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A Comparison of Collapsing and Bridging Methods for Measures of Sexual Identity Using Two National Health Surveys in the United States

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Background

- Each survey has its measurement strengths and weaknesses
  - Information specific to a single survey
  - Minimal overlap
  - Measurement differences of the same construct
  - Errors unique to a dataset (specifically measurement)

- Comparative survey methodology focuses on data combination
  - Either ex-ante (before data collection) or ex-post (after data collection)
  - The survey data recycling (SDR) framework, can be applied to combining national population surveys in the U.S.
  - SDR emphasizes harmonizing datasets and making necessary adjustments for meaningful analysis

Background

- Collapsing survey responses reduces the number of response options across surveys to the greatest common number of responses
- However, this approach overlooks survey-specific measurement errors
- An alternative is bridging survey measures
  - A model predicting the selection of a response option in one survey
  - The same model is applied to another survey to predict responses
- Compared to collapsing, bridging is expected to enhance analyses
  - Bridged point estimates are less biased when based on variables in an imputation model
  - Collapsing survey categories has found losses in statistical power and scale reliability
- No work has directly compared the two methods against one another

Background

- An example of bridging's potential effectiveness over collapsing is the measurement of sexual identity
- Multiple national surveys measure sexual identity differently
  - The National Survey on Drug Use and Health (NSDUH) uses a three-category measure (Gay/Lesbian, Bisexual, or Heterosexual)
  - The National Health Interview Survey (NHIS) uses four categories (Gay/ Lesbian, Bisexual, Heterosexual, or Something else)
- Comparing results between surveys might be inappropriate, as estimates of health disparities among sexual minorities can vary depending on whether a three- or four-category measure is used (West and McCabe, 2021; Engstrom et al., 2024**;** West et al., 2024)
- I hypothesize that bridging sexual identity will provide more predictive and efficient results than collapsing across surveys

Data and Methods

- Data collected in 2018 from two sources
  - National Survey of Drug Use and Health (NSDUH)
    - Measures substance use, mental and physical health of U.S. individuals 12 and up
    - CAPI and ACASI modes
    - Adult (18+) sample size is 43,026
    - Sexual identity is measured in a three-category fashion
  - National Health Interview Survey (NHIS)
    - Measures substance use, overall health, and demographics of U.S. individuals 12 and up
    - CAPI mode
    - Adult (18+) sample size of 25,417
    - Sexual identity is measured in a four-category fashion

Data and Methods

- Use sexual identity to illustrate the effects of bridging and collapsing on subgroup estimates of smoking-related health outcomes
  - Current smoker status, ever smoked 100 cigarettes in life, and lung cancer screening eligibility among individuals aged 50+
  - Collapsing sexual identity in the context of the NSDUH and NHIS, the number of response options would be reduced to either two or three
  - NSDUH utilizes a three-category variable
    - Gay/lesbian, Bisexual, or Heterosexual
  - NHIS utilizes a four-category variable
    - Gay/lesbian, Bisexual, or Heterosexual, or Something else
- Two options for collapsing sexual identity to match between surveys
  - Drop respondents who identify their sexual identity as “something else” on the NHIS
  - Collapse all sexual minority identities (Gay/Lesbian, Bisexual, or Something else) into a single “sexual minority” category

Data and Methods

- For bridging:
  - Draw 20 (for now) bootstrap samples of the NHIS taking into account NHIS weights and complex sample design
  - Build a random forest to predict four-category sexual identity in each bootstrapped NHIS sample
    - Random forest model includes the following variables: Age, race, Hispanic ethnicity, education, past-month smoking, lifetime 100 cigarette use, lung cancer screening eligibility among individuals aged 50+
  - Refer the four predicted probabilities for each case in the NSDUH to a random uniform(0,1) draw to impute four-category sexual identity
  - Fit the model of interest to that imputed data set and save the estimates
    - Outcome variables: Past-month smoking, lifetime 100 cigarette Use, lung cancer screening eligibility among individuals aged 50+
    - Logistic regression models
    - Account for NSDUH weights and complex sample design
      - Also done for NSDUH models with non-bridged sexual identity measure
  - Repeat for each bootstrapped NHIS sample
  - Collect regression model performance metrics based on each bootstrapped sample, construct 95% confidence intervals for each metric

Data and Methods

- Compare the results of collapsing and bridging sexual identity
  - Model outcome variables on sexual identity and control variables
  - Area under the ROC curve
  - Archer-Lemeshow goodness-of-fit
  - Pseudo R^2
  - Adjusted Wald F-test
  - Does it make a difference?

Results – Collapsing

Goodness-of-Fit and Area Under the ROC Curve Values by Type of Sexual Identity Measure Used in the NHIS

	Past-Month Cigarette Use		Lifetime 100 Cigarette Use		Lung Cancer Screening Eligibility[a]	
	Goodness of Fit P-Values	Area Under the ROC Curve	Goodness of Fit P-Values	Area Under the ROC Curve	Goodness of Fit P-Values	Area Under the ROC Curve
Collapsed Sexual Identity Measure[b]	<0.0001	0.7184	<0.0001	0.7071	0.7162	0.6950
Original NHIS Sexual Identity Measure[c]	<0.0001	0.7189	<0.0001	0.7071	0.7452	0.6943

[a] Lung Cancer Screening Eligibility was only assessed among individuals aged 50 and up
[b] Gay/Lesbian, Heterosexual, or Bisexual
[c] Gay/Lesbian, Heterosexual, Bisexual, or Something Else

Results – Collapsing

Pseudo R^2 and Wald-F Test Values by Type of Sexual Identity Measure Used in the NHIS

	Past-Month Cigarette Use		Lifetime 100 Cigarette Use		Lung Cancer Screening Eligibility[a]	
	Pseudo-R^2 [b]	Adjusted Wald-F Test[c]	Pseudo-R^2 [b]	Adjusted Wald-F Test[c]	Pseudo-R^2 [b]	Adjusted Wald-F Test[c]
Collapsed Sexual Identity Measure[d]	0.0903	<0.0001	0.0967	<0.0001	0.0505	0.3327
Original NHIS Sexual Identity Measure[e]	0.0909	<0.0001	0.0967	<0.0001	0.0507	0.1727
No Sexual Identity Used[f]	0.0892	N/A	0.0952	N/A	0.0485	N/A

[a] Lung Cancer Screening Eligibility was only assessed among individuals aged 50 and up was only assessed among individuals aged 50 and up
[b] Pseudo-R^2 values were calculated using models that only accounted for survey weights and did not include complex survey features
[c] The Adjusted Wald F-Test was used to test if sexual identity is different from 0 and should be included in the model
[d] Gay/Lesbian, Heterosexual, or Bisexual
[e] Gay/Lesbian, Heterosexual, Bisexual, or Something Else
[f] This is the same model used in the previous two rows, but excluding sexual identity

Results – Bridging

Goodness-of-Fit and Area Under the ROC Curve Values by Type of Sexual Identity Measure Used in the NSDUH

	Past-Month Cigarette Use		Lifetime 100 Cigarette Use		Lung Cancer Screening Eligibility[a]	
	Goodness of Fit P-Values	Area Under the ROC Curve	Goodness of Fit P-Values	Area Under the ROC Curve	Goodness of Fit P-Values	Area Under the ROC Curve
	Mean (95% CI)[b]	Mean (95% CI)[b]	Mean (95% CI)[b]	Mean (95% CI)[b]	Mean (95% CI)[b]	Mean (95% CI)[b]
Bridged Sexual Identity Measure[c]	0.0018 (0.0003, 0.0033)	0.7069 (0.7064, 0.7075)	0.1241 (0.0518, 0.1964)	0.6903 (0.6879, 0.6928)	0.3077 (0.1897, 0.4256)	0.7179 (0.7134, 0.7224)
Original NSDUH Sexual Identity Measure[d]	0.0015	0.7063	0.7927	0.6865	0.7504	0.7216

[a] Lung Cancer Screening Eligibility was only assessed among individuals aged 50 and up
[b] Confidence intervals are only shown for bridged sexual identity as it was assessed over 20 random forests modeled using 20 different bootstrapped NHIS Samples
[c] Gay/Lesbian, Heterosexual, Bisexual, or Something Else
[d] Gay/Lesbian, Heterosexual, or Bisexual

Results – Bridging

Pseudo R^2 and Wald-F Test Values by Type of Sexual Identity Measure Used in the NSDUH

	Past-Month Cigarette Use		Lifetime 100 Cigarette Use		Lung Cancer Screening Eligibility[a]	
	Pseudo-R^2 [b]	Adjusted Wald-F Test[c]	Pseudo-R^2 [b]	Adjusted Wald-F Test[c]	Pseudo-R^2 [b]	Adjusted Wald-F Test[c]
	Mean (95% CI)[d]	Mean (95% CI)[d]	Mean (95% CI)[d]	Mean (95% CI)[d]	Mean (95% CI)[d]	Mean (95% CI)[d]
Bridged Sexual Identity Measure[e]	0.0850 (0.0842, 0.0857)	0.0004 (0.0001, 0.0009)	0.0816 (0.0809, 0.0823)	0.0001 (0.0001, 0.0001)	0.1004 (0.0978, 0.1030)	0.1147 (0.0258, 0.2037)
Original NSDUH Sexual Identity Measure[f]	0.0844	0.0001	0.0785	0.0001	0.0940	0.4699
No Sexual Identity Used[g]	0.0821	N/A	0.0777	N/A	0.0923	N/A

[a] Lung Cancer Screening Eligibility was only assessed among individuals aged 50 and up was only assessed among individuals aged 50 and up
[b] Pseudo-R^2 values were calculated using models that only accounted for survey weights and did not include complex survey features
[c] The Adjusted Wald F-Test was used to test if sexual identity is different from 0 and should be included in the model
[d] Confidence intervals are only shown for bridged sexual identity as it was assessed over 20 random forests modeled using 20 different bootstrapped NHIS Samples
[e] Gay/Lesbian, Heterosexual, Bisexual, or Something Else
[f] Gay/Lesbian, Heterosexual, or Bisexual
[g] This is the same model used in the previous two rows, but excluding sexual identity

Results – Bridging

Past-Month Cigarette Use by Sexual Identity Across Sexual Identity Measure Used

	Original NSDUH Sexual Identity Measure [a]	Bridged Sexual Identity Measure [b]		
		Model 1	Model 2	Model 3
	Coef. (95% CI)	**Coef. (95% CI)**	**Coef. (95% CI)**	**Coef. (95% CI)**
Heterosexual	REF	REF	REF	REF
Gay/Lesbian	0.432 (0.213, 0.652)***	0.284 (0.102, 0.467)**	0.379 (0.183, 0.574)***	0.434 (0.173, 0.694)**
Bisexual	0.642 (0.465, 0.819)***	0.342 (0.161, 0.523)***	0.758 (0.591, 0.926)***	0.190 (-0.023, 0.403)
Something Else	N/A	0.552 (0.235, 0.870)**	0.413 (-0.055, 0.882)	-0.233 (-0.622, 0.156)

*P<0.05, **P<0.01, ***P<0.001

[a] 3-category measure of sexual identity

[b] 4-category measure of sexual identity after being bridged

Logistic regression models controlled for Age, Race/Hispanic Ethnicity, Sex (binary), and Educational Attainment

Results – Bridging

Lifetime 100 Cigarette Use by Sexual Identity Across Sexual Identity Measure Used

	Original NSDUH Sexual Identity Measure [a]	Bridged Sexual Identity Measure [b]		
		Model 1	Model 2	Model 3
	Coef. (95% CI)	**Coef. (95% CI)**	**Coef. (95% CI)**	**Coef. (95% CI)**
Heterosexual	REF	REF	REF	REF
Gay/Lesbian	0.337 (0.079, 0.595)*	0.694 (0.437, 0.952)***	0.608 (0.412, 0.804)***	0.556 (0.355, 0.757)***
Bisexual	0.617 (0.418, 0.815)***	0.718 (0.570, 0.867)***	0.898 (0.700, 1.095)***	0.556 (0.358, 0.754)***
Something Else	N/A	0.368 (0.018, 0.719)*	0.495 (0.116, 0.803)**	-0.467 (-0.923, -0.011)*

*P<0.05, **P<0.01, ***P<0.001

[a] 3-category measure of sexual identity

[b] 4-category measure of sexual identity after being bridged

Logistic regression models controlled for Age, Race/Hispanic Ethnicity, Sex (binary), and Educational Attainment

Results – Bridging

Lung Cancer Screening Eligibility by Sexual Identity Across Sexual Identity Measure Used for Individuals Aged 50 and Up

	Original NSDUH Sexual Identity Measure [a]	Bridged Sexual Identity Measure [b]		
		Model 1	Model 2	Model 3
	Coef. (95% CI)	**Coef. (95% CI)**	**Coef. (95% CI)**	**Coef. (95% CI)**
Heterosexual	REF	REF	REF	REF
Gay/Lesbian	0.960 (-0.798, 2.718)	-1.257 (-2.779, 0.264)	-1.715 (-3.344, -0.087)*	0.736 (-0.298, 1.770)
Bisexual	0.476 (-1.156, 2.109)	3.360 (2.077, 4.644)**	0.013 (-2.036, 2.062)	1.878 (0.868, 2.888)***
Something Else	N/A	0.243 (-2.419, 2.903)	0.108 (-2.100, 2.317)	1.466 (-1.482, 4.413)

*P<0.05, **P<0.01, ***P<0.001

[a] 3-category measure of sexual identity

[b] 4-category measure of sexual identity after being bridged

Logistic regression models controlled for Age, Race/Hispanic Ethnicity, Sex (binary), and Educational Attainment

Conclusions

	Bridged Sexual Identity	Collapsed Sexual Identity
Area under the ROC Curve	✓	
Archer-Lemeshow GOF Test	No difference	
Adjusted Wald-F Test	No difference	
Pseudo R^2	✓	
Does it make a difference?	More Info Needed	

Next Steps

- Restrict age for lung cancer screening to 50-80 instead of 50+
  - Match Low-dose Computed Tomography guidelines
- Bridge 3-category sexual identity from NSDUH to NHIS
- Include more variables in common between the surveys in the random forests
- Incorporate item-nonresponse in bridging models
- Improve model fit by including more variables in common between surveys

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Thank You

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Results – Collapsing

Past-Month Cigarette Use by Sexual Identity Across Sexual Identity Measure Used

	Original NHIS Sexual Identity Measure [a]	Collapsed Sexual Identity Measure [b]
	Coef. (95% CI)	**Coef. (95% CI)**
Heterosexual	REF	REF
Gay/Lesbian	0.688 (0.354, 1.023)***	0.688 (0.354, 1.021)***
Bisexual	0.518 (0.151, 0.884)**	0.519 (0.150, 0.887)**
Something Else	0.859 (0.164, 1.553)*	N/A

*P<0.05, **P<0.01, ***P<0.001
[a] 4-category measure of sexual identity
[b] 3-category measure of sexual identity after being bridged
Logistic regression models controlled for Age, Race/Hispanic Ethnicity, Sex (binary), and Educational Attainment

Results – Bridging

Lifetime 100 Cigarette Use by Sexual Identity Across Sexual Identity Measure Used

	Original NHIS Sexual Identity Measure [a]	Collapsed Sexual Identity Measure [b]
	Coef. (95% CI)	**Coef. (95% CI)**
Heterosexual	REF	REF
Gay/Lesbian	0.756 (0.477, 1.035)***	0.756 (0.477, 1.035)***
Bisexual	0.731 (0.415, 1.047)***	0.732 (0.415, 1.049)***
Something Else	0.574 (-0.026, 1.173)	N/A

*P<0.05, **P<0.01, ***P<0.001

[a] The Adjusted Wald F-Test was used to test if sexual identity is different from 0 and should be included in the model

[b] Confidence intervals are only shown for bridged sexual identity as it was assessed over 20 random forests modeled using 20 different bootstrapped NHIS Samples Logistic regression models controlled for Age, Race/Hispanic Ethnicity, Sex (binary), and Educational Attainment

Results – Bridging

Lung Cancer Screening Eligibility by Sexual Identity Across Sexual Identity Measure Used for Individuals Aged 50 and Up

	Original NHIS Sexual Identity Measure [a]	Collapsed Sexual Identity Measure [b]
	Coef. (95% CI)	**Coef. (95% CI)**
Heterosexual	REF	REF
Gay/Lesbian	0.485 (-0.162, 1.132)	0.483 (-0.164, 1.130)
Bisexual	0.124 (-1.066, 1.315)	0.126 (-1.064, 1.317)
Something Else	0.758 (-0.141, 1.657)	N/A

*P<0.05, **P<0.01, ***P<0.001

[a] The Adjusted Wald F-Test was used to test if sexual identity is different from 0 and should be included in the model

[b] Confidence intervals are only shown for bridged sexual identity as it was assessed over 20 random forests modeled using 20 different bootstrapped NHIS Samples

Logistic regression models controlled for Age, Race/Hispanic Ethnicity, Sex (binary), and Educational Attainment