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A study of adverse birth outcomes and agricultural land use practices in Missouri

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ABSTRACT

Background: Missouri is an agriculturally intensive state, primarily growing corn and soybeans with additional rice and cotton farming in some southeastern counties. Communities located in close proximity to pesticide-treated fields are known to have increased exposure to pesticides and may be at increased risk of adverse birth outcomes. The study aims were to assess the relationship between county-level measures of crop-specific agricultural production and adverse birth outcomes in Missouri and to evaluate the most appropriate statistical methodologies for doing so.
Methods: Potential associations between county level data on the densities of particular crops and low birth weight and preterm births were examined in Missouri between 2004–2006. Covariates considered as potential confounders and effect modifiers included gender, maternal race/ethnicity, maternal age at delivery, maternal smoking, access to prenatal care, quarter of birth, county median household income, and population density. These data were analyzed using both standard Poisson regression models as well as models allowing for temporal and spatial correlation of the data.
Results: There was no evidence of an association between corn, soybean, or wheat densities with low birth weight or preterm births. Significant positive associations between both rice and cotton density were observed with both low birth weight and preterm births. Model results were consistent using Poisson and alternative models accounting for spatial and temporal variability.
Conclusions: The associations of rice and cotton with low birth weight and preterm births warrant further investigation. Study limitations include the ecological study design and limited available covariate information.

1. Introduction

Herbicides were applied to over 95% of the corn and soybeans grown in the U.S. in 2001 (U.S. Environmental Protection Agency, 2012). Corn and soybeans are the most common crops grown in Missouri, and the proportion of land dedicated to growing soybeans and corn within a county can be as high as 58% and 37%, respectively (Fig. 1). Although agricultural chemicals have been extremely useful in boosting crop production, they can migrate away from application sites through the soil, water, air, and onto personal belongings (Chester and Ward, 1984; Rull et al., 2006). As a result, families and communities not occupationally involved

Abbreviations: (CDC), Centers for Disease Control and Prevention; (CI), confidence interval; (EPHTN), Environmental Public Health Tracking Network; (GEE), generalized estimating equations; (MDHSS), Missouri Department of Health and Senior Services; (NASS), National Agricultural Statistics Survey; (PNC), prenatal care; (RR), relative risk; (SES), socio-economic status; (SGA), small for gestational age; (USDA), United States Department of Agriculture; (WIC), Women, Infants, and Children

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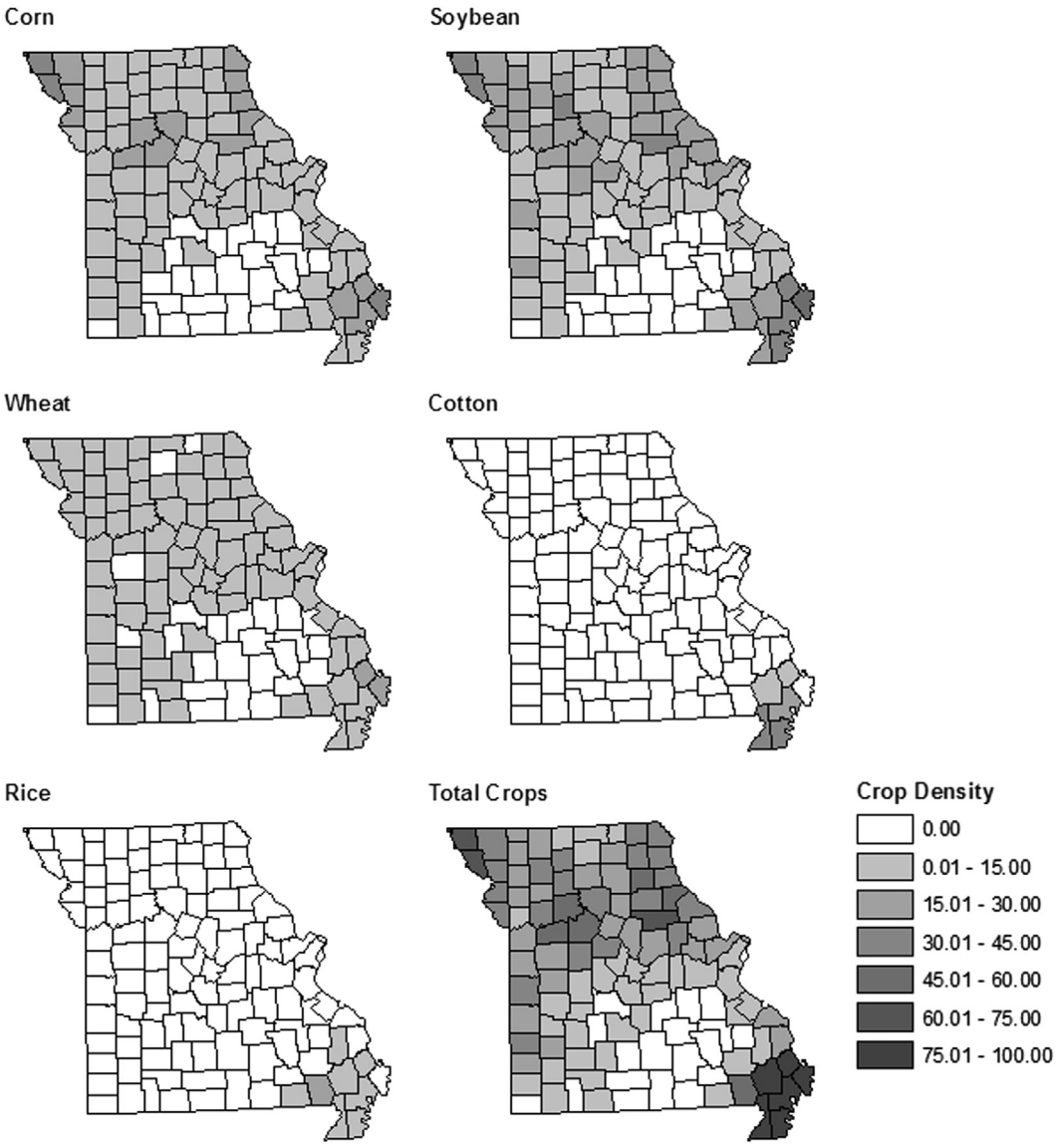

Fig. 1. Crop coverage of corn, soybeans, wheat, rice, cotton, and total crop densities in Missouri, 2005.
Data Source: United States Department of Agriculture Quick Stats 2.0, 2010

with agricultural pesticide use may also be exposed (Lu et al., 2000; Fenske et al., 2002).

Atrazine and glyphosate are two commonly used herbicides in the Midwest. Atrazine is a pre-emergence broadleaf herbicide most commonly applied to corn fields. Glyphosphate is commonly used for weed control particularly on crops that are genetically modified to be resistant to this herbicide. Atrazine is one of the most commonly detected contaminants in surface water in the U.S. and particularly in the Midwest corn-belt region (U.S. Environmental Protection Agency, 2007).

Nitrogen fertilizers are also commonly applied to agricultural fields in the U.S. Nitrate (NO_3^-) from fertilizers, livestock manure, and human waste is also a common contaminant of drinking water sources in agricultural regions (Nolan et al., 1997; Nolan and Hitt, 2006).

To date, epidemiological studies that have explored the association of community-based exposure to atrazine with adverse birth outcomes have had inconsistent results. An increased risk of delivering small for gestational age (SGA) babies was found in Iowa communities with drinking water contaminated by atrazine (Munger et al., 1997). An increased risk of SGA was also seen in Indiana when atrazine was present in drinking water during the third trimester (Ochoa-Acuña et al., 2009). Rinsky et al. (2012), observed a significantly increased risk of preterm births in Kentucky counties with the highest versus the lowest atrazine levels in drinking water. Conversely, Ochoa-Acuña et al. (2009) reported no association between atrazine in drinking water and preterm births. Maternal exposure to atrazine during pregnancy has been associated with lower birth weight, length, and head circumference (Chevrier et al., 2011), however, other studies have shown no association between atrazine exposure during pregnancy and birth weight (Villanueva et al., 2005; Sathyanarayana et al., 2010).

While there is evidence from animal studies that suggests glyphosate may be genotoxic and disrupt endocrine function (de Castilhos and Cestari, 2012; Romano et al., 2012), the evidence for such an association from human studies is sparse. Savitz et al., (1997) reported elevated odds of preterm birth among infants whose fathers had been exposed to glyphosate-based pesticides prior to and at the time of conception compared to those without exposure, although the results were not statistically significant. More recently, Gasnier et al. (2009) found glyphosate-based