Examining Health Equity Measurement and Representation through the Lens of Total Survey Error

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Overview

- In the face of emerging health challenges and rapid technological evolutions, NCHS strives to remain at the forefront of health policy guidance and research advancement.
- One of the goals set by NCHS is to strengthen NCHS' role in informing policies that promote health equity.
- Currently NCHS is not only examining overall health equity but is also looking closely at the relationship between equity and the various sources of total survey error to ensure accuracy of health equity findings.
- This presentation will include an overview of the different types of methods being used by NCHS to assess health equity measurement and representation through the lens of the total survey error paradigm leading up to dissemination.

CDC's CORE Commitment to Health Equity

An agency-wide strategy to integrate health equity into the fabric of all we do

C **CULTIVATE comprehensive health equity science**
CDC embeds health equity principles in the design, implementation, and evaluation of its research, data, surveillance, and intervention strategies.

O **OPTIMIZE interventions**
CDC uses scientific, innovative, and data-driven strategies that address environmental, place-based, occupational, policy, and systemic factors that impact health outcomes and address drivers of health disparities.

R **REINFORCE and expand robust partnerships**
CDC seeks out and strengthens sustainable multi-level, multi-sectoral, and community partnerships to advance health equity.

E **ENHANCE capacity and workplace diversity, inclusion, and engagement**
CDC builds internal capacity to cultivate a multi-disciplinary workforce and more inclusive climates, policies, and practices for broader public health impact.

CDC's CORE Commitment to Health Equity | Health Equity | CDC

National Center for Health Statistics' Commitment to Health Equity

- In the face of emerging health challenges and rapid technological evolutions, NCHS strives to remain at the forefront of health policy guidance and research advancement.
  - Strengthening NCHS' role in informing policies that promote health equity.
  - Using NCHS data, policymakers, researchers, and public health professionals will be able to identify health disparities and track progress toward greater health equity in the United States.
  - NCHS' health equity priorities:
    - 1) Expand data collection and analyses
    - 2) Innovate through methodological work
    - 3) Assess cross-sector disparities using linked data

National Center for Health Statistics' Commitment to Diversity, Equity, and Inclusion

- NCHS will meet current and future challenges by adopting innovative workforce models and establishing operational improvements.
  - Demonstrate NCHS' commitment to building and supporting a diverse workforce and inclusive culture.
  - Expanding on the success of CDC's Diversity and Inclusion Executive Steering Committee (DIESC), NCHS will continue to cultivate diversity, equity, and inclusion (DEI) efforts.
  - Including development of workforce metrics for hiring and promotions, emphasis on rewards and recognition, creation of mentorship programs for diverse hires, and increased reliance on enterprise training and education.

NCHS has always recognized the importance of measuring differences

Hearing Levels of Adults

by Race, Region, and Area of Residence

United States - 1960 - 1962

Distribution by race, region, area, age, and sex of hearing thresholds for the better ear in excess of 15 decibels and-5 decibels or more below audiometric zero as determined by pure-tone air-conduction audiometric tests at frequencies of 500, 1000, 2000, 3000, 4000, and 6000 cycles per second.

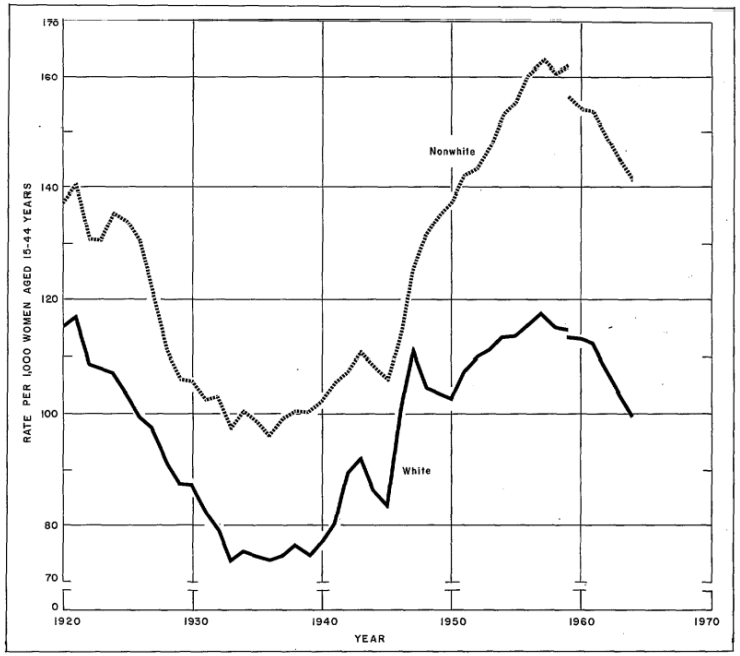


Figure 6. Fertility rates by color.

(Rates per 1,000 women aged 15-44 years. For 1959-64 based on registered live births; for 1920-59, on live births adjusted for underregistration)

HEALTH STATISTICS

FROM THE U. S. NATIONAL HEALTH SURVEY

selected health characteristics by area

Geographic Divisions and Large Metropolitan Areas

United States
July 1957-June 1959

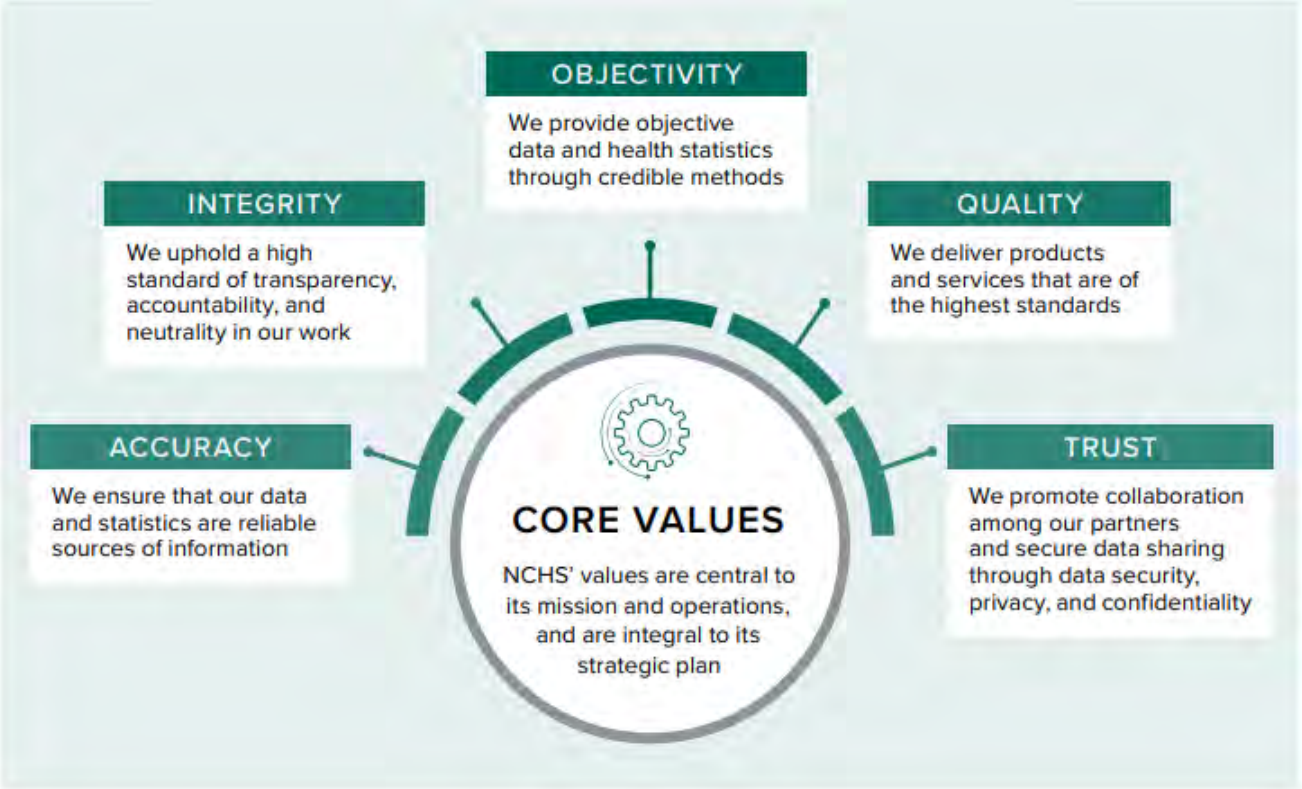
advancedata

FROM VITAL & HEALTH STATISTICS OF THE NATIONAL CENTER FOR HEALTH STATISTICS

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE • Public Health Service | Number 32 • August 22, 1978

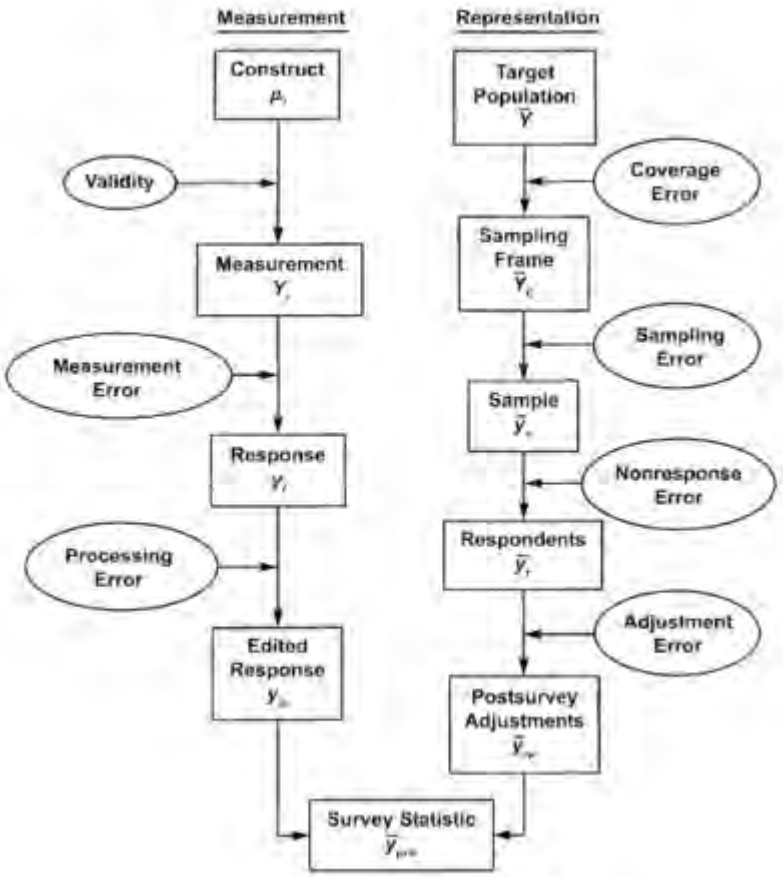
Sociodemographic and Health Characteristics of Persons by Private Health Insurance Coverage and Type of Plan: United States, 1975[1]

NCHS Core Values



Total Survey Error

Groves, R. M., & Lyberg, L. (2010). Total survey error: Past, present, and future. *Public opinion quarterly*, *74*(5), 849-879.



Why Look at Equity Through a Total Survey Error Perspective?

- To accurately assess health inequities, we need to assess, understand, and correct for measurement inequities and representation inequities.
- Some survey error inequities may be completely independent or related to different types of biases
- Some survey errors may be related to the same types of demographic biases, and therefore compound the distortion throughout the survey process long before we produce estimates of health inequity
  - If a construct was defined by and for a given population
  - If a measure was developed by and for a given population
  - If a population frame was developed by and for identifying a given population
  - If a sampling strategy was developed by and for selecting a given population
  - If a surveying strategy was developed by and for recruiting a given population
  - Is it possible that there are inherent biases in the survey process that inadvertently but ultimately exclude other populations by design? Are there systemic biases that exist in our survey processes? If so, where do they exist?

NCHS Examples of Examining Health Equity from a Total Error Perspective

Measurement

- **Construct Validity**
  - Cognitive Interviews
  - Item Response Theory
- **Measurement Error**
  - Cognitive Interviews
  - Linear Regression Trees

Representation

- **Coverage Error**
  - Combining data sources
- **Sampling Error**
  - Sampling methodology
  - Sample weights
- **Nonresponse Error**
  - Imputation
  - Adjustment weights

Quick Overview of Different NCHS Surveys Discussed in this Presentation

Traditional NCHS Surveys

- National Health Interview Survey (NHIS)
- National Health & Nutrition Examination Survey (NHANES)
- National Survey of Family Growth (NSFG)
- National Ambulatory Medical Care Survey (NAMCS)
- National Hospital Ambulatory Medical Care Survey (NHAMCS)
- National Hospital Care Survey (NHCS)

Newer Web Panel Surveys

- Research and Development Survey (RANDS)
- Rapid Surveys System (RSS)

Measurement Equity

- Measurement equity has important implications for survey outcomes, such as health and healthcare.

- It is important to understand when measures are biased or may be subject to differential measurement error as this can distort (either exacerbating or concealing) health inequities.

- Biased measures can arise from differential construct validity or differential measurement error.

Construct Validity

Examining Construct Validity Using Cognitive Interviews

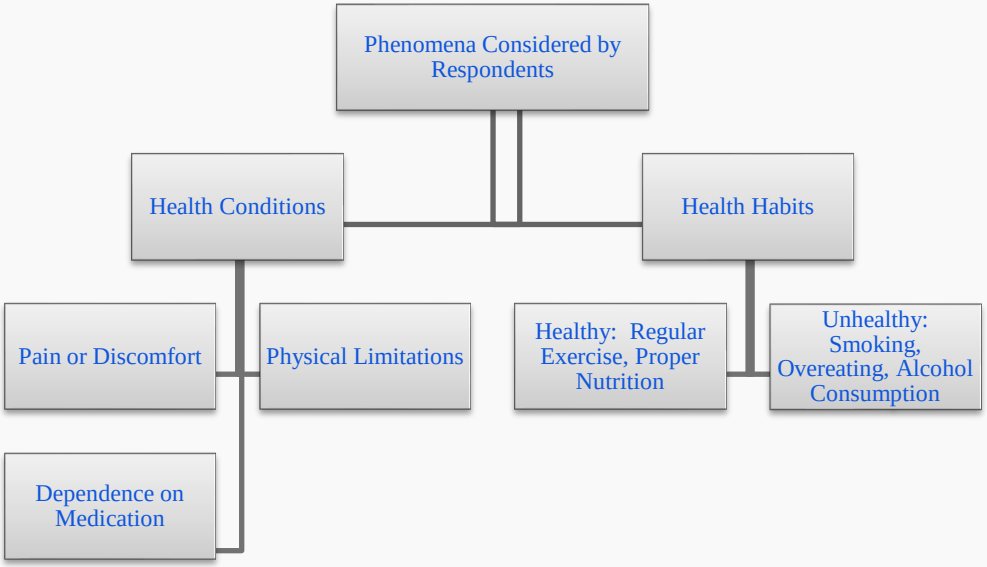
- The NCHS Collaborating Center for Questionnaire Design and Evaluation Research (CCQDER) uses cognitive interviewing methodology to make survey research more objective, so that our data is more comparable, more inclusive, and more equitable.
- Cognitive interviews are used to identify the constructs captured by individual questions by identifying the specific phenomena that account for a respondent's answers
  - What are respondents thinking about?
- Comparability studies are used to determine whether constructs are consistently captured across salient respondent groups?
  - Do demographic subgroups think about the phenomena the same?

Comparative Study

1. Identify the various constructs captured by individual questions
2. Determine whether they are consistently captured across groups of respondents
3. For identified differences, determine reason for differences
   - What about respondents' experiences inform how they interpret or process a survey question?
   - Do the differences impact comparability?

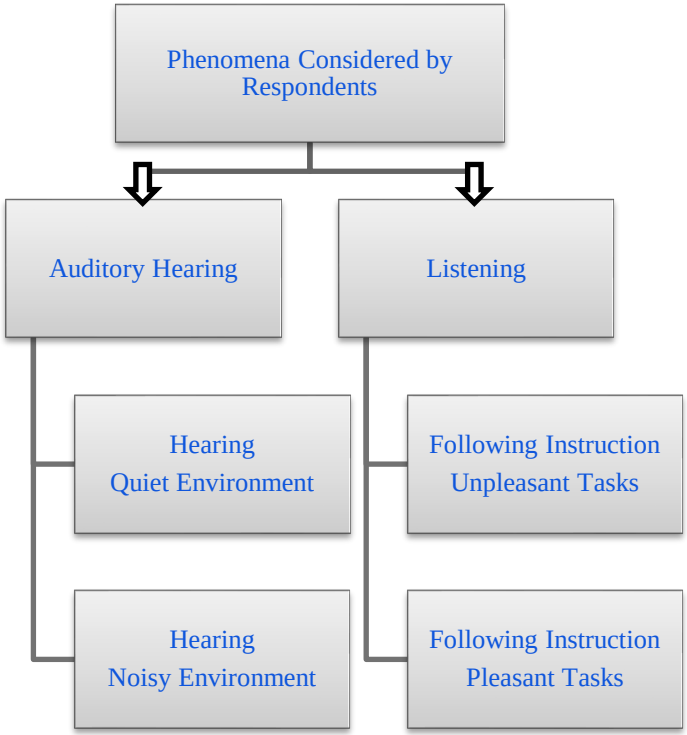
Construct Validity
Visual Representation of Construct Schema

Question: In general, would you say your health is excellent, very good, good, fair or poor?



Construct Validity
Visual Representation of Construct Schema

Question: Does your child have difficulty hearing?



Comparative Study

1. Identify the various constructs captured by individual questions
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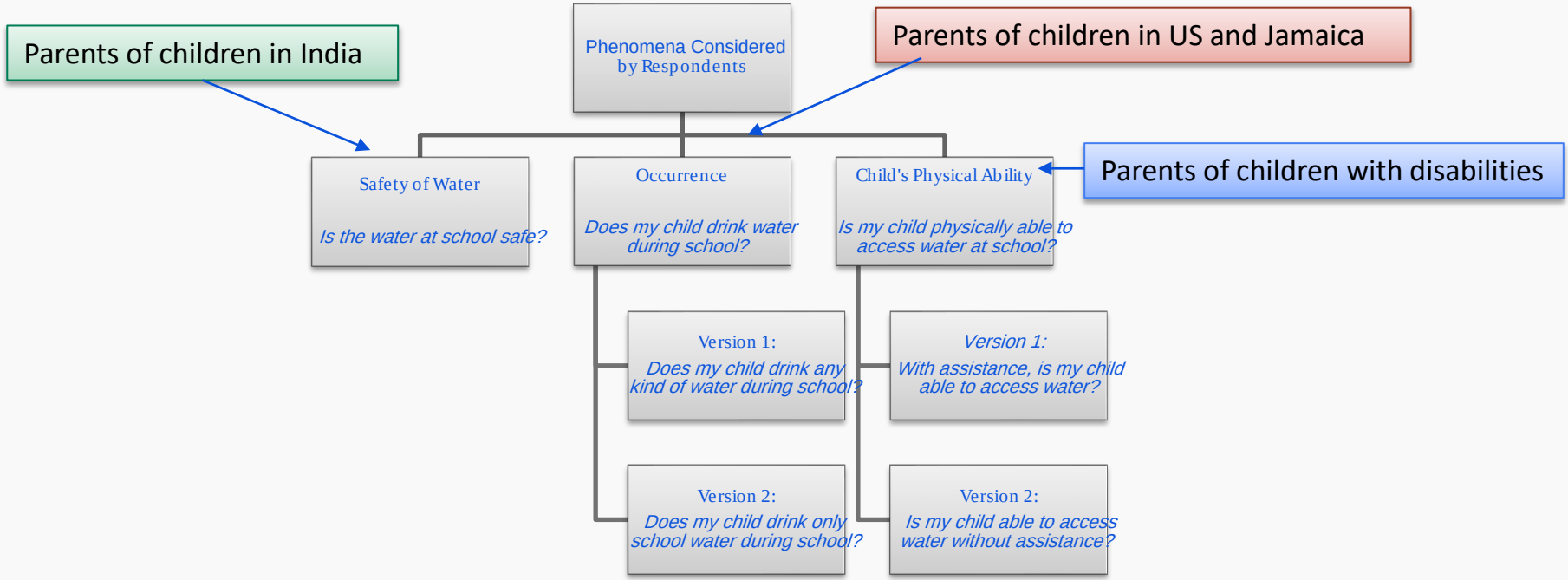
   - Do the differences impact comparability?

Comparative Study

United States/English, Jamaica/English: Does your child use drinking water facilities at school?

India/Hindi: क्या (नाम) स्कूल में की पानी पीने की सुविधा को आसानी से इस्तेमाल कर सकता/ सकती है?



Examining Construct Validity Using Item Response Theory (IRT)

- We've started using item response theory (IRT) to explore construct validity by comparing item agreeability and inter-item correlations across demographic subgroups on the National Health Interview Survey (NHIS) to better understand where differential item functioning occurs among NHIS questions

- Research Questions:
  - How does an individual's standing across multiple latent dimensions of health (θ) impact their responses to individual NHIS items?
    - Are some NHIS items easier or more difficult to agree with (b) given θ?
      - Does the difficulty/agreeability of an item for a given θ vary across demographic subgroups?
    - Do some items have a lesser/greater impact (a) on θ?
      - Does the impact on an item on θ vary across demographic subgroups?

Examining Construct Validity Using Item Response Theory (IRT) - Example

- For example, in an exploratory analysis using only a single latent dimension of heath we noticed the following:
  - Differential Item Difficulty (b):
    - Females found it more difficult than males to agree with ever having smoked 100 cigarettes or more in their life, given the same within group latent dimension standing
    - College graduates with a bachelor degree or higher found it more difficult than non-college graduates to agree with ever having smoked 100 cigarettes or more in their life, given the same within group latent dimension standing
  - Differential Item Discrimination (a):
    - Ever having smoked 100 cigarettes or more had a greater impact on within group latent dimension standing for females than for males

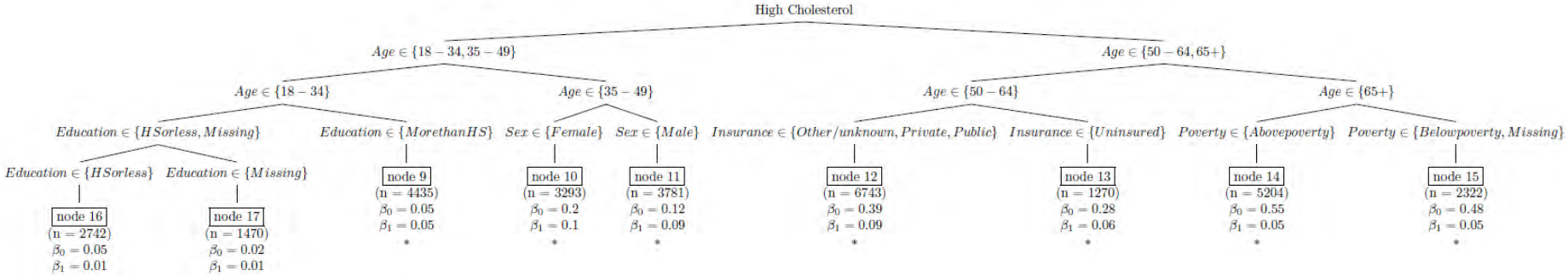
Measurement Error

Examining Measurement Error Using Cognitive Interviews

- For example, when studying interpretative response processes for gender identity, CCQDER discovered the following:
  - Gender minorities and non-minorities interpret the question in different ways
    - The information collected are riskier for gender minorities to report, and therefore may result in underreporting (false negatives) or nonresponse
    - The sex, gender, and sexual orientation constructs are less well understood and conflated by non-minorities, resulting in overreporting (false positives)

Examining Measurement Error Using Linear Regression Trees

- We used conditional linear regression trees to assess measurement error by comparing self-reported versus lab measurements of chronic conditions collected on the National Health and Nutrition Examination Survey (NHANES)
- Research Questions:
  - Do self-reporting errors (β_1) vary across demographic subgroups?
  - Are identified self-reporting errors (β_1^*) significantly different from zero?



Representation Equity

- Representation equity has important implications for survey outcomes, such as health.

- It is important to understand when estimates are biased or may be subject to differential representation error as this can distort (either exacerbating or concealing) health inequities.

- Biased representation can arise from differential coverage error, differential sampling error, or differential nonresponse error

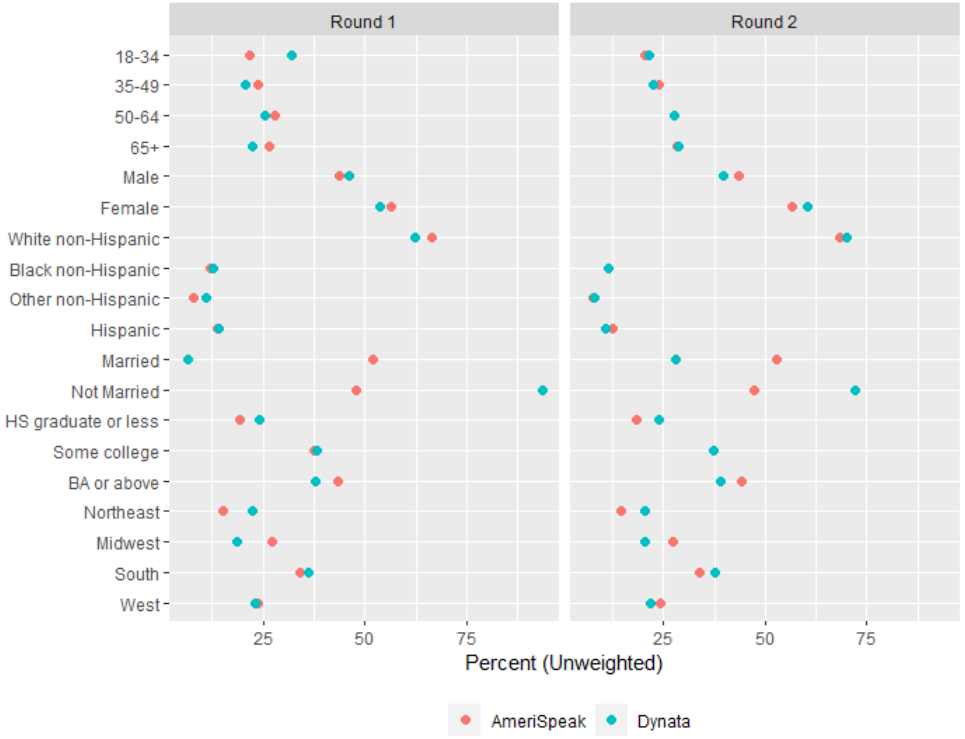
Coverage Error

Examining Coverage Error in Web Panel Data

- RANDS during COVID-19 Round 1 (June 9-July 6, 2020) and Round 2 (August 3-20, 2020) were conducted using NORC's AmeriSpeak Panel and an opt-in panel (Dynata)
- Dynata invites potential respondents through various sample sources including:
  - Travel, entertainment, media and retail loyalty programs
  - Mobile apps
  - A broad range of websites, including school and community sites

Examining Coverage Error in Web Panel Data: Example

- Respondent characteristics varied between Dynata and AmeriSpeak respondents
- Opt-in respondents compared to AmeriSpeak were
  - Younger
  - Not married
  - Had a lower education attainment
  - A higher percentage were in the Northeast and a lower percentage were in the Midwest



Sampling Error

Examining & Addressing Sampling Error

- Smaller and more rare populations or domains can produce larger standard errors.

- NCHS sometimes uses oversampling to increase statistical power and reduce sampling error for these smaller more rare populations.

- For example,
  - NCHS recently used oversampling in their Research and Development Survey (RANDS) 8 to produce a larger sample of gender minorities to better study health outcomes and produce more precise estimates among this population
  - NCHS recently used oversampling in RANDS 9 to produce a larger sample of the Afro-Caribbean and Middle East, North Africa (MENA) population to better study health outcomes and produce more precise estimates among this population

Nonresponse Error

Examining & Addressing Unit Nonresponse Error

- The NCHS Collaborating Center for Statistical Research and Survey Design (CCSRSD) examines NCHS surveys for unit nonresponse bias and develops unit nonresponse bias adjustment methods to better understand and address unit response inequity

- For example,
  - NCHS recently examined nonresponse bias in the 2016 National Ambulatory Medical Care Survey (NAMCS) Supplement on Culturally and Linguistically Appropriate Services for Office-based Physicians, specifically focusing on gender, age, and metro status
  - NCHS recently used machine learning-based approaches to improve nonresponse weights and response equity for the 2018 NAMCS across physicians', specifically focusing on age, specialty, and compensation.

Examining & Addressing Item Nonresponse Error

- The NCHS Collaborating Center for Statistical Research and Survey Design (CCSRSD) examines NCHS surveys and CDC surveillance data for item nonresponse bias and develops item nonresponse imputation methods to address item response inequity

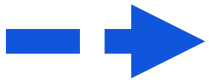
- For example, during the COVID-19 pandemic, incompleteness in surveillance data limited understanding of disparities.
  - CDC's case-based surveillance system contained case-level information on most COVID-19 cases in the United States. Case-level surveillance data were used to investigate COVID-19 disparities by race/ethnicity, sex, and age.
  - However, demographic information on race and ethnicity is missing for a substantial percentage of COVID-19 cases (e.g., 35.8% and 47.2% of cases analyzed were missing race and ethnicity information, respectively).
  - NCHS assisted with developing methods to impute missing race and ethnicity to derive more accurate incidence and incidence rate ratio (IRR) estimates for different racial and ethnic groups
  - Multiple imputation can provide more accurate incidence and IRR estimates to better monitor disparities in tandem with efforts to improve the collection of race and ethnicity information for pandemic surveillance.

Total Survey Error

Addressing Total Survey Error Using Model Based Estimates

- Estimates for small groups/small domains often suppressed due to concerns about reliability.
- Small domain estimation can be used to improve and generate estimates for small subgroups by 'borrowing strength' over time or across groups

Subgroup	Data
	27.3
	24.8
	Suppressed
	32.6
	Suppressed

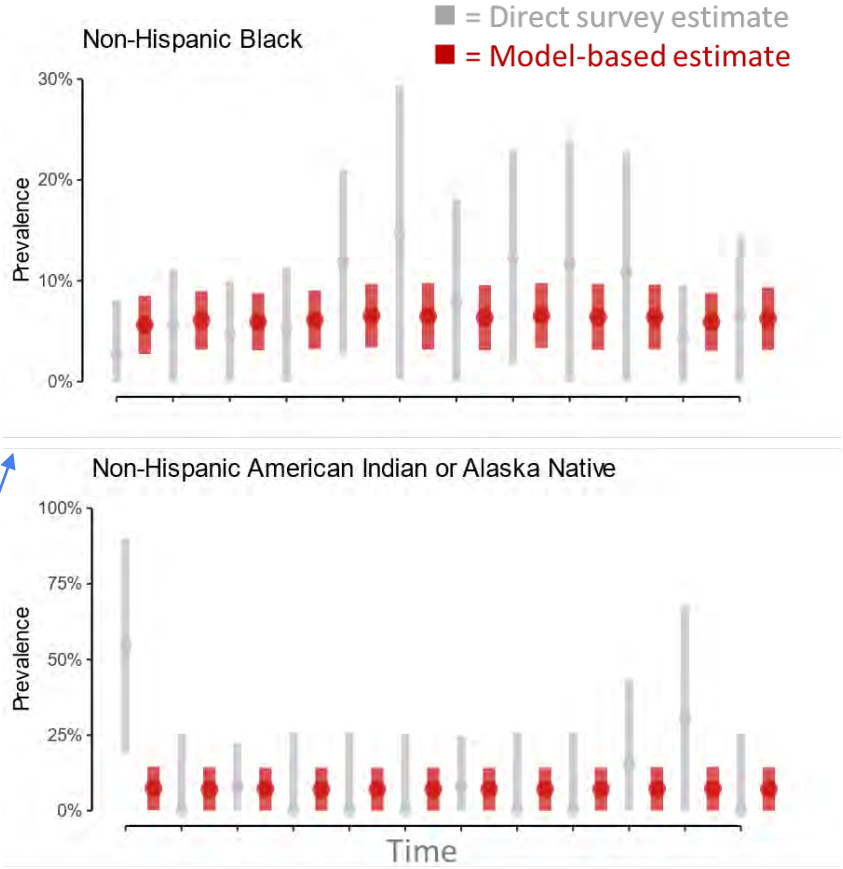


Subgroup	Estimates (95% CI)
	27.3 (24.630)
	24.8 (22.327.3)
	48.9 (39.158.7)
	32.6 (29.335.9)
	12.3 (9.814.8)

Addressing Total Survey Error Using Small Domain Estimation

- Enhancements to an existing statistical tool and modeling approach (modified Kalman filter)
- Mixed effects models borrow strength over time and across groups
- Large improvements in precision
  - Equivalent to up to a six-fold increase in sample size in some cases

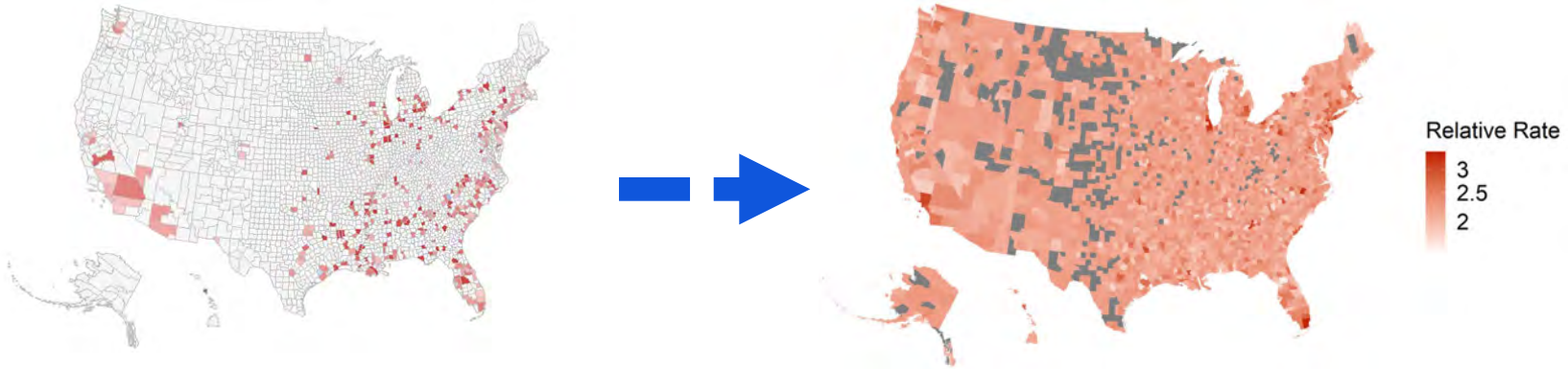
Simulated quarterly trends in diagnosed diabetes by group from the National Health Interview Survey, 2019-2021



Addressing Total Survey Error Using Model Based Estimates

- Small area estimation can be used to 'borrow strength' across geographic areas to produce more reliable estimates for small groups/geographies

Disparities in infant mortality rates between non-Hispanic Black and White infants, 2017-2019



Only ~5% of counties have sufficient data to calculate rates for both groups (n≥10)

Model-based estimates of relative Black-White disparities in infant mortality rates

■ = 0 births among non-Hispanic black infants

Summary

- CDC and NCHS have a commitment to providing data and measurements to support health equity

- NCHS has been and continues to develop methods that can be used for assessing and improving estimation of small, under-represented populations both from a measurement equity and representation equity perspective

- NCHS uses a variety of qualitative and quantitative methods to examine and address a variety of total survey errors, with a focus on reducing total survey error inequities to improve measurement and representation equity, so we can better measure, understand, and address true health inequities

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