Multilevel Regression and Post-stratification Approach for Small-Area Estimation of Population Health Outcomes at Local Geographic Areas using State BRFSS via Parametric Bootstrapping

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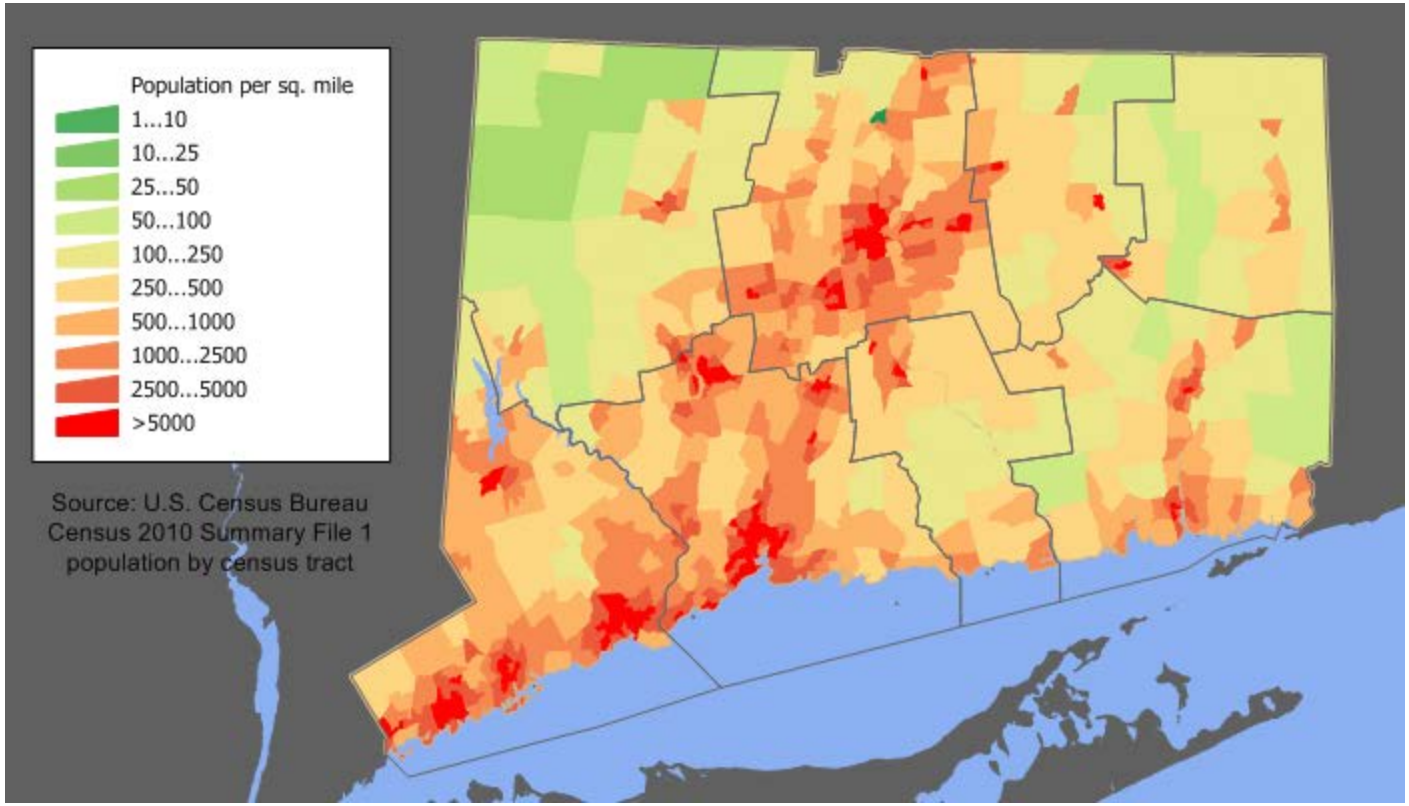
Challenge of Small Area Estimation (SAE) in Connecticut



- Total population 3,574,097, 12.01% live in rural area (62.28% of total area). *Census 2010*
- Eight counties, but no county health departments in CT.
- The next smallest common unit of analysis is the town.

Challenge of Small Area Estimation (SAE) in Connecticut

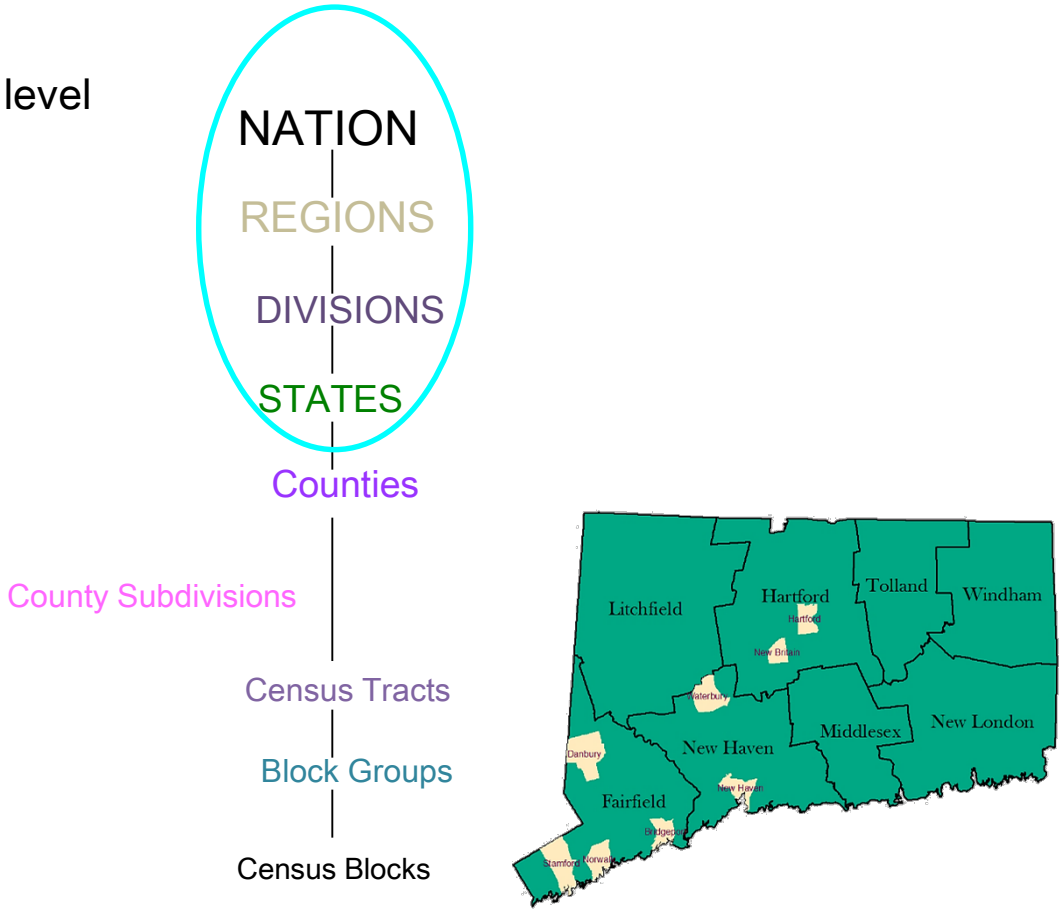
BRFSS

-Designed for state and national level
-Direct estimates

Small Area Estimation (SAE)

-statistical techniques involving estimation of reliable estimates for small areas using health survey.

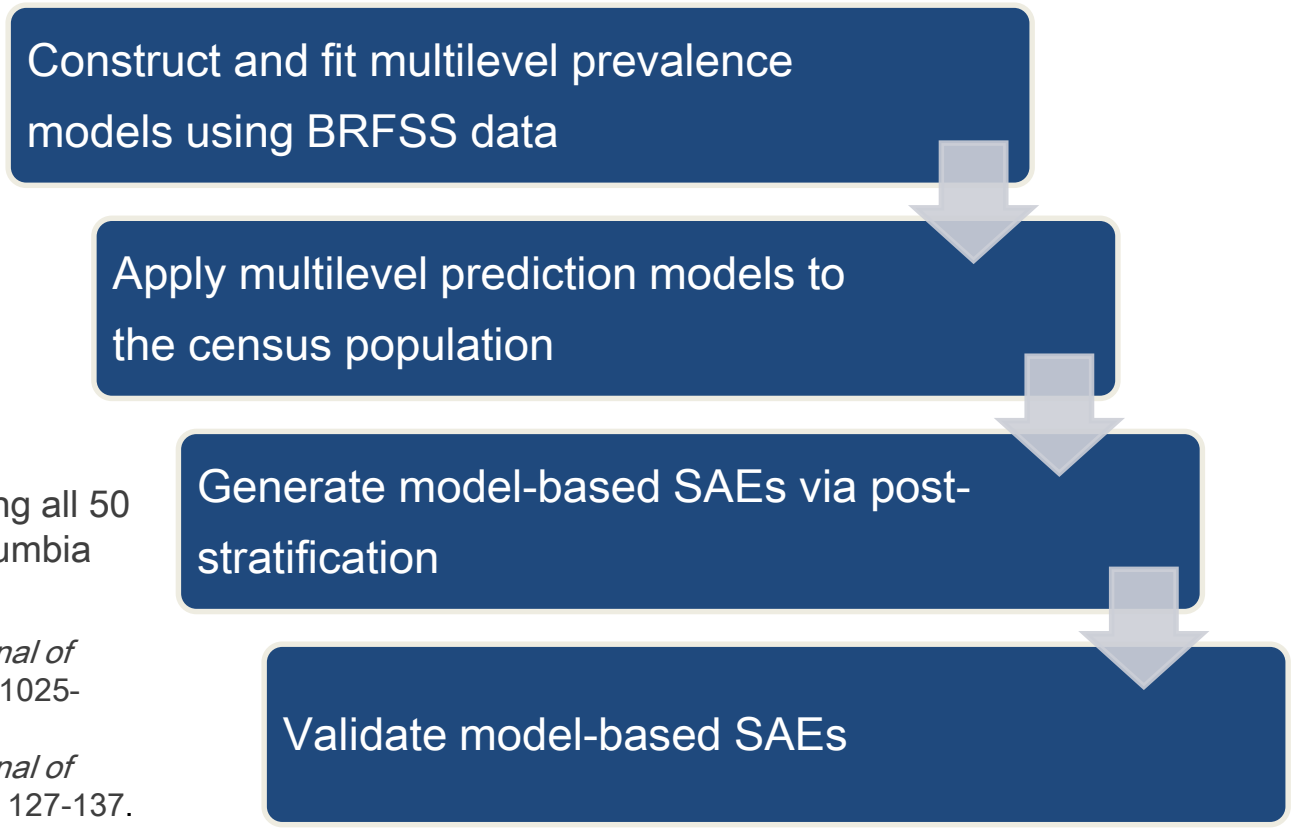
- Six SAE papers published from 2016-2017, at county level.
- CDC/RWJF 500 Cities project provided SAEs at city- and census tract-level.



What Can the CT BRFSS Do for Local Health?

- Health District Oversampling, with existing state weighting;
- Reweight BRFSS responses at the local level;
- Post-BRFSS focus surveys in sub-state geographic areas; and
- Synthetic estimates (500 Cities project www.cdc.gov/500cities)

Four Steps of Multilevel Regression and Post-stratification (MRP) Framework



Developed by Dr. Zhang, using all 50 states plus the District of Columbia (DC) 2014 BRFSS data.

- Zhang X et al. *American Journal of Epidemiology* (2014), 179 (8):1025-1033.
- Zhang X et al. *American Journal of Epidemiology* (2015), 182 (2): 127-137.

Current and Modified MRP

Limitations of Current MRP

1) Use of single year BRFSS might produce temporally inconsistent SAEs
2) Use of national BRFSS data including 50 states and DC
3) Predicted standard errors (SEs) and confidence intervals (CIs) of SAEs could be substantially underestimated or overestimated.

Extended MRP Approach

1) Use five year state BRFSS (2011-2015) data to produce SAEs for counties and towns in CT
2) Apply parametric bootstrapping approach to estimate the predicted SEs and CIs of SAEs

Methodology

Data Sources
- CT BRFSS (2011-2015)
- US Census 2010
- American Community Survey (ACS)

- Population health indicators: current asthma, depression, diabetes, obesity, high blood pressure, uninsured (18-64 yrs old);
- Population data sex*age*race;
- Poverty level data

Multilevel Logistic Model

SAS **GLIMMIX**

w/wo survey weights

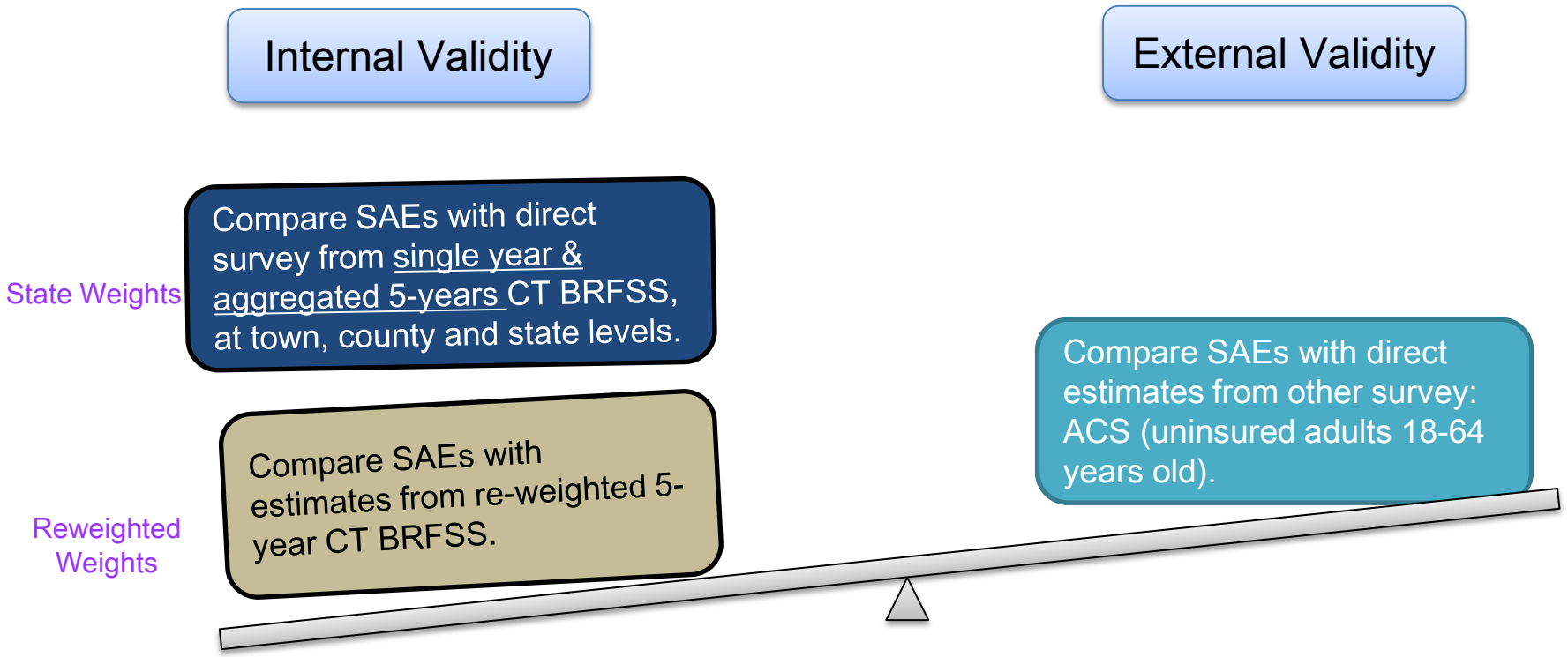
SAEs

$$\text{logit}(p)=\log(p/(1-p))=X\beta + r\_county + r\_town$$

Individual Demographics (age, sex, race/ethnicity)

County and Town Context

SAEs Validation



Compare Model-based SAEs and Direct Survey Estimates at the State, County, and Town Levels (CT BRFSS 2011-2015)

At State Level

PCC: 0.991 (unweighted), and 0.990 (weighted);
MAD: 0.775 (unweighted), and 0.892 (weighted).

At County Level

Unweighted SAEs(89.6%) and weighted SAEs (87.5%) were within direct survey estimates 95% confidence interval.

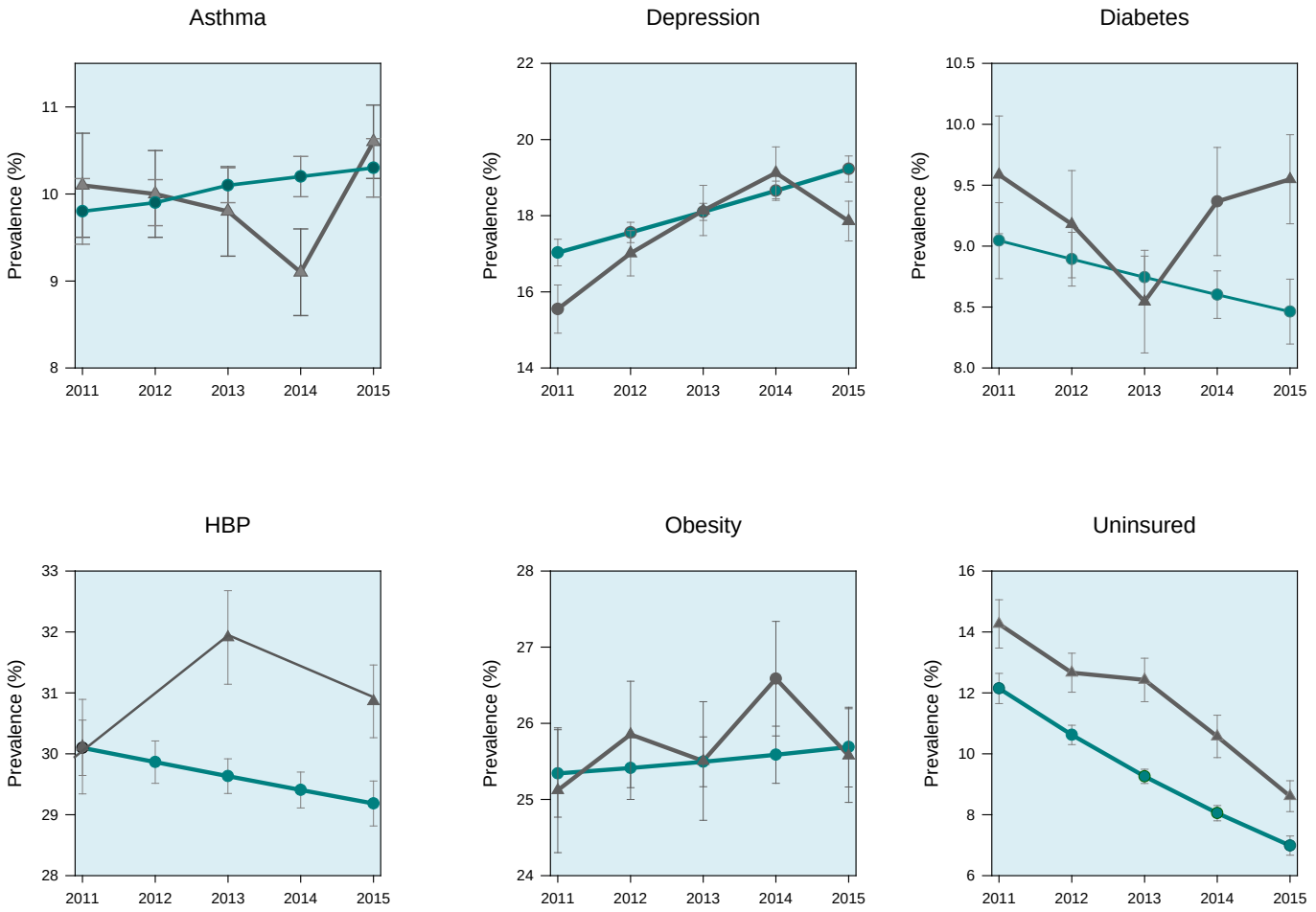
[a] SAEs without using BRFSS final survey weights ,
[b] SAEs based on using BRFSS final survey weights.

Abbreviation: Pearson correlation coefficient (PCC); Mean absolute difference (MAD)

At Town Level

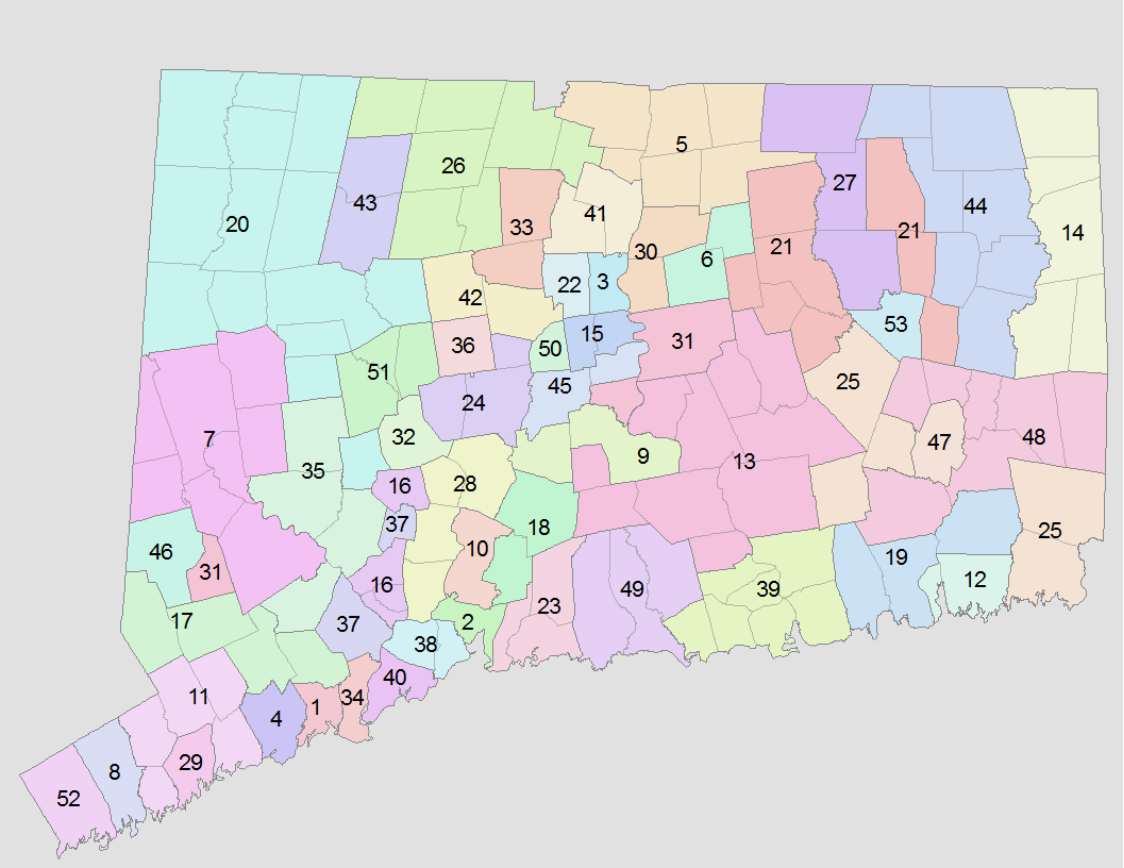
Indicators	No. of Units	PCC	MAD
Asthma			
SAE[a]	68	0.769	1.42
SAE[b]		0.831	0.58
Depression			
SAE[a]	107	0.562	1.49
SAE[b]		0.826	0.66
Diabetes			
SAE[a]	77	0.769	1.29
SAE[b]		0.548	0.26
HBP			
SAE[a]	132	0.44	1.66
SAE[b]		0.539	1.1
Obesity			
SAE[a]	130	0.89	1.13
SAE[b]		0.766	0.89
Uninsured			
SAE[a]	32	0.905	3.16
SAE[b]		0.856	3.73

Compare Model-based SAEs and Direct Survey Estimates Using Single Year CT BRFSS, at the State Level

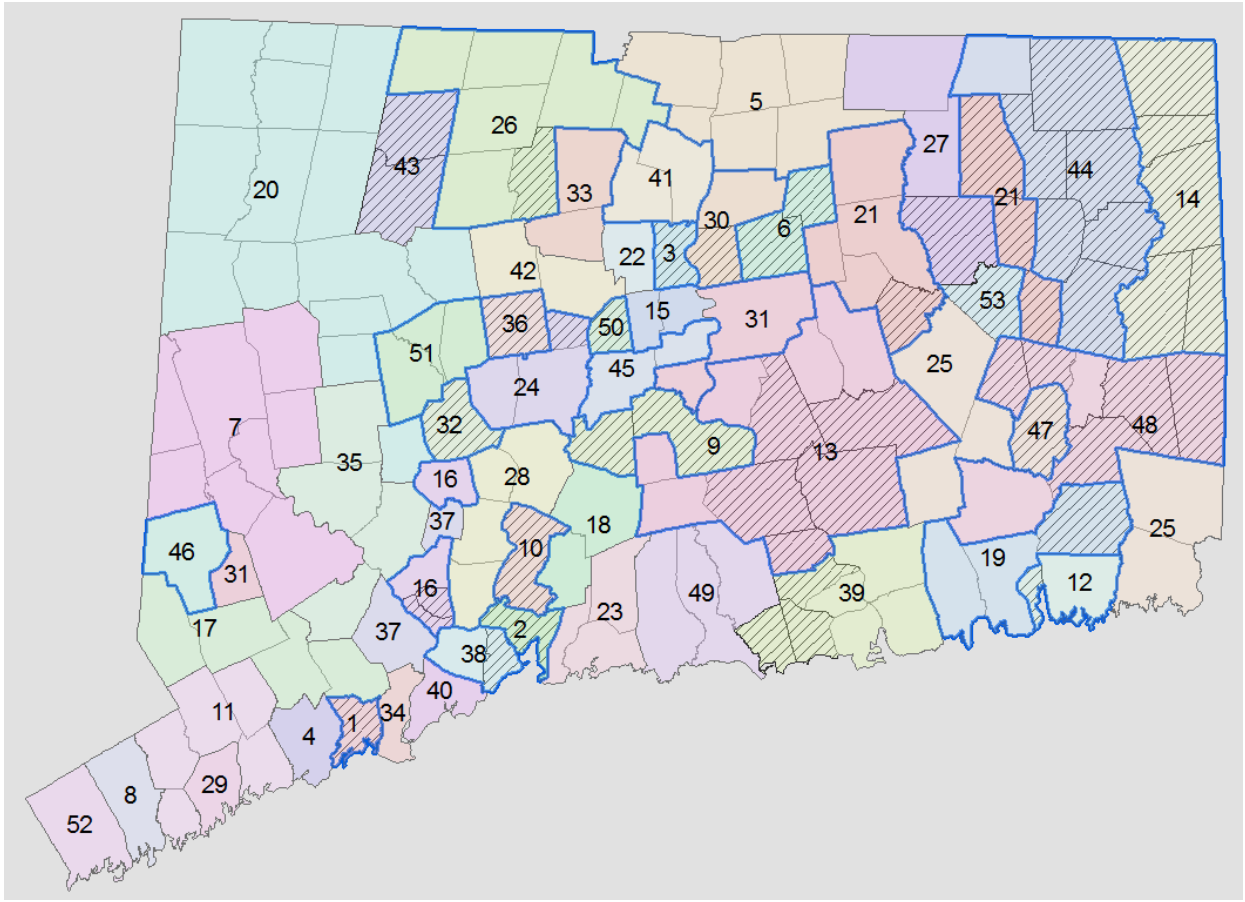


Compare Model-based SAEs and Reweighted Direct Survey Estimates

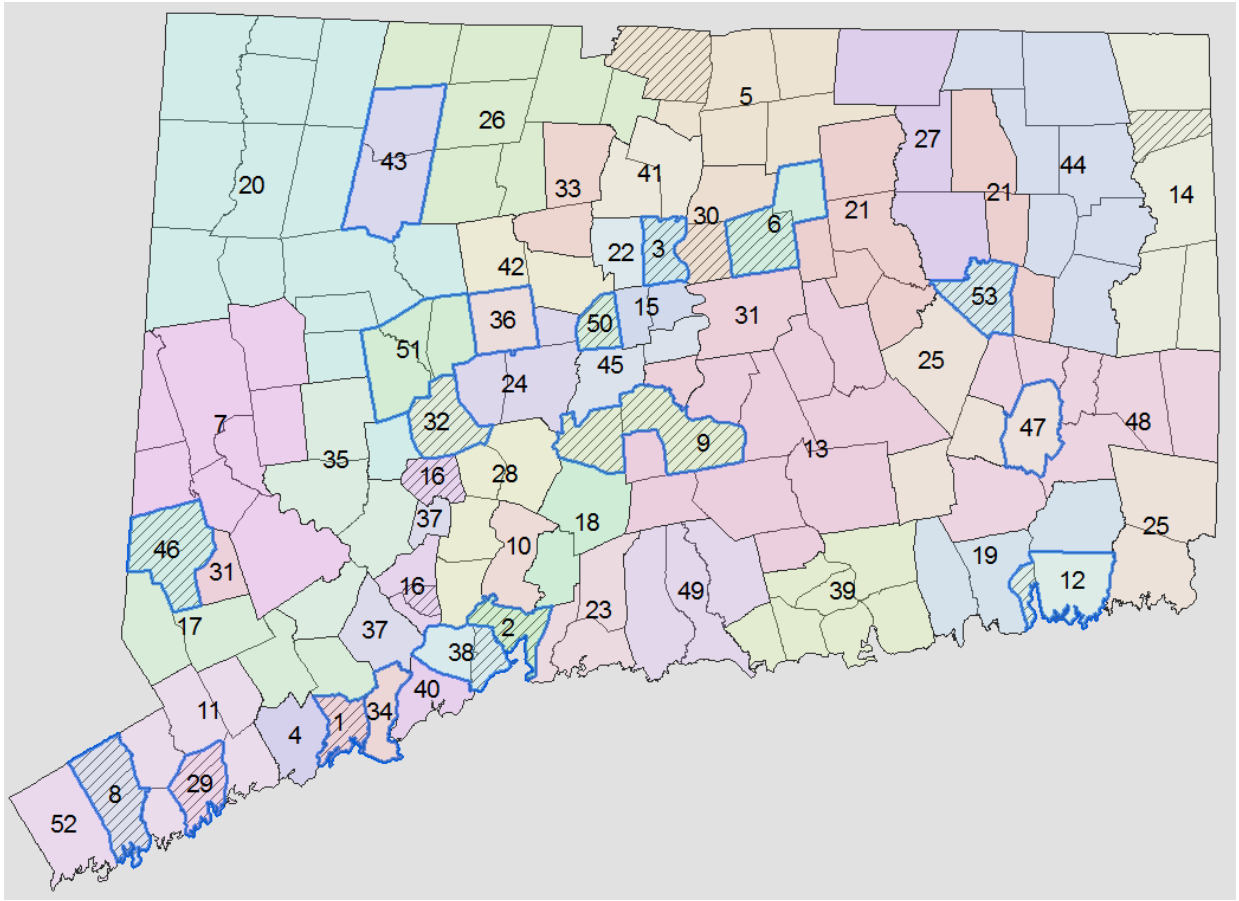
- Re-weighted 53 local area estimates using combined 5 year CT BRFSS data (2011-2015), each area requires at least 500 interviews from the responses (Stone et al., 2017).
- Heat mapping were used to show the geographic clustering, by comparing SAEs and re-weighted estimates.



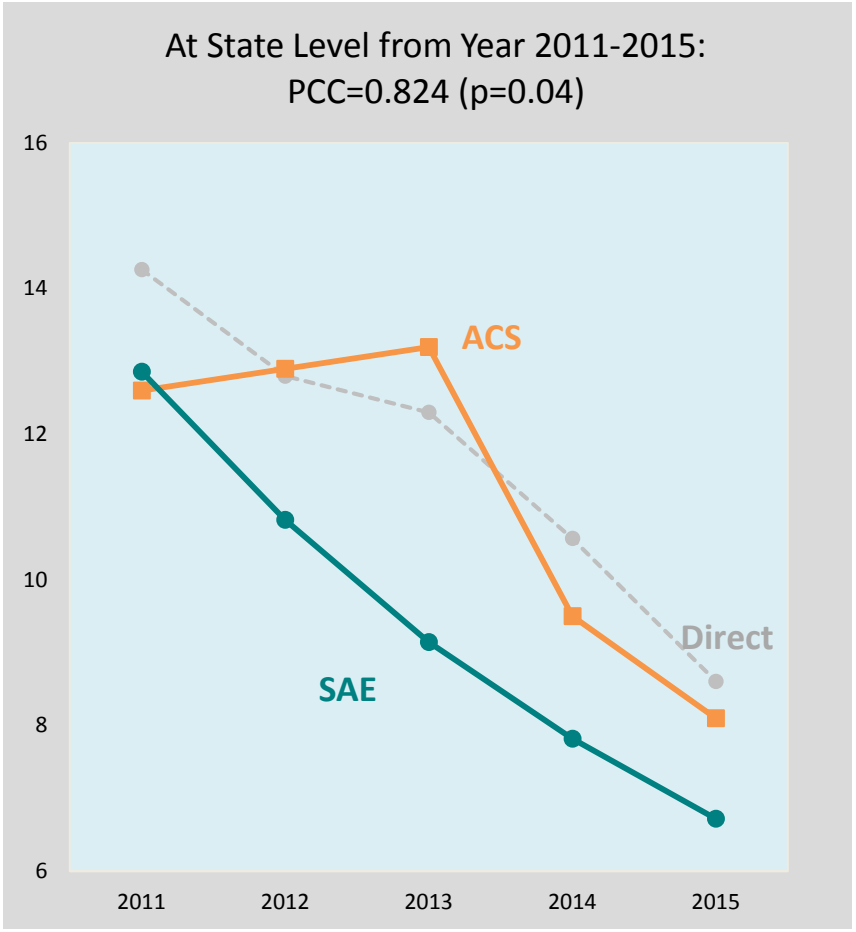
Current asthma prevalence: overlap of risk areas using SAE and reweighted estimates

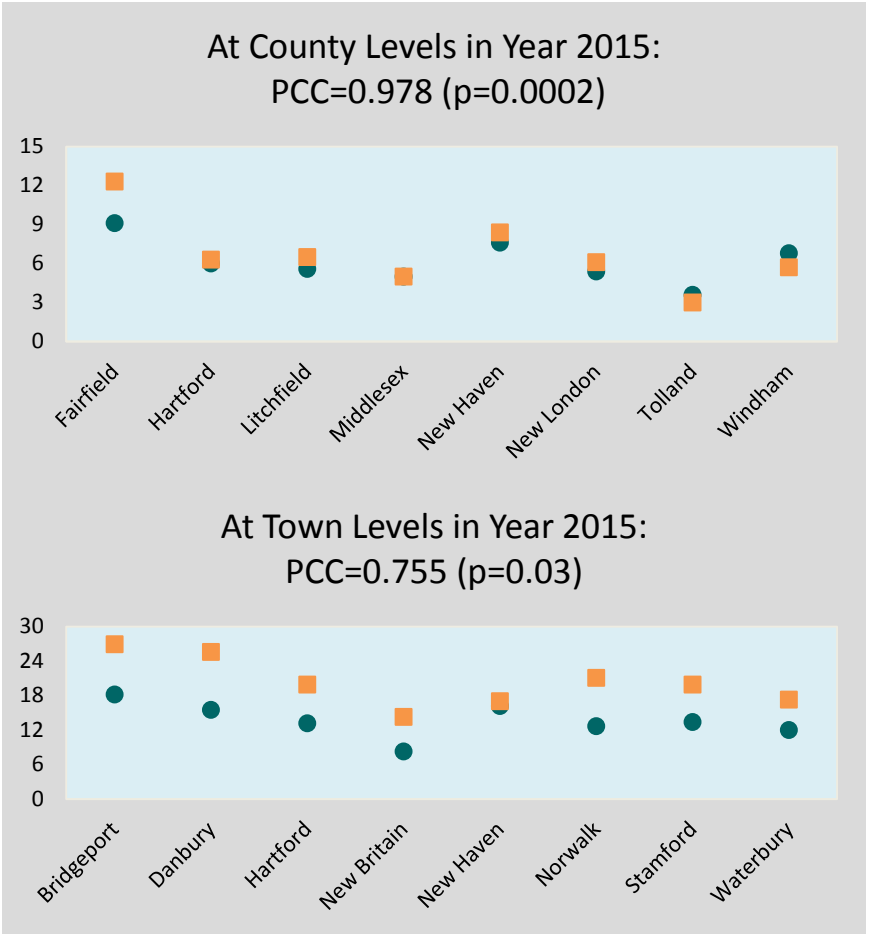


Uninsured prevalence: overlap of risk areas using SAE and reweighted estimates



Compare of SAEs and ACS estimates for uninsured adults





Summary

Extended MRP methodology,

- √ Use state BRFSS data
- √ Produce sensible SEs and CIs of SAEs
- √ With flexibility to use single or multiple years data
- √ With flexibility to incorporate survey weights
- √ Estimates are valid

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Thank you!

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