Investigation of the NCHS Data Presentation Standards for Proportions: A Simulation Study

Frances McCarty, Ph.D.
Jennifer Parker, Ph.D.

Centers for Disease Control and Prevention
National Center for Health Statistics
The views presented here are those of the author and do not necessarily represent the views of CDC, HHS, or the US government.
Background

• Should an estimate be presented? Is it accurate, could it be misleading?
• Does the estimate of 4% from our sample reflect the true prevalence in the population?
• How do we decide? Presentation Standards/Guidelines
Typical Standards

• Based on sample size and sampling error
  – Sample size - some set a minimum for the denominator and others set it for the numerator, often set at 30 or 50 observations
  – Sampling error is often assessed via the relative standard error (RSE = standard error/estimate), RSE > 30% (or some other threshold) identified as less reliable
Focus on Presentation of Estimates

– Estimates can be informative even if they’re not precise
– Estimates for small subgroups which may not meet conventional standards might be useful and acceptable for some objectives
NCHS Workgroup

- Focus on criteria for **proportions** estimated from **complex surveys** in **general health data products**

- The workgroup decided against criteria based on RSE
  - The RSE for proportions can perform poorly: too conservative for small \( p \) and too liberal for large \( p \).

- Confidence intervals (CI) provide more information and are better indicators of precision
  - Commonly used Wald intervals perform poorly so others considered
  - Exact Clopper Pearson intervals, adapted for surveys by Korn-Graubard, incorporate design effects and degrees of freedom (DF)
  - The relative CI width has similar shortcomings as the RSE so guidelines based on both relative and absolute CIs were developed.

[https://www.cdc.gov/nchs/data/series/sr_02/sr02_175.pdf](https://www.cdc.gov/nchs/data/series/sr_02/sr02_175.pdf)
Questions and Approach

Questions:

– How do different specifications (4) compare with one another in terms of the number of estimates that would be presented?

– When estimates are suppressed using the new recommendations, which criterion or combination of criteria most often lead to suppression of an estimate? What types of estimates are being suppressed?

– What sample characteristics are associated with a lower frequency of estimate presentation?

Approach:

– Sampling-based study

– Considered 2 “old” and 2 “new”:

OLD: sample size >=30 & RSE <=30% or RSE<=50%

NEW: effective sample size >=30 & absolute Korn-Graubard confidence interval width <=5 OR effective sample size >=30 and absolute Korn-Graubard confidence interval width >5 and <30 (alternative of 20) and relative confidence interval width <=130%
Methods

• Created a known population using IHIS (Integrated Health Interview Surveys) data 1997-2014 (N=1,710,059) - now, IPUMS (Integrated Public Use Microdata Series) Health Surveys

• Combined existing strata to create 15 strata, randomly split existing PSUs to create smaller PSUs for sampling purposes – 64 PSUs per strata

• SAS SURVEYSELECT was used to generate 1000 samples, selecting 2 PSUs per strata
  – Weights were assigned proportional to PSU size
    • PSUs approximately the same size

• 1000 samples used for these analyses provide a data structure characteristic of NCHS surveys
Methods

• Focused on 2 subpopulations:
  – Age <= 5 (8.9% of the total population)
  – Age <= 5 & female (effectively reduces the sample by half)

• For each of the 1000 samples, prevalence estimates were obtained for 7 outcomes by majority/minority status and region (4 levels):
  – Fair/poor health & on Medicaid (1.03%), Reverse outcome (98.97%)
  – Fair/poor health (1.75%)
  – Excellent health & no insurance (4.81%), Reverse outcome (95.19%)
  – No insurance (9.91%)
  – Poor (21.14%)
  – Medicaid (32.6%)
  – Excellent/very good health (82.53%)

• Majority/Minority was defined in 2 ways:
  – Any one NOT Mexican vs Mexican
  – Any one NOT African American vs African American

• Analyses were conducted using PROC DESCRIPT and Korn-Graubard confidence intervals were calculated based on the recommendations
Results

• Across the 1000 samples:
  – Mean total sample size was 53471 with a minimum 52509 and a maximum of 54266

• Table below shows sample sizes for each region by minority designation, subpopulation age <=5

<table>
<thead>
<tr>
<th>By group</th>
<th>N</th>
<th>Mean</th>
<th>Min</th>
<th>Max</th>
</tr>
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<td>616</td>
<td>540</td>
<td>685</td>
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Minimum and maximum degrees of freedom and percent of samples with degrees of freedom <8

<table>
<thead>
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<th>By group</th>
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<th>Max</th>
<th>df&lt;8</th>
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<td>15</td>
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<tr>
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<td>9</td>
<td>0</td>
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<tr>
<td>Region B</td>
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<td>11</td>
<td>0</td>
</tr>
<tr>
<td>Region C</td>
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<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Region D</td>
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<td>11</td>
<td>0</td>
</tr>
<tr>
<td>Mj/Rg A</td>
<td>9</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Mj/Rg B</td>
<td>11</td>
<td>11</td>
<td>0</td>
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<tr>
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<tr>
<td>Mn/Rg D</td>
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<td>11</td>
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</tr>
</tbody>
</table>
Results

How do the 4 different specifications compare with one another in terms of the number (proportion) of estimates that would be presented?

Subpopulation Age <=5, Mexican Minority

<table>
<thead>
<tr>
<th>By Group</th>
<th>Fair/Poor Health &amp; Medicaid (1.03%)</th>
<th>Fair/Poor Health (1.75%)</th>
<th>Excellent Health &amp; No Insurance (4.81%)</th>
<th>No Insurance (9.91%)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>O1 O2 N1 N2</td>
<td>O1 O2 N1 N2</td>
<td>O1 O2 N1 N2</td>
<td>O1 O2 N1 N2</td>
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<tr>
<td>Total</td>
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<td>1 1 1 1</td>
<td>1 1 1 1</td>
<td>1 1 1 1</td>
</tr>
<tr>
<td>Majority</td>
<td>1 1 1 1</td>
<td>1 1 1 1</td>
<td>1 1 1 1</td>
<td>1 1 1 1</td>
</tr>
<tr>
<td>Minority</td>
<td>0.843 0.999 1 1</td>
<td>0.987 1 1 1</td>
<td>1 1 1 1</td>
<td>1 1 1 1</td>
</tr>
<tr>
<td>Region A</td>
<td>0.341 0.875 1 1</td>
<td>0.626 0.972 0.997 0.997</td>
<td>0.945 1 0.991 0.991 0.999 1</td>
<td>0.990 0.990</td>
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<tr>
<td>Region B</td>
<td>0.348 0.873 1 1</td>
<td>0.731 0.99 1 1</td>
<td>0.997 1 0.997 0.997 1 1</td>
<td>1 1 1 1</td>
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<tr>
<td>Region C</td>
<td>0.928 1 1 1</td>
<td>0.995 1 1 1</td>
<td>1 1 1 1</td>
<td>1 1 1 1</td>
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<tr>
<td>Region D</td>
<td>0.752 0.991 1 1</td>
<td>0.977 1 1 1</td>
<td>1 1 1 1</td>
<td>1 1 1 1</td>
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<tr>
<td>Mj/Rg A</td>
<td>0.310 0.840 1 1</td>
<td>0.600 0.969 0.997 0.997</td>
<td>0.941 0.999 0.989 0.989 0.998 1</td>
<td>0.989 0.989</td>
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<tr>
<td>Mj/Rg B</td>
<td>0.206 0.754 1 1</td>
<td>0.641 0.976 1 1</td>
<td>0.991 1 0.998 0.998 1 1</td>
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<td>Mj/Rg C</td>
<td>0.767 0.997 1 1</td>
<td>0.967 1 1 1</td>
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<td>0.996 1 0.982 0.982 1 1</td>
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<td>Mn/Rg A</td>
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<td>0 0 0 0</td>
<td>0.002 0.008 0 0</td>
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<tr>
<td>Mn/Rg B</td>
<td>0.039 0.116 0.204 0.204</td>
<td>0.076 0.214 0.123 0.123</td>
<td>0.299 0.797 0.069 0.069 0.729 0.991</td>
<td>0.504 0.531</td>
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<tr>
<td>Mn/Rg C</td>
<td>0.110 0.565 0.942 0.942</td>
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<td>0.995 1 0.980 0.980 1 1</td>
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<td>Mn/Rg D</td>
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<td>0.824 0.999 0.998 0.998</td>
<td>0.998 1 0.995 0.995 1 1</td>
<td>1 1 1 1</td>
</tr>
</tbody>
</table>

O1: total sample size >=30 & rel SE<=30%, O2: total sample size >=30 & rel SE<=50%
N1: effective sample size >=30 & CI width <20 & rel CI width<=130%, N2: effective sample size >=30 & CI width <30 & rel CI width<=130%
<table>
<thead>
<tr>
<th>By Group</th>
<th>Poor (21.14%)</th>
<th>Medicaid (32.60%)</th>
<th>Excellent/Very Good Health (82.53%)</th>
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<tbody>
<tr>
<td></td>
<td>O1</td>
<td>O2</td>
<td>N1</td>
</tr>
<tr>
<td>Total</td>
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<td>1</td>
</tr>
<tr>
<td>Majority</td>
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</tr>
<tr>
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<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Region A</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Region B</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Region C</td>
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<td>1</td>
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</tr>
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<td>Region D</td>
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<td>Mj/Rg A</td>
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<tr>
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<td>Mj/Rg C</td>
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<tr>
<td>Mn/Rg D</td>
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<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
When estimates are suppressed using the new recommendations, which criterion or combination of criteria lead to suppression of an estimate? And what types of estimates are getting suppressed?
Estimates by Group According to Presentation Status

Outcome 1 (1.03%): Minority Mx

Mean n is 23
All df < 8

Mean n is 110
39% df < 8

Mean n is 352

Mean n is 616

- Eff_n_df < 30
- CI width > 30
- CI width > 5, ≤ 30, RelCI > 130
- Presented
- Population Percent
Estimates by Group According to Presentation Status

Outcome 1R (98.96%): Minority Mx

Population Percent

- Eff_n_df<30
- CI width >5<=30, RelCI>130
- Presented
- Population Percent

Legend:
Estimates by Group According to Presentation Status

Outcome 2 (1.75%): Minority Mx

Eff_n_df<30 CI width>30
CI width >5<=30, RelCI>130 Presented

Population Percent

Group

Outcome 2 (1.75%): Minority Mx

Estimates by Group According to Presentation Status
Estimates by Group According to Presentation Status

Outcome 3 (4.81%): Minority Mx

Group

Eff_n_df<30 CI width>30 CI width >5<=30, RelCI>130 Presented Population Percent

Estimates by Group According to Presentation Status
Estimates by Group According to Presentation Status
Outcome 4 (9.91%): Minority Mx

Population Percent

Group
Eff_n_df<30 CI width>30 CI width >5<=30, RelCI>130 Presented

Minority Mx

Estimates by Group According to Presentation Status
Estimates by Group According to Presentation Status
Outcome 5 (21.14%): Minority Mx

- Eff_n_df<30
- CI width >5<=30, RelCI>130
- Presented
- Population Percent
Estimates by Group According to Presentation Status
Outcome 6 (32.60%): Minority Mx

- Eff_n_df<30
- CI width >5 <=30, RelCI>130
- Presented
- Population Percent
Outcome 7 (82.53%): Minority Mx

Estimates by Group According to Presentation Status

Group

Eff_n_df<30 CI width>30 CI width >5<=30, RelCI>130 Presented

Population Percent

Outcome 7 (82.53%): Minority Mx

Estimates by Group According to Presentation Status
Outcome 2: Minority Mx

Presentation Status of Estimates - New Method

1.75%

Presentation Status of Estimates - Old Method

Presentation Status of Estimates - Alternative n>=50 & df>=8

Presentation Status of Estimates - Alternative n>=30
Outcome 6: Minority Mx

Presentation Status of Estimates - New Method

Presentation Status of Estimates - Old Method

Presentation Status of Estimates - Alternative n>=50 &df>=8

Presentation Status of Estimates - Alternative n>=30

32.6%
Summary

• New presentation guidelines allow for presentation of estimates that might not have been presented using previous guidelines
• Guidelines incorporate sample size information as well as information about the uncertainty of a particular estimate
• In general, you see suppression of overestimates for smaller proportions and underestimates for larger ones
• Any method will lead to suppression of some “good” estimates because of the uncertainty associated with a particular estimate
Thank You

Data Suppression Workgroup:
Jennifer D. Parker, Ph.D., Division of Research and Methodology
Makram Talih, Ph.D., Office of Analysis and Epidemiology
Donald J. Malec, Ph.D., Division of Research and Methodology
Vladislav Beresovsky, Ph.D., Division of Research and Methodology
Margaret Carroll, M.S.P.H., Division of Health and Nutrition Examination Surveys
Joe Fred Gonzalez, Jr., M.S., Division of Research and Methodology
Brady E. Hamilton, Ph.D., Division of Vital Statistics
Deborah D. Ingram, Ph.D., Office of Analysis and Epidemiology
Kenneth Kochanek, M.A., Division of Vital Statistics
Frances McCarty, M.Ed., Ph.D., Division of Research and Methodology
Chris Moriarity, Ph.D., Division of Health Interview Statistics
Iris Shimizu, Ph.D., Division of Research and Methodology
Alexander Strashny, Ph.D., Division of Health Care Statistics
Brian W. Ward, Ph.D., Division of Health Care Statistics
Calculate effective sample size

nominal or effective sample size <30?

NO

Calculate 95% CI

absolute value of CI >=0.30?

NO

absolute value of CI <=0.05?

NO

Calculate relative CI width

relative CI width >130% of proportion?

NO

number of events=0?

YES

Statistical review

YES

Suppress

NO

NO

NO

NO

Present

Extra