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Estimating Neighbourhood-Level Behavioural Risk Factor Prevalence from Large Population-Based Surveys: A Bayesian Approach

L Seliske[1], T Norwood[1,2], J McLaughlin[2,3], S Wang[2], C Palleschi[4], E Holowaty[2]

1. Cancer Care Ontario, Toronto, ON, Canada
2. Dalla Lana School of Public Health, Toronto, ON, Canada
3. Public Health Ontario, Toronto, ON, Canada
4. Lambton Public Health, Sarnia, ON, Canada

Journal Article

"Estimating micro area behavioural risk factor prevalence from large population-based surveys: a full Bayesian approach"

L. Seliske, T.A. Norwood, J.R. McLaughlin, S. Wang, C. Palleshi, and E. Holowaty

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Outline

- Background
- Rationale & Objectives
- Study Area
- Methods
- Results
- Strengths & Limitations
- Conclusions
- Acknowledgements

Background

- Meeting local health needs a key objective of public health units (PHUs)
- Localized risk factor prevalence estimates:
    i. Provide information for targeted public health programs
    ii. Inform neighbourhood-level models of related chronic diseases

Background

- Complex surveys provide high quality data at a regional level, but not neighbourhood level
- Small numerator and denominators are a challenge in neighbourhood-level analyses
- Bayesian methods can overcome these challenges

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Study Rationale & Objectives

Study Rationale

To generate neighbourhood-level covariate-adjusted estimates of behavioural risk factors:

i. to help public health planning

ii. to inform future neighbourhood-level models of chronic disease

Objectives

i. Estimate current smoking and excess bodyweight prevalence with acceptable precision and accuracy, accounting for spatial correlation and potential confounders

ii. Identify areas of unusually high prevalence

iii. Describe the spatial distribution over the entire study area by sex

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Study Area

Ontario
Cancer Care Ontario

Study Area

Study Area

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Methods

CCHS Data

- Risk factor data from Canadian Community Health Survey (CCHS), 5 cycles (2000-2001 to 2009-2010). Similar to BFRSS

  Current Smoking: smoke daily or occasionally

  Excess Bodyweight: body mass index (BMI) $\geq$ 25 kg/m^2

- Postal code conversion file used to identify respondents' neighbourhoods

Geographical Data

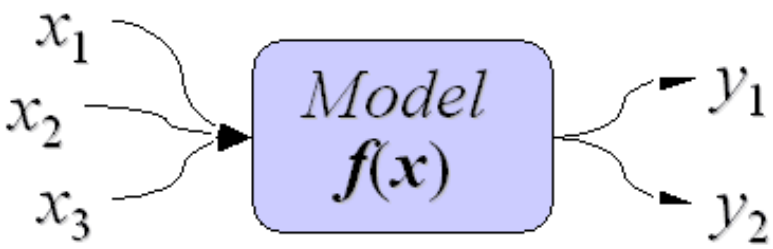
- Geographical unit ("neighbourhood") = 2006 Census Dissemination Area (DA)
  - Smallest geographical unit with full set of census data
  - Population: 400-700 people
  - Size varies: urban area =~ city block, rural DAs are larger, defined by rivers, roads, etc.

Bayesian Analysis

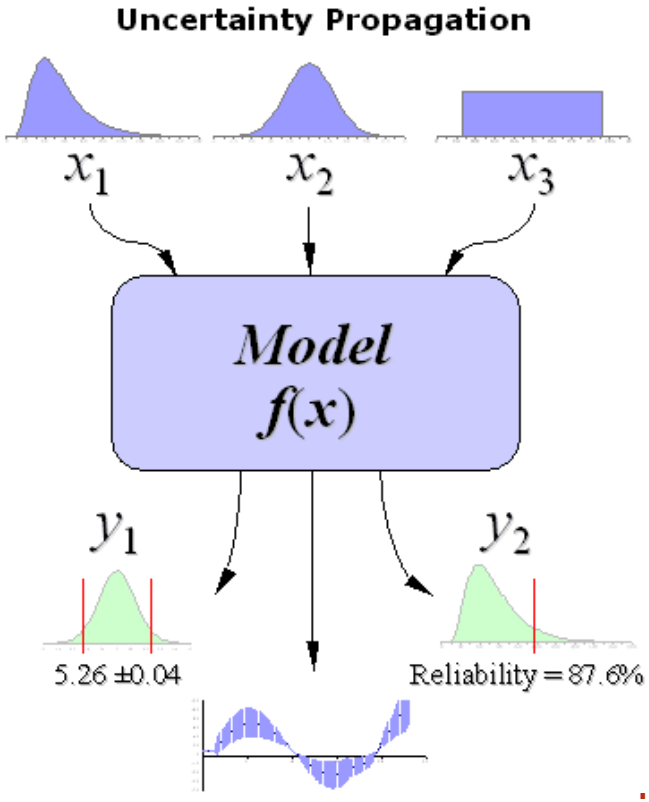
- Problems:
  i. Small numbers of cases (0, 1, 2,...)
  ii. Spatial dependence
- Solution: Bayesian modeling with hierarchical random effects
  - Allows for uncertainty due to low counts
  - Uses spatial dependence to pool information from adjacent areas

Fixed vs. Random Effects

Deterministic Model



Stochastic Uncertainty



Model Specification

- **Outcome:** binary individual-level risk factor (yes/no) for current smoking and excess bodyweight
- **Logistic regression:** log(p/(1-p))
- **Covariates:** CCHS cycle, age group (10 yr groups), median neighbourhood-level income

  Model 1: CCHS cycle & age group only

  Model 2: CCHS cycle, age group, income

Model Specification

- Bayesian analysis using Besag, York & Mollié (BYM) model
- Post-stratification weighted findings based on neighbourhood demographics due to complex CCHS sampling
- SaTScan used to corroborate findings using raw CCHS data

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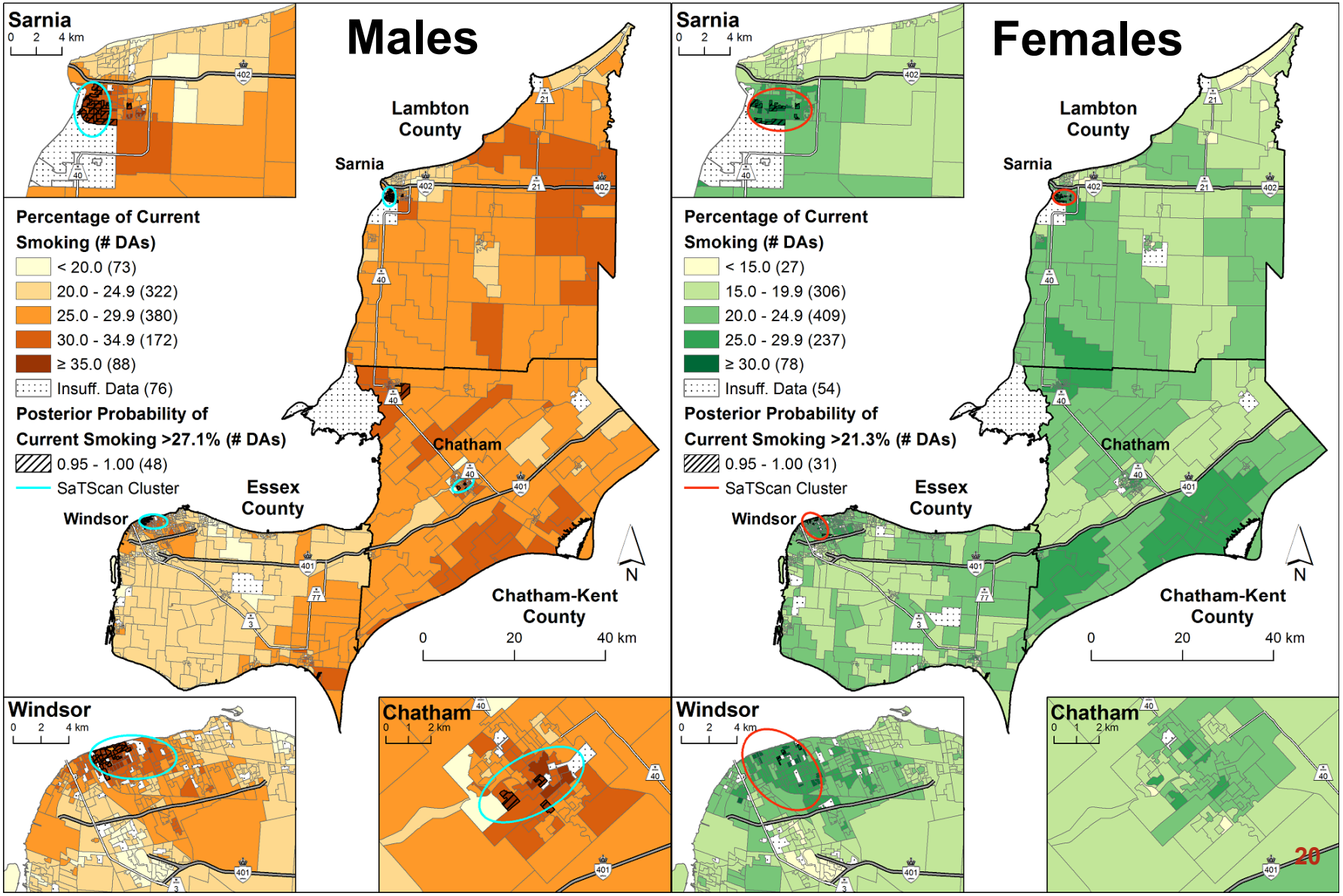
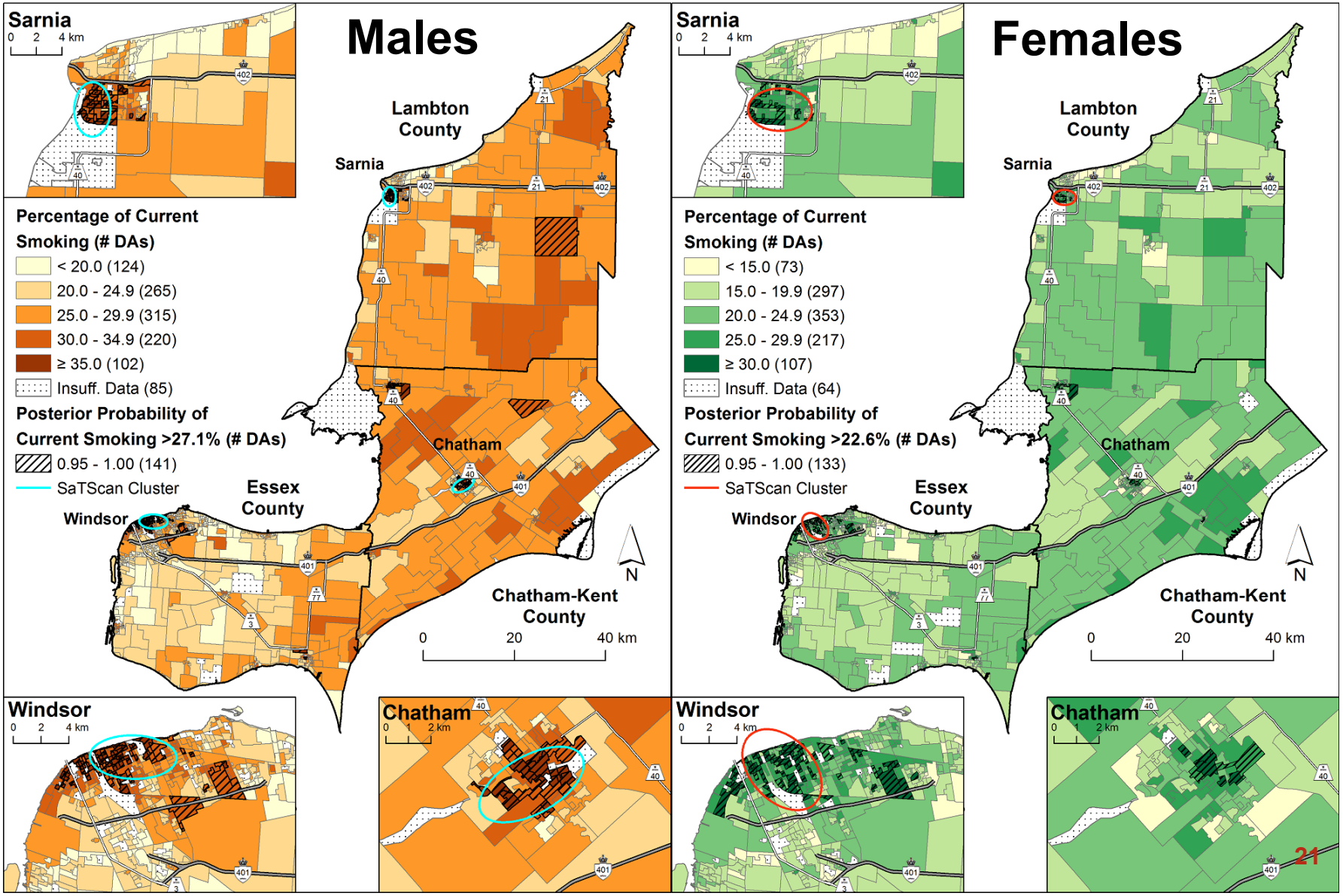
Results

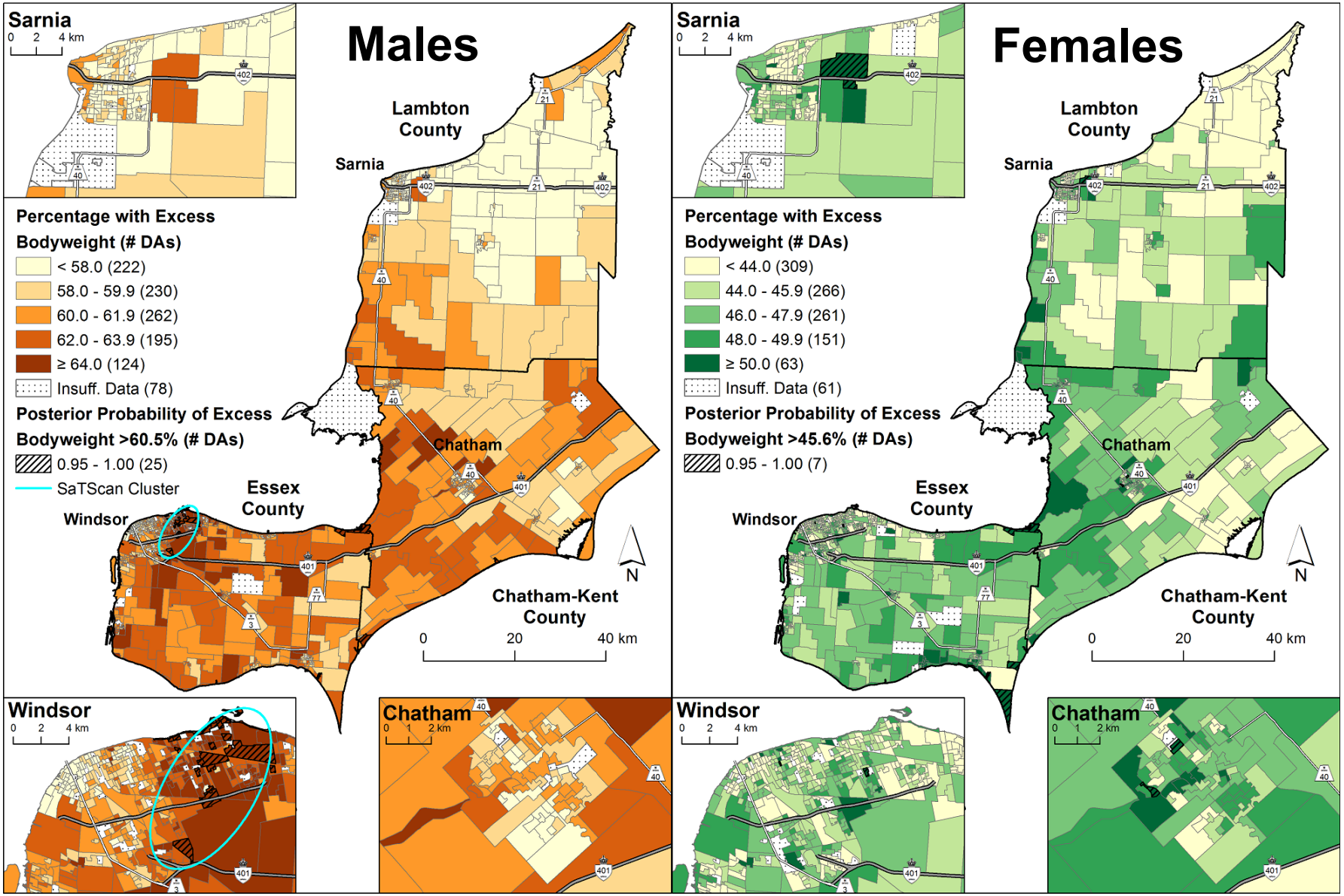
Current Smoking: Model 1



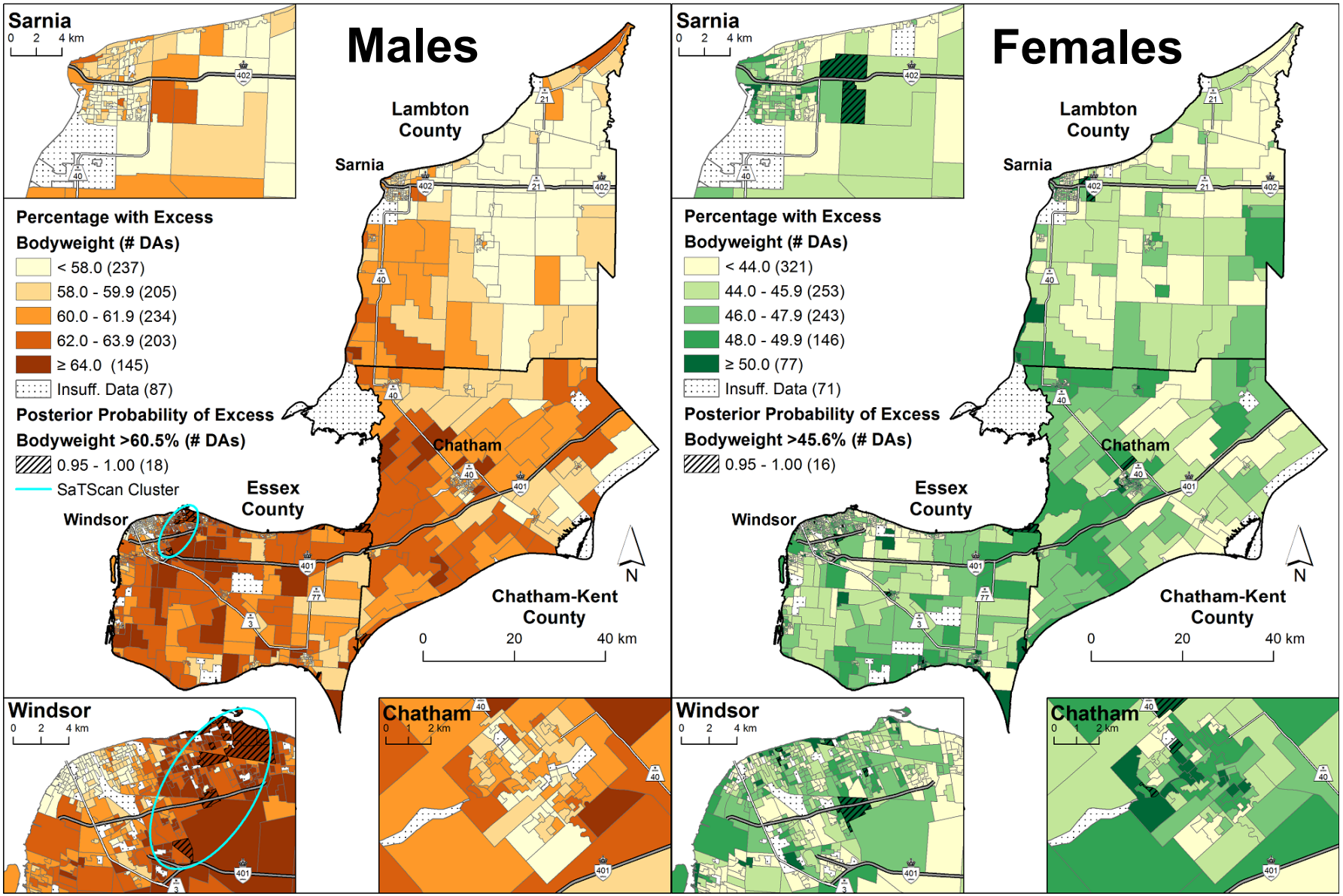
Current Smoking: Model 2



Excess Bodyweight: Model 1



Excess Bodyweight: Model 2



Validity & Precision

Validity: Bayesian model-based estimates corresponded to CCHS design-based results

Precision: Coefficient of variation (CV; std error/ mean). Statistics Canada's CV thresholds (low, marginal, acceptable) for each neighbourhood

Current Smoking:

Model 1: mostly marginal (M: 90.1%, F: 96.5%),
Model 2: mostly acceptable (M: 89.1%, F: 62.1%)

Excess Bodyweight: Mostly acceptable CVs in both sexes and models (>99%)

Strengths & Limitations

Strengths:

- High resolution heterogeneity vs. surveys
- Consistent Bayesian & SaTScan findings
- Assessed validity & precision

Limitations

- Self-reported survey data
- CCHS not designed to be pooled
- Assume neighbourhood-level household income stable over time

Conclusions

- Estimating high resolution risk factor prevalence from large survey data is feasible
- Better precision for Model 2, suggesting that inclusion of key covariates is important
- Applications for public health planning and studies of related chronic disease outcomes (e.g. cancer) at neighbourhood level

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Thank you!

Laura.Seliske@cancercare.on.ca

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