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# Measuring Food Waste Through Mobile App Data Collection: Lessons Learned for Research Design, Recruitment, and Response Rates

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# Rationale and Objectives

**Application of Mobile App Data Collection to Measure Household Food Waste**

# Why Use Mobile Apps to Measure Household Food Waste?

## ITS IMPORTANT

- Economic impacts
- Environmental impacts
- Contribution of household consumption habits
- Research → Solutions

## BUT DIFFICULT

- Behavioral awareness
- Time & effort
- Potential for error
- Between vs. within household variability

## METHODS

- Recall
- Volume estimation
- Scales/weight
- Dumpster diving

## MODES

- Dumpster diving
- Surveys (web or mail)
- Mobile apps

## MOBILE APPS

**BENEFITS**

- Daily diary/EMA
- Reduced burden
- Auto-syncing of scale input
- Intervention platform

**CHALLENGES**

- Response rates
- Access to technology
- Comfort with technology
- User experience
- Research design

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# The MITRE-Gallup National Food Waste Study

- **Who?** Members of the Gallup Panel (N = 451)
  - Subset of more than 17,000 web recruits

- **What?** Daily tracking of food waste using MITRE Food Waste Tracking app for 7 consecutive days
  - Random assignment to condition: volume estimation vs. Bluetooth scale
  - Random assignment to order: survey first vs, diary first

- **When?** January – November 2023
  - Data collection: June, 21$^{st}$ – August 23$^{rd}$

- **Where?** United States – all 50 states except WY

- **Why?** (1) To learn about household food waste patterns (2) To help measurement and methodology

- **How?**

$n$ =95

$n$ =71

$n$ = 119

$n$ =166

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# Research Design and Methodology

Designing Protocols for Mobile App Data Collection + Survey Integration

# Key Research Design Elements

## STUDY GROUPS

### Initial Sample

**Group 3**
**Order**: Survey first
**Scale**: With scale

**Group 5**
**Order**: App first
**Scale**: With scale

**Group 4**
**Order**: Survey first
**Scale**: No scale

**Group 6**
**Order**: App first
**Scale**: No scale

### Supplemental

**Group 7**
**Order**: App first
**Scale**: No scale

**(1) Staggered Deployment**
- Easier for operations
- Easier for tracking
- Allows for adjustments
- Analyses to compare weeks

**(2) Pre-communications before surveys**
- Best practice for survey recall
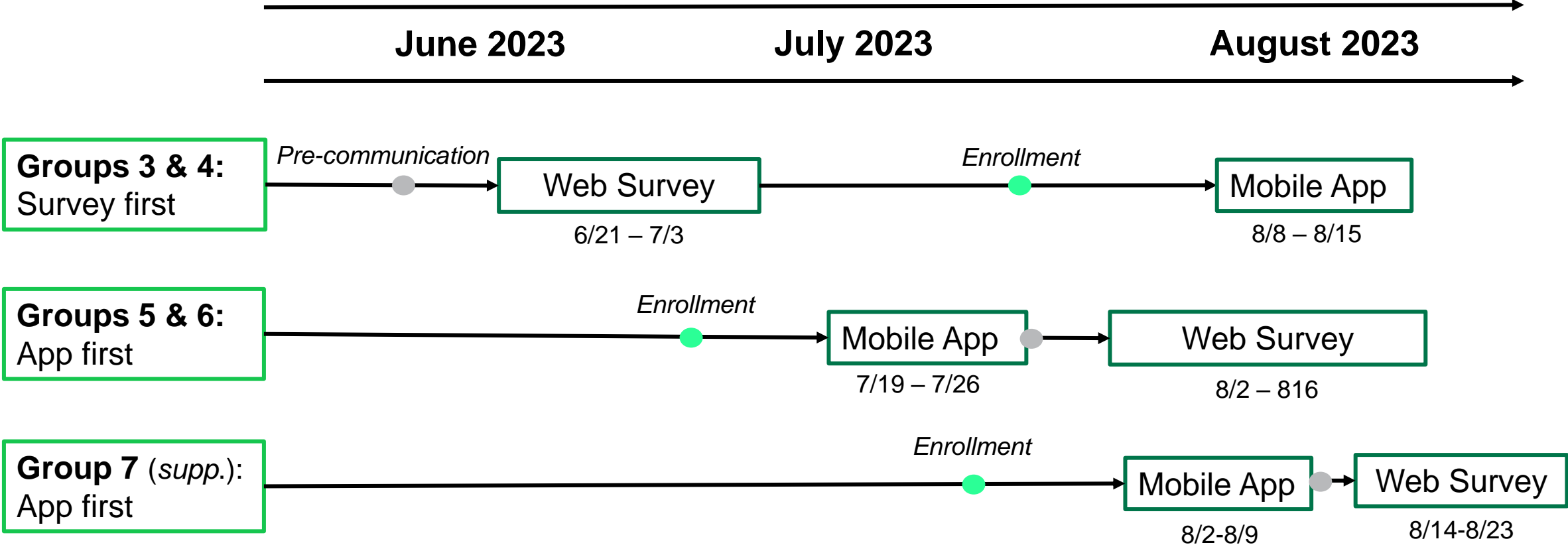- Comparability to mobile app collection

**(3) Enrollment survey:**
- Early indication of participation rates
- Address for scale deployment
- Analyses of differential attrition
- Initiate communications

**(4) Other design choices:**
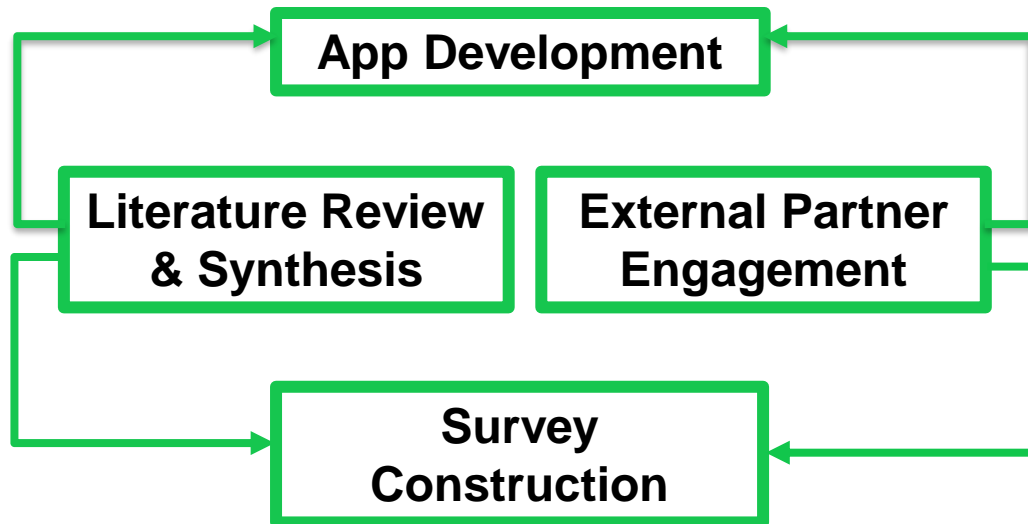- Specifying same
- Mid-week start
- Incentives

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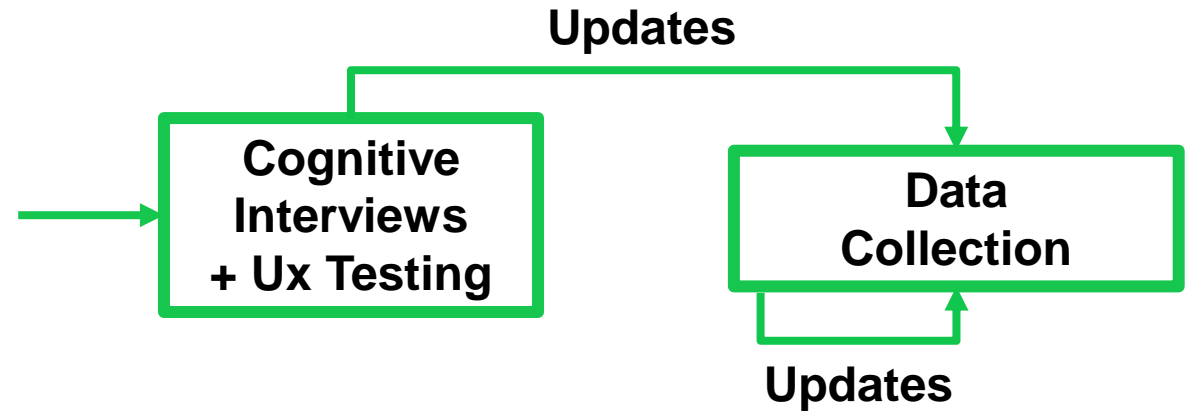
# Methodology Overview

## DATA COLLECTION

June 2023          July 2023          August 2023

**Groups 3 & 4:**
Survey first

*Pre-communication*    Web Survey    *Enrollment*    Mobile App

6/21 – 7/3          8/8 – 8/15

**Groups 5 & 6:**
App first

*Enrollment*    Mobile App    Web Survey

7/19 – 7/26          8/2 – 816

**Group 7** (*supp.*):
App first

*Enrollment*    Mobile App    Web Survey

8/2-8/9          8/14-8/23

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# Methodology Overview

# Communications Overview

**SURVEY**
- Pre-communication for survey
- Survey invitations, reminders, and close

**APP ENROLL**
- Enrollment survey invitation, reminders and close
- Confirmation of enrollment

**SCALE**
- Scale notification and explanation
- Scale shipped with letter insert
- Scale reminder

**APP ONBOARD**
- App download/setup instructions and reminders

**DIALY DIARY**
- Daily diary start date reminder
- Days 1-7 entry reminders
- Daily diary close/instructions

**SUPPORT**
- Technical/logistical/member support

| | |
|---|---|
| Pre-communication email | 14-Jun |
| Survey Invitation | 21-Jun |
| Reminder #1 | 23-Jun |
| Reminder #2 | 26-Jun |
| Reminder #3 | 28-Jun |
| Survey closed | 30-Jun |
| Sample for daily diary pulled and loaded | 7-Jul |
| Daily Diary Enrollment invite email sent | 10-Jul |
| Enrollment Reminder #1 | 13-Jul |
| Enrollment Reminder #2 | 17-Jul |
| Daily Diary Enrollment complete | 19-Jul |
| Diary enrollment data processed | 21-Jul |
| Confirmation of enrollment email sent | 25-Jul |
| Scale - explanation email -send details | 27-Jul |
| Scale shipped with letter insert | 27-Jul |
| Scale reminder email | 31-Jul |
| App Reminder email #1 | 2-Aug |
| App Reminder email #2 | 4-Aug |
| Diary Start date invite | 7-Aug |
| Day 1 -Daily Diary Entry Reminder #1 | 8-Aug |
| Day 2-Daily Diary Entry Reminder #2 | 9-Aug |
| Day 3-Daily Diary Entry Reminder #3 | 10-Aug |
| Day 4-Daily Diary Entry Reminder #4 | 11-Aug |
| Day 5-Daily Diary Entry Reminder #5 | 12-Aug |
| Day 6-Daily Diary Entry Reminder #6 | 13-Aug |
| Day 7-Daily Diary Entry Reminder #7 | 14-Aug |
| Day 8-Daily Diary Entry Close | 15-Aug |

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# Cognitive Interviews: User Experience & Communication

## AREAS OF FOCUS

**MITRE Food Tracking App**

- Downloading and setting up app
- Communications and instructions
- Look & feel
- App entries
- Household capture
- Reactions to using app
    - Perceptual/behavioral changes

**Bluetooth scale**

- Setting up & syncing the scale
- Operating scale/scale entries
- Communications and instructions

## UPDATES

**COMMUNICATIONS**

- **Pre-comm:**
    - Prompting notes & food categories
- **Comms:**
    - Clarify tracking of household members
    - Scale - tare feature instructions
    - Scale - manual entry instructions
- **FAQs:**
    - Food category clarifications

**FUNCTIONS**

- **App entries:**
    - Food source (e.g., gift)
    - Disposal reason  (e.g., dropped/spilled)
- **App operations:**
    - Editing
    - App notifications

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# Data Collection

## CHALLENGES

1. "I don't know my Study ID!"

2. Participation Rates

3. Incentives for 0-Waste Days

## SOLUTIONS

- Emails through Gallup support
- Study ID added to all communications, including daily reminders

- Afternoon email reminders
- Additional sample group

- Manual incentives for days with no waste, upon request

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# The Results Are In!

**Response Rates, Sample Composition, and Concordance of Measures**

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# Summary of Mobile App Data

*Note*. These groups were fielded first!

| | Survey THEN App + Scale | Survey THEN App | App + Scale THEN Survey | App THEN Survey | App THEN Survey (SUPP) |
|---|---|---|---|---|---|
| Total Entries | 1288 | 939 | 842 | 567 | 2344 |
| Total Respondents | 87 | 70 | 69 | 52 | 173 |
| Average Entries | 15 | 13 | 12 | 11 | 13.5 |
| | | | | | |
| Average Days Complete | 6.0 | 5.7 | 5.2 | 5.1 | 5.6 |
| Average Entries Per Day | 1-2 | 1-2 | 1-2 | 1-2 | 1-2 |
| | | | | | |
| Total "Full" Completes | 44 | 33 | 26 | 15 | 75 |
| Percent "Full" Completes | 51% | 49% | 38% | 29% | 43% |

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# Response Rates Across the Recruitment-Completion Pipeline

| | Invited | Responded to enrollment survey | Enrollment survey response rate | Consented on enrollment survey | Consent rate | Completed diary | Diary response rate (completed/consented) | Final Response Rate |
|---|---|---|---|---|---|---|---|---|
| Survey THEN App + Scale | 400 | 111 | 28% | 106 | 95% | 87 | 82% | 22% |
| Survey THEN App | 397 | 111 | 28% | 102 | 92% | 70 | 69% | 18% |
| App + Scale THEN Survey | 400 | 110 | 28% | 90 | 82% | 69 | 77% | 17% |
| App THEN Survey | 393 | 89 | 23% | 79 | 89% | 52 | 66% | 13% |

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# Response Rates by Demographics

| | Survey THEN App + Scale | Survey THEN App | App + Scale THEN Survey | App THEN Survey |
|---|---|---|---|---|
| 18-40 | 27 | 19 | 30 | 17 |
| 41-60 | 26 | 17 | 17 | 17 |
| 61+ | 17 | 17 | 10 | 8 |
| | | | | |
| Male | 18 | 15 | 16 | 9 |
| Female | 27 | 20 | 19 | 17 |
| | | | | |
| < college year grad | 21 | 17 | 15 | 13 |
| Bachelor+ | 22 | 18 | 19 | 14 |
| | | | | |
| Children | 31 | 27 | 19 | 21 |
| No Children | 21 | 17 | 19 | 13 |
| | | | | |
| White | 19 | 19 | 15 | 13 |
| Non-White | 32 | 14 | 26 | 13 |

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# Sample Composition

## INVITED

| | Survey THEN App + Scale | Survey THEN App | App + Scale THEN Survey | App THEN Survey |
|---|---|---|---|---|
| 18-40 | 26.3 | 22.9 | 26.5 | 23.7 |
| 41-60 | 26.3 | 27.7 | 26.5 | 32.8 |
| 61+ | 47.5 | 49.4 | 47.0 | 43.5 |
| | | | | |
| Male | 52.4 | 49.5 | 55.3 | 47.8 |
| Female | 47.1 | 49.2 | 44.2 | 51.4 |
| | | | | |
| < college year grad | 40.8 | 44.9 | 44.3 | 40.2 |
| Bachelor+ | 59.2 | 55.1 | 55.7 | 59.8 |
| | | | | |
| Children | 20.3 | 22.4 | 20.3 | 23.4 |
| No Children | 69.0 | 65.7 | 67.8 | 62.3 |
| | | | | |
| White | 78.3 | 80.1 | 78.0 | 72.3 |
| Non-White | 21.8 | 19.9 | 22.0 | 27.7 |

## COMPLETED

| | Survey THEN App + Scale | Survey THEN App | App + Scale THEN Survey | App THEN Survey |
|---|---|---|---|---|
| 18-40 | 32.2 | 24.3 | 46.4 | 30.8 |
| 41-60 | 31.0 | 27.1 | 26.1 | 42.3 |
| 61+ | 36.8 | 48.6 | 27.5 | 26.9 |
| | | | | |
| Male | 42.5 | 41.2 | 52.2 | 30.8 |
| Female | 57.5 | 57.4 | 47.8 | 67.3 |
| | | | | |
| < college year grad | 39.5 | 42.9 | 38.2 | 38.5 |
| Bachelor+ | 60.5 | 57.1 | 61.8 | 61.5 |
| | | | | |
| Children | 28.7 | 34.3 | 21.7 | 36.5 |
| No Children | 67.8 | 62.9 | 73.9 | 59.6 |
| | | | | |
| White | 67.8 | 84.3 | 66.7 | 73.1 |
| Non-White | 32.2 | 15.7 | 33.3 | 26.9 |

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# Behavioral Factors

| | Invited but Not Completed | Invited and Completed |
|---|---|---|
| **Typical week?** %yes | 70% | 71% |
| **Responsibility for Food Purchase?** %always or usually | 56% | 58% |
| **Responsibility for Cooking?** %always or usually | 53% | 56% |
| **Responsibility for Discarding?** %all or most | 58% | 60% |
| **Make a Shopping List** %always or often | 81% | 79% |
| **Stick to Shopping List** %always or often | 79% | 77% |
| **Food Label/Dates Influence Purchase** %always or often | 61% | 58% |

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# Attitudinal Factors

| | Invited but Not Completed | Invited and Completed |
|---|---|---|
| **I Try to Limit my Spending When I Shop**<br>%agree + strongly agree | 68% | 77% |
| **I Feel Guilty When I Throw Away Food**<br>%agree + strongly agree | 65% | 72% |
| **Throwing Away Food Bad for Environment**<br>%agree + strongly agree | 43% | 51% |

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# Attitudinal Factors

| To what degree are you motivated to reduce food waste by…. | Invited but Not Completed | Invited and Completed |
|---|:---:|:---:|
| **Reducing my Impact on the Environment** | | |
| %A great deal | 12% | 20% |
| **Food Shortages** | | |
| %A great deal | 13% | 17% |
| **Saving Money** | | |
| %A great deal | 37% | 50% |
| **Wanting to Manage My Home Efficiently** | | |
| %A great deal | 30% | 42% |
| **Feelings of Guilt** | | |
| %A great deal | 25% | 32% |

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# Order Effects?

| | Survey First | Diary First |
|---|:---:|:---:|
| **Check Food Before Obtaining More** %always | 40% | 32% |
| **Make a Shopping List** %always | 51% | 44% |
| **Throw Away Leftovers** %weekly or more | 26% | 34% |
| **Throwing Away Bad for Environment** %agree or strongly agree | 43% | 55% |
| **Americans Should Do More to Reduce** %agree or strongly agree | 83% | 90% |
| **Motive: Reducing Impact on Environment** %a great deal or fair amount | 36% | 47% |
| **Motive: Food Shortages** %a great deal or fair amount | 36% | 45% |
| **Wasting Food is a Problem in the US** %strongly agree | 36% | 45% |

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# Concordance Rates

**Key design features that enabled these analyses:**
(1) Integration of mobile app data and survey data
- Maximizing comparability of app & survey data
(2) Random assignment of scales for mobile app data collection

**KEY FINDINGS**

| | | |
|---|---|---|
| Volume estimate vs. weight via app | $n = 143$ | $r = .70$, between<br>$r = .68$, within |
| Survey recall vs. weight via app | $n = 143$ | r = .45 |
| Survey recall vs. volume estimation | $n = 257$ | r = .41 |

*NOTE. the pattern of correlations varied across food categories, indicating that the degree of overlap between food waste measures changes depending on the type of food being assessed.*

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# Conclusions

**Summary, Lessons Learned, and Future Directions**

# The Total Survey Error Perspective

## FRAMEWORK
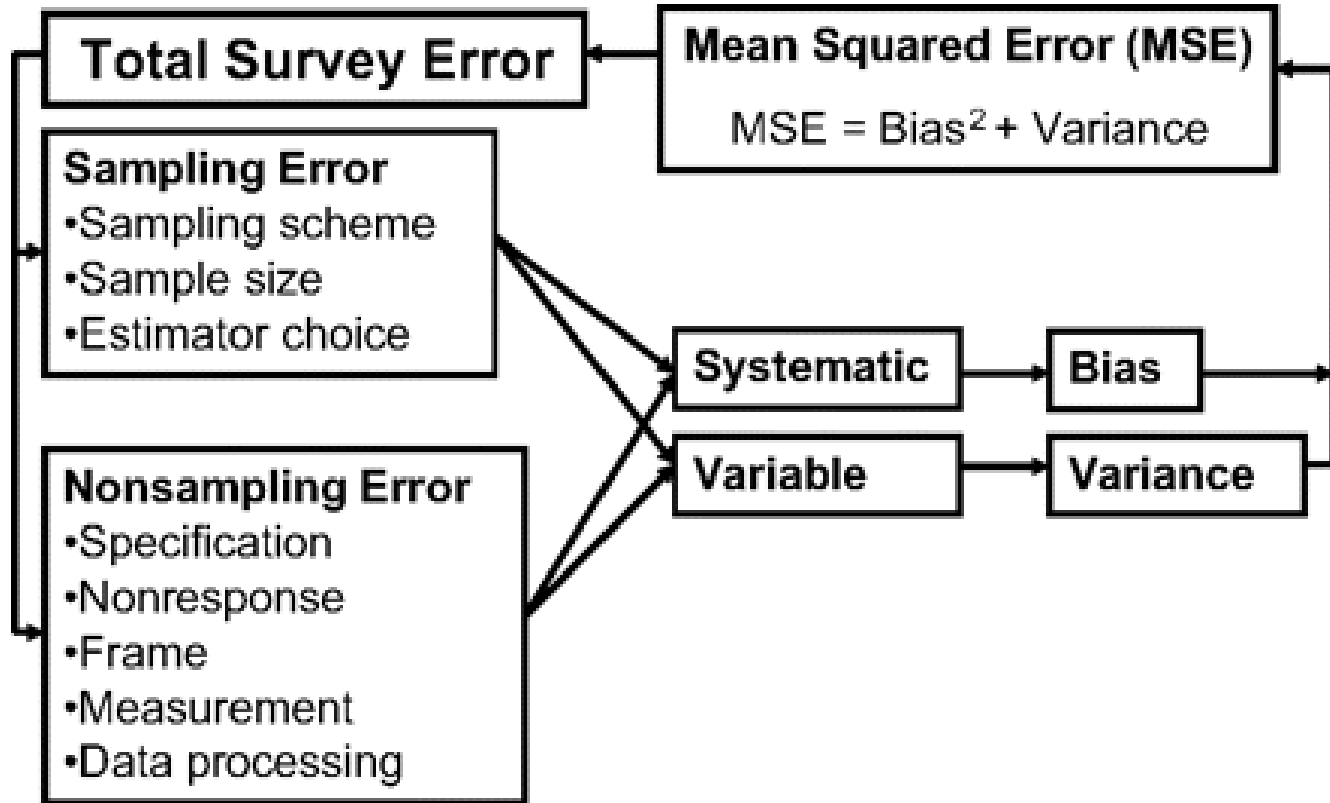


## PRIMARY SOURCES OF ERROR

① **Measurement**

② **Specification**

③ **Nonresponse**

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# Should We Use Mobile Apps to Measure Household Food Waste?

**YES.**

(1) **Accuracy**

(2) **Convenience**

(3) **Intervention**

**But...**

**?** **Who are we missing?**

**?** **How do we boost response rates?**

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# What did we Learn about Using Mobile Apps to Measure Household Food Waste?

## WHAT WORKED WELL

- Recontacting survey respondents
- Supplying a scale
- Collaboration
- Ux Testing
- Communications
- Staggering fieldwork
- Specifying start & stop dates
- 7-day data collection

## WHAT TO WORK ON

- Study ID
- Reminders & push notifications
- Reaching older respondents
- Timing
- "Household" data

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# Acknowledgements

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