

# Revisiting Total Survey Error Framework in a Multimode and Multidata Environment with Two Case Studies

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2024 ITSEW



# Multimode Surveys

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- Single mode paradigm no longer applies in the 21<sup>st</sup> century (de Leeuw & Berzecklak, 2016)
- Different types of multimode designs (Dillman et al., 2014)

	1 contact mode		>1 contact mode	
	1 response mode	>1 response mode	1 response mode	>1 response mode
Direct data collection	Mail-only	Web+mail through mailing	Web through mailings + text	Web+mail through mailing + text

# Multidata Environment

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- “...official statistical offices need to move from the probability sample survey paradigm ... to a mixed data source paradigm for the future” (Citro, 2014, p137)
- Data from different sources (besides survey data) can be used/combined to access people and obtain information from/about people
  - administrative data, social media, biospecimen, passive data
  - designed vs. gathered data (Groves, 2011)

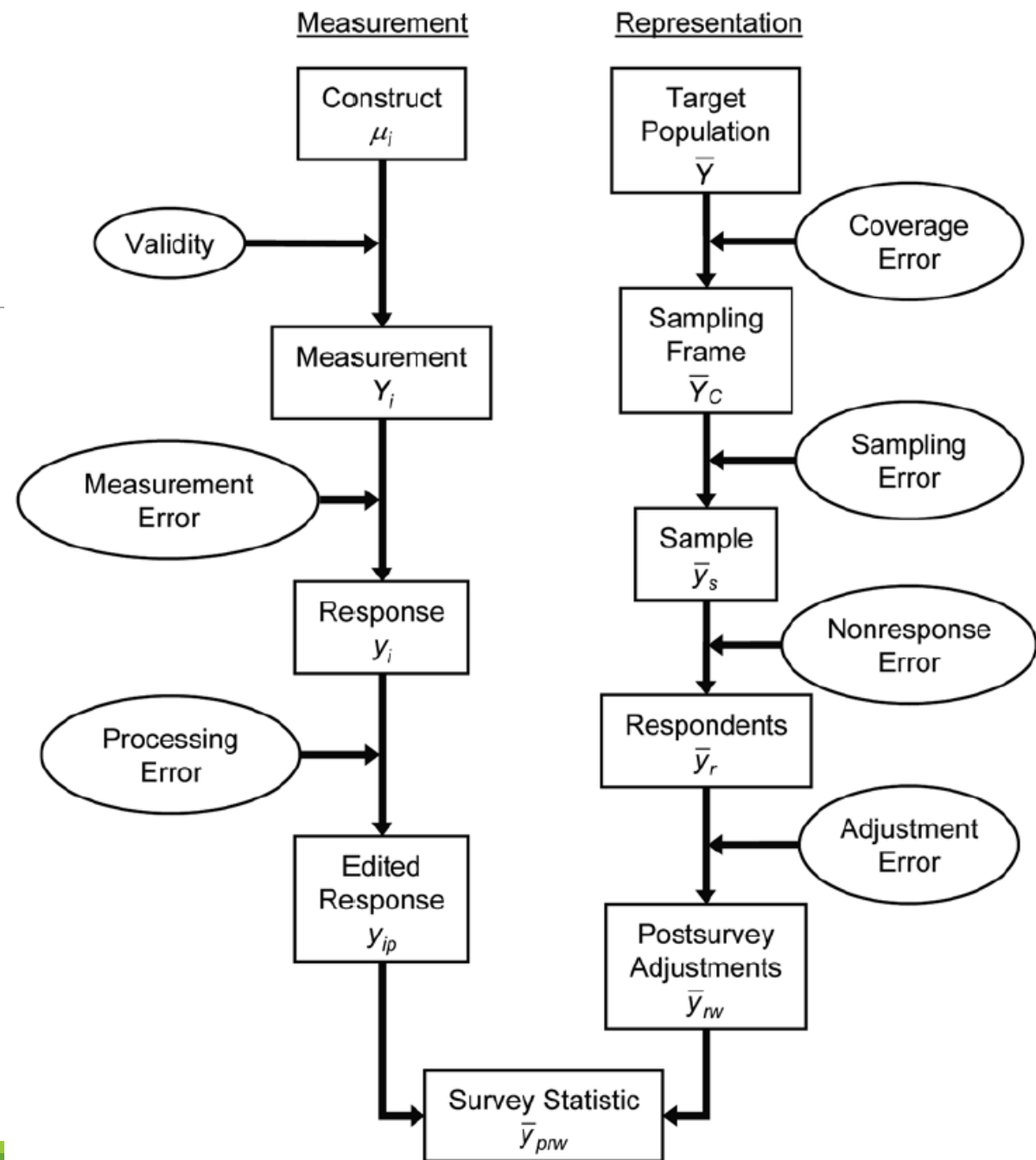
# Multimode and Multidata Environment

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- Imagine a multimode and multidata study
  - Combines an address-based sample and a list of WIC participants sampled from WIC administrative records
  - Recruits participants by mailings and in-person visits
  - Interviews them by web and ACASI
  - Tracks their location and travel through GPS
  - Collects their physical activity through wearable
  - Links to their medical records

# Total Survey Error (TSE)

- Survey error=deviation of what is desired from what is attained
  - Error of non-observation
  - Error of observation
- Goal is to reduce error given cost constraints, or reduce costs for given level of quality/error



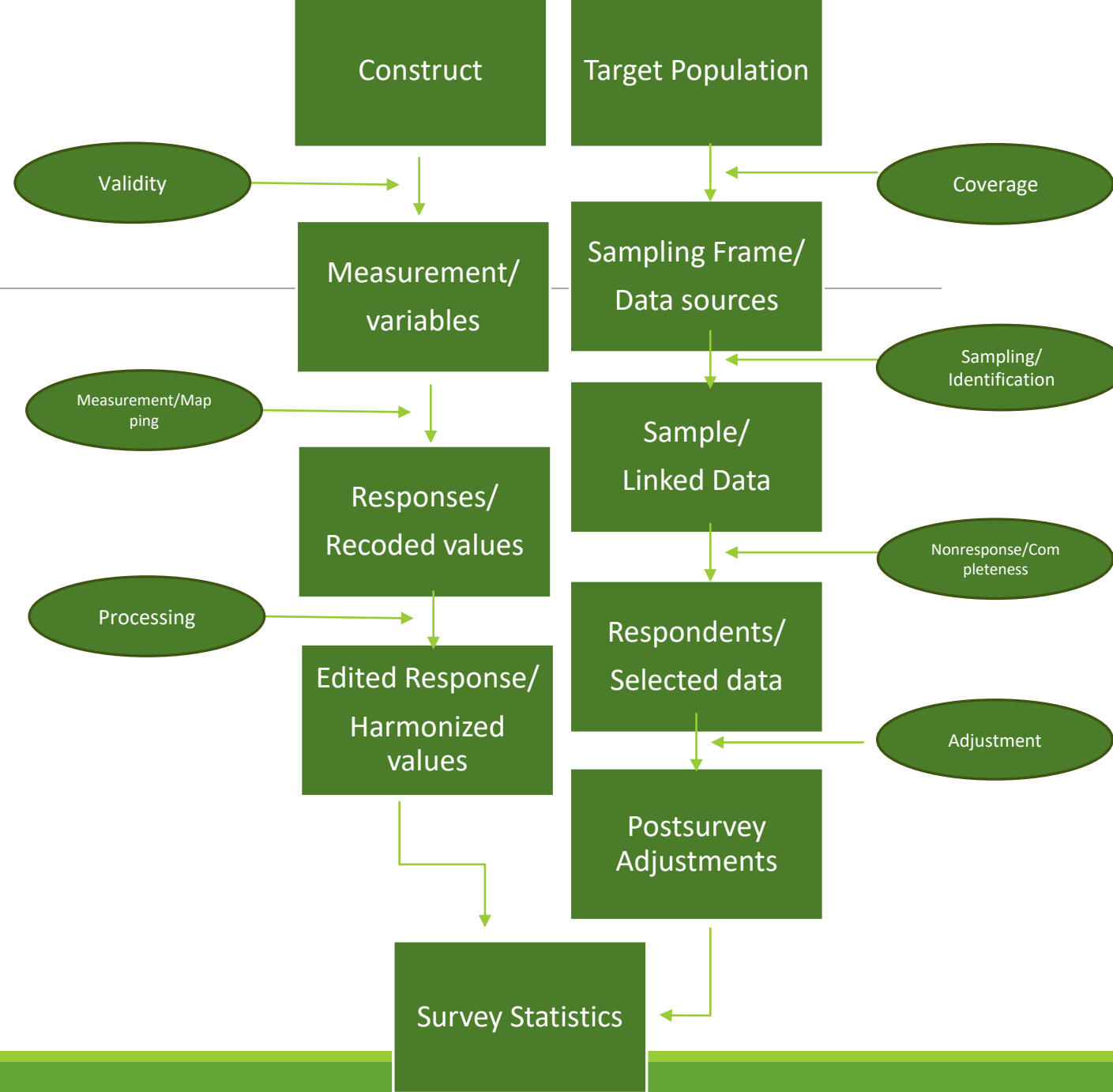
# Extensions of TSE (with New Names)

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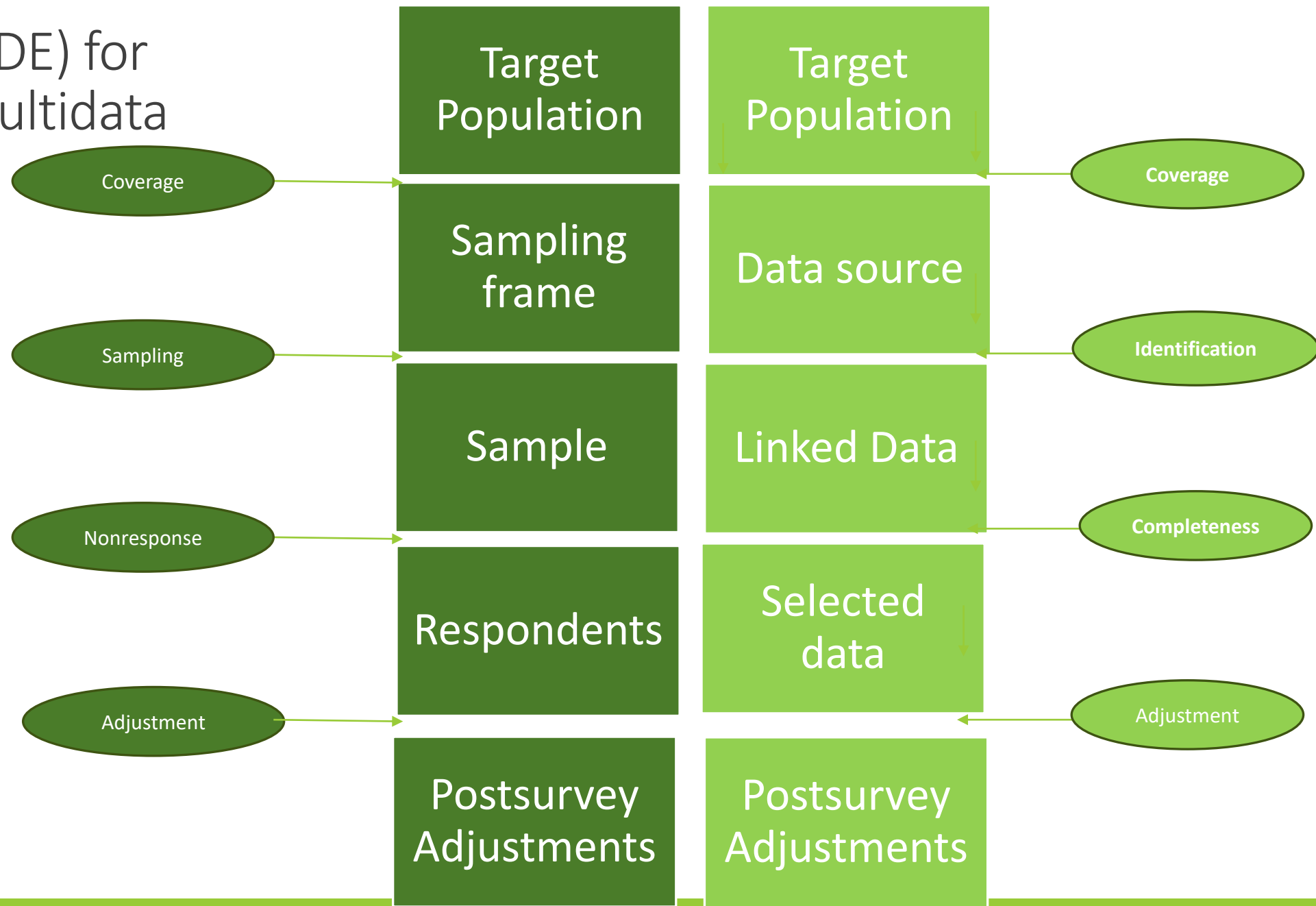
- For multiple surveys (including cross-cultural and cross-national surveys)
  - Total Survey Measurement Variation (Smith, 2011)
- For integrating administrative data
  - Two-phase life cycle of integrated statistical micro data (Zhang, 2012)
- For digital traces of human behaviors on online platforms (including social media data)
  - TED-On (Sen et al., 2021)
- For integration of data from different sources
  - Total Data Quality Framework (University of Michigan)

# Total Data Error (TDE) for Multimode and Multidata Environment

- In multimode and multidata environment
  - Shift from TSE to TDE
  - Goal is still to reduce error given cost constraints, or reduce costs for given level of quality/error
- Multimode and multidata designs have the potential to
  - Improve quality
  - Reduce error
  - Reduce cost

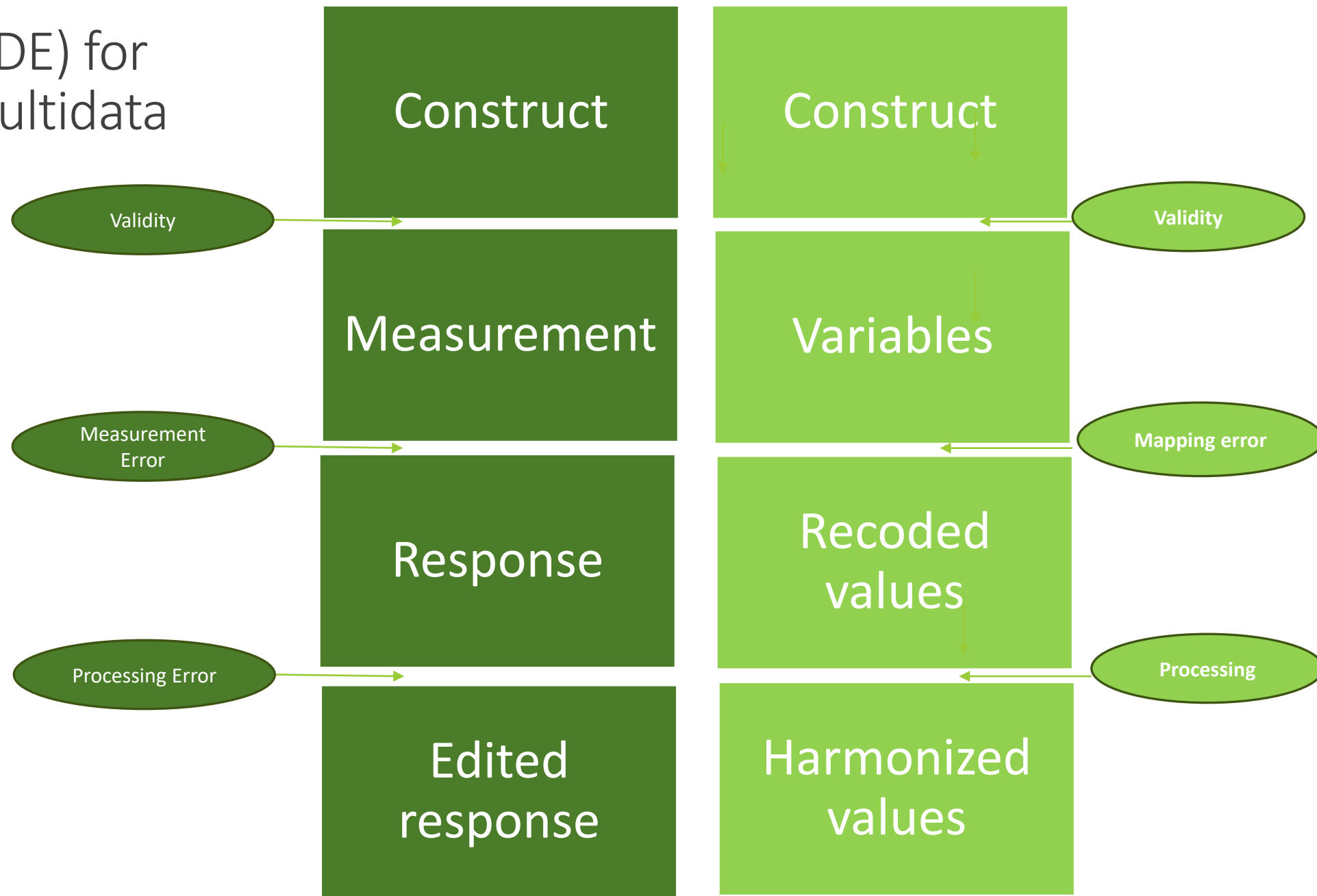


# Total Data Error (TDE) for Multimode and Multidata Environment





# Total Data Error (TDE) for Multimode and Multidata Environment



# Total Data Error (TDE): Putting it all together

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- Effort to reduce one error could potentially increase another error
  - Offering a paper mode reduces nonresponse error at the risk of increasing measurement error and processing error
  - Including data from records reduces measurement error at the risk of increased coverage error and/or nonresponse error
  - Including data from records reduces coverage and/or nonresponse error at the risk of increased measurement/mapping error
- Additional cost and time, for obtaining, linking, cleaning, manipulating, editing, coding, harmonizing

# Case Study 1: Use of Accelerometry Data

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- Accelerometry data can be obtained from a wearable device (e.g., Fitbit, Apple watch)
  - Continuously, passively, unobtrusively
  - Can be used to estimate intensity, duration, and frequency of physical activity.
- Compared to self-report from survey respondents.
  - Free from measurement error due to forgetting, difficulty of estimation, and social desirability bias
- But what about other errors?

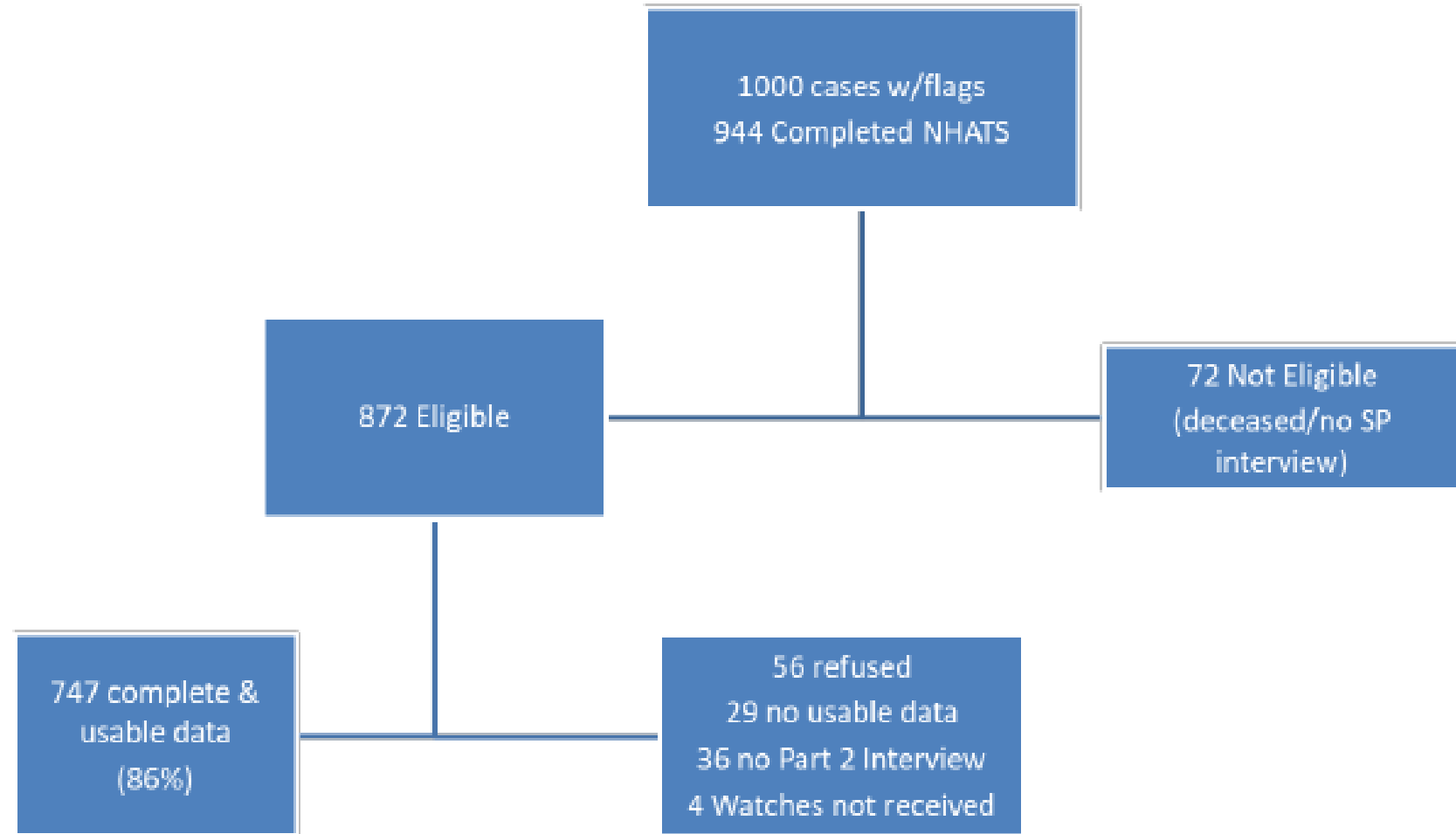
# Case Study 1: NHATS R11 and R12

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- National Health and Aging Trends Study (NHATS)
  - Annual national study of Medicare beneficiaries ages 65 and older
- Round 11
  - A random sample of sample persons asked to wear an activity watch for 8 days
- Round 12
  - Respondents who completed Round 11 interview and wore the activity watch for 8 days were asked to wear the watch again for 8 days
- Acceleration data are downloaded from the activity watch and aggregated to measure intensity, duration, and frequency of physical activity.

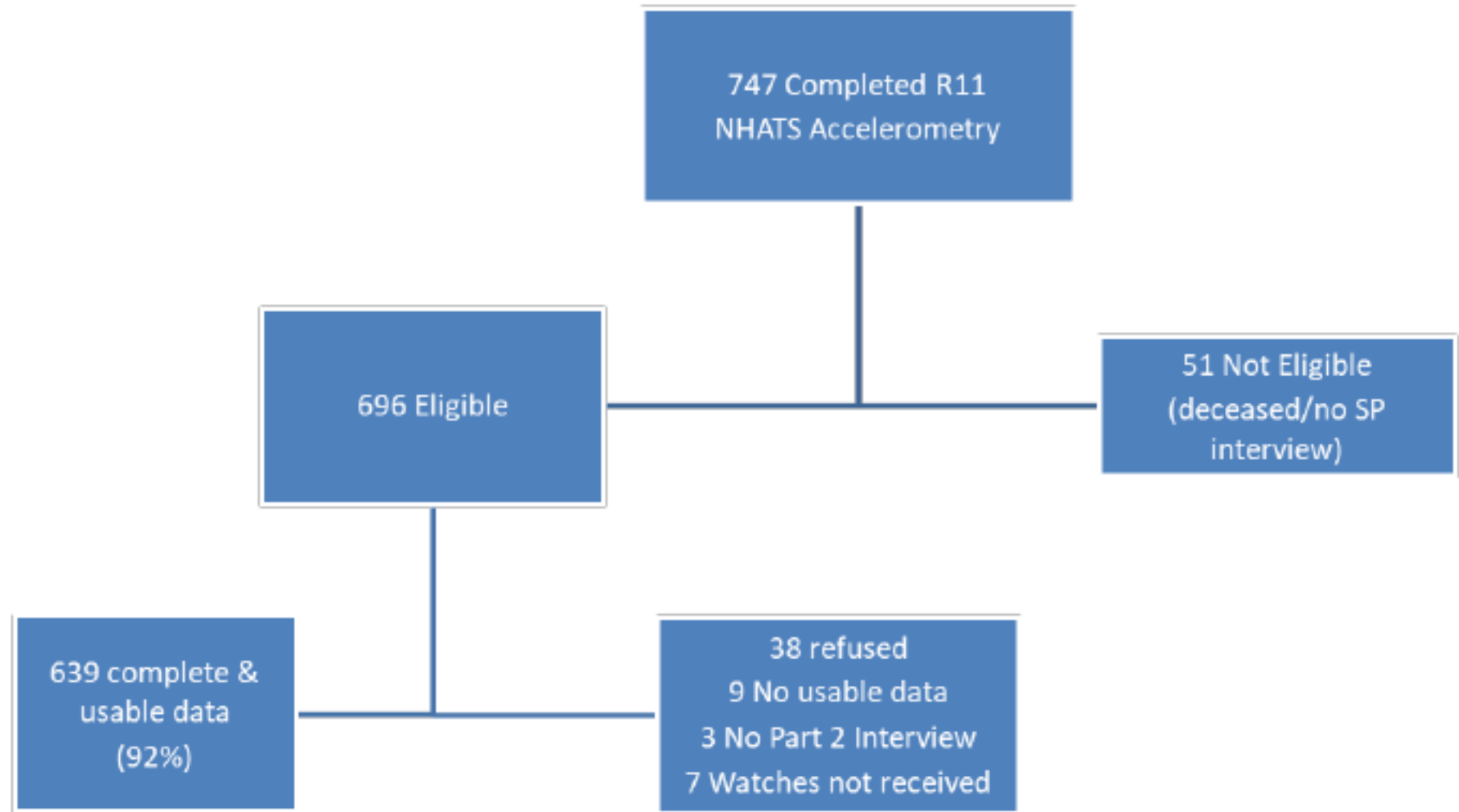
# Representation

## Round 11



# Representation

## Round 12



# Potential Bias in Accelerometry Data due to Undercoverage and Incomplete information

	Round 11			Round 12		
	Aged 70 to 79	Able to walk 3 blocks	Vigorous activities last month	Aged 70 to 79	Able to walk 3 blocks	Vigorous activities last month
Selected and compliant	60%	69%	41%	63%	72%	42%
Selected and not compliant	58%	61%	34%	51%	60%	34%
Not selected	35%	57%	34%	35%	57%	34%

# Case Study 1: Summary

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- Accelerometry data have better measurement properties
- But worse representation properties
- A trade-off to consider if using accelerometry data to estimate, say, frequency of physical activities
- How to combine or blend with survey data given what we know?
  - Future research is much needed!!



# Case Study 2: Using Administrative Data

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- Most of administrative data sets are specific to persons with certain characteristics (e.g., WIC participants, Medicare beneficiaries, students)
  - Incomplete coverage of general population
- Can they be used to save cost and reduce timeline of screening for people with desired characteristics?

# Case Study 2: MEPS Alternative Sample Design Pilot

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- Medical Expenditure Panel Survey (MEPS)
  - A nationally representative survey on Americans' health care utilization and expenditures
    - Sample drawn from households that participated in prior year's National Health Interview Survey (NHIS)
- Pilot study evaluating the feasibility to use
  - Address-based sampling (ABS) frame to achieve complete coverage
  - Medicare administrative data to achieve sampling efficiency and to reduce screening cost

# MEPS Pilot

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- MEPS Alternative Sample Design Pilot
  - Sampled addresses matched to administrative data
  - Four strata were created based on address matching status, presence of cost data in administrative data for matched addresses, predicted cost
  - Differential sampling rates applied to strata

# MEPS Pilot (2)

Stratum	Initial Sample Size	Sampling Rate	Final Sample Size	Screener Response Rate
1. Matched to CMS, moderate- and high-cost	9%	1.00	24%	33%
2. Matched to CMS, not moderate- and high-cost	10%	0.47	13%	29%
3. Matched to CMS, with no CMS cost data	12%	0.47	15%	31%
4. Not matched to CMS	70%	0.25	48%	19%
Overall	100%	NA	100%	26%

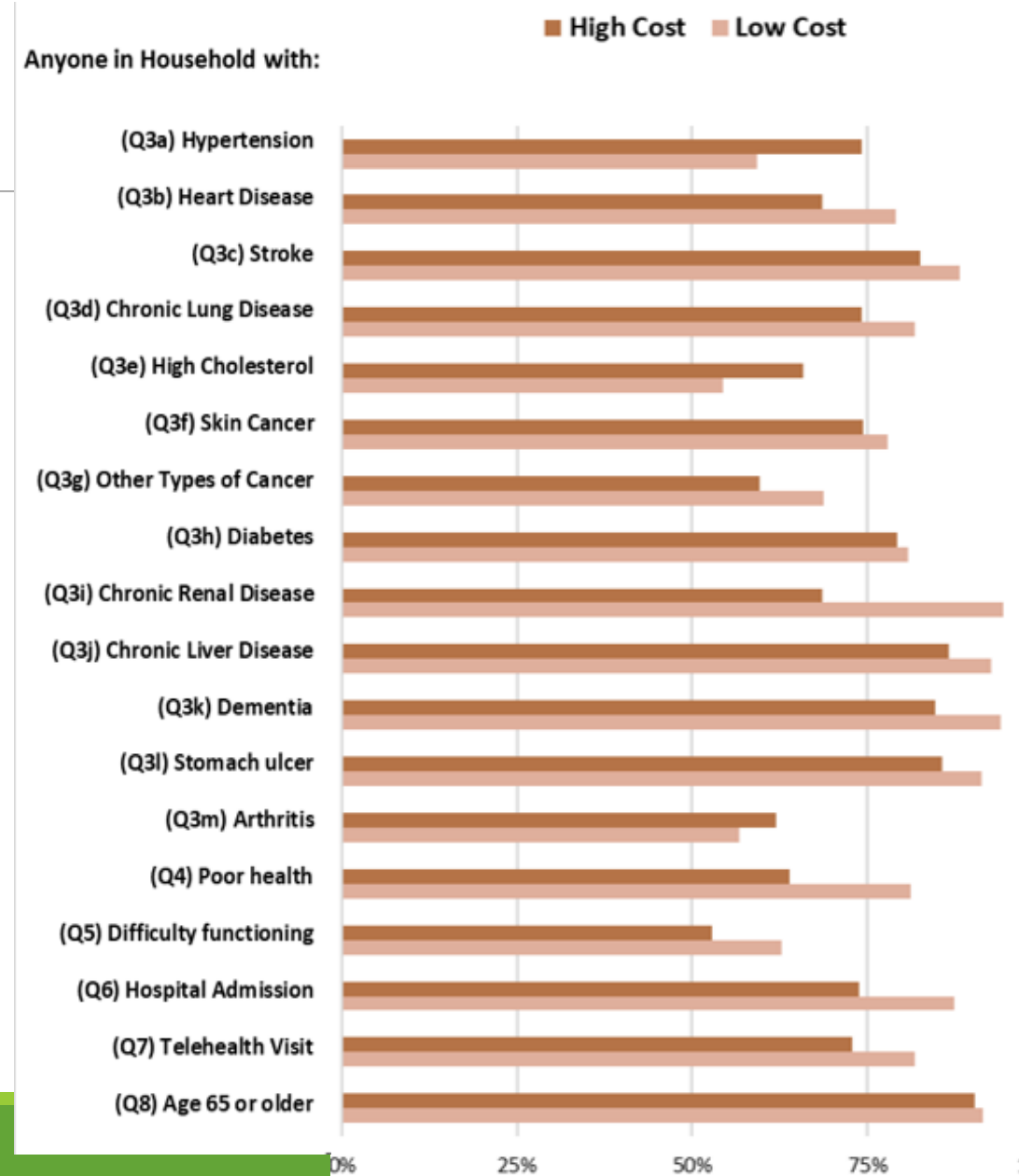
# Differences b/w Matched vs. Unmatched Addresses

Stratum	Fair/poor physical health	Total number of chronic health conditions	Having function limitation	In hospital for 2+ nights in past 12 months
1. Matched to CMS, moderate- and high-cost	19.6%*	3.7*	52.0%*	21.1%*
2. Matched to CMS, not moderate- and high-cost	13.8%	2.6*	33.8%*	10.6%
3. Matched to CMS, with no CMS cost data	18.1%	3.1*	41.8%*	16.8%*
4. Not matched to CMS	13.3%	1.7	21.5%	9.1%

# Quality of Administrative Data

- Evaluated administrative data against survey response data for strata 1 and 2
  - Stratum 1: 7 out of 18 variables have a concordance rate <70%
  - Stratum 2: 5 out of 18 variables have a concordance rate <70%

Respondent and CMS Data Concordance  
(Includes Yes/Yes and No/No Agreement)



# Case Study 2: Summary

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- Great use of administrative data to improve sampling efficiency and to reduce screening cost
- Trade-offs with
  - Errors arising from availability, identification, completeness, (construct) mapping, and processing

# Total Data Error: Call for Research

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- To use this framework to inform decisions on balancing errors and making trade-offs
  - Requires knowledge of different mode/data source on each source of error
    - Designed data: in our control, we know more
    - Gathered data: not in our control, we need to know more and be more transparent
  - Requires systematic examination of error trade-offs
  - Be mindful of the dynamic nature of the trade-offs/balances



# Thank you!

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