Liver cancer and immigration: small-area analysis of incidence within Ottawa and the Greater Toronto Area, 1999 to 2003.

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Population Studies and Surveillance

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Outline

- Background
- Objective
- Data, Methods and Tools
- Results
- Implications
- Limitations
- References
- Questions
- Future work

Background

- Liver cancer:
  - Worldwide, sixth most common cancer and third most common cause of cancer mortality (Chen et al, 2008).
  - > 80% of cases and mortality are in developing countries, with majority in sub-Saharan Africa or Eastern Asia, with China accounting for >50% of cases (McGlynn and London, 2005).
  - Hepatocellular carcincoma (HCC) accounts for 75%-90% of liver cancers, and HCC incidence is two-to-four times higher among men (McGlynn and London, 2005).

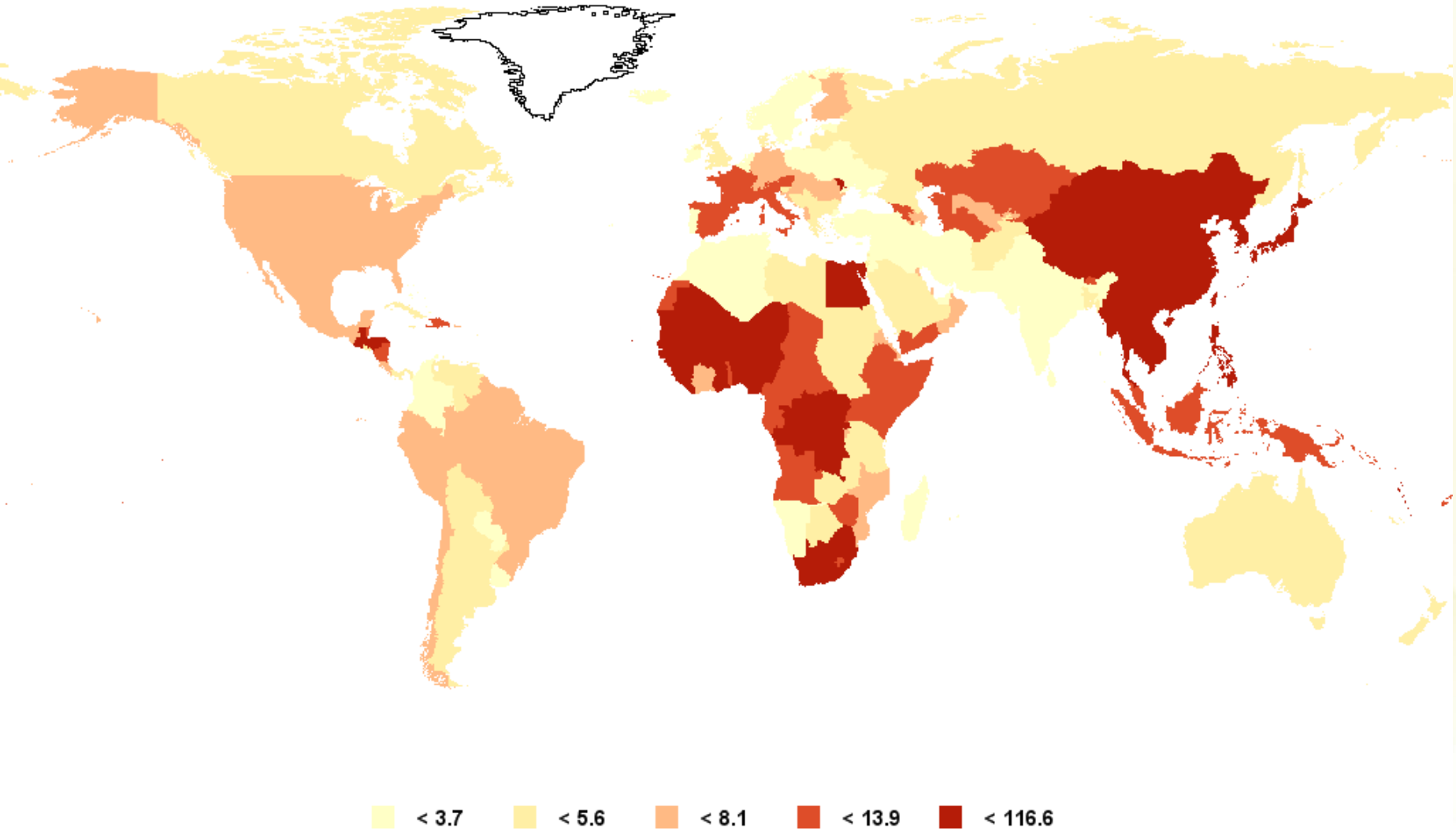
Background

- Risk factors:
  - For HCC, chronic infection with Hepatitis B or C (HBV or HCV)
  - Exposure to aflatoxin B_1 (AFB1)
  - Alcohol consumption

  (IARC, 2010; Seitz and Becker, 2007; McGlynn and London, 2005).

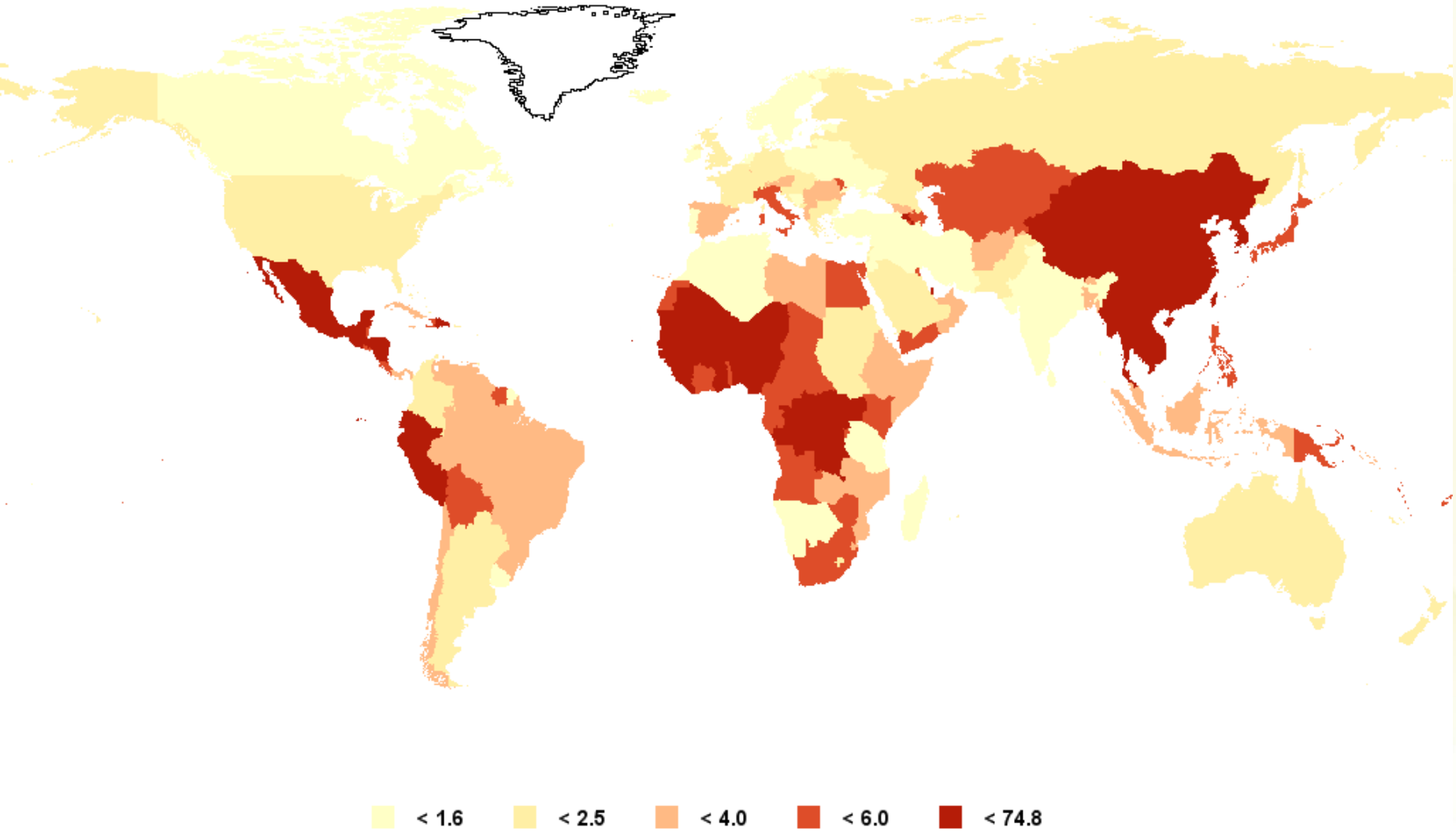
International Agency for Research on Cancer
World Health Organization

Estimated age-standardised incidence rate per 100,000
Liver: male, all ages



GLOBOCAN 2008 (IARC) - 14.6.2010

Estimated age-standardised incidence rate per 100,000
Liver: female, all ages

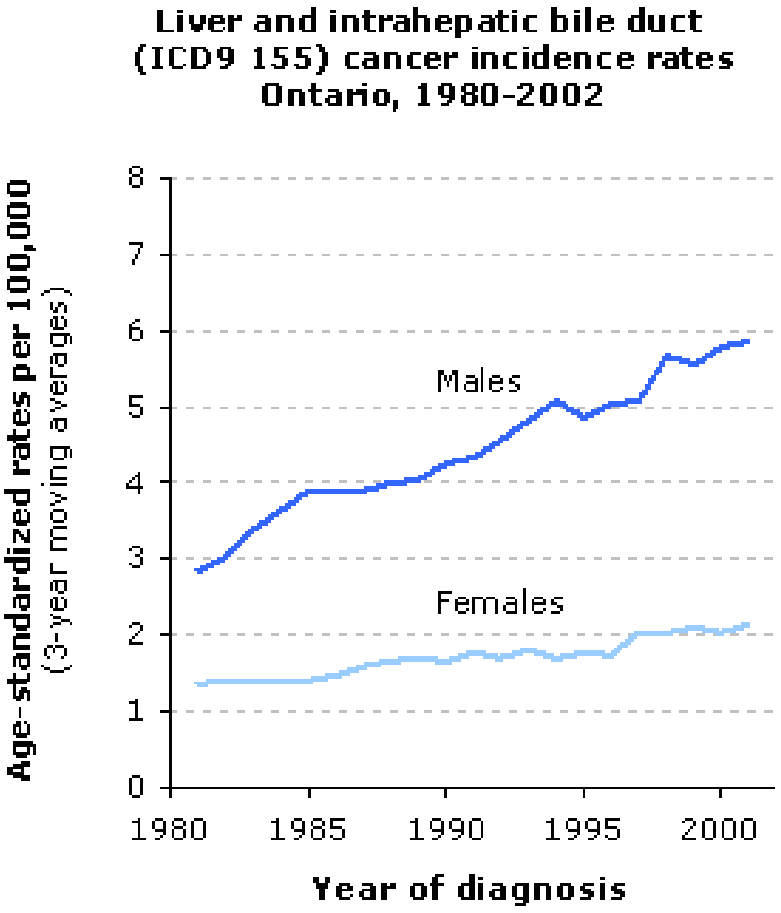


GLOBOCAN 2008 (IARC) - 14.6.2010

Background

- Liver cancer in Ontario:
  - 4th most fatal cancer
  - HCC most common.
  - Increasing trend may be related to increasing immigration from areas with endemic HBV infection and exposure to AFB_1.
  - **Male incidence increased 3.3% annually from 1980 to 2002.**

(Cancer Care Ontario, 2005 and 2006)



Source: Cancer Care Ontario (Ontario Cancer Registry, 2006)

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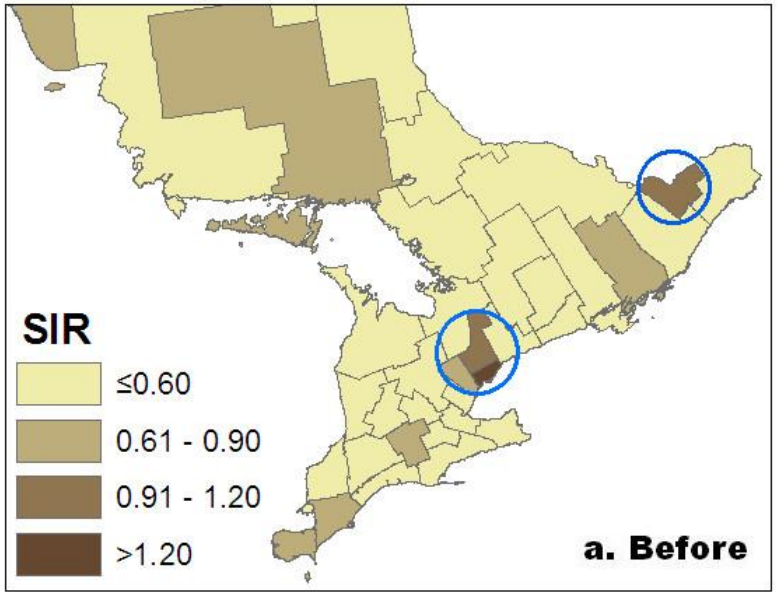
Chen, Yi and Mao (2008)

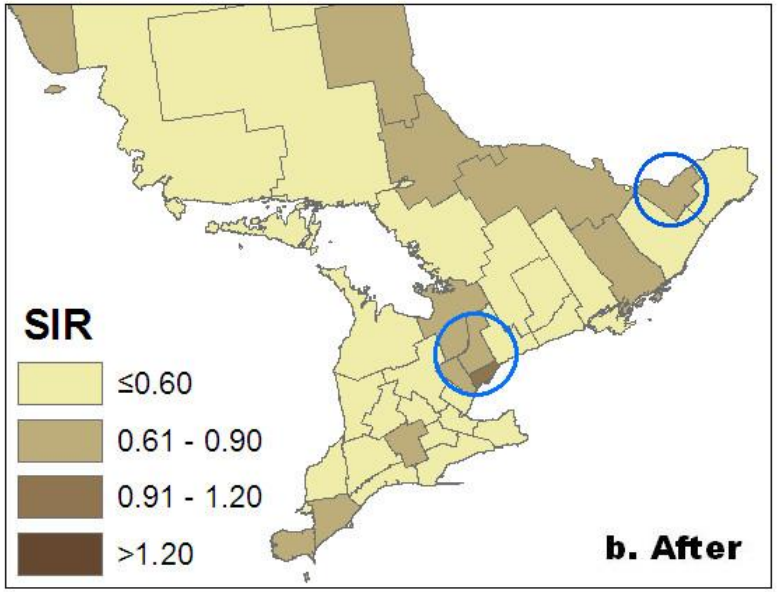
Standardized incidence ratios for the 35 public health units Ontario

a. Before adjustment for proportion of immigrants, age, sex and geographic location
b. After adjustment for proportion of immigrants, age, sex, and geographic location

Table 3: Regression coefficients (β) and standard errors (SE_β) for liver cancer in Ontario – Poisson regression analysis

Variables	β	SE_β	p value
Intercept	-4.9339	1.6249	0.005
Age (years)			
15–49	-1.991	0.320	<0.001
50–59	0.334	0.303	0.270
60–69	0.645	0.277	0.021
70–79	0.913	0.272	<0.001
80+	(Reference)		
Sex			
Male	(Reference)		
Female	-0.745	0.1598	<0.001
Sex × age interaction			
15–49	-0.463	0.220	0.037
50–59	-0.949	0.219	<0.001
60–69	-0.470	0.189	0.013
70–79	-0.343	0.182	0.061
Proportion of immigrants	0.00791	0.00248	0.002
Geolocation			
Latitude	0.0106	0.0273	0.699
Longitude	0.0505	0.0208	0.015





Ottawa, Toronto and York Immigration

NAME	Population	Immigrant Pop.	% Immigrant Po	Chinese born	% Chines
Toronto Division	2456805	1214625	49.44%	102635	8.45%
Peel Regional Municipality	985565	424820	43.10%	9970	2.35%
York Regional Municipality	725665	283790	39.11%	22380	7.89%
Hamilton Division	484385	119810	24.73%	2450	2.04%
Halton Regional Municipality	372410	83250	22.35%	1105	1.33%
Ottawa Division	763790	166745	21.83%	12840	7.70%
Essex County	371085	79775	21.50%	2875	3.60%
Waterloo Regional Municipality	433875	92775	21.38%	2315	2.50%
Middlesex County	398565	77005	19.32%	1635	2.12%
Durham Regional Municipality	502905	94890	18.87%	1110	1.17%
Niagara Regional Municipality	404590	71200	17.60%	905	1.27%
Wellington County	184840	30470	16.48%	900	2.95%
Elgin County	80150	11390	14.21%	70	0.61%
Brant County	116750	15230	13.04%	155	1.02%
Frontenac County	135410	16755	12.37%	660	3.94%
Dufferin County	50360	6130	12.17%	25	0.41%
Simcoe County	372325	43460	11.67%	515	1.18%
Lambton County	125565	14520	11.56%	155	1.07%
Haldimand-Norfolk Regional Municipality	103330	11815	11.43%	35	0.30%
Oxford County	97965	10825	11.05%	25	0.23%

Top 20 Ontario Census Divisions sorted by immigrant population (in descending order).
Source: 2001 Census of Canada, Statistics Canada

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Objective

- Follow-up on the findings of Chen, Yi and Mao (2008) to determine if the association of liver cancer and immigrant population exists at the small-area level.

Data Sources, Methods and Tools

Liver Cancer data
- Ontario Cancer Registry, 1999-2003

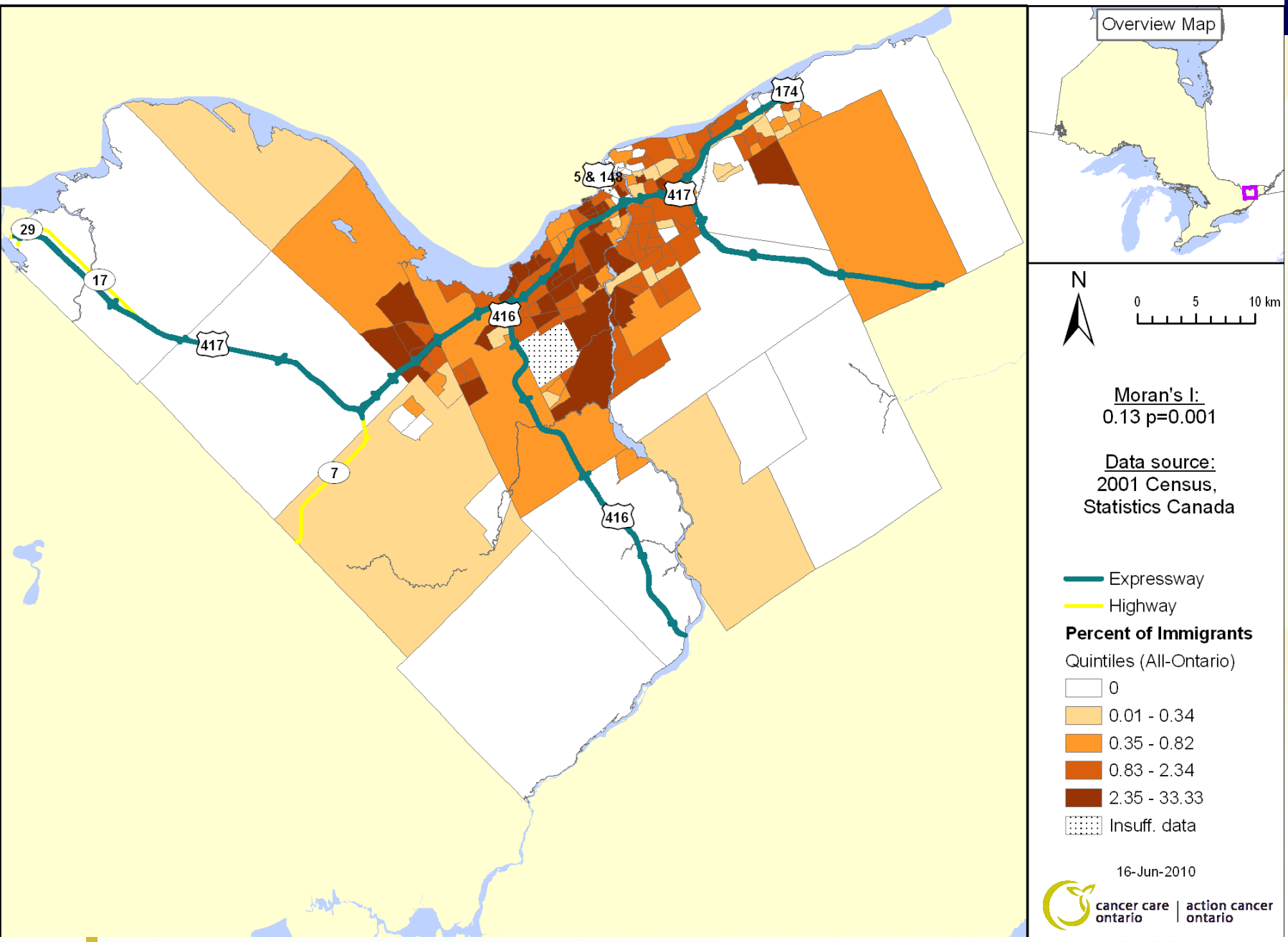
Statistics Canada Census 2001
- Census geography
- Population by 5 year age group and sex
- Immigrant birth place

Link data
Postcode - DA
CT, CMA/CA
CSD, CD boundaries
PCCF+

Tools Methods
- Rapid Inquiry Facility -> SIRs
- ArcGIS -> mapping/spatial
- WinBUGS -> Bayesian inference
- Besag, York, Mollié (BYM) model
- SaTScan -> corroboration

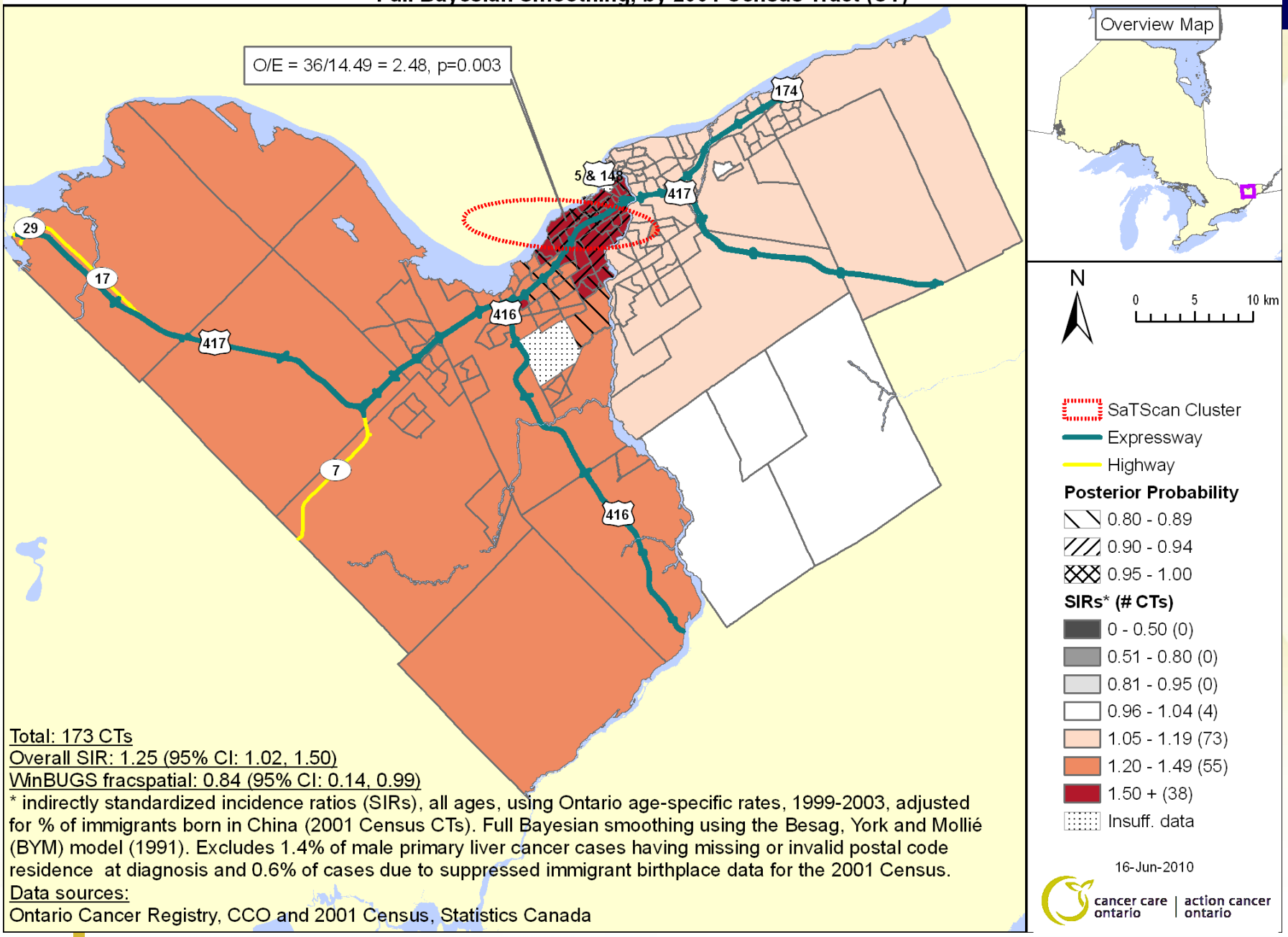
RESULTS

Chinese-born Immigrant Population, 2001, Ottawa Division by Census Tract (CT)



Male Primary Liver Cancer Incidence 1999-2003 (127 observed cases), Ottawa Division

Full Bayesian Smoothing, by 2001 Census Tract (CT)



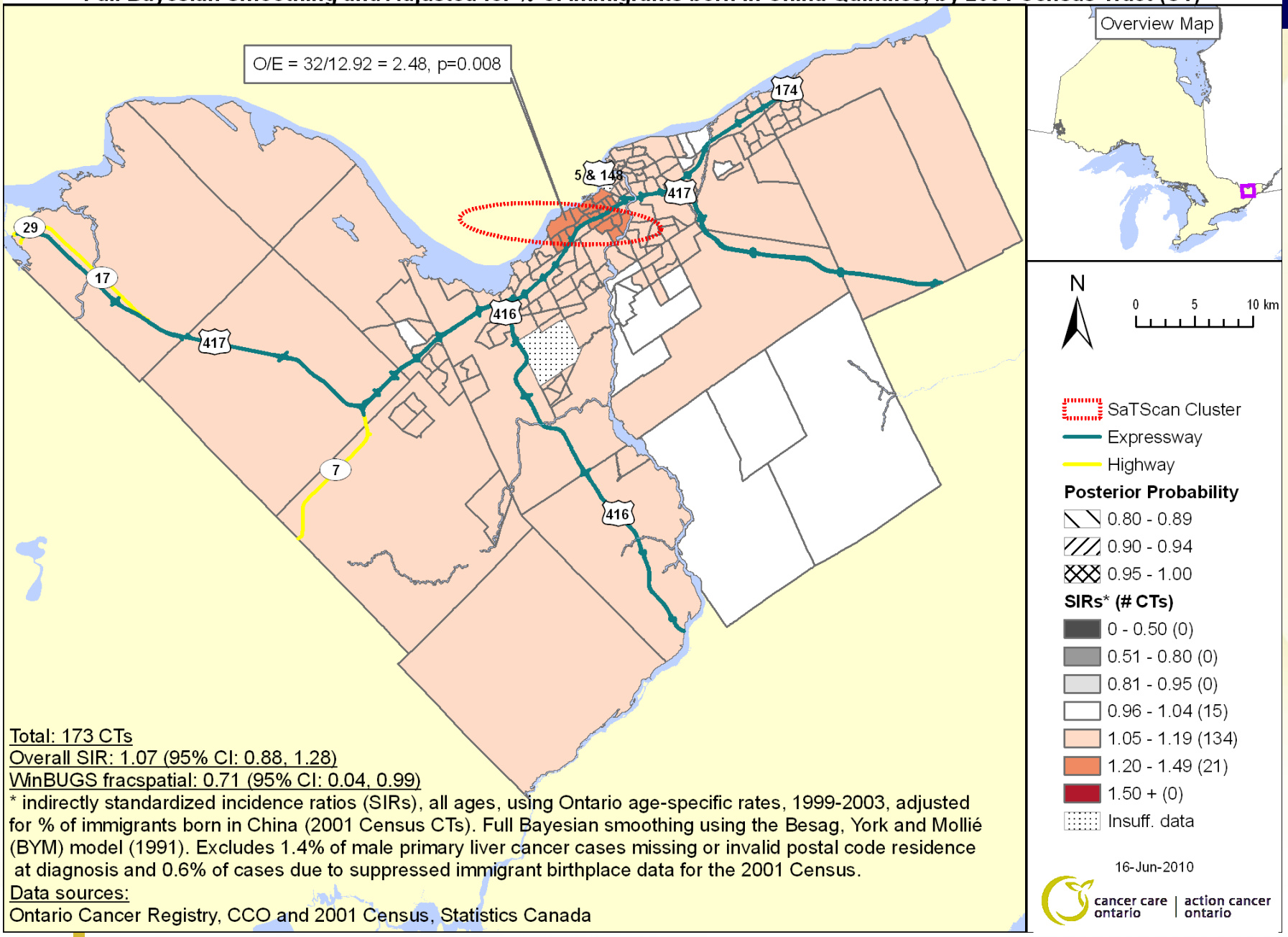
Total: 173 CTs
Overall SIR: 1.25 (95% CI: 1.02, 1.50)
WinBUGS fracspatial: 0.84 (95% CI: 0.14, 0.99)

* indirectly standardized incidence ratios (SIRs), all ages, using Ontario age-specific rates, 1999-2003, adjusted for % of immigrants born in China (2001 Census CTs). Full Bayesian smoothing using the Besag, York and Mollié (BYM) model (1991). Excludes 1.4% of male primary liver cancer cases having missing or invalid postal code residence at diagnosis and 0.6% of cases due to suppressed immigrant birthplace data for the 2001 Census.

Data sources:
Ontario Cancer Registry, CCO and 2001 Census, Statistics Canada

Male Primary Liver Cancer Incidence 1999-2003 (127 observed cases), Ottawa Division

Full Bayesian Smoothing and Adjusted for % of Immigrants born in China Quintiles, by 2001 Census Tract (CT)



Total: 173 CTs
Overall SIR: 1.07 (95% CI: 0.88, 1.28)
WinBUGS fracspatial: 0.71 (95% CI: 0.04, 0.99)

* indirectly standardized incidence ratios (SIRs), all ages, using Ontario age-specific rates, 1999-2003, adjusted for % of immigrants born in China (2001 Census CTs). Full Bayesian smoothing using the Besag, York and Mollié (BYM) model (1991). Excludes 1.4% of male primary liver cancer cases missing or invalid postal code residence at diagnosis and 0.6% of cases due to suppressed immigrant birthplace data for the 2001 Census.

Data sources:
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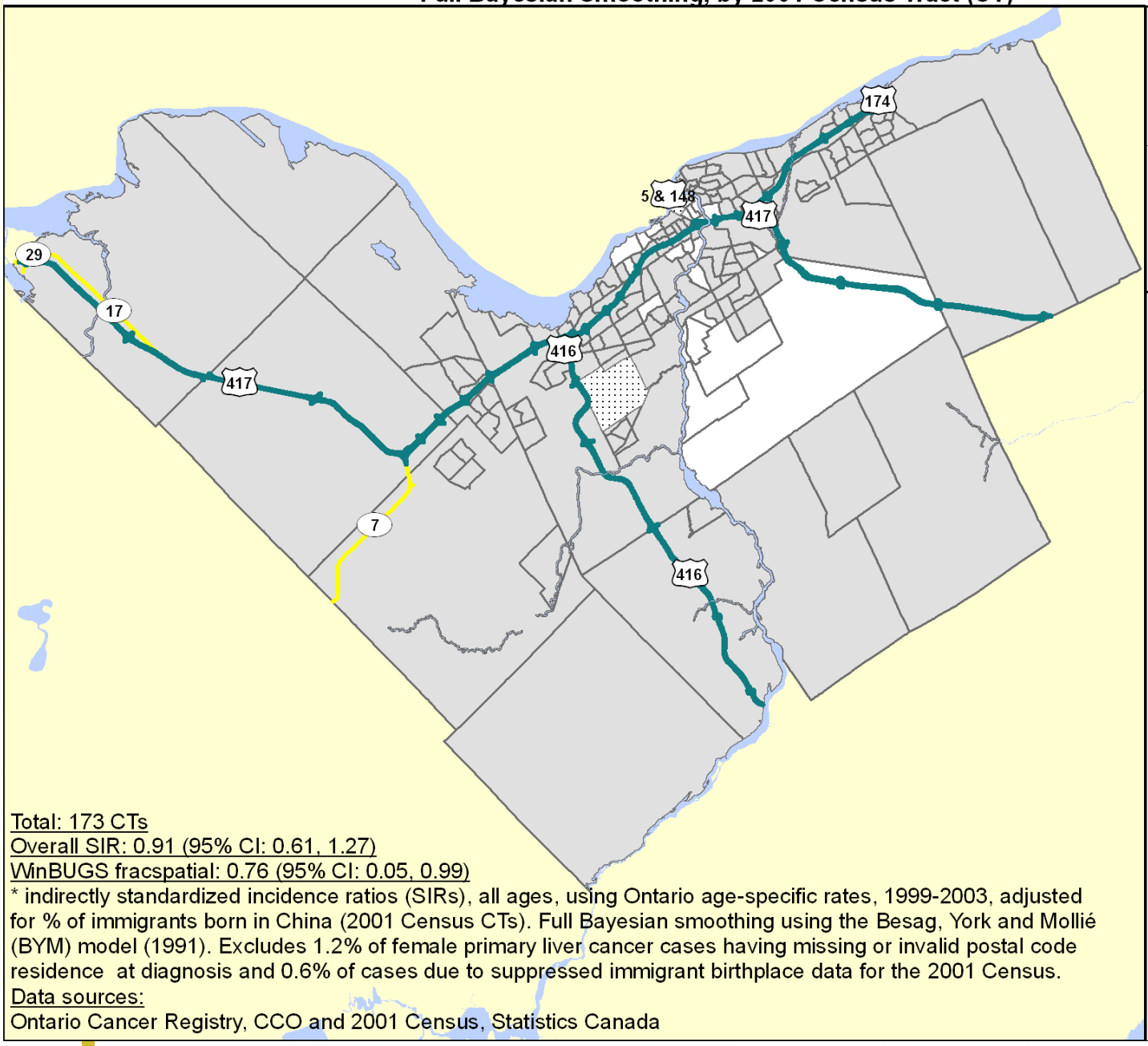
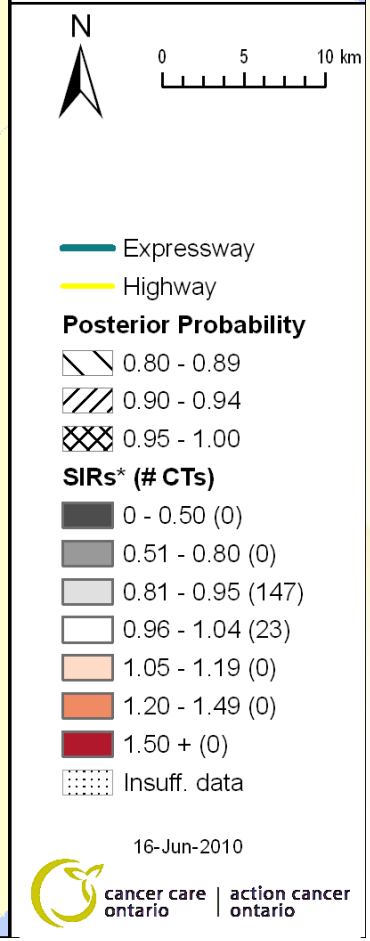
Female Primary Liver Cancer Incidence 1999-2003 (30 observed cases), Ottawa Division

Full Bayesian Smoothing, by 2001 Census Tract (CT)





Total: 173 CTs
Overall SIR: 0.91 (95% CI: 0.61, 1.27)
WinBUGS fracspatial: 0.76 (95% CI: 0.05, 0.99)

* indirectly standardized incidence ratios (SIRs), all ages, using Ontario age-specific rates, 1999-2003, adjusted for % of immigrants born in China (2001 Census CTs). Full Bayesian smoothing using the Besag, York and Mollié (BYM) model (1991). Excludes 1.2% of female primary liver cancer cases having missing or invalid postal code residence at diagnosis and 0.6% of cases due to suppressed immigrant birthplace data for the 2001 Census.

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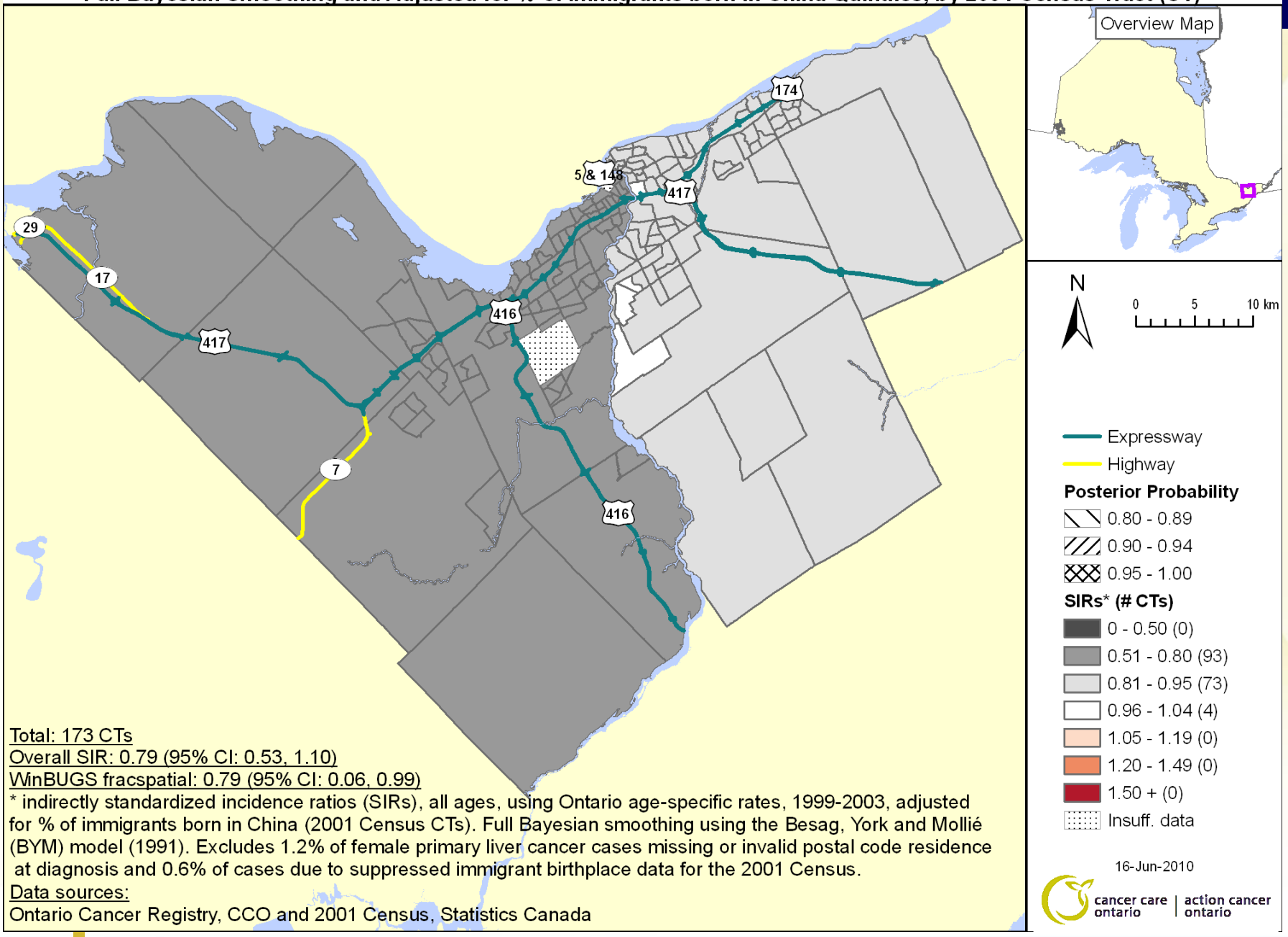
Full Bayesian Smoothing and Adjusted for % of Immigrants born in China Quintiles, by 2001 Census Tract (CT)



Total: 173 CTs
Overall SIR: 0.79 (95% CI: 0.53, 1.10)
WinBUGS fracspatial: 0.79 (95% CI: 0.06, 0.99)

* indirectly standardized incidence ratios (SIRs), all ages, using Ontario age-specific rates, 1999-2003, adjusted for % of immigrants born in China (2001 Census CTs). Full Bayesian smoothing using the Besag, York and Mollié (BYM) model (1991). Excludes 1.2% of female primary liver cancer cases missing or invalid postal code residence at diagnosis and 0.6% of cases due to suppressed immigrant birthplace data for the 2001 Census.

Data sources:
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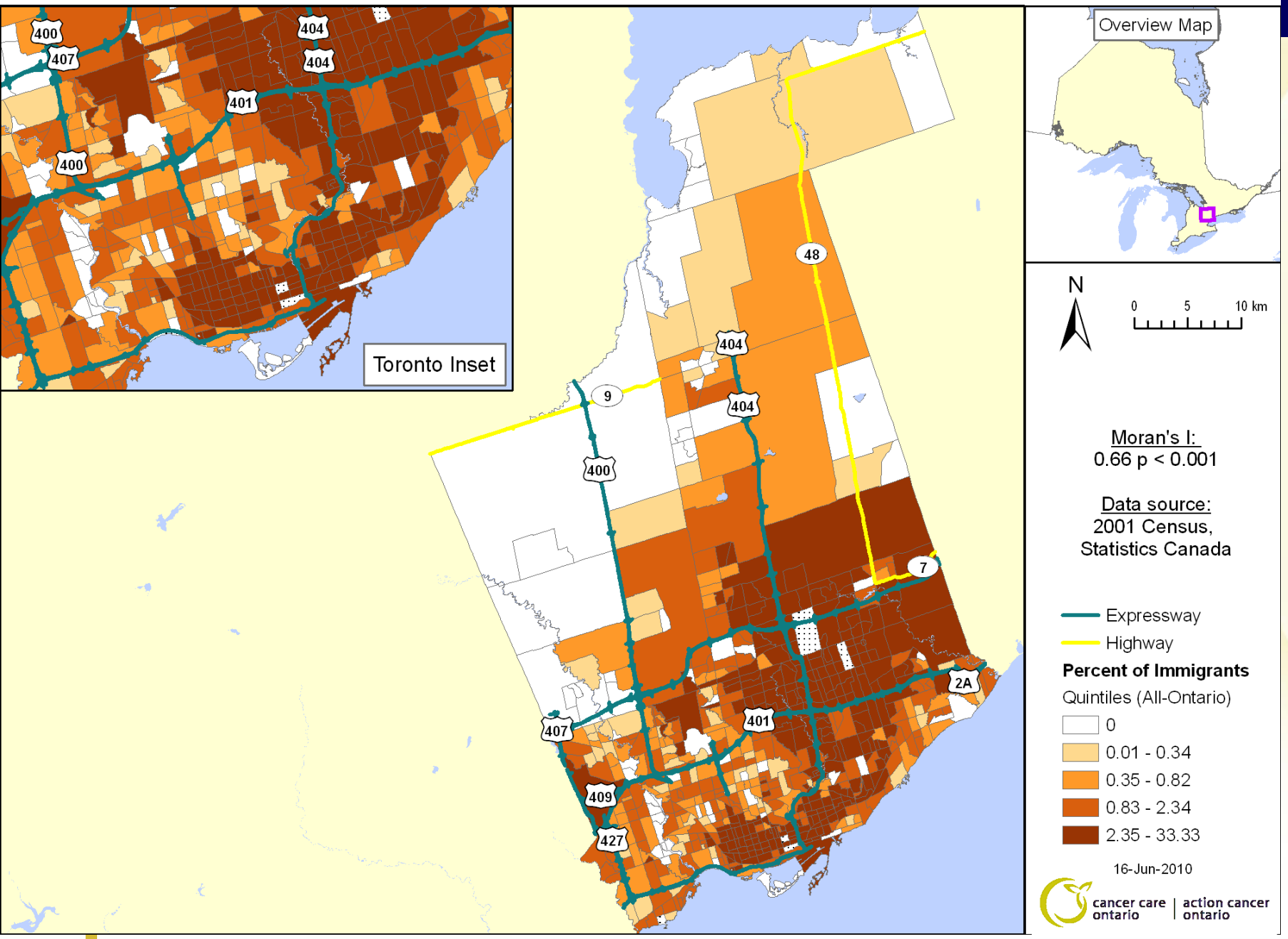
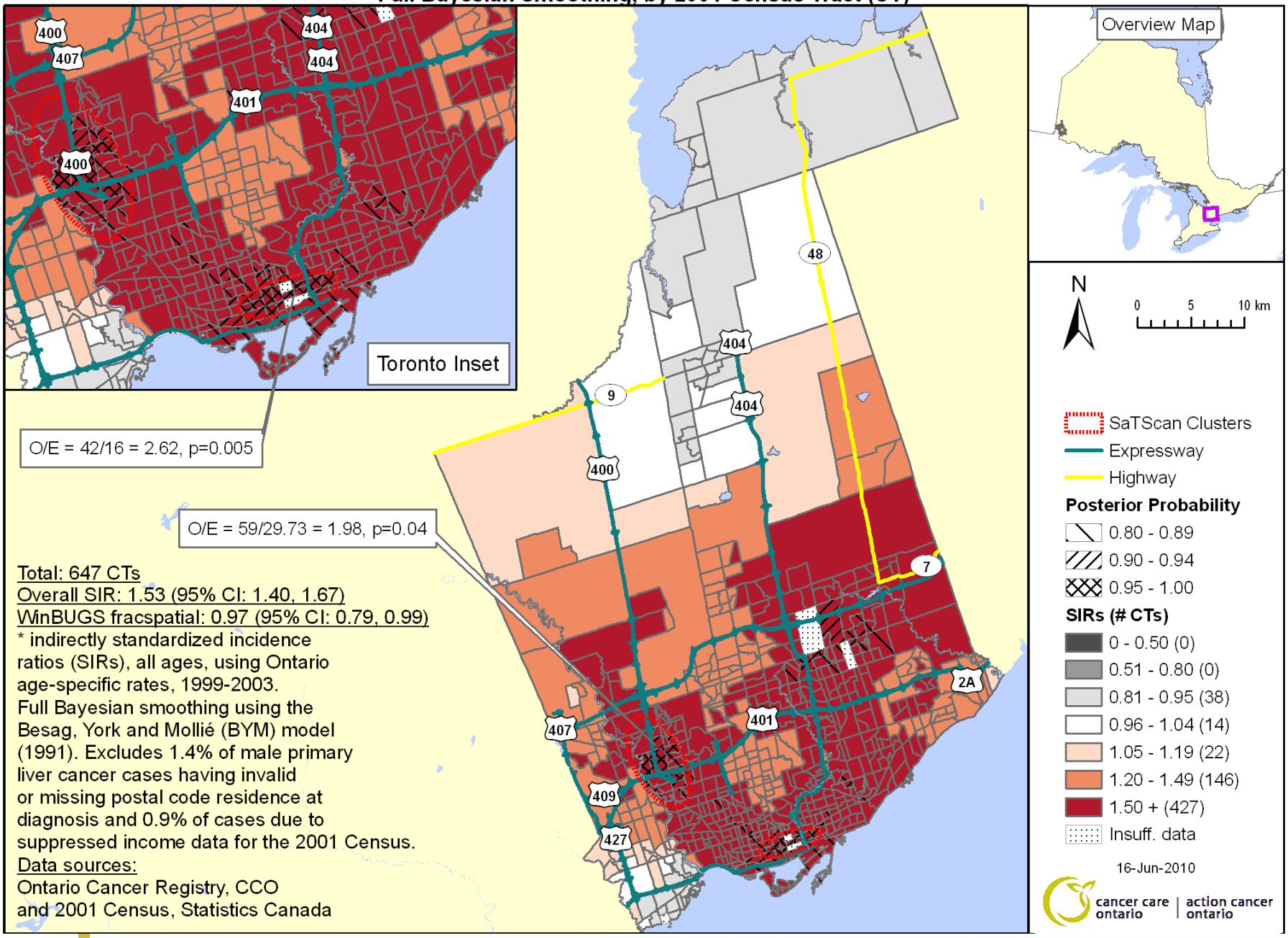
Chinese-born Immigrant Population, 2001, Toronto and York Regions by Census Tract (CT)



Male Primary Liver Cancer Incidence 1999-2003 (690 observed cases), Toronto and York Regions

Full Bayesian Smoothing, by 2001 Census Tract (CT)



Total: 647 CTs
Overall SIR: 1.53 (95% CI: 1.40, 1.67)
WinBUGS fracspatial: 0.97 (95% CI: 0.79, 0.99)

* indirectly standardized incidence ratios (SIRs), all ages, using Ontario age-specific rates, 1999-2003.
Full Bayesian smoothing using the Besag, York and Mollié (BYM) model (1991). Excludes 1.4% of male primary liver cancer cases having invalid or missing postal code residence at diagnosis and 0.9% of cases due to suppressed income data for the 2001 Census.

Data sources:
Ontario Cancer Registry, CCO
and 2001 Census, Statistics Canada

Male Primary Liver Cancer Incidence 1999-2003 (690 observed cases), Toronto and York Regions

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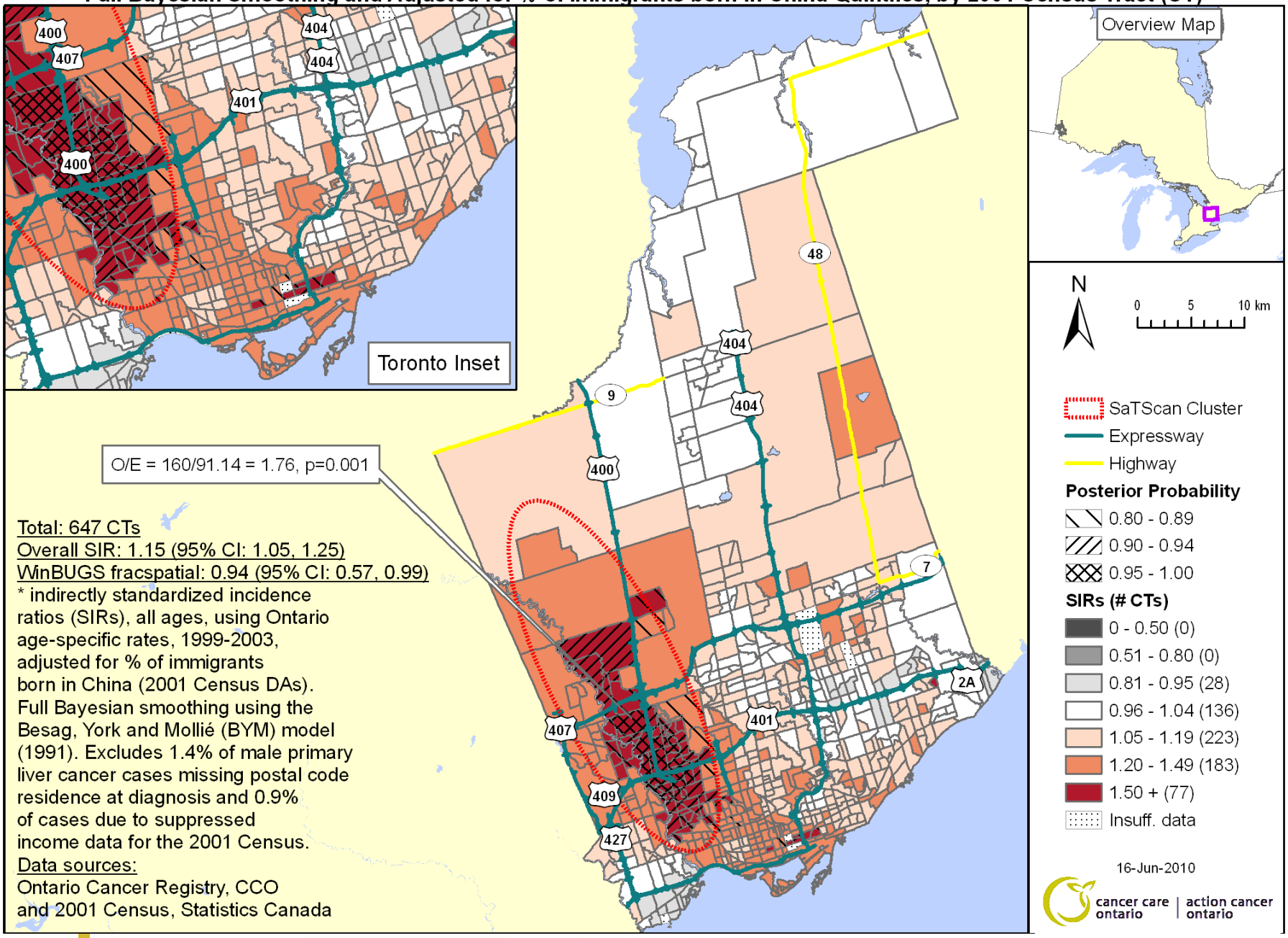


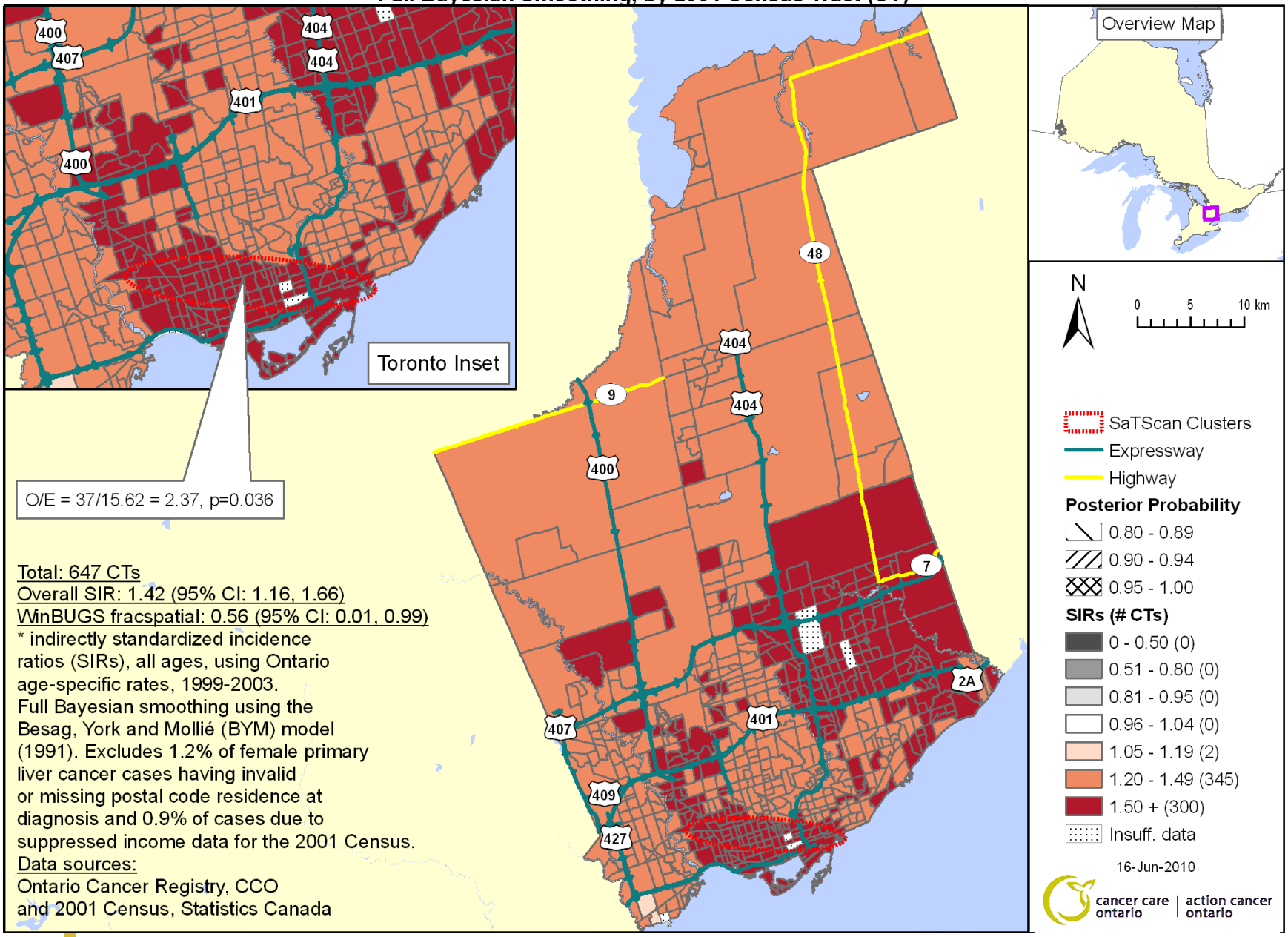
Total: 647 CTs
Overall SIR: 1.15 (95% CI: 1.05, 1.25)
WinBUGS fracspatial: 0.94 (95% CI: 0.57, 0.99)

* indirectly standardized incidence ratios (SIRs), all ages, using Ontario age-specific rates, 1999-2003, adjusted for % of immigrants born in China (2001 Census DAs). Full Bayesian smoothing using the Besag, York and Mollié (BYM) model (1991). Excludes 1.4% of male primary liver cancer cases missing postal code residence at diagnosis and 0.9% of cases due to suppressed income data for the 2001 Census.

Data sources:
Ontario Cancer Registry, CCO
and 2001 Census, Statistics Canada

Female Primary Liver Cancer Incidence 1999-2003 (206 observed cases), Toronto and York Regions

Full Bayesian Smoothing, by 2001 Census Tract (CT)



Total: 647 CTs
Overall SIR: 1.42 (95% CI: 1.16, 1.66)
WinBUGS fracspatial: 0.56 (95% CI: 0.01, 0.99)
* indirectly standardized incidence ratios (SIRs), all ages, using Ontario age-specific rates, 1999-2003.
Full Bayesian smoothing using the Besag, York and Mollié (BYM) model (1991). Excludes 1.2% of female primary liver cancer cases having invalid or missing postal code residence at diagnosis and 0.9% of cases due to suppressed income data for the 2001 Census.
Data sources:
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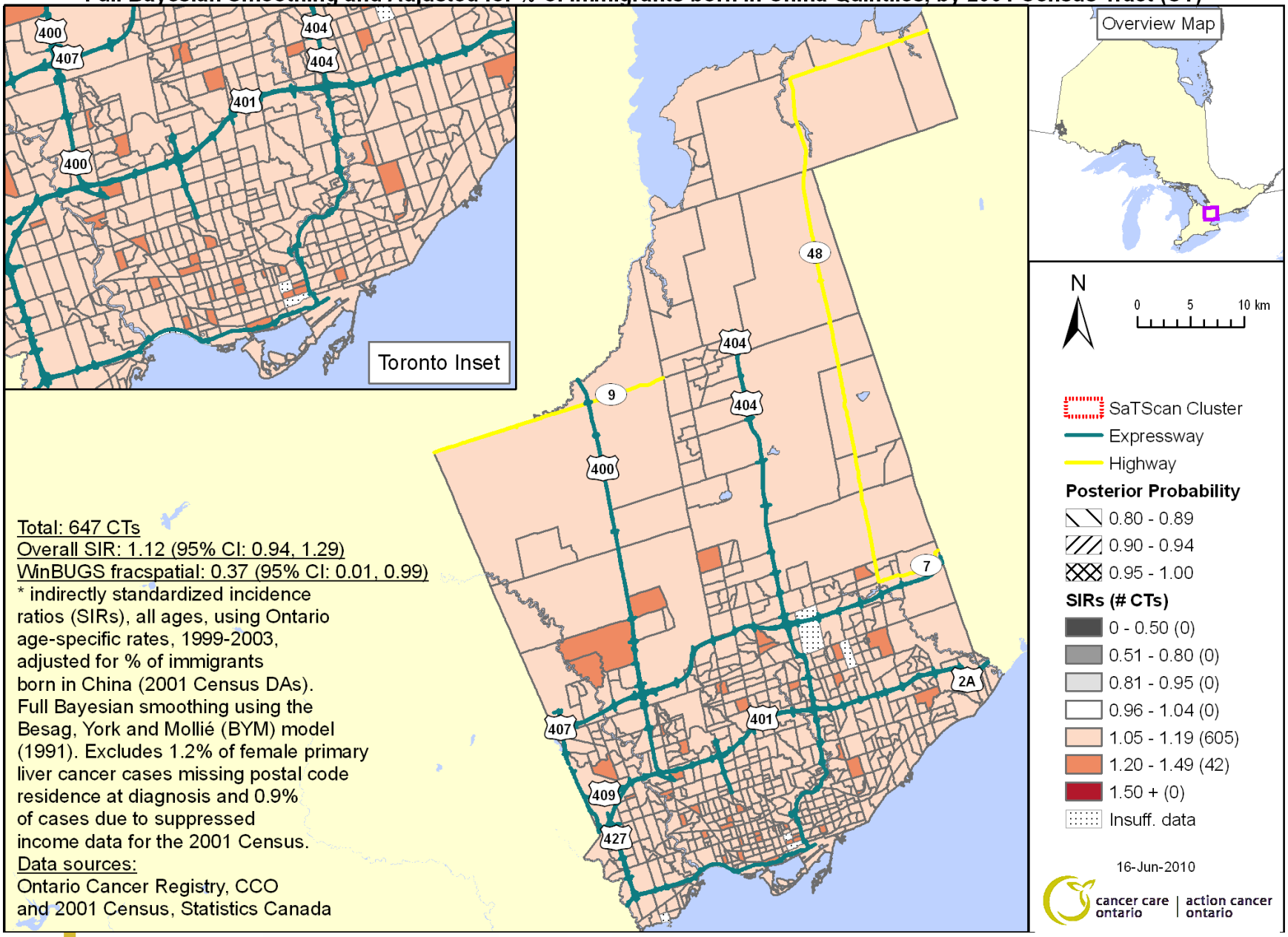
Female Primary Liver Cancer Incidence 1999-2003 (206 observed cases), Toronto and York Regions

Full Bayesian Smoothing and Adjusted for % of Immigrants born in China Quintiles, by 2001 Census Tract (CT)



Total: 647 CTs
Overall SIR: 1.12 (95% CI: 0.94, 1.29)
WinBUGS fracspatial: 0.37 (95% CI: 0.01, 0.99)

* indirectly standardized incidence ratios (SIRs), all ages, using Ontario age-specific rates, 1999-2003, adjusted for % of immigrants born in China (2001 Census DAs). Full Bayesian smoothing using the Besag, York and Mollié (BYM) model (1991). Excludes 1.2% of female primary liver cancer cases missing postal code residence at diagnosis and 0.9% of cases due to suppressed income data for the 2001 Census.

Data sources:
Ontario Cancer Registry, CCO
and 2001 Census, Statistics Canada

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Summary

- Spatial clustering of elevated rates of primary liver cancer incidence exists for the 1999-2003 period for males in Ottawa, and for both sexes in the Toronto-York regions.
- % of population that were Chinese-born attenuates elevated SIRs overall, but does not account for all variations in local-area spatial patterns.
- Continue investigation…

Implications

- Planning for service utilization
- Collaboration with Public Health to promote HBV immunization targeted to areas with high risk for liver cancer.

Limitations

- % immigrant population by birth place covariate:
  - not sex-specific;
  - for use in the RIF, converted to ordinal data (quintiles) and not possible to quantify effect as a coefficient
- Ecological analysis -> associations not causality

References

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QUESTIONS?

Future work

- Implement BYM model using R and WinBUGS using Bayesian inference with immigrant birth place as continuous covariate to quantify the association and significance;
- Examine ethnicity, SES as covariates;
- Examine different time periods: 1984-1988 and 2004-2008 to explore temporal and spatial persistence of these clusters
- Include estimates of HBV and HCV prevalence (if possible);
- Utilize birth place of individual from mortality file linked to OCR.