How to Run a Surveillance System in the 21st Century

Ali H. Mokdad, Ph.D.

Centers for Disease Control and Prevention

Atlanta, GA, USA

Multi-Mode Surveillance

Ali H. Mokdad, Ph.D.

Centers for Disease Control and Prevention

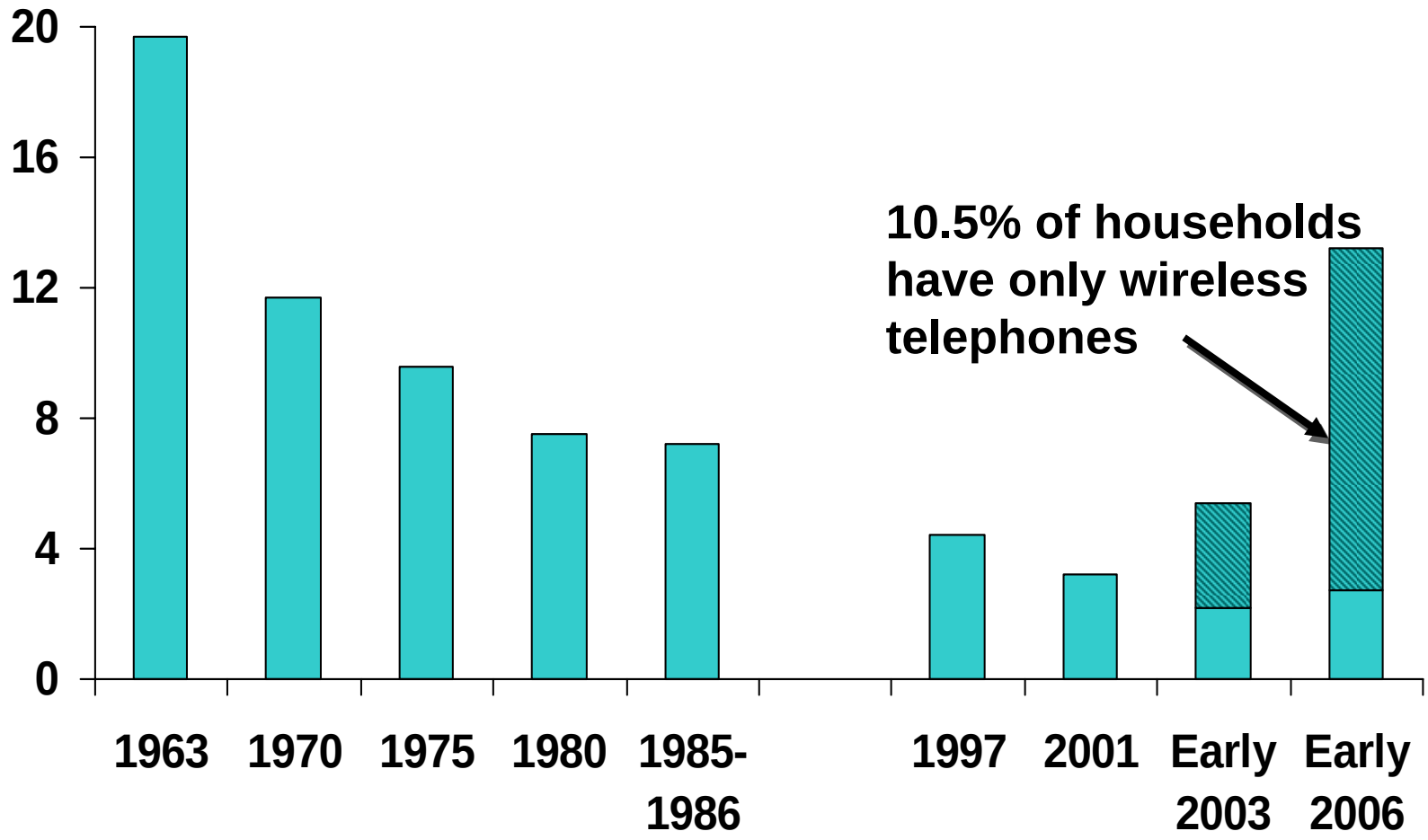
Atlanta, GA, USA

I. What problems are we trying to address?

Coverage problems

- **Face-to-face coverage:**
  - Available household lists not complete
  - Need to manually count and list
- **Telephone coverage:**
  - Households with no telephones (2-3%)
  - Cell phone only households (8-10%)
  - No directory of cell phone numbers
  - Number portability and erosion of geographic specificity
- **Mail coverage:**
  - USPS list only readily available source for general populations
    - Poor coverage in rural areas
- **Email coverage:**
  - No systematic directory of addresses

Example: Trend in Percentage of U.S. Households without Landline Telephones



- Source: National Health Interview Survey

Behavioral Risk Factor Surveillance System (BRFSS)

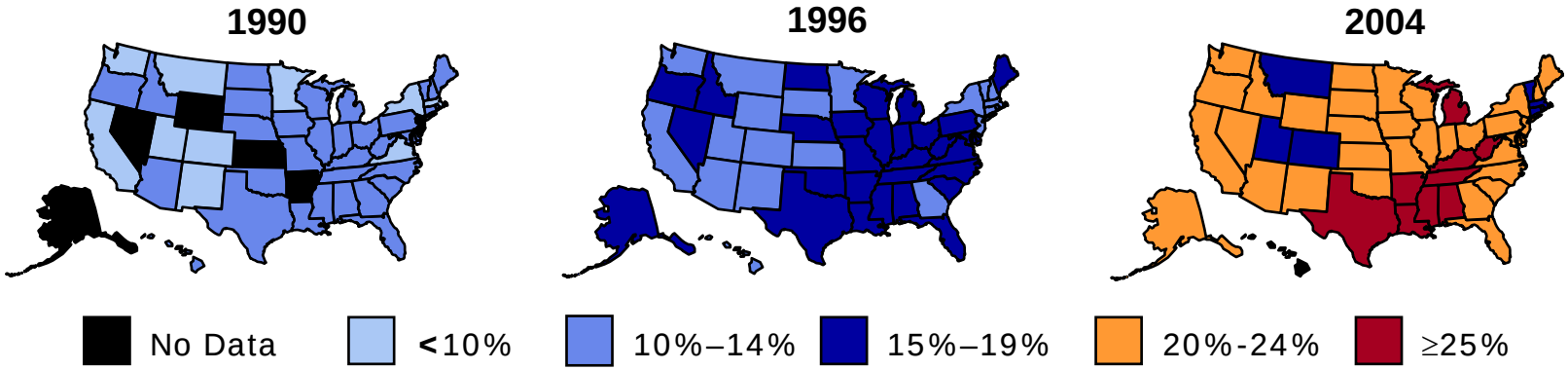
- Monthly state-based RDD survey of health issues
- 50 states, District of Columbia, Puerto Rico, Guam, and Virgin Islands
- 350,000+ adult interviews conducted in 2006
- From 2002 to 2006:
  - completed 1,517,000 interviews
  - Dialed 14,381,000 telephone numbers

BRFSS Strengths

- Flexible
- Timely
- Standardized
- Useful

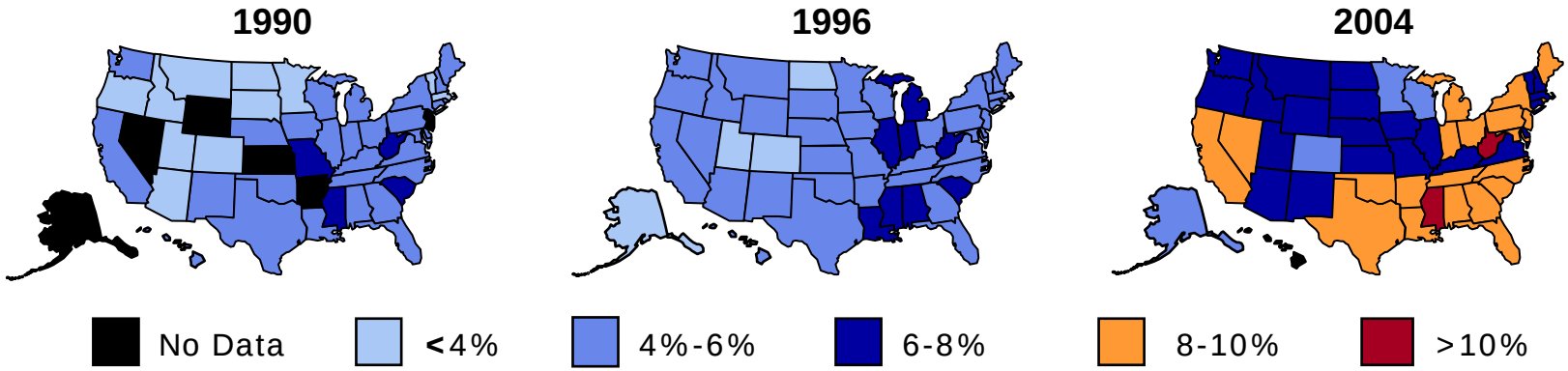
Prevalence of Obesity* Among U.S. Adults

(*BMI ≥30, or about 30 lbs overweight for 5'4" person)



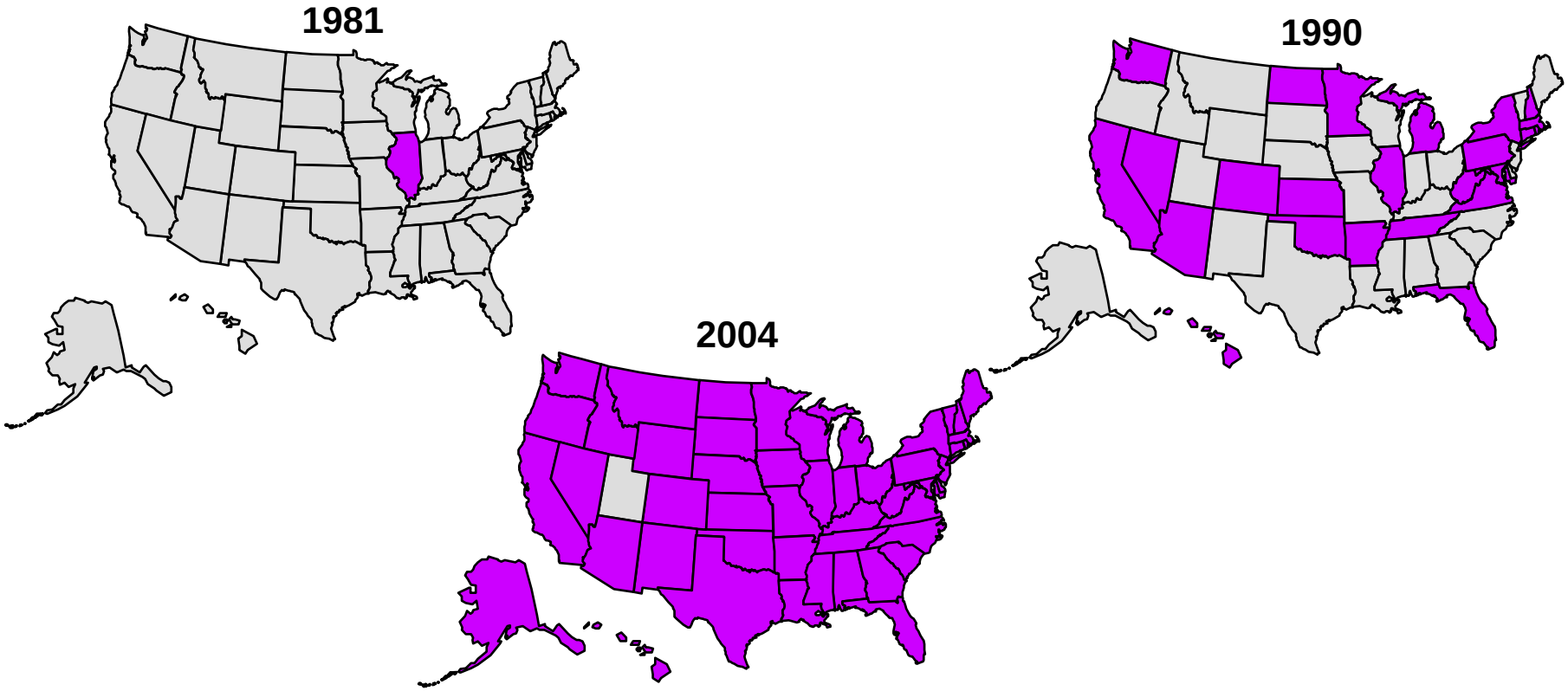
Prevalence of Diabetes* Among U.S. Adults

(*Includes gestational diabetes)



Support Policies and Legislation:

Mandatory Insurance Coverage for Screening Mammography

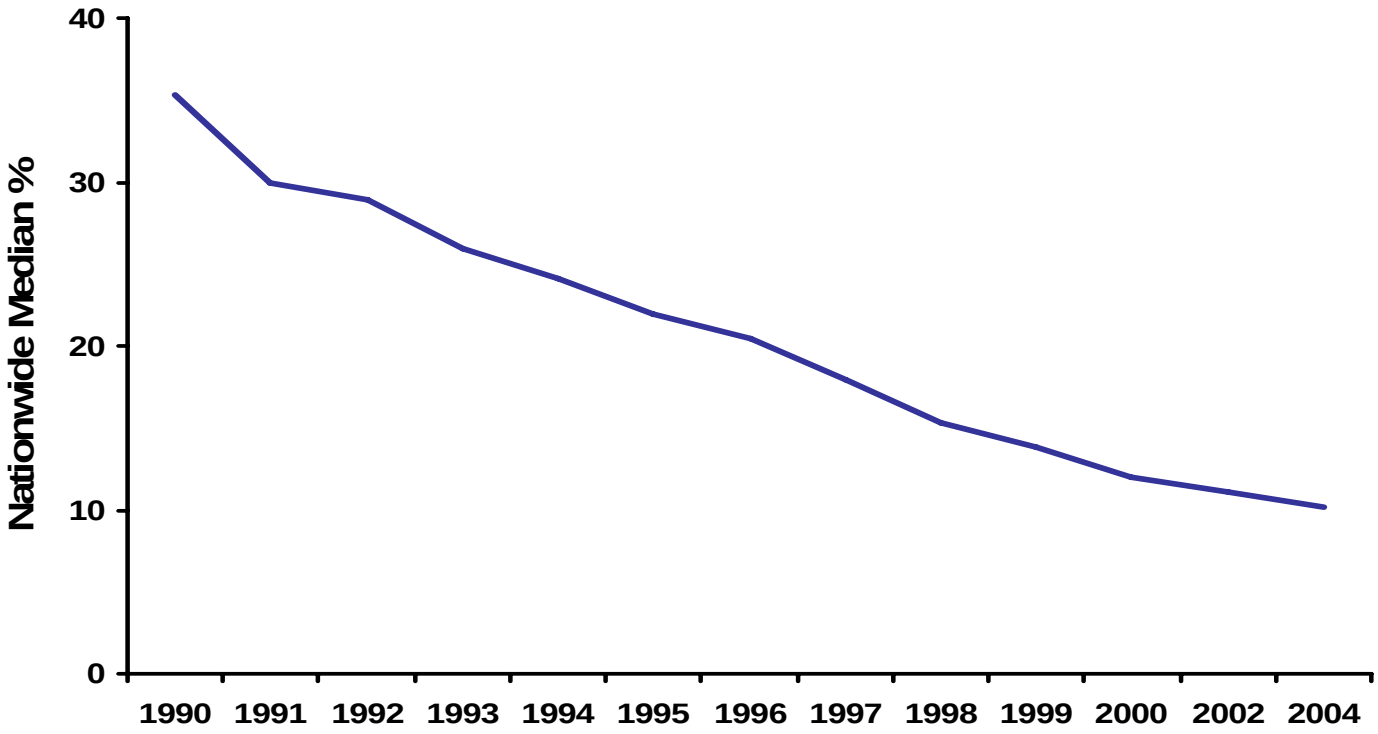


No mandatory insurance coverage for screening mammography.

Mandatory insurance coverage for screening mammography.

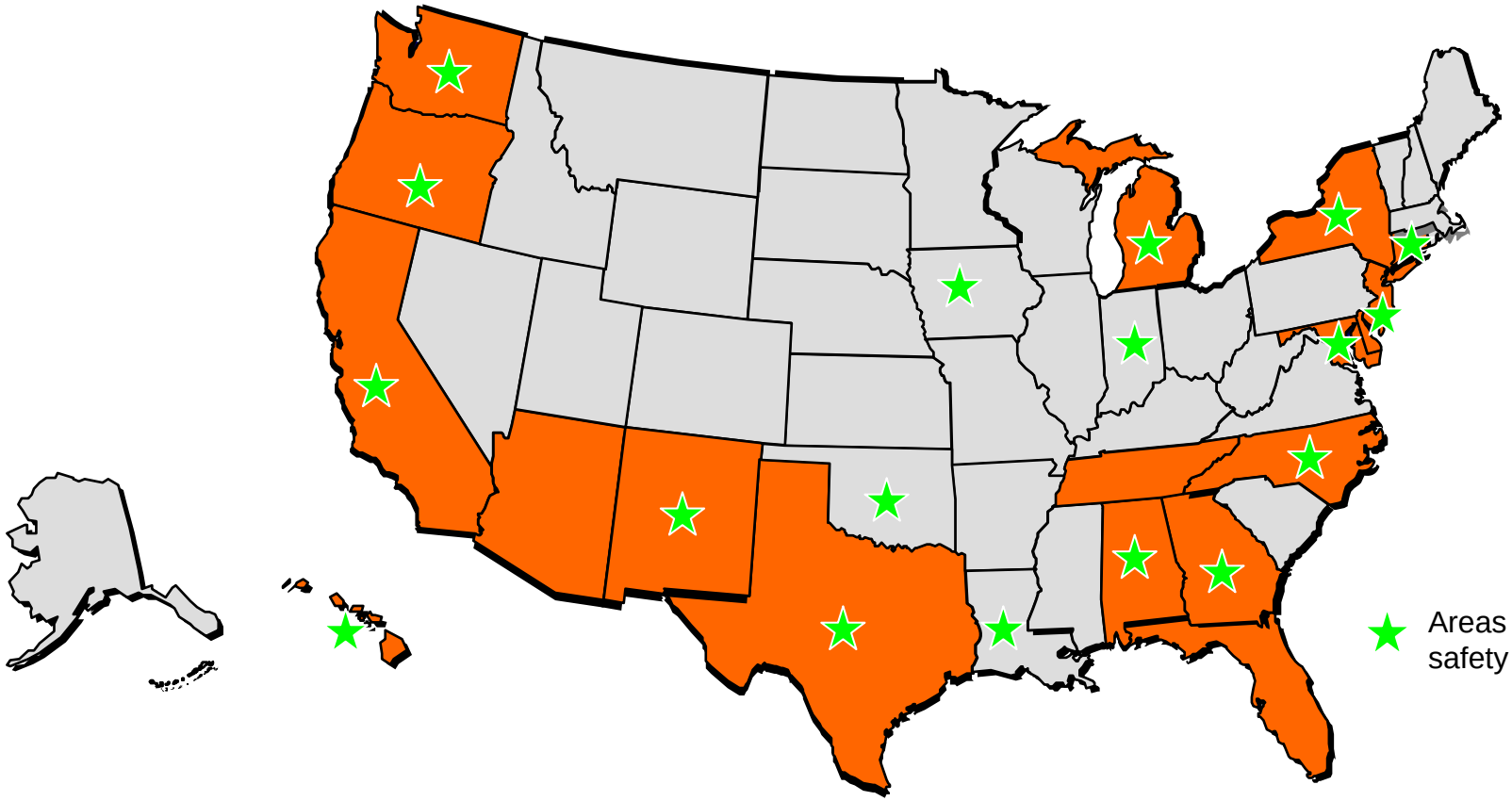
Source: National Cancer Institute — State Cancer Legislative Database Program, Bethesda, MD, 2004.

Prevalence of Women Who Never Had a Mammogram, Ages 40 and Older BRFSS 1990–2004



Support Policies and Legislation:

Prevalence of Safety Belt Use, 2002

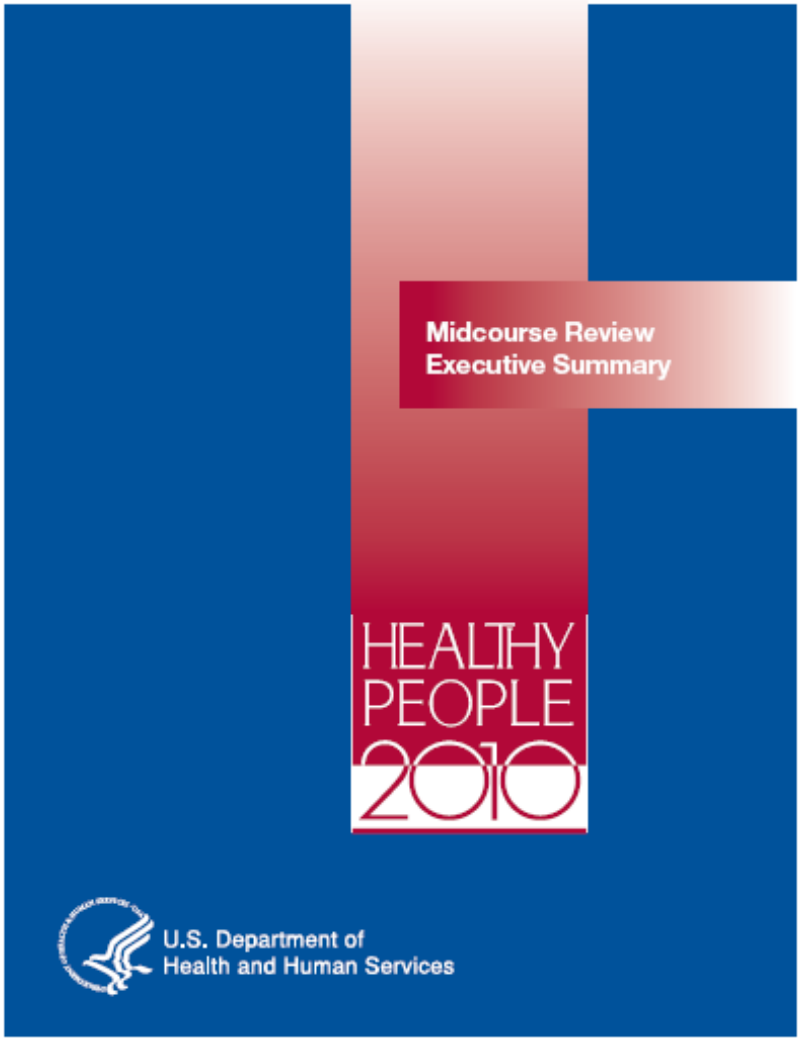


Prevalence ≥ 80% of always using a safety belt among persons aged ≥ 18 years.

Prevalence < 80% of always using a safety belt among persons aged ≥ 18 years.

Source: CDC. Impact of primary laws on adult use of safety belts – United States, 2002. MMWR 2004;53:257-260.

Establish and Track Health Objectives



Develop Local Programs and Policies: SMART BRFSS in Fargo

- Fargo, ND – 24.9% binge drinking

vs. 16.4% nationwide

- Formed community coalition:

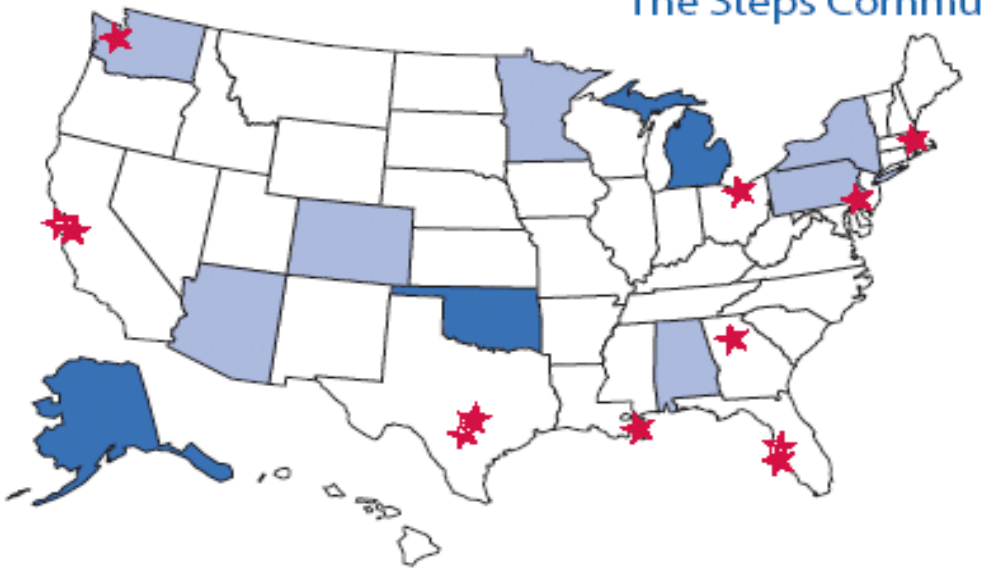
AMP (Alcohol Misuse Prevention)

- Mission: Reduce alcohol use among those under 21 in the Fargo-Moorhead area.
  - Anti-binge drinking campaign
  - Policy change sanctioning facilities
  - Intervention with ER doctors

Healthy People in Healthy Places

Steps to a HealthierUS

The Steps Communities



State-Coordinated Small Cities/Rural Communities

AL	2 Areas	NY	4 Counties
AZ	4 Areas	PA	3 Counties
CO	4 Counties	WA	4 Areas
MN	4 Areas		

Tribes/Tribal Entities

Cherokee Nation Health Services Group, OK
Inter-Tribal Council of Michigan
Southeast Alaska Regional Consortium

Large Cities/Urban Communities

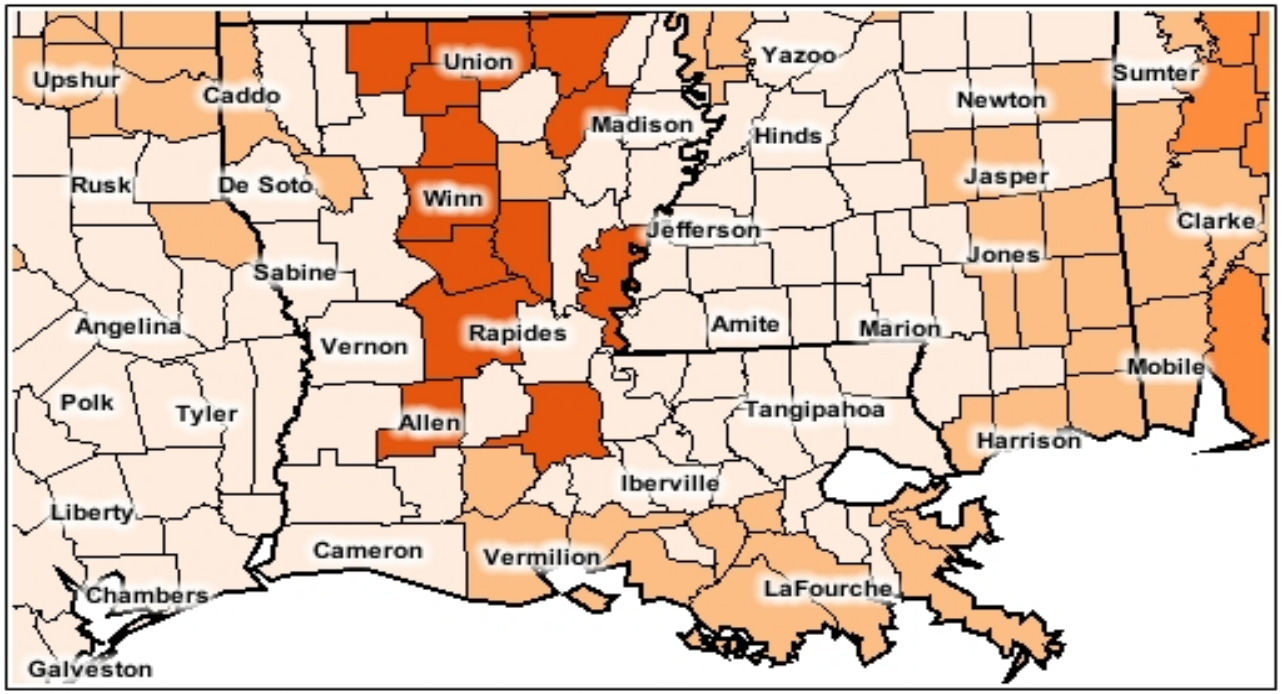
Austin–Travis County, TX	Philadelphia, PA
Boston, MA	Salinas–Monterey County, CA
Cleveland, OH	San Antonio, TX
DeKalb County, GA	Santa Clara County, CA
Hillsborough County, FL	Seattle–King County, WA
New Orleans, LA	St. Petersburg–Pinellas County, FL

People Prepared for Emerging Health Threats

BRFSS - Hurricane Katrina: Implications for Chronic Diseases

Adults who have been told they currently have asthma

2003 - 2004: Percent of respondents reporting Yes



Statistical Method: Quantile

Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Behavioral Risk Factor Surveillance System. BRFSS Maps [online]. 2006. [accessed 2006 March 8]. URL:http://apps.nccd.cdc.gov/gisbrfss/

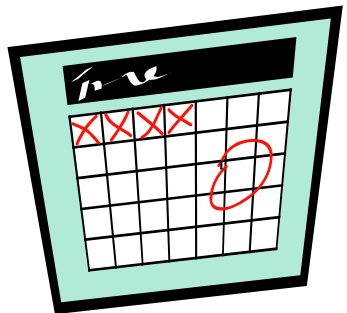
Department of Health and Human Services
Centers for Disease Control and Prevention
National Center for Chronic Disease Prevention and Health Promotion
Behavioral Risk Factor Surveillance System

Vaccine Shortage – Timeline

- Oct 5: Vaccine shortage announced
- Oct 5: Initial discussions within CDC
- Oct 19: Call with BRFSS state coordinators
- Oct 19-26: New questions developed and cognitively tested
- Oct 27: CATI specifications to states
- Nov 1: Data collection began

From Implementation to First Report

- November 1 – Questions implemented by states
- November 8 – Data first submitted by states
- November 10 – First data report available
- November 15 – NIP/BRFSS analysis team develop first executive summary and table

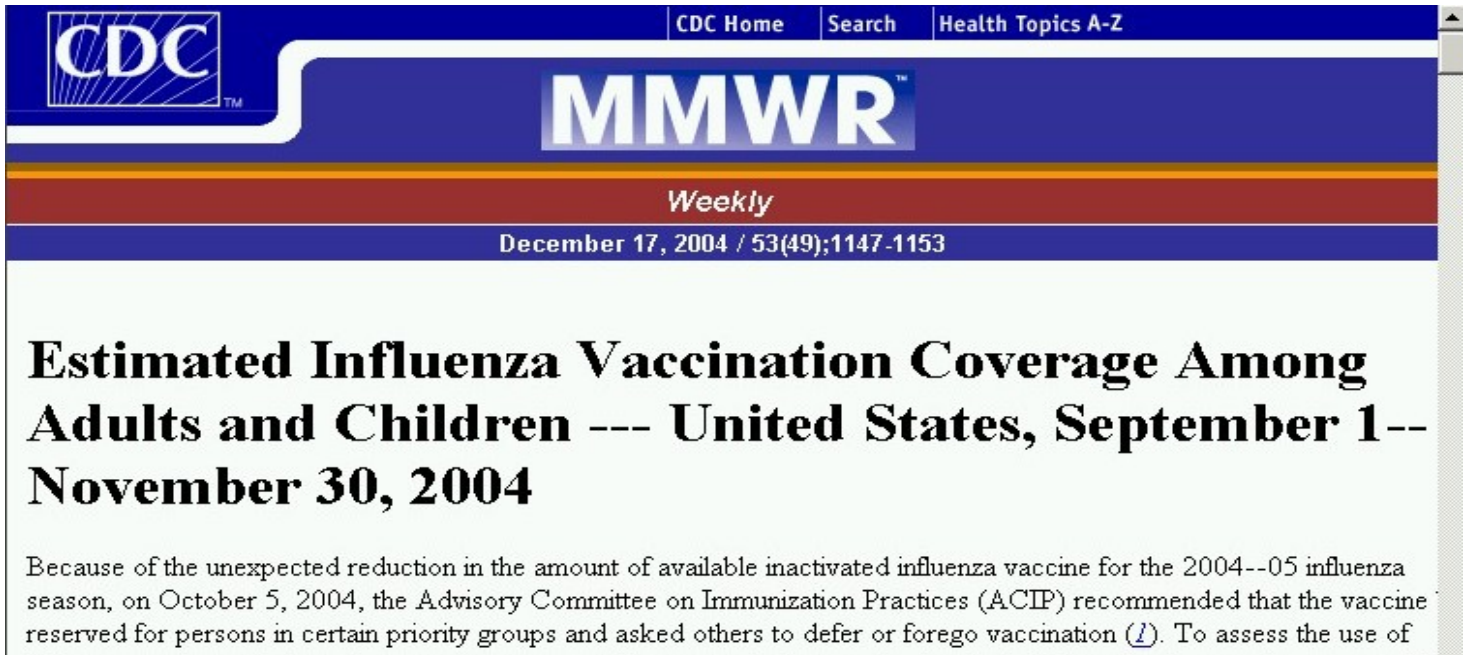


The Effort Involved …

- 4 months of data collection (Nov ’04-Feb ’05)
- 35 data collection centers
- 50 states + DC
- 92 grant/contract modifications
- 400 interviewers trained
- 2,000 total staff mobilized
- 35,106 child interviews (via proxy)
- 105,743 adult interviews

December MMWR

- Dec 1-11: States collected December data
- Dec 13: Submitted files to CDC
- Dec 16: Dr. Gerberding holds press conference & MMWR released on the CDC website



CDC Home | Search | Health Topics A-Z

CDC

MMWR

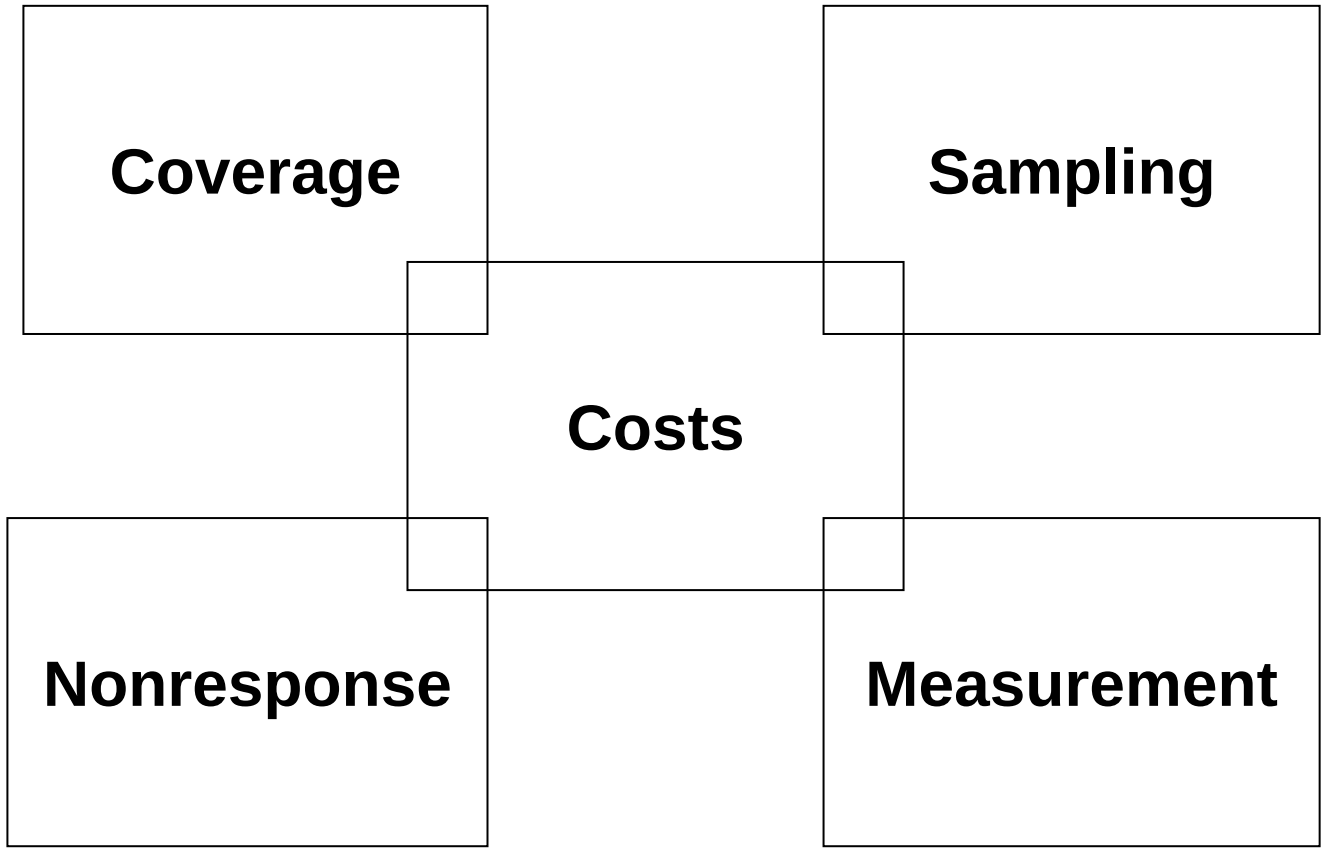
Weekly

December 17, 2004 / 53(49);1147-1153

Estimated Influenza Vaccination Coverage Among Adults and Children --- United States, September 1--November 30, 2004

Because of the unexpected reduction in the amount of available inactivated influenza vaccine for the 2004--05 influenza season, on October 5, 2004, the Advisory Committee on Immunization Practices (ACIP) recommended that the vaccine reserved for persons in certain priority groups and asked others to defer or forego vaccination (*1*). To assess the use of

Goal: Optimize survey design to decrease total survey error for a given cost



Cost for multimodes

- Typically design mix of modes to:
  - Optimize coverage, response, and costs
  - Less expensive to most expensive

- However:
  - Set-up costs with each mode
  - Per unit costs may be high even for “low cost” mode if few use the mode

III. Operational considerations

Multimode: Operational Considerations

- Population of interest
- Sequential versus concurrent use of modes
- Comparability
  - Within study
  - Across studies
- Questionnaire design and reducing measurement error

Reaching population of interest

- Need to understand certain elements of population you are trying to reach:
  - Physical accessibility
  - Telephone access
    - Landline
    - Cell phone
  - Literacy level
  - Web-enabled
- How do respondents prefer to be interviewed?
- Need to match mode combination to best fit population

Comparability across modes

- Changing methods over time in longitudinal surveys
  - Confounding time and mode effects
- Different modes for different subgroups
  - Are groups really different or is it mode effect?
- Different modes for different samples
  - Comparing across surveys conducted using different modes

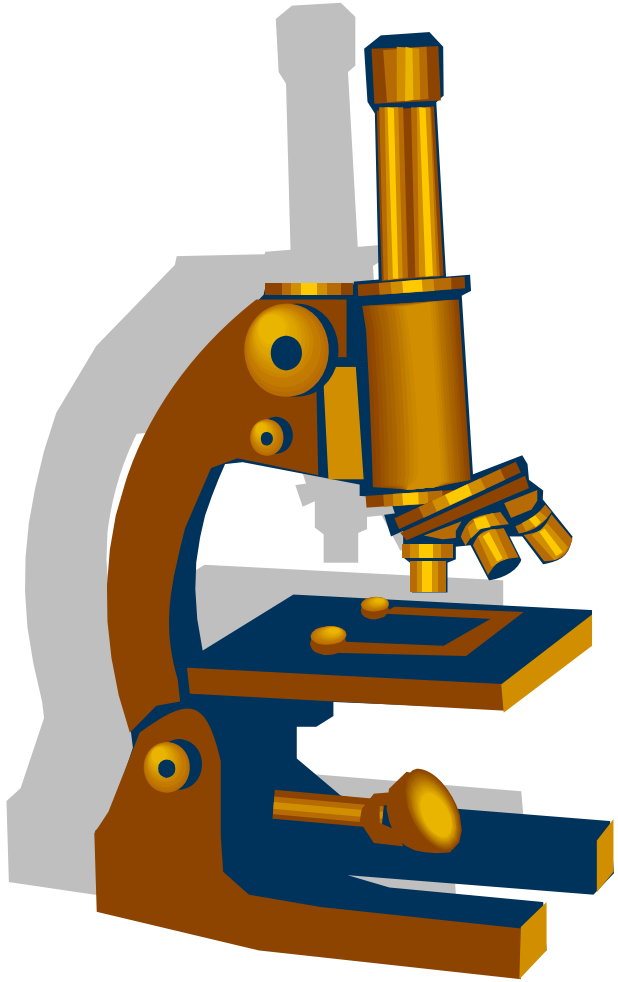
Reducing measurement error

- Different modes have tradition of different formats
- Question format has effect on response distribution
- Consequences: Designers routinely enhance unwanted mode effects in mixed-mode surveys
- What to do?

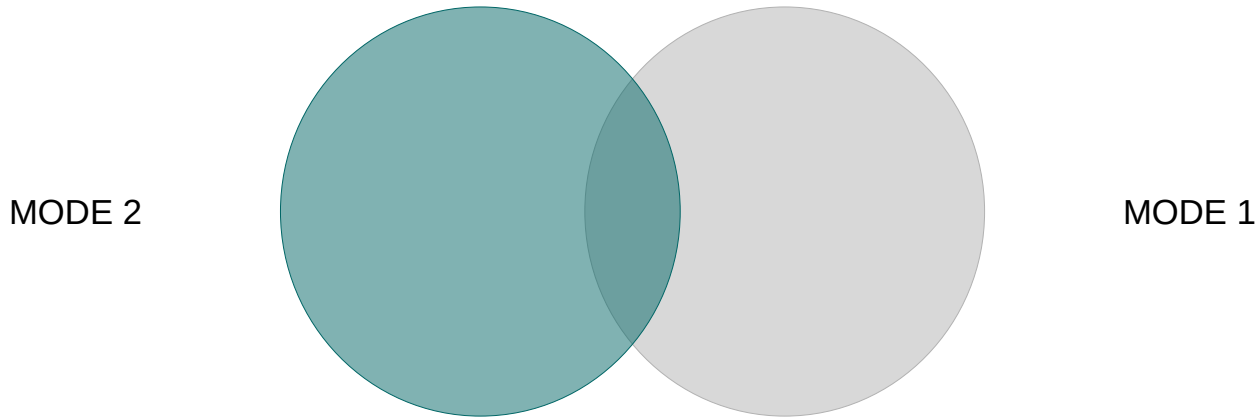
MULTI-MODE

- MAY ALLOW FOR LOWER TOTAL SURVEY ERROR FOR GIVEN COST
- BUT
- ADDED COMPLEXITY MAY PRODUCE MISTAKES AND UN-EXPECTED CONSEQUENCES

ASSESSING MODE EFFECTS



ASSESSING MODE EFFECTS KEY ENABLER IS “OVERLAP”



ASSESSING MODE EFFECTS

- MULTI MODE OVERLAPPING MEASURES SAME SAMPLE ELEMENTS
  - FEWER ASSUMPTIONS REQUIRED
  - ORDER EFFECTS AND CONDITIONING
- MULTI MODE OVERLAPPING MEASURES DIFFERENT SAMPLE ELEMENTS BY SAME FRAME
  - SELECTION BIAS
  - OTHER RESPONSE RELATED FACTORS

IMPACT ON TOTAL SURVEY ERROR

- MAY BE USED TO INCREASE "RESPONSE RATE" (MULTIPLE VIEWS)
  - HIGHER RESPONSE WILL LOWER TOTAL SURVEY ERROR
  - HIGHER RESPONSE RATE MAY NOT LOWER TOTAL SURVEY ERROR

Assessing Data Validity

What do we mean by “validity”?

- The closeness of our survey estimates to the “true value”
  - Ideally there is no difference
  - Potential survey bias is minimized
- “Bias” in survey estimates results from product of:
  - Level of nonresponse
  - Difference between respondents and nonrespondents on measures of interest

Ensuring validity of BRFSS Estimates

- Monitoring data collection process
- Refining post-survey adjustments
- Benchmarking to other studies
- Testing alternative ways of collecting data
  - Cell phone interviewing
  - Address-based sampling (ABS)

Monitoring the Data Collection Process

Monitoring 54 monthly surveys

- BRFSS data collection process is semi-centralized
- States:
  - In charge of own data collection
  - Conduct front-line monitoring
- Centers for Disease Control (CDC):
  - Provides sample
  - Weighting
  - Quality reports

Web-based systems are key

- Data transfer via upload/download site
- Automated quality control programs
  - State level and CDC level
- Monthly detailed reports to states:
  - Key quality indicators
  - Deviations from norm and/or past trends within state
- Year-end quality report
  - Comparison across states
- Newest tool: Simplified web-based / color coded system

DACH/BSB Intranet

Data Quality Report

Year: 2007 Display: All states Numbers Go

Total Monthly Issues

Select a number to view that month's submissions.

* Resubmitted Issues

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Details	AL	5	3	3	4								
Details	AK	3	5	3	2	3							
Details	AZ	7	6	8	8								
Details	AR	5	6	6	6	6							
Details	CA	7*	7	7	6								
Details	CO	4*	4*	3*	4								
Details	CT	9	6	7	8								
Details	DE	5*	4*	5	5								
Details	DC	6	6	6	7								
Details	FL	4	4	4*									
Details	GA	8	8	9	8								
Details	GU			5	4*								
Details	HI	3	4	3	5								
Details	ID	5*	5	6	4	5							
Details	IL												

Data Quality Report

Back to Total Monthly Issues

Glossary | E-mail Report

Georgia Issue Details

Select a number to view that month's submissions.

* Resubmitted ‡ Change in quality status ☐ Issues

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Total Issues	10	10	11	10								
Completes	350	426	418	369								
Partial Completes	14.84	7.99	12.73	14.98								
Terminations	9.67	10.1	9.79	8.05								
Household, no eligible respondent	0.1	0.09	0.21	0.16								
CASRO response rate	29.66	30.88	32.58	31.86								
Cooperation rate	52.58	53.58	55.07	54.09								
Income missing values, Male	12.7	8.19	7.78	11.94								
Income missing values, Female	15.79	13.36	21.4	17								
Discrepancy in sex	18.2	11.92	11.28	17.98								
Discrepancy in percent White, Non-Hispanic	13.18	16.37	9.14	12.85								
Discrepancy in age, 18-24	-9.51	-10.1	-9.53	-11.6								
Discrepancy in age, 65-74	9.46	8.47	9.26	8.78								
Assignment of interviewers	3	3	2	2								
Records with insufficient number of call attempts		2	2									

* Resubmitted ‡ Change in quality status ☐ Issues

What did we learn?

- Estimates are only as valid as the process in which the data were collected
- Tools for monitoring the quality of data collection and collecting valid data are only good:
  - ... if they are actually used
  - ... and if they are understood
  - ... and initiate follow-up action

Refining post-survey adjustments

Goals and limits of weighting

- Weighting and other post-survey adjustments are used to correct for imbalances in the data due to issues of:
  - Coverage
  - Sampling
  - Nonresponse
- Weighting methodology affects the estimates produced
- Can only weight data you have
  - Assumes no difference between respondents and nonrespondents on variables of interest
- Can only weight to external standards that exist
  - Typically limits weighting to a handful of demographic variables, not “substantive” variables

Current BRFSS Weighting System

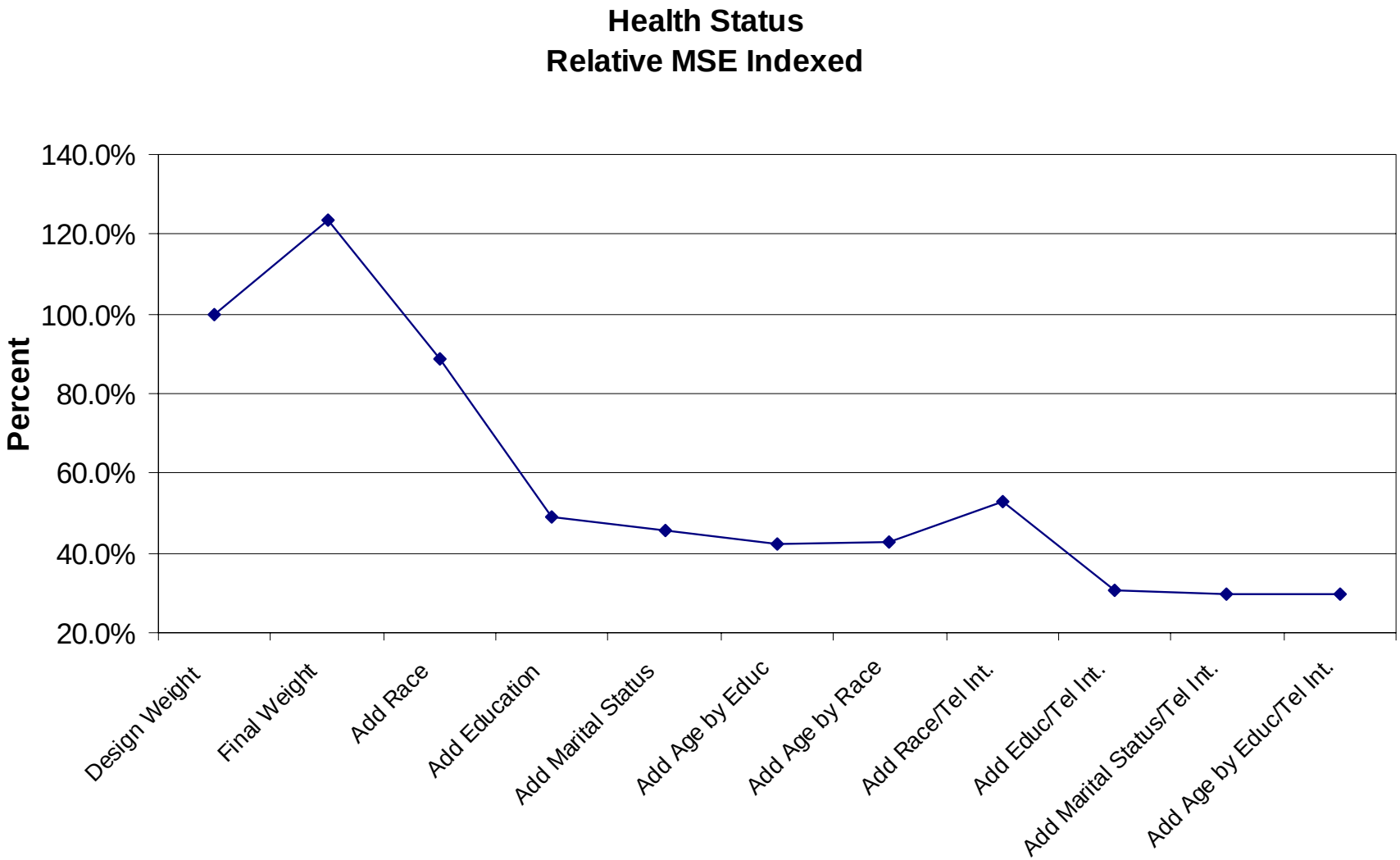
- Use poststratification (cell-based approach)
- Controls for:
  - Age by sex
  - Race/Ethnicity (in some states)
  - Region (in some states)
- Problems:
  - Small sample cells produce highly variable weights and require collapsing
  - No factor to account for socioeconomic status

New weighting system

- Uses “Multi-Dimensional Raking” (Sample Balancing)

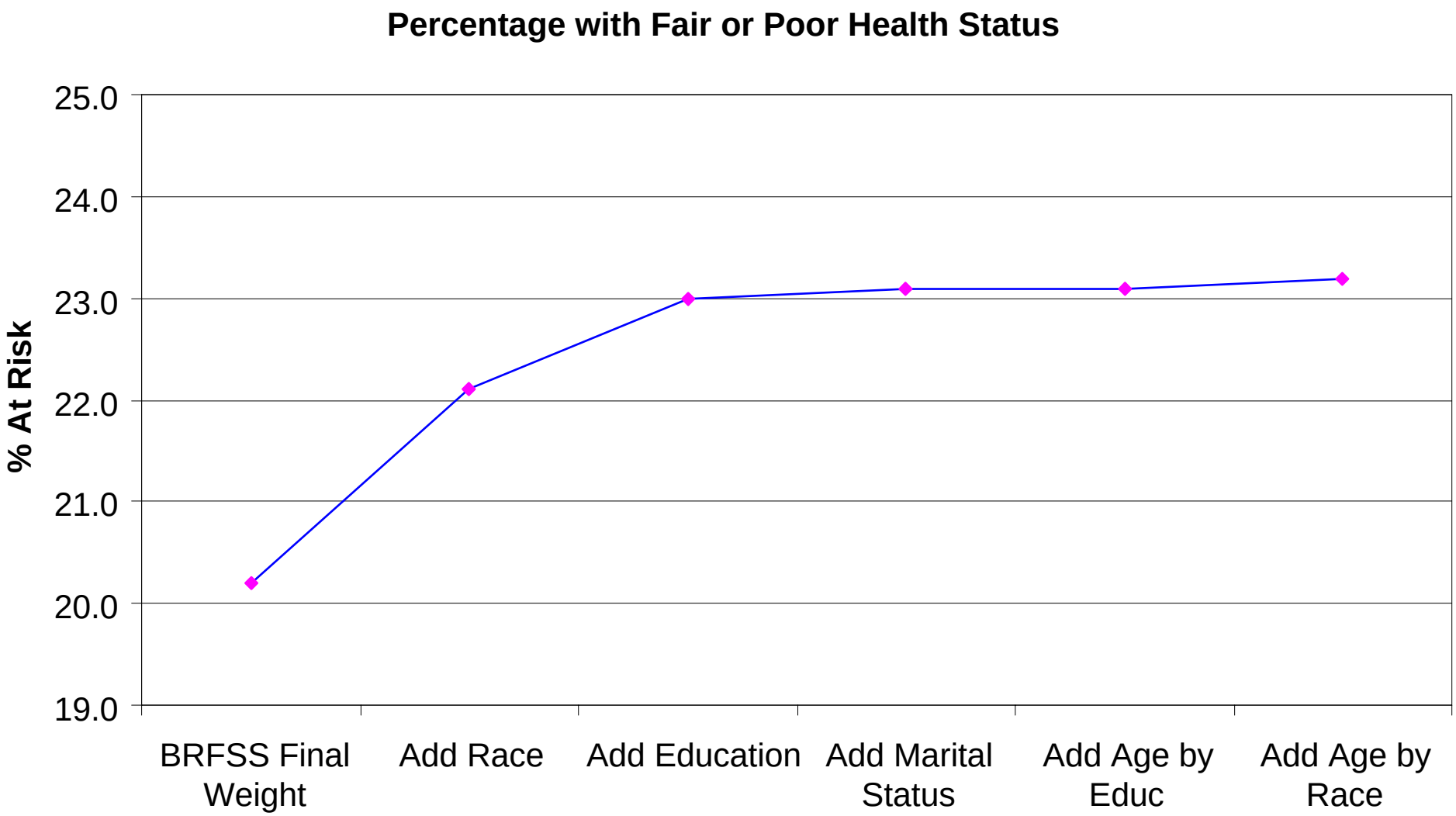
- Controls for:
  - Age by sex
  - Race/ethnicity (2.5% rule)
  - Region (as necessary)
  - Education level
  - Marital status
  - Telephone service interruption

Does It Represent an Improvement?



(NOTE: Relative MSE indexed to MSE of BRFSS design weight estimate)

Changes in estimate of health status



Implications for users of BRFSS data

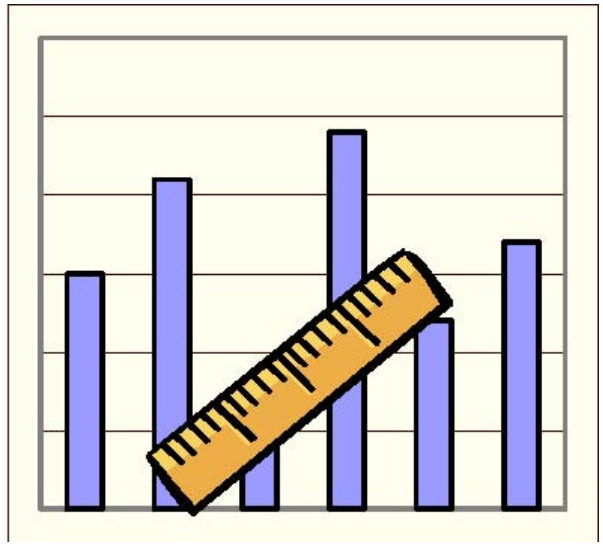
- Break in time series
- Plan to release both classic (old) and new weights
- Full changeover in 2010
- Health condition and risk factor estimates will likely be higher

What did we learn?

- Modifications to post-survey adjustments can improve the quality of the estimates produced

- Sometimes need to be innovative in the use of external data in developing population estimates

Benchmarking to external standards



Importance and challenges of benchmarking

- True standards rarely exist in health surveys – relative standards
  - Better coverage, response
- No two studies are identical
  - Populations
  - Modes / procedures
  - Wording / question order
  - Post-survey adjustments / population standards

Benchmark surveys for BRFSS

- National Health Interview Survey (NHIS):
  - In-person interviews with adults 17+
  - 2004: 94,460 adults in 36,579 households
  - Household-level response rate = 86.9%

- National Health and Nutrition Examination Survey (NHANES):
  - In-person survey with physical measures at mobile lab
  - 2003-04: 10,122 adults
  - Household-level response rate = 91.0%

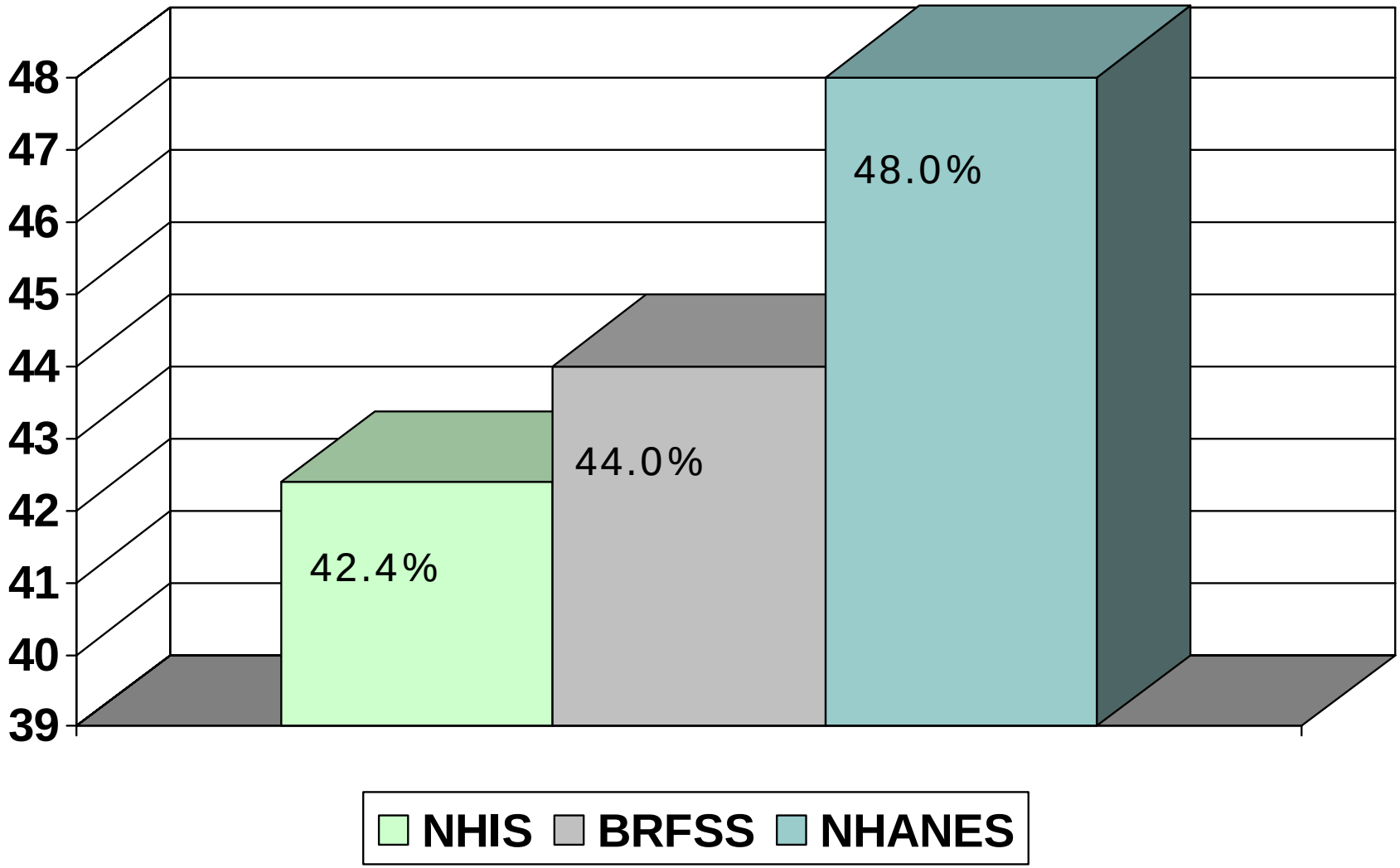
Comparison across 15 key health variables

- Cigarette smoking
- Diabetes
- Height
- Weight
- Body mass index
- Health status
- Asthma
- HIV testing
- Alcohol consumption
- Medical coverage
- Influenza vaccination
- Pneumonia shot

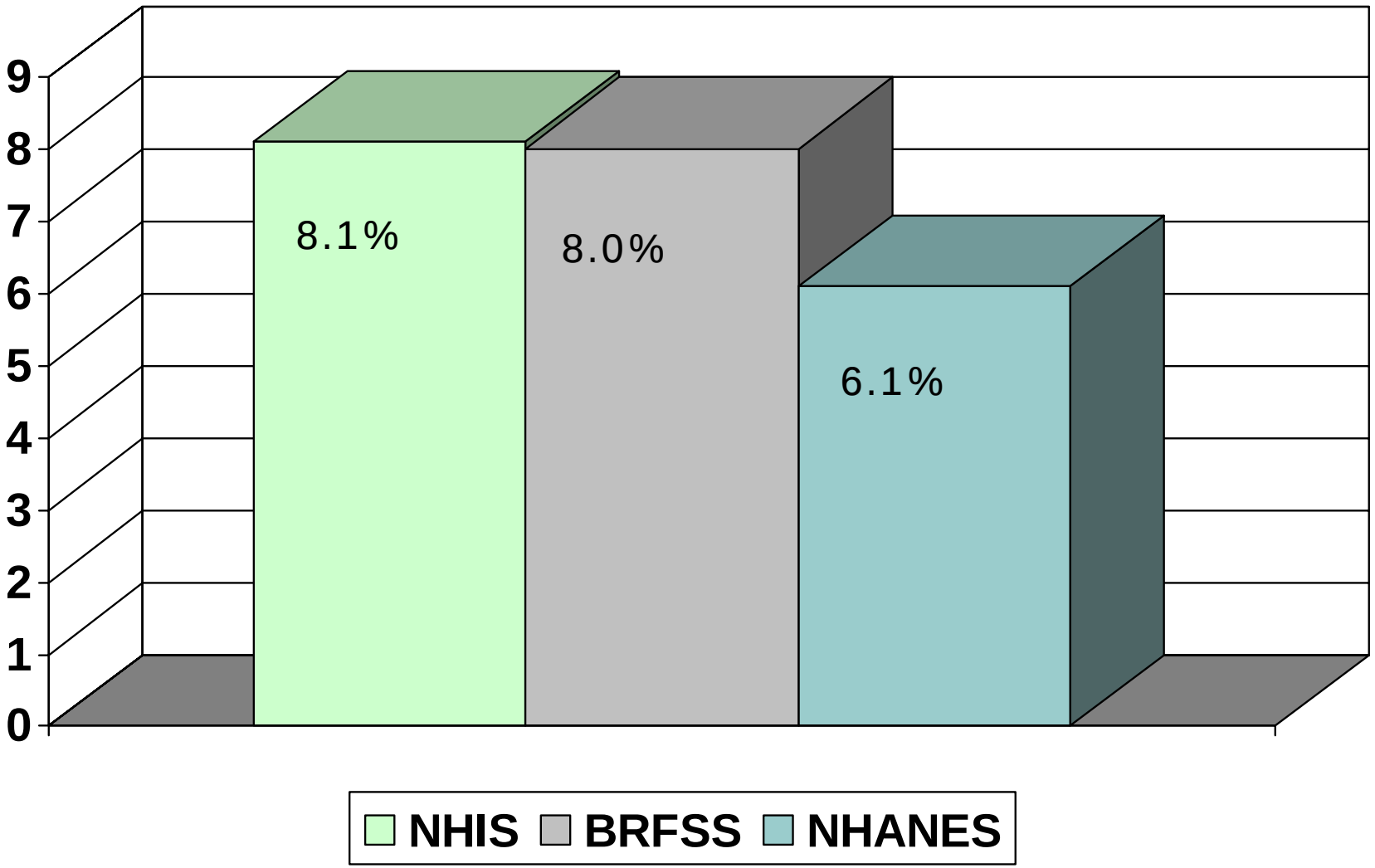
Summary of findings

- BRFSS vs NHIS estimates:
  - Significantly different on 10 of 15 variables
  - Relative difference:
    - Asthma = +35%
    - HIV testing = +26%
- BRFSS vs. NHANES estimates:
  - Significantly different on 5 of 6 variables
  - Relative difference:
    - Current smoking = -12.2%
    - Body mass index = -2.1%

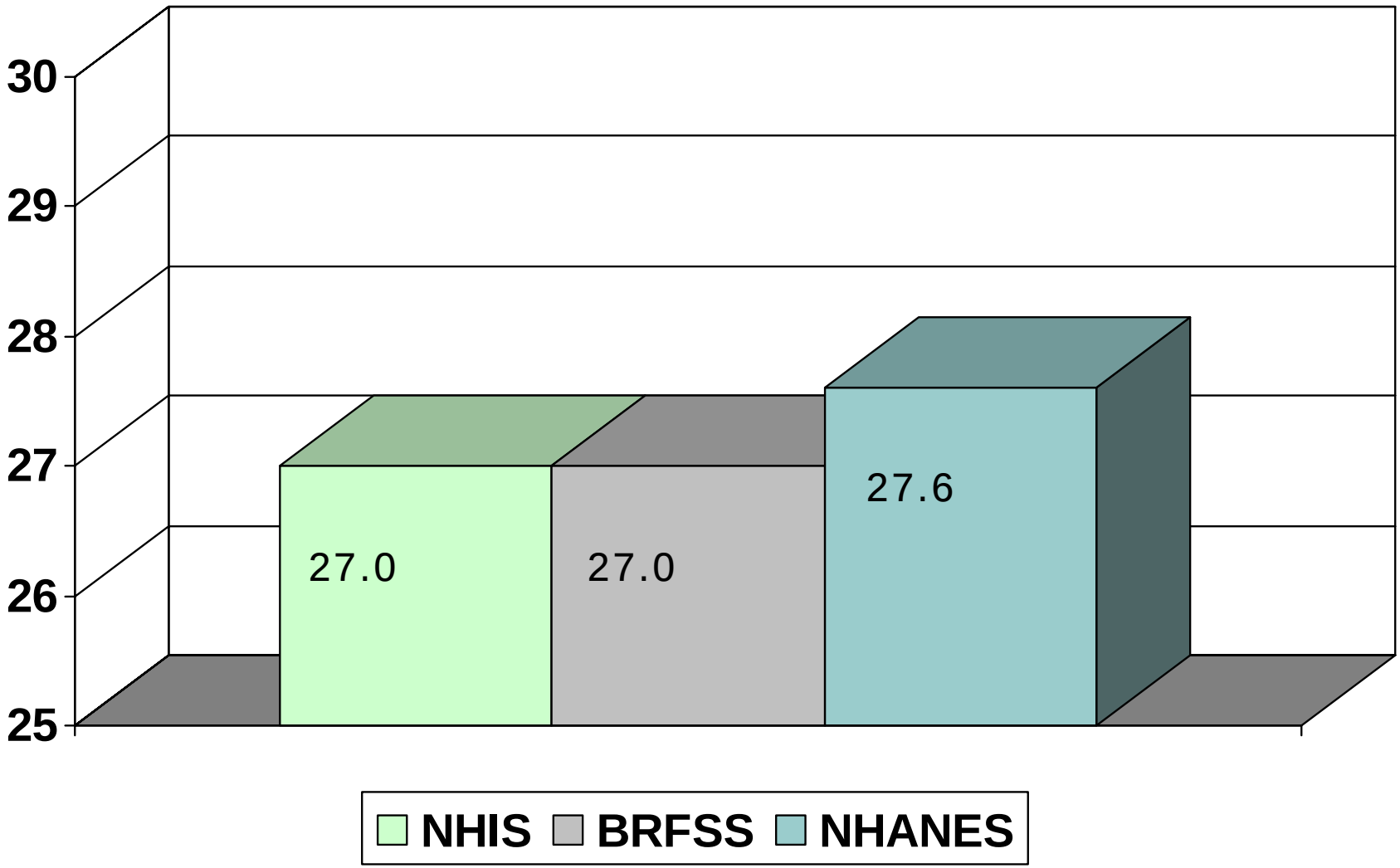
Ever smoke cigarettes



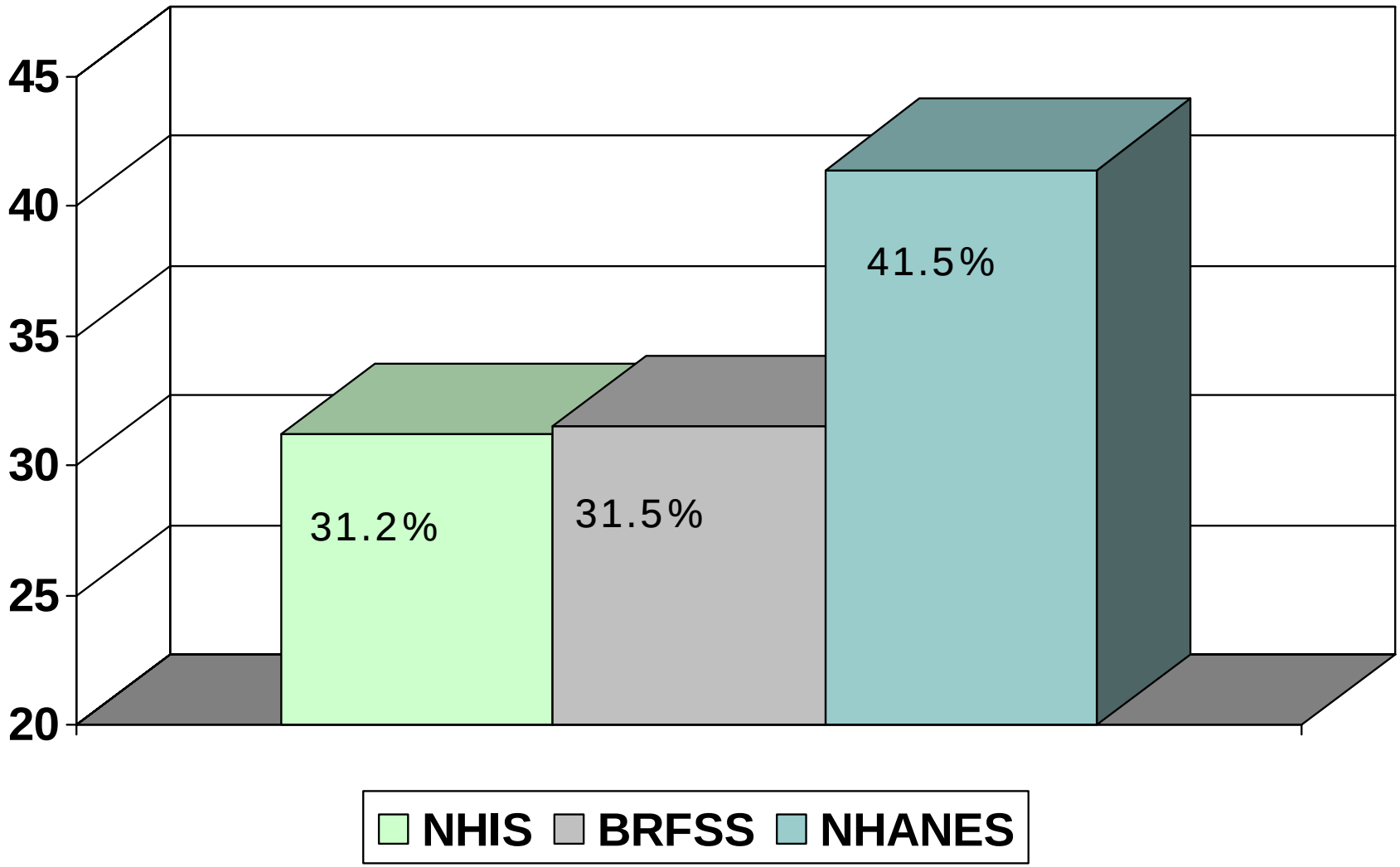
Ever told had diabetes



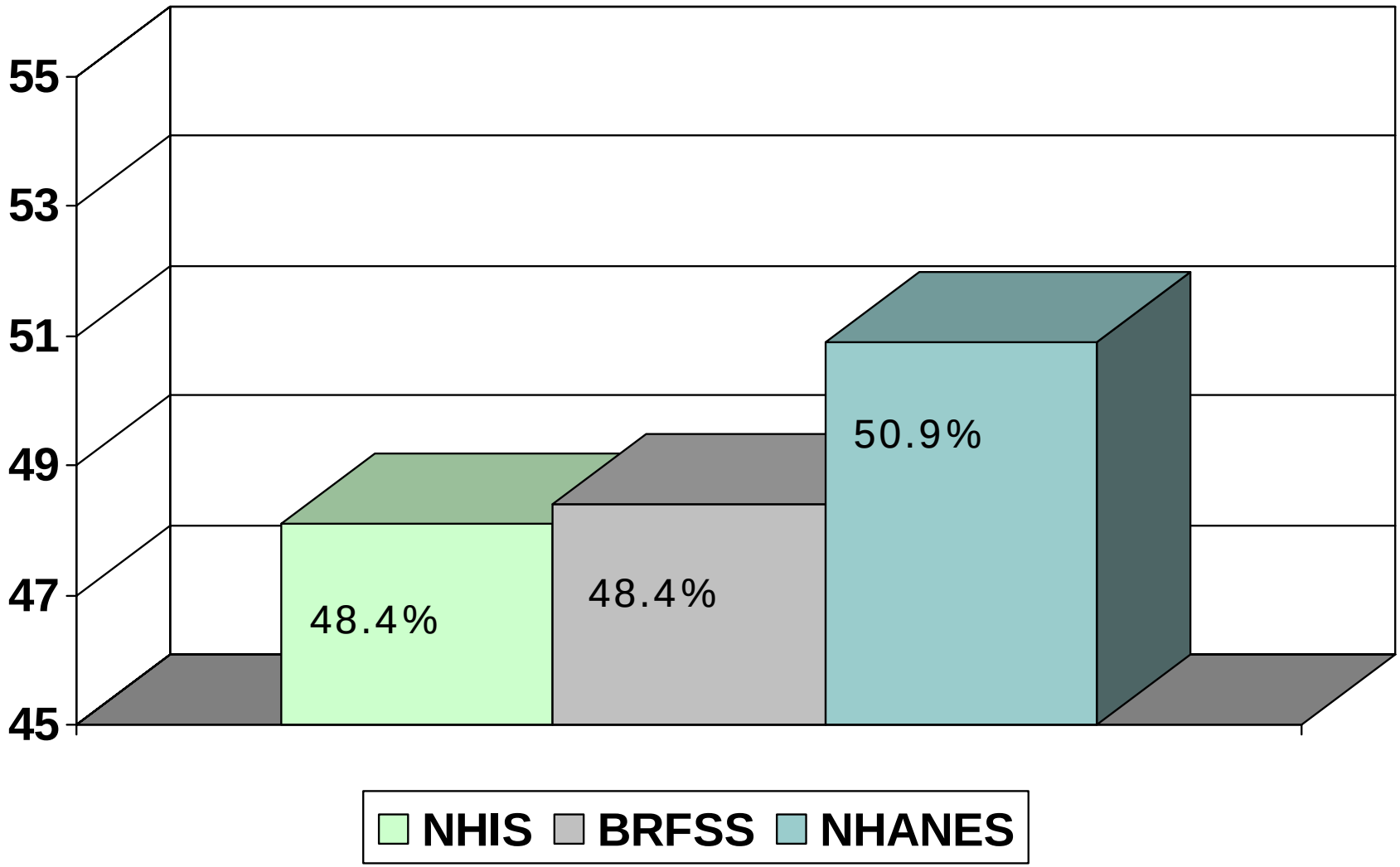
Body Mass Index



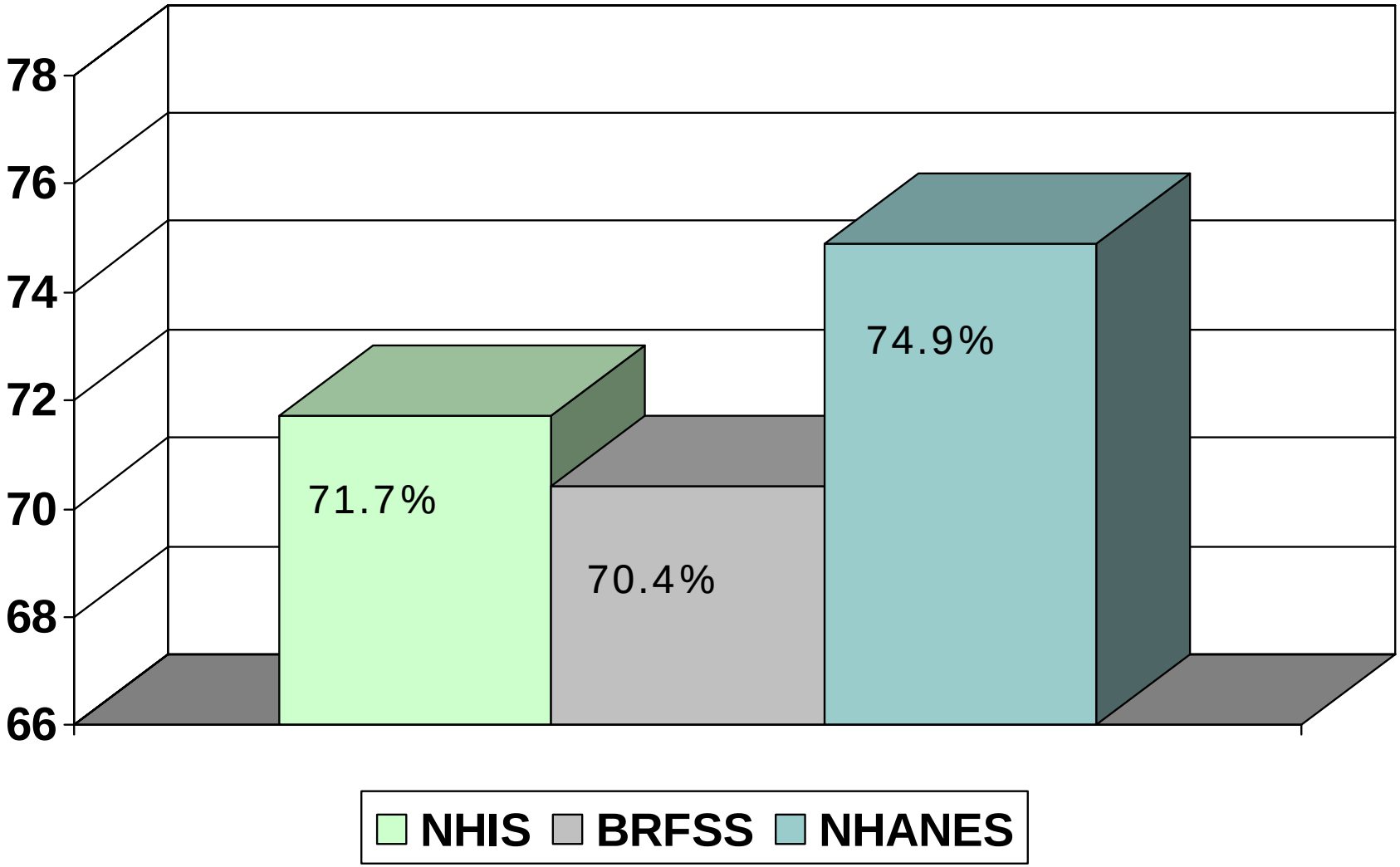
Percentage of 18–34 year olds



Percentage of Males



Percentage of whites



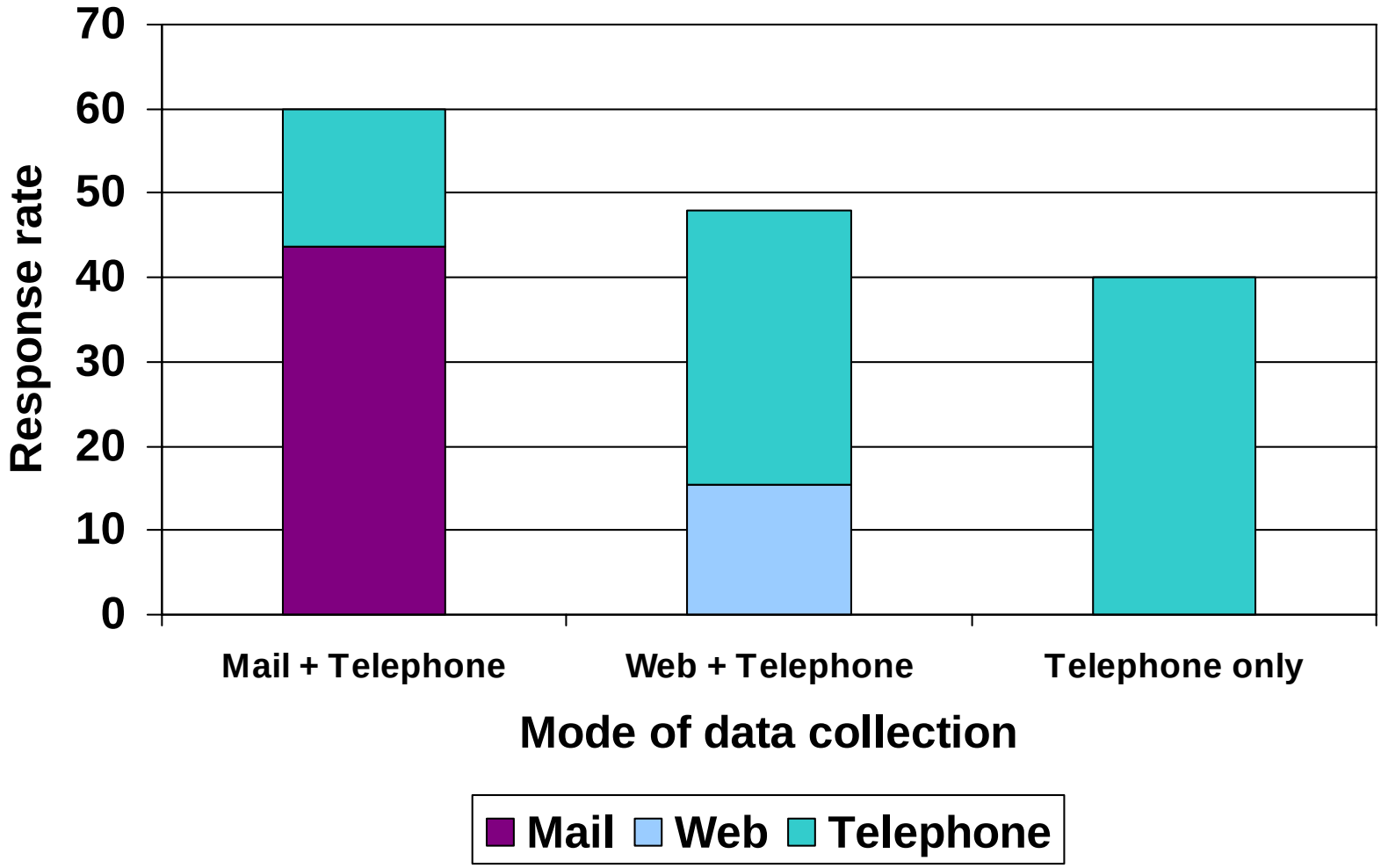
What did we learn?

- There are no “gold standards” in health statistics
- All comparisons are relative
  - Surveys can vary in terms of backend processing just as much as on front-end design and operational issues
- Determining if BRFSS compares favorably with other surveys is a matter of perspective

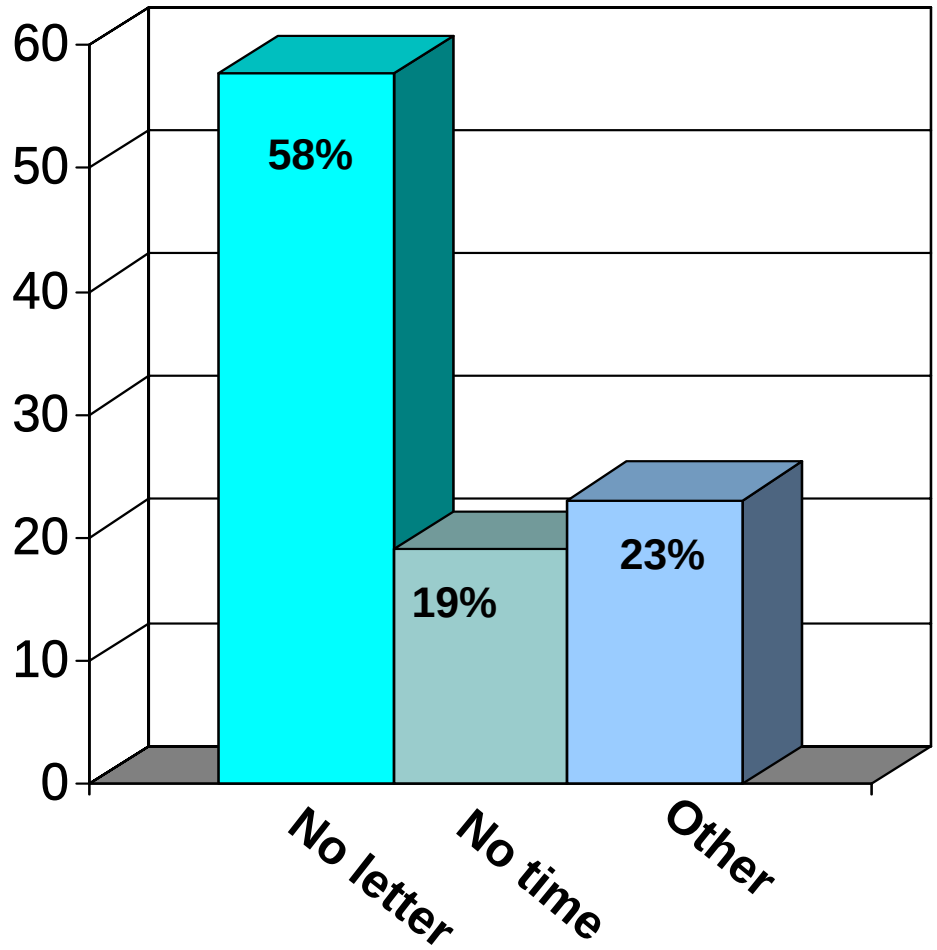
Finding new ways of collecting data:

Cell phones
&
Address-based sampling

Response rates by mode: 2003 BRFSS mode pilot (address-matched sample)

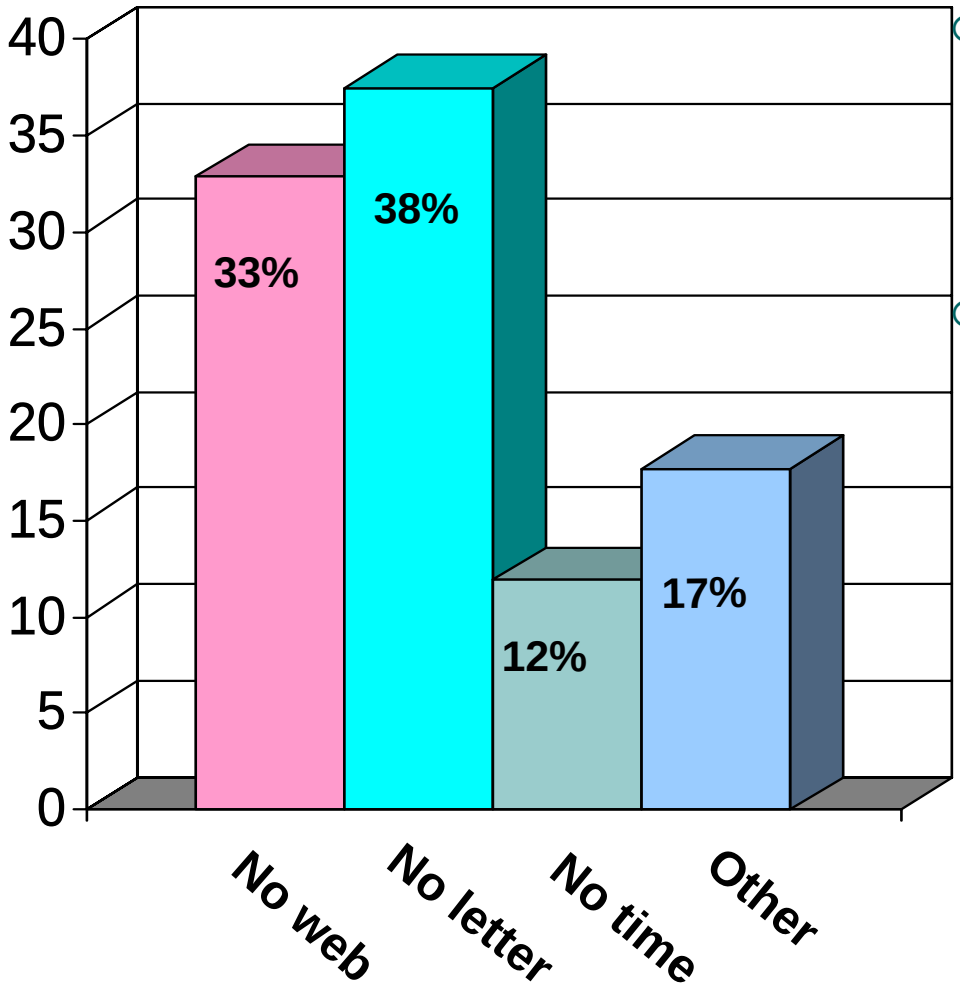


Why Not Complete Mail Survey?



- Letter not received:
  - Men
  - Blacks/Hispanics
  - 18-34
- Other reasons:
  - Lost questionnaire
  - Too much junk mail
  - Just don't like surveys!

Why Not Complete Web Survey?



- No web access:
  - 65 and older
  - Lower SES
  - No children
- Letter not received:
  - Men
  - 18-34
  - Upper SES
  - Blacks/Hispanics
  - HHs with children

Item Nonresponse: Telephone vs Mail (Percent DK / RF / Blank)

Health condition / risk factor	Telephone (%)	Mail (%)
Asthma	0.2	**2.4*****
Diabetes	0.1	**0.9*****
High blood pressure	0.2	**1.7*****
Obese (BMI > 30)	**8.2**	3.0***
Current smoker	0.4	**1.9*****
Binge drinking	2.3	2.1
Tested for HIV[1]	**5.6**	2.8***
HIV risk behaviors[1]	3.7	3.4

Note: Percentages are unweighted. Significance: * p<.05, ** p<.01, *** p < .001

[1] Questions not asked of respondents age 65 years or older

Potential mode affects on response: Unadjusted estimates

Health condition / risk factor	Unadjusted prevalence estimates		
	CATI % (95% CI)	Mail Survey % (95% CI)	Web survey % (95%CI)
Asthma	11.7 (10.3-13.1)	12.0 (9.8-14.2)	11.9 (10.0-13.8)
Diabetes	9.5 (8.2-10.8)	11.9 (9.7-14.1)	10.2 (8.4-12.0)
High blood pressure	31.1 (29.1-33.1)	38.1 (34.8-41.4)	33.2 (30.5-35.9)
Obese (BMI > 30)	21.6 (19.8-23.4)	26.5 (23.5-29.5)	25.6 (23.0-28.2)
Current smoker	22.8 (21.0-24.6)	16.9 (14.4-19.4)	17.3 (15.1-19.5)
Binge drinking	14.4 (12.9-15.9)	12.3 (10.1-14.5)	21.6 (9.0-24.2)
STD prevention[1]	8.2 (6.8 - 9.6)	4.3 (2.6 - 6.0)	3.3 (2.2 - 4.4)
Tested for HIV[1]	38.8 (36.3-41.3)	30.8 (27.0-34.6)	32.1 (29.1-35.1)

‡ Questions not asked of respondents age 65 years or older

Potential mode affects on response: Adjusted estimates

Health condition / risk factor	Adjusted odds ratios*		
	CATI	Mail survey AOR (95%CI)	Web survey AOR (95%CI)
Asthma	1.0	1.07 (0.84-1.34)	1.06 (0.83-1.38)
Diabetes	1.0	1.16 (0.89-1.51)	1.30 (1.01-1.67)
High blood pressure	1.0	1.22 (1.01-1.46)	1.30 (1.09-1.54)
Obese (BMI > 30)	1.0	1.37 (1.12-1.66)	1.31 (1.10-1.57)
Current smoker	1.0	0.83 (0.67-1.03)	0.77 (0.63-0.93)
Binge drinking	1.0	1.17 (0.90-1.52)	1.87 (1.50-2.34)
STD prevention[1]	1.0	0.69 (0.43-1.12)	0.51 (0.33-0.78)
Tested for HIV[1]	1.0	0.81 (0.65-1.01)	0.85 (0.71-1.03)

* Models are adjusted for respondents' state of residence, sex, race, age, education, and number of adults in the household.
[1] Questions not asked of respondents age 65 years or older

The Plague of Cell Phones!!!

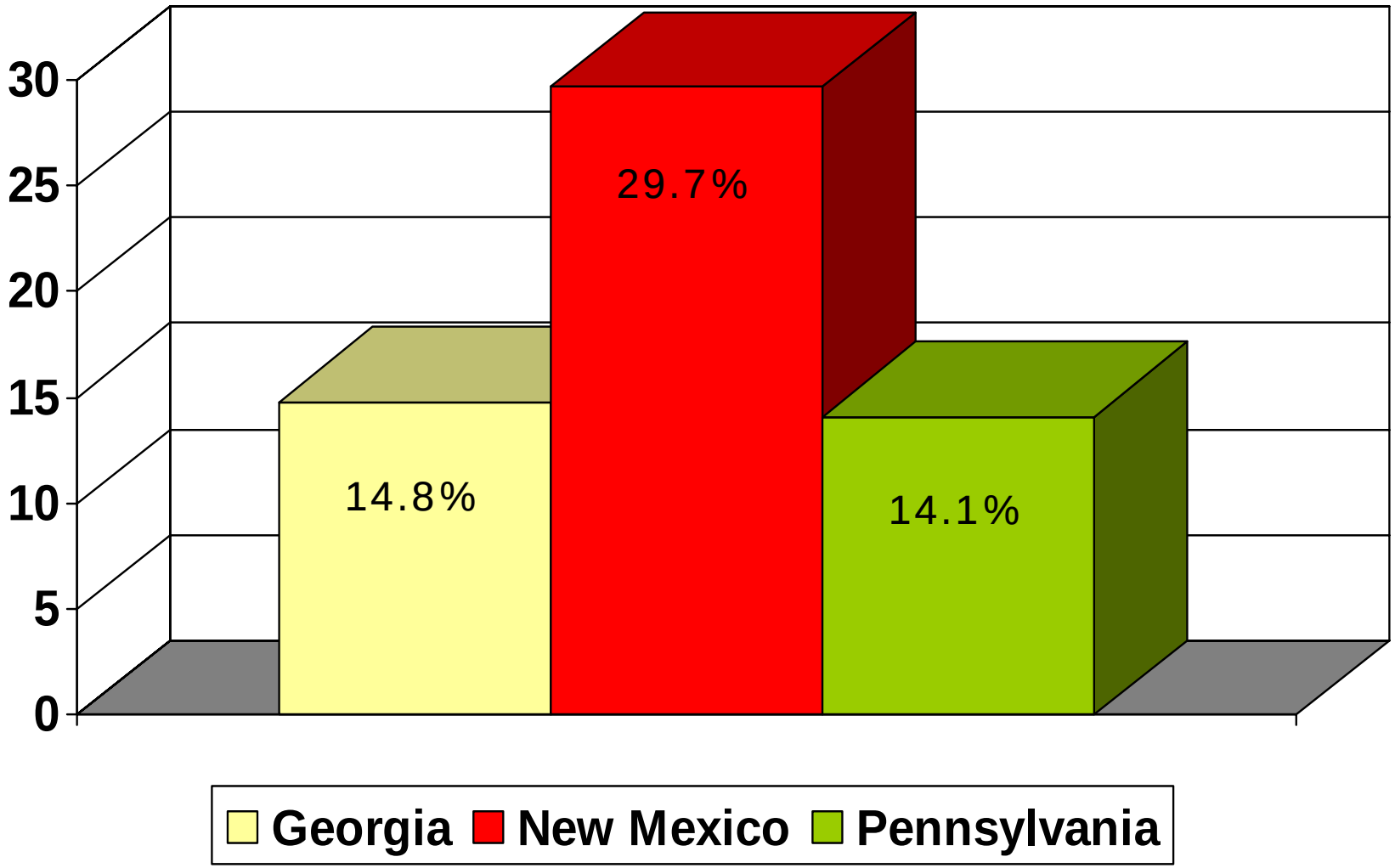
Cell phones and telephone surveys

- Reliance on cell phones increasing:
  - Nearly 70% of households in US have a working cell phone
  - In late 2006, 12.8% of households were cell phone-only
- Conducting surveys via cell phones can be operationally challenging:
  - Cell phone frame very inefficient
  - Cannot use autodialers
  - Charges for incoming calls/minutes used
  - Safety concerns
  - Potential mode effects / measurement errors

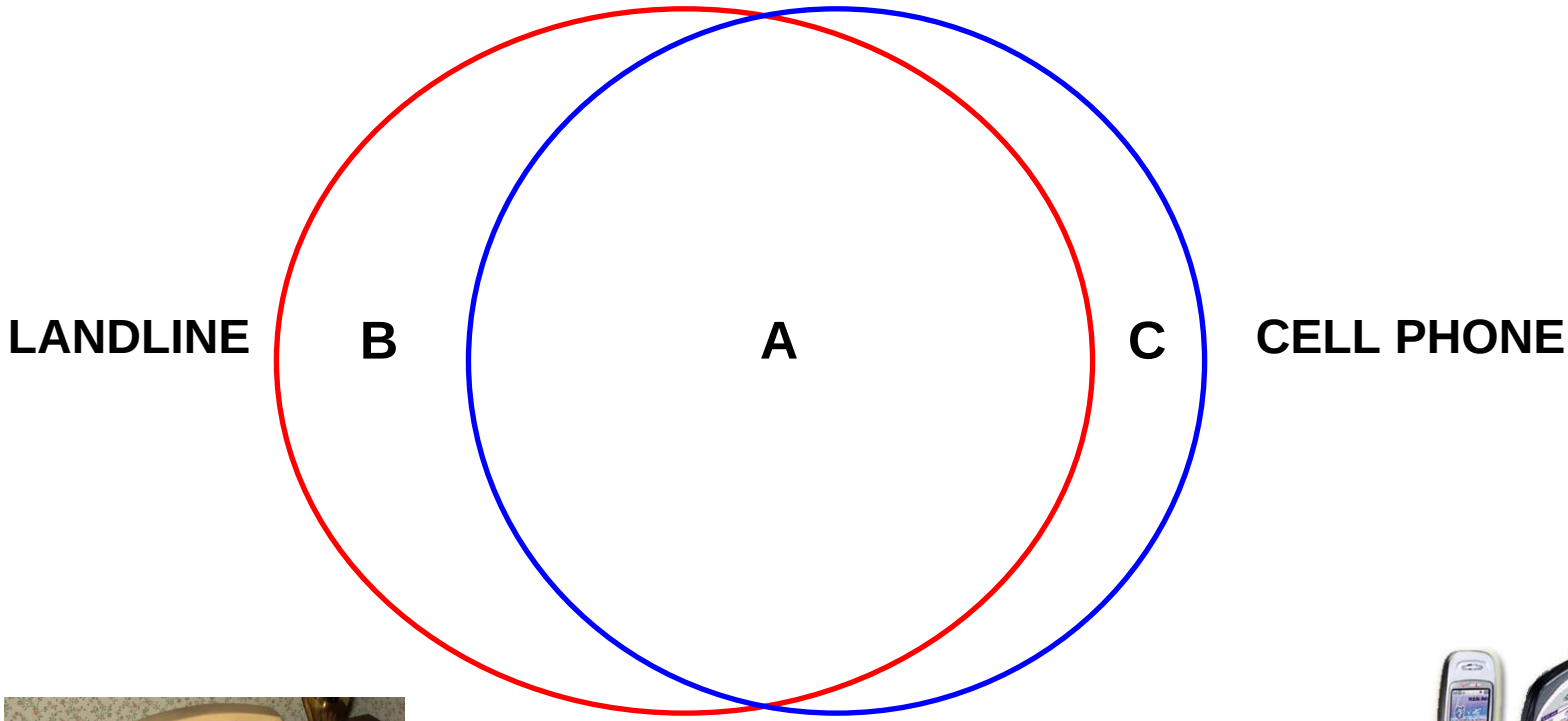
2007 BRFSS cell phone pilot

- Conducted in 3 U.S. states
- Target: 600 cell & landline / 600 cell-only
- Abbreviated BRFSS core interview:
  - 66 questions
  - 15-17 minutes (on average)

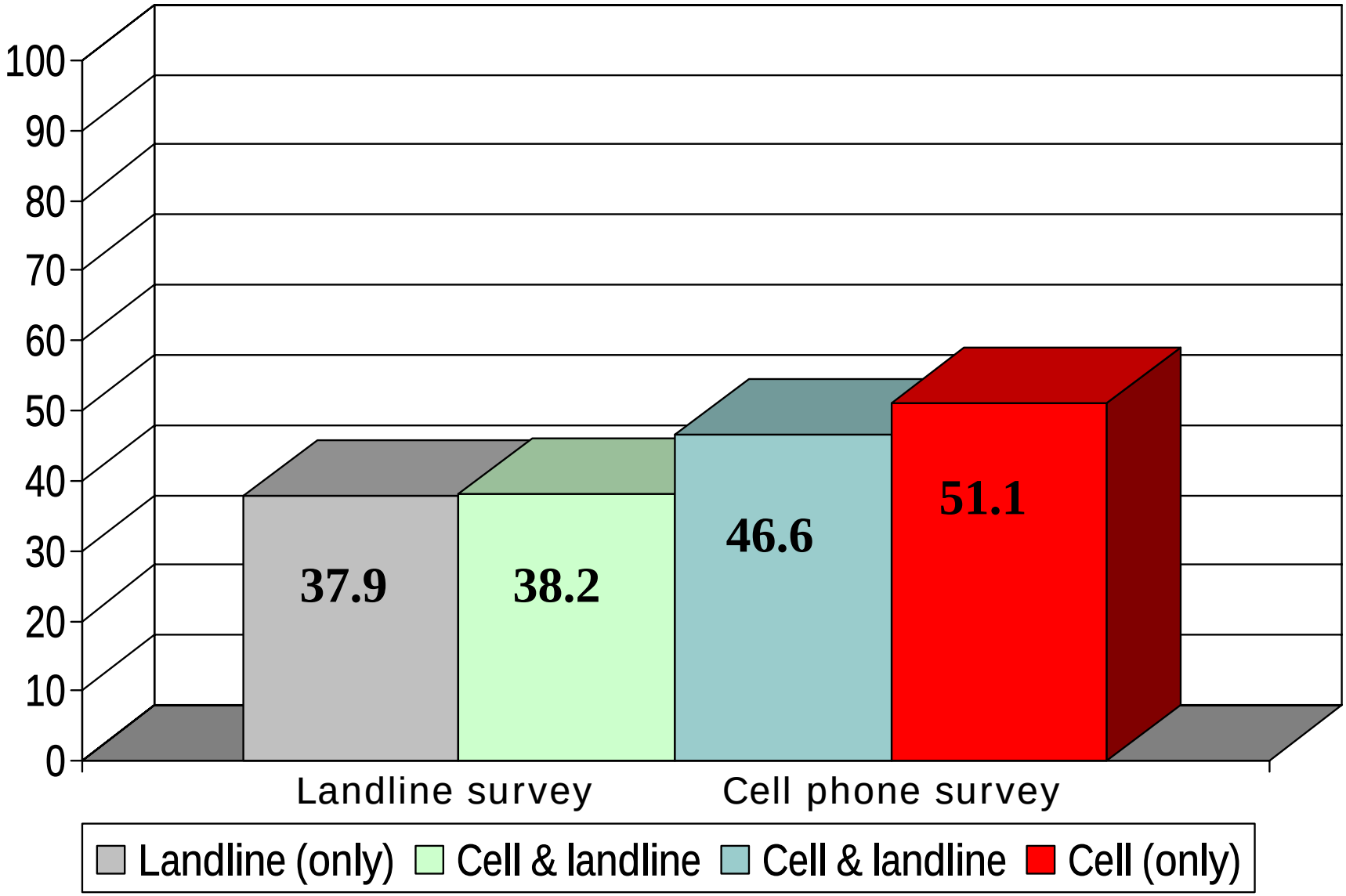
Response rates



Landline and Cell phone populations and frames

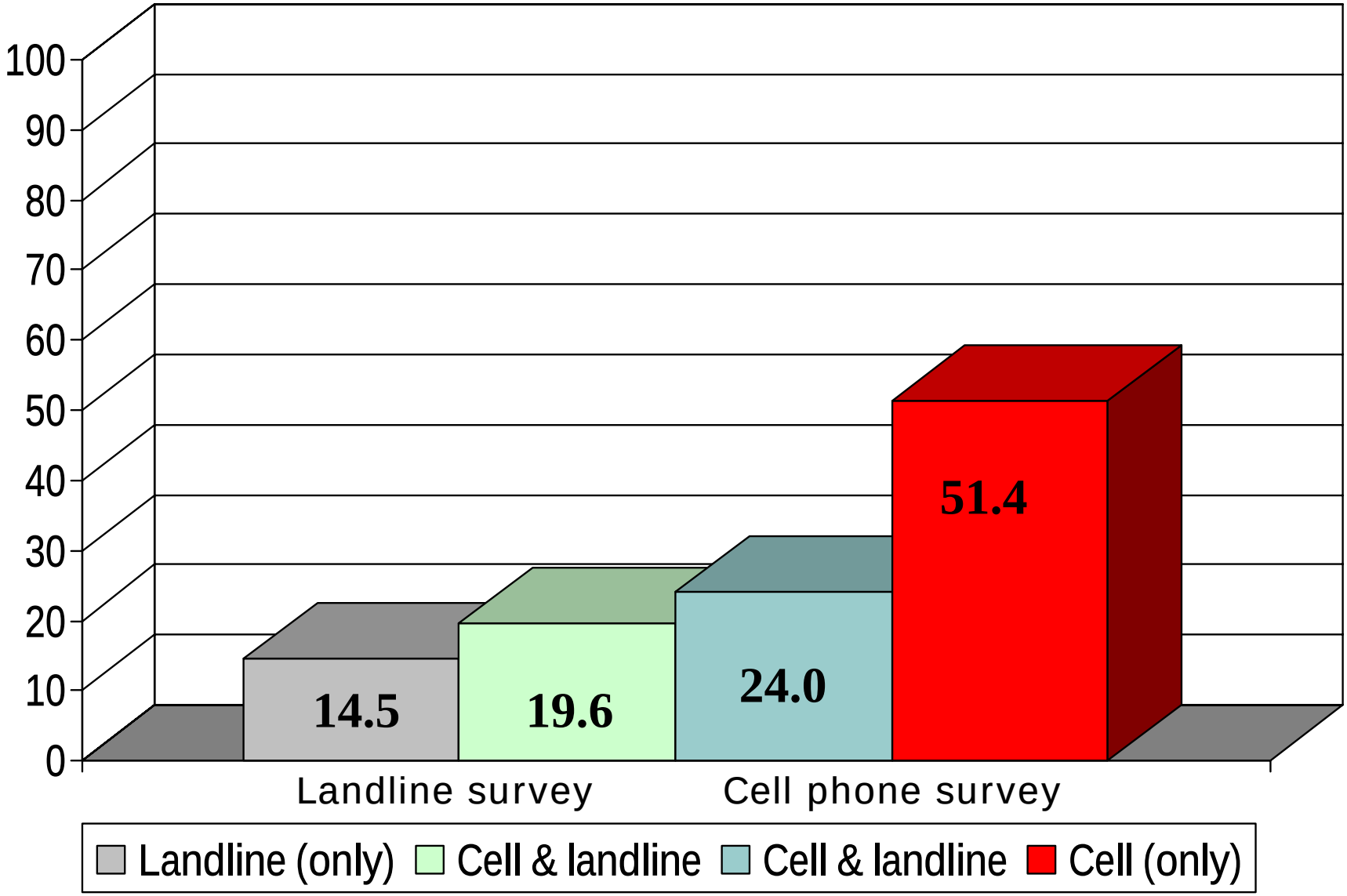


Percent male



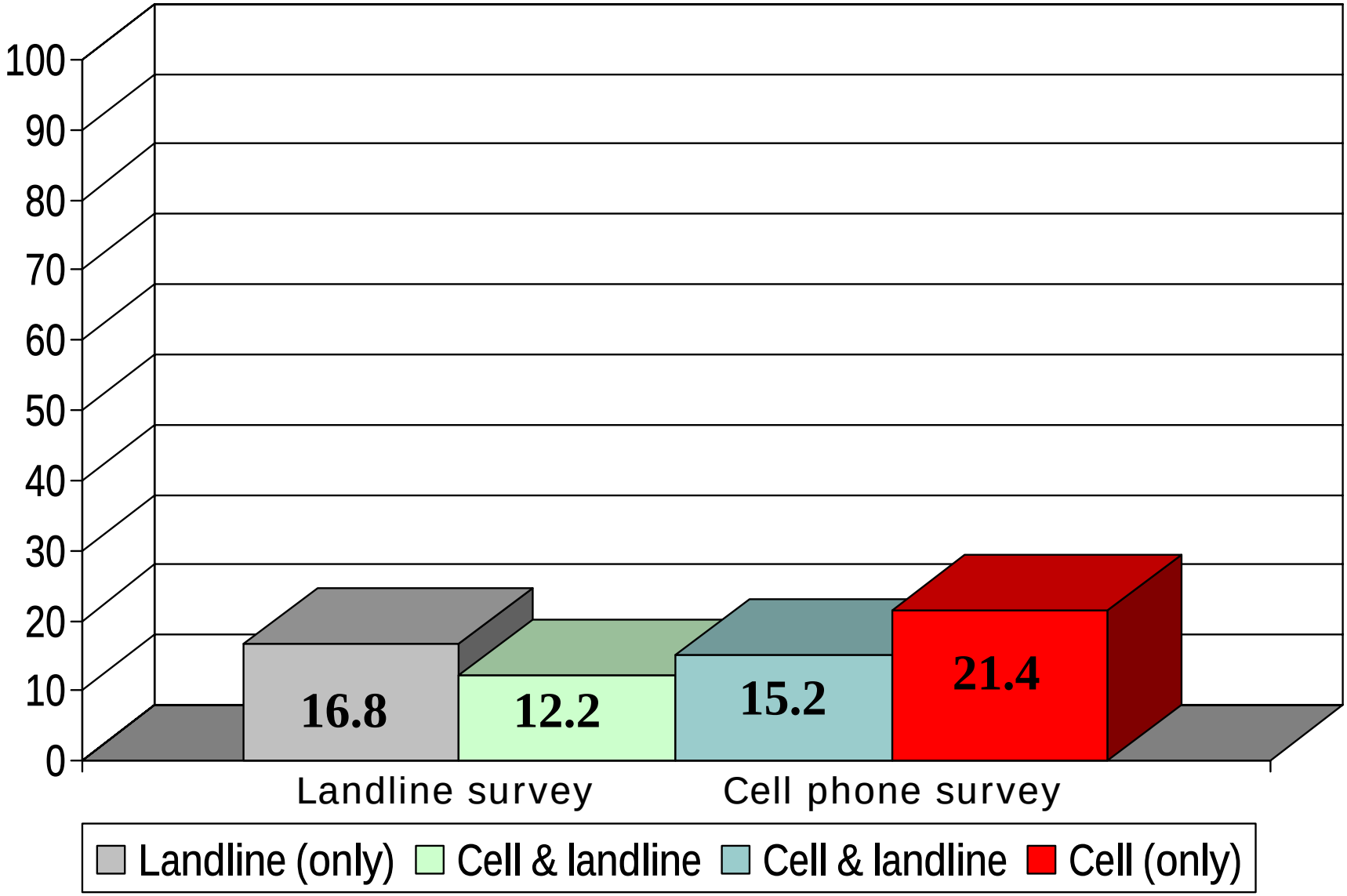
State equalized design weight applied

Percent 18–34 years



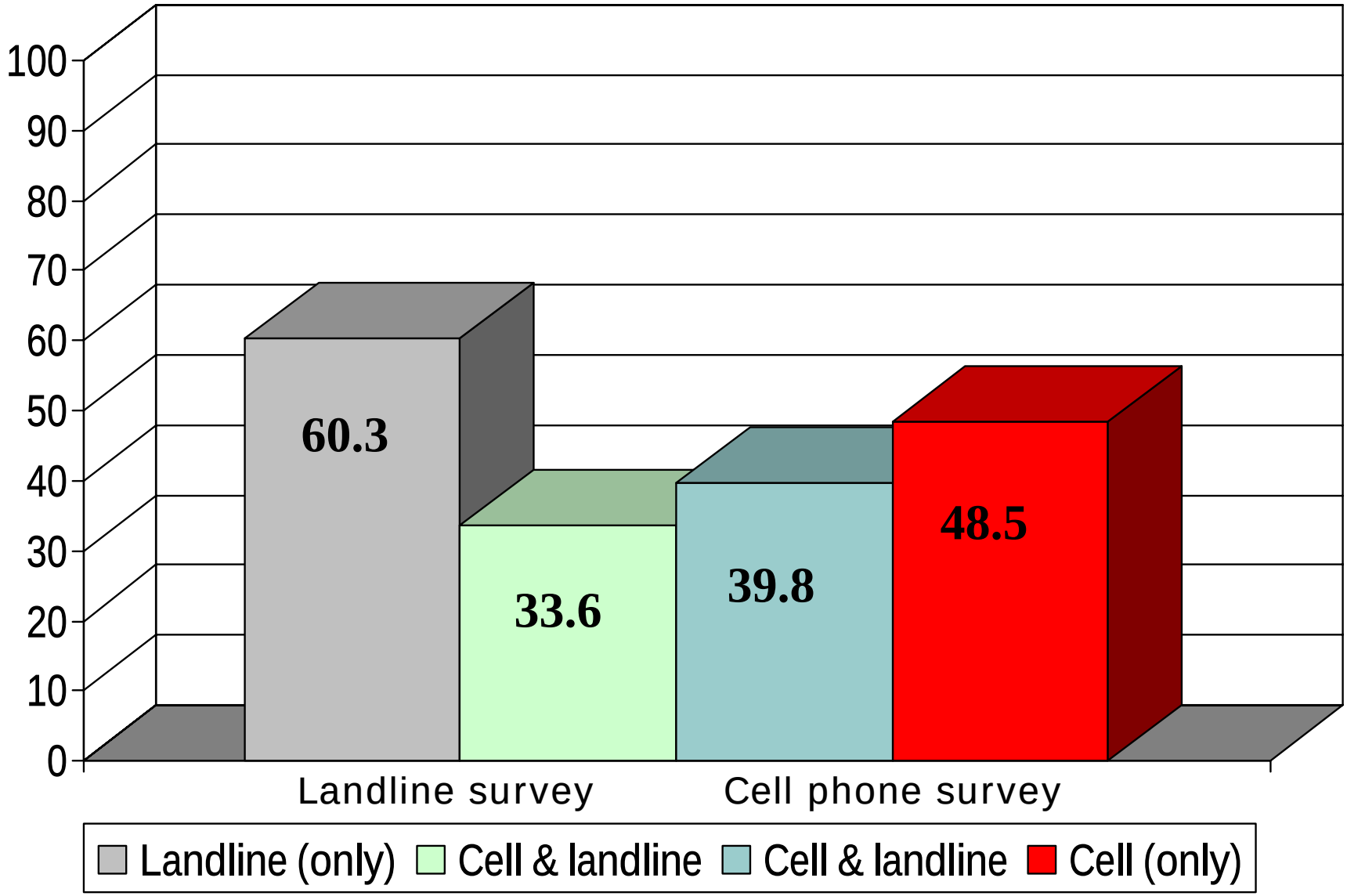
State equalized design weight applied

Percent Hispanic



State equalized design weight applied

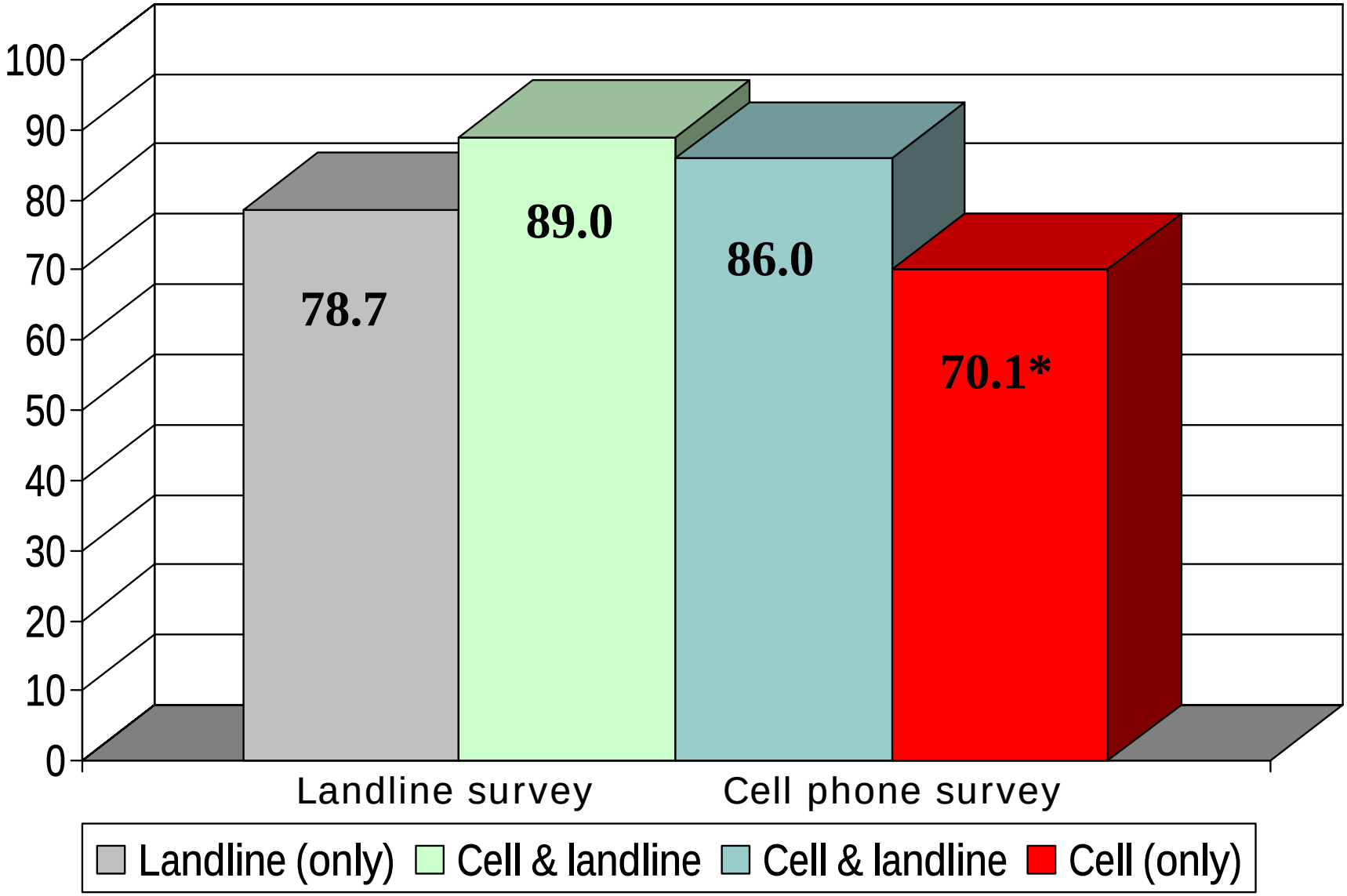
Percent high school or less education



State equalized design weight applied

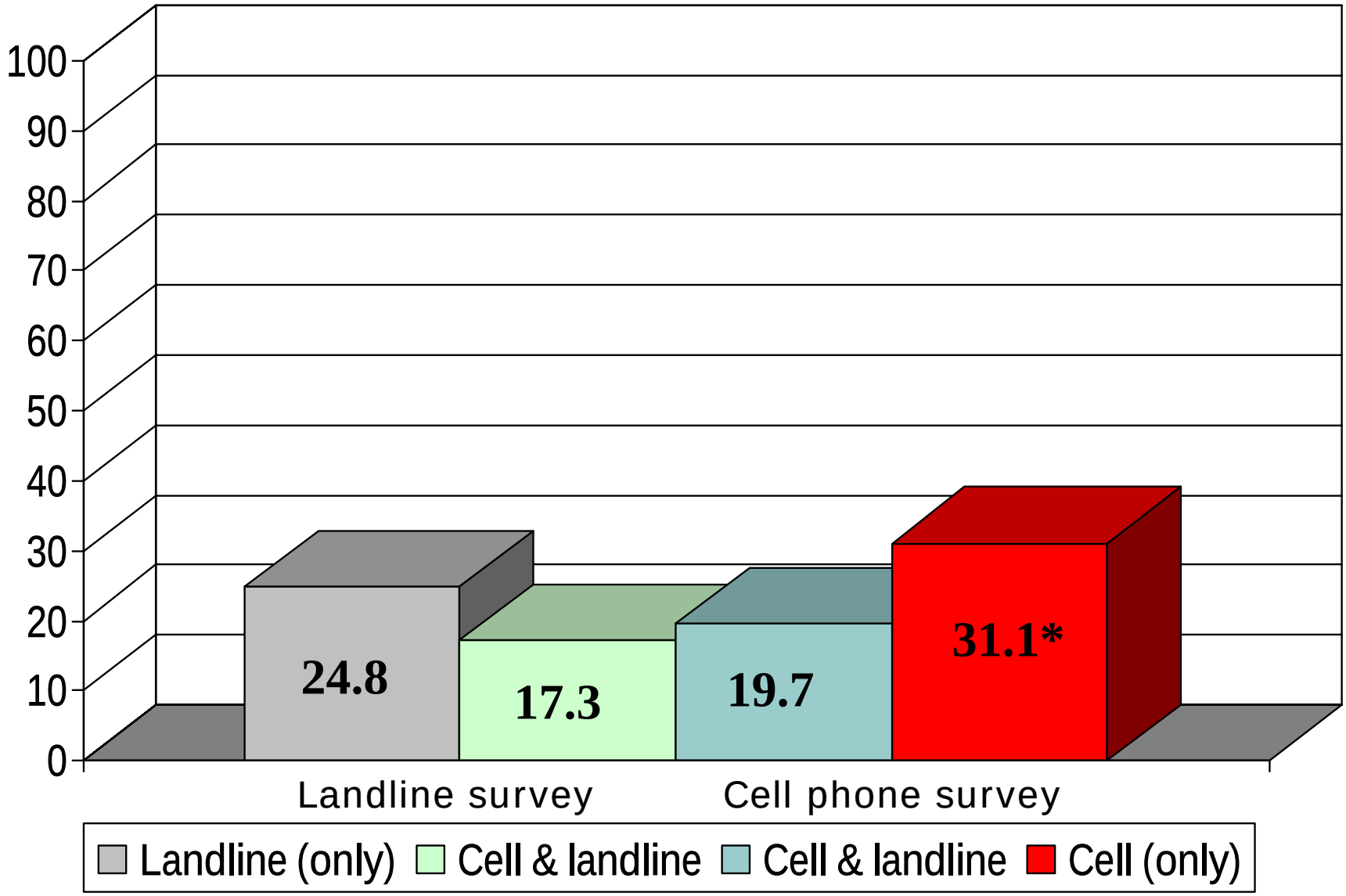
Comparison of key survey estimates

Percent any kind of health care coverage



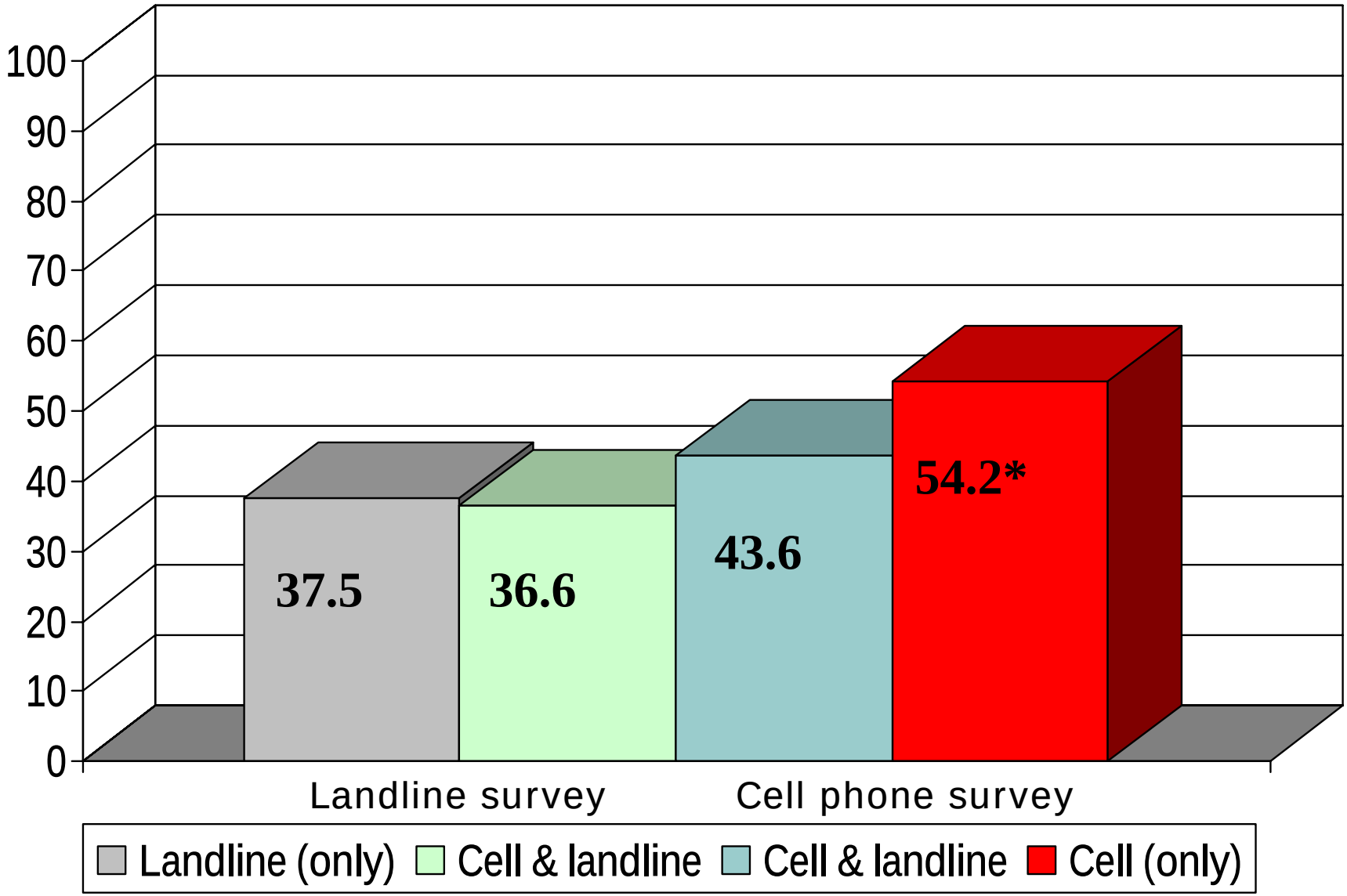
State equalized design weight applied

Percent currently smoke cigarettes



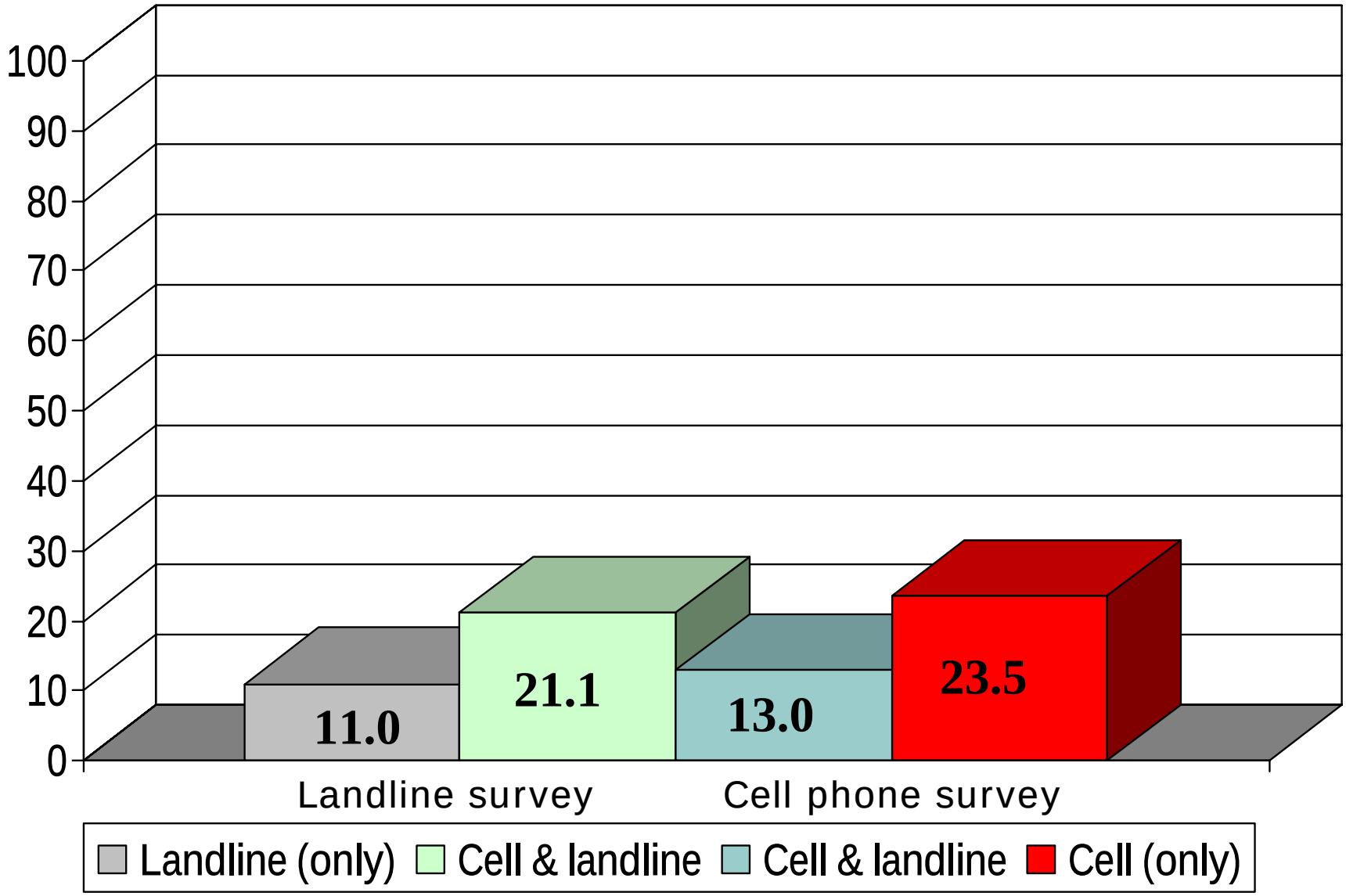
State equalized design weight applied

Percent ever tested for HIV



State equalized design weight applied

Percent binge drink past 30 days



State equalized design weight applied

What did we learn?

- The part of the population we are missing due to cell phones is different from those we interview --- and we cannot ignore them

- Missing critical information needed to integrate landline and cell phone samples at the sub-national level
  - No reliable external standards denoting telephone usage at subnational level

Concluding thoughts

- Producing valid survey estimates is a multi-phase / multifaceted process
- Assessing validity is often quite difficult, involving a mix of scientific rigor and subjective judgment
- Ensuring validity is a necessity for the long-term survival of any health surveillance system

Contact:
Ali Mokdad
AMokdad@cdc.gov

For more information on BRFSS:

www.cdc.gov/brfss