SSM -Population Health 2 (2016) 502–511

Contents lists available at ScienceDirect

SSM -Population Health

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

Article

The impacts of public mammography screening on the relationship between socioeconomic status and cancer stage

Søren T. Klitkou *

Department of Health Management and Health Economics, Institute of Health and Society, University of Oslo, Oslo, Norway

ARTICLE INFO

Article history:
Received 14 March 2016
Received in revised form
28 June 2016
Accepted 13 July 2016

Keywords:
Breast cancer screening
Socioeconomic status
Cancer stage
Education level
Mortality
Public mammography program

ABSTRACT

This study aimed to investigate the relationship between socioeconomic inequality and mortality following the introduction of a public mammography screening program in Norway by exploring the role of change in stage distribution as the mechanism for differences before and after the introduction of the screening program. Attained education level was used as a measure of socioeconomic status in this population-based study. All women aged 50–69 years diagnosed with breast cancer from 1999–2008 and with follow-up data until the end of 2009 were included. The primary endpoint was all-cause mortality. The results of a mediation analysis indicated that the introduction of screening led to stage distribution related reductions of −5.6 (95% confidence interval = −6.7 to −4.5), −2.5 (−3.0 to −2.1), and −1.4 (−1.9 to −0.9) fewer deaths per 1000 women for with a primary school education, secondary school education, and university education, respectively. The study showed that stage distribution explained −5 (−5.9 to −4.1) fewer deaths among women with a university education and −2.4 (−2.9 to −2.0) fewer deaths among women with a secondary school education before program implementation when compared to the group with a primary school education. There were significant reductions in mortality due to stage distribution after program implementation with differences relative to women with primary school of −1.8 (−2.2 to −1.4) and −0.7 (−0.9 to −0.5) fewer deaths in favor of women with university education and secondary school, respectively. The results indicate reduced importance of cancer stage as a reason for differences in mortality by socioeconomic status after the introduction of a public mammography program.

1. Introduction

Despite the interest and controversy regarding the effects of breast cancer screening programs, little is known about subsequent changes related to socioeconomic inequality in mortality. Different research groups (Kalager et al., 2009; Kalager, Zelen, Langmark, & Adami, 2010; Olsen et al., 2012) have investigated the introduction of public screening in Norway; however, their principal aims were to examine the overall impacts of the program on mortality and not to describe change according to interactions with sociodemographic characteristics. Previously published studies on breast cancer and socioeconomic status (SES) have emphasized the relationship between the incidence of cancer, patient mortality, and breast cancer mortality in the general population. However, while the incidence of breast cancer and breast cancer mortality among the general population has been shown to concentrate among women with a higher SES (Braaten, Weiderpass, Kumle, & Lund, 2005; Menvielle et al., 2011; Pudrovska, Carr, McFarland, & Collins, 2013; Robsahm & Tretli, 2005; Strand et al., 2007; Strand, Tverdal, Claussen, & Zahl, 2005), this is not so for breast cancer mortality among patients.

Among patients diagnosed with breast cancer, a poor prognosis is more frequent among women with a lower SES (Byers et al., 2008; Halmin et al., 2008; Kravdal, 2000; Louwman, van de Poll-Franse, Fracheboud, Roukema, & Coebergh, 2007), and this relationship has been shown to relate to differences in cancer stage at diagnosis. Indeed, this is a finding common among a wide array of cancer types (Lyratzopoulos et al., 2012; Woods, Rachet, & Coleman, 2006). In Norway, Kravdal (2000) used pre-screening program data from 1960 to 1991 to document the importance of SES (focusing on attained education) for mortality among cancer patients in general. Furthermore, for breast cancer, Kravdal found that differences in stage distribution had a mediating role, explaining a quarter of differences between education levels. Link, Northridge, Phelan, and Ganz (1998) discussed education as an important marker of SES in the context of breast cancer since a given education leads to particular working careers and associated incomes as well as knowledge and interpersonal power.

* Correspondence address: Postbox 1089 Blindern, NO-0317 Oslo, Norway.
E-mail address: s.t.klitkou@medisin.uio.no

http://dx.doi.org/10.1016/j.ssmph.2016.07.002

In the setting of screening, Yabroff and Gordis (2003) investigated the relationship between breast cancer incidence, survival, and mortality. Yabroff and Gordis stressed that the relative importance of these aspects on the overall association between SES and breast cancer mortality depends on the stage distribution of new cases and the relation of stage distribution with SES as well as the strength of the relationship between SES and survival, all aspects that are susceptible to change under new cancer control programs. These authors further mentioned that other factors, such as adjuvant therapy, may also differ by SES.

In Norwegian counties, organized mammography screening for breast cancer was introduced in phases starting in 1995/1996 and again in 2004. Following the objectives of the Norwegian Breast Cancer Screening Program (NBCSP), screening was introduced to reduce breast cancer mortality through earlier detection (Cancer Registry of Norway, 2000). It should be noted that, in Norway, higher education in public institutions is tuition-free, and universal access to health care is provided within a single-payer public system.

Any mammography screening conducted prior to the introduction of the public program in Norway has been referred to as a setting of opportunistic screening. This describes a situation where the general practitioner or social network promoted, or the women themselves pursued, unsystematic mammography screening at some, often irregular, interval (Hofvind, Vacek, Skelly, Weaver, & Geller, 2008; Lynge et al., 2011). Lynge et al. estimated that some 40% of Norwegian women had a mammography examination prior to introduction of the program. However, with the introduction of organized screening in Norway, every female aged 50–69 was invited to be screened every 2 years resulting in an overall participation rate of 77% (Giordano et al., 2012).

In addition, Link et al. (1998) point to the dynamics of changing inequalities, whereby higher SES groups are more adept to make use of technologies when introduced. Link et al. also discussed the diverging inequalities concerning mammography screening in an opportunistic screening setting. From a technology diffusion point of view, these authors did not comment on whether population-based screening programs could contribute to narrowing the gap in inequalities.

Against this background, the aims of this article are twofold. The first aim is to explore changes in patient mortality rates associated with changes in cancer stage at the introduction of the screening program for each level of education (the within-education group changes). The second aim is to describe changes to the marginal importance of cancer stage for differences by education level before and after the introduction of the screening program (the between-education group differences). Motivated by the discussion of Yabroff and Gordis (2003), a small sensitivity analysis was conducted to determine the plausibility of the results. Thus, education-specific changes in the incidence of breast cancer at the introduction of the program were investigated and the results on mortality were compared after adjusting for the association between education and the risk of dying from causes other than breast cancer.

2. Methods and setting

The data from all Norwegian women aged 50–69 who were diagnosed with breast cancer between 1999 and 2008 were collected for this study. Patients were followed until death (from any cause) or latest date of follow-up as of December 31, 2009 (maximum follow-up of 11 years). The death from any cause approach may be regarded as conservative, since this includes deaths that are possibly unrelated to breast cancer (Cuzick, 2008). During the sample period, 15 out of 19 counties in Norway implemented the program; 4 counties had already implemented the program in 1995/1996. The county specific implementation sequence and the period of data collection can be seen in Table 1. The introduction was not randomized and took place according to administrative considerations. The patients were analyzed according to the county in which they lived in the year when diagnosed with breast cancer. Information from the cancer registry, which is 99.95% complete for female breast cancer patients in Norway (Larsen et al., 2009), was linked with information on SES as well as time and cause of death from Statistics Norway.

Attained education level was used as a proxy for SES and was grouped according to primary school (6–9 years of schooling), secondary school (10–12 years of schooling), and university education. Out of a total of 15,862 women, 149 had missing data concerning education level and 92 had missing data concerning cancer stage and were excluded from the analysis leaving data for 15,622 women for analysis. Cancer stage was categorized according to tumor, node, and metastasis (TNM) staging as follows: ductal carcinoma in situ (DCIS), TNM I, TNM II, TNM III/IV.

The applied regression models sought to separate the differences in mortality due to stage distribution from the differences in mortality due to screening introduction and education. A mediation analysis was appropriate for this setting because it captures the net and gross differences in mortality as a function of exposure variables—screening introduction (via time period) and education—and a mediator (cancer stage). The part of the analysis with time period as the exposure analyzes the within-education group changes, while the part of the analysis with education as the exposure analyzes the between-education group differences (elaborated below). Thus, the analysis considered the joint exposure of screening introduction and education, of which the screening program is the exposure that was intervened upon. Primary interest lies with the indirect effects (those through cancer stage), whereas the direct effects of the exposures then consider differences other than through this mediator.

All analyses were adjusted for age at diagnosis, year of diagnosis, civil status, and parity. Civil status and parity were included because both variables reflect additional resources within the household, and parity has been found to be related to breast cancer incidence, survival, and SES (Lappegård et al., 2005; Menvielle et al., 2011). Year of diagnosis was included to capture

Table 1
Date of the NBCSP[a] introduction in Norwegian counties.

County	Date of introduction	Data collection period relative to introduction
Rogaland	November 20, 1995	3.1–13.1 years after
Oslo	January 8, 1996	3.0–12.9 years after
Hordaland	January 15, 1996	3.0–12.9 years after
Akershus	February 12, 1996	2.9–12.9 years after
Telemark	September 13, 1999	−0.8 to 9.3 years after
(1) Aust-Agder and (2) Vest-Agder	November 1, 1999	−0.8 to 9.1 years after
(1) Troms and (2) Finnmark	May 22, 2000	−1.3 to 8.5 years after
Østfold	April 17, 2001	−2.3 to 7.7 years after
Nordland	May 17, 2001	−2.4 to 7.6 years after
Buskerud	September 10, 2001	−2.7 to 7.3 years after
(1) North and (2) South Trøndelag	September 17, 2001	−2.7 to 7.3 years after
Oppland	January 15, 2002	−3.0 to 6.9 years after
Møre og Romsdal	April 14, 2002	−3.3 to 7.6 years after
Sogn og Fjordane	February 13, 2003	−4.1 to 5.9 years after
Hedmark	August 25, 2003	−4.6 to 5.3 years after
Vestfold	February 2, 2004	−5.1 to 4.9 years after

[a] NBCSP: Norwegian Breast Cancer Screening Program.