS System for Windows, release 9.13/2003.¹³

RESULTS

The population-based service mammography screening programme started in 1987. Thus, the period for analysis of breast cancer incidence (the screening period) was 11 years (years 1987–97) and the pre-screening period was equally long (years 1976–86). During this 22-year period, 3660 new invasive breast cancer cases were diagnosed, and during the follow-up period for mortality (1976–90 and 1987–2001) 1015 of these women died of breast cancer. Table 2 shows the numbers of women-years as well as the numbers of new cancers and deaths.

Table 1 Screening map of Turku and Tampere

Age in 1987	Birth year	Calendar year														
		1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	
69	1918					A			A		A					
	1919								A		A					
	1920					A			A		A					
	1921								A		A					
65	1922						A			A		A				
64	1923				A			A		A		A				
	1924				A			A		A		A				
	1925					A			A			A				
	1926				A			A		A		A				
60	1927					A			A			A		A		
59	1928				A		AB			A		A		A		
	1929					A			A		A		AB		A	
	1930	B		B	A	B	A		A		A	B	A	A	B*	
	1931				A	A	B	A		A		A	B	A	B*	
55	1932	B		B	A	B	A		A		A	B	A	B	A	

A = Turku, B = Tampere, AB = both

All screenings were provided free of charge with the exception of screenings for two birth cohorts in Tampere in 1997, marked with *

The Finnish service screening programme covers all women aged 50–59, but owing to the gradual start of the programme, no screening was provided for the birth cohorts above during the study years in the city of Helsinki, which permitted formation of a non-screened 55–69 birth year cohort (at entry)

Table 2 Woman-years and new invasive breast carcinoma cases and breast carcinoma deaths in Helsinki, Tampere, and Turku in the study population and reference populations

Study population					
Birth cohort (age in 1987)	City	Woman-years in 1987-97	New carcinomas in 1987-97	Woman-years in 1987-01	Deaths in 1987-01
1928-32 (55-59)	Helsinki	147,761	449	196,104	113
	Tampere	57,171	150	76,856	24
	Turku	54,720	157	73,614	28
1923-27 (60-64)	Helsinki	142,019	440	186,215	111
	Tampere	54,017	150	71,510	44
	Turku	53,195	146	70,418	19
1918-22 (65-69)	Helsinki	99,522	314	167,012	98
	Tampere	35,997	114	60,769	31
	Turku	35,933	109	60,864	15
Total		680,335	2029	963,362	483
Reference population					
Birth cohort (age in 1976)	City	Woman-years in 1976-86	New carcinomas in 1976-86	Woman-years in 1976-90	Deaths in 1976-90
1917-21 (55-59)	Helsinki	160,656	360	210,886	113
	Tampere	52,762	89	70,649	32
	Turku	53,039	112	70,775	37
1912-16 (60-64)	Helsinki	163,663	401	211,903	124
	Tampere	51,288	116	67,256	45
	Turku	52,254	91	68,427	29
1907-11 (65-69)	Helsinki	119,263	287	195,626	91
	Tampere	36,997	83	61,015	33
	Turku	36,334	92	60,127	28
Total		726,256	1631	1,016,664	532

Table 3 Breast cancer incidence in the reference group during the pre-screening period (1976-86) and in the study group during the screening period (1987-97), and incidence rate ratios between periods by age group in Helsinki, Tampere, and Turku

Age group (birth years of the reference group and the study group)	City	Incidence rate/100,000 woman-years		RR (95% CI) between periods (S/P)	Ratio (95% CI) of RR compared with Helsinki*	Ratio (95% CI) of RR compared with Tampere*
		Reference group pre-screening period (P) 1976-86	Study group screening period (S) 1987-97			
55-59 years (1917-21, 1928-32)	Helsinki	224.1	303.9	1.36 (1.18-1.56)	1.00 reference	
	Tampere	168.7	262.4	1.56 (1.20-2.02)	1.15 (0.85-1.54)	1.00 reference
	Turku	211.2	286.9	1.36 (1.07-1.73)	1.00 (0.76-1.32)	0.87 (0.61-1.25)
60-64 years (1912-16, 1923-27)	Helsinki	245.0	309.8	1.26 (1.10-1.45)	1.00 reference	
	Tampere	226.2	277.7	1.23 (0.96-1.56)	0.97 (0.74-1.28)	1.00 reference
	Turku	174.1	274.5	1.58 (1.21-2.05)	1.25 (0.93-1.67)	1.28 (0.90-1.83)
65-69 years (1907-11, 1918-22)	Helsinki	240.6	315.5	1.31 (1.12-1.54)	1.00 reference	
	Tampere	224.3	316.7	1.41 (1.06-1.87)	1.08 (0.78-1.49)	1.00 reference
	Turku	253.2	303.3	1.20 (0.91-1.58)	0.91 (0.66-1.26)	0.85 (0.57-1.26)
All ages	Helsinki	236.3	309.0	1.31 (1.21-1.42)	1.00 reference	
	Tampere	204.3	281.3	1.38 (1.19-1.61)	1.05 (0.89-1.25)	1.00 reference
	Turku	208.3	286.4	1.38 (1.19-1.60)	1.05 (0.89-1.25)	1.00 (0.81-1.23)

*Comparison of rate ratios in Turku and Tampere compared with Helsinki and in Turku compared with Tampere. Statistically significant results ($P < 0.05$) are printed in bold

Breast carcinoma incidence increased statistically significantly between the two periods in the three cities by 31-38% in the whole study population, and no marked differences occurred between the cities in the change (Table 3). A statistically significant increase in breast carcinoma incidence was observed during the screening period as compared with the pre-screening period in all age cohorts and in all cities with two exceptions: non-significant trends were observed among women aged 60-64 at entry in Tampere and among women aged 65-69 at entry in Turku (Table 3). The most prominent increases in

incidences were observed among women aged 55-59 at entry in Tampere (relative risk [RR], 1.56; 95% CI, 1.20-2.02; $P = 0.001$), and among women aged 60-64 at entry in Turku (RR, 1.58; 95% CI, 1.21-2.05; $P < 0.001$). Compared with Helsinki, no statistically significant differences were seen in the other two cities in the change of incidence rates, although a non-significant increase of 25% was observed in Turku among women aged 60-64 at entry (Table 3).

In Turku, a statistically significant mortality reduction of 36% was observed during the screening period in the whole

Table 4 Incidence-based breast cancer mortality in the reference group during the pre-screening period (1976–86+4 additional years) and in the study group during the screening period (1987–97+4 additional years), and death rate ratios between periods by age group in Helsinki, Tampere, and Turku

Age group (birth years of the reference group and the study group) City	Death rate/100,000 woman-years		RR (95% CI) between periods (S/P)	Ratio (95% CI) of RR compared with Helsinki**	Ratio (95% CI) of RR compared with Tampere**	
	Reference group pre-screening period (P) 1976–90*	Study group screening period (S) 1987–2001†				
55–59 years (1917–21, 1928–32)	Helsinki	53.6	57.6	1.08 (0.83–1.40)	1.00 reference	
	Tampere	45.3	31.2	0.69 (0.41–1.17)	0.64 (0.34–1.16)	
	Turku	52.3	38.3	0.73 (0.45–1.19)	0.68 (0.39–1.18)	1.06 (0.51–2.17)
60–64 years (1912–16, 1923–27)	Helsinki	58.5	59.6	1.02 (0.79–1.32)	1.00 reference	
	Tampere	66.9	61.5	0.92 (0.61–1.39)	0.90 (0.55–1.47)	1.00 reference
	Turku	42.4	27.0	0.64 (0.36–1.14)	0.62 (0.33–1.18)	0.69 (0.34–1.41)
65–69 years (1907–11, 1918–22)	Helsinki	46.5	58.7	1.26 (0.95–1.68)	1.00 reference	
	Tampere	54.1	51.0	0.94 (0.58–1.54)	0.75 (0.42–1.32)	1.00 reference
	Turku	46.6	24.6	0.53 (0.28–0.99)	0.42 (0.21–0.84)	0.56 (0.25–1.24)
All ages	Helsinki	53.0	58.6	1.11 (0.95–1.29)	1.00 reference	
	Tampere	55.3	47.3	0.86 (0.65–1.12)	0.77 (0.57–1.06)	1.00 reference
	Turku	47.2	30.3	0.64 (0.47–0.88)	0.58 (0.41–0.83)	0.75 (0.49–1.14)

*Incident cases at ages 55–74 years in 1976–86 and subsequent deaths at ages 55–84 years in 1976–90

†Incident cases at ages 55–74 years in 1987–97 and subsequent deaths at ages 55–84 years in 1987–2001

**Comparison of rate ratios in Turku and Tampere compared with Helsinki and in Turku compared with Tampere. Statistically significant results ($P < 0.05$) are printed in bold

study population (RR 0.64; 95% CI 0.47–0.88; $P = 0.007$) (Table 4). In Helsinki, a statistically non-significant increase in mortality of 11% was seen during the screening periods compared with the pre-screening period in the whole study population, whereas a statistically non-significant mortality reduction by 14% was seen in Tampere (Table 4). Compared with Helsinki, the change in the breast cancer refined mortality rate in Turku was significantly lower by 42% (RR 0.58; 95% CI 0.41–0.83; $P = 0.003$) in the whole study population. Compared with Helsinki, in Tampere the change in the breast carcinoma refined mortality rate was 23% lower, but the result was not statistically significant. Compared with Tampere, the change in the mortality rate in Turku was 25% lower, but the difference was not statistically significant either (Table 4).

In Helsinki and Tampere, no statistically significant changes occurred in refined breast cancer mortality rates during the screening period compared with the pre-screening period in any of the age cohorts (Table 4). In Helsinki, an increase of 26% was seen among women aged 65–69 at entry, whereas in Tampere breast cancer-refined mortality showed a decrease of 31% among women aged 55–59 at entry. In Turku, a consistent mortality reduction of 27%, 36% and 47% was seen among women aged 55–59, 60–64 and 65–69 at entry, respectively, and mortality reduction was statistically significant in the oldest birth cohort (RR 0.53; 95% CI 0.28–0.99; $P = 0.047$) (Table 4). Compared with Helsinki, the change in mortality was statistically significantly lower in Turku among women aged 65–69 at entry (RR 0.42; 95% CI 0.21–0.84; $P = 0.014$). When compared with Tampere, the decrease in mortality was higher in Turku in the two oldest birth cohorts; among women aged 60–64 at entry, RR was 0.69, and among women aged 65–69 at entry, RR was 0.56, but the differences were not statistically significant (Table 4). Among women of 60–69 years at entry (newer screened at Tampere), the effects were +22% (RR 1.22; 95% CI 0.84–1.77) in Helsinki and –34% (RR 0.66; 95% CI 0.39–1.21) in Turku, respectively (data not shown).

Before screening (1970–86), routine (i.e. non-refined rate in the general population of the same age) breast cancer incidence increased in Helsinki by 33% ($P < 0.001$), in Tampere by 21% ($P = 0.02$), and in Turku by 6% ($P = 0.47$) over 10 years. The P value was 0.058 for the interaction term of the incidence trend over the three cities, 0.35 and 0.02 for comparing the trend in Helsinki with that in Tampere and in Turku, and 0.25 for comparing the trend in Tampere with that in Turku. Routine breast cancer mortality was relatively stable during 1970–86; the change was –1% ($P = 0.96$) over 10 years in Turku and +10% in Helsinki ($P = 0.12$) and Tampere ($P = 0.38$), showing statistically non-significant trends.

DISCUSSION

The present study is the first to show mortality reduction in conjunction with mammography screening for women aged 60–69 at entry in Finland. At present, most Finnish municipalities only screen women aged 50–59.¹⁴ Our results showed a reduction in refined breast carcinoma mortality over the screening period, but only in birth cohorts screened in each city. A statistically significant reduction in mortality was found for the whole study population only in Turku, which was the only city screening all the birth cohorts. In addition, a consistent mortality reduction, although statistically significant only for women aged 65–69 at entry, was observed. On the other hand, in Helsinki, where no screening has been employed for any of the birth cohorts, the death rate increased between pre-screening and screening periods among all the studied age cohorts. In Tampere, where the birth cohort aged 55–59 years in 1987 had been screened, a decrease in mortality was observed, although it was not statistically significant. Thus there is a clear indication of a larger decrease in breast cancer mortality during the screening period in Turku compared with Helsinki. Before screening, no similar change in breast cancer mortality was seen. In fact, mortality rates had been

relatively stable in Turku. Comparison between breast cancer mortality rates between Turku and Tampere among women aged 60–69 at entry, who had been invited for screening in Turku but not in Tampere, may provide the most valid point estimate of the screening effect in Turku in this study. In this comparison, a decrease of 34% occurred in breast cancer mortality, but it was not statistically significant, at least partly because of the limited statistical power of that comparison. It is also noteworthy that breast cancer mortality decreased by 6–8% in Tampere in the non-screened age groups.

The incidence of breast cancer during the pre-screening period appeared to be highest in Helsinki, which is consistent with the fact that Helsinki was a clearly more urbanized city than the other two cities at that time. Women in upper social classes, with a good educational background and a low number of children, are at a higher risk of breast cancer. Helsinki and Tampere were chosen as reference cities to Turku, because they are among the largest five cities in Finland. All three cities have populations higher than 160,000, are located in the South of Finland, have similar sociodemographic structures regarding age structure, educational and professional backgrounds of the female population, and have similar living standards and habits. No differences occur in race or home language either. Although Helsinki is the most urbanized of the three cities, no other Finnish cities offer less-biased materials for a study like this.

Helsinki has seen the greatest increase in incidence rates before the screening period, indicating the greatest increase in the background risk. But on the other hand, because the study population was not screened in Helsinki, no lead time or prevalence effects of screening occurred in the incidence level of Helsinki during the screening period. Thus, Helsinki's incidence rates are not fully comparable with those of cities where the screening effect occurred. However, the effects of these developmental issues could not be directly controlled in the statistical analysis on mortality. Comparisons between Helsinki and Tampere also suggested a tendency towards a larger decrease in breast cancer mortality in Tampere, although the difference between the two cities was not statistically significant. Different developments of the background risk indicated that, historically, there might have been the greatest need for screening among elderly women in Helsinki.

The increase in breast cancer incidence over the 22 years can be explained by the general trend for increasing incidence of breast cancer among women in the Western World and the fact that the incidence of breast cancer increases as women grow older. No marked differences occurred in the increase in breast cancer incidence between the cities within the studied birth cohorts. The developments in routine breast cancer incidence trends before screening suggested that expectations without screening would have shown differences between the cities. The potential effects of screening on breast cancer incidence may have been underestimated in Turku.

To properly estimate the effects of screening on incidence, one should also consider lead-time bias.¹⁵ Estimates of lead-time bias were not available in this study. Further, it has been claimed that breast cancer mammography screening detects such cancers that would never harm the women. Overdiagnosis refers to the detection of cancers that would never have been detected without screening during a woman's lifetime. Overdiagnosis of ductal carcinoma *in situ* may be particularly common, but overdiagnosis is also possible in invasive cancers.^{15,16} In the Florence service

screening programme, the estimated overdiagnosis of invasive cancers was a non-significant 2% over a 10-year follow-up.¹⁵ If breast cancer screening found small and indolent cancers (i.e. overdiagnosis), there should be more cancers in the city of Turku. Since no difference was seen between the incidences of invasive cancers in the cities studied, our results do not support the view of a high rate of overdiagnosis of breast cancer attributable to mammography screening programmes, as recently discussed by Zahl *et al.*⁹ In contrast to their materials, our study was provided with precise screening data and long-term follow-up data, which may explain the difference between the studies. Moreover, as we have previously shown, no increase occurred in the incidence of tubular cancers, in many cases considered indolent, over the first 10 years of service breast cancer mammography screening in Turku.¹⁷ This supports the view that screening does not harm the subjects.

In addition to mammography, some other factors may improve survival. A proportion of the decreased mortality may be attributable to increased breast health awareness among women and better availability of treatment options, as suggested by Feig.¹⁸ However, the study design reduced such confounding factors. The unlike collected material bias was avoided by using data from registers covering national databases only, because they are collected by standardized procedures. *In situ* carcinoma bias was avoided by exclusion. During the study period, breast cancer treatment has evolved relatively uniformly throughout the country, following the commonly implemented breast cancer treatment guidelines, thus reducing the effect of treatment as a confounding factor. All previously mentioned prerequisites allowed us to analyse changes in breast cancer incidence and mortality in the three cities with different screening histories before and after initiation of service breast cancer screening in 1987. Although our total study population was large, some subgroups were small and the confidence limits were therefore wide, indicating limitations in the precision of the point estimates.

Since the late 1980s, breast cancer screening programmes (service screening) have been in progress in more than 20 countries.¹ To date, only a few studies have reported decreased breast cancer mortality attributable to service mammography screening.^{2–7,19} In these reports, a 16–48% reduction of breast cancer mortality among women aged 40–69 has been seen after the initiation of a screening programme compared with the situation without screening. The same is true of the USA, where a study from 1979 to 2000 based on modelling techniques showed that the proportion of the total reduction in the rate of death from breast cancer attributed to screening varied in the seven models from 28% to 65% (median 46%), with adjuvant treatment contributing the rest.²⁰ Our results support findings from case-control studies started in the 1960–80s, of which meta-analyses have been published,^{21,22} as well as findings among Dutch women aged 55–74.²¹ The overall change in breast cancer mortality also agrees with the results of the Diagnostisch Onderzoek Mammacarcinoom (DOM) project (Utrecht), where a 46% reduction in breast cancer mortality was seen,²³ and those of a study from Nijmegen, where about a 45% fall among women aged more than 65 was reported.²⁴ Olsen *et al.*²⁵ reported 18–42% decreases in breast carcinoma mortality in comparable groups by age at death in Copenhagen, attributable to screening and other developments. In Finland, mortality reduction attributable to service screening has been reported earlier at 24% among women screened at ages 50–64² and at 19% among women screened at ages 50–59 in Helsinki.²⁶

No earlier studies are available from Finland of breast cancer screening programmes targeted at older age groups. Even though the mortality reduction seen among elderly women in Turku cannot be interpreted as being due to screening only, the development in the breast cancer mortality pattern must be considered outstanding. In our previous study reports, we have already shown a significant improvement in breast cancer survival, risk of recurrence, and treatment costs resulting from early diagnosis by population-based mammography screening.^{17,27,28} Randomized breast carcinoma screening trials suggest that the impact on mortality is more pronounced among women starting breast cancer screening at the age of 60–69 than among those starting at a younger age.²⁹

In Europe, most countries providing screening are beginning to encourage screenings of elderly women, but official guidelines do not generally recommend that women continue to undergo mammography after the age of 69. International Agency for Research on Cancer (IARC) has concluded that there is sufficient evidence on the efficacy of breast cancer screening among women screened at ages 50–69 and limited evidence for screening at ages 70–74.¹⁶ The opinions have often been based on randomized trials, reporting effects of screening on mortality by age at the start of screening, not by age during the screening period, or by age during treatments of screen-detected cancers. Recently, encouraging results of the benefits of screening in the elderly population have started to appear.^{30–32} The present study suggests that continuing screening until the age of and beyond 70 years is effective. The lesser benefits seen in the cohort aged 55–59 at entry may be due to the provision of a large number of clinical mammographies in this age group in Helsinki.

We conclude that service mammography screening is associated with reduced breast cancer mortality, particularly in elderly birth cohorts. Our results support the conclusion made by de Koning that 'there seems no reason to change or halt the current nation-wide population-based screening programmes'.³³ The comprehensive screening programme, extended to the elderly birth cohorts in the city of Turku, appears to result in a significant reduction in breast cancer mortality among those women. As mortality reduction in elderly birth cohorts was even more pronounced than in younger birth cohorts, it can be concluded that older women also obtain substantial benefit from mammography screening.

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