Where is the Risk? Identification of geospatial hotspots of un-immunized children in Ontario

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Disclosure slide

- I have no affiliation (financial or otherwise) with a pharmaceutical, medical device or communications organization.

Background

- The *Immunization of School Pupils Act* (*ISPA*) requires students in Ontario to be appropriately immunized against designated diseases, submit a medical or non-medical (religious/conscientious) exemption, or risk school suspension.[1]

- Despite concerns of rising vaccine hesitancy, there are many knowledge gaps about unimmunized students in Ontario.

- Studies have found geographical clustering of persons with non-medical exemptions,[2,3] resulting in areas at higher risk of vaccine-preventable disease transmission.

[1]Immunization of School Pupils Act, RRO 1990, c Reg.645. Available from: https://www.ontario.ca/laws/regulation/900645

[2]Carrel M, Bitterman P. Personal belief exemptions to vaccination in California: a spatial analysis. *Pediatrics*. 2015;136(1):80-88.

[3]Lieu TA, Ray GT, Klein NP, Chung C, Kulldorff M. Geographic clusters in underimmunization and vaccine refusal. Pediatrics. 2015;135:280-9.

Study objectives

1. **Hotspot detection**

   - **To identify geographic clusters (hotspots) of un-immunized children**

2. Contributing factors (future)

   - To characterize the contribution of spatial effects and neighbourhood-level characteristics on hotspots

?

Methods

- ## Analytic cohort

  - Students aged 7-17 who attended school in Ontario in the 2016-17 school year as recorded in provincial immunization repository (n=1,651,729)

- ## Outcome: Un-immunized children

  Zero doses of any vaccine
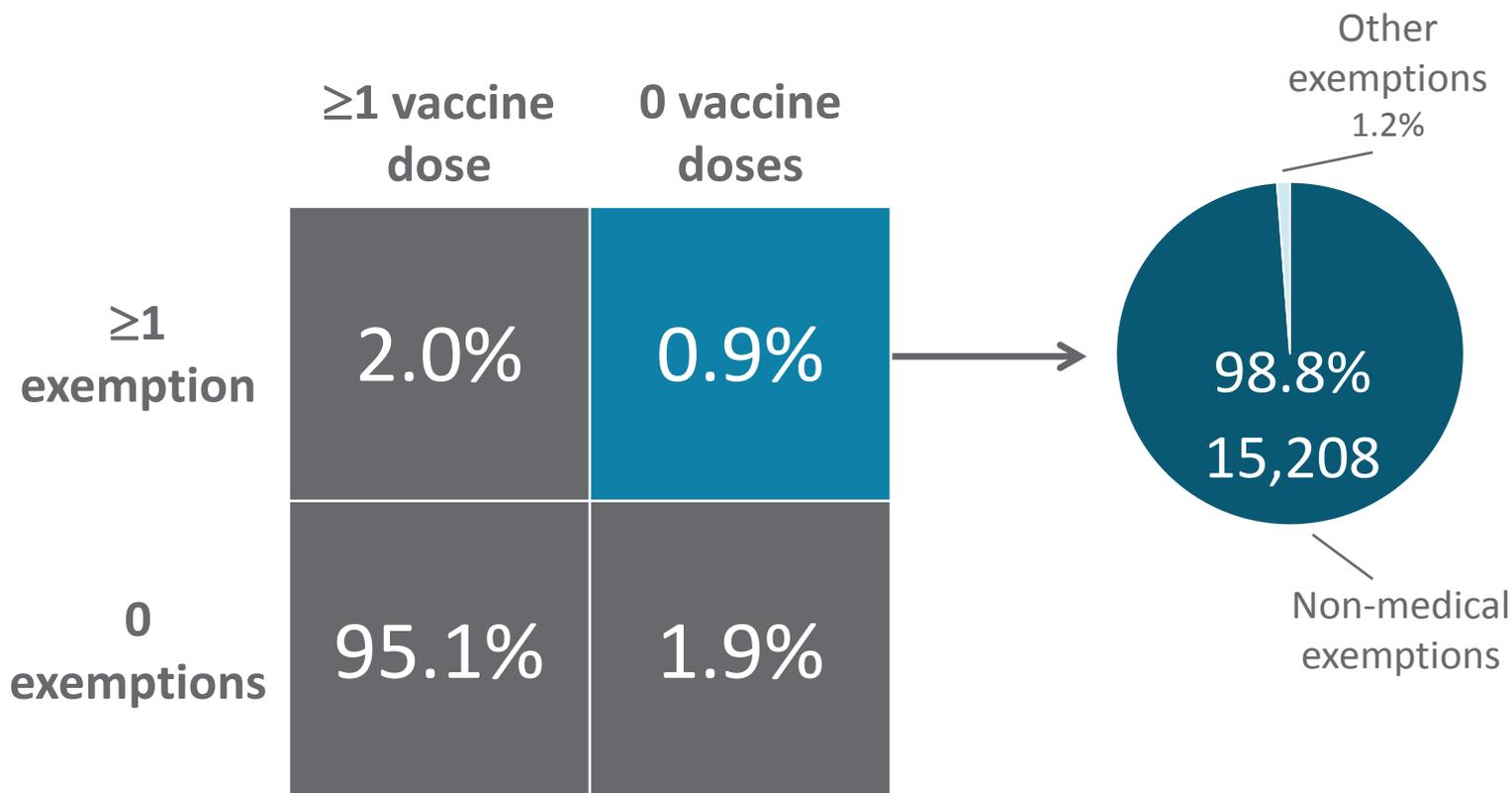
  and

  A non-medical exemption to any antigen

- ## Unit of analysis

  - Census Subdivisions (CSDs)

Census geography

- Used residential postal code to assign children to census geographies for analysis
  - 99.8% students assigned via PCCF+

- 575 CSDs in Ontario (2016)
  - Excluded CSDs which capture the complete boundaries of First Nations reserves (0.3% of geocoded students removed)
    - Uncertainty regarding completeness of the provincial repository for indigenous children living on-reserve
    - Project team composition does not currently include indigenous communities

Identification of unimmunized children
(from n=1,643,486)

	≥1 vaccine dose	0 vaccine doses
≥1 exemption	2.0%	0.9%
0 exemptions	95.1%	1.9%

Other exemptions 1.2%

98.8% 15,208

Non-medical exemptions

Identification of analytic cohort
(from n=1,643,486)

	≥1 vaccine dose	0 vaccine doses
≥1 exemption	2.0%	0.9%
0 exemptions	95.1%	1.9%

% unimmunized

$$= \frac{15{,}208}{1{,}611{,}595}$$

$$= \quad 0.94\%$$

Statistical analysis

- **Descriptive analysis**

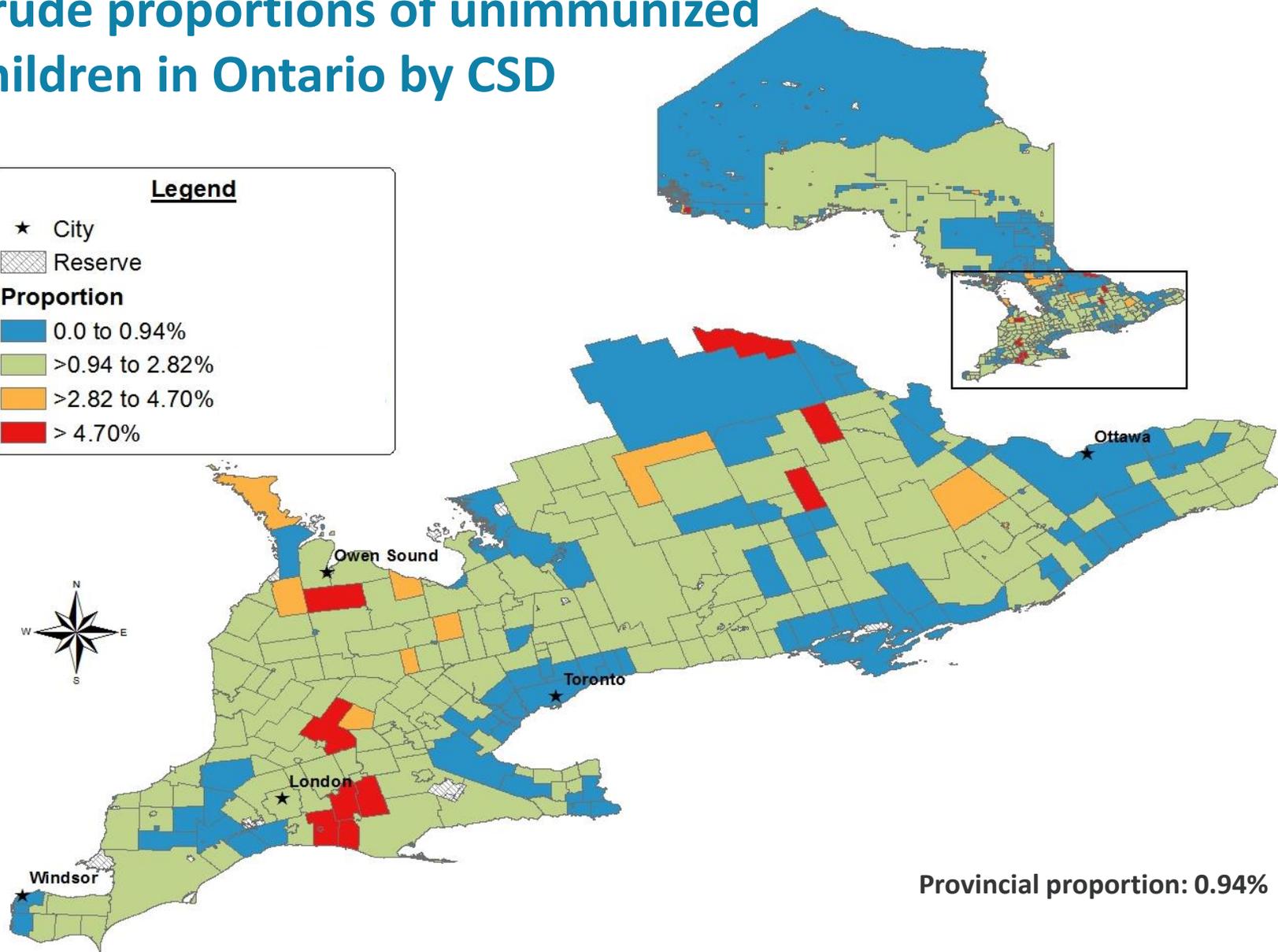 - Proportions of unimmunized students by CSD

- **Hotspot analysis**

  - Bayesian spatial smoothing using the Besag, York and Mollié (BYM) model to identify areas with elevated risk (hotspots) of unimmunized students.

    - Based on proportion of unimmunized students in each CSD and spatial clustering/proximity of unimmunized students by CSD
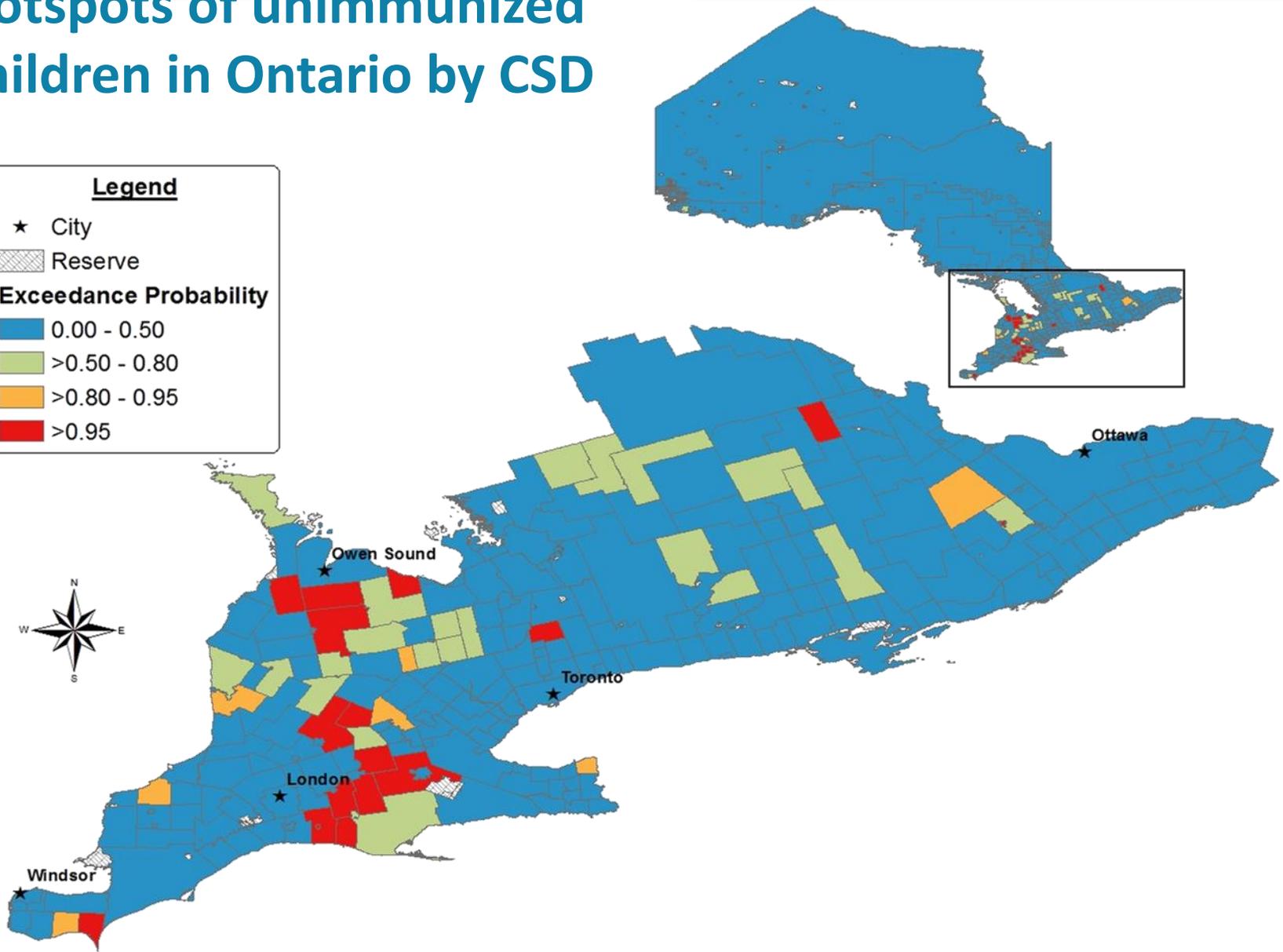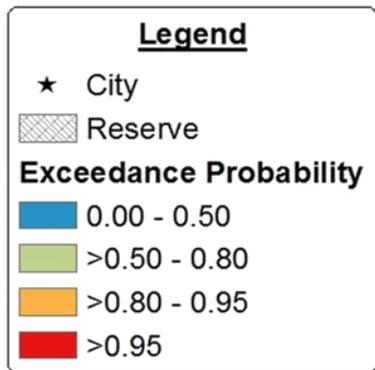
Hotspot definition:
CSD with an exceedance probability of > 95% that the risk is 2x greater than the provincial average of all CSDs

Crude proportions of unimmunized children in Ontario by CSD

Legend

★ City

▨ Reserve

Proportion

■ 0.0 to 0.94%
■ >0.94 to 2.82%
■ >2.82 to 4.70%
■ > 4.70%

Owen Sound

Ottawa

Toronto

London

Windsor

Provincial proportion: 0.94%

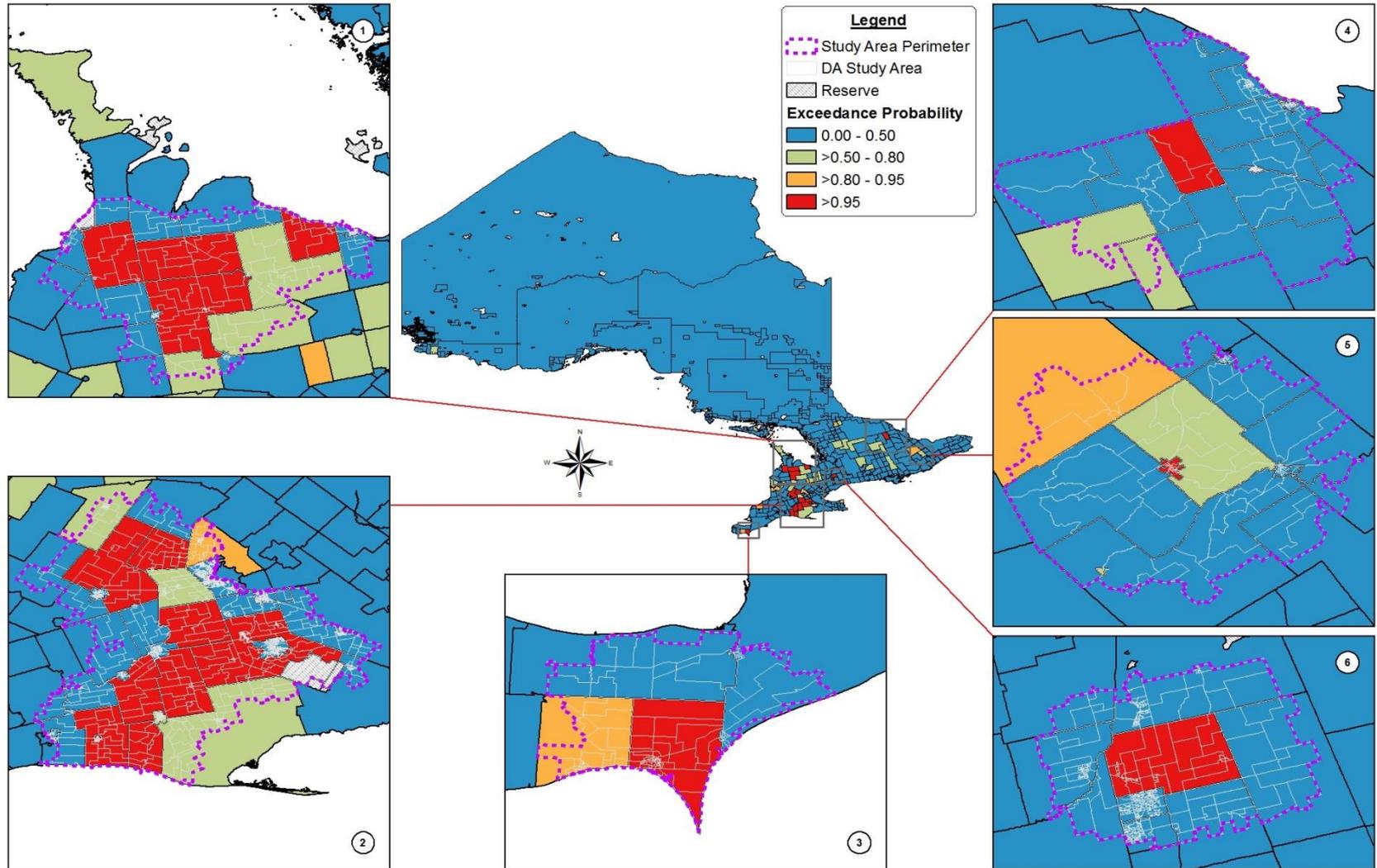# Hotspots of unimmunized children in Ontario by CSD

Discussion

- Hotspots should be considered in the context of other outcomes to understand the full landscape of immunization and disease risk

  - e.g. immunization coverage, partially immunized

- Area-level bias

  - Hotspots were identified at the CSD-level, but true risk may not be in the entire CSD

- Edge effects

  - Areas neighbouring lakes or borders may have more uncertainty in their results from BYM model relative to other areas

Next steps

- Results are a screening method which have identified areas of interest for further exploration

  - Dissemination area (DA)-level spatial analysis to identify more precise areas of risk and area-level characteristics

- Sharing findings with Public Health Units for better understanding of local-level context including:

  - Community attitudes and immunization practices

  - Immunization/exemption data collection procedures

Hotspot areas for further analysis at DA-level

Legend
Study Area Perimeter
DA Study Area
Reserve
Exceedance Probability
0.00 - 0.50
>0.50 - 0.80
>0.80 - 0.95
>0.95

Project team members and collaborators

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