**Methods**

Census data

We included populated census blocks for the year 2010 obtained from the National Historical Geographic Information System (NHGIS) website (Manson et al., 2018; US Census Bureau, 2010). Each block included information on total population of children <18 years, and whether the census block was designated as an urban or rural block. Median household income was available only for census block groups, which is a level higher than census block, divided into five categorized: <$20,000, $20,000 to <$35,000, $35,000 to <$50,000, $50,000 to <$75,000 and ≥$75,000. There were 2686 (0.04%) census blocks with missing median income data in 2010 which were excluded the analysis of median household income. Table 1 summarizes the geographical and demographic data.

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Asthma incidence and prevalence rates

An incidence rate is defined as the number of new cases, within a specified time period, among an at-risk population. To estimate childhood asthma incidence rate, new asthma childhood cases, and at-risk children, we used the Asthma Call Back Survey (ACBS) and Behavioral Risk Factor Surveillance System (BRFSS) (CDC, 2009, 2011) following the methods described by Winer et al. (2012). In brief, participants in the BRFSS were asked “Has a doctor, nurse, or other health professional ever said that the [name of child] has asthma?” if the answer is “yes”, the respondent is requested to participate in the ACBS follow up survey. The ACBS survey further asks “How old was the [name of child] when a doctor or other health professional first said [he/she] had asthma? How long ago was that?” a new asthma incident case would answer “within the past 12 months”. At-risk children are the sum of new asthma cases and total who never had asthma (i.e. by subtracting the prevalent cases from total children).

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Each respondent is assigned a weight:

For the BRFSS “The sum of the BRFSS child weights for records reporting children with lifetime asthma is an estimate of the total population of children in the state with lifetime asthma”

For the ACBS “The sum of the ACBS final weights for all ACBS child records is equal to the estimated total state population of children with lifetime asthma in the state.”

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Using the ACBS and BRFSS data sets for the years 2006 through 2010, we aggregated and estimated all available state-specific asthma incidence rates. States not included in the data set and did not have a specific incidence rate, were assigned the overall aggregated asthma incidence rate.

The asthma incidence rate is then estimated by dividing asthma incident cases by the total number of children.

Childhood asthma incidence rate was estimated for 32 states (Table – 9; Childhood Asthma incidence rate by state). The aggregate national incidence rate across 2006-2010 ( IR = 12.3 per 1,000) was used for states that did not have a childhood asthma incidence rate available.

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NO2 exposure assessment

Annual average NO2 concentrations for each populated census block were available at the centroid location for the year 2010. Concentrations were derived from a land use regression model utilizing Environmental Protection Agency (EPA), satellite data and several GIS covariates. A detailed description of the model can be found at Bechle et al. (2015). NO2 concentrations were converted from ppb to ug/m3through multiplying by 1.88 (WHO, 2005).

Concentration-response function

We used a concentration-response function (CRF) of 1.05 (95% CI = 1.02-1.07) per 4ug/m3 of NO2. The CRF was obtained from a meta-analysis of 20 studies examining the association between exposure to traffic-related air pollution (TRAP) and risk of developing asthma among children (Khreis et al., 2017).

Burden of disease estimate

To estimate the burden of disease, we used a standard assessment methods described by Mueller et al. (2017) with the following steps:

We estimated the at-risk children for each state by subtracting the total number of prevalent cases from the total children within the state. We then estimated the number of asthma cases for each state by multiplying the state-specific childhood asthma incidence rate with at-risk children for each census block.

*At-risk children = Total children – (Total children \* Prevalence rate) (1)*

*Asthma incident cases = At-risk children \* Incidence rate (2)*

We then calculated the relative risk (RRdiff) for asthma due to exposure difference between estimated exposure levels (NO2 concentration at the census block level) and no exposure (zero NO2 concentration).

*RRdiff = e((ln(RR)/RRunit\*Exposure level) (3)*

Where RR is the CRF and RRunit is the exposure unit for the CRF. The population attributable fraction (PAF) is then estimated.

*PAF = (RRdiff – 1)/(RRdiff) (4)*

The attributable number of asthma incident cases (AC) is estimated by multiplying the PAF with the number of incident asthma cases at each census block. The AC is then summed up to get the total AC.

**Results**

Asthma incident cases

Attributable number of cases

Attributable number of cases by living location

Attributable number of cases by median household income

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