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Evaluation of Strategies to Improve the Utility of Estimates from a Non-Probability Based Survey

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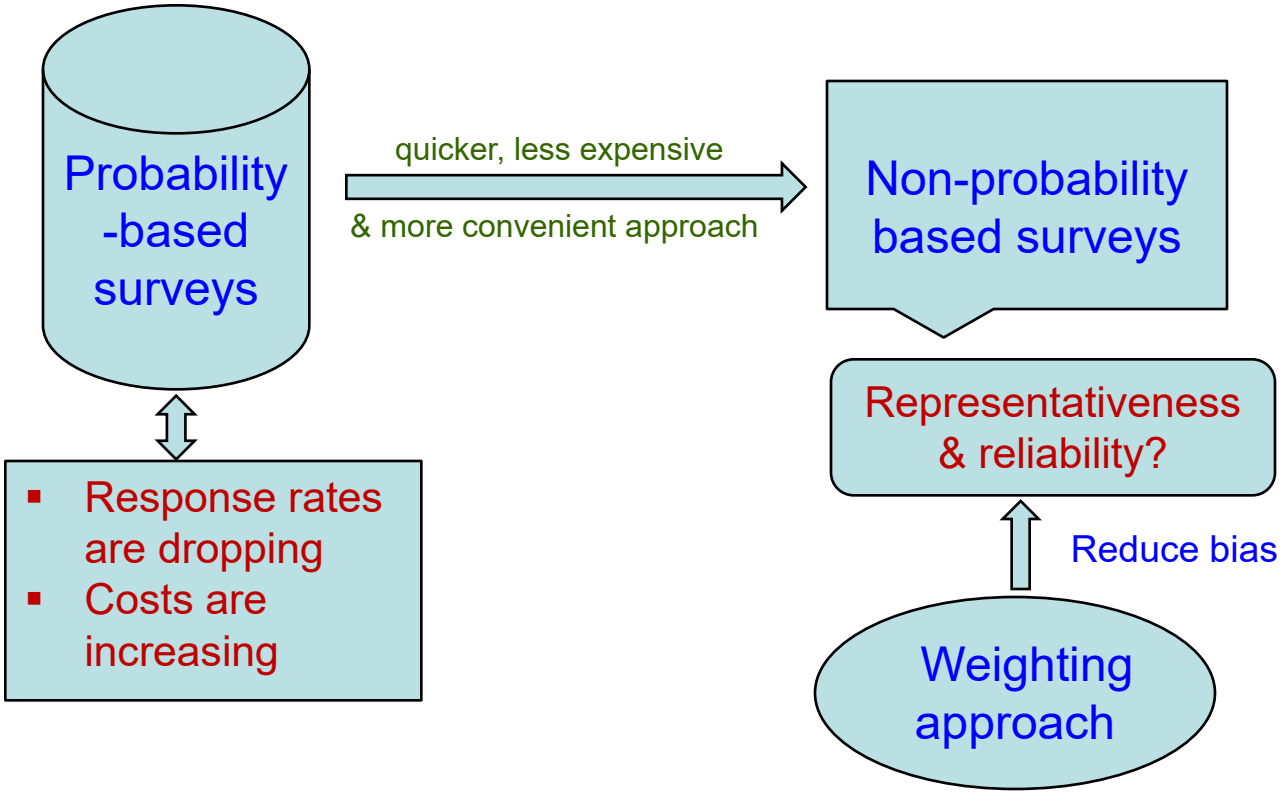
Background and Research Goal



- **Research goal: empirically examine the impact of applying weight adjustments to non-probability-based survey data and compare results to those obtained from a probability-based survey based on a similar questionnaire**

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Data Source #1: Probability Sample

- *2011* ***Medical Expenditure Panel Survey*** *(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 full year RR=54.9%; CSAQ RR=90%
  - Analytic sample: n = 1,203

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Data Source #2: Non-probability Sample

- *2012 **LIVESTRONG** Survey*
  - Same questionnaire as MEPS CSAQ
  - **Web-based**, opt-in, available to **cancer survivors** via email, social media and newsletters
  - Analytic sample (U.S. residents aged 18+ who had ever been diagnosed with cancer at or after age of 17): n= 5,394

    Response rate is undefined

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Different Weighting Approaches for the LIVESTRONG Sample

- Unweighted
- **Sample-based Raking:** *Adjust LIVESTRONG data to distribution of demographic or other characteristics from MEPS CSAQ*
- **Propensity Score Adjustment (PSA):** *Weight data by inverse of estimated propensity to be in the LIVESTRONG sample relative to MEPS (Lee, 2006)*
- **PSA + Raking:** *PSA first, then raking (Lee and Valiant 2009, Brick 2015)*

Choices of Weighting Variables

- **Four** key demographic variables: Age, sex, race/ethnicity, region (same variables used in the core MEPS raking)
- Additional **five** socio-demographic variables: education, marital status, current employment status, cancer type, years from first diagnosis
- Raking dimensions were formed using either

– the four single variables; or

– the nine single variables; or

– the intersection of age by other variables (e.g., age*sex, age*race/ethnicity, age*sex*employment, etc.)

Table 1a: Estimates for Variables used in Weighting*

	Probability: MEPS CSAQ		Non-Probability: LIVESTRONG					
	n=1,203	Weighted	n=5,394	Unweighted	A (Raked 4 vars)	B (PSA 4 vars)	C (Raked 9 vars)	D (PSA 9 vars)
	n	%	n	%	%	%	%	%
Age								
18-49	175	**13.1**	2,075	38.5	**13.1**	26.0	**13.1**	27.0
50-64	390	**32.3**	2,484	46.1	**32.3**	38.9	**32.3**	42.4
65+	638	**54.6**	835	15.5	**54.6**	35.0	**54.6**	30.5
Sex								
Male	468	**42.5**	1,855	34.4	**42.5**	37.2	**42.5**	38.1
Female	735	**57.5**	3,539	65.6	**57.5**	62.8	**57.5**	61.9
Region								
Northeast	185	**16.9**	1,079	20.0	**16.9**	17.8	**16.9**	17.1
Midwest	294	**23.2**	1,181	21.9	**23.2**	22.4	**23.2**	22.3
South	475	**40.7**	1,698	31.5	**40.7**	36.7	**40.7**	36.7
West	249	**19.2**	1,436	26.6	**19.2**	23.0	**19.2**	24.0
Race/Ethnicity								
Hispanic, NH black, NH Asian	273	**12.9**	428	7.9	**12.9**	10.0	**12.9**	9.4
Other	930	**87.1**	4,966	92.1	**87.1**	90.0	**87.1**	90.6

* "PSA+Raking" method gave the same estimates as "Raking" alone for the variables used in weighting

Table 1b: Estimates for Variables used in Weighting*

	Probability: MEPS CSAQ		LIVESTRONG					
	n=1,203	Weighted	n=5,394	Unweighted	A (Raked 4 vars)	B (PSA 4 vars)	C (Raked 9 vars)	D (PSA 9 vars)
	n	%	n	%	%	%	%	%
Education								
High school or less	606	**42.8**	416	7.7	8.4	8.1	**42.8**	21.8
Some college or more	597	**57.2**	4,978	92.3	91.6	91.9	**57.2**	78.2
Marital Status								
Married	641	**57.2**	3,802	70.5	70.2	70.2	**57.2**	64.3
Not married	562	**42.8**	1,592	29.5	29.8	29.8	**42.8**	35.7
Current Employment Status								
Full-time	302	**27.1**	3,022	56.0	39.3	47.5	**27.1**	45.6
Part-time	105	**8.8**	474	8.8	8.4	8.6	**8.8**	9.9
Retired	380	**33.8**	974	18.1	41.5	29.7	**33.8**	24.7
Not employed for wages / Other	416	**30.4**	924	17.1	10.8	14.1	**30.4**	19.7
Cancer Type								
Breast	235	**17.7**	1,636	30.3	27.9	29.7	**17.7**	24.4
Prostate	159	**14.2**	341	6.3	12.0	8.8	**14.2**	9.9
Colorectal	59	**4.7**	328	6.1	6.2	6.1	**4.7**	4.8
Multiple	86	**6.9**	589	10.9	14.5	12.6	**6.9**	9.3
Other single cancers	664	**56.5**	2,500	46.3	39.5	42.9	**56.5**	51.6
Years from First Cancer DX								
<2	129	**11.1**	1,082	20.1	17.2	18.6	**11.1**	15.9
2-5	291	**24.3**	2,095	38.8	33.9	36.4	**24.3**	32.7
6-10	236	**18.8**	1,137	21.1	22.7	21.8	**18.8**	20.7
11+	547	**45.7**	1,080	20.0	26.2	23.1	**45.7**	30.7

*"PSA+Raking" method gave the same estimates as "Raking" alone for the variables used in weighting

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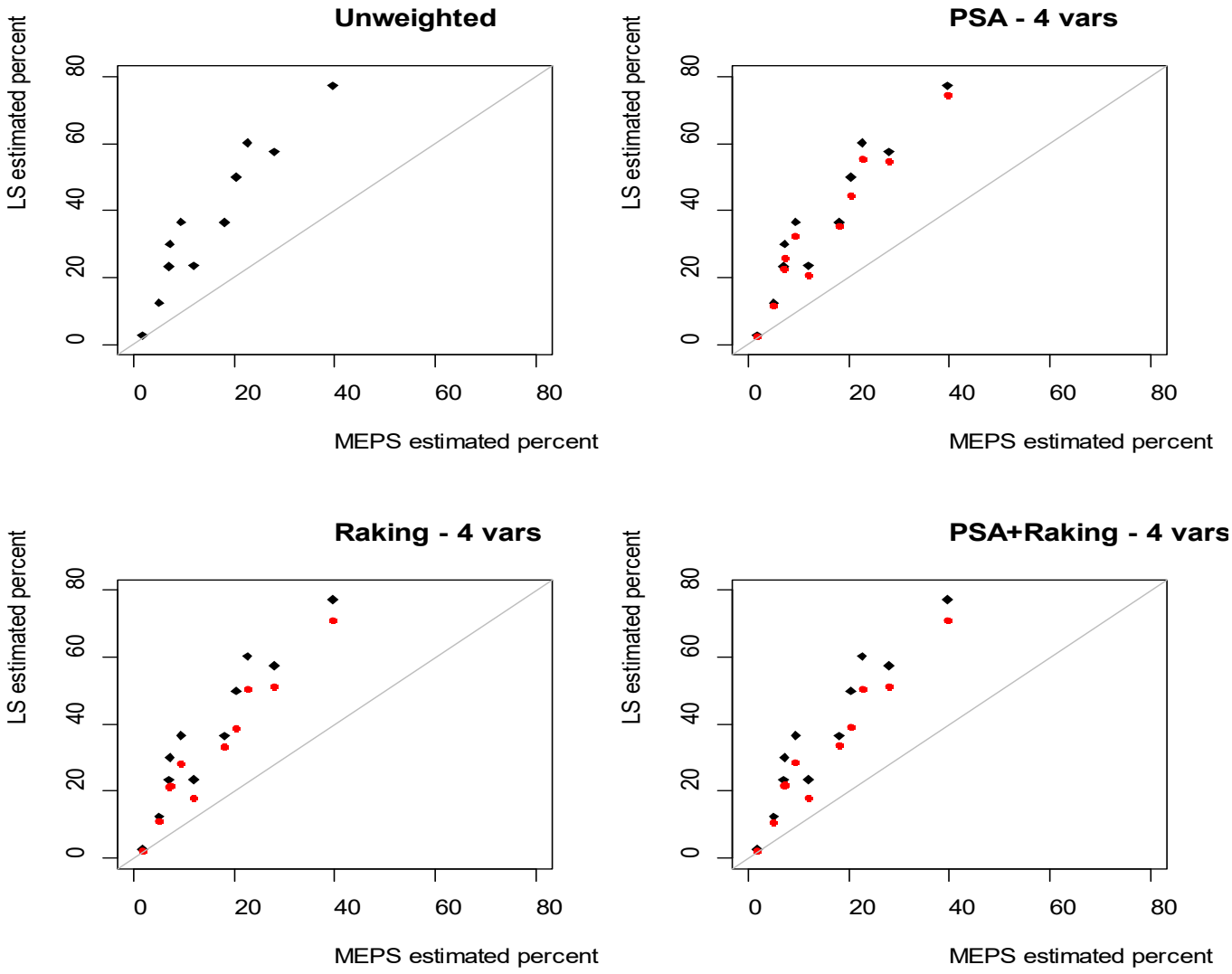
Major Outcomes of Interest
(11 binary outcomes in total)

- Employment changes (5 outcomes)
  - Made work changes since cancer diagnosis (composite measure)
  - Took extended paid time off from work because of cancer
  - Took unpaid time off from work because of cancer
  - Changed from working full-time to part-time because of cancer
  - Changed from working part-time to full-time because of cancer
- Financial Burden (6 outcomes)
  - Financial impact because of cancer (composite measure)
  - Had to borrow money or go into debt because of cancer
  - Ever filed for bankruptcy because of cancer
  - Made other financial sacrifices because of cancer
  - Ever unable to cover share of cancer medical costs
  - Ever worry about paying medical bills related to cancer

Estimates: Employment Changes and Financial Burden (11 outcomes)

Different weighting using Age, Sex, Race/Ethnicity, Region

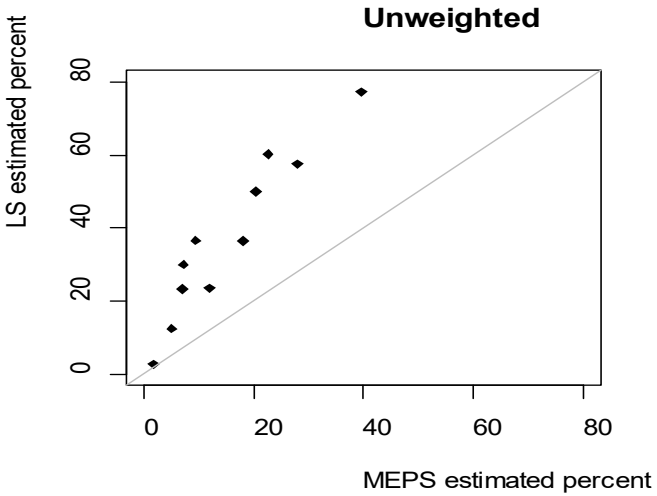


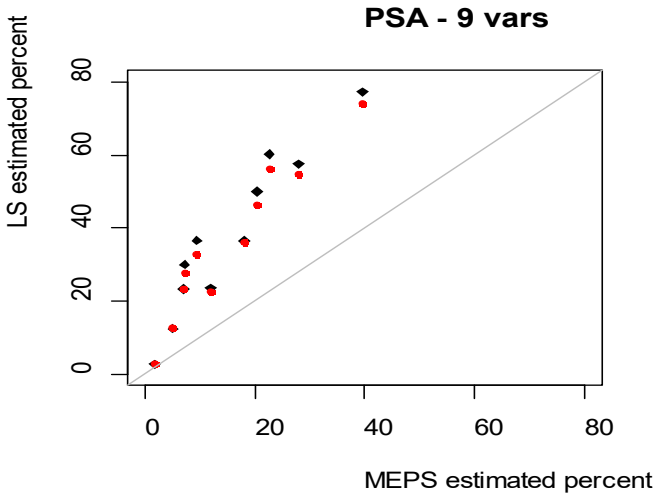
Black diamonds: unweighted; Red dots: weighted

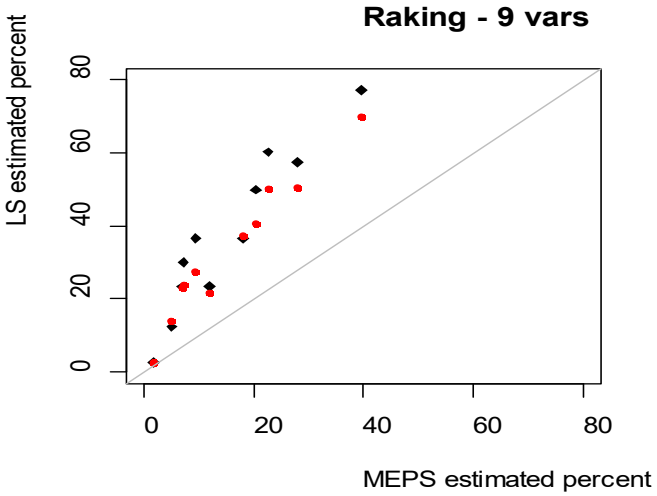
- All the red points are expected to be on the diagonal if a weighting method works perfectly

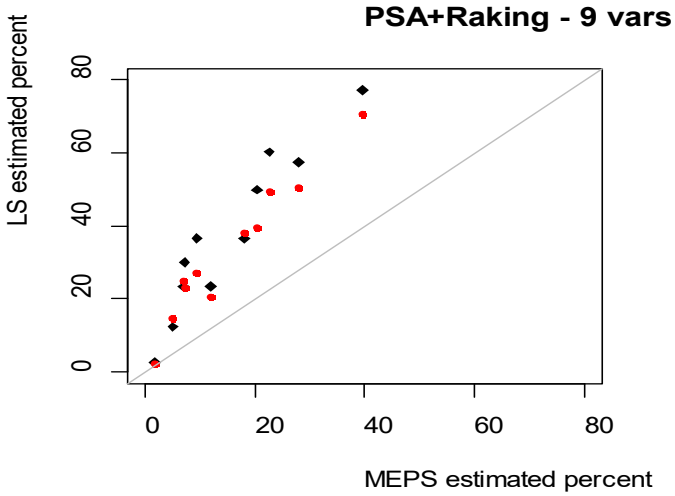
Estimates: Employment Changes and Financial Burden (11 Outcomes)

Different weighting using Age, Sex, Race/Ethnicity, Region + Five Other Variables*









*Five variables:

- Education
- Marital status
- Employment status
- Cancer type
- Years from 1st DX

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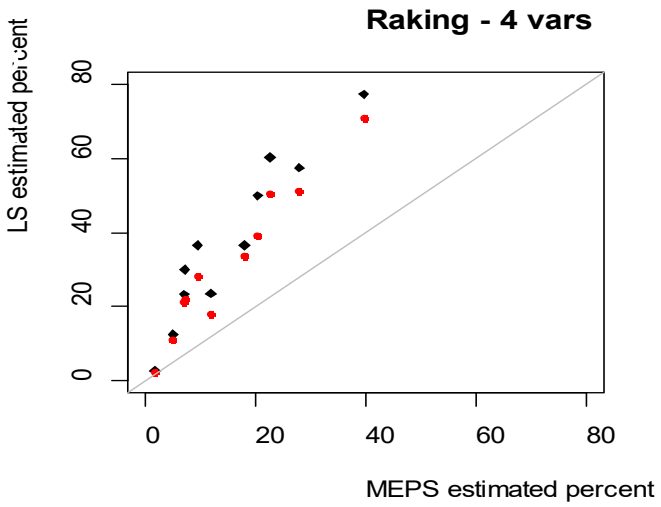
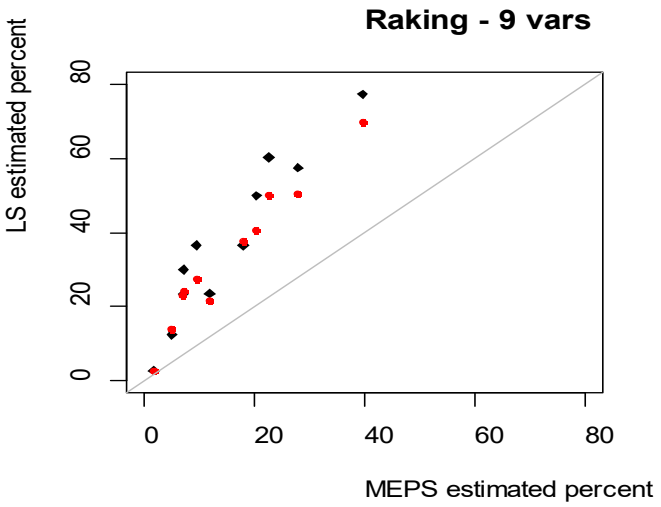
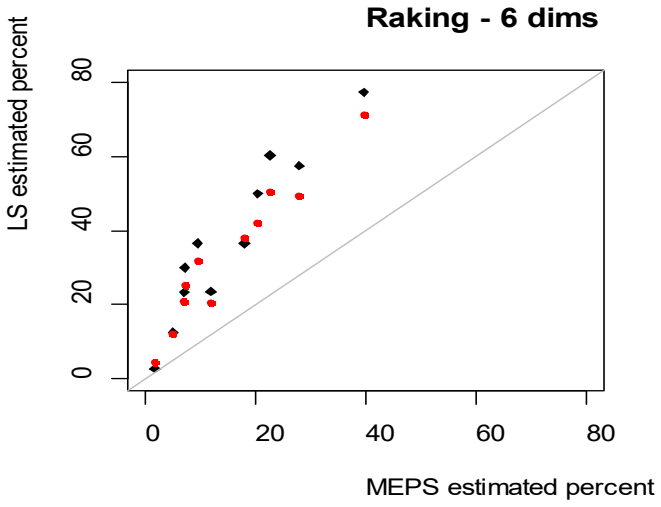
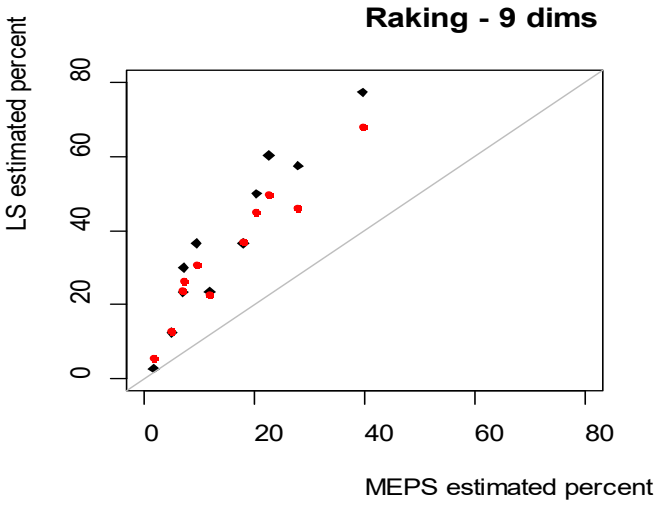
Estimates: Employment Changes and Financial Impacts (11 Outcomes)

Different Raking Variables/Dimensions









6 dimensions:

age*sex
Age*raceethnic
Age*region
Age*employment
Age*sex*employment
Age*marital status

Additional 3 dimensions:

Age*education
Age*cancer type
Age*yrs since DX

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Association Analyses

Run Multivariate logistic regression models

- Two outcomes:
  - Any financial Impact due to cancer
  - Any work change due to cancer
- Predictors included:

  Age(3), Sex(2), Education(2), Race/ethnicity(2), Marital Status(2), Region(4), Years from Cancer Diagnosis(4)

  - Degrees of freedom: 12
- Unweighted and weighted using different set of weights

Table 2: Association Between Variables: Adjusted ORs

Dependent Variable: Any financial Impact due to cancer

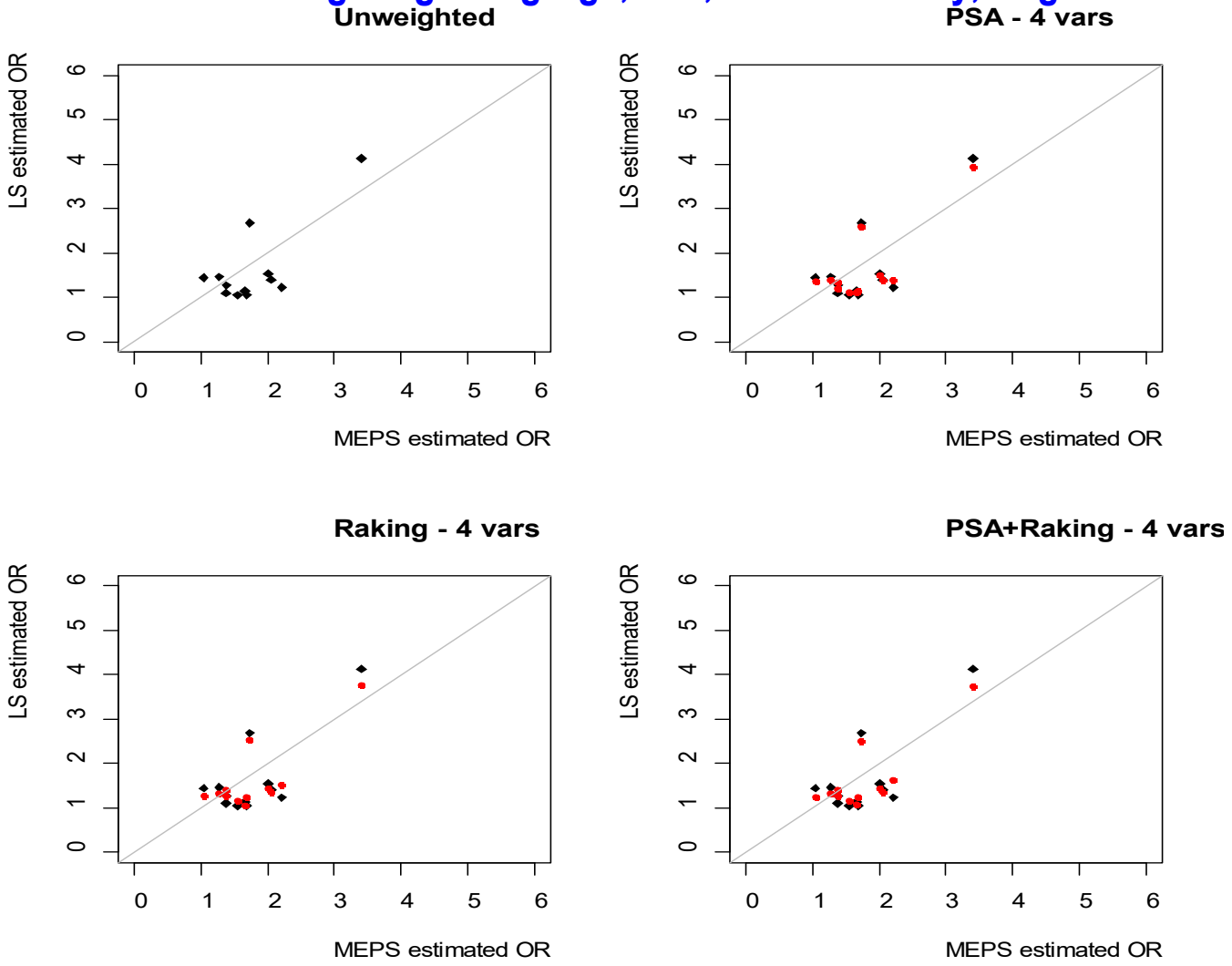
Respondent characteristics	MEPS (n=1,203)	LIVESTRONG (n=5,394)	
	Weighted	Unweighted	Weighted (Raked 4 vars)
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age group			
18-49	3.41 (2.14 - 5.41)	4.13 (3.44 - 4.96)	3.75 (2.98 - 4.72)
50-64	1.73 (1.19 - 2.54)	2.68 (2.24 - 3.19)	2.53 (2.07 - 3.08)
65+	REF	REF	REF
Sex			
Male	REF	REF	REF
Female	1.38 (0.93 - 2.05)	1.27 (1.13 - 1.43)	1.40 (1.15 - 1.69)
Education			
High school graduate or less	1.04 (0.72 - 1.51)	1.44 (1.16 - 1.77)	1.27 (0.93 - 1.75)
Some college or more	REF	REF	REF
Race/Ethnicity			
Hispanic, NH black, NH Asian	2.21 (1.51 - 3.23)	1.23 (1.00 - 1.53)	1.52 (1.03 - 2.25)
Other	REF	REF	REF

Respondent characteristics	MEPS (n=1,203)	LIVESTRONG (n=5,394)	
	Weighted	Unweighted	Weighted (Raked 4 vars)
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Marital Status			
Married	REF	REF	REF
Not married	1.27 (0.90 - 1.79)	1.46 (1.29 - 1.65)	1.33 (1.09 - 1.63)
Region			
Northeast	REF	REF	REF
Midwest	1.66 (0.85 - 3.26)	1.14 (0.96 - 1.35)	1.06 (0.80 - 1.40)
South	2.01 (1.11 - 3.65)	1.54 (1.31 - 1.81)	1.43 (1.11 - 1.85)
West	2.05 (1.05 - 4.02)	1.40 (1.19 - 1.65)	1.36 (1.04 - 1.78)
Years from First Cancer DX			
<2	1.69 (0.99 - 2.88)	1.05 (0.88 - 1.25)	1.24 (0.93 - 1.67)
2-5	1.55 (1.06 - 2.27)	1.05 (0.90 - 1.23)	1.15 (0.90 - 1.47)
6-10	1.37 (0.86 - 2.20)	1.10 (0.93 - 1.31)	1.27 (0.96 - 1.67)
11+	REF	REF	REF

Association Between Variables: Adjusted ORs

Dependent Variable: Any financial Impact due to cancer

Different weighting using Age, Sex, Race/Ethnicity, Region



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Association Between Variables: Adjusted ORs

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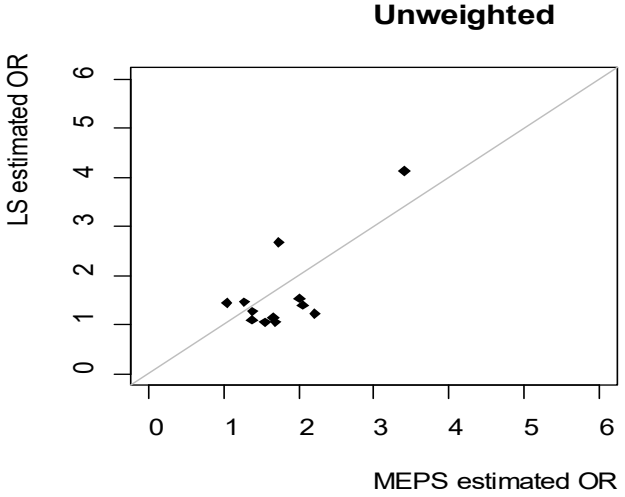

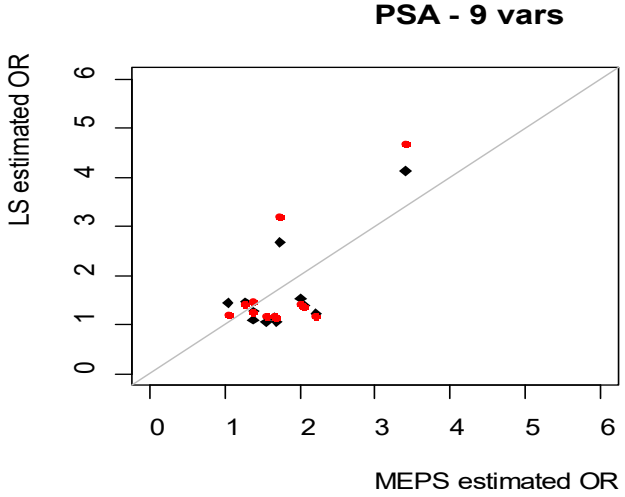

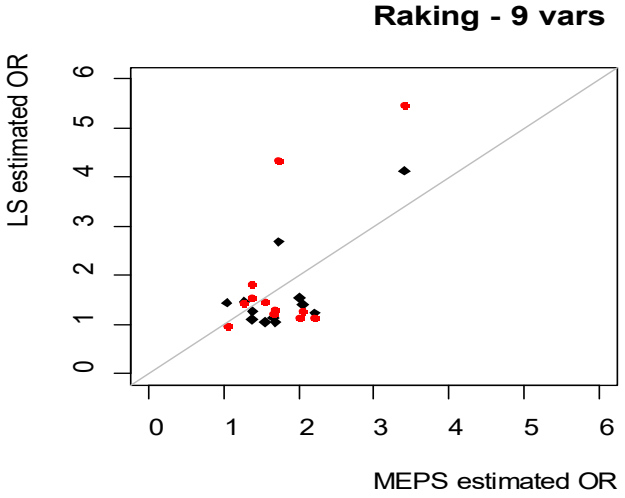

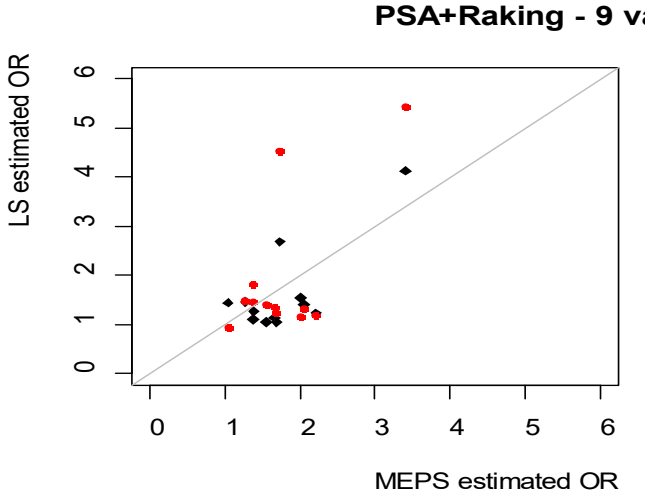

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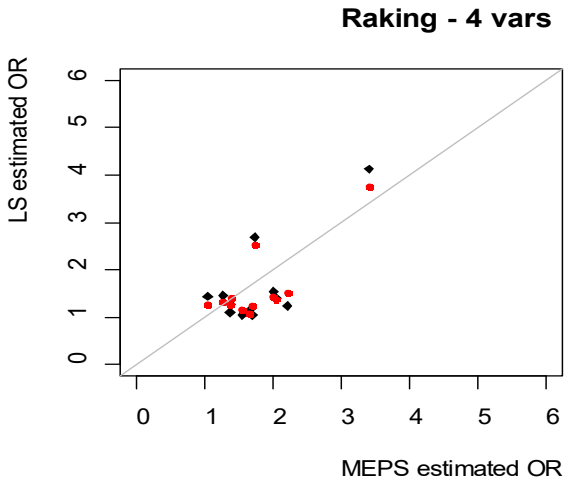
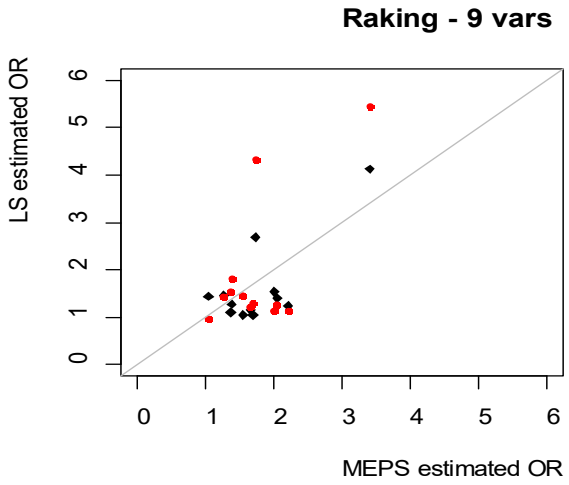
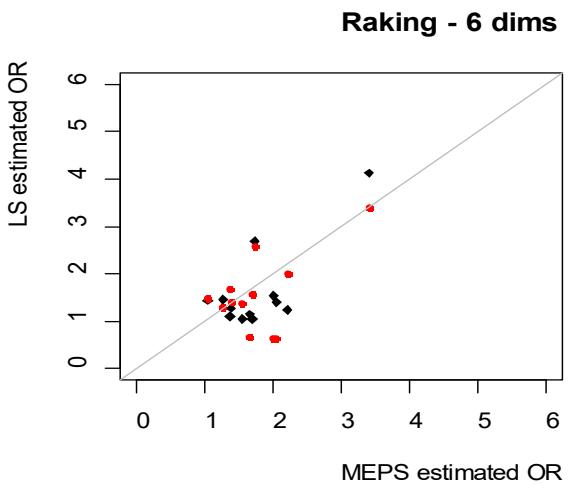
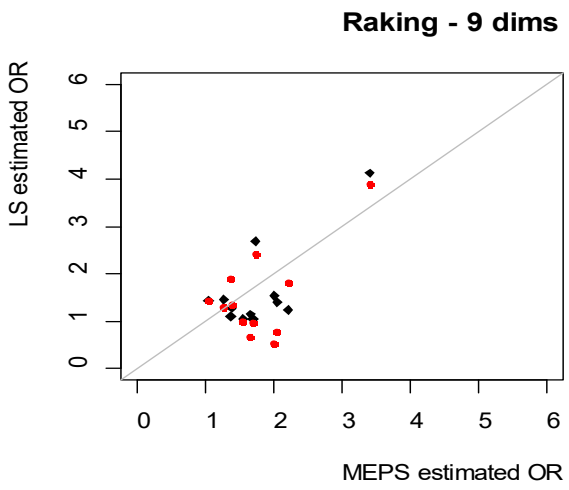
Dependent Variable: Any financial Impact due to cancer

Different Raking Variables/Dimensions









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Age*region
Age*employment
Age*sex*employment
Age*marital status

Additional 3 dimensions:

Age*education
Age*cancer type
Age*yrs since DX

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Summary and Discussion

For estimation of (absolute) population quantities:

- *For our measures of financial burden and employment, estimates from LIVE**STRONG** non-probability sample, even weighted, 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 irrespective of weighting methods or no weighting*

Overall:

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

Summary and Discussion

- Raking is more efficient than the propensity score weighting approach in terms of reducing bias
- The composite approach (PSA first then raking) may give similar results as raking alone
- Weighting variables and raking dimensions need to be carefully chosen, weighting may introduce more bias depending on the set of weighting variables used
- Raking with carefully chosen variables helps reduce some bias, but not a lot

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Limitations

- **Mode confounding? MEPS-CSAQ** was paper-based, **LIVESTRONG** a web survey
- **MEPS contains sampling error**
  - Implication for control totals (adding additional variances to the LIVESTRONG weighted estimates)
  - Some cell sizes are very small
  - Challenges in variance estimation

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References

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3. Brick, J. Michael (Sept, 2015). Non-Probability sampling assumptions and methods. Presented at the Washington Statistical Society Seminar on the topic of Non-probability Samples.

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Any Questions?

Thank you!

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