

GEOGRAPHIC CLUSTERING OF ADVERSE BIRTH OUTCOMES IN ONTARIO:

COUNTER-INTUITIVE FINDINGS

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Adverse outcomes are complex and dynamic

- Premature birth proportions have been consistently increasing
- (SGA) births decreased over past decade
- Stillbirths decreased in Ontario over past decade
- Significant disparities between health regions

- They are also expensive
- There are significant disparities between health regions

Research goal:

- Augment our understanding of four adverse birth outcomes: late and mod/very premature, SGA, stillbirth:
 - Are there hotspots for each of four outcomes? Where are they? Are they in the same places?
 - For like outcomes - do predictors differ in diverse areas? At different scales?
 - For different outcomes – do predictors differentiate between outcomes?

Methods:

Four adverse birth outcome indicators were created:

1. Late premature births (LateP): ≥ 35 weeks, <37 weeks),
2. Moderate to very premature births (ModVP): <35 weeks,
3. Small-for-gestational-age (SGA): lowest 10%
4. Stillbirths

Methods:

- Observations: BORN Perinatal Data Base
 - Ontario 2005-9
 - 90%+ of births
 - Maternal and birth characteristics
- Linked to 2006 Census DAs (about 19,000)
- Linked to Census variables

Methods:

- After grooming: 621,750 birth records for analysis
- Linked to 15,808 Ontario DAs.

Methods:

Local Moran's I (I) cluster analysis used to identify the hotspots

Results: yes, there are hotspots.

Birth outcome	Hotspots (hotDAs*)	Hotspot % adverse birth outcomes	Provincial % adverse birth outcomes
LateP	132 (789)	6.2%	4.9%
ModVeryP	152 (833)	5.85%	3.69%
SGA	252 (1402)	13.16%	9.14%
Stillbirth	27 (197)	0.99%	0.58%

*There were 15808 total DAs considered in the analysis.

Results: Where are they?

LateP birth hotspots

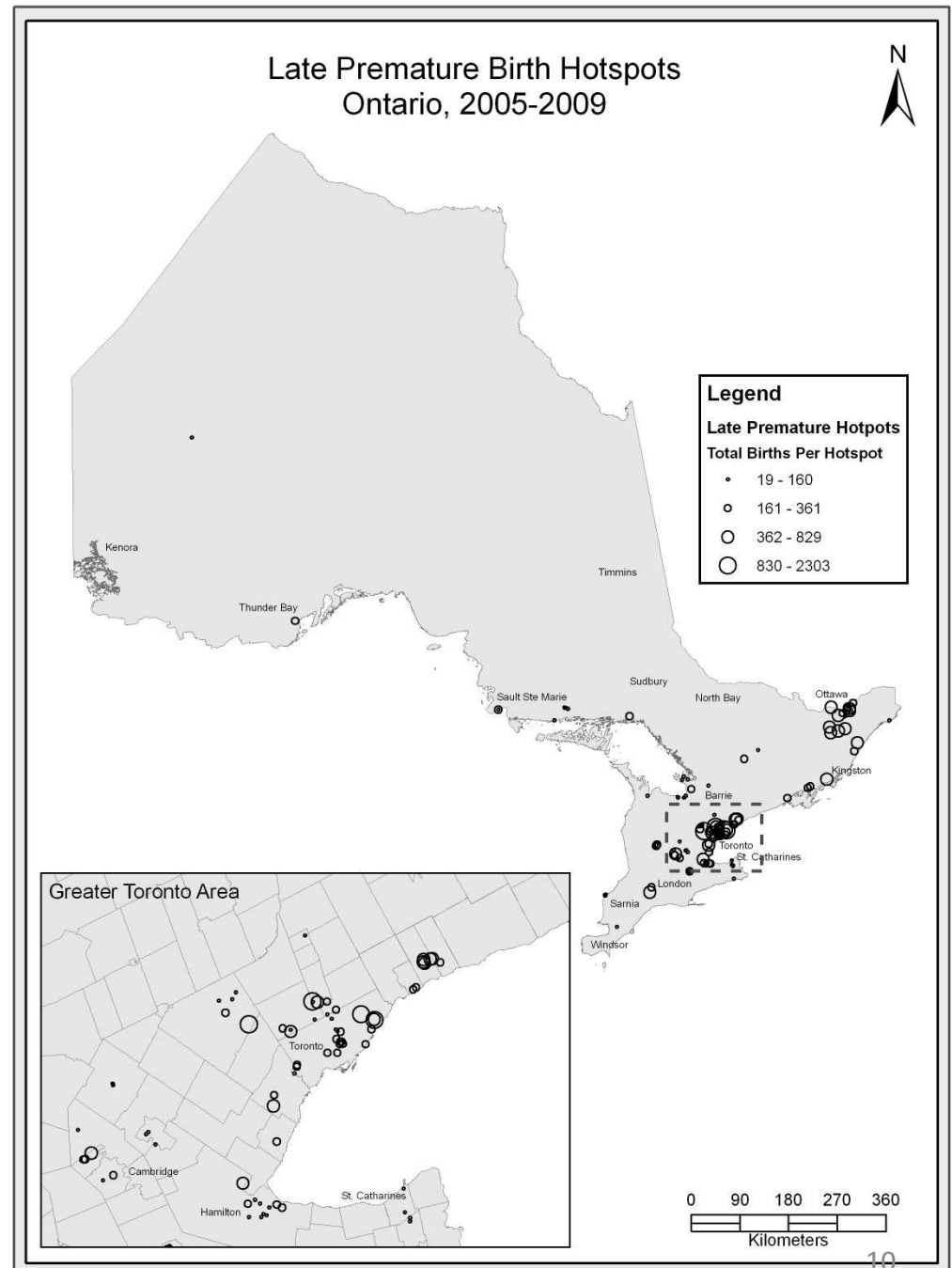
Hotspots 132

HotDAs 789

Population: 619,237

Total births: 31,958

LateP births: 1981
(6.2%)



Results: Where are they?

ModVP birth hotspots

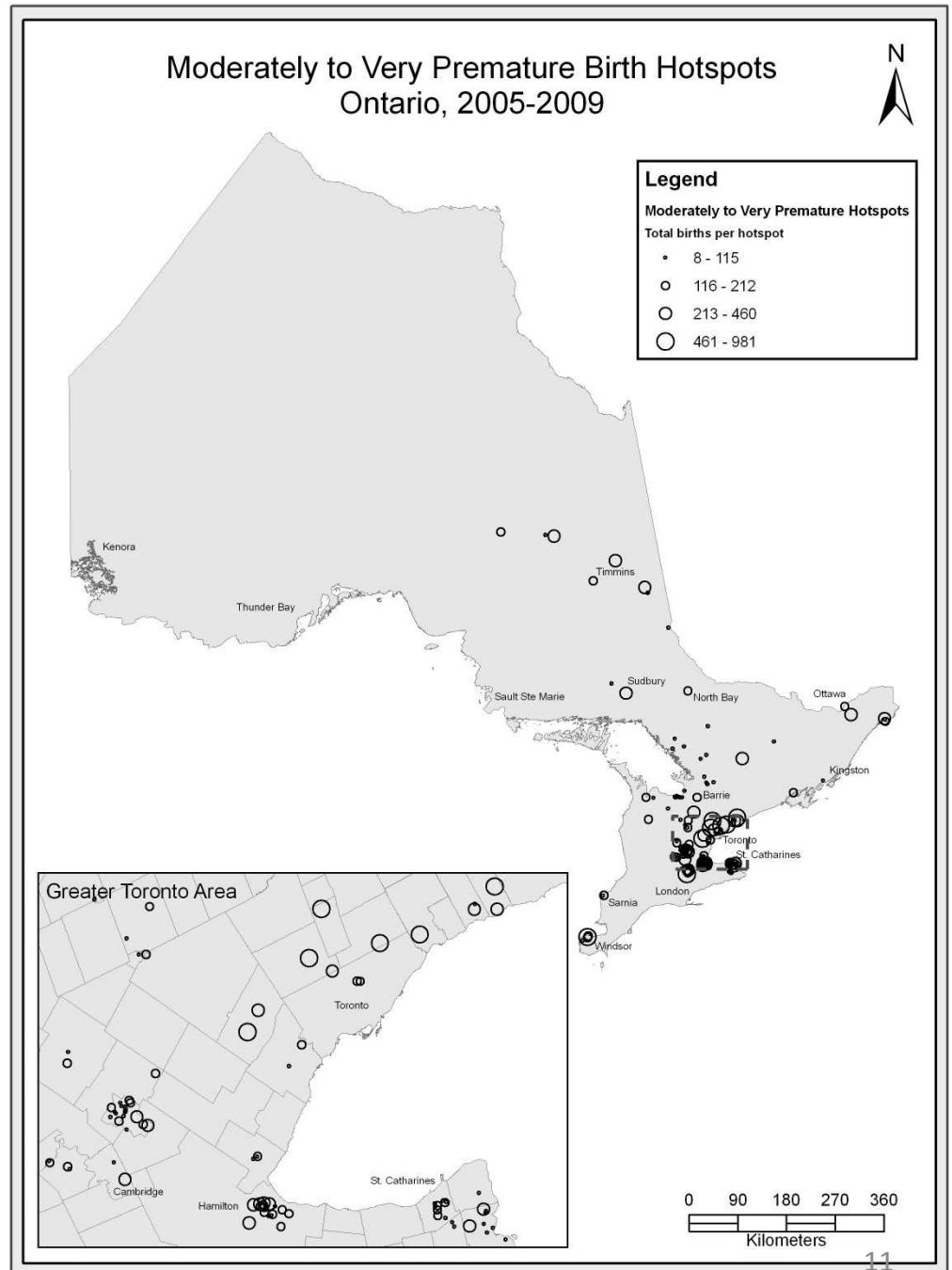
Hotspots 152

HotDAs 833

Population: 646,014

Total births: 21,450

LateP births: 1255
(5.85%)



Results: Where are they?

SGA birth hotspots

Hotspots 252

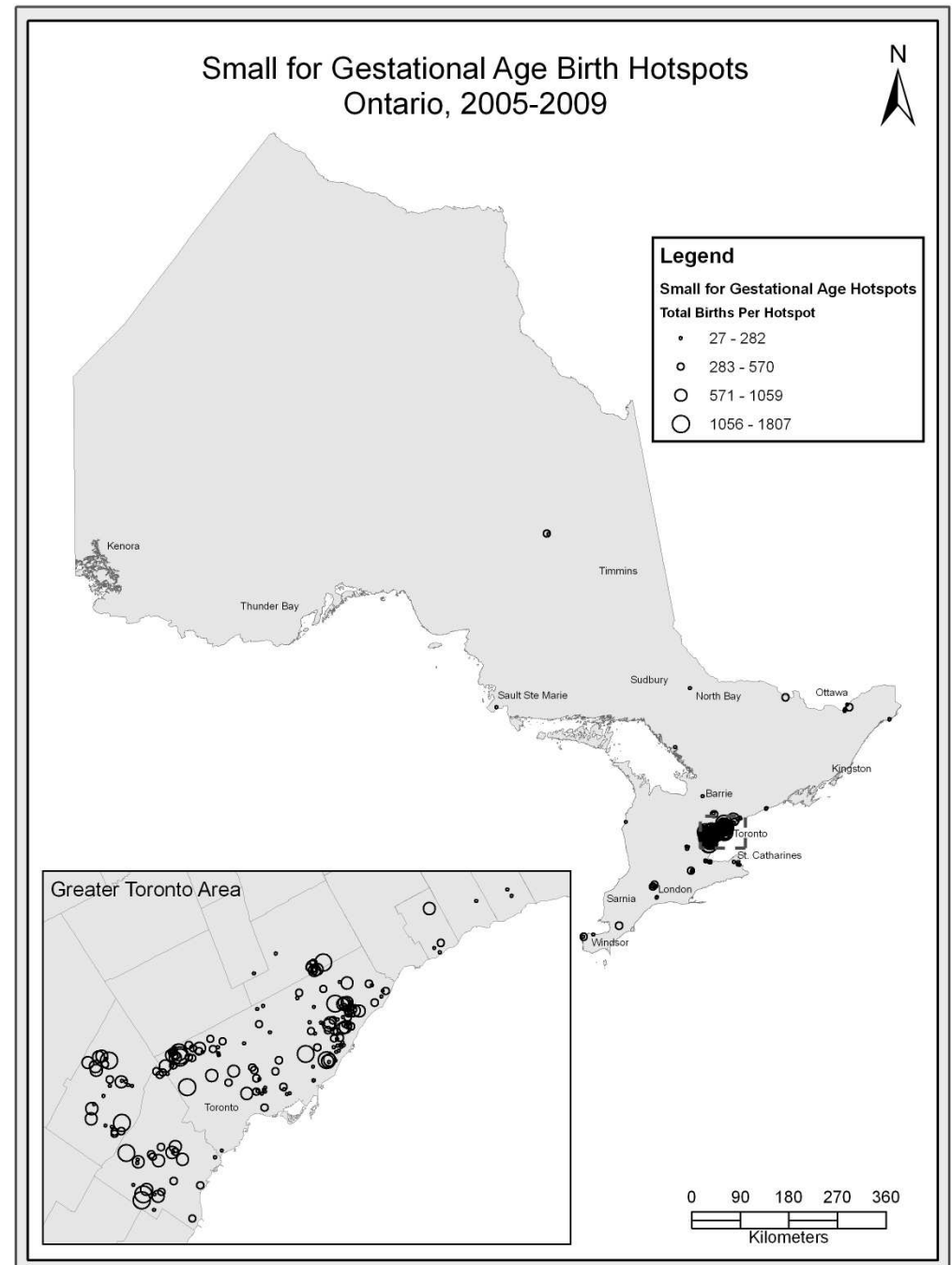
HotDAs 1402

Population: 1,131,417

Total births: 31,958

SGA births: 4206

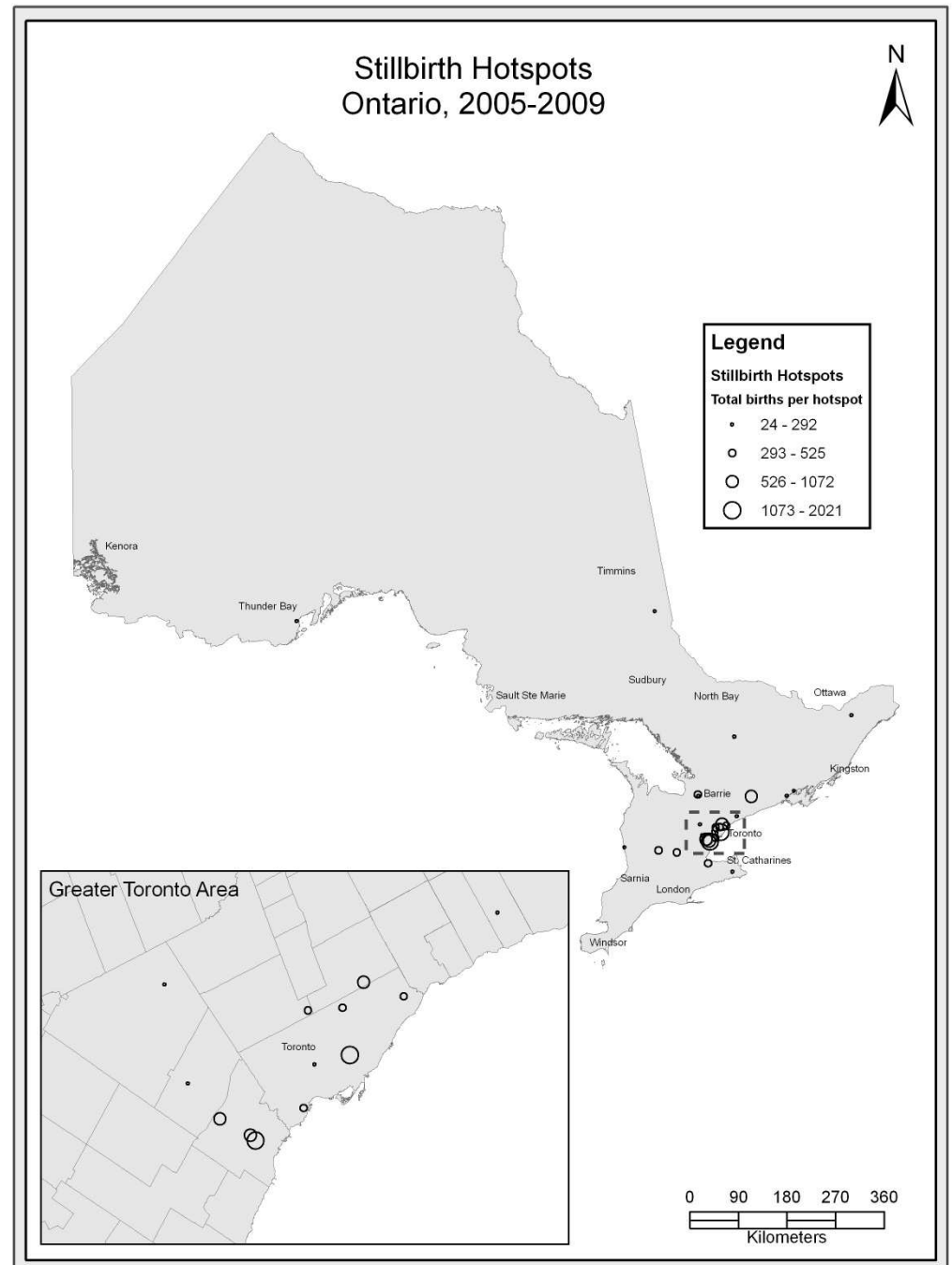
(13.16%)



Results: Where are they?

Stillbirth birth hotspots

Hotspots	27
HotDAs	197
Population:	168,895
Total births:	10,658
Stillbirths:	165
	(0.99%)



Results: characterizing hotspots

Hotspots for the different outcomes are largely geographically exclusive of each other.

They do not share the same places.

Results: characterizing hotspots

Measures of agreement: Shared hotDAs and Kappa Coefficient

Shared geographic space: Count of shared hotspots per birth outcome and Simple Kappa coefficient		
Outcome pairs	HotDAs shared (% of combined total DAs)	Simple Kappa coefficient
LateP-ModVP	70 (4.5)	- 0.91
LateP – SGA	55 (2.6)	- 0.8
LateP – Stillbirth	6 (0.6)	-0.46
ModVP - SGA	81 (3.6)	-0.82
ModVP – Stillbirth	6 (3.1)	-0.38
SGA - Stillbirth	24 (1.5)	-0.24

The next research questions:

- For like adverse outcomes: do full-province and local hotspots share explanatory risk factors?
- For different outcomes: do models differentiate?

Methods:

Groups of hotspots were identified to meet confidentiality and statistical test requirements.

- except stillbirths; assumptions could not be met.

Methods: Hotspot Groups

Late Premature		Moderate to Very Premature		SGA	
Location	Hotspots (hotDAs)	Location	Hotspots (hotDAs)	Location	Hotspots (hotDAs)
North Toronto	12 (64)	Hamilton	17 (117)	East Toronto	55 (201)
St. Catharine's	4 (25)	Cambridge	21 (87)	London	8 (50)
SW Ottawa	4 (14)	Southern Georgian Bay	27 (80)	Northwest Toronto	24 (81)
		North Ottawa Valley	9 (29)		

Methods: hierarchical regression modeling

Individual (birth) level risk factors*:

- Older maternal age: >35 years
- Teen maternal age: <20 years
- Smoked: any time during pregnancy
- Maternal preexisting health problems

*Known predictors from previous research available from BORN and Statistics Canada census

Methods: Hierarchical regression modeling

Ecologic (Census DA) level risk factors:

- Median household income per DA
- Urban vs. rural DA
- Lower education: % < high school degree per DA
- Higher education: % > bachelor's degree per DA
- % Asian immigrant population per DA

*Known predictors from previous research available from BORN and Statistics Canada census

Results: LateP Risk Factors

Full Province

1. %NoDip*Olderage (risk)
2. %Asian*Urban (protective)
3. HlthProb *Teen (protective)
4. Urban*Teen (risk)

Results: LateP Risk Factors

Full Province

- %NoDip*Olderage (risk)
- %Asian*Urban
(protective)
- HlthProb *Teen
(protective)
- Urban*Teen (risk)

Hotspot groups

- Northern Toronto
 - Olderage*%NoDip
(risk)
- St. Catharine's
 - %NoDip*HlthProb
(risk)
- SE of Ottawa
 - Olderage*%HigherEd
(protect)

Results: LateP Risk Factors

Full Province

- $\%NoDip * Olderage$ (risk)
- $\%Asian * Urban$
(protective)
- $HlthProb * Teen$
(protective)
- $Urban * Teen$ (risk)

Hotspot groups

- Northern Toronto
 - $Olderage * \%NoDip$
(risk)
- St. Catharine's
 - $\%NoDip * HlthProb$
(risk)
- SE of Ottawa
 - $Olderage * \%HigherEd$
(protect)

Results: ModVeryP Risk Factors

Full province

1. %Asian*Teen (risk)
2. %NoDip*Olderage (risk)
3. MedInc*Smoke (protect)
4. Urban*Smoked (risk)
5. Health Problem*Smoked (risk)
6. Teenage*Smoked (protect)
7. Teenage*Morbidity (protect)

Results: ModVeryP Risk Factors

Full province

1. %Asian*Teen (risk)
2. %NoDip*Olderage (risk)
3. MedInc*Smoke (protect)
4. Urban*Smoked (risk)
5. Health Problem*Smoked (risk)
6. Teenage*Smoked (protect)
7. Teenage*Morbidity (protect)

Hotspot groups:

N Ottawa Valley:

- MedInc (protect)
- %HigherEd*Smoked (protective)

Cambridge:

- MedInc* %HigherEd (protective)

Hamilton:

- Smoked*%Asian (protective)
- %NoDip*Health Problem(protective)

S. Georgian Bay

- MedInc*%HigherEd (Risk)

Results: SGA Risk Factors

Full province

1. MedInc*%NoDip (risk)
2. MedInc*%HigherEd (risk)
3. MedInc*Teenage (risk)
4. MedInc*Smoked (protect)
5. Morbidity*Smoked (risk)
6. %Asian*Smoked (protect)
7. %NoDip*Smoked risk)
8. Urban*Smoked (see forest plot)
9. Olderage*Smoked (risk)
10. %Asian*Olderage (protect)
11. %NoDip*Urban (risk)
12. Morbidity*Teen (protective)

Results: SGA Risk Factors

Full province

1. MedInc*%NoDip (risk)
2. MedInc*%HigherEd (risk)
3. MedInc*Teenage (risk)
4. MedInc*Smoked (protect)
5. Morbidity*Smoked (risk)
6. %Asian*Smoked (protect)
7. %NoDip*Smoked (risk)
8. Urban*Smoked (see forest plot)
9. Olderage*Smoked (risk)
10. %Asian*Olderage (protect)
11. %NoDip*Urban (risk)
12. Morbidity*Teen (protective)

Hotspot clusters:

East Toronto:

- Teenage (protect)
- Olderage (protect)

London:

- Smoked (risk)

Northwest Toronto:

- Teenage (risk)
- Smoked (risk)

Results: SGA Risk Factors

Full Province:

- Olderage
- MedInc
- %NoDip
- %HigherEd*Smoked

No local group models due to confidentiality requirements

Full-province Models Comparisons:

LateP

- *Smoked*
- *Olderage*%NoDip*
- *%Asian*Urban*
- *Teenage*Urban*
- *Teenage*HlthProb*

ModVeryP

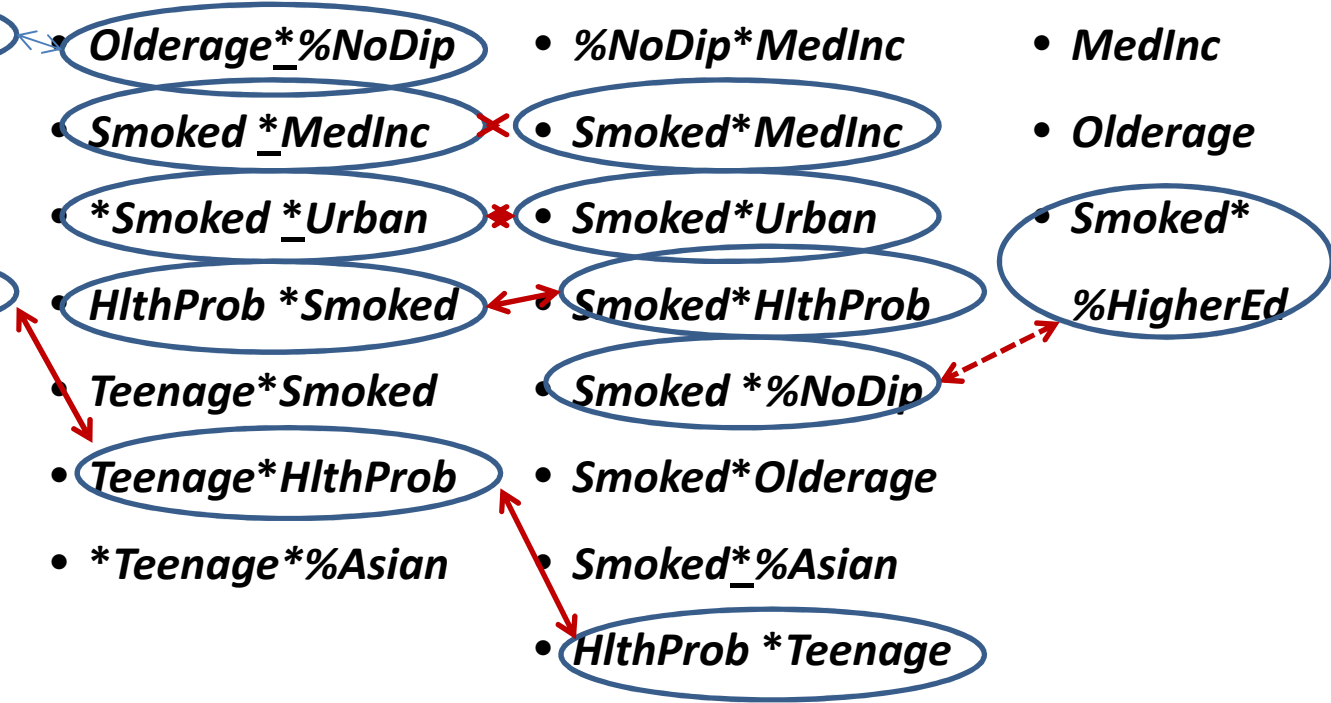
- *%HigherEd*
- *Olderage*%NoDip*
- *Smoked*_MedInc*
- **Smoked*_Urban*
- *HlthProb*Smoked*
- *Teenage*Smoked*
- *Teenage*HlthProb*
- **Teenage*%Asian*

SGA

- *%NoDip*Urban*
- *%NoDip*MedInc*
- *Smoked*MedInc*
- *Smoked*Urban*
- *Smoked*HlthProb*
- *Smoked*%NoDip*
- *Smoked*Olderage*
- *Smoked*%Asian*
- *HlthProb*Teenage*
- *MedInc*%HigherEd*
- *Teenage*MedInc*
- *Olderage*%Asian*
- *Olderage*%HighrEd*

Stillbirth

- *%NoDip*
- *MedInc*
- *Olderage*
- *Smoked**
- *%HigherEd*



Comparisons across provincial models:

- Older women in low education areas group at greatest risk:
- Smoked is the most influential single factor
 - Consistently risk increasing
 - Modifiable by other ecologic variables
- %NoDip consistently risk increasing
- Teenage consistently risk reducing - protective
- While LateP and ModVeryP represent arbitrary segments of a continuum they share few predictors

Comparisons across local models:

LateP

Northern Toronto

- Olderage* %NoDip

St. Catharine's

- %NoDip*HlthProb

SW Ottawa

- Olderage*%HigherEd

ModVeryP

N Ottawa Valley:

- MedInc
- %HigherEd*Smoked

Cambridge:

- MedInc* %HigherEd

Hamilton:

- Smoked*%Asian
- %NoDip*HlthProb

S. Georgian Bay

- MedInc*%HigherEd

SGA

East Toronto:

- Teenage
- Olderage

London

- Smoked

Northwest Toronto

- Teenage
- Smoked

Contradictory Findings:

- Hotspots for different adverse outcomes: largely spatially exclusive.
- *Teenage*: protective/risk-reducing relationship
- Median household income: no major / inconsistent presence
- Ecologic levels of education: more influential, more consistent predictor than income.

Conclusions:

- Small spatial scale analysis is required for understanding adverse birth outcome aetiologies
 - Identical predictors (teenage, median income*HigherEd) had opposite effects in different hotspot group models.
- Ecologic and individual-level risk factors and interactions are both important
- Preterm and *SGA* each need to be analyzed as multifaceted phenomena.

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