Environmental Pollution 214 (2016) 394–399

Contents lists available at ScienceDirect

Environmental Pollution

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

Short communication

Breast and prostate cancer mortality and industrial pollution☆

Javier García-Pérez [a, b, *], Natalia Pérez-Abad [c], Virginia Lope [a, b], Adela Castelló [a, b], Marina Pollán [a, b], Mario González-Sánchez [a, b], José Luis Valencia [c], Gonzalo López-Abente [a, b], Pablo Fernández-Navarro [a, b]

[a] Cancer and Environmental Epidemiology Unit, National Center for Epidemiology, Carlos III Institute of Health, Avda. Monforte de Lemos, 5, 28029 Madrid, Spain
[b] Consortium for Biomedical Research in Epidemiology and Public Health (CIBER Epidemiología y Salud Pública – CIBERESP), Spain
[c] Faculty of Statistical Studies, Complutense University of Madrid, Madrid, Spain

ARTICLE INFO

Article history:
Received 15 February 2016
Received in revised form
7 April 2016
Accepted 7 April 2016
Available online 22 April 2016

Keywords:
Breast cancer
Prostate cancer
Industrial pollution
BYM model
INLA
PRTR register

ABSTRACT

We investigated whether there might be an excess of breast and prostate cancer mortality among the population residing near Spanish industries, according to different categories of industrial groups. An ecologic study was designed to examine breast and prostate cancer mortality at a municipal level (period 1997–2006). Population exposure to pollution was estimated by means of distance from town of residence to industrial facilities. Using Besag-York-Mollié regression models with Integrated Nested Laplace approximations for Bayesian inference, we assessed the relative risk of dying from these tumors in 2-, 3-, 4-, and 5-km zones around installations, and analyzed the effect of category of industrial group. For all sectors combined, no excess risk was detected. However, excess risk of breast cancer mortality (relative risk, 95% credible interval) was detected near mines (1.10, 1.00–1.21 at 4 km), ceramic industries (1.05, 1.00–1.09 at 5 km), and ship building (1.12, 1.00–1.26 at 5 km), and excess risk of prostate cancer was detected near aquaculture for all distances analyzed (from 2.42, 1.53–3.63 at 2 km to 1.63, 1.07–2.36 at 5 km). Our findings do not support that residing in the vicinity of pollutant industries as a whole (all industrial sectors combined) is a risk factor for breast and prostate cancer mortality. However, isolated statistical associations found in our study with respect to specific industrial groups warrant further investigation.

1. Introduction

In 2012, breast cancer was the leading tumor, in terms of new cases and deaths, in women worldwide, whereas prostate cancer ranked second in incidence and fifth as cause of cancer death among men worldwide (Torre et al., 2015). In Spain, there were 6264 deaths due to breast cancer in 2012 (accounting for 15.4% of all female cancer-related deaths) and 6038 prostate cancer deaths in the same year (which accounts for 9.1% of all cancer-related deaths in men) (Carlos III Institute of Health (2016)).

Both tumors are "hormone-dependent cancers", being influenced by steroid hormones that regulate the growth and development of both the mammary and prostate glands (Mokarram et al., 2016; Omoto and Iwase, 2015). They share similar characteristics, such as genetic abnormalities that could contribute to the acquisition of the malignant phenotype by both mammary and prostatic epithelial cells (Wu et al., 2015), and are both influenced by several lifestyle and environmental factors (Lopez-Abente et al., 2014b; Lopez-Otin and Diamandis, 1998; Risbridger et al., 2010).

With regard to industrial pollution, residential proximity to industries that release pollutants to air and water is a source of exposure to a high number of toxic substances, inasmuch as many types of industries release known or suspected carcinogens – such as dioxins, metals, and polycyclic aromatic hydrocarbons (PAHs), which have been related to breast and prostate cancer risk (Mitra

Abbreviations: PAHs, Polycyclic aromatic hydrocarbons; EDCs, Endocrine disrupting chemicals; NSI, National Statistics Institute; ICD, International Classification of Diseases; IPPC, Integrated Pollution Prevention and Control; E-PRTR, European Pollutant Release and Transfer Register; RRs, Relative risks; 95%CrIs, 95% credible intervals; BYM, Besag, York and Mollié; INLAs, Integrated nested Laplace approximations; POPs, Persistent organic pollutants.

☆ This paper has been recommended for acceptance by David Carpenter.

* Corresponding author. Área de Epidemiología Ambiental y Cáncer, Centro Nacional de Epidemiología, Instituto de Salud Carlos III, Avda. Monforte de Lemos, 5, 28029 Madrid, Spain.

E-mail addresses: jgarcia@isciii.es (J. García-Pérez), natalia_perezabad@hotmail.com (N. Pérez-Abad), vicarvajal@isciii.es (V. Lope), acastello@isciii.es (A. Castelló), mpollan@isciii.es (M. Pollán), mariogonzalez@isciii.es (M. González-Sánchez), joseval@estad.ucm.es (J.L. Valencia), glabente@isciii.es (G. López-Abente), pfernandezn@isciii.es (P. Fernández-Navarro).

http://dx.doi.org/10.1016/j.envpol.2016.04.027
0269-7491/

and Faruque, 2004; Rybicki et al., 2006) –, as well as endocrine disrupting chemicals (EDCs), substances that alter functions of the endocrine system and are related with the increase in incidence of these tumors (Rachon, 2015; Sweeney et al., 2015). Also, industrial installations generate large amounts of toxic waste, such as metalworking fluids and mineral oils, related to prostate cancer risk (Agalliu et al., 2005; Rybicki et al., 2006). Accordingly, it would seem necessary to assess the relationship between industries and the frequency of breast and prostate cancer in their environs.

The aim of this study was to assess possible excess mortality due to breast and prostate cancer among the Spanish population residing in the environs of industrial installations.

2. Materials and methods

We designed an ecologic study to evaluate the association between breast and prostate cancer mortality and proximity to industrial installations at a municipal level (8098 Spanish towns), over the period 1997–2006.

2.1. Mortality data

Observed municipal mortality data were drawn from the records of the National Statistics Institute (NSI) for the study period, and corresponded to deaths coded as: malignant neoplasm of female breast – codes 174 (International Classification of Diseases-9th/ICD-9) and C50 (ICD-10); and malignant neoplasm of prostate – codes 185 (ICD-9) and C61 (ICD-10). Expected cases were calculated by taking the specific rates for Spain as a whole, broken down by age group (18 groups) and five-year period (1997–2001, 2002–2006), and multiplying these by the person-years for each town, broken down by the same strata. Person-years for each quinquennium were calculated by multiplying the respective populations by 5 (with data corresponding to 1999 and 2004 being taken as the estimator of the population at the midpoint of the study period).

2.2. Industrial pollution exposure data

Population exposure to industrial pollution was estimated by taking the distance from the centroid of town of residence to the industrial facility. We used the industrial database – industries governed by the Integrated Pollution Prevention and Control (IPPC) Directive and facilities pertaining to industrial activities not subject to IPPC but included in the European Pollutant Release and Transfer Register (E-PRTR) – provided by the Spanish Ministry for Agriculture, Food & Environment in 2009. Bearing in mind the minimum induction period for solid tumors, generally 10 years (UNSCEAR, 2006), we selected the 1970 installations which released emissions into air, water, land, or generated toxic waste in 2009, and came into operation prior to 1993 (10 years before the mid-year of the study period). The year of commencement of the respective industrial activities was provided by the industries themselves and, owing to the presence of errors in the initial location of industries, their geographic coordinates were previously validated (Garcia-Perez et al., 2008, 2013).

Finally, each of the installations was classified into one of the 27 categories of industrial groups created by us, on the basis of the similarity of their pollutant emission patterns.

2.3. Statistical analysis

Two types of analysis were performed to assess possible excess breast and prostate cancer mortality in towns lying near ("near") versus those lying far ("far") from pollutant industries, known as a "near vs. far" analysis. In all cases, several distances of 2, 3, 4 and 5 km were taken as the area of proximity ("exposure") to industrial installations:

1) in a first phase, we conducted a "near vs. far" analysis to estimate the relative risks (RRs) of towns situated at each one of the above-defined distances from industries as a whole (all sectors). The variable, "exposure", was coded as: a) exposed or proximity area ("near"): towns at ≤2, 3, 4 and 5 km from any facility; and, b) unexposed area ("far"): towns having no (IPPC+E-PRTR)-registered industry within each one of the above-defined distances of their municipal centroid (reference group); and,
2) lastly, we analyzed the risk according to the different categories of industrial groups. To this end, we created a variable of "exposure" for each industrial group in which the exposed area was stratified into the following levels: a) exposed or proximity area ("near"): towns at ≤2, 3, 4 and 5 km from any installation belonging to the industrial group in question; b) intermediate area: towns lying at the above-defined distances from any industrial installation other than the group analyzed; and, c) unexposed area ("far"): towns having no (IPPC+E-PRTR)-registered industry within each one of the above-defined distances of their municipal centroid (reference group);

For the above analyses, RRs and their 95% credible intervals (95% CrIs) were estimated on the basis that the number of deaths per stratum followed a Poisson distribution, using a Bayesian conditional autoregressive model proposed by Besag, York and Mollié (BYM) (Besag et al., 1991), with explanatory variables:

$$O_i \sim Poisson\ (\mu_i), \text{ with } \mu_i = E_i\lambda_i$$

$$\log(\lambda_i) = \alpha Expos_i + \sum_j \beta_j Soc_{ij} + h_i + b_i \Rightarrow \log\ (\mu_i) = \log(E_i) + \alpha Expos_i + \sum_j \beta_j Soc_{ij} + h_i + b_i$$

$$Soc_{ij} = ps_i + ill_i + far_i + unem_i + pph_i + inc_i$$

$$i = 1, \ldots, 8098\ towns, \quad j = 1, \ldots, 6\ potential\ confounders$$

$$h_i \sim Normal(\theta, \tau_h)$$

$$b_i \sim Car.Normal(\eta_i, \tau_b)$$

$$\tau_h \sim Gamma(1,0.01)$$

$$\tau_b \sim Gamma(1,0.001)$$