An Assessment of Interrupted Telephone Service Adjustment (ITSA) in Random Digit Dialing (RDD) Telephone Surveys

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turning knowledge into practice

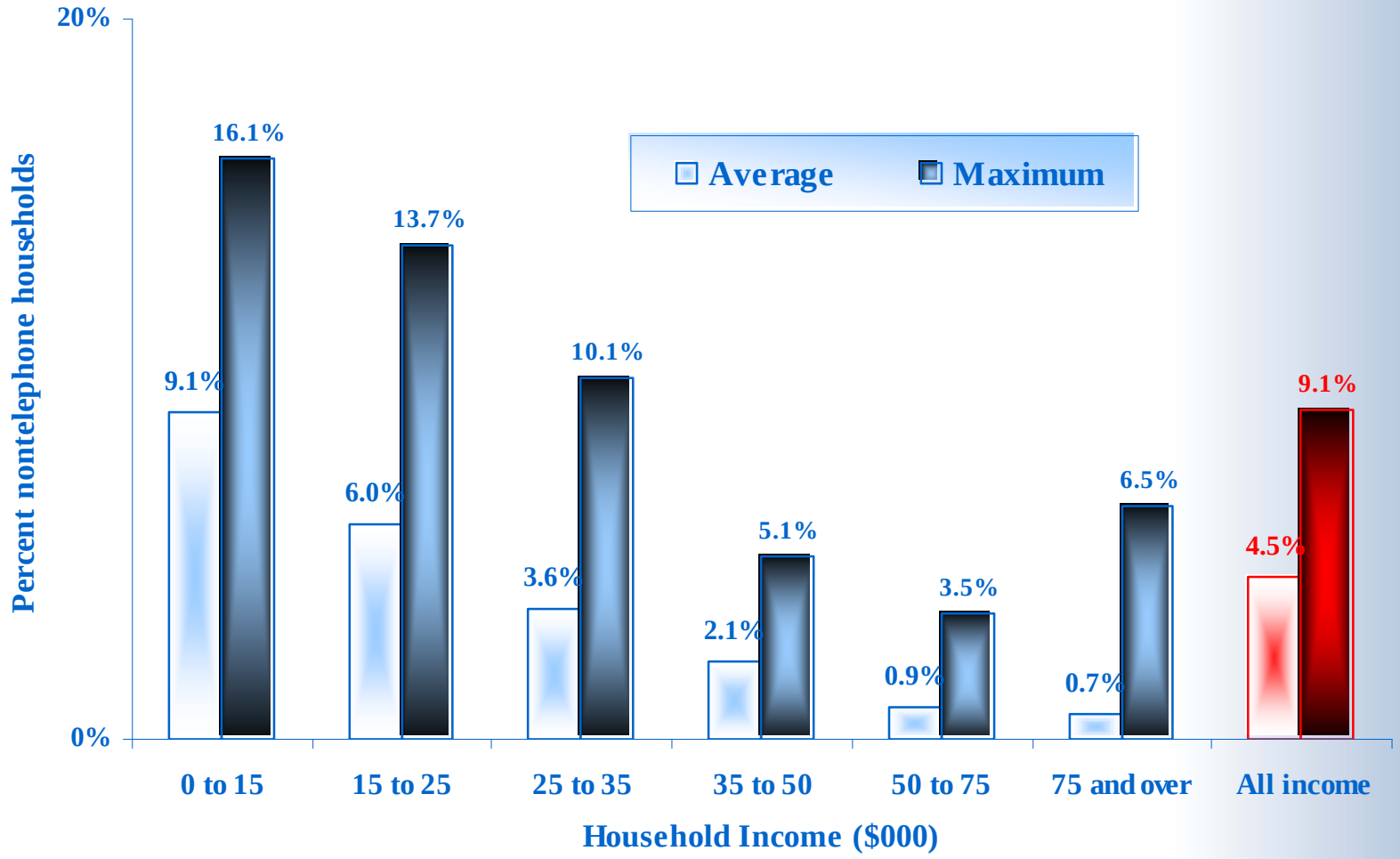
Research Triangle Park, North Carolina

Agenda

- Nature of the Problem
- Existing Research
- Survey Data Used for Evaluation of the Proposed Solution
- Proposed Solution
- Evaluation of the Proposed Solution
- Summary & Conclusions

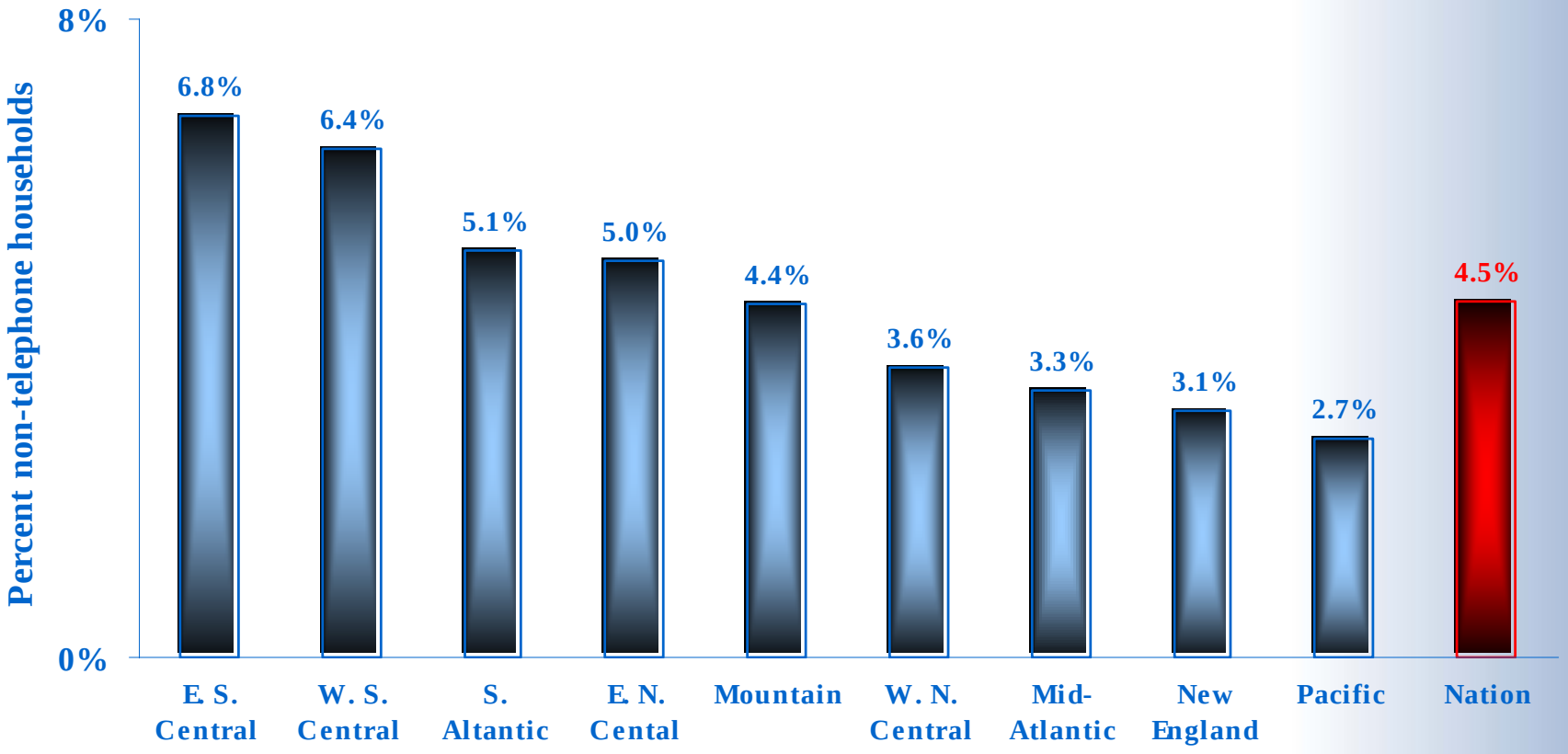
Nature of the Problem

Average and maximum percent nontelephone households by household income (CPS 2002)



Nature of the Problem

Percent households without telephone by the Census division (CPS 2002)



Existing Research

- Literature promoting an *ITSA* type procedures first appeared in an article by Keeter (1995), suggesting the use telephone service interruption as a surrogate for lack of telephone service.
- Frankel et. al. (1998) indicates that *ITSA* methodology can reduce the bias due to telephone noncoverage.
- Brick, et. al. (1996) seems to offer a less enthusiastic support for the general utility of this type of adjustment for all RDD surveys.
- Cautious endorsements for using an adjustment of this form for survey estimates that are socioeconomic related.

Behavioral Risk Factor Surveillance System (BRFSS)

- Coordinated by the Centers for Disease Control and Prevention and all state health departments, employs the world's largest RDD survey.
- In 2002 the sample sizes ranged from 2,408 in the District of Columbia to 13,491 in Pennsylvania, with a median state sample size of 4,401.
- Survey data are weighted to account for oversampling of listed telephone numbers, households with multiple telephone lines, and subsampling of adults in each household.
- Moreover, the resulting base weights are post-stratified to CPS counts within age, gender, and race/ethnicity cells for each state.

The Big Question

Is the gain in bias reduction worth the variance inflation when applying *ITSA*?

Justification/Application

- BRFSS is uniquely qualified for *ITSA*, since this survey focuses on risk factors and prevalence estimates for disease, both of which are highly related to the socioeconomic status of individuals.

- For illustration purposes, use will be made of the BRFSS:03 survey data to assess the bias reduction capability of this methodology against the potential loss in precision that will result from variance inflations.

Notation

w_{ijk}^{B} **Base weight for the *k*th respondent in the *i*th state and *j*th household income category**

w_{ijk}^{P} **Post-stratified weight for the *k*th respondent in the *ij*th cell based on the 2003 methodology**

n_{ij} **Number of respondents in the *ij*th cell**

I_{ij} **Subset of respondents in the *ij*th cell with telephone service interruptions**

N_{ij}^{T} **Number of adults in telephone households in the *ij*th cell**

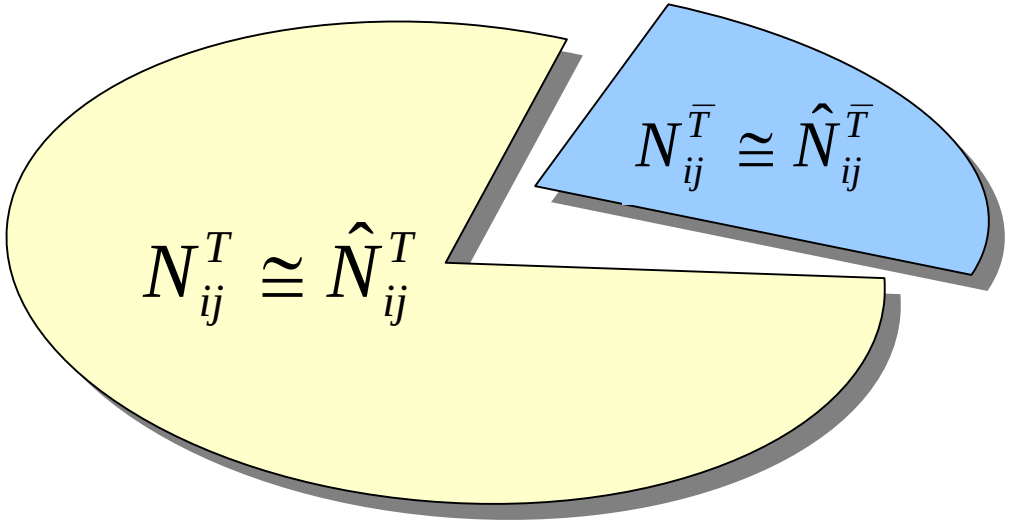
$N_{ij}^{\bar{T}}$ **Number of adults in non-telephone households in the *ij*th cell**

N_{ij}^{I} **Number of adults in households with telephone service interruptions in the *ij*th cell**

$N_{ij}^{\bar{I}}$ **Number of adults in households with no telephone service interruptions in the *ij*th cell**

Ingredients

- Unfortunately, none of the above four population numbers are readily known.
- However, the first two can be estimated from the CPS:

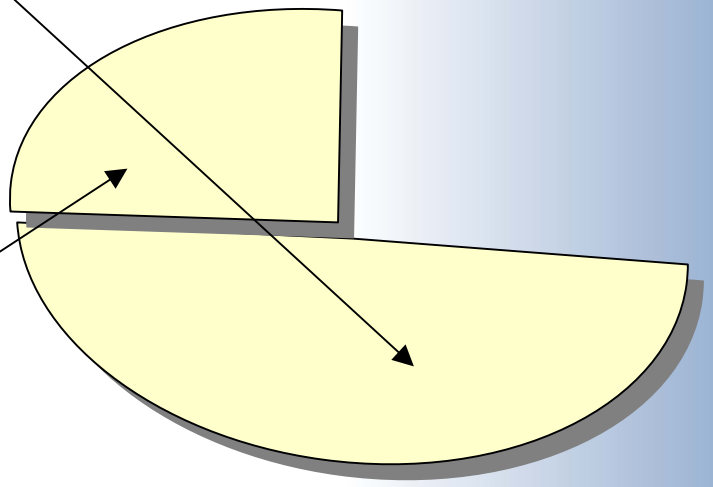


Ingredients

- The latter two can be estimated from the survey data:

$$N_{ij}^{\bar{I}} \cong \hat{N}_{ij}^{\bar{I}} = \hat{N}_{ij}^{T}\left(1-\frac{\sum_{k\in I_{ij}} w_{ijk}^{P}}{\sum_{k=1}^{n_{ij}} w_{ijk}^{P}}\right) = \hat{N}_{ij}^{T} \times \frac{\sum_{k\notin I_{ij}} w_{ijk}^{P}}{\sum_{k=1}^{n_{ij}} w_{ijk}^{P}}$$

$$N_{ij}^{I} \cong \hat{N}_{ij}^{I} = \hat{N}_{ij}^{T}\left(\frac{\sum_{k\in I_{ij}} w_{ijk}^{P}}{\sum_{k=1}^{n_{ij}} w_{ijk}^{P}}\right) = \hat{N}_{ij}^{T} - \hat{N}_{ij}^{\bar{I}}$$



ITSA Methodology

- Design weight of all respondents are adjusted for telephone non-coverage by:

$$w_{ijk}^{A} = \begin{cases} w_{ijk}^{B} \times \dfrac{\hat{N}_{ij}^{I} + \hat{N}_{ij}^{\bar{T}}}{\sum\limits_{k \in I_{ij}} w_{ijk}^{B}}, \forall k \in I_{ij} \\ w_{ijk}^{B} \times \dfrac{\hat{N}_{ij}^{\bar{I}}}{\sum\limits_{k \notin I_{ij}} w_{ijk}^{B}}, \forall k \notin I_{ij} \end{cases}$$

- The resulting weights are pos-stratified to CPS counts

Evaluation

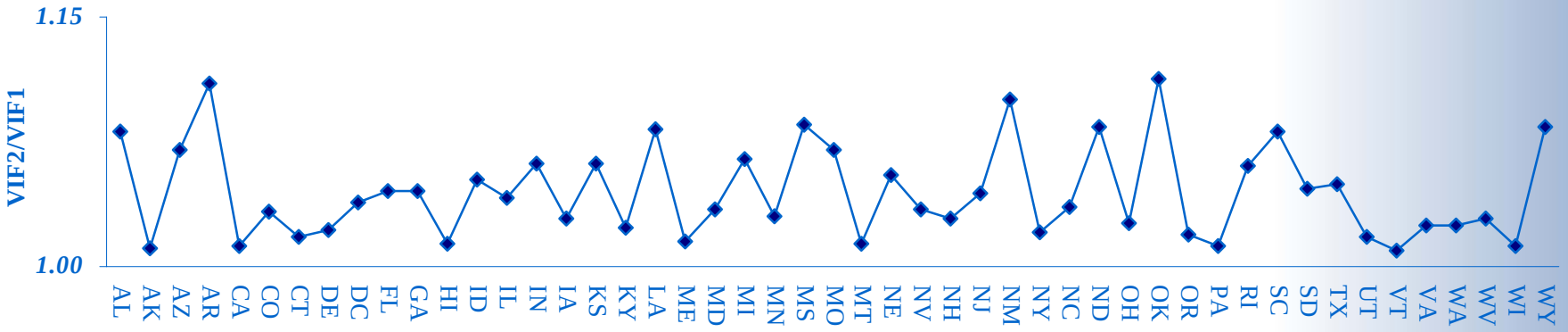
- Does the resulting inflation in variance of survey estimates due to this adjustment outweigh the gain in bias reduction?
- Inflation in variances due to unequal weighting effect (UWE) can be approximated by:

$$UWE = 1 + \left[CV(w_i)\right]^2 = 1 + \frac{\sum_i \frac{\left(w_i - \overline{w}\right)^2}{n-1}}{\overline{w}^2}$$

Evaluation

(UWE ratios under *ITSA* and standard weighting methodologies by state)

- As expected, the variability in weights increases, as all calculated ratios are greater than one.
- The average UWE across all states for the standard methodology is 1.63 while that for the ITSA methodology is 1.70, with an average ratio of 1.04.



Evaluation

- A more telling indicator that takes into account the negative effect of variance inflation as well as the positive gain due to bias reduction is Mean Square Ratio (MSR):

$$MSR(\hat{p}) = \frac{MSE(\hat{p}_{ITSA})}{MSE(\hat{p}_{Old})}$$

- Assuming that the bias reduction under the *ITSA* methodology will render the resulting point estimate unbiased, then:

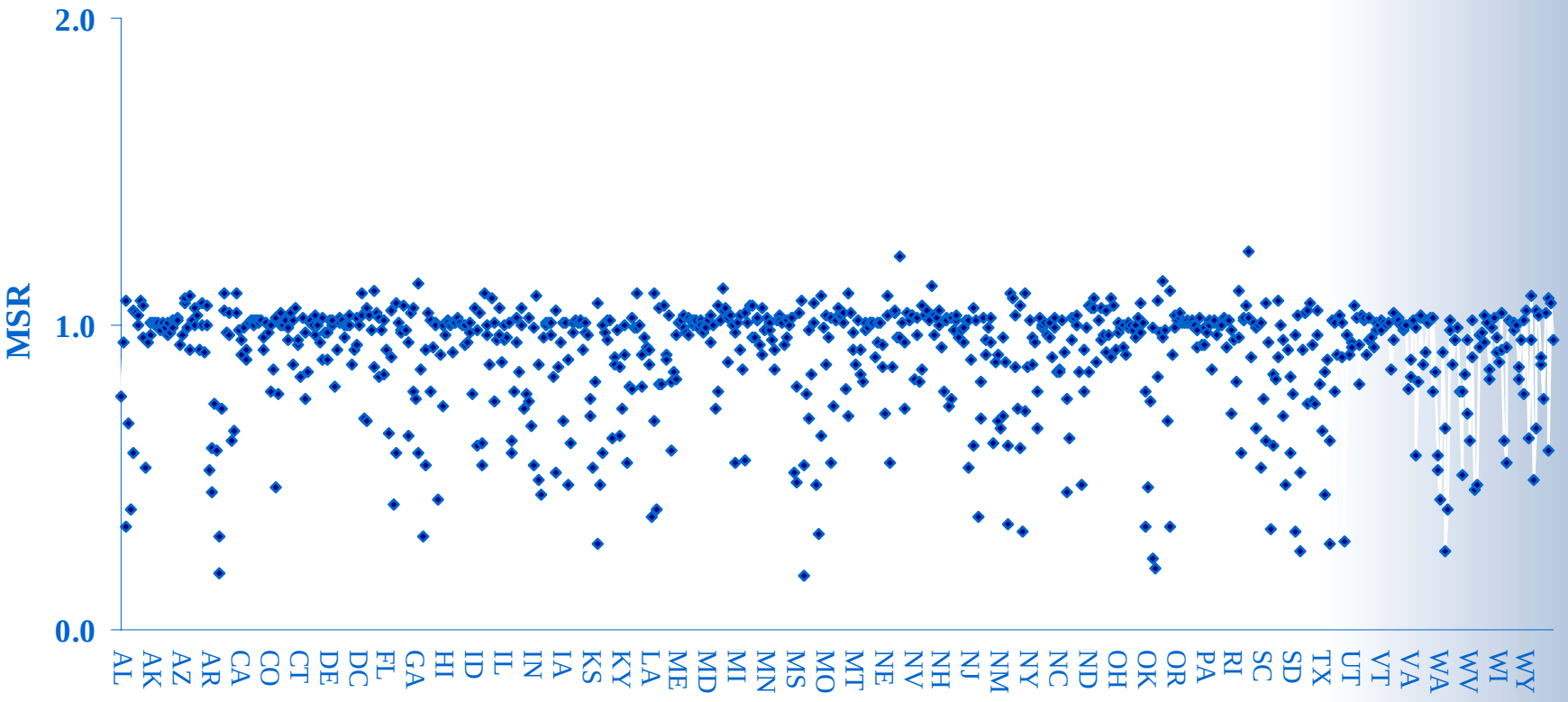
$$MSR(\hat{p}) = \frac{V\left(\hat{p}_{ITSA}\right)}{V\left(\hat{p}_{Old}\right) + \left(\hat{p}_{Old} - \hat{p}_{ITSA}\right)^2}$$

Evaluation (Key outcome measures)

Outcome Measure	Variable
General health status	GOODHLTH
Any kind of health care coverage	HLTHCOV
Cost prevented dr. Visit, past 12 months	COSTPREV
Any exercise, past month	EXERCISE
Diagnosed diabetes, excluding pregnancy	EVERDIAB
Diagnosed high blood pressure, excluding pregnancy	EVERBP
Diagnosed high blood pressure, excluding pregnancy, and currently taking medicine	CURBPMED
Ever had blood cholesterol checked	BP
Currently trying to lose weight	CURLOSEW
Currently have asthma, Dr. Diagnosed	CURASTH
Had flu shot, past 12 months	FLU
Ever had pneumonia shot, people 65+	PNEUM
Current smoking status	CURSMK
Obesity	OBESE
Binge drinking	BINGE
Ever tested for HIV, excluding tested when donating blood, people 18-64	HIVTEST
Any activities limited due to physical, mental, or emotional problems	LIMACT

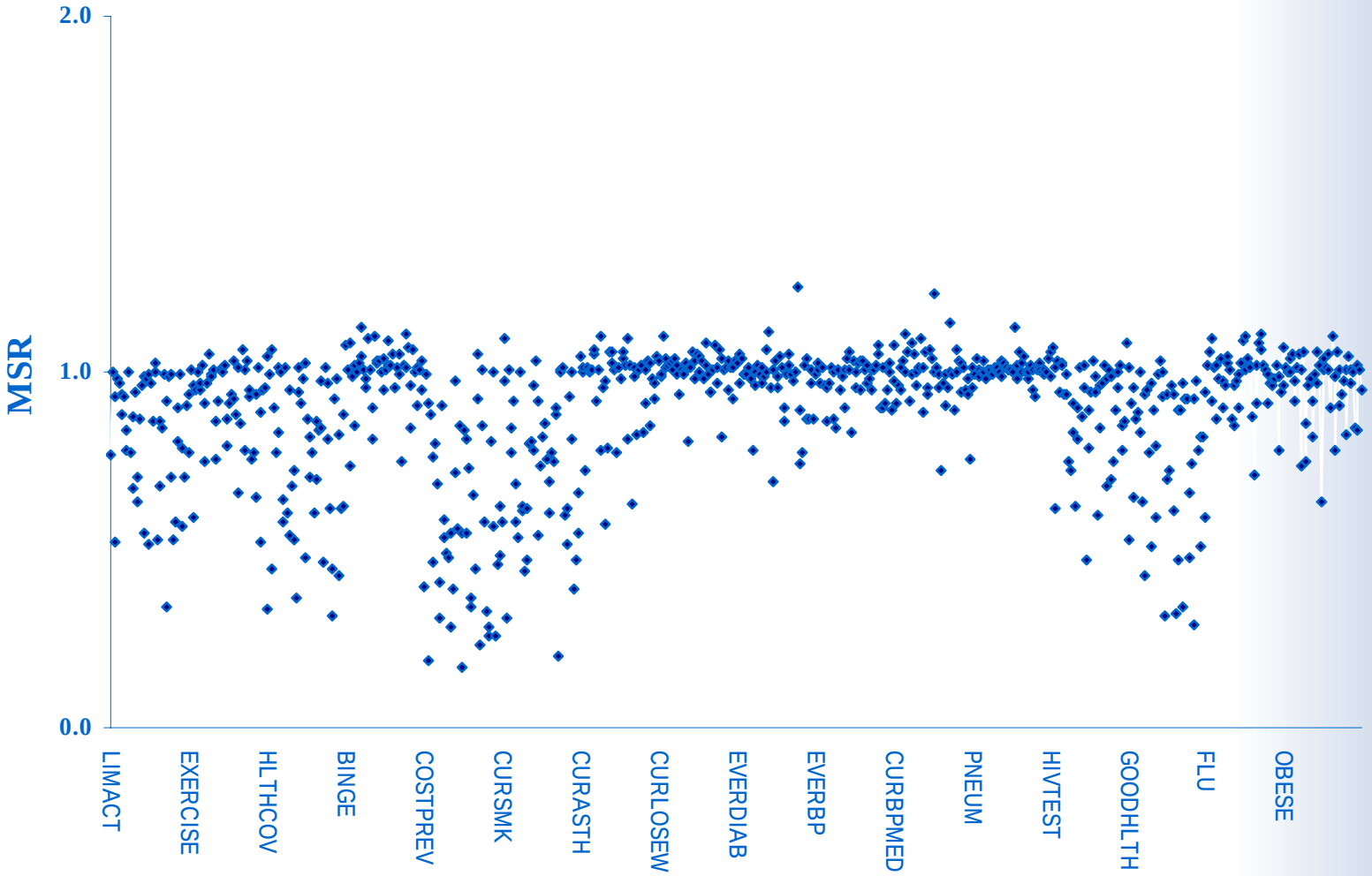
Evaluation

(Mean Square Ratio (MSR) of key outcome measures by state)



Evaluation

(Mean Square Ratio (MSR) by key outcome measure across states)



Conclusions

- For estimates that are influenced by the socioeconomic status of respondents, *ITSA* seems to reduce the bias due to lack of telephone coverage without increasing the variance of estimates significantly.
- It is expected that the *ITSA* type weighting will be more effective when applied within weighting cells indexed by categories of household income or education.
- There are other sources of bias for RDD surveys, such as the emerging prevalence of cell-only households, which need to be addressed.

References

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