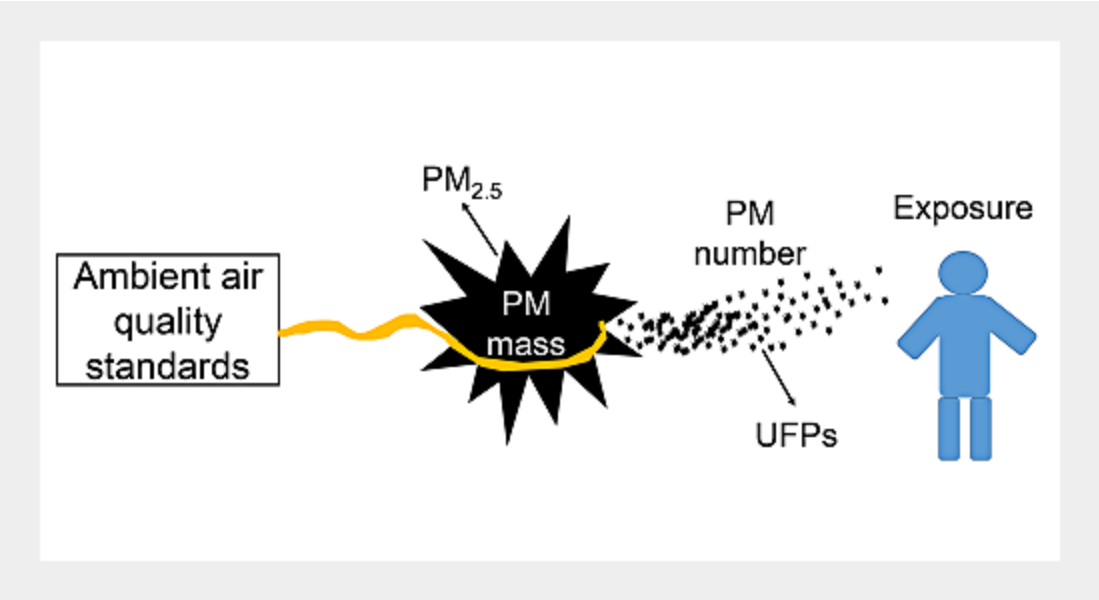
Associations between PM2.5 components, brake and tire wear markers, ultrafine particles, and childhood cancers in Canada

Eric Lavigne, PhD




Outdoor particles – Heterogeneity

- Outdoor fine particulate matter (PM2.5) and UFPs are a heterogeneous mix



- Most epidemiological studies only contrast PM2.5 and UFP concentrations

PM2.5, UFPs & pediatric cancer development

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Maternal exposure to ambient air pollution and risk of early childhood cancers: A population-based study in Ontario, Canada

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PM2.5, UFPs & pediatric cancer development

RR for associations between PM2.5 and incidence of selected childhood cancers

Cancer site	Obs. cases	$PM_{2.5}$ (IQR=2.9 µg/m3) Crude[a] HR (95% CI)	Model 1[b] HR (95% CI)	Model 2[c] HR (95% CI)
ALL	365	1.04 (0.91-1.18)	1.05 (0.91-1.22)	1.03 (0.88-1.20)
Astrocytoma	88	1.14 (0.88-1.47)	1.38 (1.01-1.88)	1.35 (1.00-1.85)
Wilms tumour	88	1.10 (0.84-1.44)	1.17 (0.86-1.59)	1.20 (0.88-1.64)

a Unadjusted model.
b Model adjusted for maternal age at delivery, infant sex, parity, year of birth, census tract median family income, census tract proportion of population who are visible minority and census tract proportion of the adult female population aged 25-64 years old who completed postsecondary education.
c Additional adjustment for maternal cigarette smoking during pregnancy using multiple imputation

PM2.5, UFPs & pediatric cancer development

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Ambient ultrafine particle concentrations and incidence of childhood cancers

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Table 4
Hazard ratios[a] (HR) and 95% confidence intervals (95% CI) for the associations between UFPs (per 10,000/cm^3) over specific periods and childhood cancer risk ≤ 6 years of age with additional adjustment for $PM_{2.5}$ and NO_2.[b]

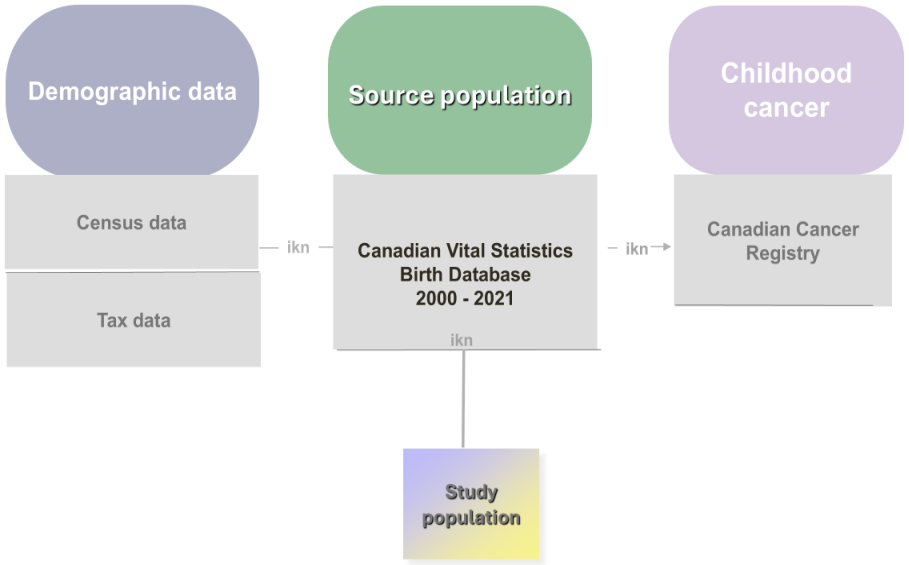
Cancer site	1st trimester	2nd trimester	3rd trimester	Entire pregnancy	Childhood exposure
UFPs + NO_2					
All cancers	1.11 (1.02–1.21)	1.00 (0.88–1.07)	0.96 (0.89–1.06)	1.00 (0.91–1.12)	0.97 (0.92–1.03)
ALL	1.23 (0.87–1.74)	0.90 (0.58–1.27)	1.07 (0.78–1.44)	1.06 (0.77–1.42)	1.04 (0.75–1.40)
Astrocytoma	0.49 (0.18–1.34)	0.80 (0.55–1.45)	1.00 (0.64–1.55)	0.90 (0.51–1.48)	0.71 (0.46–1.10)
Neuroblastoma	0.91 (0.58–1.43)	0.98 (0.70–1.31)	0.88 (0.64–1.12)	0.81 (0.59–1.11)	1.11 (0.80–1.54)
UFPs + $PM_{2.5}$					
All cancers	1.10 (1.01–1.19)	0.97 (0.86–1.07)	0.91 (0.82–1.01)	0.99 (0.88–1.11)	0.96 (0.88–1.09)
ALL	1.14 (0.95–1.36)	0.87 (0.60–1.27)	1.07 (0.79–1.46)	1.03 (0.75–1.44)	0.95 (0.72–1.28)
Astrocytoma	0.65 (0.37–1.13)	0.85 (0.55–1.47)	1.00 (0.61–1.50)	0.82 (0.51–1.50)	0.78 (0.50–1.18)
Neuroblastoma	1.05 (0.77–1.49)	1.01 (0.73–1.35)	0.90 (0.69–1.18)	0.98 (0.71–1.32)	1.12 (0.79–1.54)
UFPs + $PM_{2.5}$ + NO_2					
All cancers	1.13 (1.03–1.22)	1.01 (0.89–1.08)	0.97 (0.90–1.07)	1.01 (0.92–1.13)	0.97 (0.92–1.04)
ALL	1.22 (0.85–1.72)	0.90 (0.58–1.28)	1.07 (0.78–1.45)	1.06 (0.76–1.43)	1.04 (0.74–1.41)
Astrocytoma	[illegible]	0.85 (0.53–1.47)	1.00 (0.60–1.58)	0.91 (0.52–1.49)	0.75 (0.48–1.12)
Neuroblastoma	0.95 (0.63–1.45)	0.98 (0.70–1.31)	0.89 (0.65–1.13)	0.88 (0.65–1.17)	1.12 (0.81–1.55)

Objective

EVALUATE THE ASSOCIATIONS BETWEEN PRENATAL & EARLY LIFE EXPOSURES TO PM2.5 COMPONENTS, BRAKE & TIRE WEAR MARKERS, ULTRAFINE PARTICLES AND CHILDHOOD CANCER RISK

Methods

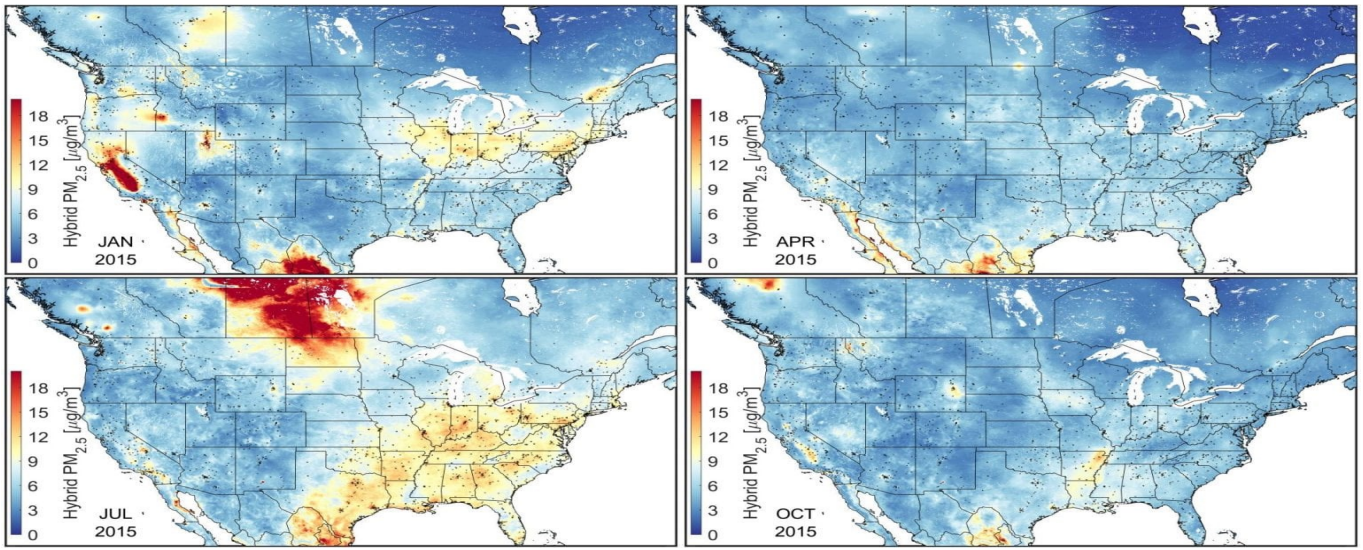
- Study Design: Population-based retrospective cohort study
  - » Canadian Vital Statistics Birth Database linked to Canadian Cancer Registry from 2000 to 2021



(ikn: encrypted health card numbers)

Exposure data

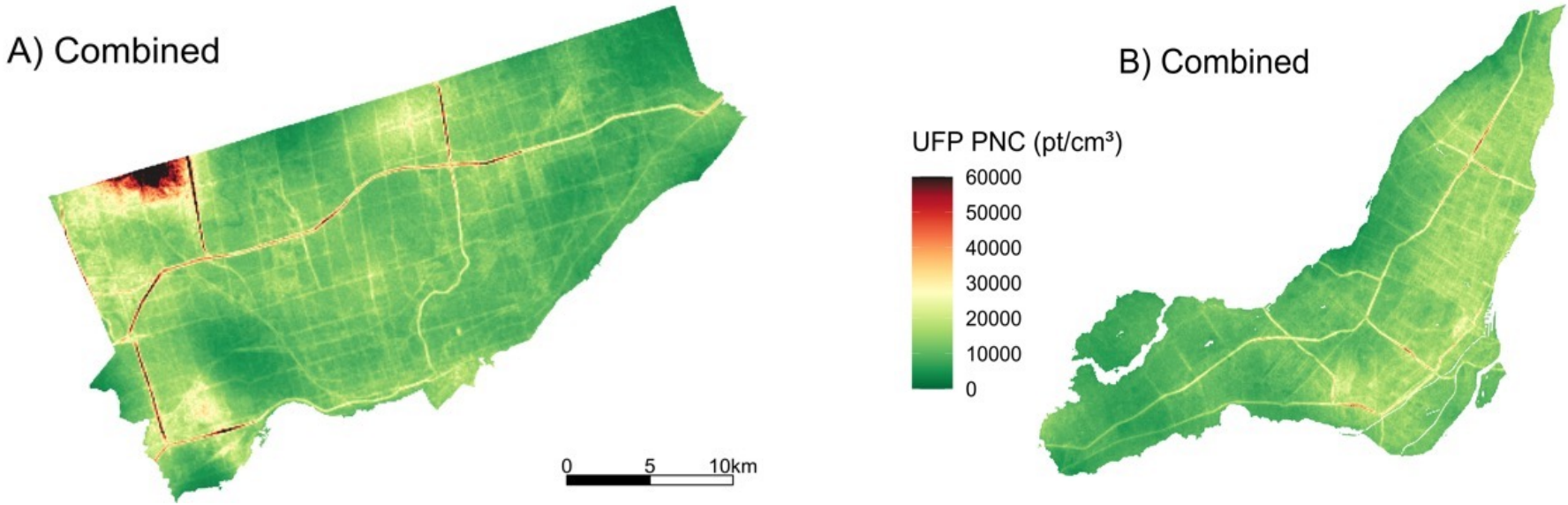
Bi-weekly PM2.5 total mass and component (SO4, NH4, NO3, SS, BC, dust, OM) estimates at 1x1km derived from satellite-based estimates with geographically weighted regression (2000 to 2021)



Long term measure of Barium [Ba] as a marker of brake dust and Zinc [Zn] as a tire and road wear marker (available for 40 sites across Canada) (data measured from 2016 to 2018)

Exposure data

Model predictions of within-city spatial variation in median daily outdoor UFP levels UFP number concentration for two largest cities in Canada (Toronto and Montreal)



Statistical analysis

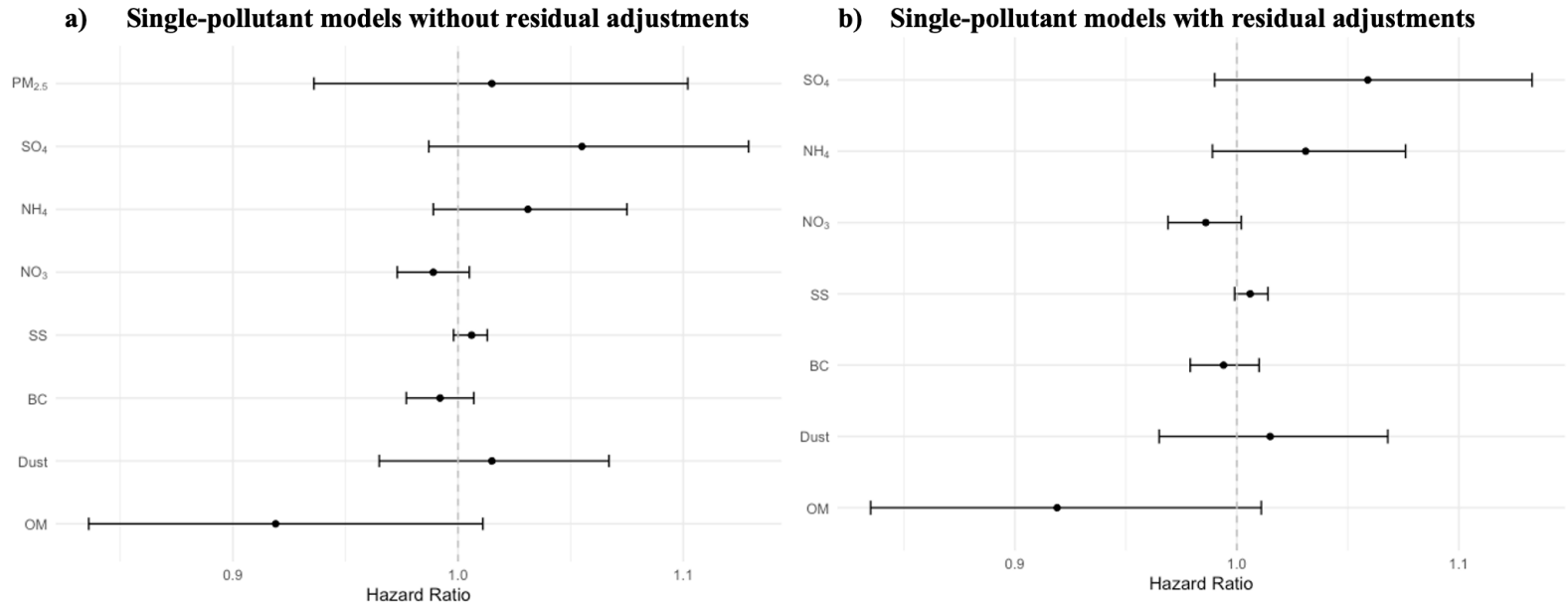
- Cox proportional hazards models assessing risk until 14 years of age
- Distributed Lag Non-Linear Models (DLNM) extension accounting for gestational weekly exposures for PM components and UFPS
- Long term measures for Ba and Zc
- Hazard ratios (HR) presented per IQR increase
- Covariates: maternal age, parity, infant sex, birth weight, area-level socioeconomic variables, geographic location (rural/urban), season of birth, year of birth
  - Maternal smoking only for the province of Ontario

Results

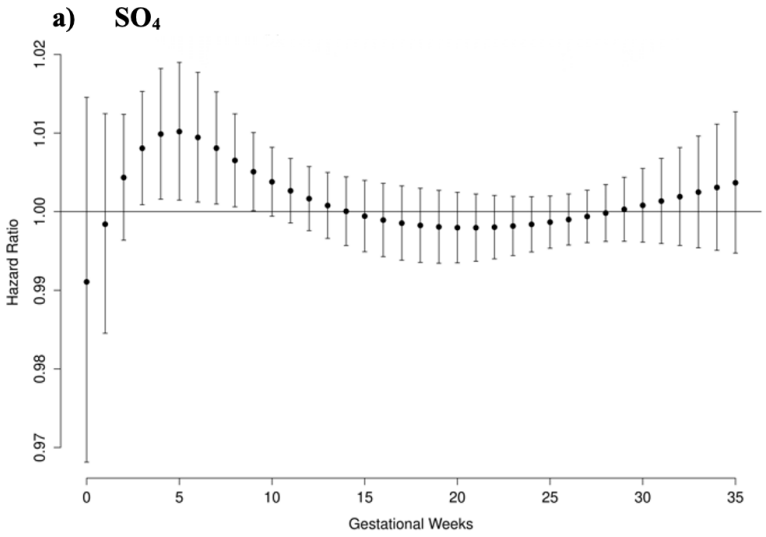
Study population (2000 – 2021)

Variable	Total cohort - all births	All pediatric cancer cases	Acute Lymphoid Leukemia	Acute Myeloid Leukemia	Astrocytoma
N	8,383,345	22,230	5,240	960	1,780
Maternal age at delivery, mean years (SD)	29.52 (5.49)	29.49 (5.53)	29.56 (5.54)	30.39 (5.70)	29.11 (5.48)
Male	51	54	56	52	51
Female	49	46	44	48	49
PM 2.5 during pregnancy, mean (SD)	7.57 (2.22)	7.87 (2.14)	7.79 (2.10)	7.61 (2.22)	7.74 (2.14)

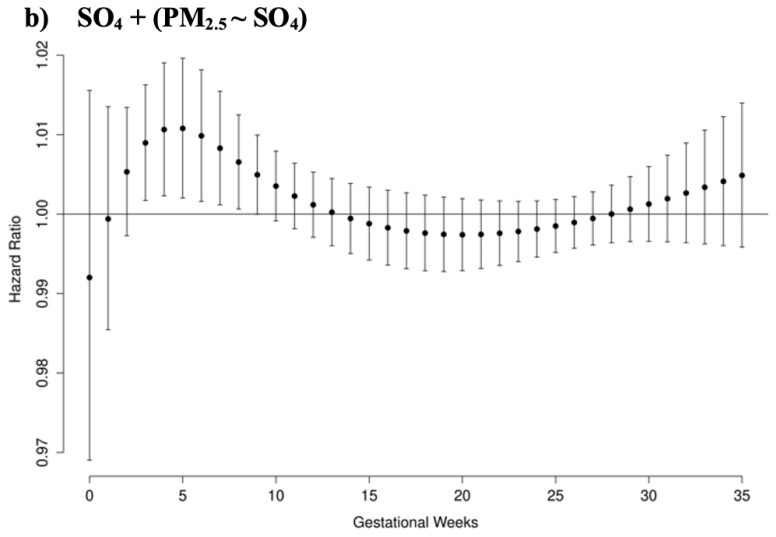
Results - HRs for gestational exposures to PM components on the risk of ALL



Results - HRs for gestational exposures on the risk of leukemia

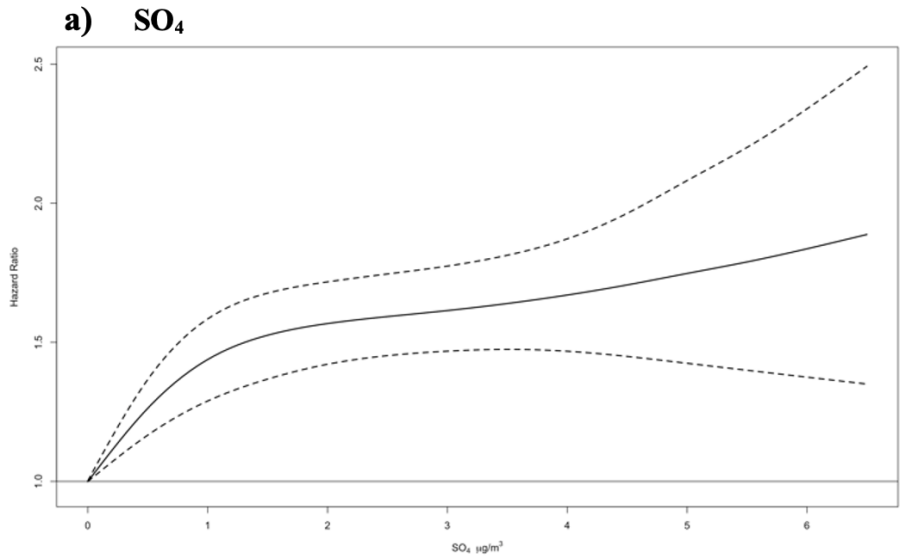


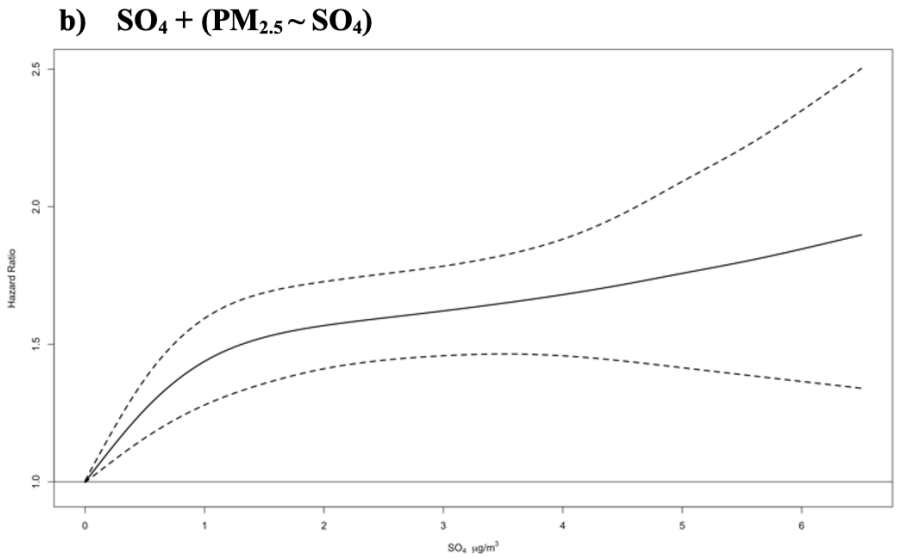
HR= 1.050 (1.007-1.095)



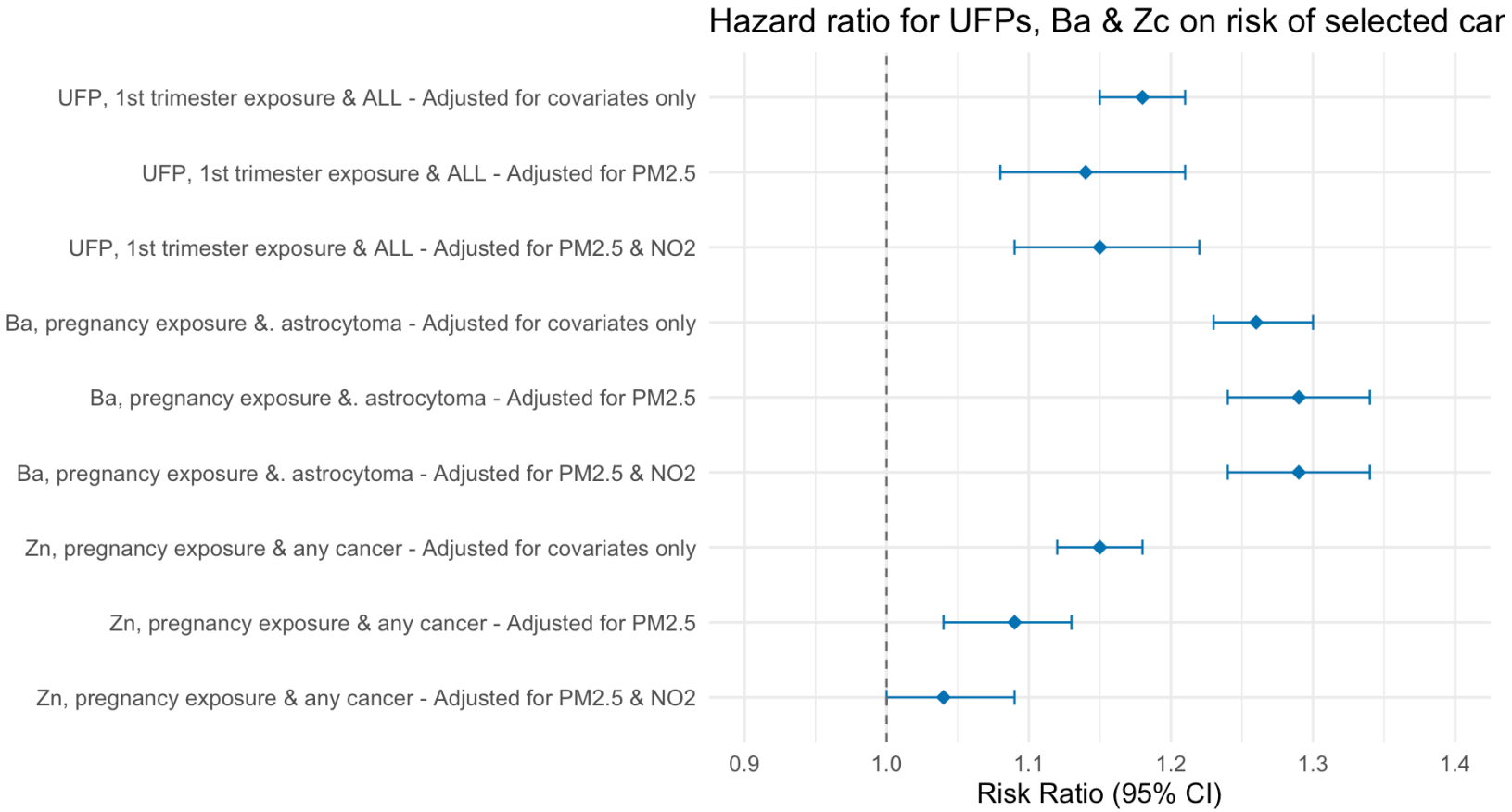
HR= 1.052 (1.009- 1.097)

Results - SO_4 concentration-response curve on the risk of leukemia



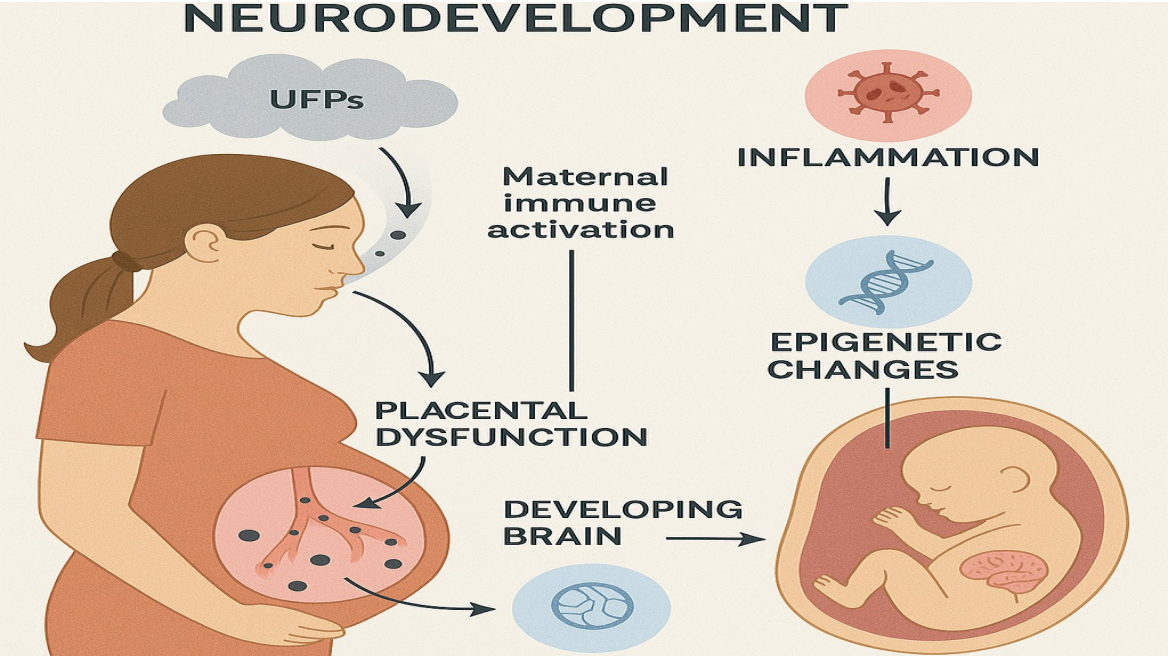


Results – UFPs, Ba & Zc on the risk of selected cancer types



Discussion

- SO_4 & UFPs were associated with ALL
  - » Early gestation (first few weeks) appeared to be a sensitive period
- Barium was associated with risk of astrocytoma



Conclusion

- Future studies should investigate components with finer temporal resolution models
- UFPs & particle size and childhood cancers should be further studied
- Ongoing research investigating childhood cancer survival, other cancer incidence subtypes & childhood exposures

THANK YOU

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Santé Canada Health Canada