Direct and indirect costs of the Norwegian Breast Cancer Screening Program

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Abstract

Norway has had a nationwide, biennial public screening program for breast cancer since 2005. The program includes all women aged 50-69 years. The aim of this study was to estimate the total societal costs of one screening round. The cost analysis was based on the number women in the relevant age group, the proportions attending screening, estimated travel time to nearest mammography facility, and the proportion of women having repeat examination. Unit costs were taken from the DRG price list and other sources. The cost of mobile mammography units were based on cost accounts. The total costs of one screening round were estimated to be NOK521 million (NOK1,262 per woman attending screening), of which 64% were health care costs, and 36% were travel costs and productivity losses. The total costs of repeat examinations in one screening round for women with suspicious findings or inadequate quality on the screening mammograms were NOK52.8 million (NOK3,655 per woman reexamined). NOK44.4 million of these costs may be due to false positive findings in the screening mammograms.

Preface

The Norwegian Research Council – on behalf of the Ministry of Health and Care Services – has initiated a research-based evaluation of the Norwegian Breast Cancer Screening Program. The main objective is to evaluate whether the program has fulfilled its objectives, where the primary goal was to achieve a 30 % reduction in breast cancer-related mortality among women in the target population (women aged 50 – 60 years).

The evaluation has three main objectives:

- Assess the effects of the Norwegian Breast Cancer Screening Program with respect to mortality, shift in the distribution of stage at diagnosis, and shift in the occurrence of advanced cancers.
- Assess the organizational structure of the Norwegian Breast Cancer Screening Program and its impact on accessibility, quality and learning attributable to the program.
- Assess total costs and cost-effectiveness of the Norwegian Breast Cancer Screening Program.

This report is a part of the economic evaluation of the program. The main objective of this sub-project was to estimate:

- the total societal costs of one round of breast cancer screening. Because one screening round of all women aged 50-74 takes two years, we included two years of program costs.
- the direct costs included the total cost per mammography, the total cost per repeat examination and the costs of running the mammography buses.
- the indirect costs included costs related to invitations and reminders, travel costs and productivity losses.

The analyses are divided into screening and repeat examinations recommended because of suspicious mammography findings or inadequate quality of the primary mammography. For the repeat examinations, a simple estimate of the costs due to false positive screening results is calculated.

1 Introduction

Background and epidemiology of breast cancer in Norway

Breast cancer remains the most frequent type of cancer among women in Norway, accounting for 22% of all cancers detected in the female population (1). Depending on whether the cancer was local (TNM stage I) or distant (TNM stage IV) at diagnosis, the five-year relative survival of breast cancer in Norway varied between 95.3 % and 18.8%, during the period 2005-2009 (1). In 2009, 2,760 new cases of breast cancer were detected in Norway, where only 15 cases (0.005%) were in men. The incidence of breast cancer is increasing with age, but the greatest number is observed in women 50-69 years of age due to the age distribution of women. (1). The age-adjusted incidence of breast cancer in women has doubled during the last 45 years, but has declined over the past few years, from an age-adjusted incidence of 77.4 per 100,000 person years in 2004 to 70.7 per 100,000 in 2009 (1). Among women diagnosed with breast cancer during the period 1999-2008, 35,966 were still alive in 2009 (1). Due to the ageing population, the incidence of breast cancer is expected to increase in the future (2).

Risk factors for breast cancer include gender, age, high age at first birth, few children, early menarche, late menopause, family history of breast cancer (genetic predisposition), a previous benign breast disease, high estrogen levels including the use of hormone replacement therapy, elevated body height, high post-menopausal or low pre-menopausal body mass index, high breast density and exposure to ionizing radiation (3). Protective factors include low age at first childbirth, multiple childbirths, having Asian decent and regular exercise (4).

Public mammography screening

Public mammography screening has been introduced in several countries in recent years. The goal of breast cancer screening is to detect cancers at an earlier stage to increase survival. In Norway, breast cancer screening began as a pilot project in 1996, including 4 out of 19 counties. It was expanded to gradually include all counties by February 2004. Thus, by 2005 all Norwegian women in the age group 50-69 years were invited to biennial screening (1). The Norwegian Breast Cancer Screening Program is run by the Cancer Registry of Norway. There are 27 screening units at hospitals in Norway. In addition, there are four mammography buses which have biennial routes around Norway, to ensure that the travel distance to the nearest screening facility is reasonable. The buses are administered by the Vestre Viken Hospital Trust. From the start of the program through December 2009, 20% of the screenings were undertaken in buses (Personal communication, Hofvind, Norwegian Cancer Registry).

Cost of mammography

The costs of the Norwegian Breast Cancer Screening Program include direct costs incurred in the health care sector, direct costs incurred in other sectors, and indirect costs from work absenteeism among patients and their relatives (6). Norway has a public health care system funded through taxes and small patient co-payments. Thus, the majority of the direct costs incurred in the health care sector are covered by the government. To our knowledge, there has only been one previous attempt to estimate the cost of the breast cancer screening program in Norway (7). In that study, direct health care costs were evaluated based among women screened at Oslo Breast Diagnostic Center. The analysis did not consider travel costs or productivity losses. Our study has a societal perspective and aims to include indirect costs (production losses from work absenteeism) as well travel costs, as the travel distances in Norway are considerable, and may constitute a significant proportion of the overall costs. In the estimation we only used publicly available data sources, *i.e.* data available on the web sites of Statistics Norway and the Cancer Register of Norway or by personal contact as described in "*Data*" below.

2 Material and methods

Data

Information on the total number of women in the screening age groups in Norway was acquired from the Statistics Norway (8). The data included the number of women aged 50-69 years in each municipality (data for 2009), the proportion of employed women in each municipality for the age groups 55-66 years (2008) and the average monthly gross salary for women aged 50 years and up (data from 2012). A data matrix for the travel distance and travel time between all municipalities in Norway was provided by professor Tor Iversen at HELED. Data on the location of mammography facilities, including stops for the mammography buses, and the proportion of women who attended mammography per county were provided by the Norwegian Cancer Registry (5). These data were from 2008, as this was the final year information on attendance rates per county was published.

Direct health care costs

The different cost components are summarized in Table 1, divided into screening and repeat examinations. The unit cost of screening mammography was estimated using information on the capital costs of a mammograph, the number of radiologists and technicians involved in screening, costs of office space including heating and cleaning and the number of mammograms per year. The details of the costing model are available from the authors. Data on the capital and running costs for the mammography buses were acquired from Aage Dolven Jacobsen, chief engineer at Vestre Viken Hospital Trust.

If a tumor suspect finding is detected on the mammogram, the woman is invited to a repeat examination. In Norway, this applies to 3.5% of the screened women (10). They may undergo a clinical examination (palpation) and additional clinical mammography (with new images) and/or an ultrasound examination. Also, approximately 50% of the women have a biopsy taken (Personal communication, Hofvind, Norwegian Cancer Registry). MR, CT and open (surgical) biopsies are rarely used in Norway, and are not included in the cost of repeat examination. Hence the direct cost of a repeat examination involves the cost of ultrasound, mammography and biopsy. The unit cost for biopsy was estimated using a similar approach as for screening mammography. Input data stemmed from hospital accounts and pathologists. The unit costs of clinical mammography and ultrasound were estimated using reimbursement rates for these procedures and out-of-pocket payment rates for 2012, set by the Norwegian Directorate of Health (9). The cost of the repeat examination was estimated to be NOK2,860, assuming that both ultrasound and biopsy are used in 50% of the examinations each.

Additional direct costs include invitation letters to the women for the primary screening and for repeat examination. Non-attendees receive one reminder, and attendees receive information about their mammogram by mail, including information on repeat examination if necessary. An additional letter with the information about the findings of the repeat examination is also sent. The cost per letter sent was set to NOK9 excluding administration costs.

Travel costs

We assumed that a few women may have mammography facilities within walking distance while others use public transport, private care or even taxi. In Norway, the government refunds its employees by NOK3.90 per kilometer for use of private car (11, 2012). This amount is supposed to cover capital costs, maintenance, fuel and insurance. Lacking any information on the actual means of transport, we used NOK3.90 per kilometer as an estimate of the average travel cost across all types of transport. Women are assumed to travel to the nearest screening facility (bus or hospital). For women living in municipalities with a screening facility, the one-way travel distance was set to 10 km. The maximum travel cost was set to NOK1,500, as there will be some very long distances especially for the repeat examinations that only can be conducted at hospitals with breast cancer diagnostic equipment. Hence, when using the per kilometer refund rate, some women would otherwise get unrealistically high travel costs (up to NOK8,000).

Productivity losses

The cost per hour of productivity loss was based on the average pretax monthly salary (weighted average across full time and part time employees) for women aged 50 years and above of NOK36,200 (Statistics Norway, 2012). Assuming 22 working days of 7.5 hours for each woman, the cost per lost hour of productive work was NOK220. An extra 40% was added to account for the value of the workers' productivity that is not returned to them as wage. This includes employer tax, payment for

holiday and pension contributions in Norway, giving an estimate of NOK308. This estimate was further adjusted down by the proportion of women 50-69 years of age who were not participating in the workforce using municipality specific data from Statistics Norway (2008). The travel time was based on the matrix mentioned in "*Data*" above. The round-trip travel time within municipalities was set at 0.67 hours. If the round-trip travel time to the nearest screening facility was greater than 7.5 hours, we assumed that the maximum number of hours work absenteeism was 7.5 hours. The time for performing a standard mammography was set to 0.25 hours including waiting time (Hofvind, personal communication), and the time for repeat examinations was set at 0.5 hours.

Table 1. Cost components of the analysis. All costs are measured in 2012 Norwegian Kroner (NOK) (€1.00~NOK7.50)

Cost area	Cost component	Unit price (NOK)	Source of information
Cost of screening mammography	Mammography buses per screening round	18,000,000	Aage Dolven Jacobsen, Vestre Viken Hospital Trust
	Screening mammography, both breasts	745	Cost model based on expert opinion
	Printing and sending invitation letter	9	Norway Post
Cost of repeat examination	Clinical mammography, one breast	732	Norwegian Directorate of Health
	Ultrasound-guided biopsy	1430	Cost model based on expert opinion
	Ultrasound examination	695	Norwegian Directorate of Health
	Printing and sending invitation letter	9	Norway Post
Travel costs and productivity losses, screening and repeat examination	Travel cost per kilometer	3.90	Tax Norway
	Productivity loss per hour	220	Statistics Norway

Statistical analysis

The data were analyzed in SPSS version 16.0. The data file included all 430 municipalities in Norway (2009). The analysis was divided into two parts, 1: estimating the costs for one screening round divided into direct costs, travel costs and productivity loss, and 2: estimating the costs for the repeat examinations resulting from one screening round, also divided into direct costs, travel costs and productivity loss. Costs are presented as means with standard deviations (SD). Weighted means based on the number of women attending screening or repeat examinations in each municipality are used to get per woman cost estimates.

The number of attendees per municipality was estimated by multiplying the number of 50-69 year-olds and the proportion of women attending the screening program in each county (6), as data at the municipality level was not available. The total costs were estimated by multiplying the number of attendees and the unit cost of service and adding the operating costs of the buses. The number of repeat examinations per municipality was estimated by multiplying the number of attendees and the probability of a repeat examination, which is 3.5% (10). The travel distance and travel time is higher for repeat examinations than for screening because all such examinations take place at hospitals with breast cancer diagnostic equipment. In addition, we present a simple estimate for the total costs of false positives by using the estimated cost of a repeat examination and the proportion of false positive screening mammographies. As indicated in (10), only 15.9% of the repeat examinations are true positive (*i.e.* a cancer is detected).

3 Results

Costs of screening

The total direct and indirect costs of one screening round in Norway were estimated to be NOK521 million. The average costs per woman attending mammography in Norway were NOK1,262 (Table 1).

NOK336 million (69%) of the total cost were direct health care costs. The health care cost per woman attending screening was NOK812.

Indirect costs accumulated to 36% of the total cost (Table 1), of which NOK78 million (15%) were travel costs, while NOK107 million (21%) were productivity costs, corresponding to respectively NOK190 and NOK260 per woman attending screening.

Table 2: Costs of the Norwegian Mammography Program in 2012. Norwegian Kroner (NOK) (€1.00~NOK7.50)

Cost area	**Average cost per woman attending screening (SD*)** **N=412,850**	**Average cost per municipality (SD*)** **N=430**	**Total costs**	**Percent of total**
Cost of screening mammography	812 (6)	780,000 (1,889,000)	336 mil.	64%
Travel costs	190 (184)	183,000 (236,000)	78 mil.	15%
Productivity loss	260 (196)	249,000 (441,000)	107 mil.	21%
Total costs	1,262 (353)	1,212,000 (2,490,000)	521 mil.	100.0%

*SD = standard deviation

Tables 3 and 4 show the municipalities with the respectively highest and lowest total mammography costs per woman attending screening. The tables illustrate the vast differences in travel distance and travel time across municipalities in Norway.

Table 3: The five municipalities with highest mammography cost per woman attending screening.

Municipality (county)	**Cost per woman (NOK)**
1) Rødøy (Nordland)	3411
2) Lesja (Oppland)	3148
3) Dovre (Oppland)	3146
4) Lierne (Nord-Trøndelag)	3123
5) Skjåk (Oppland)	3114

Table 4: The five municipalities with lowest mammography cost per woman attending screening.

Municipality (county)	**Cost per woman (NOK)**
1) Nøtterøy (Vestfold)	948
2) Rælingen (Akershus)	949
3) Haugesund (Rogaland)	953
4) Skien (Telemark)	993
5) Asker (Akershus)	999

Cost of repeat examinations

The repeat examinations involve more procedures, and thus the unit costs for repeat examinations are higher than for screening mammography. The total cost of the repeat examination for one screening round was estimated to NOK52.8 million, representing an average cost of NOK3,655 per woman attending a repeat examination (Table 4). The direct health care costs for a repeat examination represented 79% of the total repeat examination cost, *i.e.* NOK41.5 million.

The travel costs represented NOK4.9 million or 9% to the total repeat examination costs. The average cost per woman of travelling was NOK342. The productivity losses associated with the repeat examinations were NOK6.4 million, or 12% of the repeat examination costs. The average productivity loss per woman was NOK444.

Table 5: Costs of repeat examinations in The Norwegian Mammography Program in 2012. Norwegian Kroner (NOK) (€1.00~NOK7.50).

Cost area	Average cost per woman attending recall examinations (SD*) N=14,450	Average cost per municipality (SD) N=430	Total costs	Percent of total
Health care costs	2,869 (0)	96,000 (232,000)	41.5 mil	79%
Travel cost	342 (400)	12,000 (14,000)	4.9 mil	9%
Productivity loss	444 (378)	15,000 (22,000)	6.4 mil	12%
Total cost	3,655 (761)	123,000 (258,000)	52.8 mil	100.0%

*SD = standard deviation

As only 15.9% of the repeat examinations can be assumed to be cancer cases (10), the total direct and indirect costs of the false positives were NOK44.4 million. The average cost per false positive case can be estimated from Table 4 directly, as NOK3,655.

4 Discussion

The results of this study indicate travel costs and productivity loss constitute a large proportion of the total costs. Indirect costs represent 36% of the total costs of breast cancer screening. For repeat examinations, travel costs and productivity loss contribute somewhat less, 21% of the total, due to higher direct costs of the repeat examinations. However, approximately 84% of the costs of repeat examinations may be attributable to false positive screening results. At the municipality level, both travel costs and productivity losses contribute to a large difference in the total costs per woman participating in the mammography program. The most costly municipalities have more than three times higher costs per woman than the least costly ones.

This report presents a fairly simple analysis based on data that are aggregated per municipality. Individual level data would have given more precise estimates of both travel costs and productivity losses, using the salary of each individual. Overall, though, the variation in the indirect costs should be fairly well described, as the travel distance and time on average is correct. The costs of diagnostic procedures are fixed, and hence do not contribute with any variation in the analysis. Wang (7) used a

more direct approach when estimating the unit costs, measuring the time used per screening and cost of equipment at the Oslo Breast Diagnostic Centre. That approach results in better estimates for the centre in question, but may be less representative for the whole country. For repeat examinations, we did not include multiple visits to the physician, surgical conferences, telephone calls between health personnel, etc. In a Swedish study in which such costs were included (12) the direct costs was estimated at SEK6,000-7,000 (SEK1.00 ≈ NOK1.00)per false positive case in the first and second screening round in Stockholm County, using 1993 price levels. The fee schedule for diagnostic procedures has different procedures in each of reimbursement categories, and this may bias the estimated costs for our procedures. Also, the cost weights which the fee schedule is based on have not been updated recently. It should be noted that we did not use reimbursement rates of the fee schedule when estimating the unit cost of screening mammography and biopsy because these are not included in the fee schedule. . We estimate the unit costs of screening mammography to be NOK745. In June 2012, private hospitals offer screening mammography from NOK650 to NOK900 (web sites of Unilabs (13), Curato (14) and Kristiansund X-Ray Institute (15), prices from June 2012) have prices. Hence, the estimate used in this study is within the range of the prices of private providers. We estimate the cost of ultrasound and biopsy to be NOK695 and NOK1430. Curato offers combined mammography and ultrasound of NOK1600 and charges an additional NOK600 if biopsies are needed, so our estimate of NOK2,860 for all repeat examinations is higher. As the repeat examinations include more than one procedure, a reduction in the unit prices for repeat examinations might be relevant (several procedures undertaken during one encounter may be less costly than the sum of the unit costs of the individual procedures in the examination).

The main aim in Wang (7) was to present a cost-effectiveness analysis of screening, based on results from the first four counties implementing the screening program in Norway. In addition, aggregate estimated costs of the screening program for the period 1996-2020 were presented, based on the predicted population aged 50-69 years. The difference in the approaches makes it difficult to compare the results any further. Comparisons to studies conducted in other countries are difficult due to national differences in cost levels, salaries and travel distances. An estimate of the total costs of breast cancer screening in the US (16), is estimated to be in the region of $3-$5 billion. The percentage of women screened, cost per mammogram, cancer to biopsy ratio, repeat rate and cost of repeat are found to be the major cost drivers. Here, travel costs and productivity loss is not considered. In fact, there have been few studies looking at the impact of travel costs. A significant proportion are from Australia (see e.g.17 and 18), also a country with vast travel distances. Another study conducted in the US (19) found that increased travel time to screening or diagnosis facilities was not associated with late stage at diagnosis.

Used in other studies (20) the government reimbursement rate for private car may result in under- as well as overestimation of travel costs. The method will overestimate the costs for long-distance

travelling, and we therefore applied a maximum travel cost of NOK1,500. This estimate mainly affects the travel costs for repeat examinations, as the women have to travel further. The salary level of the women should preferably be specific for the individual municipality, but such information is not readily available.

The effectiveness of the screening program has been debated in Norway and elsewhere. Some researchers claim that there is little or no evidence of improved survival from screening mammography, and that the negative consequences of the false positive mammograms outweigh any small gain in survival (21, 22 and 23). Other researchers claim a significant improvement in survival since the introduction of breast cancer screening, and observe that the false positive rates declines with increasing rounds of screening (24, 25 and 26). This report does not intend to add any additional insight into whether breast cancer screening is effective or cost-effective, as we only focus on the costs of the diagnostic procedures. A cost-effectiveness analysis would need to include treatment costs and estimate survival with and without screening.

In conclusion we have, using easily available although simple data, estimate of the overall costs of breast cancer screening in Norway and consider some of the most important factors contributing to the overall costs.

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