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Extreme winter temperature and birth defects: A population-based case-control study

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ABSTRACT

Background/objective: We examined the relationship between extreme winter temperatures and birth defects to determine whether pregnant women might be vulnerable to the weather extremes expected with climate change.

Methods: In this population-based, case-control study, we linked the New York State Congenital Malformations Registry to birth certificates (1992–2006). Cases were defined as live births with birth defects, and controls were selected from a 10% random sample of live births. We assigned meteorological data based on maternal birth residence and summarized universal apparent temperature across gestational weeks 3–8 (embryogenesis). We defined an extreme cold day as a day with mean temperature below the 10th percentile of the regional winter temperature distribution and a cold spell as 3 consecutive extreme cold days. We averaged temperature for each week of the first trimester to identify susceptible periods. We estimated adjusted odds ratios (ORs) and 95% confidence intervals (CIs) with multivariable logistic regression for 30 birth defects groups.

Results: Among 13,044 cases and 59,884 controls with at least 1 week of embryogenesis in winter, coarctation of the aorta was associated with a 1 °C decrease in mean universal apparent temperature (OR 1.06, 95% CI 1.02-1.11), cold spell (OR 1.61, 95% CI 1.11-2.34), and number of extreme cold days. We observed reduced odds of hypoplastic left heart syndrome and dislocated hip for some cold indicators.

Conclusions: Most birth defects were not associated with cold indicators; however, we found positive associations between cold indicators and coarctation of the aorta in the biologically-relevant developmental window which warrants replication.

1. Introduction

Climate change may increase the frequency and severity of weather extremes, including heat waves and cold spells (Intergovernmental Panel on Climate Change, 2007). At present, pregnant women are not considered to be particularly vulnerable to climate change. However, in a review of studies of seasonality and ambient temperature in relation to preterm, low birth weight, and stillbirth, Strand et al. (2011) suggested that the observed peaks in winter, summer, or both seasons might indicate that extremes of temperature are an important determinant of poor birth outcomes. We previously reported on the association between extreme heat in summer and congenital cataracts in New York State (Van Zutphen et al., 2012). In a study of the seasonality of birth defects using the New York State Congenital Malformations Registry, conceptions in winter months were associated with ventricular septal defect and coarctation of the aorta, suggesting that cold ambient temperatures might play a role in the etiology of congenital heart defects (Caton, 2012).

Though peripheral vasoconstriction, a physiologic response to cold (Borkenhagen, 1988), plausibly could alter uteroplacental perfusion and adversely affect the developing fetus, there are few studies on the relationship between maternal exposure to cold ambient temperatures and adverse birth outcomes. Hypertensive disorders of pregnancy were associated with winter delivery in a systematic review of the literature (TePoel et al., 2011). Low birth weight has been associated with low temperatures in the first (Chodick et al., 2007), second (Elter et al., 2004; Murray et al., 2000), and third trimesters (Chodick et al., 2007; Lawlor et al., 2005). Exposure to "too cold" environmental conditions at work was associated with spontaneous abortion in one study (McDonald et al., 1988). An occupational study in New York State showed no relationship between congenital heart defects and time

Abbreviations: OR, odds ratio; CI, confidence interval

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spent in environments with temperatures less than 0 °F (−18 °C) (Judge et al., 2004). In a study of congenital heart defects in Tel-Aviv Israel, a 1-day increase in extreme heat events in the cold season was associated with multiple congenital heart defects and isolated atrial septal defects (Agay-Shay et al., 2013).

To determine whether pregnant women and their infants in New York might be vulnerable to cold weather extremes, we explored the relationship between ambient winter temperatures, extreme cold days, cold spells, and the occurrence of selected birth defects using the population-based, New York State Congenital Malformations Registry.

2. Methods

2.1. Study population and data sources

The source population was all live births to residents of New York State (excluding New York City) from 1992 through 2006. Appropriate institutional review board approvals were granted to access New York State birth certificate data from Vital Records and birth defects data from the Congenital Malformations Registry. The birth certificate contains data on maternal and infant characteristics, such as maternal age, race, ethnicity, education, date of last menses, prenatal care (e.g., timing and number of visits), residential address, and maternal behavioral characteristics (e.g., smoking), infant date of birth, sex, birth weight, and gestational age. The Congenital Malformations Registry is a population-based registry that receives mandated reports on children who were born in New York State and were diagnosed with birth defects, metabolic defects, or chromosomal anomalies up until 2 years of age from hospitals and physicians. The registry routinely matches reports to the New York State birth certificate files and has a 95% match rate. Roohan et al. (2003) assessed the validity of information reported on the New York State birth certificate by checking medical records and found high specificity (91–100%) for most data elements and high sensitivity for infant information such as birth weight (100%) and maternal lifestyle (86–100%). Hospital audits are conducted to capture the unreported Congenital Malformations Registry cases. On site hospital medical record audits documented that the Congenital Malformations Registry reports were >90% correct (Wang et al., 2010), which is comparable to that of Metropolitan Atlanta Congenital Defects Program, an active surveillance system which is regarded as the "gold standard" (Honein and Paulozzi, 1999).

2.2. Study design

We used the case-control study design to determine the association between cold ambient temperature during the critical period of embryogenesis and the risk of birth defects. Cases were defined as New York State (excluding New York City) live births with birth defects delivered in the 1992–2006 study period. A 10% random sample of live births without birth defects selected from the same period and geographic region was used as the control group.

2.3. Outcome assessment

Using ICD-9-CM diagnoses codes from the Congenital Malformations Registry records, birth defect cases were classified into the 45 birth defects categories that meet the reporting standards of the National Birth Defects Prevention Network (2010). Of these, chromosomal anomalies (Trisomies 13, 18, and 21), fetal alcohol syndrome, and case groups with fewer than 50 cases (anencephalus, encephalocele, anophthalmia/microphthalmia, aniridia, tricuspid atresia/stenosis, Ebstein's anomaly, biliary atresia, bladder exstrophy, and amniotic bands) were excluded from analyses.

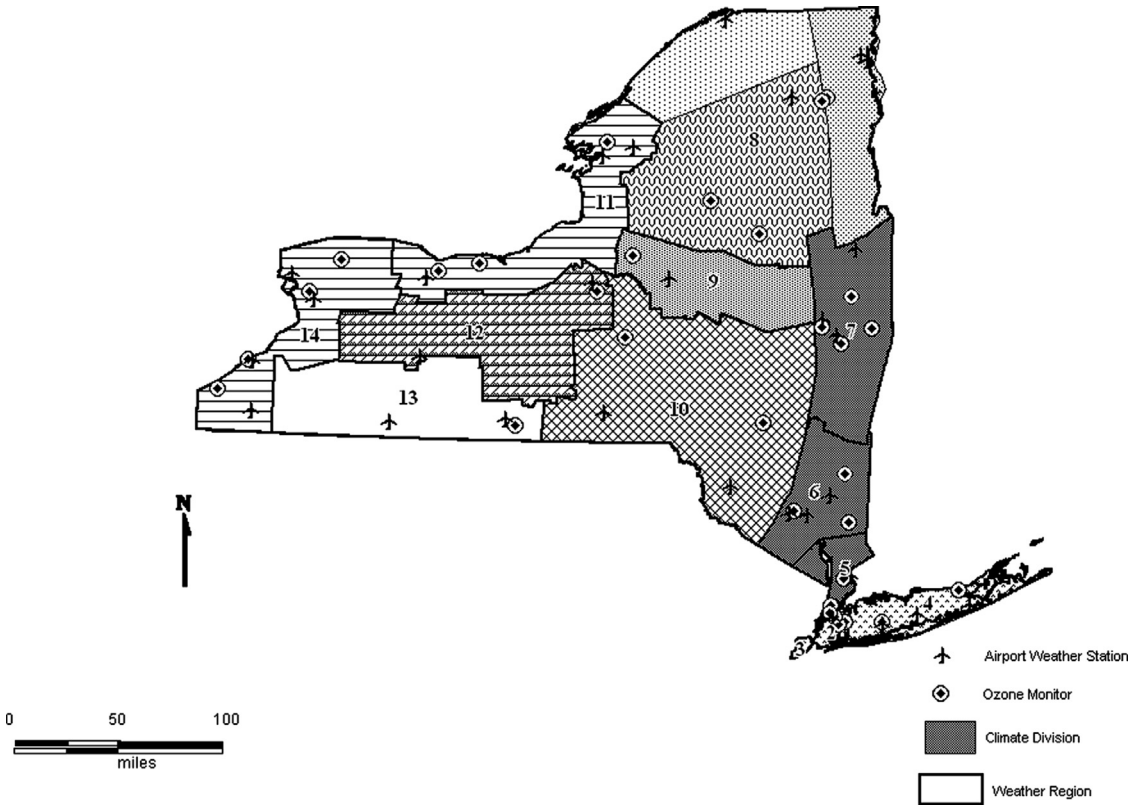

Fig. 1. Weather regions, climate divisions, airport weather stations, and ozone monitors in New York State.