NONRESPONSE BIAS SENSITIVITY ANALYSIS FOR THE PRAMS SURVEY, 2019

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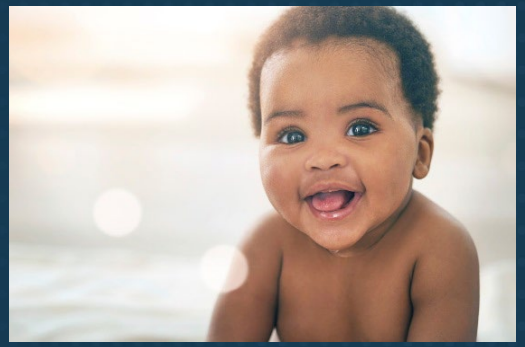
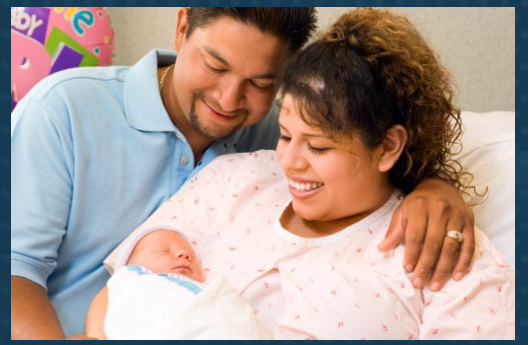


Centers for Disease Control and Prevention

National Center for Chronic Disease Prevention and Health Promotion

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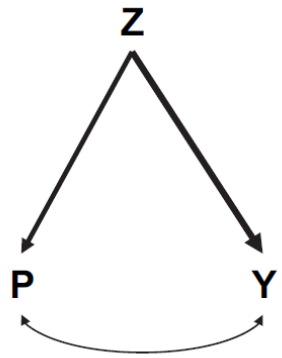
CHALLENGE OF NON-RESPONSE BIAS ANALYSIS

- **Estimating non-response bias is always imperfect; we cannot really know what non-responders 'would have answered'…**

- **<u>Research Question</u>: Despite this, can we find a plausible upper limit of nonresponse bias (i.e., the 'worst case scenario')?**

MISSINGNESS SCENARIOS

- **Missing-at-random (MAR)**
  - Subgroups of the population can *systematically differ* in their propensity to respond (P)
  - Yet we can still produce unbiased estimates (of Y) conditioned on auxiliary variables (Z; e.g., demographics, geography…)



- **Missing-not-at-random (MNAR; aka *non-ignorable nonresponse*):**
  - Response probability is driven by the survey topic itself
  - Adjustments based on auxiliary variables would not produce unbiased estimates
  - Example Topics: Poverty, depression, substance abuse, …

From Groves (2006) Nonresponse rates and nonresponse bias in household surveys.

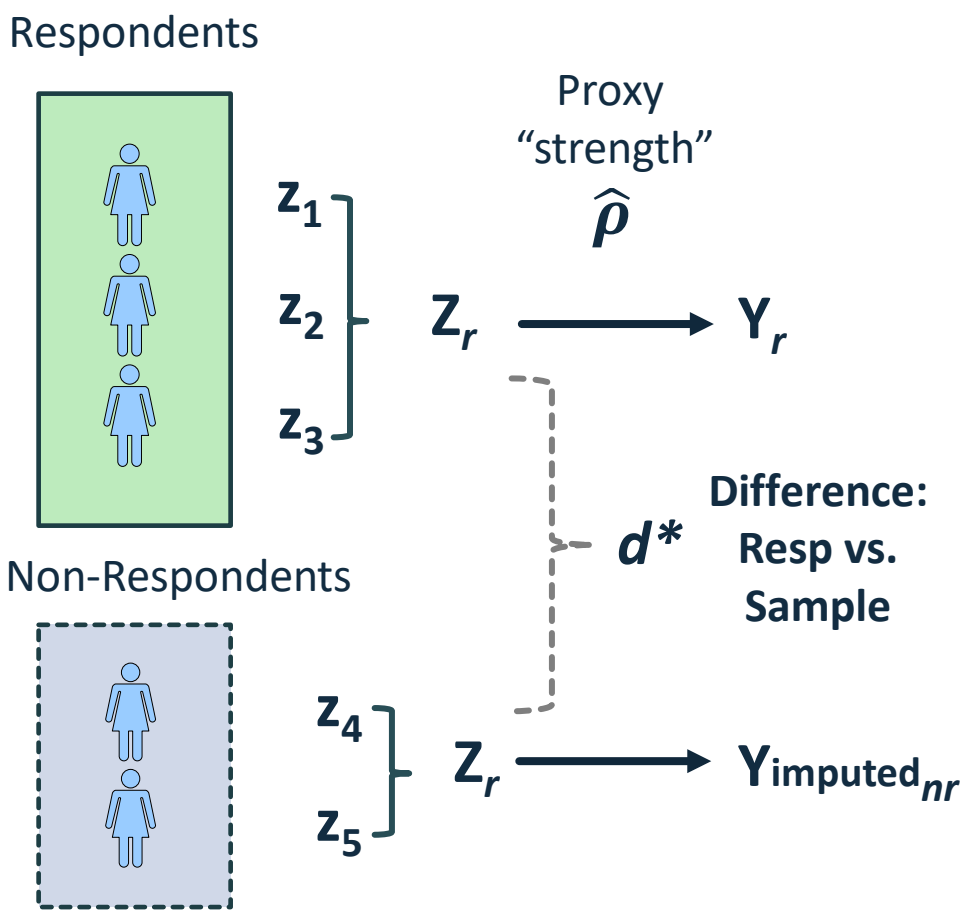
NEW ADVANCES IN STUDY OF BIAS

- **Proxy Pattern-Mixture Analysis (PPMA; Andridge and Little, 2020*)**
- **PPMA is a *sensitivity analysis* method: "Given the observed data, how do changes to our assumptions about nonresponse impact estimates of bias?"**
- **New: PPMA can now simulate *binary outcomes* under varying missingness assumptions**
  - **Missing-at-random (best case) → missing-not-at-random (worst case)**
- **PRAMS data contains rich auxiliary data for the full sample (respondents + non-respondents)**
  - **Ideal for PPMA analyses**

Journal of Official Statistics, 2020, vol. 36, issue 3, 703-728*

METHODS: PPMA IN CONCEPT

- ***Step 1:*** **Create a *proxy* predicting the outcome among the respondents (aux vars)**
  - **Assess proxy 'strength'**
  - **Calculate proxy across nonrespondents**
  - **Calculate d* (difference parm)**
- ***Step 2:*** **Impute outcomes based on proxy variable, under 3 missingness scenarios**
  - **MAR (best case ϕ=0),**
  - **Moderate MNAR, ϕ=.5**
  - **Extreme MNAR (worst case ϕ=1)**
- ***Step 3:*** **Estimate bias-adjusted proportions and confidence limits for each scenario**



METHODS (DATA): PRAMS, 2019

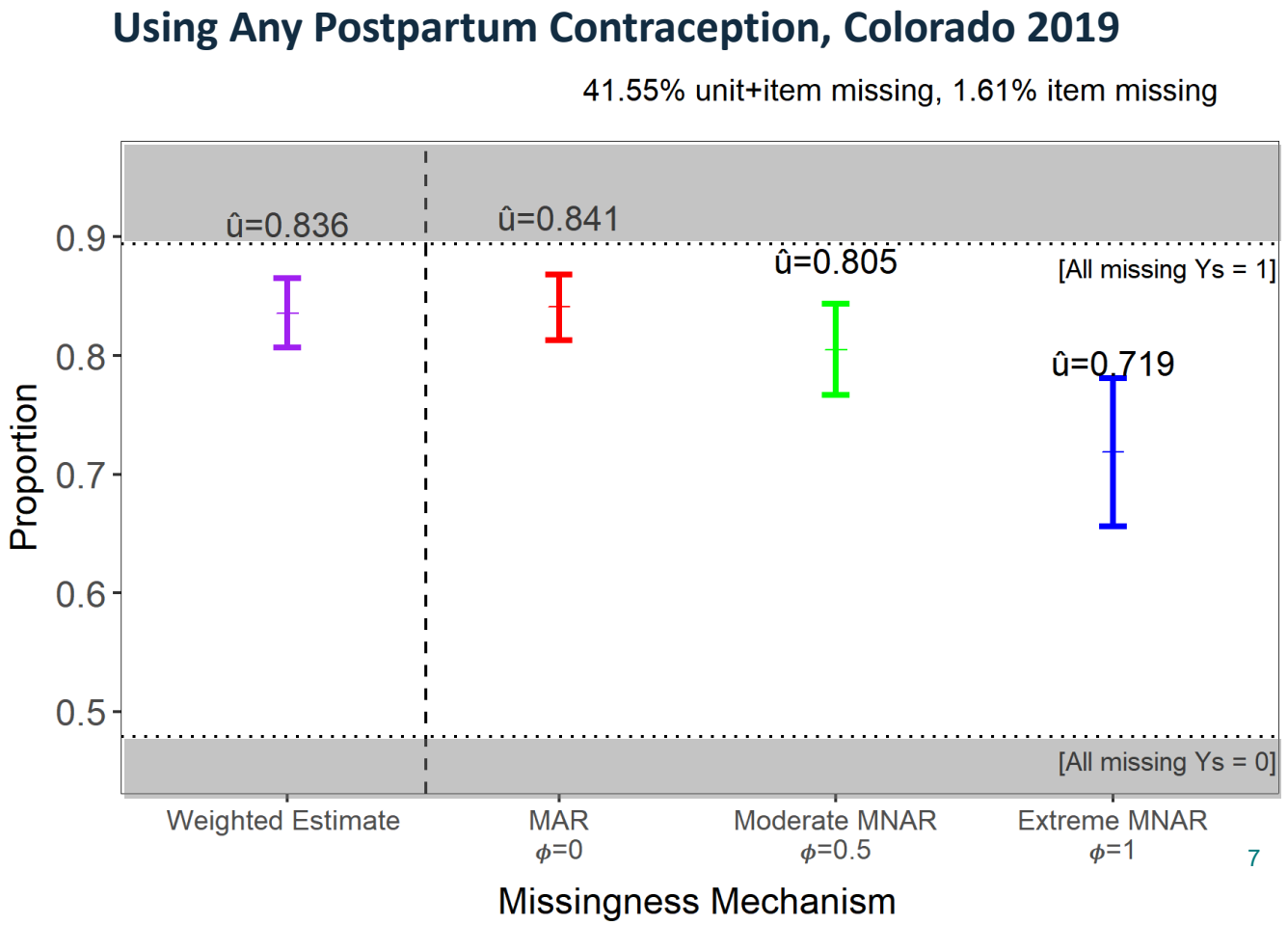
- **Analyzed 13 survey indicators: contraceptive and other behaviors, medical conditions, poverty**
- **Grouped 45 PRAMS sites into 5 response rate groupings:**
  - **Low (39.8% -- 50.1% RR; 8 sites)**
  - **Med-Low (50.5% -- 55.0% RR; 8 sites)**
  - **Med (55.5% -- 59.7% RR; 15 sites)**
  - **Med-High (60.4% -- 65.0% RR; 8 sites)**
  - **High (65.3% -- 81.0% RR; 6 sites)**

- **Unique benefit of PRAMS:**
  - **Multi-site survey with same protocol & questions; lends confidence to findings across 45 sites**
  - **Fully "known" population**

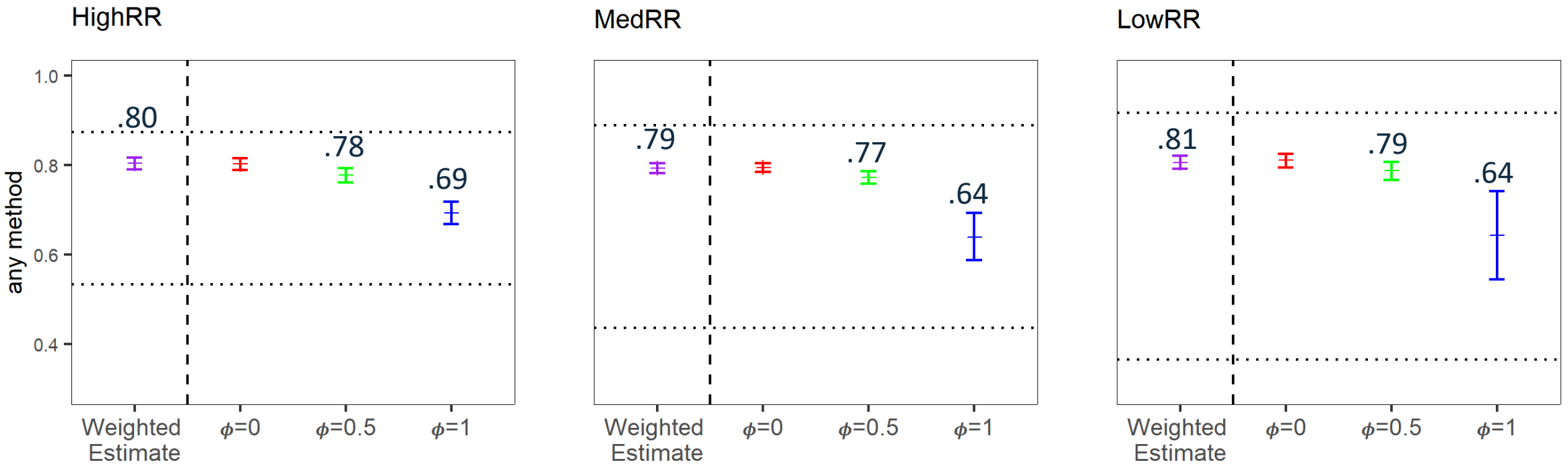
PRAMS Auxiliary Variables	
Education	Race
Age	Ethnicity
Marital Status	Previous Live Birth
Medicaid Birth Coverage	Prenatal Care
Women, Infants and Children Program Status	Top 20% Hospital & County ranked by # births

FINDINGS: EXAMPLE GRAPH

- **PRAMS weighted estimate**
- **Manski bounds (horizontal dotted lines)**
  - **Nonresponders set to "all yes" or "all no"**
  - **Impossible boundary**
  - **Upper=0.89; Lower=0.48**
- **3 missingness simulations**
  - **MAR (ϕ = 0.0, best case)**
  - **Moderate MNAR (ϕ = 0.5)**
  - **Extreme MNAR (ϕ = 1.0, worst case)**

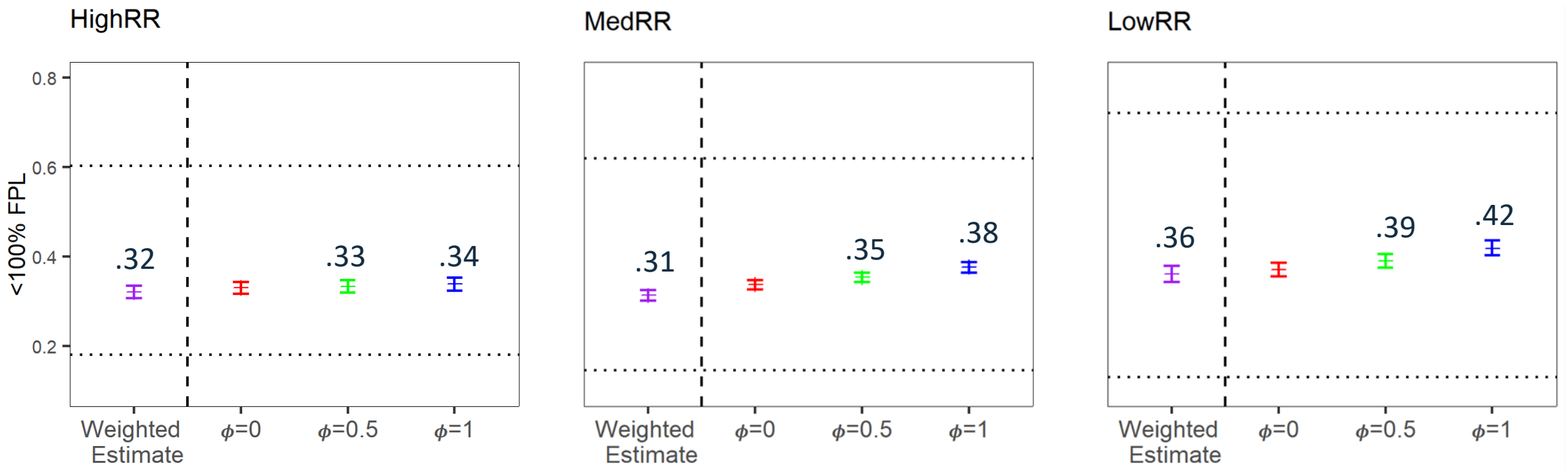


FINDINGS: ANY POSTPARTUM CONTRACEPTION



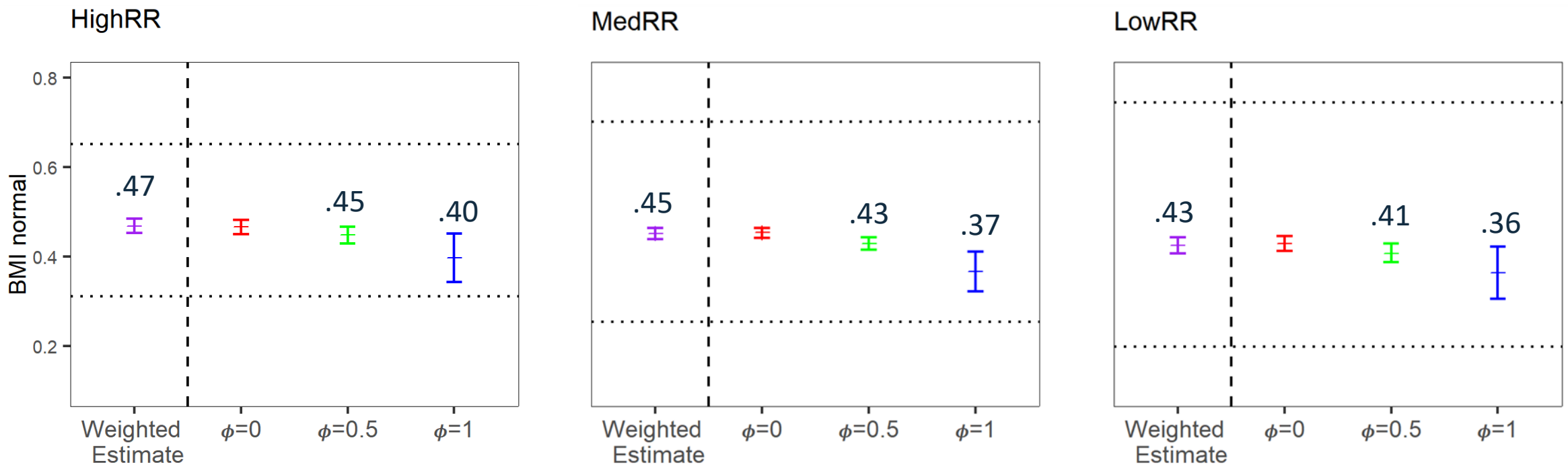
- **As MNAR worsens, PRAMS over-estimates proportion of women using postpartum contraception.**
- **Patterns are similar as you go from high to low RR sites; yet confidence worsens as RR decreases.**
- **Median bias across 45 sites: Moderate MNAR = +1.5%; Extreme MNAR = +6.25%.**

FINDINGS: POVERTY



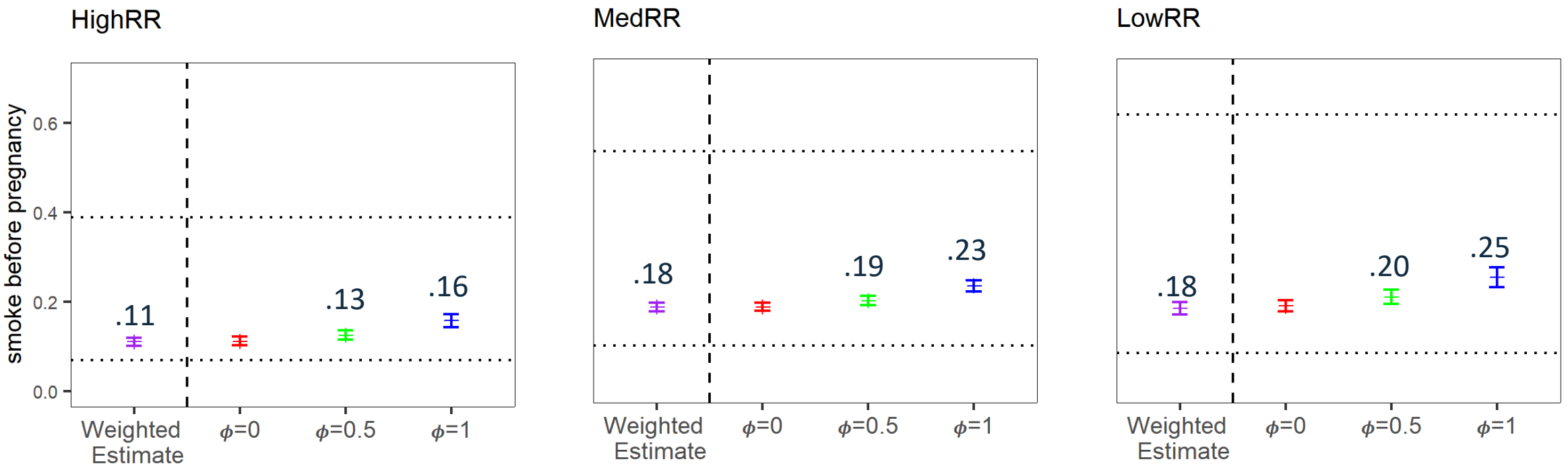
- **As MNAR worsens, PRAMS tends to *under-estimate* proportion of women below poverty line.**
- **Under-estimation is more pronounced with lower response rates.**
- **Median bias across 45 sites: Moderate MNAR = -3.15%; Extreme MNAR = -5.25%.**

FINDINGS: NORMAL BMI (BODY MASS INDEX)



- **As MNAR worsens, PRAMS slightly over-estimates proportion of women with normal BMI.**
- **Median bias across 45 sites: Moderate MNAR = 0.85%; Extreme MNAR = 3.15%.**

FINDINGS: SMOKING BEFORE PREGNANCY



- **As MNAR worsens, PRAMS under-estimates proportion of women smoking before pregnancy.**
- **Median bias across 45 sites: Moderate MNAR = -1.25%; Extreme MNAR = -3.10%.**

KEY TAKEAWAYS

- As we increased MNAR, weighted survey:
  - Tended to overestimate "healthy/positive" indicators
    - E.g., postpartum contraception, normal BMI
  - Tended to underestimate "risky/negative" indicators
    - E.g., smoking before pregnancy, poverty

- Lower response rates were associated with ***increased*** bias -- regardless of missingness assumption

- Moderate MNAR scenarios showed relatively "acceptable" biases
  - Median bias estimates (45 sites) usually within 0-3 percentage points of PRAMS weighted estimate

- Extreme MNAR (among the *most biased* indicators) showed *median* bias (45 sites) within 6-8 percentage points of the PRAMS weighted estimate

IMPLICATIONS

- **Estimates of bias and uncertainty can be reasonably quantified (topic-by-topic)**
  - **Bias estimates are driven by:**
    - **Proxy differences between responders & nonresponders**
    - **Missingness assumptions (MAR → MNAR)**
  - **Uncertainty around bias is reduced by:**
    - **Higher proxy correlation with topic**
    - **Higher response rates**

- **Sensitivity methods can identify the limit of *plausible* bias -- extreme MNAR as the "worst case"**
  - **More precise than Manski boundaries (i.e., *impossible* bias)**
  - **Offers more interpretibility than 'MAR' assumption**
  - **Imputation is relatively efficient (and programmable)**

LIMITATIONS

- **Weaker proxy association with indicator (e.g., contraception) yields less precise bias estimates**
- **Good auxiliary data is the key to identify (as well as adjust for) potential bias**
- **Model performance becomes less stable with smaller sample sizes (n<1000)**
- **Generalizability:**
  - **PRAMS population is only among postpartum women**
  - **PRAMS, unlike many surveys, has 'luxury' of auxiliary variables at the record level**

THANK YOU

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EXTRAS

METHODS

- **Examples among the 13 binary outcomes selected for this study**

Contraception-Related Behaviors/Services	Medical Conditions /Health Services	Other Behavioral Indicators	Demographic/SES
Any postpartum birth control (BC) method	Gestational diabetes	Physical abuse during pregnancy	Less than 100% of federal poverty level
Moderate/Most effective postpartum BC method	BMI normal	Smoking before pregnancy	
Discuss BC with doctors at postpartum visit			