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Estimates of Cigarette Smoking From the NJ Adult Tobacco Survey: Real or Spurious?

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Abstract

Objective—To explore, post hoc, whether a large decline in smoking estimates between the 2005 and 2006 New Jersey Adult Tobacco Surveys is real or spurious given various methodological and environmental changes between the 2 time periods of data collection.

Methods—Using multiple data sources, we explored survey timing, poststratification approach, midinterview terminations, wireless substitution, and question order.

Results—Changes in question order were likely responsible for the majority of the unexpected decline in smoking prevalence; to a lesser degree, wireless substitution and midinterview terminations also likely contributed to an artificially exaggerated decline.

Conclusion—Methodological changes can artificially affect trends in prevalence estimates.

Keywords

cigarette smoking; surveillance; survey methods; response rates; survey bias

The New Jersey Adult Tobacco Survey (NJATS) has been an important surveillance and evaluation system for the New Jersey Comprehensive Tobacco Control Program (CTCP) since 2000. Cigarette smoking prevalence estimates from the NJATS have typically been approximately one percentage point lower than those generated by the New Jersey Behavioral Risk Factor Surveillance System (NJBRFSS). This phenomenon has been noted elsewhere where estimates from general surveys are routinely higher than those from topic-specific surveys.^{1–3} Despite the differences in estimates, smoking trends over time have

been similar between the 2 surveillance tools, except in 2006, when a sharp decline in the NJATS estimate diverged considerably from the NJBRFSS. This unexpected result warranted an investigation of the possible explanations for the NJATS estimate. In particular, we suspected that methodological and/or environmental changes contributed to the observed estimate rather than a real decline in smoking. The NJATS sampling approach and survey instrument remained fairly consistent over time until 2006 when the survey was conducted for the first time with CDC's support, which resulted in 3 methodological changes: (1) smokers, recent quitters, or young adults were no longer oversampled; (2) the CDC supported-ATS used slightly different demographic categories for poststratification than those used in prior NJATSs; and (3) questions on smoking behavior appeared earlier in the survey compared to prior NJATSs. In addition, the 2006 NJATS was collected during a time that coincided with the introduction of the New Jersey's Smoke-Free Air Act (SFAA). Subsequently, we suspected that either methodological and/or environmental changes could have impacted our estimate.

Methodological issues and changes can indeed produce changes in population estimates.^{4,5} Population surveys have experienced declining response rates in the past decade, including refusals at contact and midinterview terminators.^{6,7} Moreover, some research suggests that the use of different poststratification methodologies aimed to counter increasing nonresponse can also impact population estimates.⁸ The ordering and particular sequencing of questions on survey instruments can impact respondents' willingness to complete a survey as well as influence responses to questions, a phenomenon known as *context effect*.^{9,10} Lastly, recent research has found that the rate of wireless substitution has increased exponentially and that certain subgroups (eg, young adults) were more likely to live in cell-phone-only households.¹¹ Indeed, adults in cell-phone-only households had higher odds of reporting cigarette smoking relative to adults with landline telephones.¹¹ This creates a sampling issue, specifically undercoverage, for traditional landline RDDs.

This paper explores whether the unexpectedly large decline could represent a real decline in smoking, is attributable to the methodological differences between the 2005 and 2006 NJATSs or some other methodological artifact, or is the result of a combination of the factors reviewed above. We formulated 5 post hoc hypotheses to explore based on survey research methodology literature and issues specific to New Jersey:

1. Data for the 2006 NJATS were collected from late January to early June, coinciding with the passage (January 2006) and implementation (April 2006) of NJ's SFAA. Increased media attention surrounding the implementation of the SFAA may have influenced smokers to quit and/or underreport their smoking behaviors.
2. Differences in poststratification approach for the 2005 and 2006 NJATSs are responsible for the different estimates.
3. An increase in midinterview terminations among smokers between 2005 and 2006 caused a larger underestimation of cigarette smoking in 2006.

4. An increase in the proportion of adults who live in cell-phone-only households between 2005 and 2006 led to a larger underestimation of smoking behavior in 2006.
5. A context effect resulting from a change in the ordering of questions led to respondents' underreporting smoking behaviors in 2006.

METHODS

Our post hoc study employed a mixed-methods approach using several data sources. A brief description of each data source and the methods used for analysis of each source are provided below.

The New Jersey Adult Tobacco Survey and NJ Behavioral Risk Factor Surveillance System (NJBRFSS)

The NJATS is a point-in-time, random-digit-dial (RDD) telephone survey that collects data on smoking behavior, knowledge, and attitudes among New Jersey adults. The survey has been conducted periodically (ie, 2000, 2001, 2002, 2005, and 2006) to monitor trends over time and assess whether the CTCP goals are being reached. Historically, certain population subgroups (ie, young adults, current smokers, and recent quitters) were oversampled to ensure adequate sample sizes for analyses; but as mentioned previously, in 2006 we no longer oversampled for these groups. The data in 2005 and 2006 were collected over a 5-month period (ie, January through May). The data are weighted to adjust for varying probabilities of selection and nonresponse, yielding prevalence estimates that are generalizable to the adult population of New Jersey.

Details on the BRFSS methodology are provided elsewhere.¹² Because some data suggest that smoking behavior may be influenced by seasonal variations in smoking,¹³ we repeated our analyses restricting the NJBRFSS to the time frame corresponding to the NJATS data collection periods to rule out seasonality as a confounding factor. Self-reported current smoking status was defined as having smoked 100 cigarettes in a lifetime and now smoking cigarettes every day or some days. Data analysis was conducted with SUDAAN statistical software, which corrects for the complex sample design.

Analysis of Media Coverage

To examine media attention surrounding the implementation of the SFAA, we analyzed tobacco-related newspaper clippings. As part of an independent evaluation of the New Jersey CTCP, the number and content of tobacco-related clippings appearing in New Jersey news publications (as well as in select national and regional newspapers) were tracked. News articles mentioning any number of smoking-related keywords were clipped and provided by Garden State Press Clippings Bureau, a news clipping service in New Jersey. Clippings were searched from over 500 news publications in New Jersey, including daily, weekly, and monthly newspapers. Received clippings were processed and coded as part of an ongoing content analysis of this news coverage for source variables such as publication name and date and content variables such as the primary tobacco issue covered in the article (eg, tobacco control policy, cessation). We analyzed tobacco-related clippings collected in

2005 and 2006 for the time period leading up to and including each of the NJATS administrations (January through May, 2005 and 2006). During these 2 time periods, a total of 3910 tobacco-related clippings (including all news/feature articles, editorials, letters to the editor, and cartoons/photos) were collected from 178 publications. An increase in smoking-related media coverage during the 2006 NJATS administration may have influenced respondents to be more likely to underreport their smoking behavior or quit smoking compared to 2005 NJATS respondents.

Poststratification Analysis

The CDC used different demographic categories for the 2006 poststratification than the NJATS had in previous years. Briefly, the 2006 data, using CDC methods, were poststratified to population estimates within 24 cells formed by crossing age, gender, and race/ethnicity whereas the 2005 NJATS adjusted to population estimates within 32 cells formed by crossing age, gender, and race/ethnicity. We computed several poststratification weights to compare compared smoking estimates – the methods of which are described in Table 1. These additional weights were intended to see how sensitive our estimates are to poststratification methods.

Cell-Phone-Only Analysis

We merged data from a cell-phone-only RDD survey of NJ adults conducted in late 2006 with the 2006 NJATS. The instrument for the cell-phone-only survey was an abbreviated version of the NJATS. The weights for this analysis were calculated in a multistage process. Preliminary weights were constructed to correct for differential probabilities of selection of both households and members within households and to adjust to the population of cell-only NJ residents (estimated to be 9.7%). These preliminary weights were then poststratified using NJATS 2005 methods (ie, weight 5 from Table 1). The cell-phone-only respondents had an average weight about 9 times the size of landline respondents due to the small sample (n=82) compared to landline respondents (n=6789). NJ-specific cell-phone survey data are not available for 2005, so we cannot make direct comparisons. Thus, our analysis does not allow us to determine if the increased rate of wireless substitution between 2005 and 2006 impacted the sharp decline. It is, however, reasonable to assume that part of the decline can be attributed to wireless substitution if the prevalence estimate is higher when the cell-phone-only population is included.

Midterm Drop-offs

We identified all midinterview terminators in the 2006 NJATS for whom we could identify smoking status and gender. A total of 344 midinterview terminators in the NJATS for which we could identify gender and smoking status were identified and combined with the raw data. Each was then assigned the mean weight for his or her respective gender.

Context Effect/Question Ordering

As mentioned previously, the ordering of questions for the NJATS changed in 2006. Prior to 2006, questions asking attitudes about smoking policies and the harmful effects of smoking (ie, “How much do you think a person can smoke regularly without harming his or her

health?”) were followed by questions about media awareness and then smoking behavior. In contrast, the cigarette use questions on the 2006 NJATS immediately followed the attitudinal question about smoking policies and harmful effects. Additionally, the 2005 NJATS oversampled smokers via a screener placed *before* the actual survey. Thus respondents were asked their smoking status before the broader attitudinal items, negating or minimizing a context effect from the harmful-effects question item. The 2006 NJATS did not include screener questions about cigarette use; respondents were asked about their cigarette use only after the harm-to-health attitudinal question. The proximity of the harm-to-health question to the smoking behavior questions. To investigate context effect, we calculated the proportion of respondents who indicated that there was no safe level of smoking and the adjusted odds (controlling for demographic variables) of reporting being a current smoker based on the response to the harm-to-health attitudinal question and compared the results from the 2005 and 2006 surveys.

RESULTS

Comparison of NJATS and NJBRFSS

Figure 1 presents the trend in smoking prevalence as measured by the NJATS and NJBRSS respectively. Smoking prevalence in New Jersey declined steadily by approximately half a percentage point per year between 2000 and 2003, before the rate of decline slowing. However, the 2006 administration of the NJATS observed a decline of 3.1 percentage points from the 2005 NJATS ($14.3\% \pm 1.2\%$ vs $17.4\% \pm 1.8\%$), which roughly translates to 200,000 fewer smokers. In this time period, the NJBRFSS remained unchanged ($18\% \pm 1.8\%$ vs $18\% \pm 1.8\%$). Cigarette smoking estimates derived from the NJBRFSS during the time frame corresponding to the NJATS data collection periods for 2005 and 2006 were actually slightly higher, albeit not significantly so, in 2006 ($19.4 \pm 1.8\%$) compared to 2005 ($17.4 \pm 1.6\%$) (data not shown in table).

Media Coverage

Figure 2 displays the number of tobacco-related clippings collected monthly in 2005 and 2006 for the time period leading up to and including each of the survey administrations (January through May, 2005 and 2006). During these 2 time periods, a total of 3910 tobacco-related clippings (including all news/feature articles, editorials, letters to the editor, and cartoon/photos) were collected from over 178 publications, corresponding to approximately 900 more tobacco-related news clippings in 2006 than in 2005 during the period of interest—an increase of approximately 60%.

Differences in Poststratification Weighting

Table 1 presents estimates with 95% confidence intervals for the different poststratification approaches. The CDC weights produced an estimated prevalence of 14.4% ($\pm 1.2\%$) whereas the 2005 NJATS (weight 4) methodology produced an estimated prevalence of 14.3% ($\pm 1.2\%$). These estimates are neither statistically nor substantively different. The other poststratification methodologies we computed all produced estimates slightly below both the 2005 NJATS and CDC methods, but none differed statistically (range: 13.3% to 14.1%).

Midterm Drop-offs and Cell-phone-only Households

Among the 344 identified midinterview terminators in the NJATS, 16.3% identified themselves as current smokers. In contrast, the unweighted smoking estimate among those who completed the interview was 12.5%. After merging these 344 cases into the sample, the adjusted weighted smoking prevalence increases to 14.6% ($\pm 1.2\%$), a 0.3 percentage point increase. Among the 82 cell-phone-only cases in the cell-phone pilot study, 23.2% identified themselves as current smokers. Including cell-phone-only adults in the 2006 NJATS increased the estimated smoking prevalence by 0.6 percentage points from 14.3% ($\pm 1.2\%$) to 14.9% ($\pm 1.4\%$). Both adjusted estimates (ie, with midinterview terminators and with cell-phone-only case) are within the 95% confidence interval of the 2005 smoking estimate, suggesting that no significant differences exist between 2005 and 2006.

Context Effect/Question Ordering

Figure 3 shows the prevalence estimates for the 2005 and 2006 NJATS grouped by perceived harm to health. Among those who reported “no safe level of smoking,” 13.4% ($\pm 1.9\%$) reported being a current smoker in 2005 compared to 8.6% ($\pm 1.2\%$) in 2006 – almost a 5 percentage point difference. In addition, the adjusted odds ratio predicting current smoking based on the response to the harm-to-health question indicated those who agreed there was some safe level of smoking were more likely to report smoking relative to those who said there is no safe level, and this relationship that was much stronger in 2006 NJATS (AOR = 3.3 [2.7–4.1]) than in 2005 NJATS (AOR=1.8 [1.4–2.4]).

DISCUSSION

We believe our observed decline in estimated smoking prevalence from the NJATS is a methodological artifact rather than a real decline in smoking among NJ adults. If a real decline had occurred, we would expect to see this in other smoking indicators. However, the NJBRFSS estimate remained steady from 2005 to 2006. Moreover, per capita consumption, as measured via state cigarette tax stamps, shows a flattening, and perhaps a slight increase, in 2006 for the first time in 5 years (37.5 in 2005 vs 37.7 in 2006), rather than a decrease.¹⁴

Although we cannot identify one sole reason, our analysis identified some plausible explanations that warrant further discussion. First, our findings suggest that changes in question sequencing are likely responsible for the majority of the unexpected decline in smoking prevalence. It is difficult to precisely estimate the exact contribution this effect may have had on the 2006 cigarette smoking prevalence rate. However, if the relationship between the 2 questions is held constant from 2005 to 2006, then based on the distribution of responses to the “harm” question in 2006, we estimate a hypothetical prevalence rate of 17.1% for 2006. This estimate is within the 95% confidence interval of the 2005 smoking estimate, suggesting that no significant differences between the 2 years would be observed.

The phenomenon of context effects has been well documented as a general concern in survey research methodology.¹⁰ Our results, though not conclusive, suggest that cigarette smoking is no exception to this possibility. Surveillance researchers are advised to carefully

consider the impact that a change in instrumentation –adding or deleting questions, or changing order – may have on their estimates before implementing such changes.

Our analysis found that including midinterview terminators increased the estimated smoking prevalence slightly. Although this was not statistically significant, it is plausible that this could account for some of the observed decline in smoking, though we cannot quantify the extent. Although we did not have historical data on the rate of midinterview terminators in NJATS, the rate of midinterview termination more than doubled in the NJBRFSS between 2000 and 2006.⁷ If smokers were more likely than nonsmokers to terminate midinterview, an increase in midinterview terminators could produce an artificially lower estimate.

The increase in cell-phone-only households may have caused some of the observed decline. Our analyses found a slight increase in the estimated prevalence after including cell-phone-only households in our sample. Though this was not statistically significant, it is consistent with previous research demonstrating that the exclusion of cell-phone-only households may artificially lower cigarette smoking estimates.^{11,15} Moreover, this is the only attempt of which we are aware to adjust for cell-phone-only households in a RDD tobacco-specific survey. Given the rapidly increasing rate of the cell-phone-only population,¹⁶ surveillance researchers should consider whether exclusion of cell-phone-only households from RDD systems can bias estimates and, if appropriate, include cell-phone-only sample in their data collection.

Lastly, the clippings data suggest the SFAA generated more news coverage about smoking in 2006 compared to 2005 and, in particular, framed smoking as something that needed to be controlled. Although prior research suggests that increases in smoking-related news stories correlate with decreases in smoking,^{17,18} we believe that the media attention heightened perceptions about the unacceptability of tobacco use and prompted socially desirable responses from some smokers (ie, deny tobacco use). If there were increased cessation activity surrounding the SFAA, we would expect to see some evidence of this in various cessation indicators. Although an increase in NJQuitline use was noted during the first quarter of 2006 compared to 2005, increased usage translated into approximately 700 additional smokers, too small a figure to have had a noticeable impact on smoking prevalence. Moreover, it would be unlikely that a substantial number of smokers quit without aids as we would then expect to observe a decline in the NJBRFSS and/or consumption data.

Although we focused primarily on exploring methodological causes of the unexpected decline from 2005 to 2006, we do not discount the possibility that part of the decline may have been a real drop in cigarette smoking prevalence among New Jersey adults. However, based on other available data sources, the magnitude of a real decline would have been small or nonexistent.

The limitations of our study include the self-report of smoking, which can be subject to underreporting, the extent of which cannot be determined. Also, the response rates for the NJATS were low. In recent years, similar RDD surveys conducted in New Jersey, such as the NJBRFSS, have had low response rates; and cigarette smoking might differ among

respondents and nonrespondents. Lastly, the cell-phone analysis includes only 82 cases and should be considered only suggestive of the effect of exclusion of cell-phone-only sample.

As is typical with post hoc analyses, our findings do not provide definitive answers as to what specifically contributed to the 3 percentage point decline between 2005 and 2006. However, the findings are compelling enough to conclude that much of the documented decline is a methodological artifact. Researchers should use caution when modifying surveys that are intended to monitor trends over time, as these changes can impact prevalence estimates that do not reflect actual changes in the population.¹⁹ Moreover, when modifications are necessary, we recommend a priori approaches, such as the use of split sample studies, to measure the magnitude of the effect.

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Figure 1.
Prevalence of Current Smoking among New Jersey Adults, 2000–2006
* NJATS data not available for 2003 and 2004

Figure 2.
Newspaper Stories in New Jersey Related to Smoking or Tobacco

Figure 3.
Cigarette Smoking Prevalence by Perceptions of Cigarette Safety, 2005–2006

Table 1

2006 NJATS Cigarette Smoking Prevalence Estimates, With 95% CI by Various Poststratification Methods

Design	Description	Prevalence Estimate (95% CI)
CDC Method:	Cell weighting ratio adjustment within 24 cells formed by crossing age (18–24, 25–34, 35–44, 45–54, 55–64, 65+), gender, and race/ethnicity (White, Nonwhite)	14.4% (13.2%–15.6%)
Weight 1:	Cell weighting ratio adjustment (poststratification) with weighting classes defined by age-group (18–24, 25–34, 35–44, 45–54, 55–64, 65+) and gender.	13.7% (11.7%–15.7%)
Weight 2:	2-dimensional raking algorithm with the first dimension defined by 6 age-groups (18–24, 25–34, 35–44, 45–54, 55–64, 65+) and gender, and the second dimension defined by 5 race groups (Hispanic, NH white, NH black, NH Asian and NH other).	13.3% (11.4%–15.1%)
Weight 3:	3-dimensional raking algorithm with the first dimension defined by 6 age-groups (18–24, 25–34, 35–44, 45–54, 55–64, 65+) and gender, the second dimension defined by 5 race groups (Hispanic, NH white, NH black, NH Asian and NH other) and the third dimension by county.	14.1% (12.9%–15.3%)
2005 NJATS:	Cell weighting ratio adjustment (poststratification) with weighting classes defined by 4 age-groups (18–24, 25–44, 45–64, 65+), gender and 4 race groups (Hispanic, NH white, NH black and NH other).	14.3% (13.2%–15.5%)