

# Modeling Total Survey Error in the 2011 National Immunization Survey (NIS): Pre-School Children and Teens

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# NIS Program Overview

- Household CATI survey followed by a mailed provider record check study(PRC)
  - Landline RDD sampling frame before 2011 for official estimates
  - Since 2011 Cell RDD samples have been added
  - Household interview screens
    - NIS-Child: 19-35 months of age
    - NIS-Teen: 13-17 years of age
- Assess and monitor vaccination coverage rates of children and teens in the United States.
- Publish official vaccination estimates at the national, state, and selected local levels
- Sponsored by the Centers for Disease Control and Prevention

# Total Survey Error (TSE)

- TSE is the sum of errors from each survey stage and includes:
  - Sampling Error
  - Non Sampling Error
    - Noncoverage
    - Nonresponse
- TSE Analysis can help answer questions:
  - What is the size of bias due to noncoverage and nonresponse and what is its impact on estimated vaccination coverage rates?
  - What is the impact of different weighting methodologies on the total survey errors?

# Comparison of TSE Analysis in the NIS (2010 vs. 2011)

2010

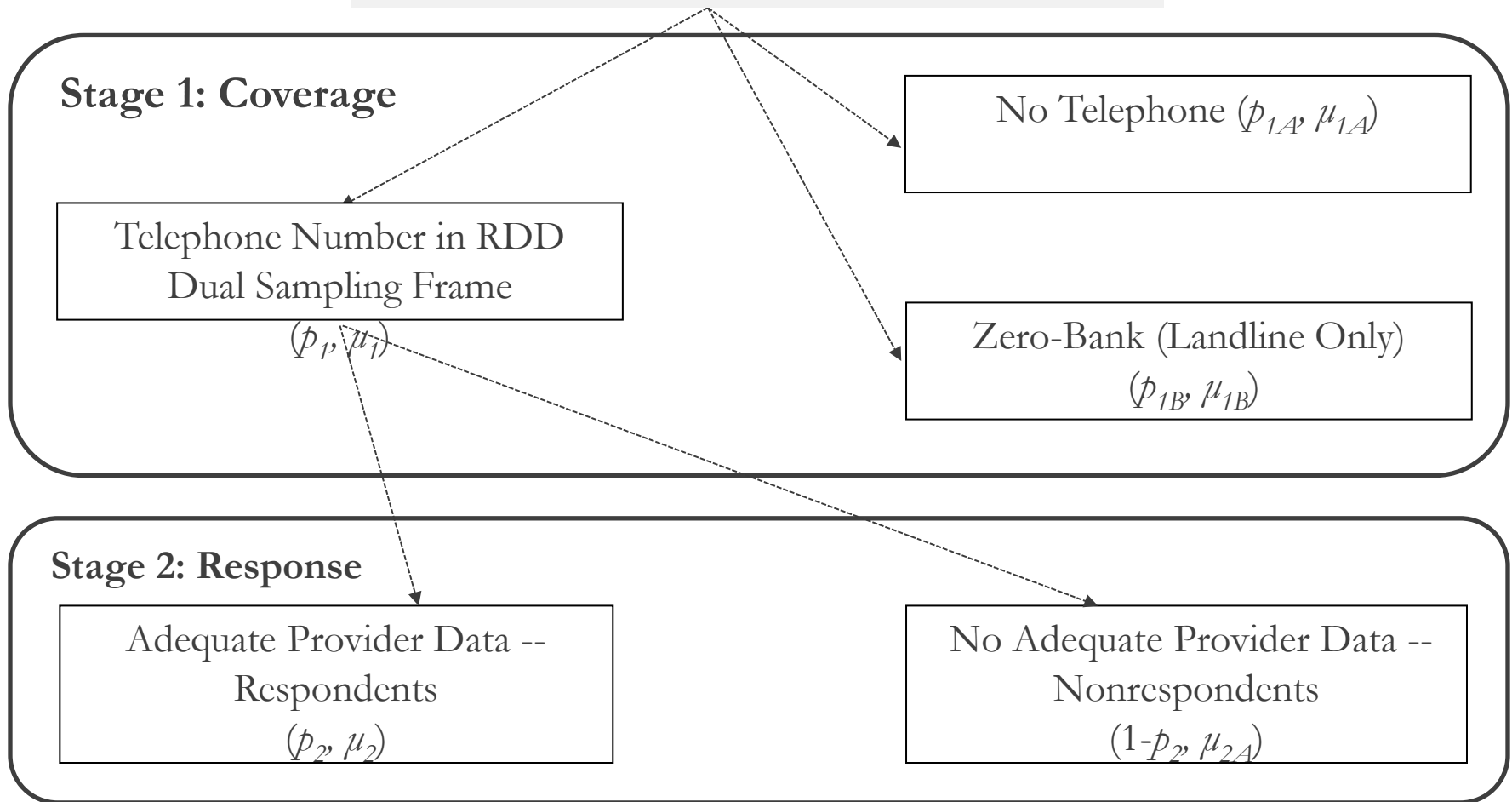
- Assessed bias for multiple NIS-Child and NIS-Teen vaccination coverage estimates
- Considered noncoverage bias potentially introduced by missing the cell phone only and zero-bank population along with no phone population

2011

- Repeated TSE to include improvement in population coverage by including a RDD cell phone frame
- Assessed bias under two different dual frame weighting approaches (shrinkage weighting vs. unbiased weighting)
- Assessed nonresponse bias from decreased response rates

# Universe of Eligible Children

## Universe of Eligible Children



# Methodology for TSE Analysis (1)

## Total Survey Error Analysis Steps:

A. Develop a model describing the survey stages at which component error may enter:

1. Coverage

2. Response (Both the Household interview and the mailed PRC)

*Bias due to Nonresponse*

$$q_1 = \hat{\mu}_1 - \mu_1 = \hat{p}_2 q_2 + (1 - \hat{p}_2) q_{2A} - v_2 (q_2 - q_{2A})$$

*Total Bias*

$$\begin{aligned} q_0 &= \hat{\mu}_0 - \mu_0 \\ &= (1 - \hat{p}_{1A} - \hat{p}_{1B}) q_1 + \hat{p}_{1A} q_{1A} + \hat{p}_{1B} q_{1A} + \\ &\quad v_{1A} (q_1 - q_{1A}) + v_{1B} (q_1 - q_{1B}) \end{aligned}$$

$\mu$  denotes the conditional mean of vaccination coverage rates among children/teens living in a certain household;

P denotes the corresponding probability of living in such households.

V denotes the sum of sampling and nonsampling error in the estimated probability.

## Methodology for TSE Analysis (2)

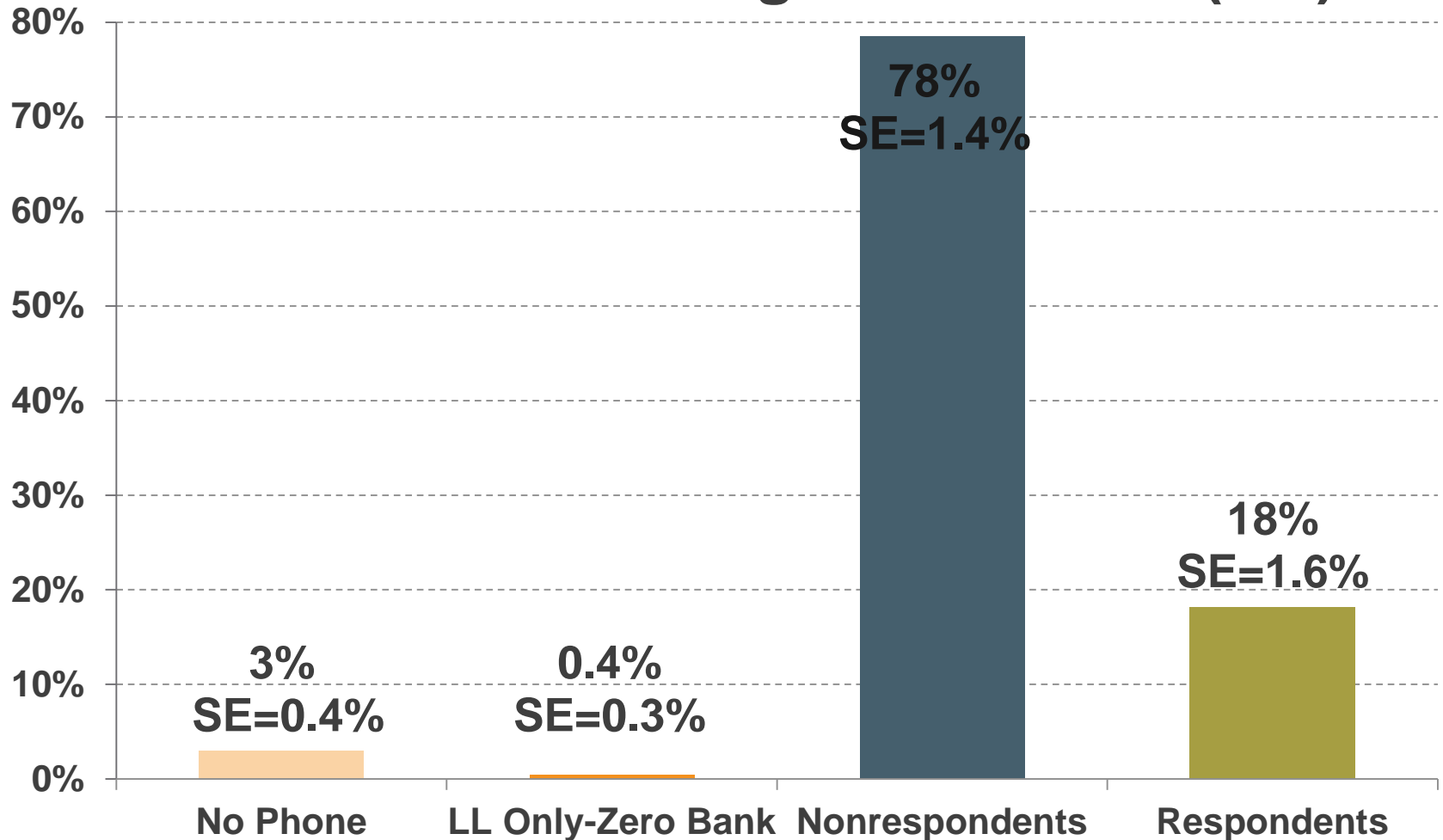
B. Obtain best estimates of each component error from sources with higher coverage and/or response rates

- 1) Vital Statistics data
- 2) American Community Survey (ACS)
- 3) National Health Interview Survey (NHIS) and NHIS-Provider Record Check Study (NHIS-PRC)

C. Generate a Monte Carlo simulated dataset using the best sources of component error to estimate total bias in vaccination coverage rate estimates and associated sampling error.

# 2011 Simulation Inputs -- NIS-Child (1)

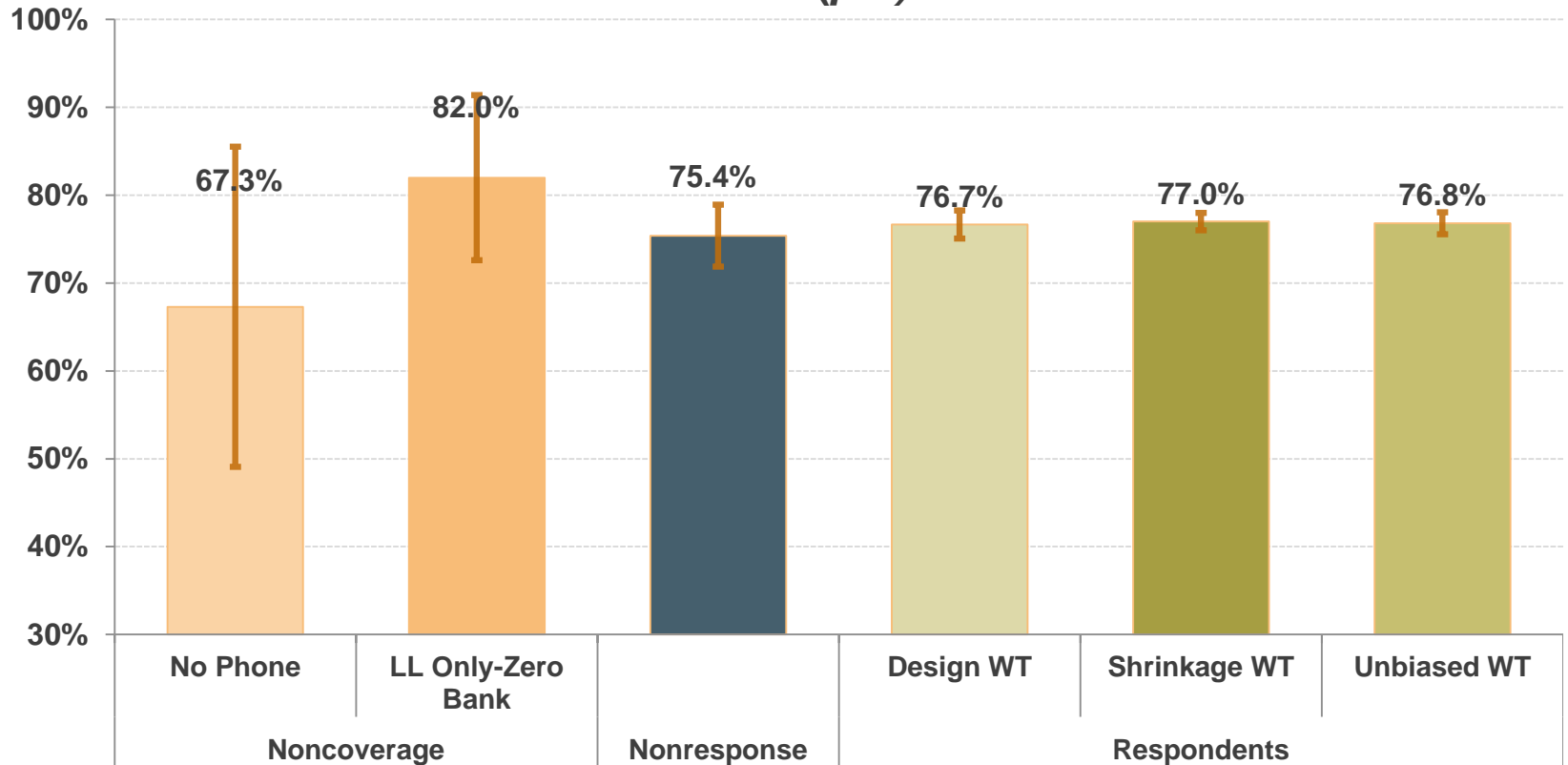
## Distribution of Eligible Children (P's)





# 2011 Simulation Inputs -- NIS-Child (2)

## Best Estimated Vaccination Coverage Rates for 4:3:1:3:3:1 Series ( $\mu$ 's)



# Three Different Weighted Estimates

- **Design Weights**

- Adjust for the selection probabilities
- Adjust for the multiplicity of telephone lines
- Adjust for the in household selection for the landline sample
- Adjust for the overlap of the landline and cell sample.

- **Unbiased Weights and Shrinkage Weights**

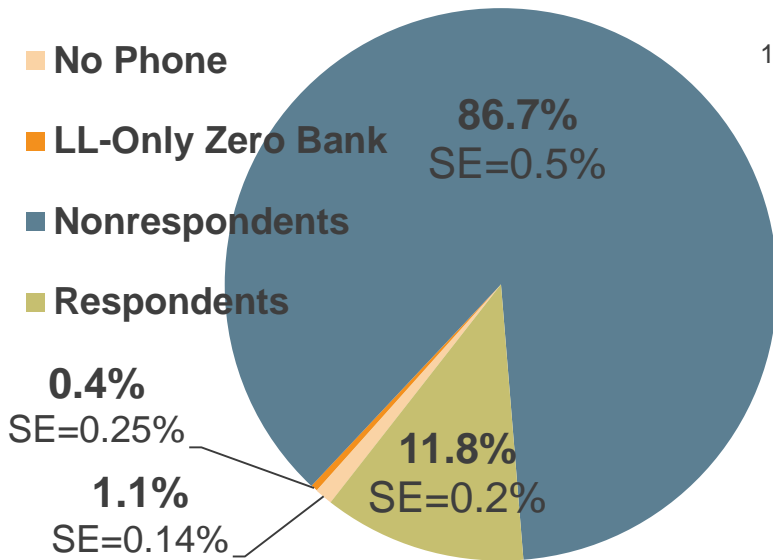
- Full set of weighting adjustment including adjustments for selection probabilities, nonresponse, combining the landline and cell samples, and raking.
- Unbiased weights: used the true cell phone only cases to represent the cell phone only population
- Shrinkage weights: used the true cell phone only cases along with some borrowed landline cases to represent the cell phone only population

# 2011 Simulation Inputs -- NIS-Child (3)

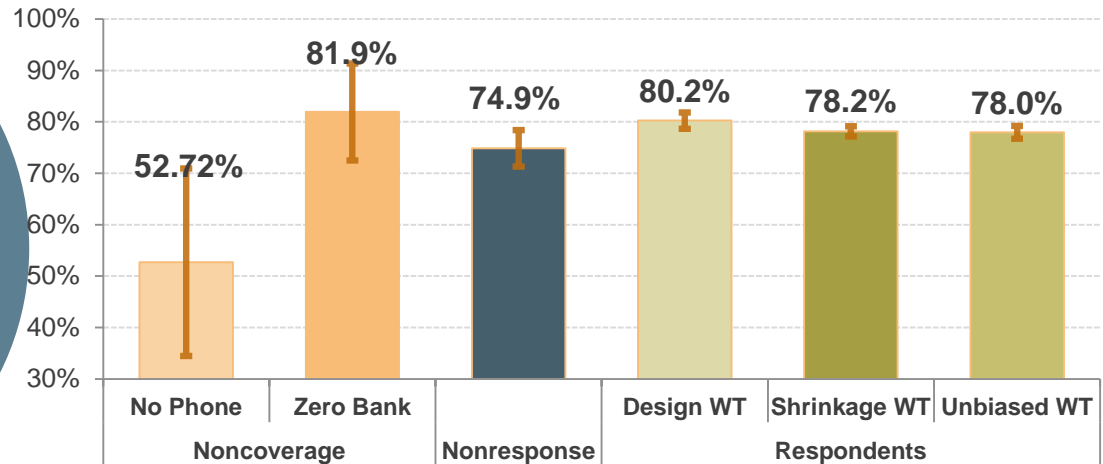
		4+ DTaP		1+ MMR		4:3:1:3:3:1	
		mean	SE	mean	SE	mean	SE
<b>Non-Covered</b>	No phone	67.3%	9.3%	82.0%	7.2%	67.3%	9.3%
	LL-only zero-bank	86.1%	4.3%	93.0%	3.0%	82.0%	4.8%
<b>Non-Respondent</b>	Non-APD	83.4%	1.6%	91.6%	1.2%	75.4%	1.8%
<b>Respondent</b>	NIS weighted (Design wt)	84.0%	0.7%	91.2%	0.5%	76.7%	0.8%
	NIS final weighted (Shrinkage wt)	84.6%	0.5%	91.6%	0.4%	77.0%	0.6%
	NIS final weighted (Unbiased wt)	84.4%	0.6%	91.5%	0.5%	76.8%	0.7%

# 2011 Simulation Inputs -- NIS-Teen

## Distribution of Eligible Teen (P's)

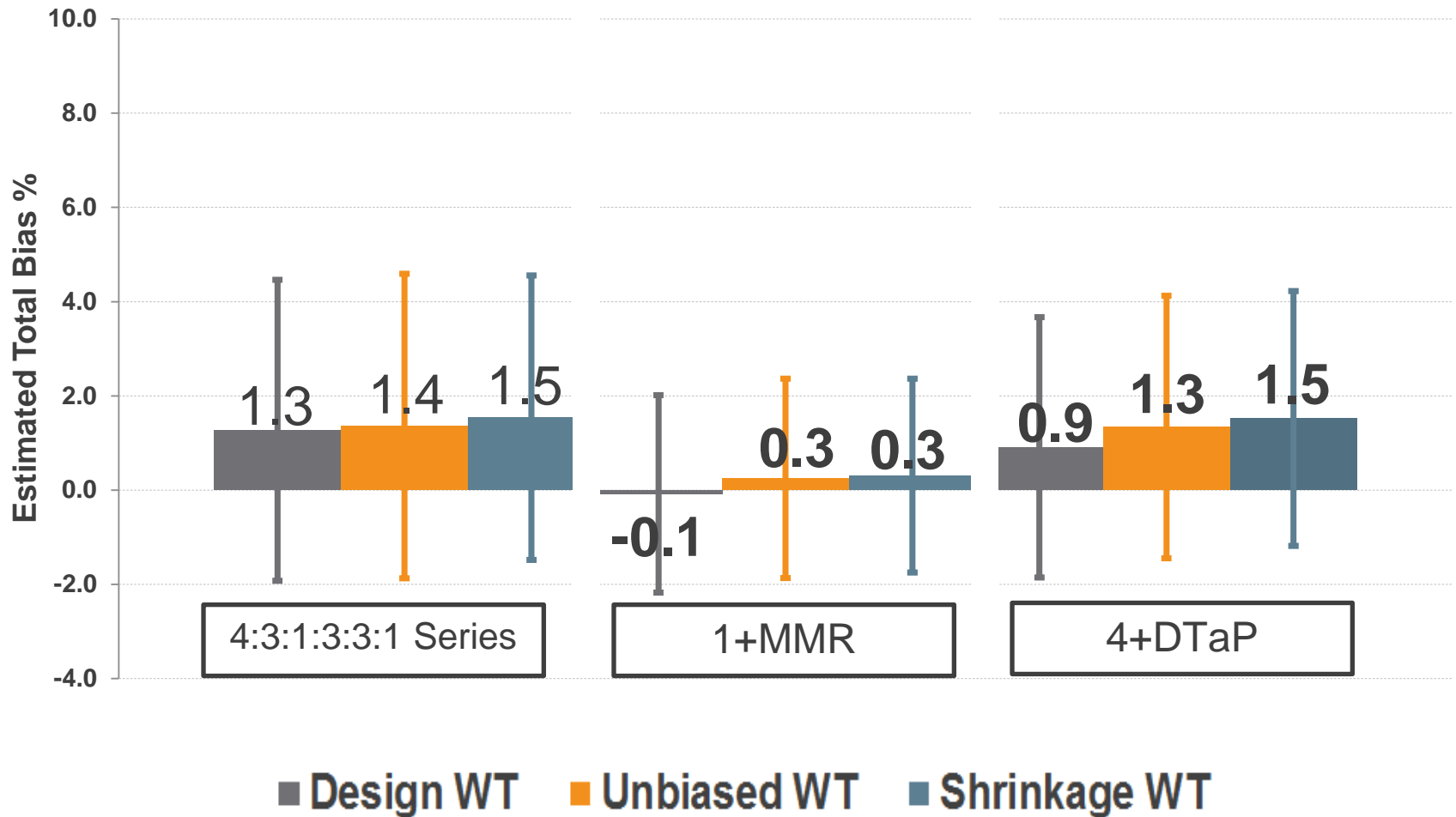


## Best Estimated Vaccination Coverage Rates for 1+ Tdap ( $\mu$ 's)

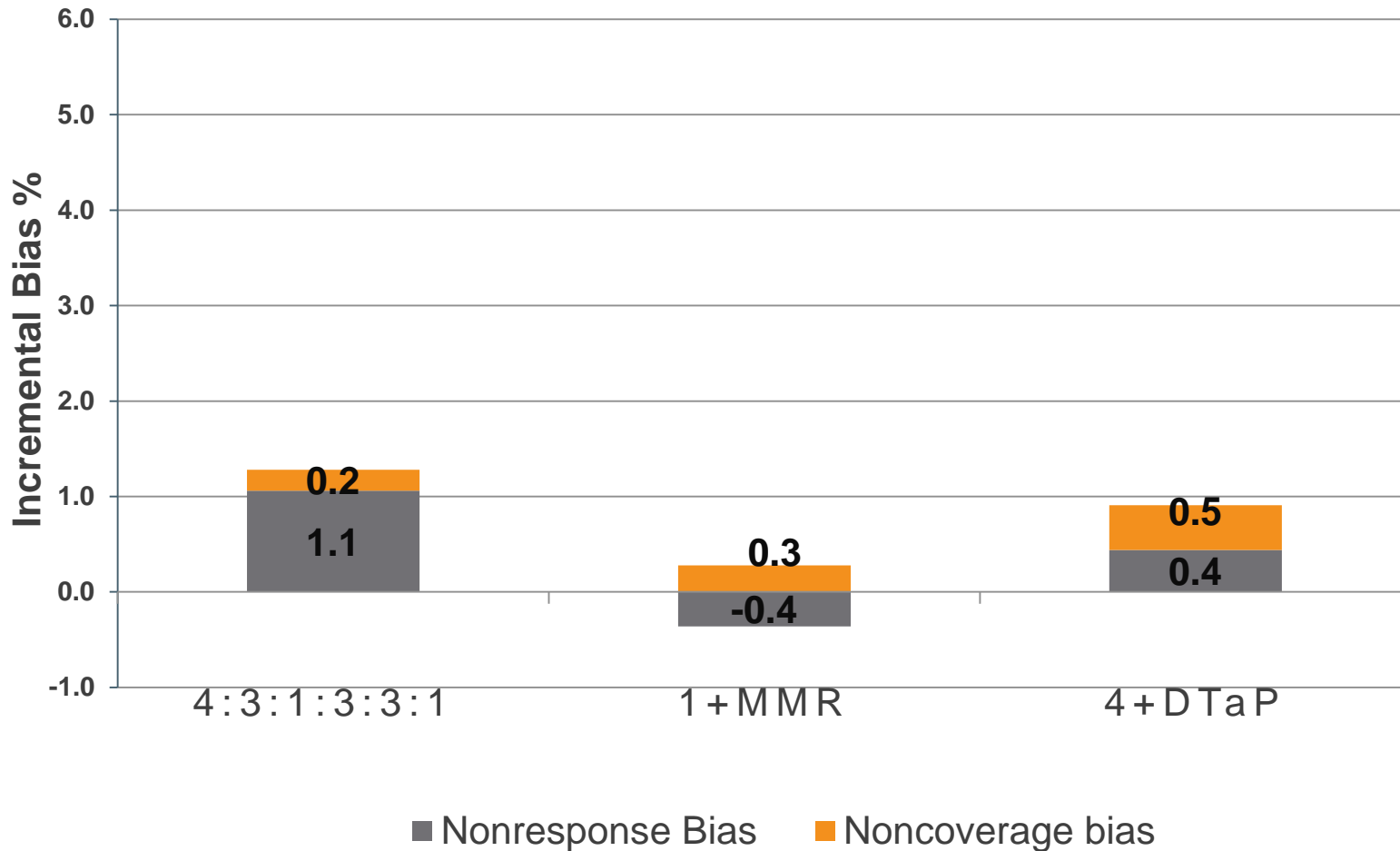


	1+ Tdap		1+ MenACWY		1+ HPV among females		
	mean	SE	mean	SE	mean	SE	
<b>Non-Covered</b>	No phone	52.7%	13.6%	54.0%	12.1%	67.0%	17.3%
	LL-only zero-bank	81.9%	3.6%	70.8%	4.3%	46.8%	6.3%
<b>Non-Respondent</b>	Non-APD	74.9%	1.1%	67.9%	1.2%	46.4%	1.8%
<b>Respondent</b>	NIS weighted (Design wt)	80.2%	0.5%	72.2%	0.6%	51.4%	1.0%
	NIS final weighted (Shrinkage wt)	78.2%	0.5%	70.5%	0.5%	53.0%	0.8%
	NIS final weighted (Unbiased wt)	78.0%	0.6%	69.9%	0.6%	52.8%	1.0%

# Result 1: Estimated Total Bias Using Three Alternative Weights – 2011 NIS-Child

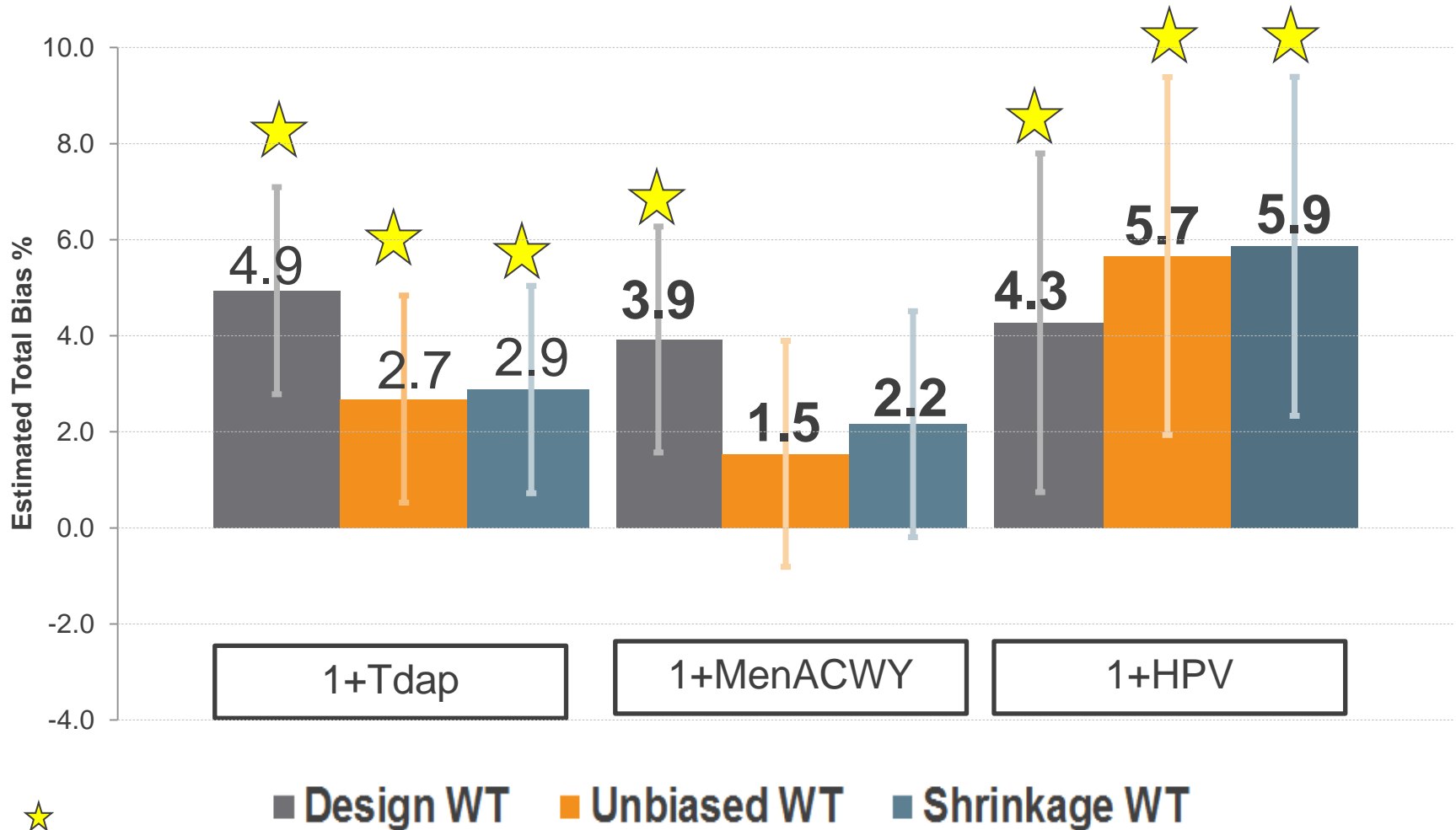


## Result 2: Estimated Incremental Bias due to Noncoverage and Nonresponse – 2011 NIS-Child

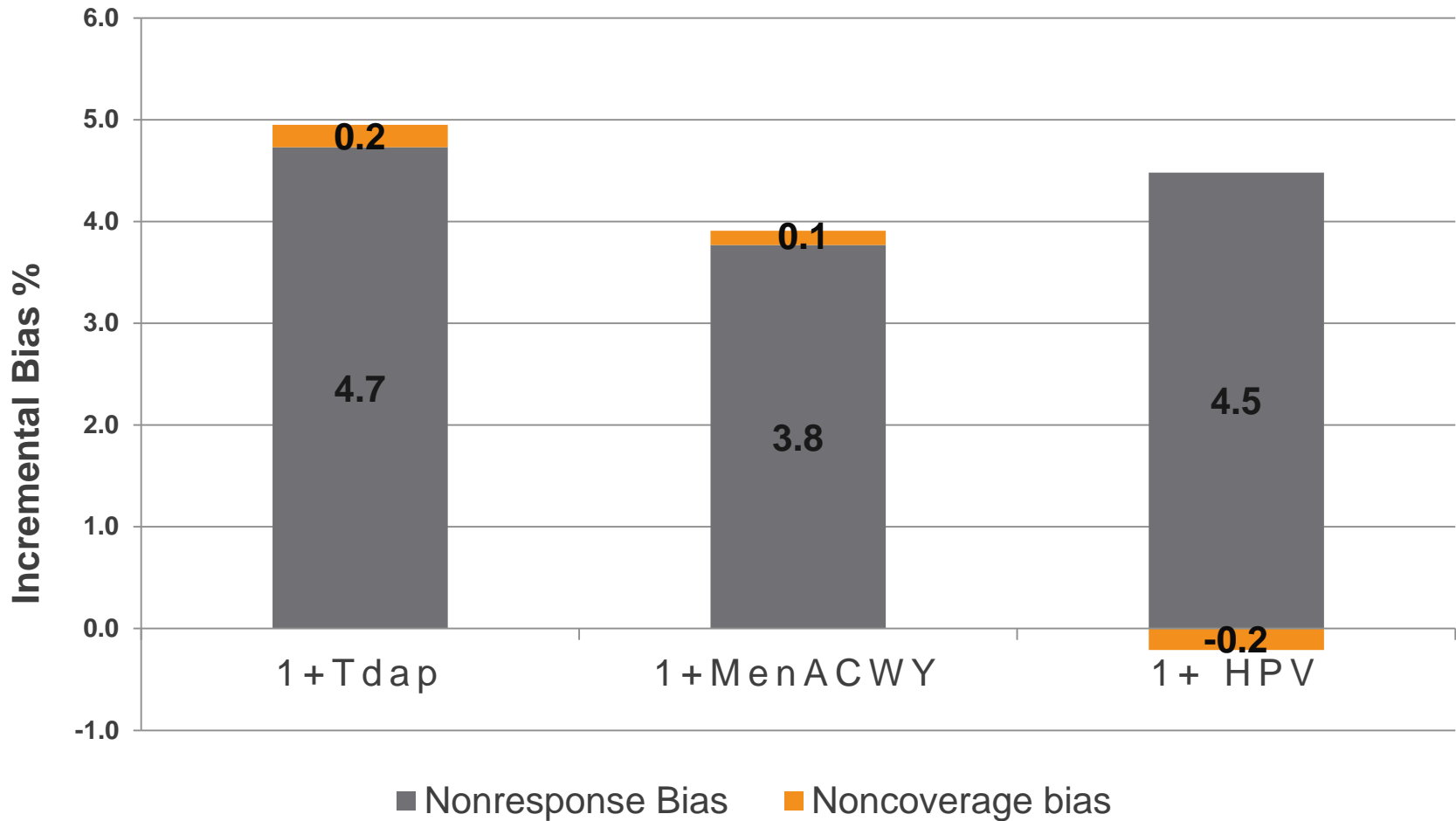


# Result 3: Estimated Total Bias using 3 Alternative Weights

## – 2011 NIS-Teen



## Result 4: Estimated Incremental Bias due to Noncoverage and Nonresponse – 2011 NIS-Teen





## Discussion (1)

- The estimated bias associated with population noncoverage is found to be small for both NIS-Child and NIS-Teen with the dual frame telephone sample design.
- NIS-Child:
  - The total bias in the 2011 vaccination coverage rates examined are quite small ( $\leq 1.5\%$ ) and not significantly different from zero, which is comparable to 2010 results.
- NIS-Teen:
  - Statistically significant biases were detected in the 2011 NIS-Teen vaccination coverage rates ranging from 2.9% to 5.9% (under shrinkage weights)
  - The estimated bias from nonresponse dominate the total survey error.

## Discussion (2)

- Use of shrinkage weights in 2011 was effective at reducing variance in vaccination coverage rate estimates without increasing bias.
- Limitation wise, as with other TSE studies, results are based on several assumptions, multiple sources of data, and models used in simulation.
- Total Survey Error analysis will be repeated using 2012 NIS Child and Teen data which has a larger cell-phone sample.

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Thank You!

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