Revisiting the Balance:
The Household Pulse Survey in a
Total Survey Quality Framework

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International Total Survey Error Workshop:

Total Survey Error in the Age of COVID-19

TSE for Data Collections about COVID

September 24, 2021

Any opinions and conclusions expressed herein are those of the author and do not represent the views of the U.S. Census Bureau. All results are from the Household Pulse Survey website that notes the following: *The U.S. Census Bureau reviewed this data product for unauthorized disclosure of confidential information and approved the disclosure avoidance practices applied to this release. CBDRB-FY21-286.*

Outline

Highlight the frameworks

- Total Error
- Total Survey Error
- Total Survey Quality

Setting for the Household Pulse

- Collection environment

Components of Error and Quality and exchanges for Household Pulse

- Priorities (speed, content, and transparency)

Targets for improvement and roadmap for a rapid response data system

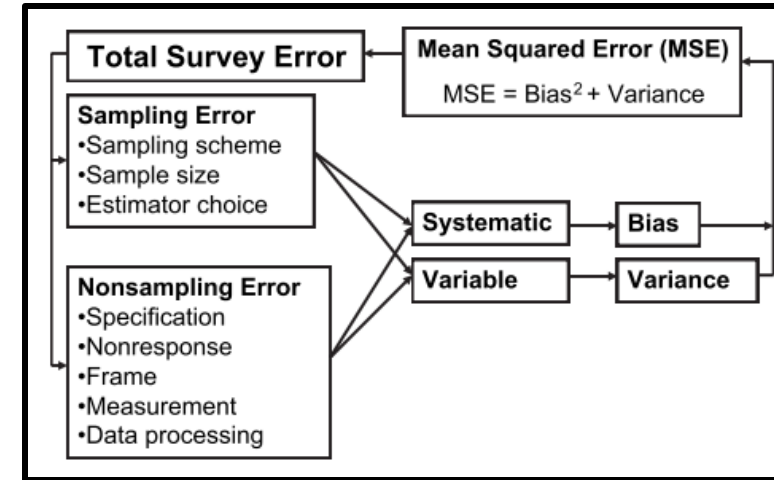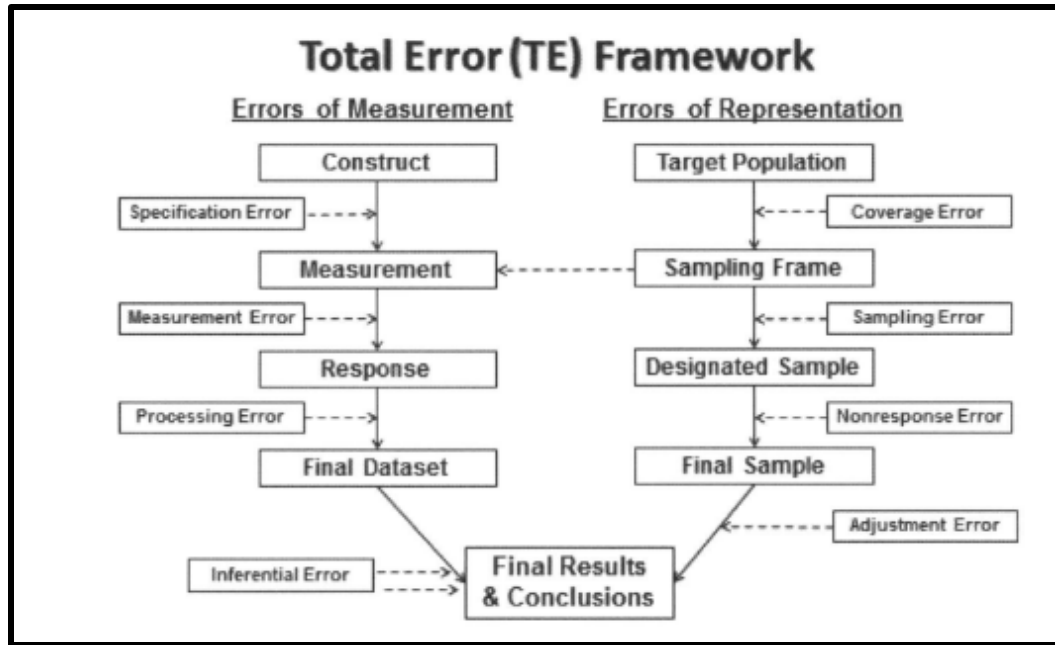- Procedures which can help reduce the error component

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Error and Quality Framework

Total Error (TE) Framework

Errors of Measurement | **Errors of Representation**

Construct
- Specification Error --→
Measurement
- Measurement Error ----→
Response
- Processing Error --→
Final Dataset

Target Population
- ←--- Coverage Error
Sampling Frame
- ←--- Sampling Error
Designated Sample
- ←--- Nonresponse Error
Final Sample
- ←--- Adjustment Error

- Inferential Error --→

Final Results & Conclusions

Total Survey Error ← **Mean Squared Error (MSE)**

$$MSE = Bias^2 + Variance$$

Sampling Error
- Sampling scheme
- Sample size
- Estimator choice

Nonsampling Error
- Specification
- Nonresponse
- Frame
- Measurement
- Data processing

Systematic → Bias

Variable → Variance

Table 1. Common Dimensions of a Survey Quality Framework

Dimension	Description
Accuracy	Total survey error is minimized
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Relevance	Data satisfy users needs
Accessibility	Access to the data is user friendly
Timeliness/Punctuality	Data deliveries adhere to schedules
Completeness	Data are rich enough to satisfy the analysis objectives without undue burden on respondents
Coherence	Estimates from different sources can be reliably combined

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- Groves, R. M., et al. (2004,2009). Survey Methodology. Hoboken, New Jersey, John Wiley & Sons, Inc.

- Lavrakas, P. J. (2013). "Presidential Address: Applying A Total Error Perspective For Improving Research Quality In The Social, Behavioral, And Marketing Sciences." The Public Opinion Quarterly **77**(3): 831-850.

- Biemer, P. P. (2010). "Total Survey Error: Design, Implementation, and Evaluation." Public Opinion Quarterly **74**(5): 817-848.

EXPERIMENTAL DATA

Setting the Stage

Issues of the Moment (as of February…)

- *Census 2020* – operations accelerating and April 1, 2020 Census Day imminent
- Declining response
- Maintaining data quality
- Enhancing use of administrative records and adaptive design
- Developing survey based small-area estimates
- Moving forward with disclosure protection development for surveys

COVID-19 ONSET [MARCH 13 through the end of MARCH]

- In-person field data collection ceased
- Mail-center activities at National Processing Center (NPC) ceased
- Telephone Interviewing (CATI) centers closed
- Field personnel shifted from in-person to decentralized telephone interviewing
- Headquarters staff were shifted to full-time telework

Survey changes

- Content changes for ongoing surveys was expedited, but did not change survey cycles

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The Household Pulse

What are the goals of the pulse?

- Focus on quickly and efficiently, collecting data on a range of ways in which people's lives have been impacted by the pandemic

- Serve federal agencies to meet their critical information gaps in household information needed for their decisions related to the pandemic

- Provide data as rapidly as possible with as much transparency in methods and quality as possible

- Experimental data collection – Proof of concept – Accepting that this does not meet regular program quality standards

Sampling Design

- **Utilizes the Census Bureau's Master Address File (MAF) as the source of sampled housing units (HUs)**
  - Phases 1-3 utilized the January 2020 MAF
  - Phase 3.1 and 3.2 takes advantage of the latest MAF updates as of January 2021

- **Systematic sample of all eligible HUs**
  - Adjustments applied to the sampling intervals to select a large enough sample to create state level estimates and estimates for the top 15 MSAs

- **Sixty-six independent sample areas were defined**
  - For each data collection period, independent samples were selected
  - Each sampled HU was interviewed once in Phases 2-current
  - Phase 1 attempted longitudinal collection, reincluding households for up to three interviews

- **A target of a 3% coefficient of variation (CV) for an estimate of 40 percent of the population would be achieved for all sample areas except for the 11 smallest states**
- **In these smaller states, the sample size was reduced to produce a 3.5% CV**

*State-level sample sizes and number of responses can be found in Table A1 on the Appendix A1 tab in the State-level Quality Measures spreadsheet at https://www.census.gov/programs-surveys/household-pulse-survey/technical-documentation.html
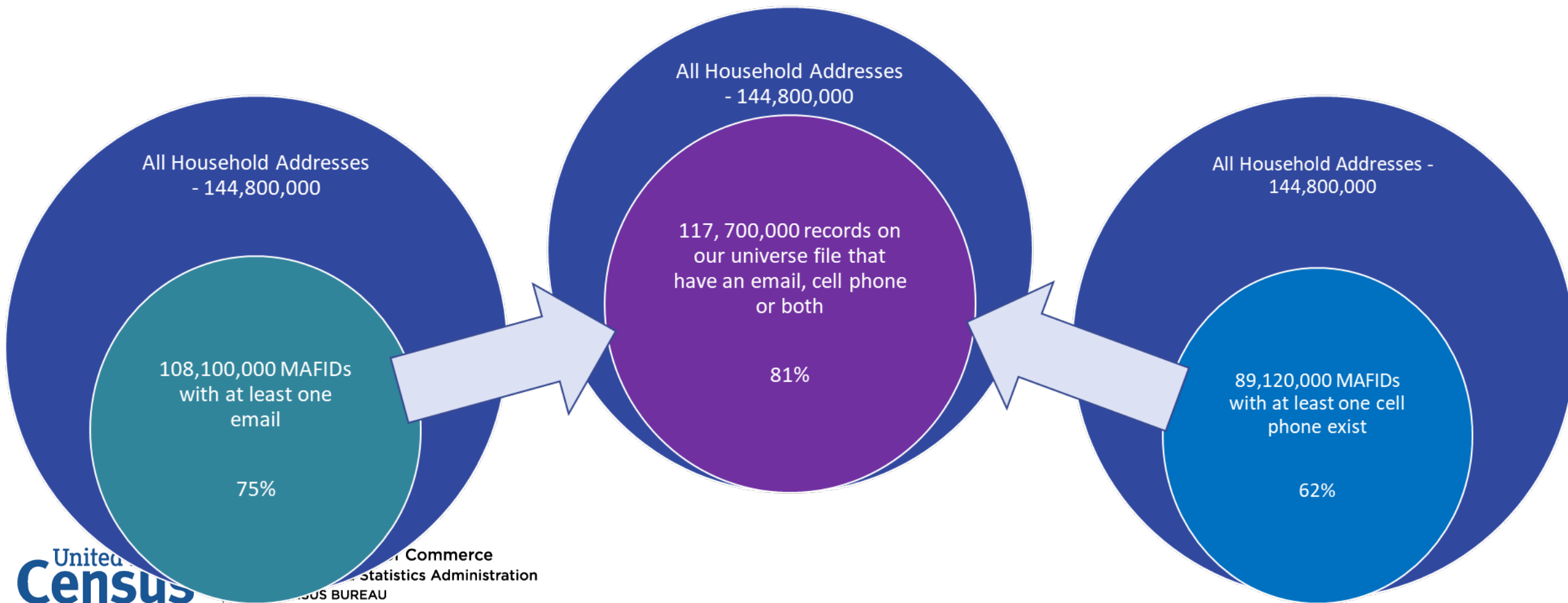
Sampling Error

The Sampling Scheme

- Simple scheme sorting cases and selecting based on interval defined by CV, non-response, and number of units
    - SAMPING AREA
    - STATE FIPS CODE
    - SAMPLE DESIGNATION
    - COUNTY FIPS CODE
    - UNGEOCODED FLAG
    - CURRENT BLOCK STATE
    - CURRENT BLOCK COUNTY
    - CURRENT BLOCK TRACT
    - CURRENT BLOCK
    - UNGEOCODED ZIP
    - MASTER ADDRESS FILE ID

- This sort does not incorporate any separate sampling strata definition and could miss important differences in the required sampling rate **(SPECIFICATION)**

Frame

Contact frame and MAF

- Matched to Census Bureau's Master Address File (MAF) records
- Emails and phone numbers from respondent contacts and from third party vendors

All Household Addresses - 144,800,000

108,100,000 MAFIDs with at least one email

75%

All Household Addresses - 144,800,000

117, 700,000 records on our universe file that have an email, cell phone or both

81%

All Household Addresses - 144,800,000

89,120,000 MAFIDs with at least one cell phone exist

62%

Non-Sampling Error - Frame

MAF

- The Master Address File (MAF) – Unit Frame file is a well-established sampling framework for measuring the household population of the United States
    - Excludes non-household population (Group Quarters and Homeless)
    - Coverage of household addresses is dependent on regular updates (but this is a really good time to use the MAF)
    - Especially with low response rates, the use of the MAF provides significant advantage over non-probability sampling **(CONTROL and ADJUSTMENT)**

The Contact Frame

- The Contact Frame is a relatively new supplemental data source with constant improvement
- Relies on probabilistic matching of purchased and collected email and phone to specific addresses
    - Does not have matches to all MAF-IDs **(COVERAGE)**
    - Contains email and phone that match to more than one MAF-ID – ranked by recency, data source, strength **(ACCURACY)**
    - Sources of information that provide email and phones to vendor files may not be evenly distributed by characteristic in the population **(BIAS)**

Responses and Nonresponse

PHASE 1 Week	Interviews	Weighted Response Rate
April 23 – May 5 : Week 1	74,413	3.8
May 7 – May 12 : Week 2	41,996	1.3
May 14 – May 19 : Week 3	132,961	2.3
May 21 – May 26 : Week 4	101,215	3.1
May 28 – June 2 : Week 5	105,066	3.5
June 4 – June 9 : Week 6	83,302	3.1
June 11 – June 16: Week 7	73,472	2.3
June 18 – June 23: Week 8	108,062	2.9
June 25 – June 30: Week 9	98,663	3.3
July 2 – July 7: Week 10	90,767	3.2
July 9 – July 14: Week 11	91,605	3.1
July 16 – July 21: Week 12	86,792	2.9

PHASE 2/3 Week	Interviews	Weighted Response Rate
August 19 – August 31: Week 13	109,051	10.3
September 2 – September 14: Week 14	110,019	10.3
September 16 – September 28: Week 15	99,302	9.2
September 30 – October 12: Week 16	95,604	8.8
October 14 – October 26: Week 17	88,716	8.1
October 28 – November 9: Week 18	58,729	5.3
November 11 – November 23: Week 19	71,939	6.6
November 25 – December 7: Week 20	72,484	6.7
December 9 – December 21: Week 21	69,944	6.5

PHASE 3 Week	Interviews	Weighted Response Rate
January 6 – January 18: Week 22	68,348	6.4%
January 20 – February 1: Week 23	80,567	7.5%
February 3 – February 15: Week 24	77,122	7.3%
February 17 – March 1: Week 25	77,788	7.3%
March 3 – March 15: Week 26	78,306	7.4%
March 17 – March 29: Week 27	77,104	7.2%

PHASE 3.1 Week	Interviews	Weighted Response Rate
April 14 – April 26: Week 28	68,913	6.6%
April 28 – May 10: Week 29	78,467	7.4%
May 12 – May 24: Week 30	72,897	6.8%
May 26 – June 7: Week 31	70,854	6.7%
June 9 – June 21: Week 32	68,067	6.4%
June 23 – July 5: Week 33	66,262	6.3%

TOTAL   35,987,146 Sampled Units
2,813,481 Interviews

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Non-Sampling Error – Nonresponse Adjustment

Nonresponse

- Responses are not collected from all those in the sample or the respondent is unwilling to provide information.

- Population mobility – it is possible for people to move to a different county, state, and country without changing their email address or cell phone number. This means there is no guarantee that respondents and nonrespondents still live in the geographic areas where they were sampled.

- Nonresponse reason – due to the method of data collection, we do not know whether a sample case failed to respond because the contact information is invalid or because they chose not to respond to the survey. This forces us to treat all noninterviews as valid units that did not respond.

- Nonrespondent characteristics – without field representative observations we may obtain from personal visit attempts, we have no way of knowing the characteristics of nonresponding cases.

Non-Sampling Error – Nonresponse Adjustment

Weighting

Table 7. Person-Level Coverage Ratios at the National Level for Household Pulse Survey Before and After Raking for Collection Week* 35: August 4 – August 16, 2021

Demographic Characteristic	Before Raking	After Raking
Total Population	1.05	1.00
Male	0.87	1.00
Female	1.21	1.00
Age 18-24	0.41	0.88
Age 25-29	0.55	0.90
Age 30-34	0.74	1.03
Age 35-39	0.97	1.04
Age 40-44	1.23	1.11
Age 45-49	1.33	1.02
Age 50-54	1.41	1.03
Age 55-64	1.34	1.03
Age 65+	1.19	0.99
Hispanic	0.72	1.01
Non-Hispanic white-only	1.20	1.00
Non-Hispanic black-only	0.73	0.95
Non-Hispanic other races	1.07	1.04
No high-school diploma	0.20	0.68
High-school diploma	0.47	1.13
Some college or associate's degree	1.13	1.00
Bachelor's degree or higher	1.80	1.00

Source: U.S. Census Bureau, Household Pulse Survey
* For Phase 3.2 the Household Pulse Survey continues to call these collection periods "weeks" for continuity with Phase 1.

https://www2.census.gov/programs-surveys/demo/technical-documentation/hhp/Phase3-2_Source_and_Accuracy_Week%2035.pdf

Non-Sampling Error – Nonresponse Adjustment

Example of the impact of response bias

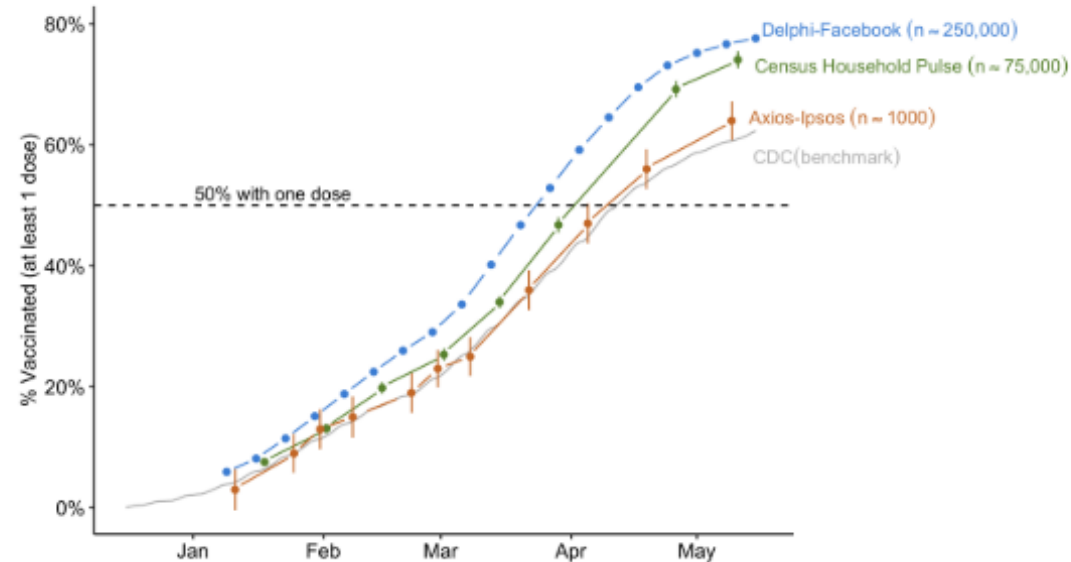Conflicting estimates of vaccine uptake and Big Data Paradox

Figure 2: Estimates of vaccine uptake for US adults compared to CDC benchmark data, plotted by the end date (in 2021) of each survey wave. 95% confidence intervals shown are calculated based on each study's reported standard errors and design effects from weighting; although those for Delphi-Facebook are too small to be visible.

Bradley, V. C., et al. (2021). "Are We There Yet? Big Data Significantly Overestimates COVID-19 Vaccination in the US." medRxiv: 2021.2006.2010.21258694.

Non-Sampling Error – Nonresponse Adjustment

Possible Correlations with Nonresponse

- Things we know
  - Age (younger)
  - Race (non-white)
  - Hispanic origin (Hispanic)
  - Education (high school and less)

- Possibilities
  - Internet access?
  - Rurality?
  - Civic engagement?
  - Likelihood to vaccinate?
  - Others…?

- What can we do?
  - Develop contact methods to reach reluctant respondents
  - Develop adjustments to compensate weighting in a more nuanced way
  - Adjust sampling strategy to oversample underrepresented population components
  - Consider measure like the data defect correlation (ddc). The ddc captures both the sign and magnitude of selection bias and is therefore a measure of data quality.

Quality, Speed, Information Gap?

What we did

- A stripped-down version of a regular survey, but faster, and with a few new features
- Knowingly exchanged some aspects of quality to provide rapid information to fill critical gaps

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What did it tell us?

- Data collection – a place for low response data collection with enough caution
- Data processing – limited data processing has an appropriate use
- Rapid collection and release prioritized along with methodological transparency has a unique and separate value in the portfolio of data products
- Incredible hunger and need for rapid information sources especially during major events
- This new work highlighted gaps in staffing that would be needed to support it

Roadmap

What we need

- Integrated data resource that can generate rapid, reliable estimates to support information needs
- Meet geographic requirements (national, states, regions, small areas) – ability to serve all the above
- Incorporate additional efforts to address Survey Error components

  - Revisit sampling design and requirements to sustain ongoing rapid collections
  - Coverage gaps – develop options to capture or adjust sampling/weighting to accommodate gaps created between contact frame and MAF
  - Response / nonresponse bias – adapt more nuanced topics and adjustments
  - Contact improvement – identify responsive/adaptive procedures to adjust contact for representativeness and effectiveness
  - Processing and estimation improvement
    - Integrate small-area estimates feasibility into the design and coverage requirements
    - Ensure that there are enough cross-over data elements to model based on linkages to the ACS
  - Incorporate administrative records and adaptive design to monitor and adjust data collection
  - Ensure transparency and the ability to communicate quality to data users

Thank you!

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Household Pulse Survey main page:
https://www.census.gov/householdpulsedata

Data tool:
https://www.census.gov/data-tools/demo/hhp

Vaccine tracker:
https://www.census.gov/library/visualizations/interactive/household-pulse-survey-covid-19-vaccination-tracker.html

Data Tables main page:
https://www.census.gov/programs-surveys/household-pulse-survey/data.html

Technical Documentation:
https://www.census.gov/programs-surveys/household-pulse-survey/technical-documentation.html

Survey Respondent overview:
https://www.census.gov/programs-surveys/household-pulse-survey.html

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