Decreased rates of advanced breast cancer due to mammography screening in The Netherlands

J Fracheboud*,1, SJ Otto1, JAAM van Dijck2,3, MJM Broeders4, ALM Verbeek4, HJ de Koning1 and National Evaluation Team for Breast cancer screening (NETB)

1Department of Public Health, Erasmus MC, University Medical Center Rotterdam, PO Box 1753, NL-3000 DR Rotterdam, The Netherlands; 2Netherlands Cancer Registry, Association of Comprehensive Cancer Centres, PO Box 19001, NL-3501 DA Utrecht, The Netherlands; 3Comprehensive Cancer Centre East, PO Box 1281, NL-6501 BG Nijmegen, The Netherlands; 4Department of Epidemiology and Biostatistics, University Medical Centre Nijmegen, PO Box 9101, 6500 HB Nijmegen, The Netherlands

The effect of the implementation of the Dutch breast cancer screening programme during 1990–1997 on the incidence rates of breast cancer, particularly advanced breast cancer, was analysed according to stage at diagnosis in seven regions, where no screening took place before 1990. The Netherlands Cancer Registry provided detailed data on breast cancer incidence in 1989–1997 by tumour stage, age and region. Annual age-adjusted incidence rates of all breast cancers and advanced cancers, defined as large tumours T2+ with lymph node and/or distant metastases, were compared with rates in 1989. In general, breast cancer incidence rose strongly in the early 1990s, especially in the age category 50–69 years (estimated annual percentage change (EAPC) 4.25; 95% CI 1.70, 6.86). The increase was mainly due to the increase in small T1 cancers and ductal carcinoma in situ. However, in women aged 50–69, advanced cancer incidence rates showed a significant decline by 12.1% in 1997 compared with 1989 (EAPC –2.14, 95% CI –3.47, –0.80), followed by a breast cancer mortality reduction of similar size after approximately 2 years. We confirm that breast cancer screening initially leads to a temporary strong increase in the breast cancer incidence, which is followed by a significant decrease in advanced diseases in the women invited for screening. It is evident that breast cancer screening contributes to a reduction in advanced breast cancers and breast cancer mortality.

British Journal of Cancer (2004) 91, 861–867. doi:10.1038/sj.bjc.6602075 www.bjcancer.com

Large-scale early detection of breast cancer leads to an increase in newly diagnosed cases and a shift of breast cancer stages toward higher proportions of less severe tumours. The effects of breast cancer screening on the overall breast cancer incidence depend on the characteristics of the screening programme such as the targeted age range, the duration of implementation, the extent of coverage and attendance, the screening interval and the programme performance. A decrease in advanced disease stages is an important predictor of the potential breast cancer mortality reduction by mammography screening (Day et al, 1989).

Population-based mammography screening started in the mid-1970s in two Dutch regions in and around the cities of Utrecht and Nijmegen (‘old’ regions). From 1989 to 1997, nation-wide breast cancer screening was implemented in The Netherlands for women aged 50–69 years. Early outcomes of the nation-wide programme, such as attendance rate, breast cancer detection and tumour stage distribution of screen-detected breast cancers, were largely in line with the expectations that were based on a cost-effectiveness analysis (de Koning et al, 1995; Fracheboud et al, 2001). During the 1990s, Netherlands Cancer Registry (NCR) data showed increases in breast cancer incidence and changes in stage distribution, particularly in the age category targeted for screening (van Dijck et al, 2000). However, data from the registry cannot distinguish screened from nonscreened women.

In this study, we describe stage-specific trends in the breast cancer incidence 1989–1997 during the implementation of the nation-wide breast cancer screening programme in The Netherlands. As we observed a significant decrease in breast cancer mortality within the population targeted for screening as of 1997 (Otto et al, 2003), we assumed a decline in advanced disease stages as well. For this reason, we focused our analyses on trends in advanced tumour stages in the seven regions that started screening activities after 1990 (‘new’ regions).

MATERIAL AND METHODS

Setting

The nation-wide breast cancer screening programme for women aged 50–69 years was gradually implemented in The Netherlands during 1989–1997. Every 2 years, eligible women get a personal invitation letter with a fixed appointment for a screen examination in one of the mostly mobile screening units. Over 75% of the
invited women attend the programme and more than 90% of the attendees reattend in the following round. Experimental, non-randomised breast cancer screening started in the mid-1970s in the city of Utrecht (central region) and its environs, and in the city of Nijmegen (eastern region). The pilot programmes were gradually integrated in the national programme around 1989. In 1990, three other regions started screening activities, followed by the remaining four regions in 1991. Up to 1994, the majority of screen examinations were initial screens, but since 1995 subsequent screens have been carried out predominantly. The number of screen examinations increased from 1300 per 100 000 women aged 50–69 in 1990 to more than 35 000 per 100 000 in 1997.

The first regional cancer registry was established in the 1950s in the southeastern part of The Netherlands. Only in the 1980s, cancer registries were launched in the other eight regions. In 1989, coverage was nation-wide, so that the regional registries could be brought together to form a single database, the Netherlands Cancer Registry (NCR, 1992). Cancer recording is based on notifications of malign pathology by the computerized national histopathological database (PALGA). The records are complemented with clinical information by the regional Comprehensive Cancer Centres and checked for missing cases by comparing them with the national registry of outpatient and in-patient diagnoses (LMR). The completeness of case ascertainment of the NCR is higher than 95% (Visser et al, 2003); this percentage will be still higher for breast cancer, because histological or cytological material is available for nearly all cases. Tumour characteristics are registered according to the International Union Against Cancer (UICC) and topography and morphology (International Classification of Diseases for Oncology (ICD-O)). The classification is primarily based on histopathological TNM information; in case of unknown pN (=X) clinical information cN is used. Usually, it takes 3 years to complete and publish the data on the cancer incidence of a certain year.

Method

The National Evaluation Team for Breast cancer screening in The Netherlands (NETB) annually collects regional aggregated data on the screening results, including attendance, referral recommendations, screen-detected breast cancers and stage distribution. Files of regional screening records are linked to the corresponding regional cancer registry database to identify interval cancers. These data are also provided to the NETB, which analyses trends in incidence and therapy of screen-detected cancers, interval cancers and breast cancers in nonscreened women.

In 2001, the NCR provided data on population, breast cancer incidence, tumour size, positive or negative lymph node stage and distant metastases by calendar year 1989–1997 and 5-year age groups for the nine cancer registry regions separately. These regions largely correspond to the nine breast cancer screening regions in The Netherlands. The data include ductal carcinoma in situ, but not lobular carcinoma in situ, which is regarded a benign lesion. To be able to study the effect of introducing a screening programme in a previously unscreened population, the NCR data were subdivided into two ‘old’ regions (the central and eastern regions where the pilot programmes took place) and into seven ‘new’ regions that did not start screening activities until 1990.

For the national evaluation, the age at screening and of breast cancer incidence is defined by birth year; that is, during a certain year, the woman is considered to keep the age she had on January 1 of the same year. For this reason, women will be invited and screened for the first time in the year when they become 50 years old, thus having the evaluation age of 49.

As we did not have detailed information on the lymph node status, we did not use UICC TNM stages, but grouped invasive breast cancers into six categories: (1) small tumours T1 (up to 20 mm in size) without metastases (T1N0); (2) small tumours T1 with lymph node or distant metastases (T1N+ /M1); (3) small tumours T1 with unknown lymph node status (T1Nx); (4) large cancers T2+ (T2: 20–50 mm in size, T3: > 50 mm in size and T4) without metastases (T2 +N0); (5) large cancers T2+ with lymph node or distant metastases (T2+N+ /M1) and (6) large cancers T2+ with unknown lymph node status (T2+Nx). We defined category (5) T2+N+ /M1 as ‘advanced cancers’ in our study. The proportion of Tx and unclassified cancers varied between 2.1 and 3.2% of the annual breast cancer total. The same variation was observed within 5-year age groups, except the oldest age group (>79 years) in which the proportion of Tx and unclassified cancers was approximately 7%.

All breast cancer incidence rates were calculated per 100 000 women by dividing the number of new breast cancer cases in a certain year by the mid-year female population (the average of the population at January 1 of that year and the population at January 1 of the following year). As the NCR did not supply population figures of January 1, 1998, we estimated it for the individual cancer registry regions by multiplying the 1997 regional age-specific population numbers by the age-specific percent change between 1997 and 1998 of the national population. All rates were age-adjusted by means of direct standardisation using the European Standard Population as reference.

Assuming a constant change of incidence rates over time, we estimated trends using the estimated annual percentage change (EAPC) by fitting a regression line to the natural logarithm of the incidence rates as dependent variable, and testing the slope by the t-distribution (number of degree of freedom equals the number of calendar year minus 2). The significance level of differences in advanced cancer incidence rates was estimated by means of the expected standard deviation of the difference in incidence rate of a certain year and age group compared with 1989, according to the method that we used for assessing changes in breast cancer mortality (van den Akker-van Marle et al, 1999; Otto et al, 2003).

RESULTS

Table 1 gives the age-adjusted combined invasive and in situ breast cancer incidence rates in 1989–1997 and the percent change compared with 1989 by different age categories. In the total Dutch female population, incidence rates increased in all age groups. They reached a maximum in 1993–1994 and then slightly declined but still remained higher than the initial level. The overall incidence was highest in 1994 (25.9% increase compared to 1989). In women aged 50–69, the incidence rate reached a maximum in 1993 (39.2% increase compared to 1989). In younger women, the increase was more gradual and reached its maximum in 1996–1997 (+15.6% compared with 1989), whereas in older women the increase did not exceed 12.5%.

The incidence of advanced breast cancers was more pronounced in the ‘new’ regions, especially in women aged 50–69, in whom the incidence rate remained beyond 300 per 100 000 from 1992 onwards (EAPC 4.25; 95% CI 1.70, 6.86; Table 1). These rates are approx. 40% higher than the incidence rate in 1989 (225.8 per 100 000), which can be regarded as baseline incidence in an unscreened population in The Netherlands. In the ‘old’ regions, in women aged 50–69, the breast cancer incidence was substantially higher in 1989 (284.2 per 100 000) and reached the highest incidence level in 1993 with 347.3 per 100 000 (increase by 22.2%). However, there was no significant change of incidence rates over the total period 1989–1997.

Figure 1 shows that the incidence rates of both, invasive and in situ breast cancers, increased in all age categories in the seven ‘new’ regions, but that this increase was the strongest in women
Table 1  Annual age-adjusted invasive and ductal in situ breast cancer rates (ESR per 100 000 woman-years) in 1989–1997 and per cent change since 1989.

| Age category | New 'regions' | Old 'regions' | Netherlands (nine regions) |
|--------------|---------------|---------------|---------------------------|
|               | Seven 'new' regions | Two 'old' regions | N | Rate | Change (1989 = 0) | N | Rate | Change (1989 = 0) | N | Rate | Change (1989 = 0) |
|< 50 years     | 1989: 1826 43.2 | 1990: 1930 44.8 | 1991: 2018 45.6 | 1992: 2057 45.3 | 1993: 2201 47.5 | 1994: 2278 48.3 | 1995: 2267 47.2 | 1996: 2375 49.2 | 1997: 2376 49.6 | 1998: 2198 43.1 | 1999: 2316 44.6 | 2000: 2473 46.4 | 2001: 2509 45.9 | 2002: 2643 47.2 | 2003: 2751 48.3 | 2004: 2711 46.7 | 2005: 2891 49.6 | 2006: 2885 49.9 |
|               | 372 42.7 | 386 43.8 | 455 50.2 | 452 48.7 | 442 46.2 | 473 48.3 | 444 44.6 | 516 51.5 | 509 51.1 | 2198 43.1 | 2316 44.6 | 2473 46.4 | 2509 45.9 | 2643 47.2 | 2751 48.3 | 2711 46.7 | 2891 49.6 | 2885 49.9 |
|               | 1.93 (1.47, 2.09) | 2.5 (1.7, 3.4) | 17.6 (13.9, 21.3) | 13.9 (10.9, 17.9) | 8.0 (6.0, 10.1) | 12.9 (10.4, 15.4) | 4.3 (3.7, 5.0) | 20.4 (18.0, 22.9) | 19.6 (17.1, 22.2) | 1.39 (–0.18, 3.39) | 1.62 (1.05, 2.22) |
| 50–69 years   | 1989: 2795 225.8 | 1990: 2999 240.8 | 1991: 3316 265.6 | 1992: 3821 304.3 | 1993: 4059 323.6 | 1994: 4105 325.0 | 1995: 3968 312.0 | 1996: 4082 314.5 | 1997: 4160 313.0 | EAPC (95% CI) 1.63 (1.47, 2.09) | 1.39 (–0.18, 3.39) | 1.62 (1.05, 2.22) |
|               | 671 284.2 | 726 301.8 | 743 304.3 | 820 338.3 | 846 347.3 | 810 323.7 | 746 296.4 | 704 273.7 | 797 300.4 | — | 3466 235.3 | — | 3725 250.7 | — | 4059 271.9 | — | 4641 309.9 | — | 4905 327.5 | — | 4915 324.8 | — | 4714 309.4 | — | 4786 307.8 | — | 4957 310.9 | — | 321.0 |
|               | 1998: 2376 49.6 | 1999: 2000 211.2 | 2000: 2075 208.4 | 2001: 2123 210.6 | 2002: 2268 221.5 | 2003: 2259 213.2 | 2004: 2583 240.2 | 2005: 2400 223.0 | 2006: 2489 221.0 | 2007: 2490 219.8 | EAPC (95% CI) 0.89 (–0.29, 2.09) | — | 2348 211.0 | — | 2533 214.8 | — | 2548 214.9 | — | 2733 223.8 | — | 2675 210.7 | — | 3036 237.3 | — | 2870 222.7 | — | 2961 222.3 | — | 2953 219.1 | — | 3.9 |
|               | 344 210.0 | 458 249.2 | 425 238.3 | 465 235.8 | 416 197.0 | 453 221.8 | 470 221.3 | 472 228.9 | 463 215.6 | — | — | 8012 103.1 | — | 8574 108.8 | — | 9080 114.5 | — | 9883 123.5 | — | 10223 127.3 | — | 10702 129.8 | — | 259.0 | — | 3.37 | — | 1.72 |
| > 69 years    | 1989: 6625 101.3 | 1990: 7004 106.1 | 1991: 7457 112.3 | 1992: 8146 121.5 | 1993: 8519 126.7 | 1994: 8966 130.2 | 1995: 8635 124.7 | 1996: 8946 127.1 | 1997: 9026 126.7 | EAPC (95% CI) 0.89 (–0.29, 2.09) | — | 8012 103.1 | — | 8574 108.8 | — | 9080 114.5 | — | 9883 123.5 | — | 10223 127.3 | — | 10702 129.8 | — | 259.0 | — | 3.37 | — | 1.72 |
|               | 1387 112.4 | 1570 122.8 | 1623 125.5 | 1737 133.6 | 1704 130.3 | 1736 127.9 | 1660 120.2 | 1692 119.4 | 1769 124.4 | — | — | 0.32 (–1.33, 2.00) | 2.46 (0.98, 3.96) |

*Start screening activities in 1990 or 1991. Screening activities before 1989 (regions with pilot programmes). EAPC is estimated annual percentage change.

Decreased rates of advanced breast cancer

J Fracheboud et al

Clinical Cancer Research UK

© 2004 Cancer Research UK

British Journal of Cancer (2004) 91(5), 861 – 867

aged 50–69. In 1997, a quarter of all newly diagnosed invasive and in situ breast cancers were detected by the screening programme, and one out of eight was diagnosed in screened women during the interval period between two screening rounds (Figure 2). In women aged 50–69 years, half of all breast cancers were screen-detected cancers and a quarter were symptomatic cancers in ever-screened women.

Figure 3 shows that the increase in overall invasive breast cancer rates (Figure 3a) was mainly caused by an increase of T1 tumours, especially lymph node negative T1 tumours (T1N0), and particularly in the age category 50–69 (Figure 3c). In this age category, the doubling of small lymph node negative tumours was followed by a decline in T2 + cancers with lymph node or distant metastases (T2 + N + /M1). In younger and older women, the incidence rates of these cancers showed a nonsignificant slightly increasing trend (EAPC 0.84 and 1.09% for women aged <50 and >69 years, respectively; Table 2). In women aged 50–69, after a moderate increase by approx. 3% up to 1994, incidence rates of advanced disease are significantly lower from 1996 onwards (EAPC = −2.14; 95% CI −3.47, −0.80; Table 2). This resulted in a decrease by 12.1% in 1997 compared to that in 1989 (63.0 vs 71.6 per 100 000). In the ‘old’ regions, the decline in this age category was larger, with an EAPC of −5.5 (95% CI −8.52, −2.37; data not shown).

Table 3 compares the incidence rates of advanced breast cancers with the breast cancer mortality in The Netherlands (all nine
regions, women aged 55–74) during the 1990s (Otto et al, 2003). This reduction of advanced diseases precedes the observed significant breast cancer mortality reduction of a comparable extent by approximately 2 years.

**DISCUSSION**

The implementation of the nation-wide breast cancer screening programme in The Netherlands from 1990 to 1997 coincided with...

---

**Figure 1** Age-adjusted invasive and in situ breast cancer incidence per 100 000 by age category, seven ‘new’ regions 1989–1997.

**Figure 2** Percent distribution of newly diagnosed invasive and in situ breast cancers as related to screening (screen-detected; in ever-screened women, in never-screened women and unknown) by age category 1990–1997.
an obvious increase in the incidence rates of both invasive and \textit{in situ} breast cancers. This increase was strongest in women aged 50–69 years, the main target population for the programme, especially in the early 1990s, when predominantly initial screen examinations were carried out. The average detection rate was at that time 6.1 per 1000 initially screened women (NETB (National Evaluation Team for Breast cancer screening in The Netherlands), 2001). In 1995–1997, with a large majority of subsequent screen examinations (average detection rate 3.4 per 1000 screened women), the overall incidence fell to a lower level. It remained, however, above the 1989 baseline. This trend is consistent with the expected development of the breast cancer incidence that had been predicted previously by our group (de Koning \textit{et al}, 1990). We found an estimated annual percentage change (EAPC) of 2.46 with respect to the overall incidence including ductal carcinoma \textit{in situ}.

In their last report, the NCR calculated for invasive breast cancers (Visser \textit{et al}, 2003). Where organised screening has been introduced, this increase is more marked, mainly as a result of the additional detection of early breast cancer stages. The extent of the increase is – besides the country-specific underlying incidence – directly related to the intensity of the screening programme, for example, the targeted proportion of the female population, the speed of implementation, the screening interval, the quality of the programme and the participation rate (Threlfall \textit{et al}, 2003). In most studies, a decline was observed after the initial screening round had been finished. Those studies with a sufficiently long follow-up provided valuable insight into the course of the total breast cancer incidence during subsequent screens. In general, the incidence remains higher than in the prescreening period, which raises the question whether the ongoing subsequent screening leads to overdiagnosis or whether the breast cancer risk is increasing. It is important to realise that the initial increase does not signify overdiagnosis, but that it is the result of the necessary downstaging of breast cancer diagnoses, if screening will be effective. Several authors concluded that overdiagnosis might be limited to a few percent (Boer \textit{et al}, 1994; Olsen \textit{et al}, 2003; Yen \textit{et al}, 2003; Paci \textit{et al}, 2004). It is likely that besides organised screening and the general tendency towards earlier detection (increased awareness, spontaneous mammography) other factors, such as declining fertility rates and the widespread use of hormone replacement therapy, contribute to the observed increase in breast cancer incidence (Prehn \textit{et al}, 2002; Beral, 2003; Coebergh, 2003; Li \textit{et al}, 2003).

The present study confirms that relatively more small lymph node negative cancers were detected in the targeted age category 50–69 after the start of the programme. More importantly, in this

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure3}
\caption{Age-adjusted invasive breast cancer rates (ESR) in 1989–1997 per 100 000 by tumour stage in seven ‘new’ regions: (A) all ages; (B) <50 years; (C) 50–69 years; (D) >69 years.}
\end{figure}
same age group, the incidence rate of large cancers with lymph node or distant metastases began to decline significantly in 1996.

Table 2: Annual age-adjusted incidence rates (ESR) and rate difference compared with 1989 of advanced breast cancers (T2+/N+/M1) per 100,000 women in the seven 'new' regions.

| Year | Rate N | Rate difference compared to 1989 (95% CI) |
|------|--------|------------------------------------------|
| <50 years |
| 1989 | 496 | 11.8 |
| 1990 | 584 | 13.6 |
| 1991 | 569 | 12.9 |
| 1992 | 559 | 12.3 |
| 1993 | 633 | 13.7 |
| 1994 | 619 | 13.1 |
| 1995 | 630 | 13.1 |
| 1996 | 621 | 12.9 |
| 1997 | 649 | 13.6 |
| EAPC | 0.84 | ($-$0.59, 2.29) |

| 50–69 years |
| 1989 | 884 | 71.6 |
| 1990 | 917 | 73.7 |
| 1991 | 914 | 73.6 |
| 1992 | 936 | 74.2 |
| 1993 | 920 | 73.7 |
| 1994 | 901 | 71.6 |
| 1995 | 815 | 64.6 |
| 1996 | 808 | 62.6 |
| 1997 | 833 | 63.0 |
| EAPC | 0.84 | ($-$0.59, 2.29) |

| >69 years |
| 1989 | 572 | 85.3 |
| 1990 | 641 | 94.9 |
| 1991 | 606 | 88.5 |
| 1992 | 664 | 94.9 |
| 1993 | 661 | 92.1 |
| 1994 | 737 | 102.0 |
| 1995 | 670 | 91.2 |
| 1996 | 726 | 96.3 |
| 1997 | 734 | 96.1 |
| EAPC | 1.09 | ($-$0.31, 2.52) |

EAPC: estimated annual percentage change.

Table 3: Annual age-adjusted rates (ESR) of advanced breast cancers (T2+/N+/M1) and breast cancer mortality in the Netherlands (all regions), and rate difference compared with observed rates in 1989 (advanced cancers) and in 1986–88 (mortality), women aged 55–74 years.

| Year | Advanced cancers (T2+/N+/M1) | Mortality* |
|------|-----------------------------|------------|
| Per 100 000 | Rate difference (95% CI) | Per 100 000 | Rate difference (95% CI) |
| 1986–88 |
| 1989 | 93.6 | — | 105.2 | — |
| 1990 | 95.6 | 2.0 | ($-$6.1, 10.1) | 102.9 | — | ($-$8.6, 4.0) |
| 1991 | 94.4 | 0.8 | ($-$7.2, 8.9) | 107.5 | 2.3 | ($-$4.1, 8.7) |
| 1992 | 97.6 | 4.0 | ($-$4.1, 12.2) | 105.0 | −0.2 | ($-$6.6, 6.1) |
| 1993 | 91.5 | −2.0 | ($-$10.0, 6.0) | 102.1 | −3.2 | ($-$9.4, 3.1) |
| 1994 | 92.0 | −1.5 | ($-$9.5, 6.4) | 101.1 | −4.1 | ($-$10.3, 2.1) |
| 1995 | 80.4 | −13.1 | ($-$20.8, −5.4) | 103.9 | −1.3 | ($-$7.6, 4.9) |
| 1996 | 80.4 | −13.2 | ($-$20.9, −5.4) | 100.2 | −5.0 | ($-$11.1, 1.2) |
| 1997 | 78.0 | −15.6 | ($-$23.2, −8.0) | 100.0 | −5.2 | ($-$11.4, 1.0) |
| 1998 | 98.2 | −7.0 | ($-$13.1, −0.9) | 96.2 | −7.0 | ($-$13.1, −0.9) |
| 1999 | 92.1 | −13.1 | ($-$19.0, −7.1) | 97.8 | −7.4 | ($-$13.4, −1.3) |
| 2000 | 89.7 | −15.5 | ($-$21.4, −9.7) | 85.3 | −19.9 | ($-$26.6, −14.2) |

*Otto et al (2003).
aged 55–74 started to decline significantly from 1997 onwards (Otto et al., 2003). After recalibration of the incidence rates for the same age band, we found a significant reduction of advanced diseases already in 1995, preceding the breast cancer mortality reduction of a similar extent by 2 years (Table 3).

CONCLUSION

Breast cancer screening led to a temporary strong increase in the breast cancer incidence, in particular of in situ carcinomas and small lymph node negative invasive cancers in women aged 50–69 years. In this age category, the incidence rate of large tumours with lymph node or distant metastases (T2 + N + /M1) decreased significantly and was 12.1% lower in 1997 than before the start of the screening programme. This reduction in advanced disease precedes the observed significant breast cancer mortality reduction of a comparable extent by approximately 2 years. The outcomes of our study confirm that population-based mammography screening contributes to a reduction of advanced breast cancer rates and breast cancer mortality.

REFERENCES

Beral V (2003) Breast cancer and hormone-replacement therapy in the Million Women Study. Lancet 362: 419 – 427
Boer R, Warmerdam P, de Koning H, van Oortmarssen G (1994) Extra incidence caused by mammographic screening (letter). Lancet 343: 979
Botha J, Bray F, Sankila R, Parkin DM (2003) Breast cancer incidence and mortality trends in 16 European countries. Eur J Cancer 39: 1718 – 1729
Buatti E, Barchielli A, Bartolacci S, Federico M, De Lisi V, Bucchi L, Ferretti S, Paci E, Segnan N, Tumino R (2003) The impact of organised screening programmes on the stage-specific incidence of breast cancer in some Italian areas. Eur J Cancer 39: 1776 – 1782
Chu KC, Tarone RE, Kesseler LG, Ries LA, Hankey BF, Miller BA, Edwards BK (1996) Recent trends in U.S. breast cancer incidence, survival, and mortality rates. J Natl Cancer Inst 88: 1571 – 1579
Coerbergh JW (2003) Early breast cancer in Europe: progress and pitfalls in detection and management at the start of the new century. Eur J Cancer 39: 1645 – 1647
Day NE, Williams DR, Khaw KT (1989) Breast cancer screening programmes: the development of a monitoring and evaluation system. Br J Cancer 59: 954 – 958
de Koning HJ, Fracheboud J, Boer R, Verbeek ALM, Collette HJA, Hendriks JHCL, van Ineveld BM, de Bruyn AE, van der Maas PJ (1995) Nation-wide breast cancer screening in The Netherlands: support for breast-cancer mortality reduction. National Evaluation Team for Breast Cancer Screening (NETB). Int J Cancer 60: 777 – 780
de Koning HJ, van Oortmarssen GJ, van Ineveld BM, van der Maas PJ (1990) Breast cancer screening: its impact on clinical medicine. Br J Cancer 61: 292 – 297
Fracheboud J, de Koning HJ, Boer R, Groenewoud JH, Verbeek AL, Broeders MJ, van Ineveld BM, Hendriks JH, de Bruyn AE, Holland R, van der Maas PJ (2001) Nationwide breast cancer screening programme fully implemented in The Netherlands. Breast 10: 6 – 11
Kricker A, Farac K, Smith D, Sweeney A, McCredie M, Armstrong BK (1999) Breast cancer in New South Wales in 1972 – 1995: tumor size and the impact of mammographic screening. Int J Cancer 81: 877 – 880
Li CI, Anderson BO, Daling JR, Moe RE (2003) Trends in incidence rates of invasive lobular and ductal breast carcinoma. JAMA 289: 1421 – 1424
McCann J, Stockton D, Day N (1998) Breast cancer in East Anglia: the impact of the breast cancer screening programme on stage at diagnosis. J Med Screen 5: 42 – 48
NCr (Netherlands Cancer Registry) (1992) Incidence of cancer in The Netherlands 1989. Utrecht: SIG Health Care Information
NETB (National Evaluation Team for Breast cancer Screening in The Netherlands), Fracheboud J, Otto SJ, Groenewoud JH, van Ineveld BM, Broeders MJM, Verbeek ALM, Hendriks JHCL, de Bruyn AE, van der Maas PJ, de Koning HJ, LETB (2001) National Evaluation of Breast Cancer Screening in The Netherlands (IX). Vol. IX. Erasmus MC, Rotterdam: Dept of Public Health
Olsen AH, Jensen A, Njor SH, Villadsen E, Schwartz W, Vejborg I, Lynge E (2003) Breast cancer incidence after the start of mammography screening in Denmark. Br J Cancer 88: 362 – 365
Otto SJ, Fracheboud J, Looman CW, Broeders MJ, Boer R, Hendriks JH, Verbeek AL, de Koning HJ (2003) Initiation of population-based mammography screening in Dutch municipalities and effect on breast-cancer mortality: a systematic review. Lancet 361: 1411 – 1417
Paci E, Duffy SW, Giorgi D, Zappa M, Crocetti E, Vezzosi V, Bianchi S, del Turco MR (2002) Quantification of the effect of mammographic screening on fatal breast cancers: The Florence Programme 1990 – 96. Br J Cancer 87: 65 – 69
Paci E, Warren J, Falini P, Duffy SW (2004) Overdiagnosis in screening: is the increase in breast cancer incidence rates a cause for concern? J Med Screen 11: 23 – 27
Prehm A, Clarke C, Topol B, Glaser S, West D (2002) Increase in breast cancer incidence in middle-aged women during the 1990s. Ann Epidemiol 12: 476 – 481
Quinn M, Allen E (1995) Changes in incidence of and mortality from breast cancer in England and Wales since introduction of screening. United Kingdom Association of Cancer Registries. BMJ 311: 1391 – 1395
Schouten LJ, de Rijke JM, Huveneers JA, Verbeek AL (2002) Rising incidence of breast cancer after completion of the first prevalent round of the breast cancer screening programme. J Med Screen 9: 120 – 124
Schouten LJ, de Rijke JM, Schlangen JT, Verbeek AL (1998) Evaluation of the effect of breast cancer screening by record linkage with the cancer registry, The Netherlands. J Med Screen 5: 37 – 41
Threlfall AG, Collins S, Woodman CB (2003) Impact of NHS breast screening on advanced disease and mortality from breast cancer in the North West of England. Br J Cancer 89: 77 – 80
van den Akker-van Marle E, de Koning H, Boer R, van der Maas P (1999) Reduction in breast cancer mortality due to the introduction of mass screening in The Netherlands: comparison with The United Kingdom. J Med Screen 6: 30 – 34
van Diijk JA, Hendriks JH, Holland R, Schouten LJ, Verbeek AL (2000) Veranderde stadiumverdeling van borstkanker zinds de invoering van de landelijke screening: onderzoek over de periode 1989 – 1995 (Alterations of stage distribution for breast cancer since the implementation of national screening program in The Netherlands during 1989 – 1995). Ned Tijdschr Geneeskd 144: 1119 – 1124
Visser O, Siesling S, van Diijk JAAM (eds) (2003) Incidence of cancer in The Netherlands 1999/2000 Eleventh report of The Netherlands Cancer Registry. Utrecht: Vereniging van Integrale Kankercentra
Yen MF, Tabar L, Vitak B, Smith RA, Chen HH, Duffy SW (2003) Quantifying the potential problem of overdiagnosis of ductal carcinoma in situ in breast cancer screening. Eur J Cancer 39: 1746 – 1754

© 2004 Cancer Research UK