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Fetal growth and air pollution - A study on ultrasound and birth measures

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ABSTRACT

Air pollution has been suggested to affect fetal growth, but more data is needed to assess the timing of exposure effects by using ultrasound measures. It is also important to study effects in low exposure areas to assess eventual thresholds of effects.

The MAPSS (Maternal Air Pollution in Southern Sweden) cohort consists of linked registry data for around 48,000 pregnancies from an ultrasound database, birth registry and exposure data based on residential addresses. Measures of air pollution exposure were obtained through dispersion modelling with input data from an emissions database (NO_x) with high resolution (100–500 m grids). Air pollution effects were assessed with linear regressions for the following endpoints; biparietal diameter, femur length, abdominal diameter and estimated fetal weight measured in late pregnancy and birth weight and head circumference measured at birth.

We estimated negative effects for NO_x; in the adjusted analyses the decrease of abdominal diameter and femur length were −0.10 (−0.17, −0.03) and −0.13 (−0.17, −0.01) mm, respectively, per 10 μg/m^3 increment of NO_x. We also estimated an effect of NO_x-exposures on birth weight by reducing birth weight by 9 g per 10 μg/m^3 increment of NO_x.

We estimated small but statistically significant effects of air pollution on late fetal and birth size and reduced fetal growth late in pregnancy in a geographic area with levels below current WHO air quality guidelines.

1. Introduction

Evidence is accumulating that poorer growth during the fetal period is an important risk factor for adverse health later in life with regard to diseases such as coronary heart disease, stroke, type 2 diabetes and hypertension (also referred to as the 'fetal programming' or 'Barker hypothesis') (Barker et al., 2002). Here we assess whether widespread environmental exposures – ambient air pollution - affect fetal growth. From a public health perspective, it is especially important to assess environmental exposures to which a large and growing proportion of the population is exposed, as is the case for air pollution. Epidemiological evidence for the effects of air pollution on birth weight is accumulating (Backes et al., 2013; Slama et al., 2008). Exposure to air pollution, especially to ultra-fine particles (< 1 μm), has been shown to induce oxidative stress and inflammation (Terzano et al., 2010). But we are only beginning to understand how air pollution exerts its effect on pregnant women and their fetuses. When inhaled, particles smaller than 1 μm, corresponding well to the size range of anthropogenic air pollution, can penetrate the alveolar wall and enter the maternal bloodstream such that particles and inflammatory mediators may reach the placenta and the fetus (Valavanidis et al., 2008).

Animal and human studies have shown that inhalation of aerosols can affect mother and offspring health at the microvascular level, possibly through impairment of mitochondrial function (Janssen et al., 2015; Stapleton et al., 2013, 2015).

Most epidemiological studies have investigated the association between air pollution and birth weight. In recent years, the focus of research shifted to addressing exposures during different periods of pregnancy and fetal growth and using ultrasound measures. To date there have been five European (Aguilera et al., 2010; Iniguez et al., 2012, 2015; Slama et al., 2009; van den Hooven et al., 2012), one Australian (Hansen et al., 2008) and one US study (Ritz et al., 2014). All of these studies have, however, been conducted in relatively small study populations (n < 16000). The largest study conducted to date (Hansen et al., 2008) used a spatially crude exposure assessment method (nearest air monitoring station approach). The aim of the study is to investigate associations between nitrogen oxides as markers of traffic related air pollution exposures and a number of fetal growth measures during different time windows in pregnancy. In the present

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study we have the opportunity to further advance our knowledge regarding the influence of air pollution on fetal growth in a large population based cohort from Southern Sweden relying on exposure measures with high spatial resolution. This study will allow us to detect even small size effects in a population exposed to relatively low levels of air pollution in Europe. This is important for regulators who need to assess whether a threshold of effect might exist and what it might be.

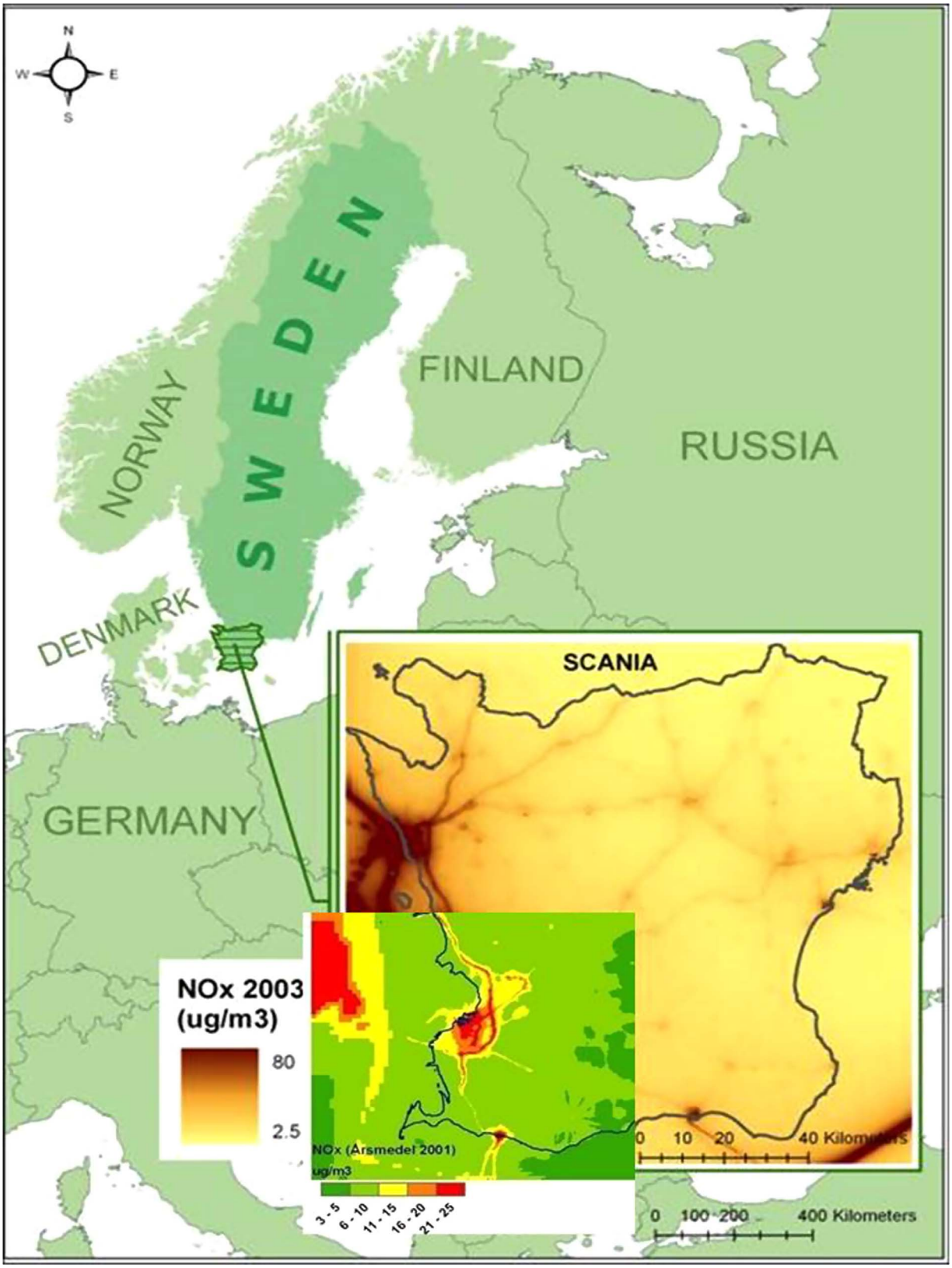

Fig. 1. Map of modelled annual mean concentrations of NO_2 for Scania (year 2001) in (a) the previously published studies and (b) the present study area (parts of Scania only).