

ONLINE SUPPLEMENTS

Online Supplement S1. Measuring air pollution exposures.

a) ***Pollutants*** - PM_{2.5} exposures were derived from total column aerosol depth retrievals from the Moderate Resolution Imaging Spectroradiometer (MODIS) that were related to near-surface PM_{2.5} using the GEOS-Chem chemical transport model and adjusted with local ground-based observations through geographically weighted regression [1]. The resulting yearly (2004 to 2012) average surface layers gridded at approximately 1 km² resolution were extended to prior years (until 1998) by applying inter-annual variation from Boys et al [2]. Estimates of PM_{2.5} greater than 20 µg/m³ were excluded from the analysis because they are believed to be due to inaccurate satellite retrievals. NO₂ exposures were estimated for 2006 from a national land use regression model that combined National Air Pollution Surveillance (NAPS) fixed-site monitoring data, satellite NO₂ estimates, road length within 10 km, industrial land use areas within various buffers, and summer rainfall [3]. Ground-level NO₂ estimates were derived using GEOS-Chem [4] from satellite tropospheric NO₂ columns. Local variation in NO₂ was captured by applying kernel density measures of highways and major roads as a multiplier to the model [3]. Ozone exposures were estimated for the months of May to October for the period of 2002 to 2009 (8 hour daily maximum) using an air pollution-specific interpolation technique to generate a 21 km² grid [5]. The model combines modeled O₃ from the Canadian Hemispheric Regional Ozone and NO_x system (CHRONOS) operational regional air quality forecast model [6] with ground-based observations from monitors in Canada and the United States. NO₂ and ozone data were adjusted for annual differences using a time series (1981 to 2012) of ground measurements from 24 census

divisions (CD). Annual means were calculated from NAPS daily mean concentrations (if ≥ 18 hourly readings available), and these were averaged for any CDs with more than one monitoring station [7]. Any gaps in the time series were imputed using an interpolation algorithm that combines classical prediction techniques and the phase-and frequency-fitting tools via the multitaper method [8], using the R package *tsinterp* [9]. For each of the 24 CDs, a cubic spline function was fitted to model the association between year and air pollutant. Ratios were determined for each year of follow-up and the source data year. For each year of follow-up, all locations were matched to the closest CD using Geographic Information Systems (GIS; ArcGIS v.10, ESRI 2010), and the corresponding time adjustment ratio was used to adjust data for annual differences in concentration. In addition to individual pollutants, we also employed total oxidants = $[(1.07 \times \text{NO}_2) + (2.075 \times \text{O}_3)] / 3.145$ as a composite measure, with pollutant weights equivalent to their respective redox potentials [10]. Exposure surface concentrations of air pollution were then assigned to participants using the centroids of their postal codes at birth and cumulated from birth onwards. Given the peak incidence of asthma and other allergic disease in early childhood [11], we focused on exposures at baseline (birth) and early life (0 to 3 years of age).

- b)* **Greenness** - The Normalized Difference Vegetation Index (NDVI) Landsat Time Series was used to measure greenness (15-19). Composite measures of NDVI calculated by Google are created from all the scenes via Google Earth Engine in each annual period beginning from the first day of the year and continuing to the last day of the year. All the images from each year are included in the composite, with the greenest pixel as the composite value, where the greenest pixel is the maximum value of the NDVI. Annual NDVI metrics were linked to all

6-digit DMTI Spatial single postal code locations and surrounding areas within 100m [12].

NDVI provides an indication of the presence and condition of green vegetation with values typically ranging from -1 to $+1$. Values of -1 generally represent water, while values of zero (-0.1 to 0.1) correspond to bare surfaces such as rock, sand, rooftops and roads. Higher values (0.2 to 0.4) represent grassland or bush land and values of $+1$ represent healthy green vegetation [13]. The greenness data surfaces for Ontario from 1996 to 2015 were obtained from the CANadian Urban Environmental Health (CANUE) research consortium (<https://canue.ca/>).

References

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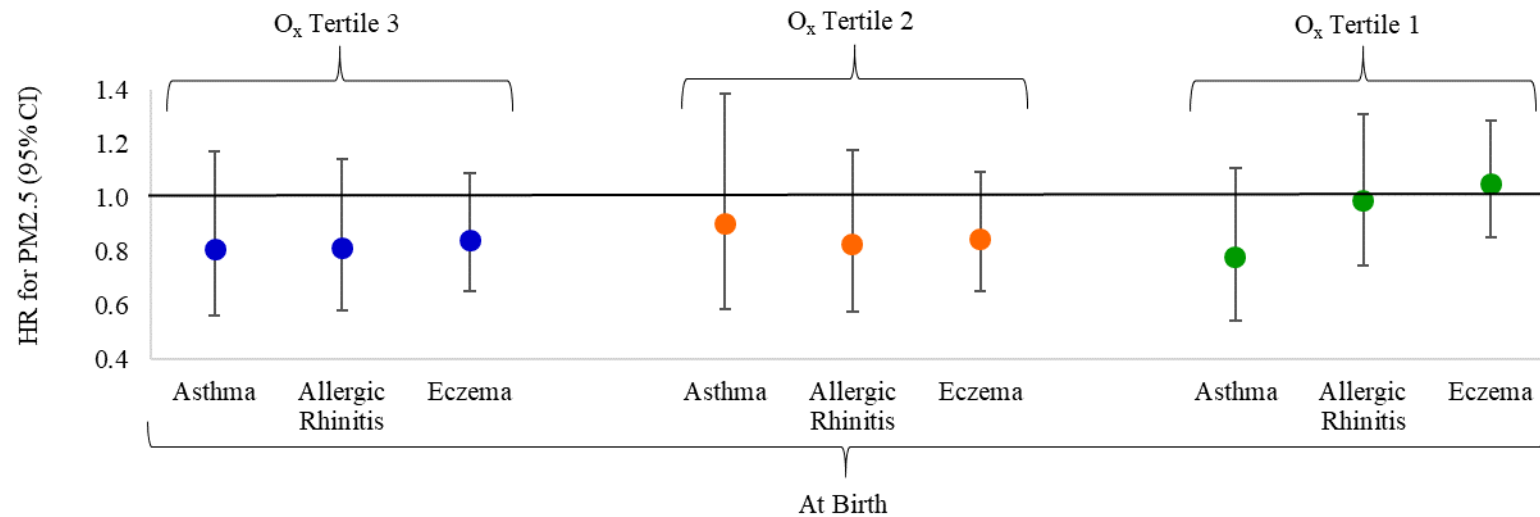
Online Supplement S2. Definition of covariates.

T-CHEQ Variable	Type of Variable	Categories
<i>Child Factors</i>		
Sex	Binary	Female; Male
Child age at survey	Continuous	
Child age at asthma, allergic rhinitis or eczema	Continuous	
Low birthweight (<2500g)	Binary	Yes; No
Child breastfed	Binary	Yes; No
Child ever attend a childcare facility/nursery school	Binary	Yes; No
Child born within 3 weeks of due date	Binary	Yes; No
Years to asthma, allergic rhinitis, eczema, or end of follow-up	Continuous	
<i>Home Environmental Factors</i>		
Mould in home first year of life	Binary	Yes; No
Roaches in home first year of life	Binary	Yes; No
Gas cook/heat first year of life	Binary	Yes; No
ETS exposure in first year of life	Binary	Yes; No
Pets in home in first year of life	Binary	Yes; No
<i>Parental/Demographic Factors</i>		
Income adequacy	Categorical	Lowest; Lower Middle; Upper Middle; Highest
Number of people in the household	Categorical	≤3, 4, ≥5
Parent's highest level of education	Categorical	Some college or below; College diploma; University degree; Master/doctorate
Either of the parents ever had asthma	Binary	Yes; No
Parent history of atopy	Binary	Yes; No
Pollutant Variable	Type of Variable	Definition
NO ₂	Continuous	
O ₃	Continuous	
PM _{2.5}	Continuous	
NDVI	Continuous	
Oxidants	Continuous	$[(1.07 \times \text{NO}_2) + (2.075 \times \text{O}_3)] / 3.145$

Abbreviations: ETS=environmental tobacco smoke; NO₂=nitrogen oxide; O₃=ozone; PM_{2.5}=particulate matter with a diameter of 2.5 µm; NDVI=normalized difference vegetation index.

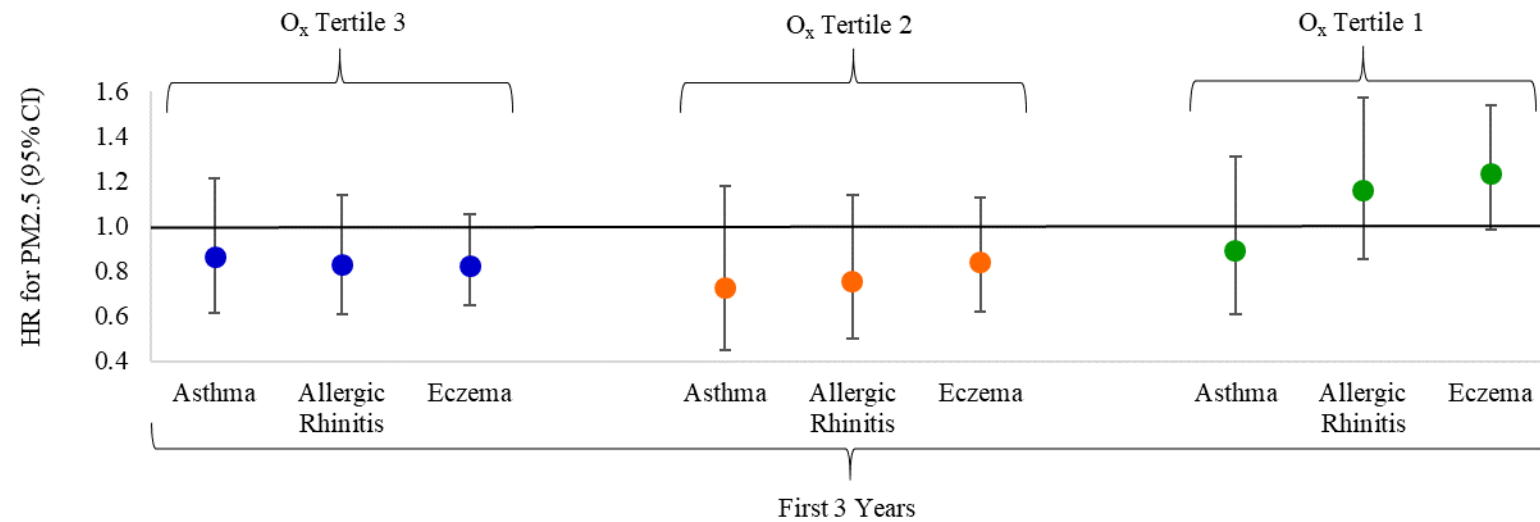
Online Supplement S3. Hazard ratios of PM_{2.5} and outcomes stratified by tertile of total oxidants.

a) At birth.



Hazard ratios for PM_{2.5} reflect changes of 4.26 µg/m³. O_x = oxidant.

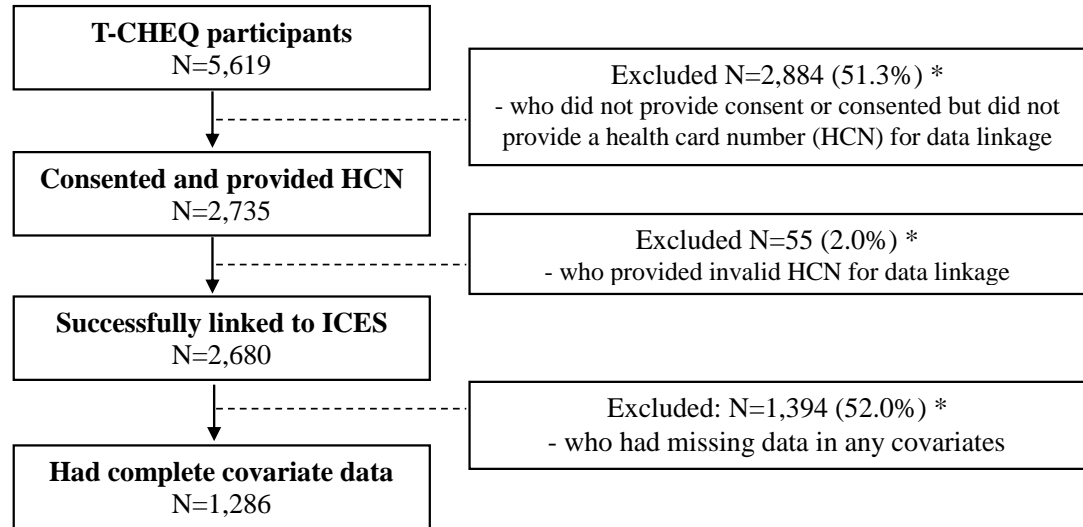
b) During the first 3 years of life.



Hazard ratios for PM_{2.5} reflect changes of 2.66 µg/m³. O_x = oxidant.

Online Supplement S4. The original and current study cohort.

a) *Flow diagram showing study cohort assembly.*



* Proportion excluded from previous step.

b) *Distribution of parent-reported conditions at the time of the T-CHEQ survey.*

Parent Reports	TCHEQ Total Cohort (N=5,619)	Consented Birth Cohort (N=1,286)	p-value
Ever asthma	16.20%	16.74%	0.6365
Ever rhinitis	24.10%	22.04%	0.1174
Ever eczema	24.30%	23.44%	0.5159

The distribution of parent-reported conditions does not show any statistically significant differences between the original cohort and the current study cohort.