International Journal of Hygiene and Environmental Health xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

International Journal of Hygiene and Environmental Health

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

Respiratory hospital admission risk near large composting facilities

Philippa Douglas[a], Ioannis Bakolis[a,b,c], Daniela Fecht[a], Clare Pearson[a], Maria Leal Sanchez[a], Rob Kinnersley[d], Kees de Hoogh[a,e,f], Anna L. Hansell[a,g,*]

[a] Small Area Health Statistics Unit, MRC-PHE Centre for Environment and Health, Imperial College London, London, United Kingdom
[b] Department of Biostatistics, King's College London, London, United Kingdom
[c] Department of Health Services and Population Research, King's College London, London, United Kingdom
[d] Environment Agency, Evidence Directorate, Deanery Road, Bristol, United Kingdom
[e] Swiss Tropical and Public Health Institute, Basel, Switzerland
[f] University of Basel, Basel, Switzerland
[g] Public Health and Primary Care, Imperial College Healthcare NHS Trust, United Kingdom

ARTICLE INFO

Article history:
Received 5 November 2015
Received in revised form 12 March 2016
Accepted 17 March 2016

Keywords:
Bioaerosol
Compost
Respiratory health
Hospitalization
Asthma
Chronic obstructive pulmonary disease (COPD)

ABSTRACT

Background: Large-scale composting can release bioaerosols in elevated quantities, but there are few studies of health effects on nearby communities.
Methods: A cross-sectional ecological small area design was used to examine risk of respiratory hospital admissions within 2500 m of all 148 English large-scale composting facilities in 2008–10. Statistical analyses used a random intercept Poisson regression model at Census Output Area (COA) level (mean population 310). Models were adjusted for age, sex, deprivation and tobacco sales.
Results: Analysing 34,963 respiratory hospital admissions in 4656 COAs within 250–2500 m of a site, there were no significant trends using pre-defined distance bands of >250–750 m, >750–1500 m and >1500–2500m. Using a continuous measure of distance, there was a small non-statistically significant ($p = 0.054$) association with total respiratory admissions corresponding to a 1.5% (95% CI: 0.0–2.9%) decrease in risk if moving from 251 m to 501 m. There were no significant associations for subgroups of respiratory infections, asthma or chronic obstructive pulmonary disease.
Conclusion: This national study does not provide evidence for increased risks of respiratory hospital admissions in those living beyond 250 m of an outdoor composting area perimeter. Further work using better measures of exposure and exploring associations with symptoms and disease prevalence, especially in vulnerable groups, is recommended to support regulatory approaches.

1. Introduction

As a result of the 1999 European Union Landfill Directive (1999/31/EC) requiring diversion of waste from landfill, more waste in member states is now being processed at composting facilities, with significant growth in the composting industry (DEFRA, 2009; European Commission, 2012). Composting facilities deal with the biodegradable components of waste and the process relies on the breakdown of the waste by microorganisms (Swan et al., 2003). During the composting process, these microorganisms can become airborne, particularly when the compost is disturbed (Taha et al., 2006), and contribute to the atmospheric loading of bioaerosol. Bioaerosols can consist of bacteria, fungi, pollen and constituents, fragments and by-products of cells (Douwes et al., 2003) that vary in size from 0.02–100 μm (Dowd and Maier, 2000). Bioaerosols with an aerodynamic diameter of less than 10 μm are of particular concern in relation to respiratory health because they can be inhaled; some are small enough to penetrate deep into the lung and to the alveolar sac which might trigger negative health effects (Douwes et al., 2003; Ivens et al., 1999). However, quantitative evidence on both exposure and response to bioaerosols from waste composting is limited (Pearson et al., 2015) and there are few studies looking at health effects of waste composting (Giusti 2009; Pearson et al., 2015; Searl, 2008; Wéry, 2014). Occupational health studies of compost site workers have mainly focussed on respiratory

* Corresponding author at: Small Area Health Statistics Unit (SAHSU), Department of Epidemiology and Biostatistics, School of Public Health, Imperial College London, St. Mary's Campus, Norfolk Place, W2 1PG, United Kingdom.
E-mail addresses: p.douglas@imperial.ac.uk (P. Douglas), ioannis.bakolis@kcl.ac.uk (I. Bakolis), d.fecht@imperial.ac.uk (D. Fecht), clare.pearson@kcl.ac.uk (C. Pearson), lealsanchezmaria@gmail.com (M. Leal Sanchez), rob.kinnersley@environment-agency.gov.uk (R. Kinnersley), c.dehoogh@unibas.ch (K. de Hoogh), a.hansell@imperial.ac.uk (A.L. Hansell).

http://dx.doi.org/10.1016/j.ijheh.2016.03.004
1438-4639/

impacts (Pearson et al., 2015), with some studies showing reduction in lung function (Bünger et al., 2007; Sigsgaard et al., 1994); respiratory symptoms (Bünger et al., 2000; Hambach et al., 2012) and symptoms consistent with allergic rhinoconjunctivitis (Bünger et al., 2007; Hambach et al., 2012; van Kampen et al., 2012); and increased chronic bronchitis (Bünger et al., 2007). Community studies have reported increases in respiratory symptoms and throat and eye irritation near sites (Pearson et al., 2015). No community studies have looked at healthcare usage.

Current UK guidance takes a precautionary approach and states that the contribution from biowaste processing to atmospheric bioaerosol concentration at the nearest 'sensitive receptor', for example a dwelling or workplace, or 250 m from the site, whichever is closer, should not exceed acceptable levels (Environment Agency, 2010). The acceptable levels are currently defined as 300, 500 and 1000 Colony Forming Units per cubic metre (CFU/m^3) above upwind concentrations for gram-negative bacteria, *Aspergillus fumigatus* and total bacteria respectively (Environment Agency, 2010) as measured by the standardised sampling protocol (AfOR, 2009). In Germany, a minimum distance of 300 m or 500 m for enclosed and open-windrow facilities resepectively, is enforced for facilities processing 3000 kg or more, although acceptable limits of bioaerosols are not provided (BUNR, 2002). To the authors' knowledge there are no existing guidelines for community levels of bioaerosols outside the UK, but there are occupational guidelines in Germany, where a regulatory occupational limit of 50,000 CFU/m^3 of mesophilic fungi is set for breathable air in the workplace (BAUA, 2013) and in the Netherlands recommendations of an occupational exposure limit for endotoxin of 90 Endotoxin Units per cubic metre (EU/m^3) (DECOS, 2010).

The aim of this national study was to examine risk of respiratory hospital admissions in areas near all large composting sites in England with an open composting element, with particular reference to areas just outside current Environment Agency permitting guidelines of 250 m from site.

2. Materials and methods

2.1. Site selection

Large scale composting facilities given permits by the Environment Agency (EA) and operating in England between 2008 and 2010 were identified (Fig. 1). A permit is usually required when composting sites store or treat in excess of 60–80 tons of compost at any one time, depending on retention time (Environment Agency, 2014). The EA record when the permit was obtained, the type of facility, the site address and British National Grid coordinates. We assumed that once a permit had been obtained the facility began operating and did not cease to operate during the period of the study. Large scale composting can be performed indoors or outdoors, and approximately 80% of sites in the UK include open windrow composting (i.e. composting is performed outdoors and the biodegradable waste is formed into long piles called windrows). Only sites with an outdoor composting component (open windrow facilities or in-vessel facilities with outdoor maturation or storage areas) were included, as bioaerosol emissions from composting processes performed outdoors are not filtered or controlled.

2.2. Exposure data

Site locations were verified using the addresses and grid references provided by the EA. The perimeter of outdoor composting areas were digitised using Google™ Earth (version 7), imported into a Geographical Information System (ArcGIS version 10.0, ESRI Inc.) and distance bands from the edge of the digitised outdoor composting areas were added. The distance bands used in statistical analyses were 0–250 m, >250–750 m, >750–1500 m and >1500–2500 m from the outdoor composting area perimeters, informed by current published literature (see Table 1 for details). Distance as a continuous measure was also examined.

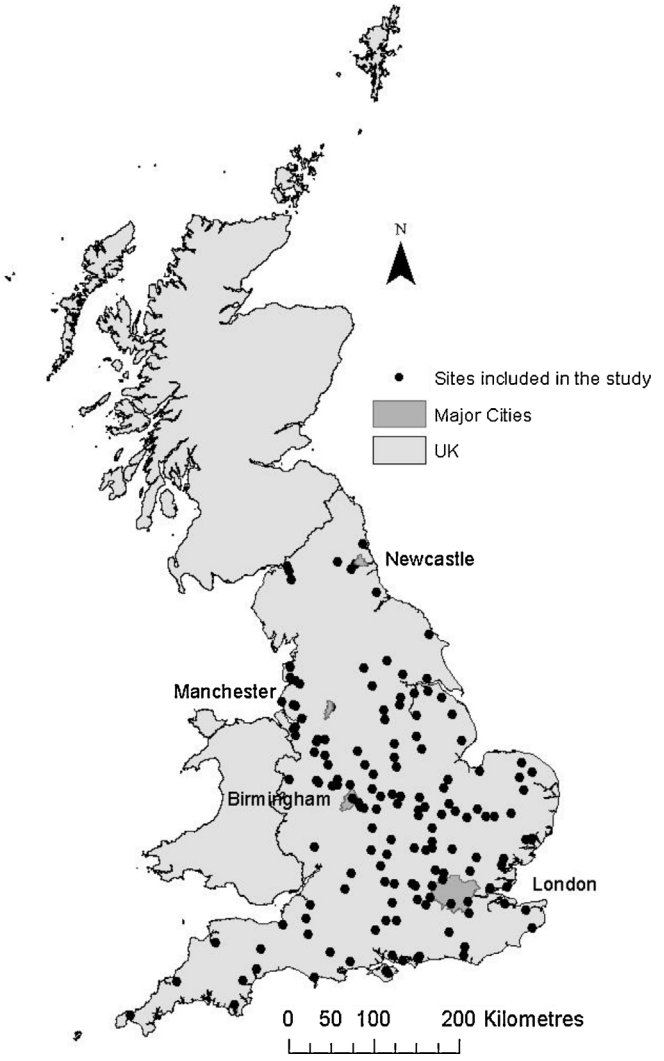

Fig. 1. Locations of large scale composting facilities in England with an outdoor composting component operating in 2008–10.

2.3. Outcome data

Postcoded emergency and non-emergency hospital admissions by age and sex between 2008–10 were obtained from Hospital Episode Statistics (HES) data held by the UK Small Area Health Statistics Unit (SAHSU), provided by the Health and Social Care Information Centre (HSCIC). Admissions with a primary diagnosis for the admission (i.e. first episode of care) of (i) respiratory disease (coded to International Classification of Disease version 10 (ICD10), chapter J), (ii) respiratory infections (ICD10 J00-22), (iii) asthma (ICD10 J45-46), and (iv) chronic obstructive pulmonary disease (COPD) (ICD10 J40- 44) were selected for those with a postcode of residence within 2500 m of a composting site. It was not possible to analyse admissions coded to diseases relating to organic dusts (ICD10 J66-67) due to very small numbers (n = 17 admissions, corresponding to 14 individuals). There were only 30 respiratory- related admissions (relating to 22 individuals) in the 0–250 m distance band so this band was consequently excluded as results would have