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University
of Idaho

SPATIAL MICROSIMULATION OF COVID-19 HEALTH PARAMETERS FOR THE STATE OF IDAHO

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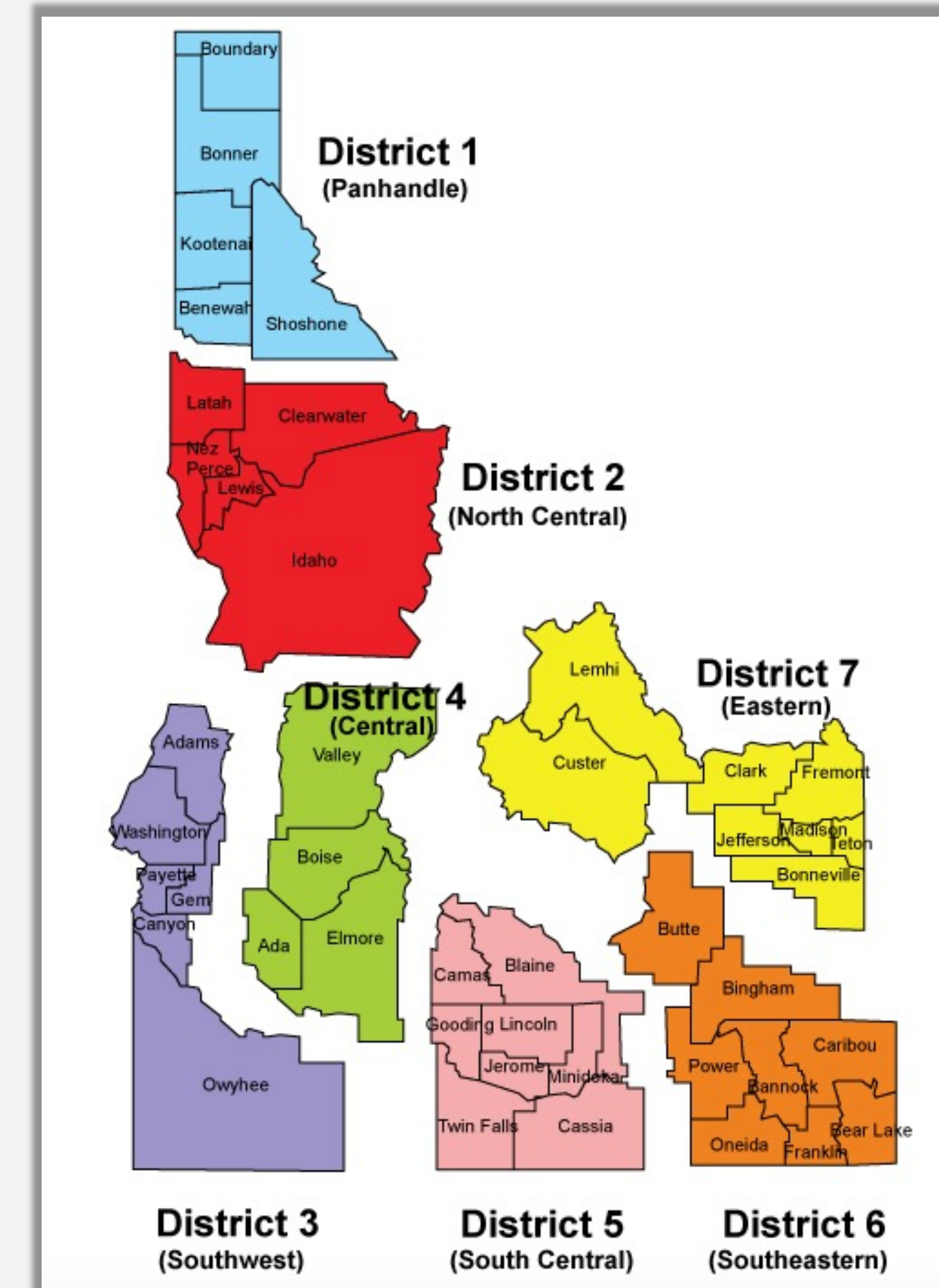
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IDAHO DEPARTMENT OF HEALTH & WELFARE

SUMMARY

- Overview
- Modified SM Methodology
- Modeling health disparities in association with COVID-19 outcomes
- Engagement with community via https://modelingidahohealth.org
- Conclusions/Future Work

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SUMMARY

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- Overview
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www.modelingidahohealth.org

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PROJECT OVERVIEW

The CDC's **Behavioral Risk Factor Surveillance Survey** (<u>BRFSS</u>), in combination with US Census data, is used to generate <u>Idaho</u> <u>county-based</u> prevalence estimates **for COVID associated health indicators**
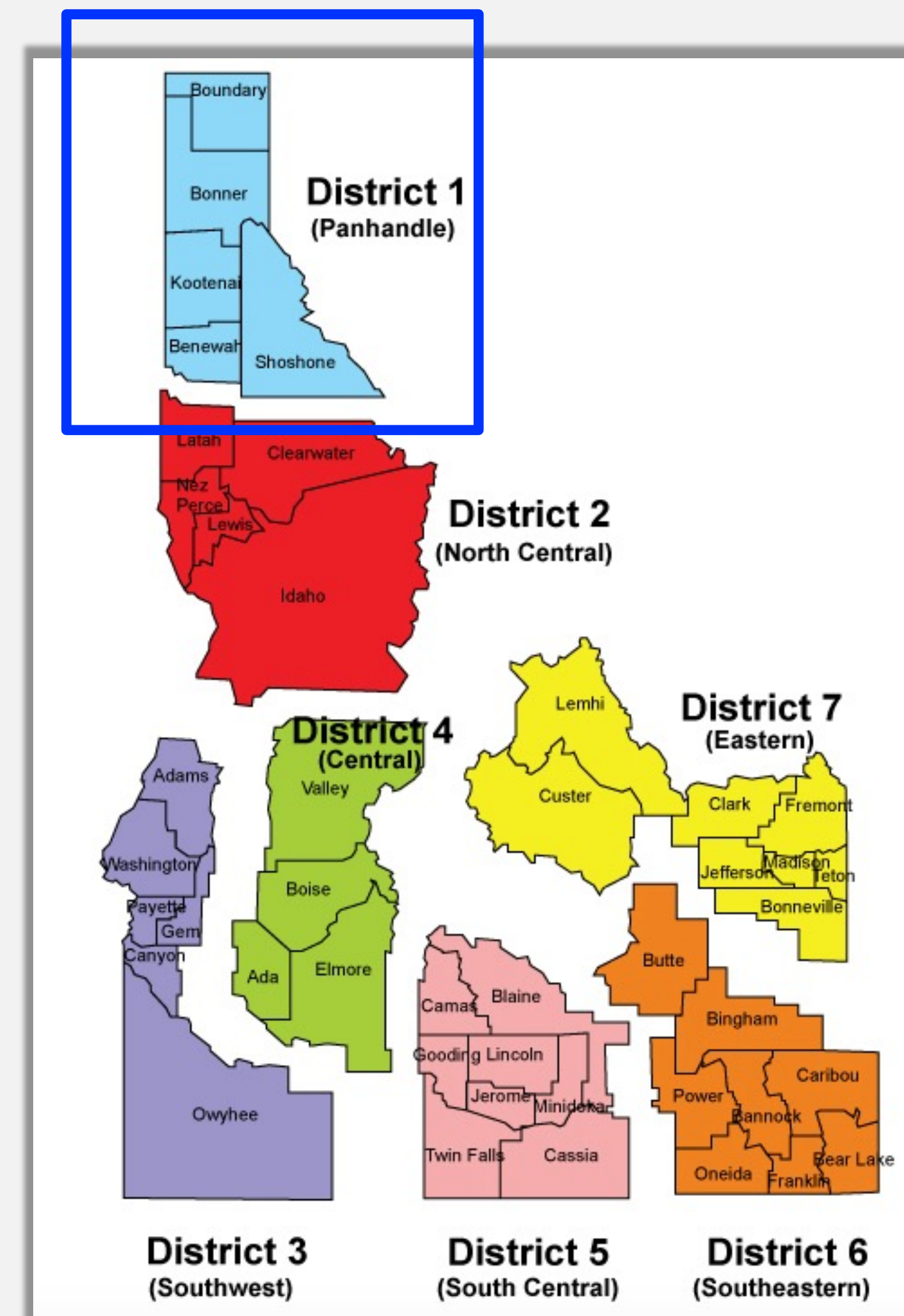
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CDC
CENTERS FOR DISEASE
CONTROL AND PREVENTION

BRFSS COVID modeling 2021: Expand to spatiotemporal models using BRFSS microsimulation outputs

$92K

BRFSS Tobacco use modeling 2021: tobacco questions and associated health conditions

$245K

BRFSS COVID Modeling 2020: 11 health questions, Risk Prevalence

$78K

BRFSS Modeling 2019: Obesity, Overweight, Diabetes

$56K

Seamon, E., Megheib, M., Williams, C. J., Murphy, C. F., & Brown, H. F. (2023). Estimating county level health indicators using spatial microsimulation. *Population, Space and Place*, e2647. https://doi.org/10.1002/psp.2647

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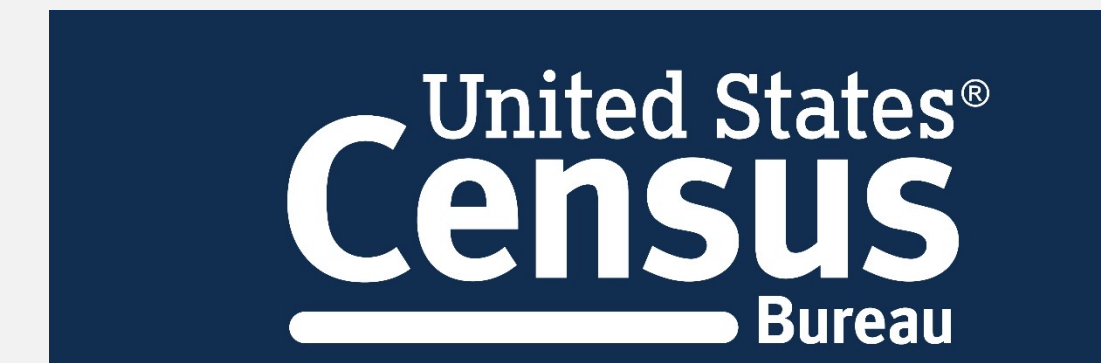
IDAHO AT A GLANCE

- Idaho has a unique urban/rural population structure
- Challenges regarding efficient usage of health $$
- State vs federal govt policy directions
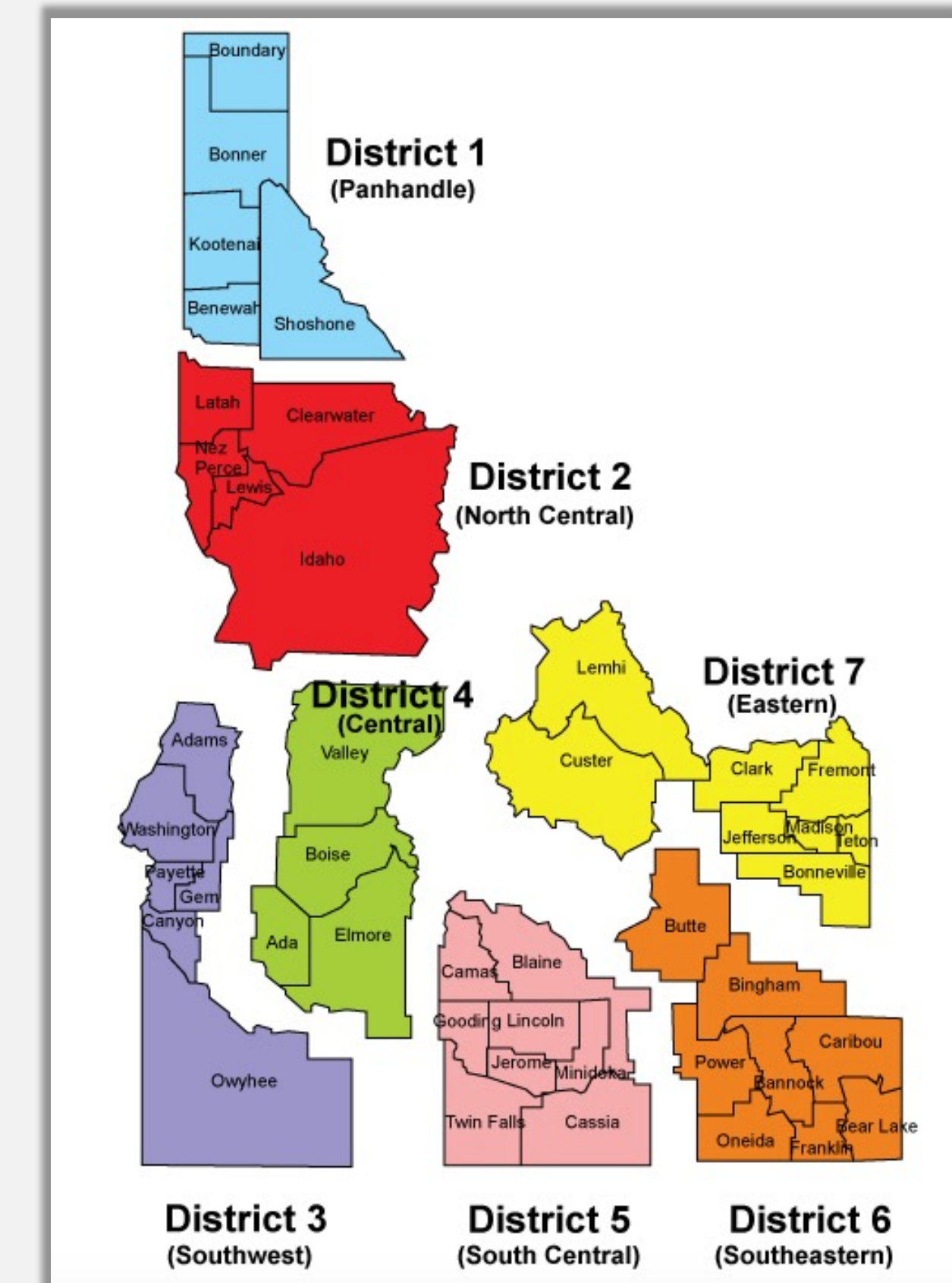- Idaho BRFSS collects data at regional scale

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COVID INDICATORS

- Heart Disease
- Angina
- Heart Attack
- Obesity
- Kidney Disease
- Suicide attempts
- Cannabis use
- Flu vaccine
- Heavy drinking
- Smokeless
- tobacco
- Smoking status
- Cognitive
- decision-making

- Smoking
- Pulmonary Disease
- Diabetes
- Hypertension
- Depression
- Cancer
- Sleep
- Frequency of routine checkups
- Health care coverage
- Not see doctor due to cost
- 14+ days poor mental health
- 14+ days poor physical health
- General health status

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METHODOLOGY

- Multilevel logistic model construction, estimating relationships optimal relationships between constraining factors and each variable, per health region

- Multilevel approach used for four (4) differing model constructs

- IPF then applied to construct weights, with fractionalization and expansion for post-stratification

- Internal and external validation for optimal model selection
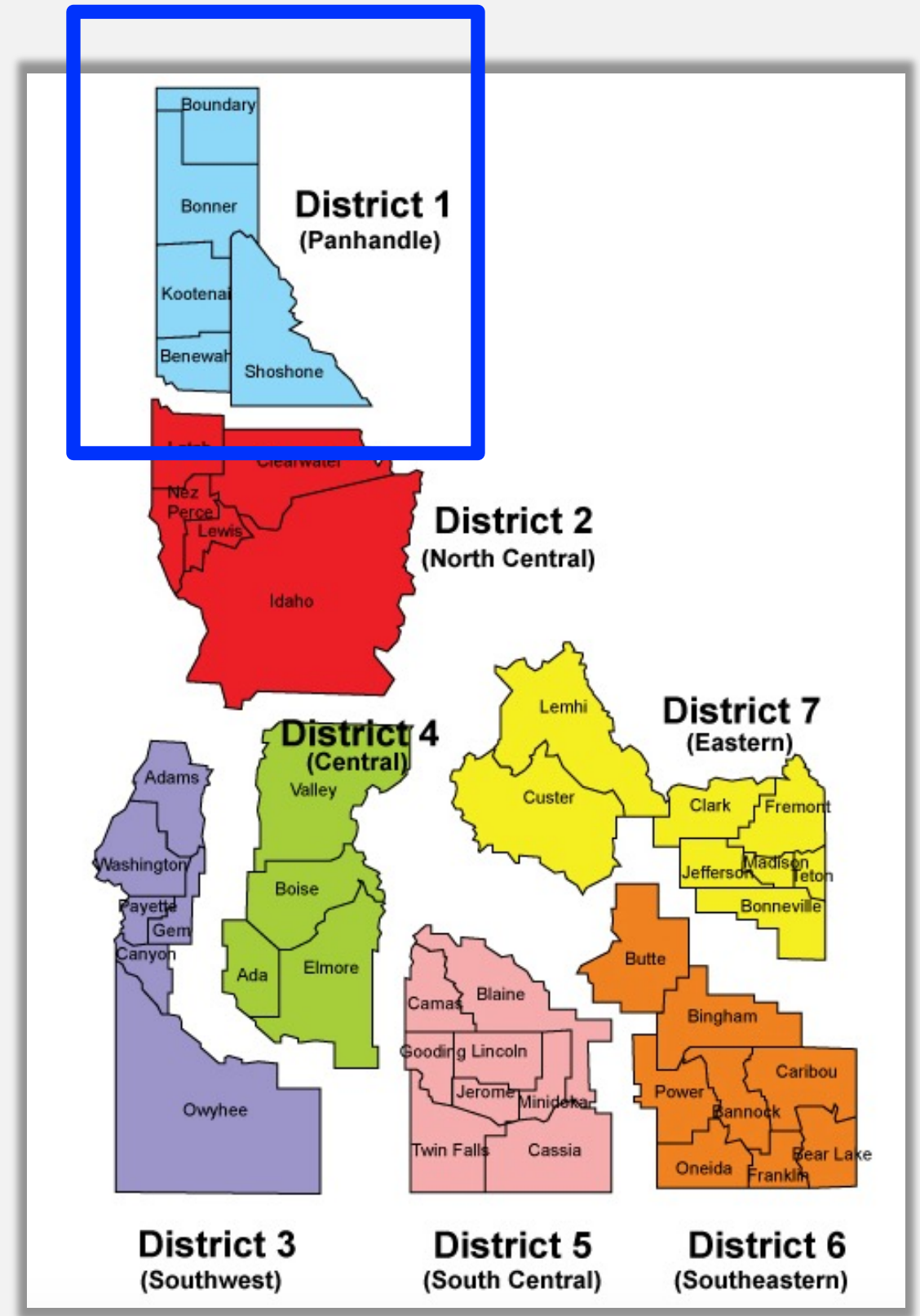
- Application of results in secondary COVID modeling

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Seamon et al, 2022, https://doi.org/10.1002/psp.2647

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Static Base

Static Grouped

Dynamic Base

Dynamic Grouped

Imputation

Constraints: age, education, race, sex
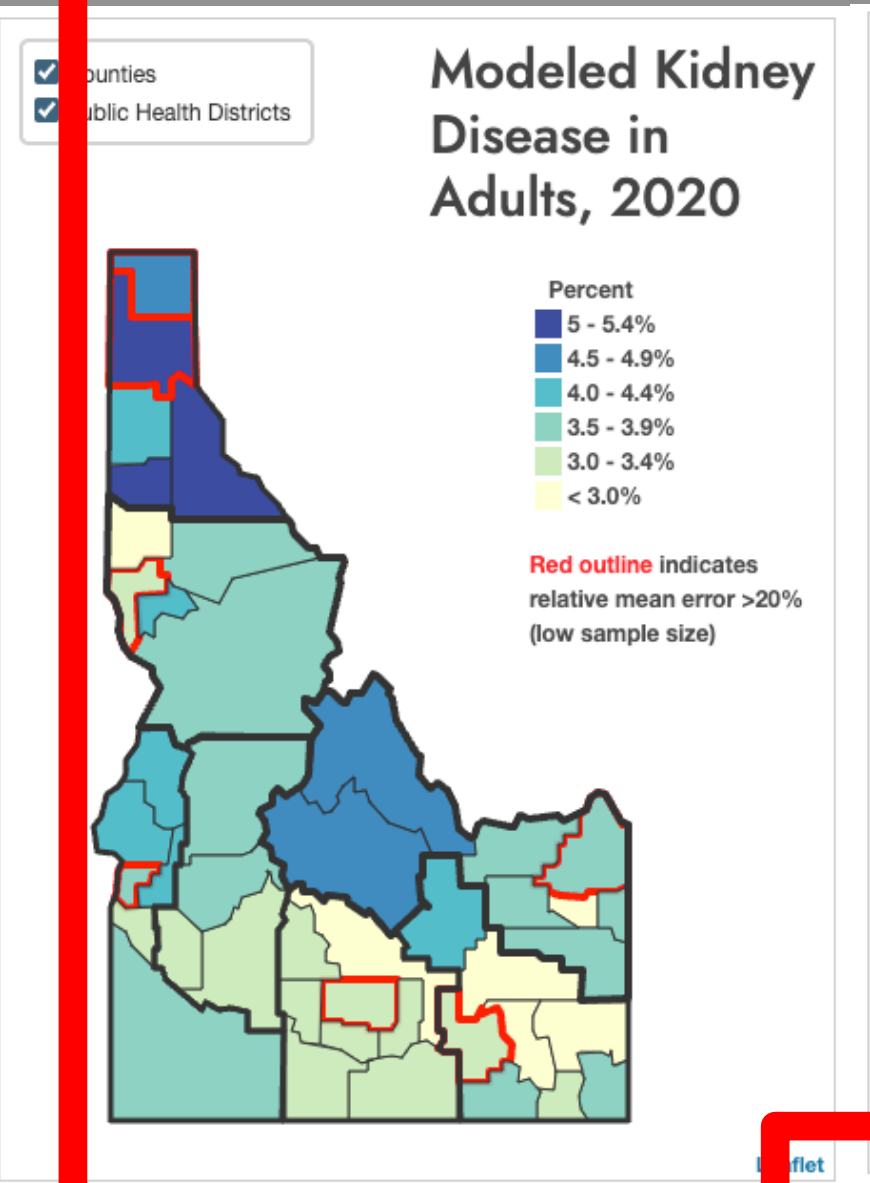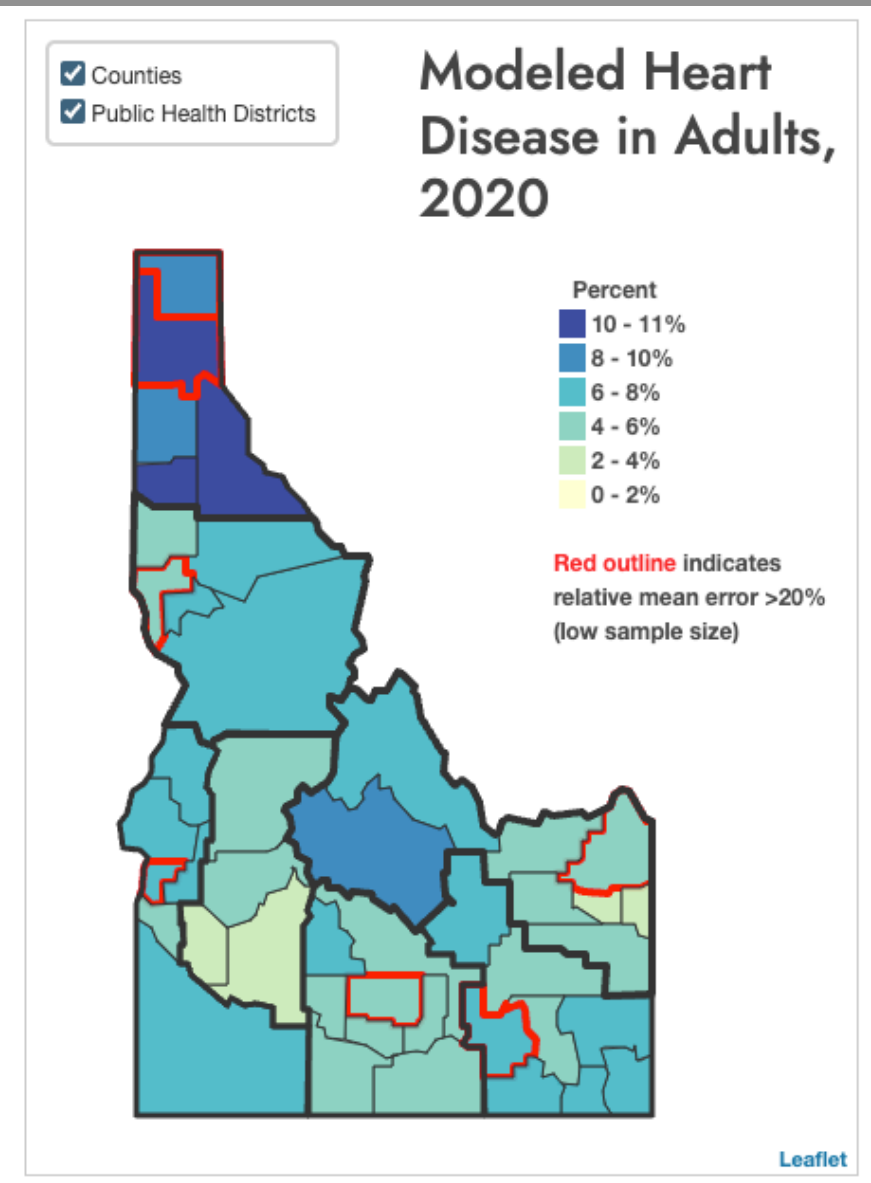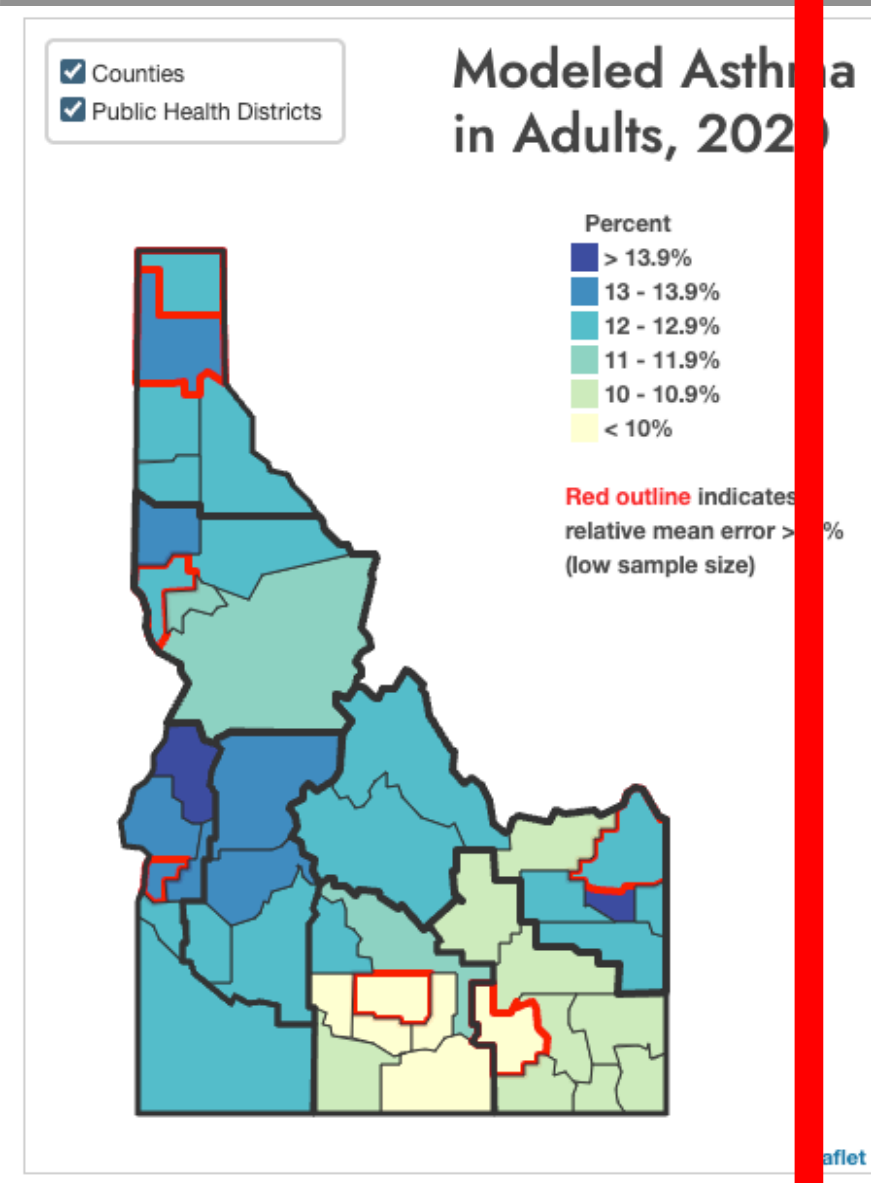
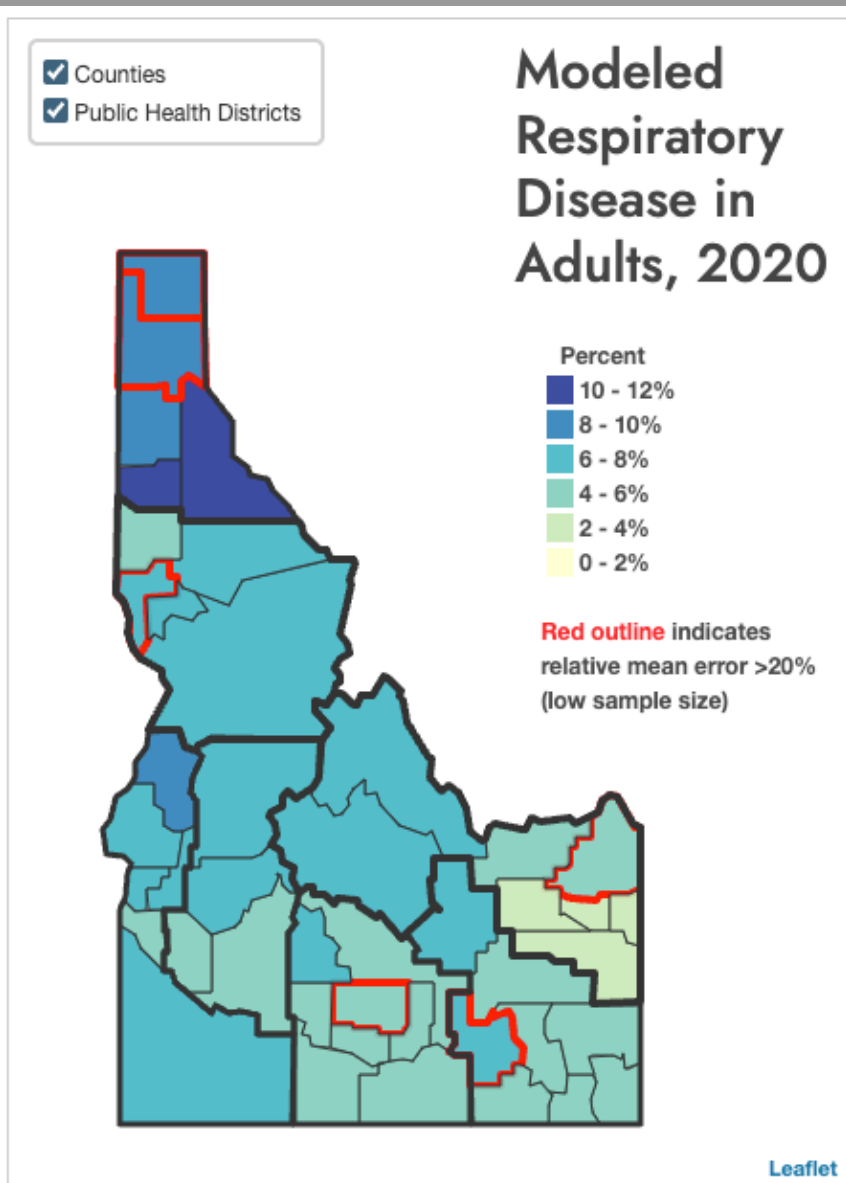## Multi level Regression

Iterative Proportional Fitting

$$w(i, z, t+1) = w(i, z, t) \times \frac{cons\_t(z, c, brfss(i,c))}{\sum_{j=1}^{n_{brfss}} w(j, z, t) \times I(brfss(j,c) = brfss(i,c))}$$
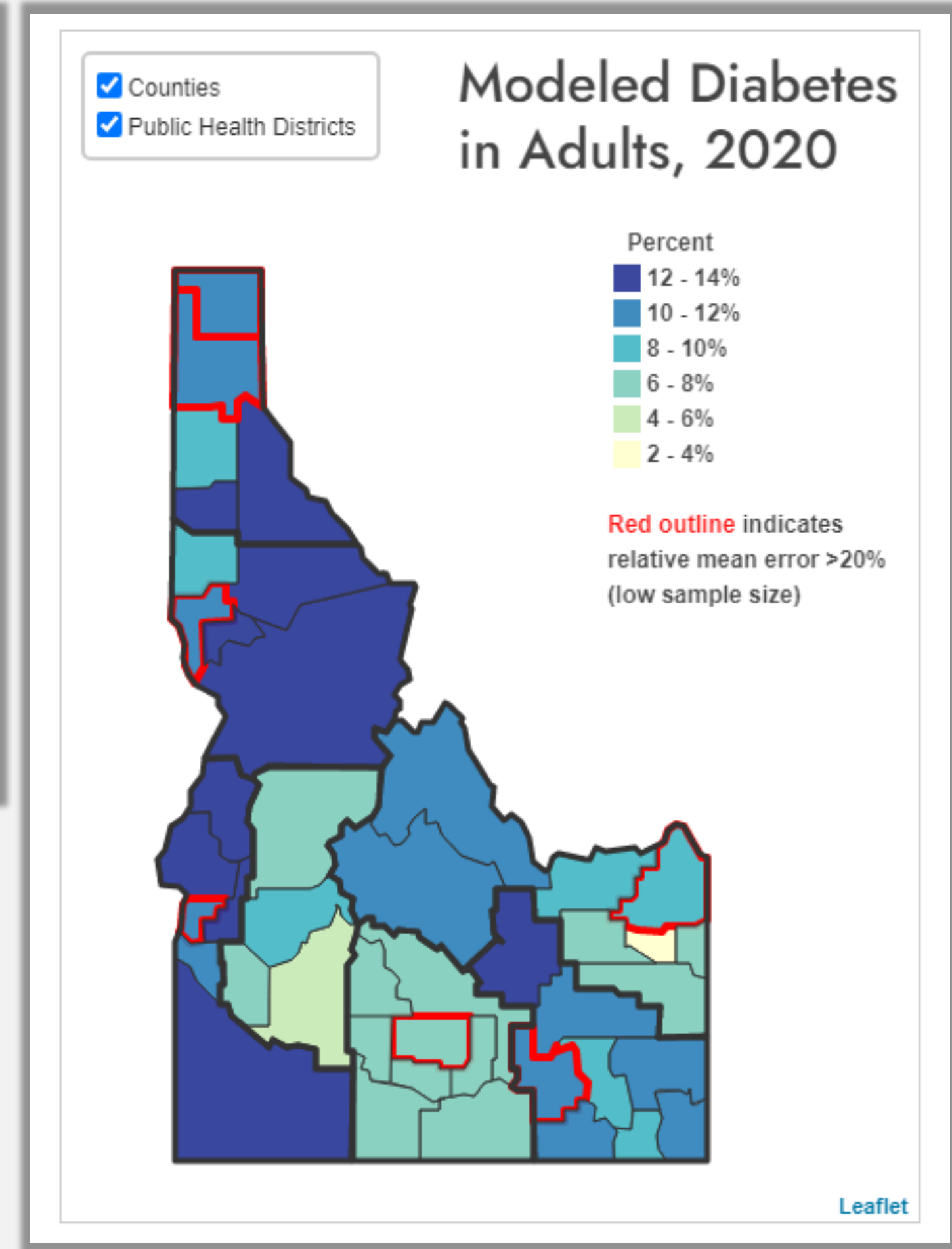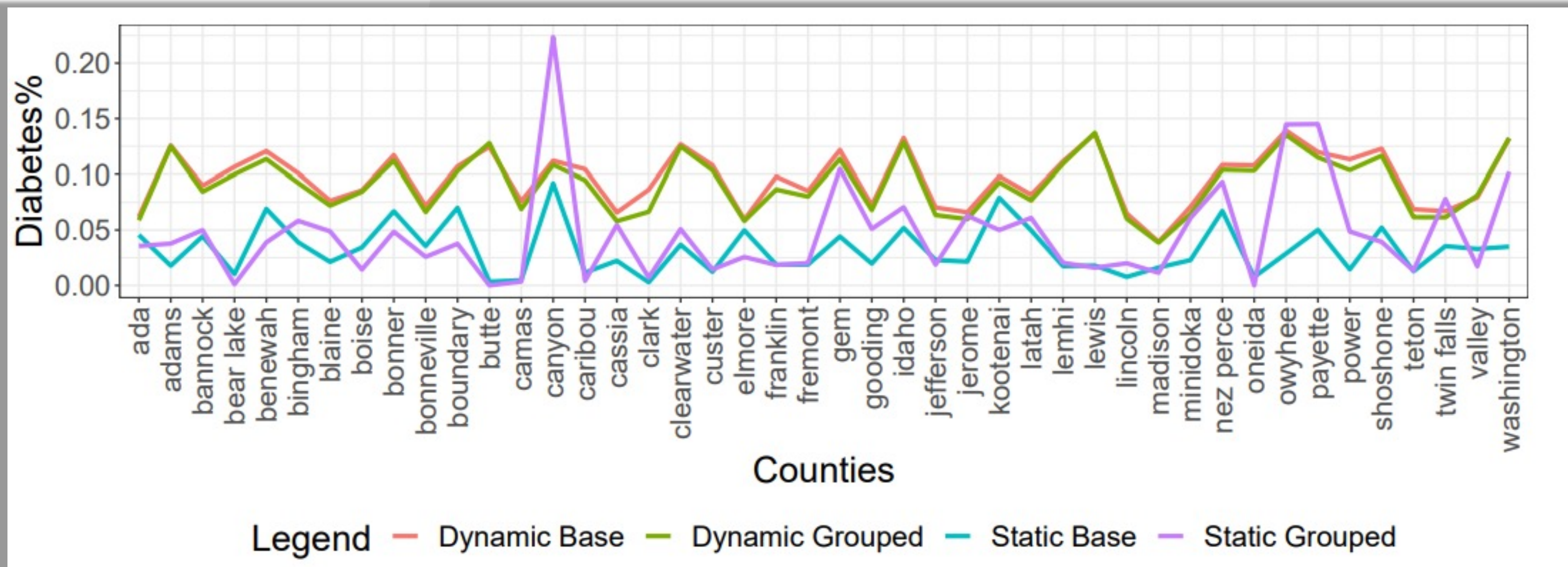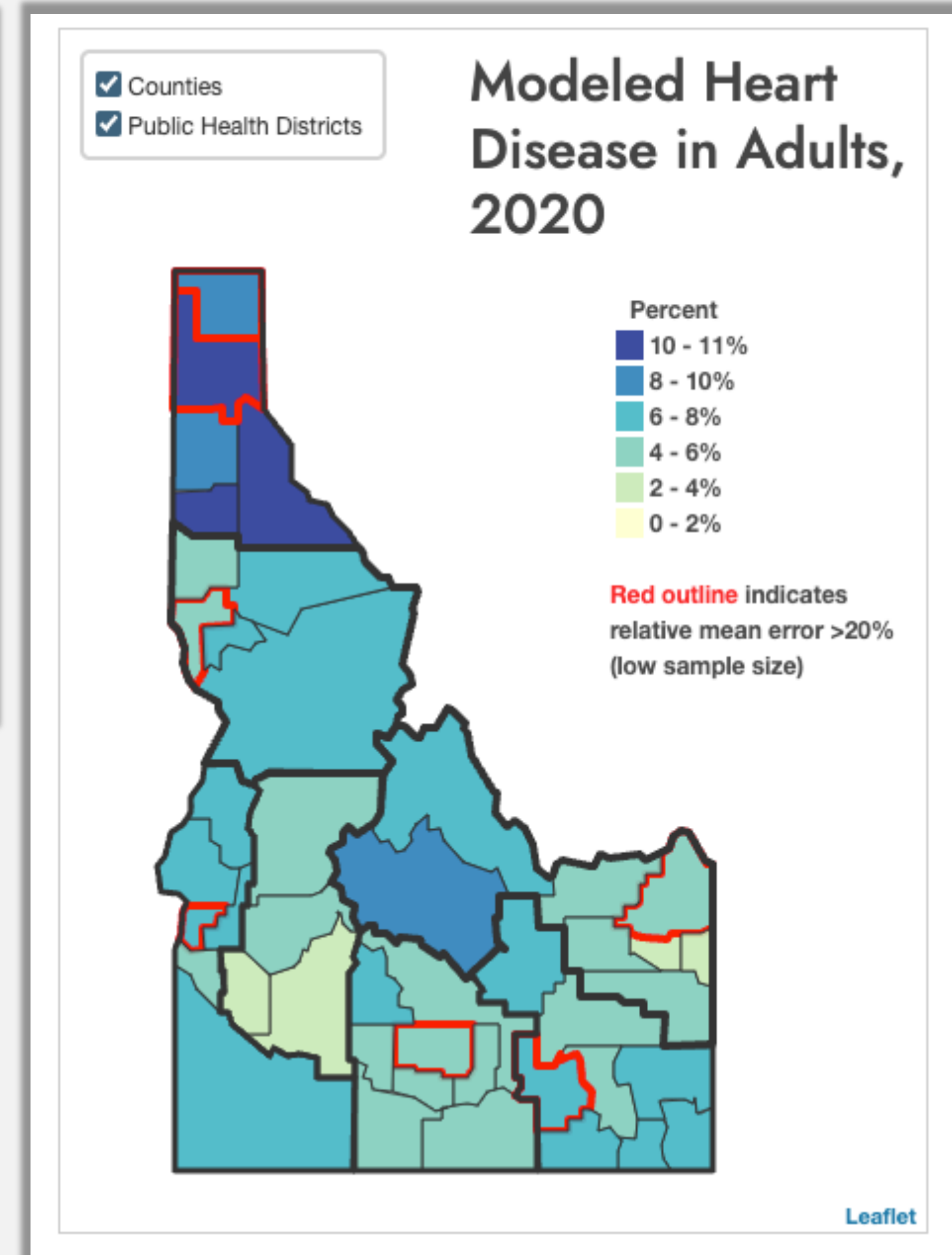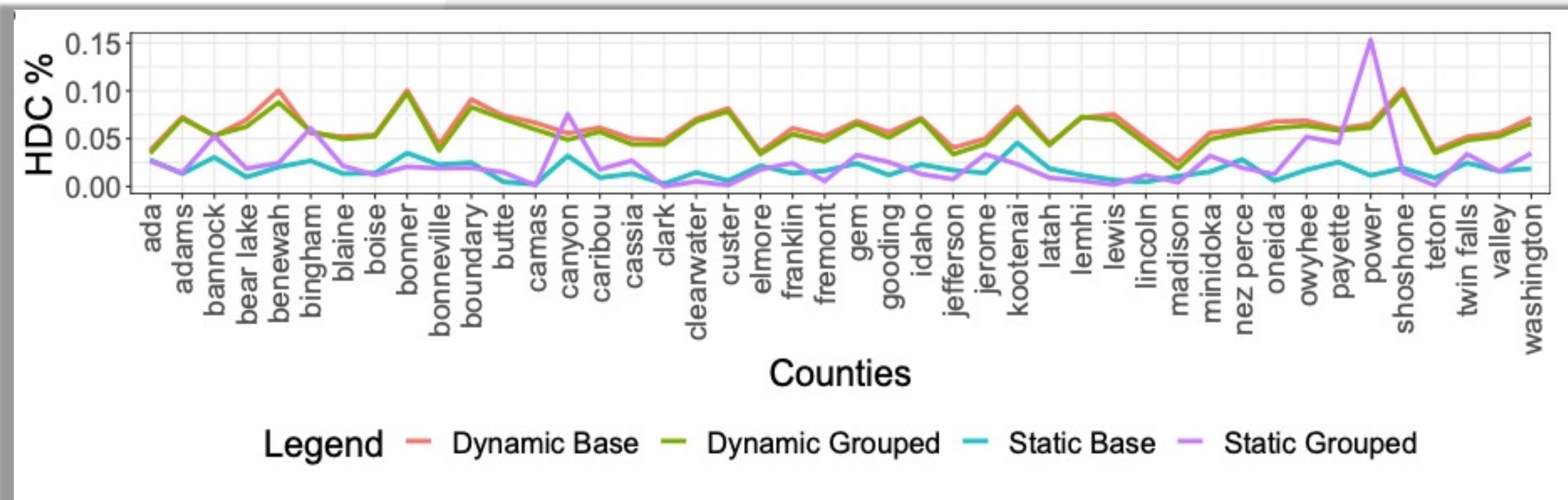

COVID modeling

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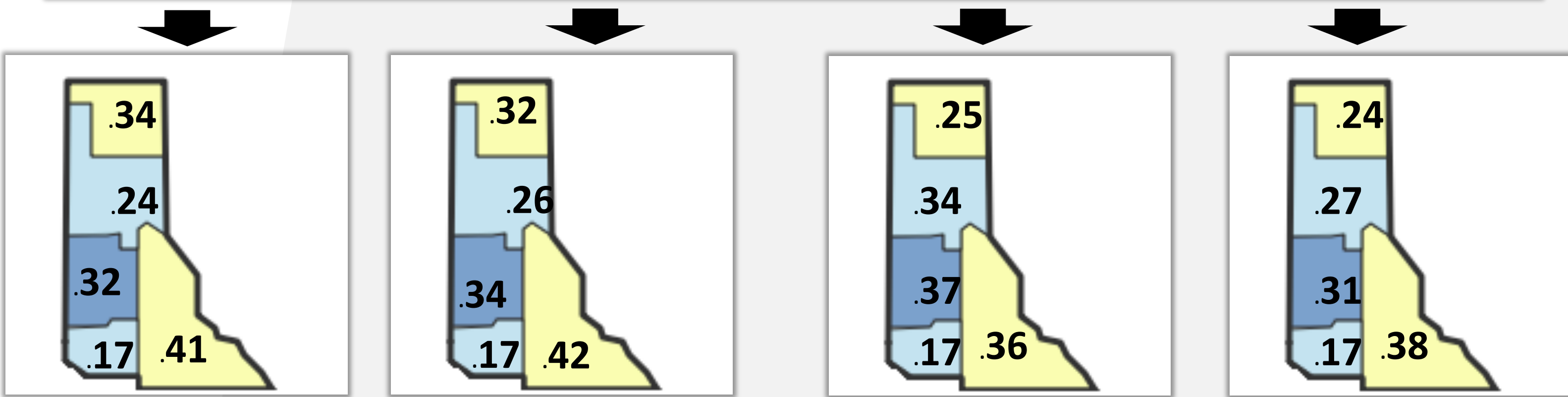
https://modelingidahohealth.org
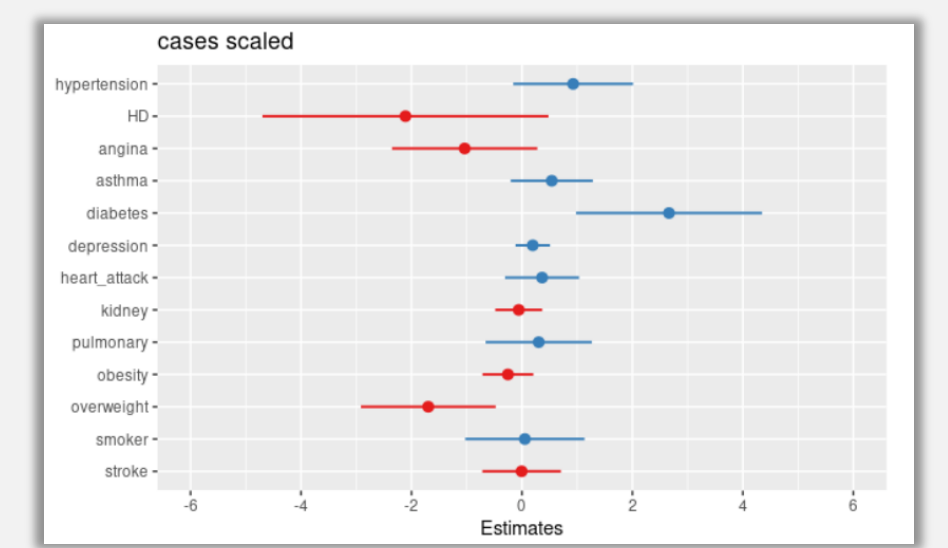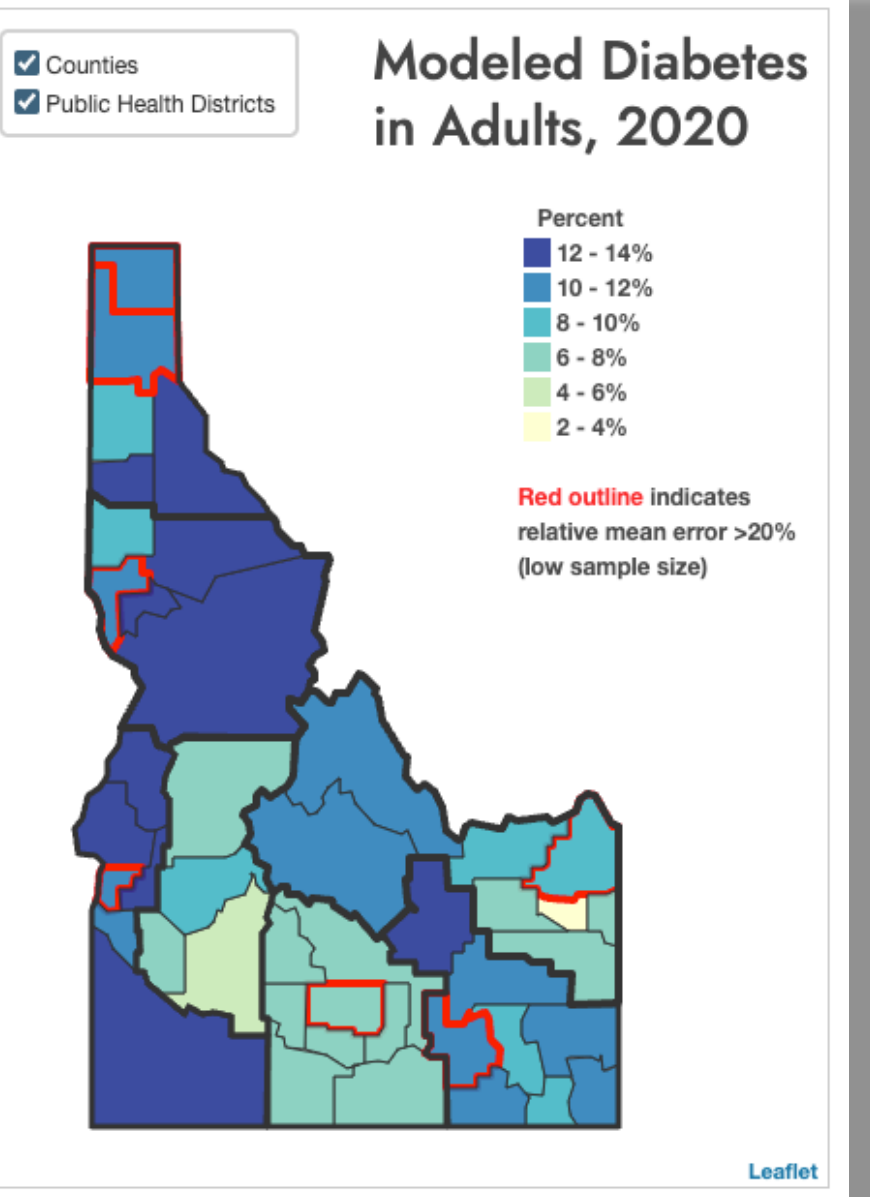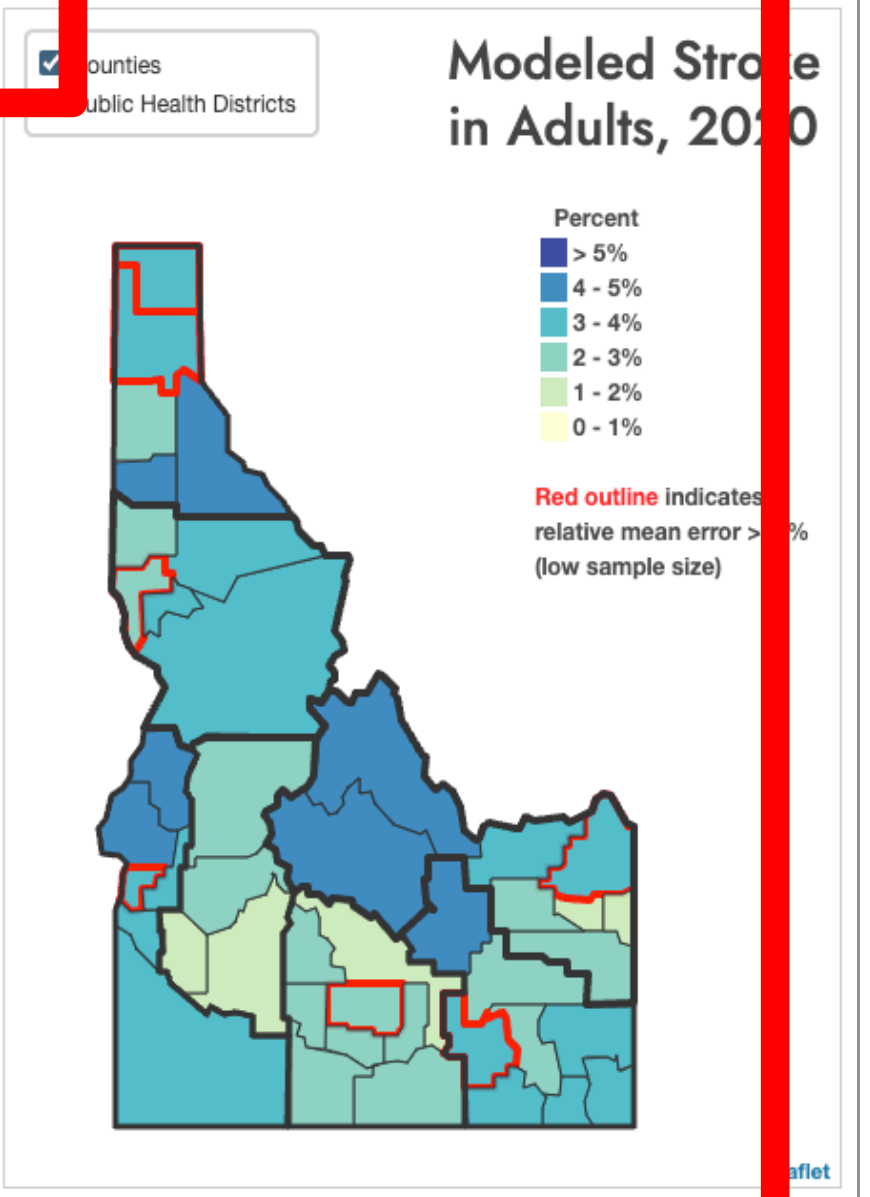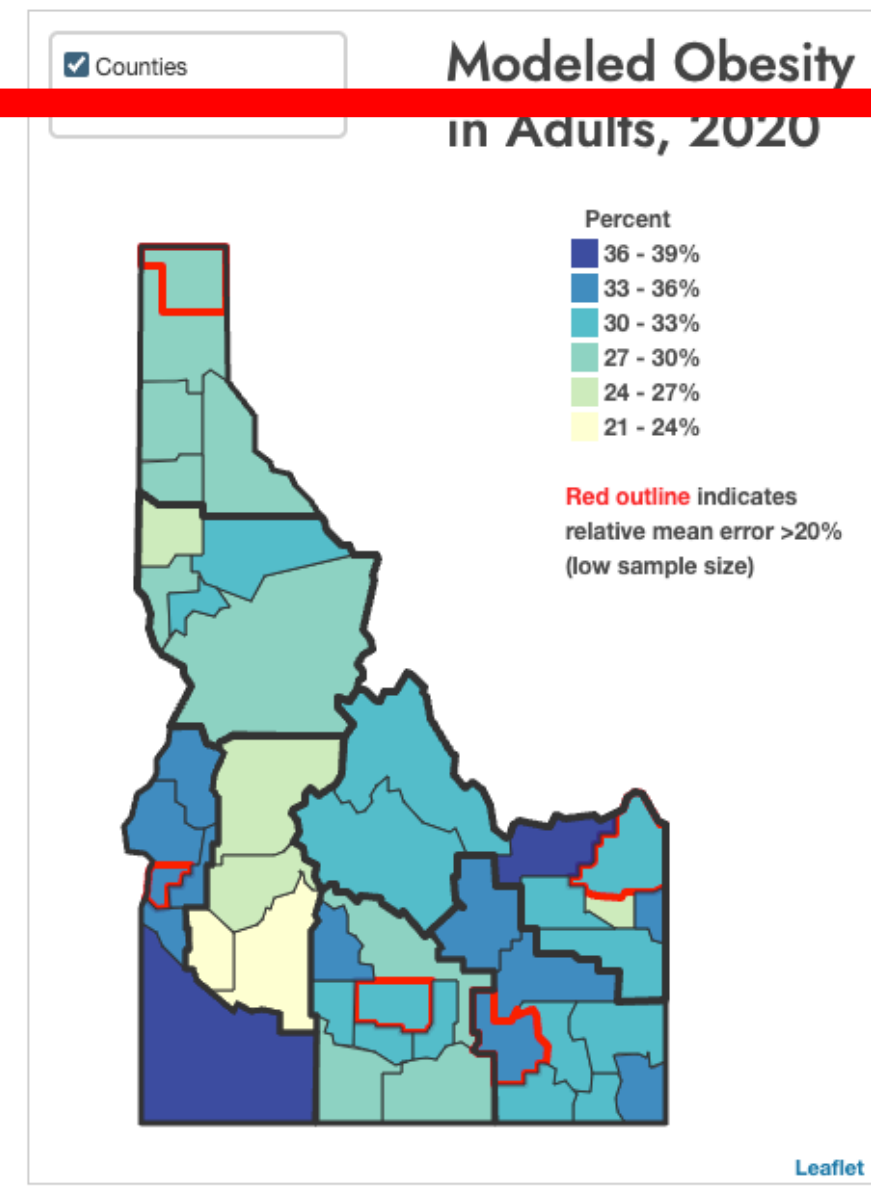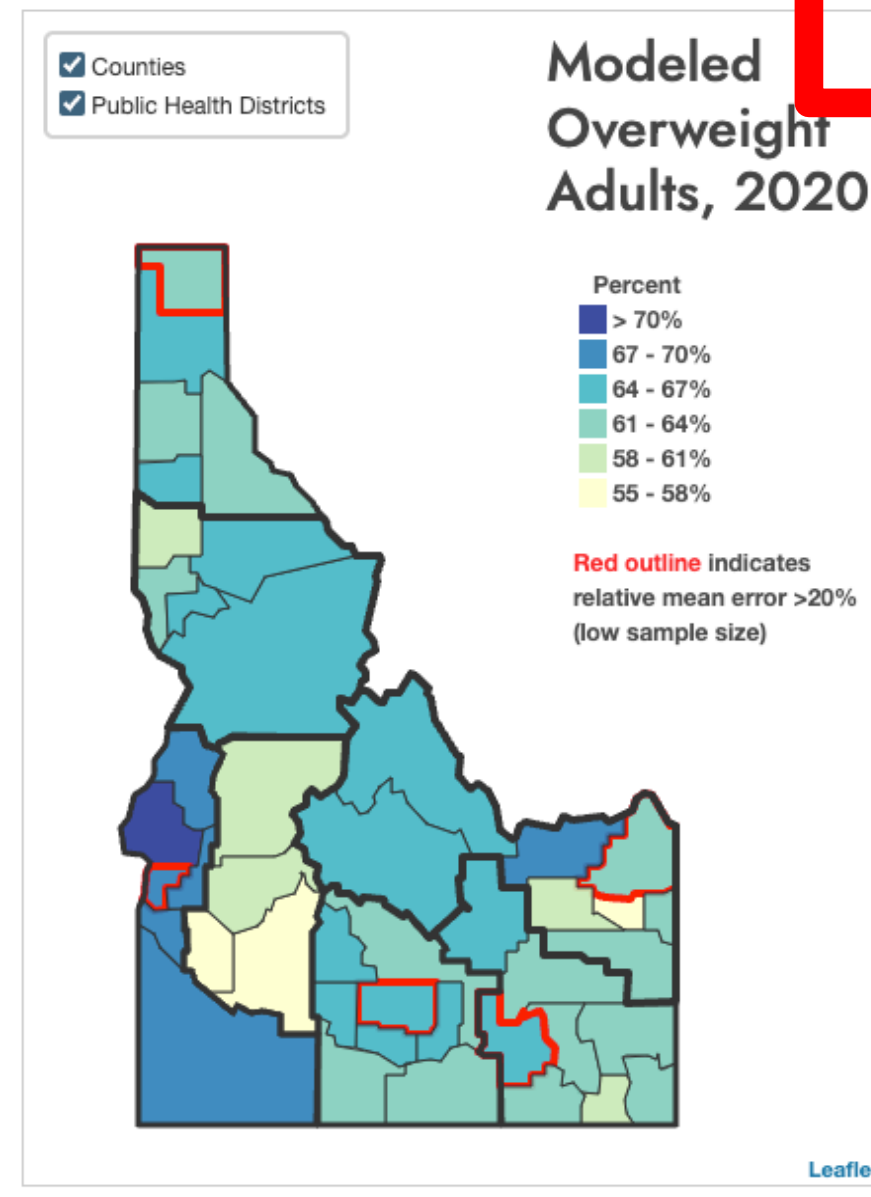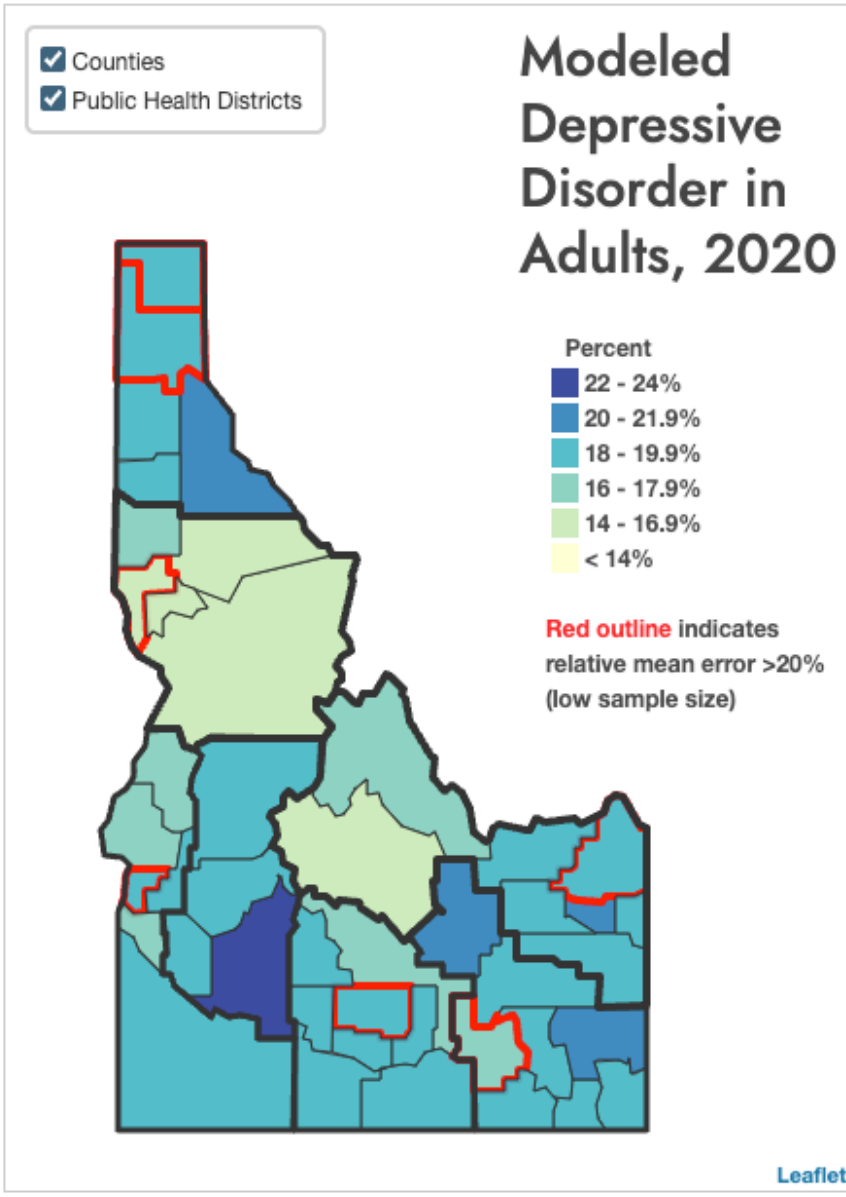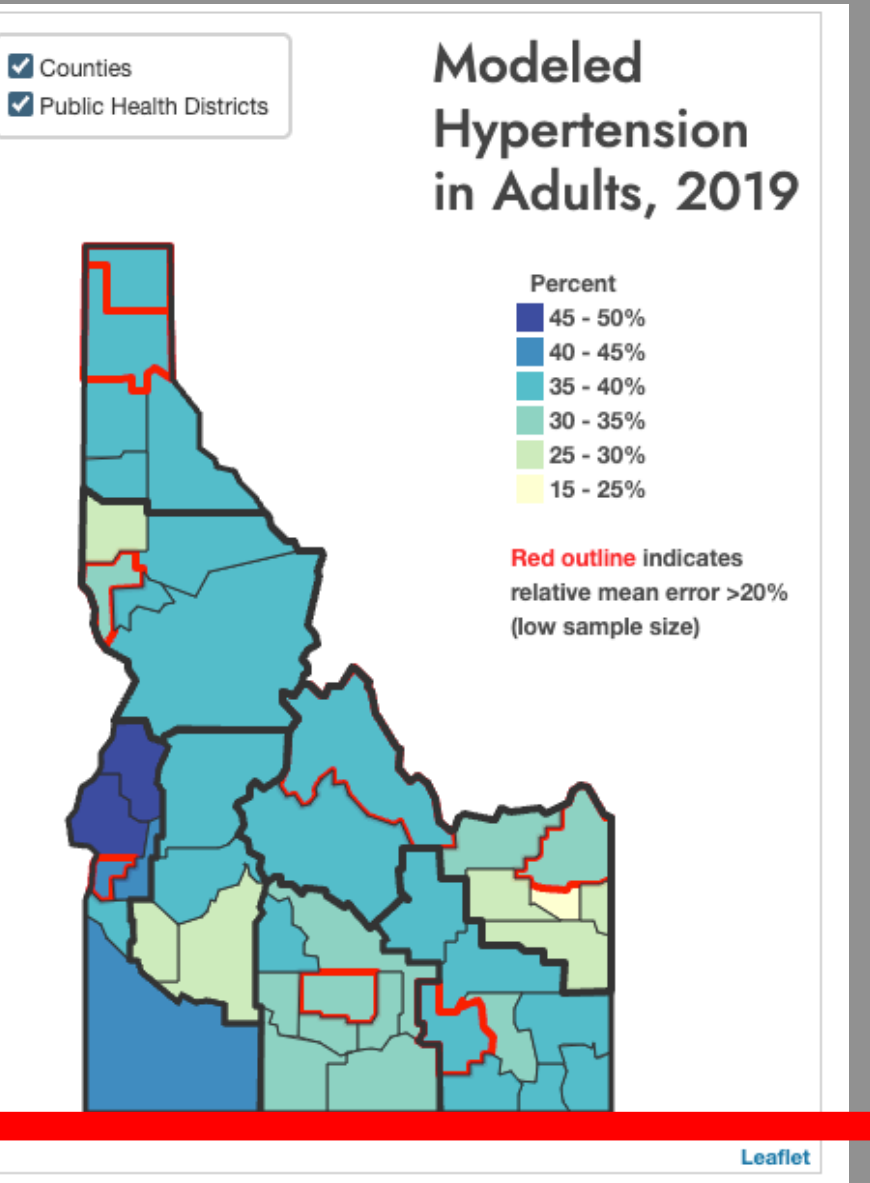
Model Results: Diabetes

Dynamic base

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Model Results: Heart Disease

Dynamic base
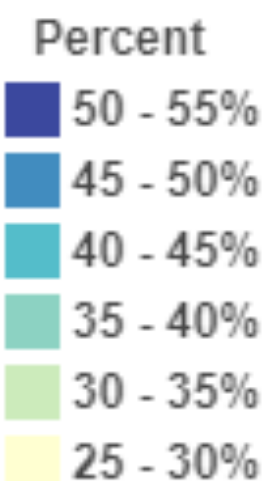
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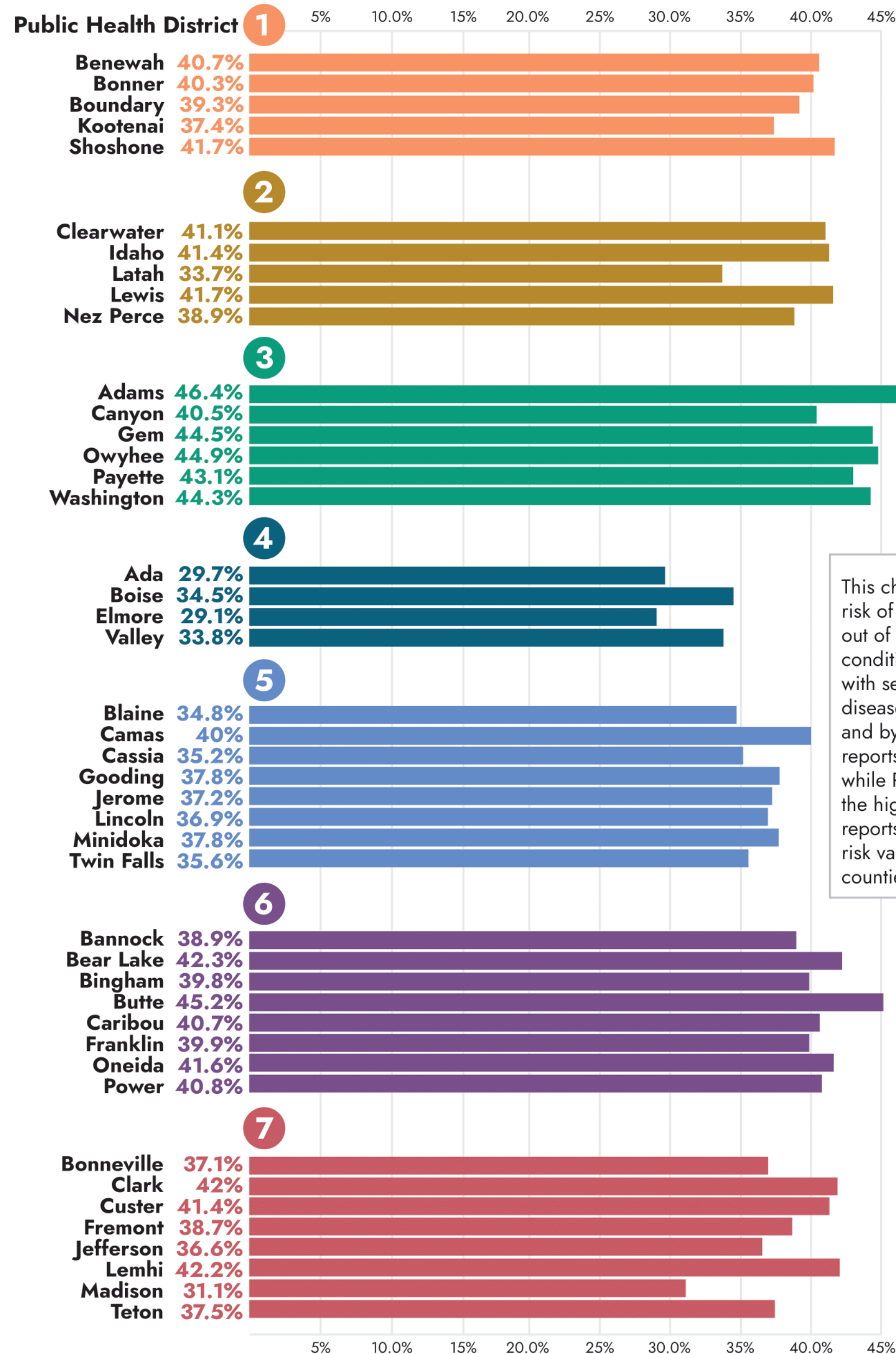
COVID Risk Prevalence 1 out of 5 health conditions

COVID MODELING

- Run over alpha, delta, and omicron windows
- Limitations in aligning annual data with variant waves
- Used cumulative deaths, cases, and hospitalizations on a per county basis
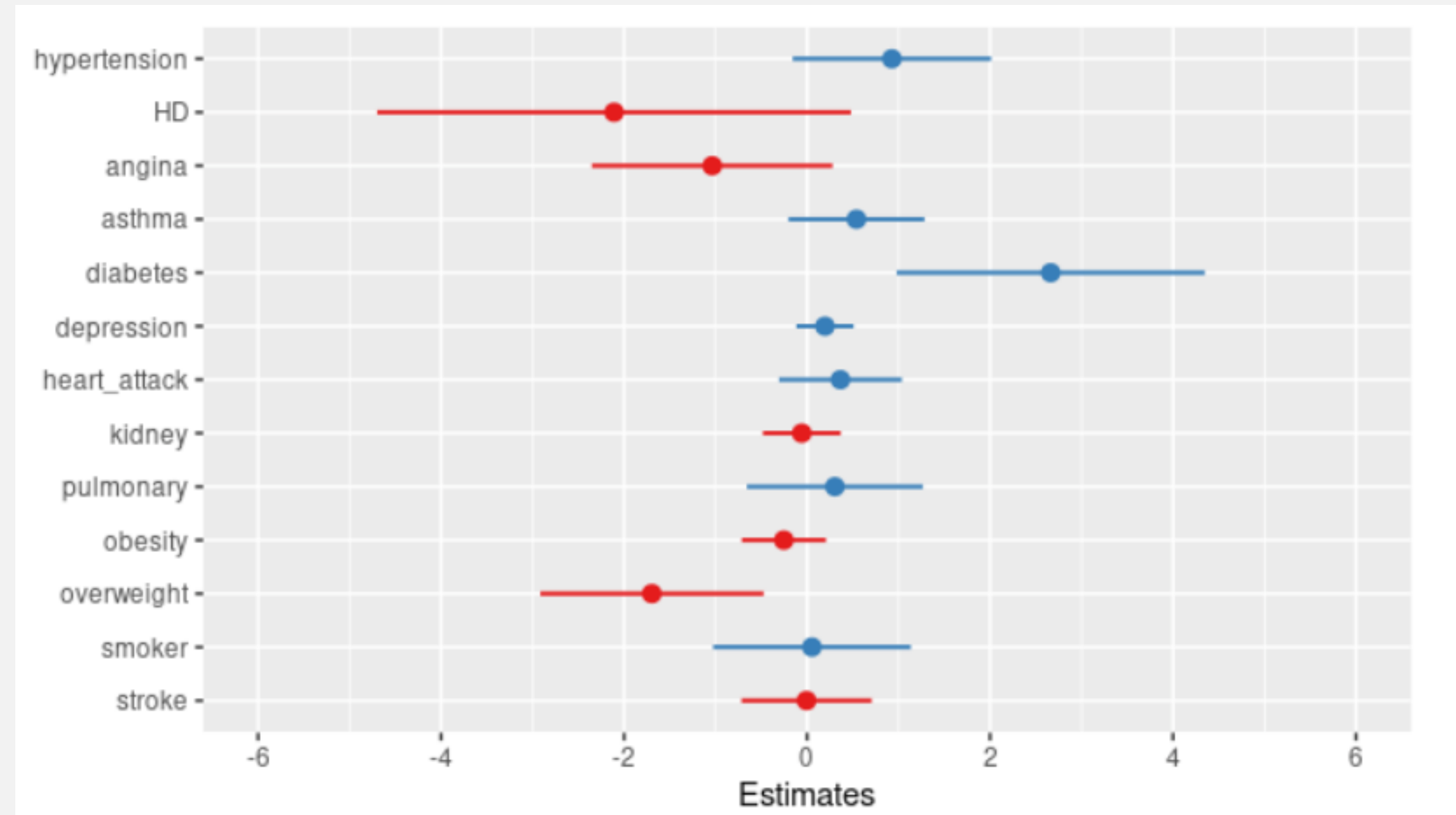
Delta time window: R2 = .49 (cumulative deaths)

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FEATURE SELECTION ANALYSIS

- Run over alpha, delta, and omicron windows
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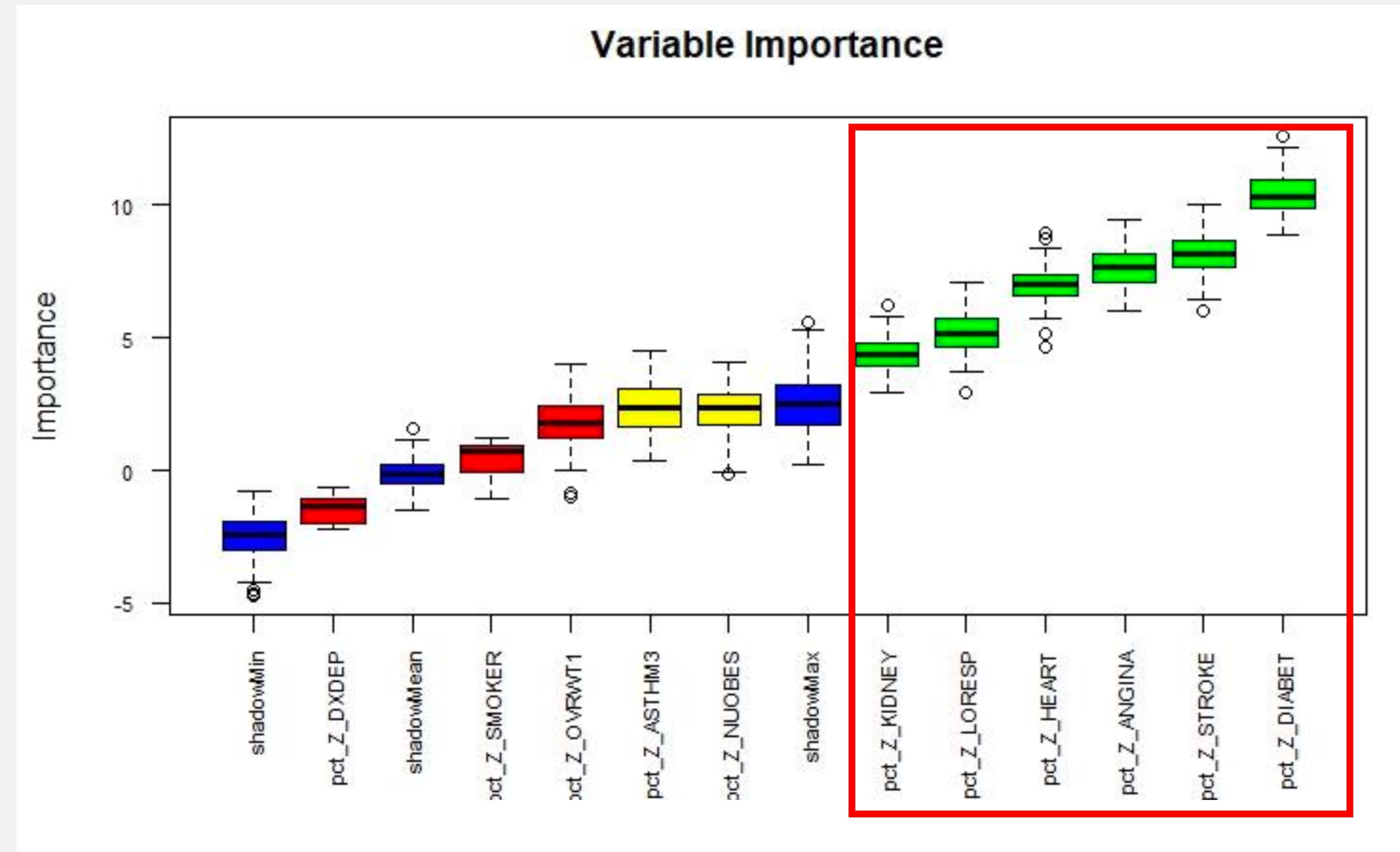
Boruta Feature Importance Algorithm (Delta Wave)

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FEATURE SELECTION ANALYSIS

- Random Forest algorithm produced best results for all waves
- Feature importance aligned with Boruta algorithm
- OOB error was lowest when the number of predictor variables at each split = 4
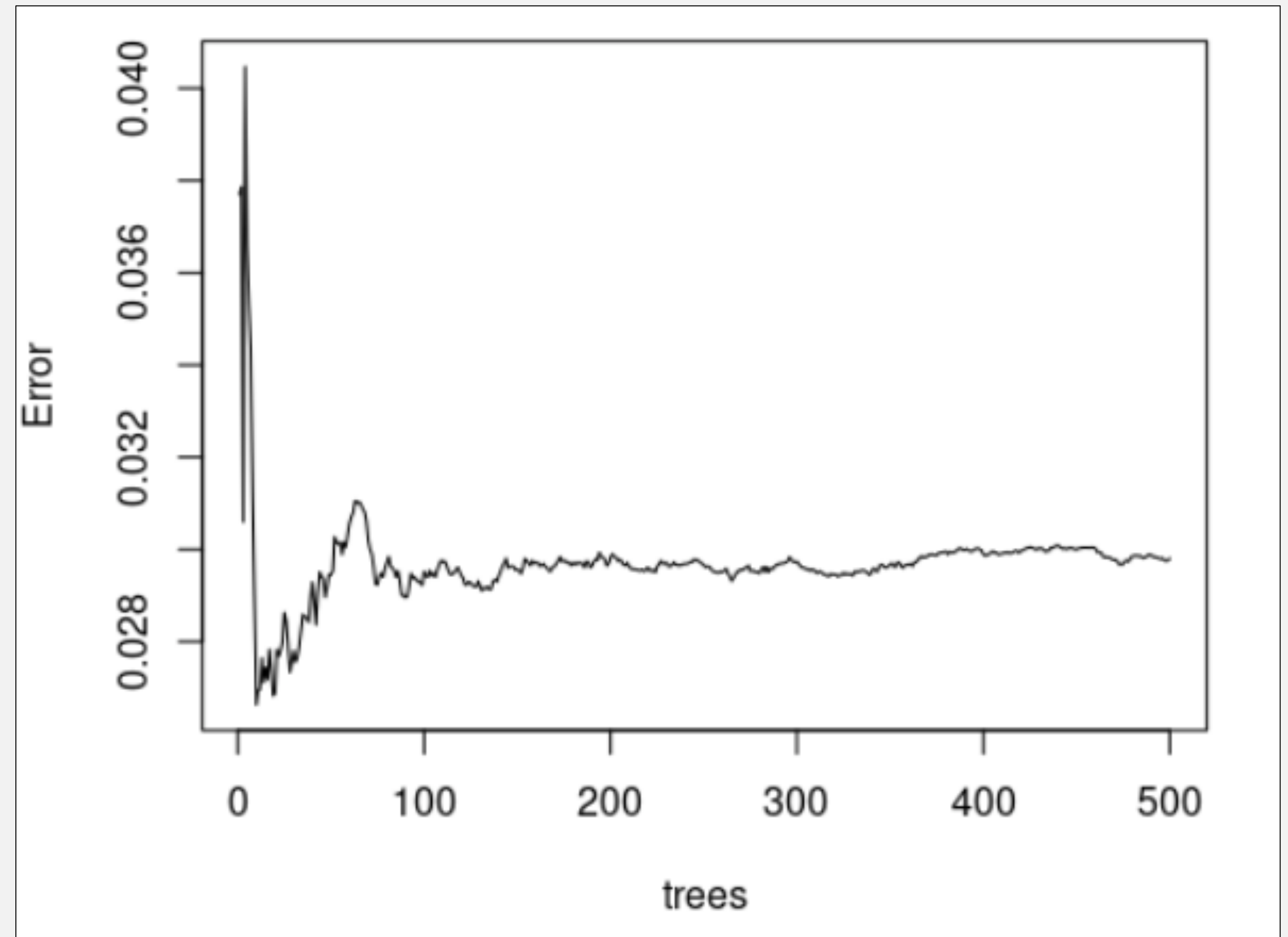
RF MSE based on number of trees

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COMMUNITY ENGAGEMENT

- Directly working with Idaho's Health and Equity Task Force
- Presented to multiple regional health and equity meetings
- Research featured on Idaho's Vandal Theory podcast

https://www.uidaho.edu/news/the-vandal-theory

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FUTURE WORK

- Address limitations with existing spatial microsimulation approach:
    - Constraint expansion/selection
    - Validation with spatially-refined surveys

    - Developing two additional spatial microsimulation approaches using combinatorial optimization and simulated annealing

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FUTURE WORK

- Expansion nationwide

- Time series analysis (2019-2023)

- Expanded to 30+ covid related questions

- Multi-directional models/predictability (e.g. Long COVID)

- Ensembled algorithmic models

- Spatial heterogeneity assessment

- Provide data/models @ http://modelingidahohealth.org

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BRFSS™

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