A Comparison of Surveys Based on Probability Versus Non-Probability Sampling Approaches

Presenter: Gordon Willis, National Cancer Institute, NIH
Willisg@mail.nih.gov

Authors: (Next Slide)

AAPOR
May 15, 2015
Authors: A Multi-Agency, Multi-Disciplinary Effort

- **National Cancer Institute (NCI), Division of Cancer Control and Population Sciences**: Erin Kent, Benmei Liu, Janet S. de Moor, Gordon Willis, Maggie Wilson, K. Robin Yabroff
- **LIVESTRONG Foundation**: Stephanie Nutt
- **Centers for Disease Control and Prevention (CDC), Division of Cancer Prevention and Control**: Donatus Ekwueme, Juan Rodriguez
- **Emory University**: Katherine S. Virgo
Perennial Question: Can we Rely on Results from Non-Probability-Based Surveys?

- **Limbo Principle:** “How low can you go”? If response rates to probability-based sample surveys drop enough, should we just go with a self-selected sample?

- **Bandwagon Principle:** Web panels, social media, other non-probability approaches seem like the ‘modern’ approach: Are the probability-sample types Luddites/dinosaurs?

- **Magic Wand Principle:** Can’t we make use of post-stratification adjustments, propensity scores, to force non-probability sample into line?
Our Study Focuses on the Magic Wand: Statistical Adjustment to the Non-Probability Sample

- **AAPOR Task Force on Non-Probability Sampling:** Cites Tourangeau, Conrad, Couper (2013):
  - Reviewed 8 studies involving adjustment procedures
  - Compare non-prob results with those of prob-based calibration study
  - Conclude that adjustment is useful, but only a partial remedy for bias.

- **AAPOR Task Force recommendations:**
  - Develop model-based methods for non-prob studies
  - Figure out what makes the data from a non-prob survey ‘fit for purpose’
Compared Cancer Survivors’ Financial Burden and Employment from Two Sources

1) **2011 Medical Expenditure Panel Study (MEPS) Experiences with Cancer follow-back survey (CSAQ)**
   - Self-administered (paper-based) supplement to the core MEPS
   - Representative of (18+) US non-institutionalized household population of cancer survivors
   - MEPS annual RR=54.9%; CSAQ RR=90%
   - Analytic sample: n = 1,203
Compared Cancer Survivors’ Financial Burden and Employment from Two Sources

2) **2012 LIVESTRONG Survey**
   - Same questionnaire as MEPS CSAQ
   - **Web-based**, opt-in, available to cancer survivors via email and social media
   - \( n = 5,394 \): *Response rate is undefined*
Research Question: Can a Non-Probability Survey be an Alternative to a Probability Survey?

Substitution: Could we use LIVESTRONG (non-prob) instead of MEPS (prob) to make inferences?

- If we had used the non-prob survey, how similar would the estimates be?
- Does similarity of results depend on purpose:
  - Estimation of population quantities? (proportions)
  - Establishment of associations between variables? (Odds Ratios)

-> Note that previous literature has been focused on population quantities, rather than on relationships between variables (which is more the focus of social scientists)
Research Question: Can a Non-Probability Survey be an Alternative to a Probability Survey?

Substitution: Could we use LIVESTRONG (non-prob) instead of MEPS (prob) to make inferences?

- Does similarity of results depend on weighting approach chosen:
  - **Post-stratification or raking**: Adjust LIVESTRONG data to distribution of demographic or other characteristics from MEPS
  - **Propensity Scoring Weighting**: Weight data by inverse of estimated propensity to be in the LIVESTRONG sample relative to MEPS (Lee, 2006)
## Estimates for Variables used in Weighting

<table>
<thead>
<tr>
<th>Weighting variables: Age, Sex, Race/Ethnicity, Region</th>
<th>Probability: MEPS CSAQ</th>
<th>Non-Probability: LIVESTRONG SURVEY</th>
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# Estimates: Other Socio-Demographic Variables

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## Estimates: Major Outcome Variables

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| FINANCIAL BURDEN                                | Probability: MEPS CSAQ  
|                                                | (n = 1,203) | Non-Probability: LIVESTRONG SURVEY  
<p>|                                                | Unweighted | Weighted | Unweighted | Raked to MEPS | Propensity Score Weighting |
| Because of cancer:                             | % | % | 95% CI | % | % | “95% CI” | % | “95% CI” |
| Borrowed money or went into debt               |   |   |       |   |   |         |   |         |
| Yes                                            | 8.6 | 7.1 | 5.7 - 8.9 | 30.0 | 22.0 | 20.5 - 23.5 | 26.0 | 24.7 - 27.3 |
| No / Missing                                   | 91.4 | 92.9 | 91.1 - 94.3 | 70.0 | 78.0 | 76.5 - 79.5 | 74.0 | 72.7 - 75.3 |
| Filed for bankruptcy                           |   |   |       |   |   |         |   |         |
| Yes                                            | 1.5 | 1.7 | 1.0 - 2.8 | 2.7 | 2.1 | 1.6 - 2.8 | 2.5 | 2.0 - 3.0 |
| No / Missing                                   | 98.5 | 98.3 | 97.2 - 99.0 | 97.3 | 97.9 | 97.2 - 98.4 | 97.5 | 97.0 - 98.0 |
| Made other financial sacrifices                 |   |   |       |   |   |         |   |         |
| Yes                                            | 9.8 | 9.4 | 7.6 - 11.5 | 36.6 | 28.4 | 26.7 - 30.2 | 32.6 | 31.2 - 34.0 |
| No / Missing                                   | 90.2 | 90.6 | 88.5 - 92.4 | 63.4 | 71.6 | 69.8 - 73.3 | 67.4 | 66.0 - 68.8 |
| Unable to cover medical costs                  |   |   |       |   |   |         |   |         |
| Yes                                            | 13.6 | 11.9 | 9.8 - 14.3 | 23.5 | 17.7 | 16.3 - 19.2 | 20.7 | 19.6 - 22.0 |
| No / Missing                                   | 86.4 | 88.1 | 85.7 - 90.2 | 76.5 | 82.3 | 80.8 - 83.7 | 79.3 | 78.0 - 80.4 |
| Financial impact                               |   |   |       |   |   |         |   |         |
| Yes                                            | 22.8 | 20.4 | 17.7 - 23.4 | 49.9 | 39.1 | 37.2 - 41.1 | 44.6 | 43.1 - 46.2 |
| No / Missing                                   | 77.2 | 79.6 | 76.6 - 82.3 | 50.1 | 60.9 | 58.9 - 62.8 | 55.4 | 53.8 - 56.9 |</p>
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## Financial Burden

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# Association Between Variables: Adjusted ORs

**IV's: Patient Characteristics (1)**

**DV: ANY Financial impact**

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<th>Non-Probability Survey: LIVESTRONG SURVEY (n=5,394)</th>
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## Association Between Variables: Adjusted ORs

**IV's: Patient Characteristics (1)**

**DV: ANY Financial impact**

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Analysis/Interpretation Challenge: Comparing the Results of Prob and Non-Prob Surveys

What is our decision rule? - *are the key estimates or measures of association ‘close’?*

- *Statistically significantly different at particular p level?*
  Requires measure of variance for the Non-Prob sample, which we do not have!

- *Can we pick a particular value (e.g., within 5% – arbitrary)?*

- *Or is this a ‘qualitative assessment’ concerning “Fitness for Use”: e.g., is associated with cancer survivors’ financial and employment burden*

We do not propose a resolution - but relied mainly on consensus concerning patterns in the data
(Tentative) Conclusions

For estimation of (absolute) population quantities:
- For our measures of financial burden and employment, estimates from LIVESTRONG non-probability sample were generally not ‘close’ to those of the MEPS-CSAQ probability sample

For associations (relative measures):
- Analysis of associations, via regression analysis, illustrated more similarity between surveys

Overall:
- Bias due to non-probability sampling may be more of a problem for quantity estimation
Limitations

- **Mode confounding?** MEPS-CSAQ was paper-based, LIVESTRONG a web survey
- **MEPS contains sampling error**
  - Implication for control totals
  - Some cell sizes are very small
  - Challenges in variance estimation
  - *We could consider investigating other sources of control totals (e.g. NHIS)*
Work in Progress and Next Steps:

1) Consider alternative methods to weight LIVESTRONG non-probability survey
   • Include additional socio-demographic variables and characteristics that are significant predictors of outcomes in the raking dimensions
   • Combine propensity score weighting and raking

2) Develop Jackknife-type replicate weights
   • To get better estimates of the standard errors for the non-probability sample
3) Rather than **Substitution**, try **Combination**:

- Can LIVESTRONG supplement the MEPS sample?:
  
  -> Can non-prob data (*LIVESTRONG*) be combined with prob data (*MEPS-CSAQ*) to increase sample size, and therefore power?

- To enable this, can a variance estimation approach to the LIVESTRONG data render them combinable with the MEPS data?

  -> Again, we need to work on variance estimation for the non-probability survey!