Preventive Medicine 73 (2015) 125–129

Contents lists available at ScienceDirect

Preventive Medicine

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

Social inequalities and smoking-associated breast cancer — Results from a prospective cohort study

Eivind Bjerkaas [a], Ranjan Parajuli [a], Anders Engeland [b,c], Gertraud Maskarinec [d], Elisabete Weiderpass [a,e,f,g], Inger Torhild Gram [a,*]

[a] Department of Community Medicine, Faculty of Health Sciences, UiT The Arctic University of Norway, N-9037 Tromsø, Norway
[b] Division of Epidemiology, Department of Pharmacoepidemiology, Norwegian Institute of Public Health, Oslo, Norway
[c] Department of Global Public Health and Primary Care, University of Bergen, Bergen, Norway
[d] University of Hawaii Cancer Center, Honolulu, HI, USA
[e] Department of Medical Epidemiology and Biostatistics, Karolinska Institutet, Stockholm, Sweden
[f] Department of Genetic Epidemiology, Folkhälsan Research Center, Samfundet Folkhälsan, Helsinki, Finland
[g] Department of Research, Cancer Registry of Norway, Oslo, Norway

ARTICLE INFO

Available online 22 January 2015

Keywords:
Breast cancer
Incidence
Education
Smoking
CONOR
Norway

ABSTRACT

Objective. The association between smoking and breast cancer has been found in most recent, large cohort studies. We wanted to investigate how smoking-associated breast cancer varies by level of education, a well-established measure of socioeconomic status.

Methods. We included 302,865 women with 7490 breast cancer cases. Participants were assigned to low, moderate or high level of education and analyzed by smoking status (ever/never), and stratified by birth cohorts (≤1950>). We used Cox proportional hazard to estimate hazard ratios (HRs) and confidence intervals (CIs), adjusting for age, number of children, age at first childbirth, BMI, age at enrollment and physical activity.

Results. Women born ≤1950 with low and moderate levels of education had a 40% increase in smoking-associated breast cancer risk (HR = 1.40, 95% CI 1.25–1.57 and HR = 1.14, 95% CI 1.05–1.24, respectively). Women in the same age group with high level of education did not have an increase in risk. No increased breast cancer risk was found among women born after 1950 for any level of education, when analyzed by smoking status. Longer duration of smoking before first childbirth was consistently associated with increasing risk of breast cancer in all three categories of education (all p for trends < 0.01).

Conclusion. Smoking for several years before first childbirth increases the risk of breast cancer, regardless of educational level.

Introduction

Socioeconomic differences in risk factors have been reported for many diseases, including breast cancer (Internatinal Agency for Resarch on Cancer, 1997; Mackenbach et al., 2008; Menvielle et al., 2009). Socioeconomic status (SES), often measured as educational achievement (Carter et al., 1989; Braaten et al., 2004; Pukkala et al., 2009), acts as an indicator for etiologically relevant risk factors (Braaten et al., 2004), and most studies find more breast cancer in women with high SES (Internatinal Agency for Resarch on Cancer, 1997; Dano et al., 2003; Braaten et al., 2005). The association between smoking and breast cancer is still under debate (Johnson et al., 2011; IARC. International Agency for Research on Cancer, 2012; U.S.Department of Health and Human Services, 2014). However, most recent, well conducted cohort studies of this relationship are relatively consistent with a 5–32% higher risk for current, and a 5–18% higher risk for former smokers, compared with never smokers (Reynolds et al., 2004; Nyante et al., 2014; Gram et al., 2005; Olson et al., 2005; Cui et al., 2006; Ha et al., 2007; Luo et al., 2011; Xue et al., 2011; DeRoo et al., 2011; Bjerkaas et al., 2013; Gaudet et al., 2013; Rosenberg et al., 2013; Dossus et al., 2014).

After the introduction of tobacco products more than 100 years ago (Graham, 1996), smoking was more common in groups with high SES (Norges offentlige utredninger, 2000). This situation changed gradually during the 1960s when smoking became more widespread in groups with low SES. Today we find a higher smoking prevalence in women with low SES; they are using more harmful smoking products, have an earlier age at smoking initiation, and have a lesser degree of smoking cessation, than women with high SES (Norwegian Institute of Public Health, 2014). As a consequence, smoking contributes to socioeconomic inequalities in health (Kulik et al., 2014; Graham, 2009).

* Corresponding author.

http://dx.doi.org/10.1016/j.ypmed.2015.01.004

As more evidence points towards a positive association between smoking and breast cancer, it is interesting to examine how this association may affect socioeconomic inequalities. In this paper we present results from a large Norwegian cohort with a high number of smokers, and with complete information on educational achievement from official statistics. The aim was to investigate how smoking-associated breast cancer varies by educational achievement, a well-established measure of SES (Carter et al., 1989; Braaten et al., 2004; Pukkala et al., 2009).

Methods

Study population

The study population has been previously described (Bjerkaas et al., 2013; Naess et al., 2008; Bjerkaas et al., 2014; Bjartveit et al., 1979), and comprises three national Norwegian health studies conducted in between 1974 and 2003 by the Norwegian National Health Screening Service. Overall, 330,342 women were eligible and 302,865 remained in the analytical cohort after exclusions due to emigrations or death prior to study enrollment (n = 3933), prevalent cancer (n = 7138), or due to missing information on covariates included in the analyses (n = 16,406). Selection of participants was based on the year of birth and residence (municipality or county). The response rate in the three studies varied from 56% to 88% (Stocks et al., 2010). The design and protocol of the three studies were similar, though some modifications regarding smoking, level of physical activity and other lifestyle factors were made in the questionnaires at different time periods. The present study was approved by the Regional Committee for Medical Research Ethics South-East, Norway.

Exposure information

All baseline questionnaires included a detailed assessment of smoking habits, though the questions related to smoking varied across studies. Current and former smokers were considered ever smokers, whereas all other participants were classified as never smokers. For parous women, the variable "smoking duration before first childbirth" was calculated in years as age at smoking initiation or duration of smoking in years, subtracted from age at first childbirth. To control for birth cohort effects (Korn et al., 1997), we displayed the results by birth cohorts (≤1950 and >1950). Based on information from the questionnaires, physical activity was categorized into three groups: low physical activity (reading, watching television, and sedentary activity), moderate physical activity (walking, bicycling, or similar activities ≥4 h per week), and heavy physical activity (light sports or heavy gardening ≥4 h per week, heavy exercise or daily competitive sports). The most recent information regarding duration of education obtained from Statistics Norway was used to assign participants to one of the three categories according to the duration of education: low (<10 years), moderate (10–12 years), and high (>12 years). Fifty years of age was used as a proxy measure of menopausal status, considering women diagnosed with breast cancer before age 50 as premenopausal breast cancer, and diagnosed after age 50 as postmenopausal breast cancer. Information on alcohol consumption was either not collected or missing in 62% of the women in the analytical cohort and was not used in our main analysis. Participants were followed through record linkages with the virtually complete official registries (Larsen et al., 2009) using the unique 11-digit personal identification number to identify all invasive breast cancer cases, deaths and emigrations. The start of follow-up was set to January 1 the year following completion of the baseline questionnaire. The Seventh Revision of the International Classification of Diseases (ICD-7 code 170) was used to identify breast cancer cases in the Cancer Registry.

Statistical analysis

We used Cox proportional hazard models (with age as the underlying time scale) to estimate the multivariate-adjusted hazard ratios (HRs) for breast cancer with 95% confidence intervals (CIs). The start of the follow-up was defined as age at enrollment, and exit time as age at breast cancer diagnosis, the date of any other incident cancer diagnosis (except basal cell carcinoma), emigration, deaths or the end of follow-up (31 December 2007), whichever occurred first. The covariates included in the final models were selected a priori based on previously performed analysis in the assessment of breast cancer risk by smoking status (Braaten et al., 2004; Key et al., 2001; IARC International Agency for Resrach on Cancer, 2014), and were age at enrollment (continuous variable), number of children (0, 1–2, 3–4, ≥5), age at first childbirth (<20, 20–24, 25–29, ≥30 years), BMI (<25, 25–29, ≥30 kg/m^2) and level of physical activity (sedentary, moderate, heavy). The reference groups were never smokers in each level of education category (low, moderate, high). We also stratified the models according to selected covariates and performed tests for linear trends across levels of exposure. The Wald's test was used for testing interaction. The results were considered significant if the p value was < 0.05. All p values are two sided. The analyses were performed in STATA version 12.0 (StataCorp, College Station, TX, USA) and in SAS version 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

We confirmed 7490 cases of breast cancer during 4.1 million person years and 14 years of median follow-up. For women born >1950, 78% of those with a lower and 44% with a higher education were smokers. For women born ≤1950 the corresponding figures were 60% and 42%. Age at first childbirth for ever smokers was 21 years for women with low education and 27 years for women with high education when born >1950 (Table 1).

Table 2 shows that compared with women with low level of education, the breast cancer risk increases for women with increasing years of education, overall and stratified by birth cohort (all p for trends <0.01). For women born ≤1950, those with a higher education had a 62% increased breast cancer risk (HR = 1.62, 95% CI 1.48–1.76) as compared with those with a low level of education.

Table 3 shows the risk of breast cancer stratified by level of education among ever compared to never smokers according to birth cohort and menopausal status at diagnosis, for different measures of smoking exposures at enrollment, with never smokers as reference. Women with a high level of education did not have a significantly increased risk in any of the two birth cohorts when ever smokers were compared with never smokers. For women born ≤1950, ever smokers had a significantly increased breast cancer risk of 40% (HR = 1.40, 95% CI 1.25–1.57) among those with lower and of 14% (HR = 1.14, 95% CI 1.05–1.24) among those with moderate education compared with never smokers. The test for interaction between low and high levels of education showed a significant difference in the oldest birth cohort (p Wald < 0.01). The analysis for menopausal status at diagnosis and birth cohorts displayed a significant difference between the birth cohorts for postmenopausal breast cancer and low (p Wald = 0.03) but not for high level (p Wald = 0.05) of education.

For women with low education, a significant test for trend was revealed for all five (age at smoking initiation, smoking duration, number of cigarettes smoked per day, number of pack years and duration of smoking in relationship to first childbirth) measures of smoking exposure displayed in the table (all p values < 0.03).

Compared with parous never smokers, women who had smoked seven or more years before their first childbirth had a significantly increased risk of breast cancer for all three [low (HR = 1.70, 95% CI 1.40–2.08); moderate (HR = 1.38, 95% CI 1.24–1.55) and high (HR = 1.37, 95% CI 1.17–1.60)] level of education. Longer duration of smoking before first childbirth was associated with increasing risk of breast cancer in all three categories of education (all p for trends < 0.01).

Discussion

This study presents the first results of a differential risk between smoking-associated breast cancer and education, a measure of socioeconomic status (SES). Our analysis shows that the incidence of breast cancer increases with higher level of education, in accordance with the results of other studies (Braaten et al., 2004; Dano et al., 2003; Braaten et al., 2005; Hussain et al., 2008). In contrast, the incidence of smoking-associated breast cancer is not increased in women with high level of education when the analyses are done by smoking status, with never smokers as reference. Also, we find increasing risk with