



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

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Acknowledgements:

Kristen Miller, Ph.D.

Stephanie Willson, Ph.D.

Paul Scanlon, Ph.D.

Van Parsons, Ph.D.

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Guangyu Zhang, Ph.D.

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National Center for Health Statistics

The National Center for Health Statistics (NCHS) is the nation's principal health statistics agency, providing data to identify and address health issues. NCHS compiles statistical information to help guide public health and health policy decisions. These health statistics allow NCHS to:

- Document the health status of the U.S. population and selected subgroups
- Document access to and use of the health care system
- Identify disparities in health status and use of health care by race and ethnicity, socioeconomic status, other population characteristics, and geographic region
- Track the impact of major policy initiatives
- Monitor trends in health indicators
- Support biomedical and health services research
- Provide data to support public policies and programs, including recent data on opioid overdose deaths

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.

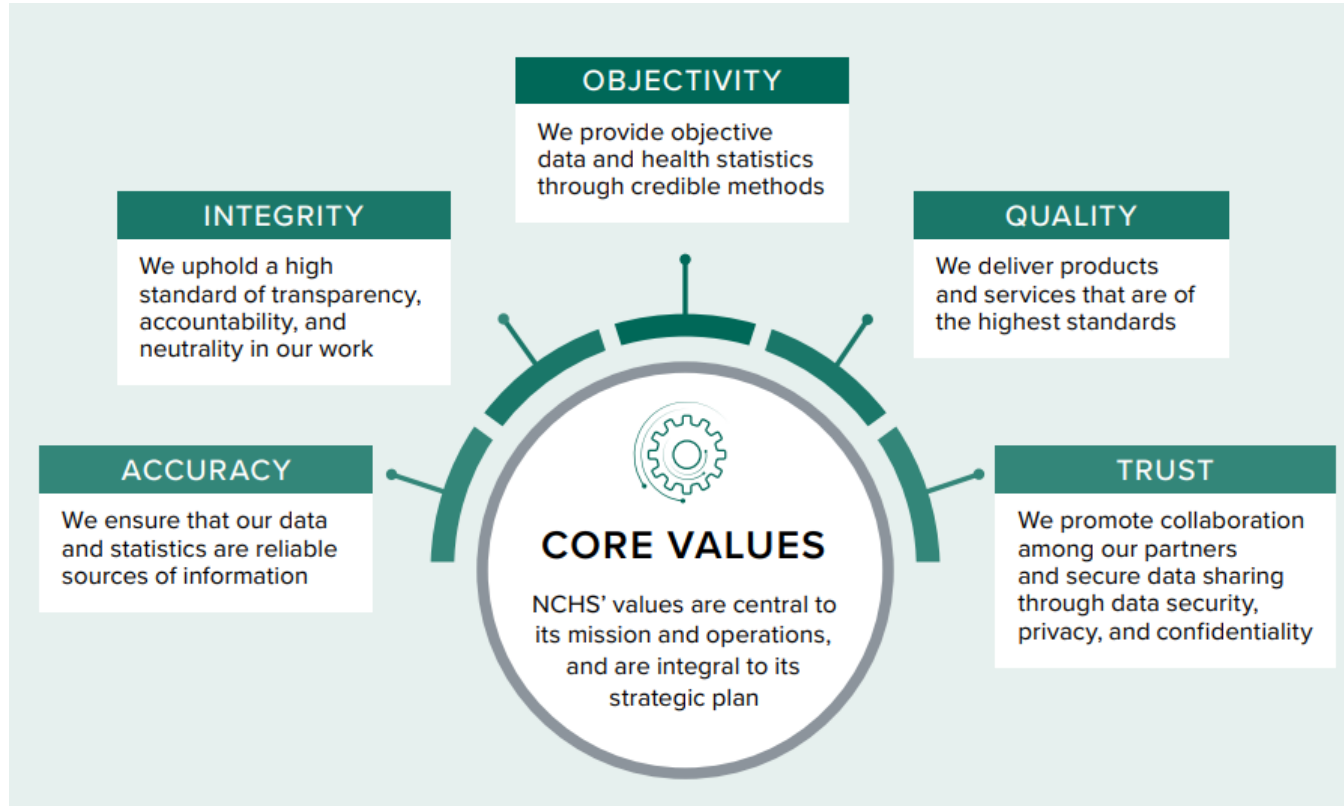
R REINFORCE and expand robust partnerships

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.

National Center for Health Statistics (NCHS)





Number 10
September 1995



HEALTHY
PEOPLE
2000

Statistical Notes

From the CENTERS FOR DISEASE CONTROL AND PREVENTION/National Center for Health Statistics

Health Status Indicators: Differentials by Race and Hispanic Origin

Christine Piepys and Richard Klein

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, 1975¹**

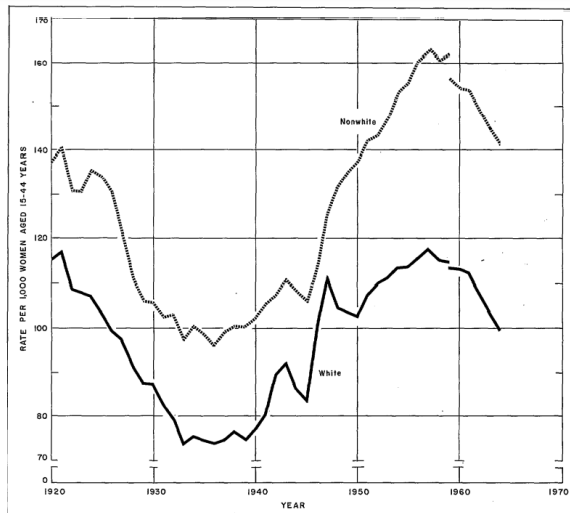


Figure 6. Fertility rates by color.

(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)

Hearing Levels of Adults by Race, Region, and Area of Residence United States - 1960 - 1962

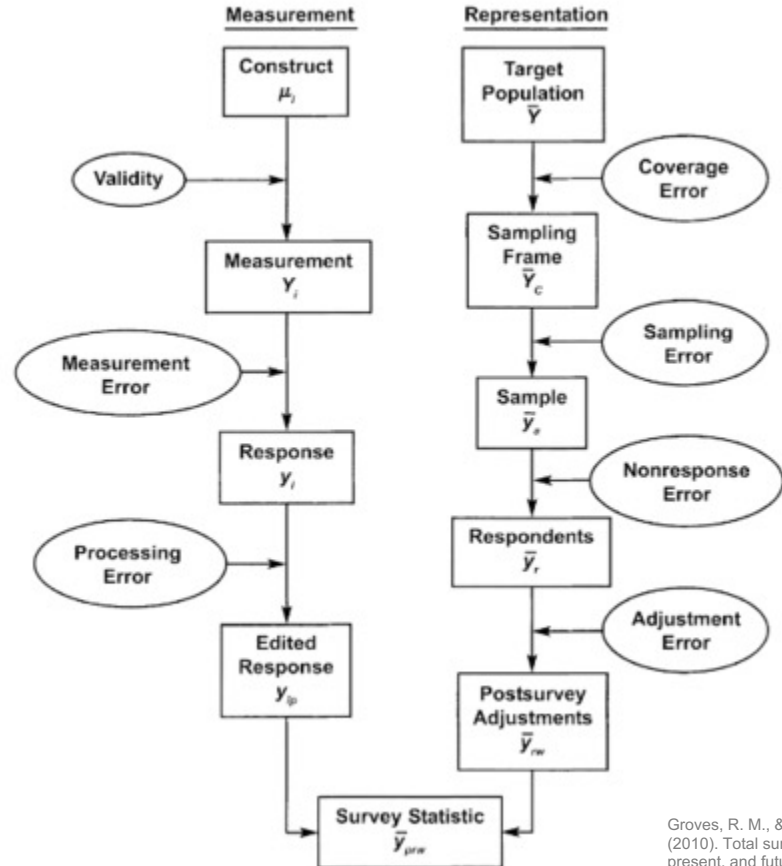
Distribution by race, region, area, age, and sex of hearing thresholds for the better ear in excess of 15 decibels and 5 decibels or more below audiometric zero as determined by pure-tone air-conduction audiometric tests at frequencies of 500, 1000, 2000, 3000, 4000, and 6000 cycles per second.

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 and is working to further strengthen our role in informing policies that promote health equity.
- Equity is baked into the NCHS 2022-2025 Strategic Plan, both in terms of developing our products, but also developing our staff. Our strategic plan is focused on strengthening NCHS' role in informing health equity priorities as well as enhancing diversity, equity, and inclusion in development, programming, and policies.
- 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.

Examining Health Equity through the Lens of Total Survey Error

- To accurately assess health inequities, we need to assess, understand, and correct for measurement 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



Why Look at Equity Through a Total Survey Error Perspective?

- If a construct was defined by and for a given population
- If a measure was developed by and for a given population
- If a list 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
- If a weighting or imputation method was developed by and to adjust for 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

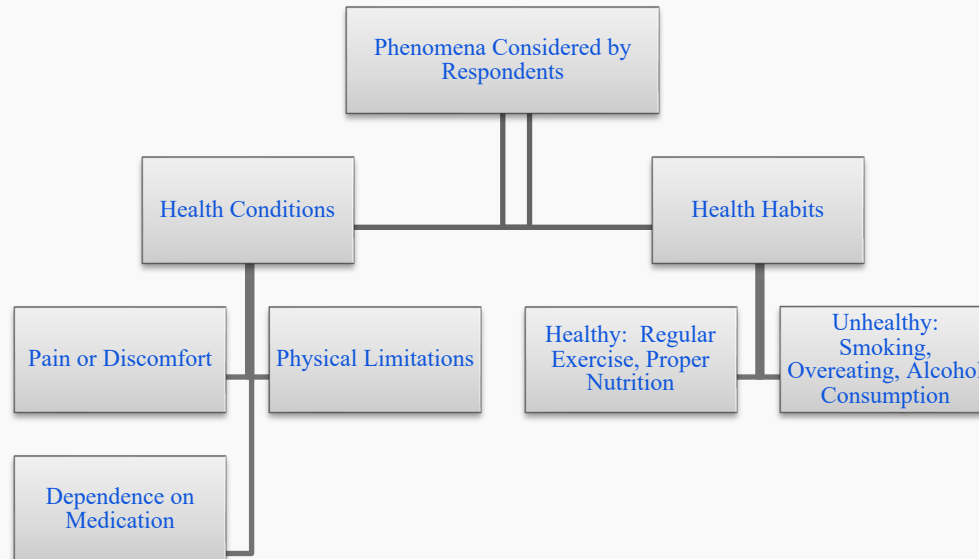
Examining Construct Validity Using Cognitive Interviews

- 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?

Construct Validity

Visual Representation of Construct Schema

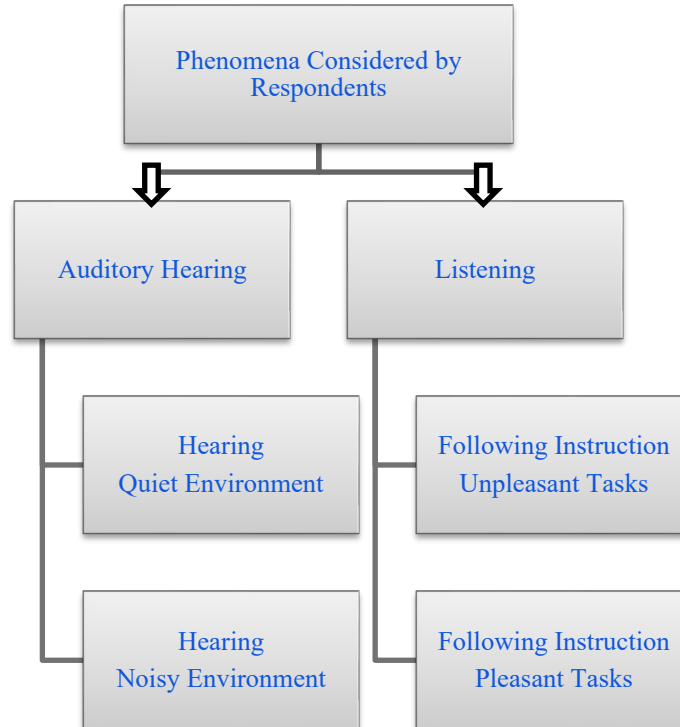
Question: In general, would you say your health is excellent, very good, good, fair or poor?



Construct Validity

Visual Representation of Construct Schema

Question: Does your child have difficulty hearing?



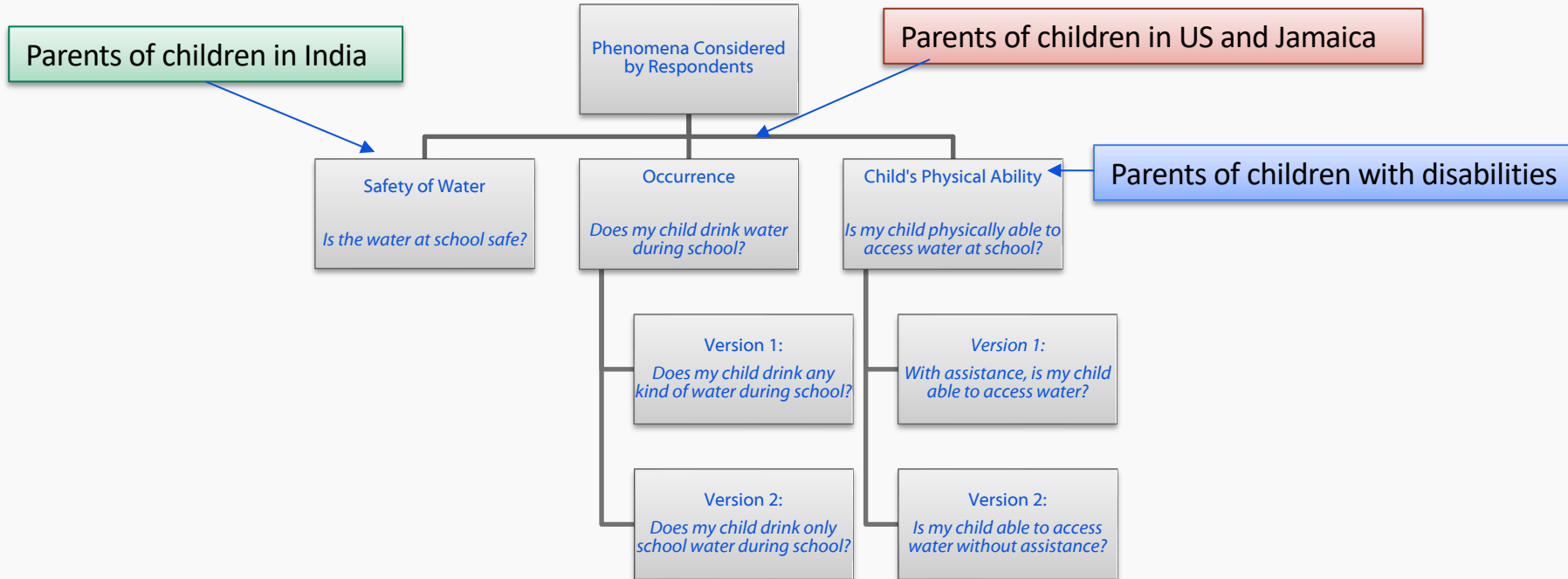
Comparative Study

1. Identify the various constructs captured by individual questions
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?

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 of 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 health 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's degree or higher found it more difficult than those with less than a bachelor's degree 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

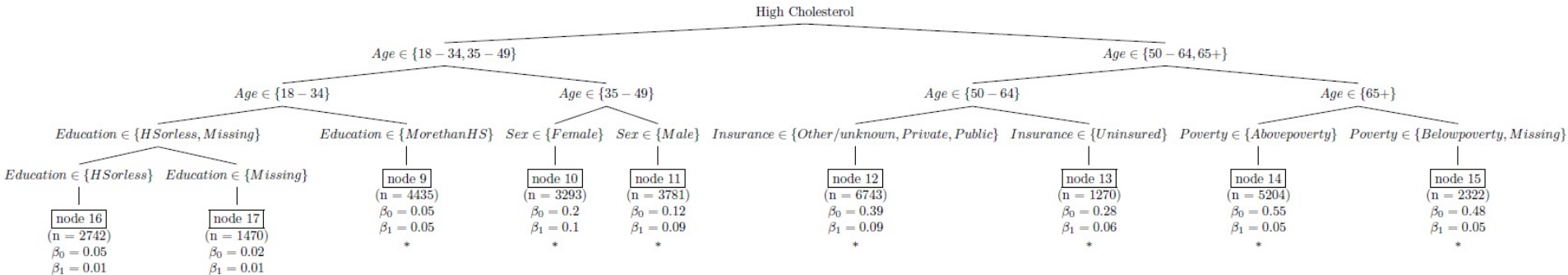
Measurement Error

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

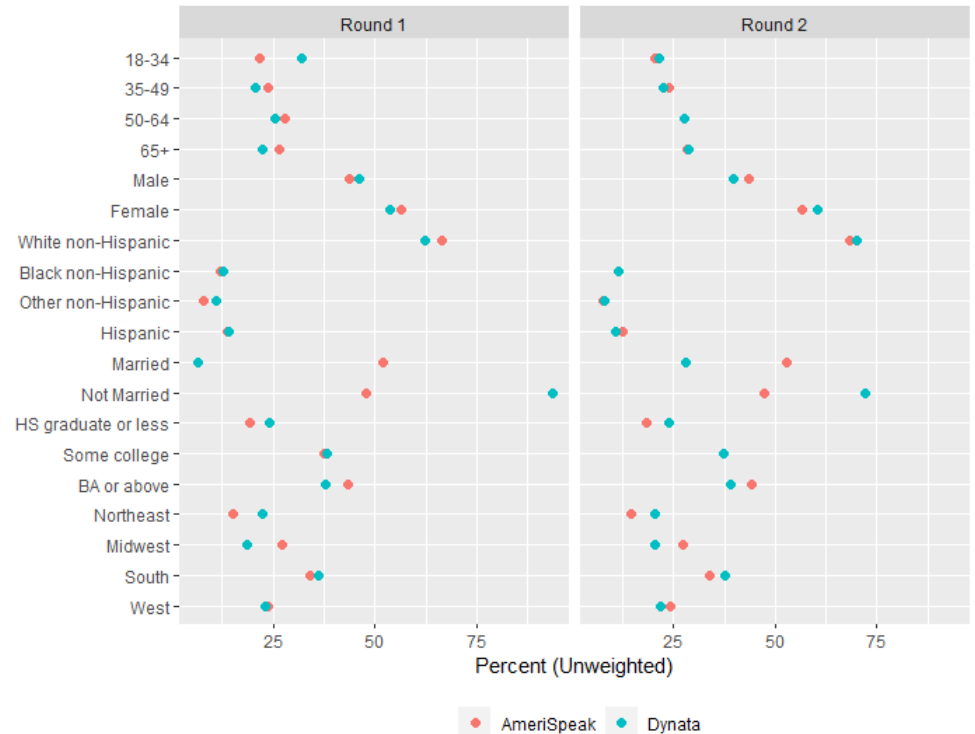
Coverage Error

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,
 - To increase the precision of estimates of the Black, Hispanic, and Asian populations, the NHIS 2006-2015 sample design oversampled Black persons, Hispanic persons, and Asian persons.
 - In addition, when Black, Hispanic, or Asian persons aged 65 years or older were present, they had increased chance of being selected as the sample adult.
 - NCHS recently oversampled gender minorities and Afro-Caribbean and Middle East, North Africa (MENA) panelists using the opt-in sample for RANDS; however, estimates of power and sampling errors rely on very strong sampling assumptions, which may not hold in an opt-in sample.

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 of physicians
 - 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 CCSRSD also 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 was 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.






Dissemination

Enhancing Dissemination using Small Domain Estimation

- Estimates for small groups/small domains are 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

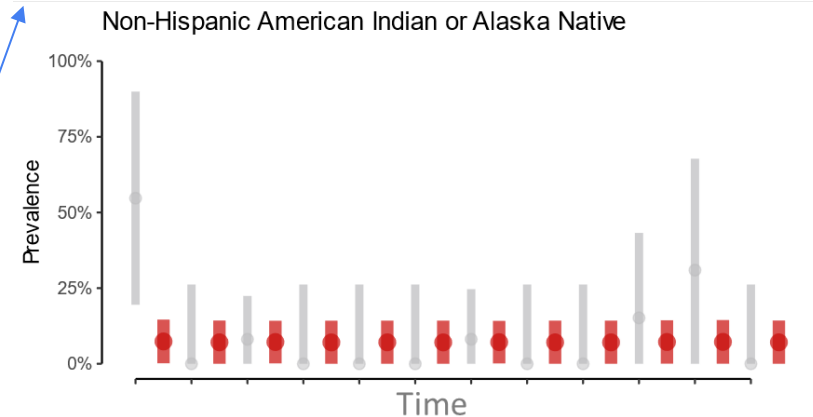
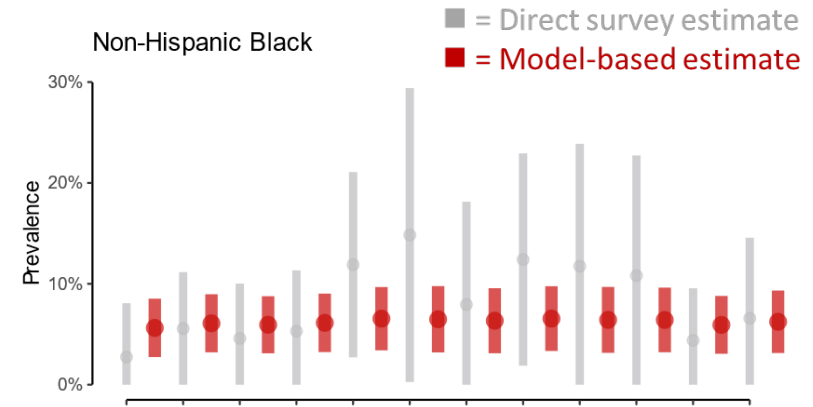


Subgroup	Estimates (95% CI)
	27.3 (24.6-30.0)
	24.8 (22.3-27.3)
	48.9 (39.1-58.7)
	32.6 (29.3-35.9)
	12.3 (9.8-14.8)

Enhancing Dissemination using Model Based 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

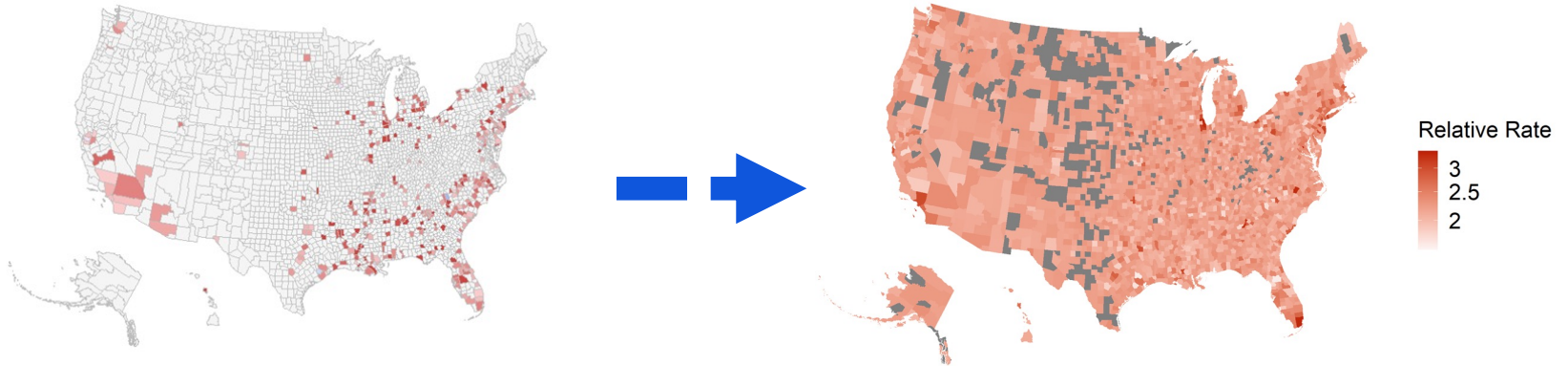
Simulated quarterly trends in diagnosed diabetes by group from the National Health Interview Survey, 2019-2021



Enhancing Dissemination using Small Area Estimation

- 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 ($n \geq 10$)

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, as well as a dissemination 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, representation, and dissemination equity, so we can better measure, understand, and address true health inequities

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The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the National Center for Health Statistics, Centers for Disease Control and Prevention.

