Environmental Pollution 222 (2017) 374–382

Contents lists available at ScienceDirect

Environmental Pollution

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

Health conditions in rural areas with high livestock density: Analysis of seven consecutive years☆

Christel E. van Dijk [a], Jan-Paul Zock [a, b, c, d], Christos Baliatsas [a], Lidwien A.M. Smit [e], Floor Borlée [a, e], Peter Spreeuwenberg [a], Dick Heederik [e], C. Joris Yzermans [a, *]

[a] NIVEL, Netherlands Institute for Health Services Research, Otterstraat 118-124, 3513 CR Utrecht, The Netherlands
[b] ISGlobal, Centre for Research in Environmental Epidemiology (CREAL), Dr. Aiguader 88, E-08003 Barcelona, Spain
[c] Universitat Pompeu Fabra (UPF), Plaça de la Mercè 10, 08002 Barcelona, Spain
[d] CIBER Epidemiología y Salud Pública (CIBERESP), Av. Monforte de Lemos, 3-5, Pabellón 11, Planta, 0 28029 Madrid, Spain
[e] Utrecht University, Institute for Risk Assessment Sciences (IRAS), Division Environmental Epidemiology, Yalelaan 2, 2584 CM Utrecht, The Netherlands

ARTICLE INFO

Article history:
Received 26 August 2016
Received in revised form
7 December 2016
Accepted 11 December 2016
Available online 30 December 2016

Keywords:
Livestock
Environmental exposure
Respiratory health
Epidemiology
General practice

ABSTRACT

Previous studies investigating health conditions of individuals living near livestock farms generally assessed short time windows. We aimed to take time-specific differences into account and to compare the prevalence of various health conditions over seven consecutive years. The sample consisted of 156,690 individuals registered in 33 general practices in a (rural) area with a high livestock density and 101,015 patients from 23 practices in other (control) areas in the Netherlands. Prevalence of health conditions were assessed using 2007–2013 electronic health record (EHR) data. Two methods were employed to assess exposure: 1) Comparisons between the study and control areas in relation to health problems, 2) Use of individual estimates of livestock exposure (in the study area) based on Geographic Information System (GIS) data. A higher prevalence of chronic bronchitis/bronchiectasis, lower respiratory tract infections and vertiginous syndrome and lower prevalence of respiratory symptoms and emphysema/COPD was found in the study area compared with the control area. A shorter distance to the nearest farm was associated with a lower prevalence of upper respiratory tract infections, respiratory symptoms, asthma, COPD/emphysema, allergic rhinitis, depression, eczema, vertiginous syndrome, dizziness and gastrointestinal infections. Especially exposure to cattle was associated with less health conditions. Living within 500m of mink farms was associated with increased chronic enteritis/ulcerative colitis. Livestock-related exposures did not seem to be an environmental risk factor for the occurrence of health conditions. Nevertheless, lower respiratory tract infections, chronic bronchitis and vertiginous syndrome were more common in the area with a high livestock density. The association between exposure to minks and chronic enteritis/ulcerative colitis remains to be elucidated.

1. Introduction

The increased risk to develop upper and lower respiratory diseases such as rhinitis, sinusitis and chronic obstructive pulmonary disease (COPD) due to occupational exposure to air pollutants in livestock farms has long been acknowledged (May et al., 2012). Livestock farm air is known to contain increased levels of various compounds that could elicit adverse health effects, such as bacteria, viruses, endotoxins, particular matter (PM) and ammonia (Dungan, 2010). For example, endotoxin concentrations in livestock stables have shown to provoke inflammatory effects in numerous studies (May et al., 2012).

More recently, the potential health risks of living in the neighbourhood of (large) livestock farms has received increasing attention. This is mainly due to health concerns of nearby residents of large, intensive livestock farms, which increasingly characterize animal production. Although information regarding exposure type and levels in the proximity of livestock farms is limited (Dungan, 2010), several studies have investigated health effects in residents living in the neighbourhood of livestock farms, not necessarily intensive livestock farms.

Most of the studies were conducted in North Carolina with one

☆ This paper has been recommended for acceptance by Dr. Chen Da.
* Corresponding author.
E-mail address: j.yzermans@nivel.nl (C.J. Yzermans).

http://dx.doi.org/10.1016/j.envpol.2016.12.023
0269-7491/

of the world's highest concentrations of large swine farms mainly located in low income, African-American communities. Comparisons between regions with and without a high density of swine farms showed increased respiratory symptoms including physician-diagnosed asthma in children, gastrointestinal symptoms, weakness, dizziness, fainting, headaches, irritating symptoms as burning eyes, negative mood and lower quality of life (Schiffman et al., 1995; Thu et al., 1997; Wing and Wolf, 2000; Bullers, 2005; Mirabelli et al., 2006). A panel study in this area showed changes in daily activities (Wing et al., 2008), increased respiratory and irritation symptoms, stress, negative mood and blood pressure with especially reporting of odour and to a lesser degree for H_2S and hardly with PM10 and endotoxin exposure (Horton et al., 2009; Schinasi et al., 2011; Wing et al., 2013). In addition, an indication for decreased forced expiratory volume in one second (FEV_1) with increased $PM_{2,5}$ was found (Schinasi et al., 2011). Two studies in Iowa, one comparing school children with and without exposure to a large swine farm and the other using individual estimates for exposure, showed increased prevalence of asthma (Sigurdarson and Kline, 2006; Pavilonis et al., 2013). Another study in Michigan showed increased Campylobacter jejuni enteritis in counties with a high poultry density (Potter et al., 2002). A study conducted around a large swine farm outside Ottawa, Canada showed no differences in respiratory symptoms, but reduced quality of life and increased prevalence of depression in residents living closer to this farm (Villeneuve et al., 2009). Two ecological studies in agricultural municipalities in Quebec showed more acute gastroenteritis hospitalization in children with increasing poultry density (Febriani et al., 2009), but no association between swine and cattle density and diarrhea in adults (St-Pierre et al., 2009). Two ecological study in Ontario showed increased Shiga toxin-producing Escherichia coli (STEC); associated with among others diarrhea and hemolytic uremic syndrome (HUS) infections in areas with a higher ratio of beef cattle number to human population (Michel et al., 1999; Valcour et al., 2002).

Studies conducted in a rural area in the Netherlands with high density of livestock farms showed decreased prevalence of asthma, allergic rhinitis and COPD with increased exposure to livestock measured as PM10 emission, presence of (specific) farm animals within 500 m radius from home, and distance to nearest farm (Smit et al., 2014; Borlée et al., 2015). An increased prevalence of pneumonia was found in residents living within 1 km from poultry (Smit et al., 2012). Another study in the same area showed increased reporting of anxiousness, sadness and respiratory and gastrointestinal symptoms in residents reporting odour annoyance (Hooiveld et al., 2015). Three studies conducted in a German area with a high density of livestock farms, especially swine and poultry, showed decreased quality of life, increased prevalence of wheezing without a cold, asthma and allergic rhinitis with increased odour annoyance, but no difference in sensitization, bronchial hyperresponsiveness and FEV_1 values (Radon et al., 2004, 2007). In addition, increased wheezing without a cold and decreased FEV_1 values in residents in the proximity of >12 farms within 500m was found and decreased FEV_1 with increased ammonia exposure (Radon et al., 2007; Schulze et al., 2011). In school children, modeled individual endotoxin levels were associated with increased asthma in children with atopic parents (Hoopmann et al., 2006). An ecological study conducted in France showed a higher incidence of HUS in children with increased dairy cattle density and the ratio of calves to children within districts (Haus-Cheymol et al., 2006).

In general, these studies indicate increased respiratory, gastrointestinal, irritation, neurological and stress/psychological symptoms with increased livestock exposure, but some studies show protective effects (Smit et al., 2014; Borlée et al., 2015). Most negative health effects are found with increased odour or odour annoyance, and these effects are to a lesser extent found for more objective measures of livestock exposure. The use of various estimates for livestock exposure complicates a direct comparison of results. To reduce the potential influence of time-specific differences and different livestock exposure estimates, the objective of the present study was to compare prevalence of various health conditions over a period of seven years using different methods to estimate livestock exposure.

2. Materials and methods

2.1. Research design and study population

This was an observational study analysing differences in the prevalence of respiratory, gastrointestinal, neurological, dermatological and psychological symptoms and diseases with livestock exposure between 2007 and 2013. This research was conducted within the framework of the “VGO” project (“Farming and Neighbouring Residents' Health”). Data was obtained from electronic health records (EHRs) of general practices in the Primary Care Database (PCD) of the Netherlands Institute for Health Services Research (NIVEL) (Verheij, 2014) Morbidity is registered following the International Classification of Primary Care (ICPC) (Lamberts and Wood, 1987). All Dutch inhabitants are obligatory listed in a general practice and GPs act as gatekeepers for specialized, secondary health care. Therefore, the EHR kept by GPs provides a complete picture of people's health. For this study, data was used from practices located in a rural area with a high density of livestock farms in the Netherlands (study area - general practices outside the larger cities in the eastern part of the province of Noord-Brabant and the northern part of the province of Limburg) and practices located in other rural areas in the Netherlands with a substantially lower livestock farm density (control area) (van Dijk et al., 2016), particularly in the provinces of Noord-Holland, Zuid-Holland, Utrecht, Gelderland, Zeeland, Overijssel and Groningen. In 2013 for instance, based on the current data, ≥ 1 large intensive livestock farms were located in 59% of the postal code area of the general practices in the study area, compared to 5% in the control area (only information available about large intensive livestock farms). Also smaller livestock farms, especially poultry and swine farms, are more common in the study area. In the selected area(s) there were no other known major landscape features that could affect residents' health. Inclusion criteria for practices were i) availability of morbidity data in the NIVEL PCD in the reporting year and one or two previous years, ii) minimum of 46 weeks of registration and iii) ICPC code registration in at least 70% of the consultations in the reporting year. In addition, for practices with one previous year one of the criteria ii and iii needed to be fulfilled and for practices with two previous years one of the criteria ii and iii needed to be fulfilled twice. As at least one previous year of data was needed to estimate prevalence rates, and as 2006–2013 data were available, we reported for the years 2007 until 2013. Table 1 shows the included practices and patients per year.

2.2. Ethics

The NIVEL PCD complies with the regulations of the Dutch Data Protection Authority and the Dutch law regarding use of health data for epidemiological research purposes (Dutch Civil Law, Article 7:458). Medical information as well as address records were kept separated at all times by using a Trusted Third Party (Stichting Informatie Voorziening Zorg, Houten). The VGO study protocol was approved by the Medical Ethical Committee of the University Medical Centre Utrecht.