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## INCLUSIVITY IN PEOPLE, METHODS, AND OUTCOMES

**PROGRAM EVALUATION**

# Analysis of Interview Breakoff in the Behavioral Risk Factor Surveillance System, 2018 and 2019

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**Introduction:** Survey breakoff is an important source of total survey error. Most studies of breakoff have been of web surveys—less is known about telephone surveys. In the past decade, the breakoff rate has increased in the Behavioral Risk Factor Surveillance System, the world's largest annual telephone survey. Analysis of breakoff in Behavioral Risk Factor Surveillance System can improve the quality of Behavioral Risk Factor Surveillance System. It will also provide evidence in research of total survey error on telephone surveys.

**Methods:** We used data recorded as breakoff in the 2018 and 2019 Behavioral Risk Factor Surveillance System. We converted questions and modules to a time variable and applied Kaplan−Meier method and a proportional hazard model to estimate the conditional and cumulative probabilities of breakoff and study the potential risk factors associated with breakoff.

**Results:** Cumulative probability of breakoffs up to the end of the core questionnaire was 7.03% in 2018 and 9.56% in 2019. The highest conditional probability of breakoffs in the core was 2.85% for the physical activity section. Cumulative probability of breakoffs up to the end of the core was higher among those states that inserted their own questions or optional modules than among those that did not in both years. The median risk ratio of breakoff among all states was 5.70 in 2018 and 3.01 in 2019. Survey breakoff was associated with the length of the questionnaire, the extent of expected recollection, and the location of questions.

**Conclusions:** Breakoff is not an ignorable component of total survey error and should be considered in Behavioral Risk Factor Surveillance System data analyses when variables have higher breakoff rates.
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## INTRODUCTION

Survey nonresponse is an important source of total survey error.[1] Survey nonresponse has different forms, such as unit nonresponse, item nonresponse, and survey breakoff. Unit nonresponse is when an eligible sampled unit fails to respond to a survey. Item nonresponse is the situation in which a unit response is obtained, but the respondent does not answer all of the survey questions. *Survey breakoff* refers to those who participate in a

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survey and terminate before completing it.[2,3] In research on survey quality, many more peer-reviewed studies of unit nonresponse have been published than of survey breakoff. Furthermore, studies of survey breakoff have mostly centered on web surveys because web surveys use a self-administered mode, and this mode has higher breakoff rates than face-to-face or telephone modes.[4−6] Information about breakoff in telephone surveys is limited.

The Behavioral Risk Factor Surveillance System (BRFSS) is an annual telephone survey on participants' health; use of preventive services; healthcare access; and health-related behavioral risk factors in all 50 states, the District of Columbia, and participating U.S. territories (referred to as states in the remaining parts of this paper).[7] The data collected are an important source for chronic disease prevention efforts for the states and the nation. BRFSS questionnaire is composed of the core questionnaire, optional modules, and state-added questions. The core questionnaire is used by all states in the survey, which is called the core survey. The optional modules, including in-depth questions about behavioral risk factors, are used by states that choose the modules. All optional modules are placed after the core survey except for the E-cigarette module, which a few states place within the core survey. The state-added questions are usually short. Most of the states insert the state-added questions after the core survey, and only a few states insert the several stated-added questions within the core survey. In core questionnaires, questions about self-rated health and healthy days come first, then come questions about healthcare access, chronic conditions, demographics, and health-related risk factors, in that order. *Participants who complete demographic questions up to the question about home ownership* are defined as respondents. If a respondent has breakoff before the end of the core survey, that is, one terminates the interview between veteran status questions and HIV/AIDS questions, the interview is considered as partial completion.

In the past 12 years, partially complete BRFSS interviews (disposition Code 1200) increased to 17% in 2019.[8] Breakoff, as a part of nonresponse, can harm the quality of survey statistics because the data only without the dropouts might not be representative of the target population. The larger this rate, the larger the risk of nonresponse error. When breakoffs occur and cause incomplete data to be collected on health-related risk behaviors, estimates about these behaviors are potentially less accurate.[3] It is therefore important to study why respondents broke off the second half of the interview and to identify the risk factors associated with the breakoffs. Such information may increase the data collected through BRFSS interviews. It can also be used in other research into telephone survey errors. As the largest telephone survey in the world, BRFSS presents a good opportunity to study breakoffs in telephone surveys.

## METHODS

BRFSS consists of statewide telephone surveys in all the 50 states, the District of Columbia, and participating U. S. territories. The probability sample of BRFSS is randomly selected landline telephone and cell phone users. In BRFSS, a core questionnaire is used in all states. BRFSS alternates core questions on some behavioral risk factors every other year, whereas some basic questions, such as on smoking, drinking, and immunization, are asked every year. States may also add optional modules and state-added questions to the survey. Each state decides whether to place the optional modules or state-added questions in the middle or after the core survey. Data used in our study are from 2018 and 2019. In 2019, New Jersey was unable to collect enough BRFSS data to meet the minimum requirements for inclusion in the 2019 annual aggregate data set; therefore, we did not include New Jersey in our analyses for 2019. The total number of eligible persons participating in the telephone interviews was 437,436 in 2018 and 418,268 in 2019.

There were 17 sections of core questions in 2018 and 14 in 2019. The demographic question section was placed in the eighth section in both the 2018 and 2019 surveys. Demographic questions include questions on age, sex, race/ethnicity, marital status, education, home ownership, veteran status, employment status, and household income. Questions located before the demographic questions are about health-related quality of life, healthcare access, and chronic conditions, and those located after the demographic questions are about health-related risk factors. The last part of the demographic questions included, in the following order, questions on veteran status, employment status, the number of children aged <18 years in the surveyed household, and income. If an eligible individual refused or broke off the interview before the veteran status question, *the individual* was defined as a nonrespondent in BRFSS. When a respondent did not complete all the survey questions beginning with the veteran status question, *the interview* was defined as partially complete. Those respondents with partially complete status, in the second half of the interview, were our study subjects for breakoffs.

To estimate the conditional probability and cumulative probability of breakoffs, we applied survival analysis techniques in which a time variable was created. We converted survey questions where breakoffs occurred into a hypothetical time, the order of survey section,

which consists of 1 or more survey questions. Breakoffs in reality always occurred in a single question. To better pinpoint a meaningful time when a breakoff occurred, we defined *the time for the survival analysis* as follows: (1) using a single question when there was no skip pattern in questions, such as on weight, height, or income; (2) using multiple questions when there was no skip pattern (e.g., we assigned the same time for disability questions if a respondent broke off at any pair of disability questions: hearing or vision, cognition or mobility, self-care or independent living); or (3) using a section of questions when there was a skip pattern, such as on tobacco use, alcohol consumption, or physical activity.

Breakoffs for optional modules or state-added questions were handled differently depending on where in the survey they were inserted so that we could have a universal time variable across states. All optional module questions were placed after the core survey by participating states except for the E-cigarettes module, which a few states placed within the core survey, right after the smoking section. A few states also inserted several short state-added questions within the core survey. For breakoffs that occurred during optional modules or state-added questions inserted between veteran status question and HIV/AIDS questions within the core survey, breakoffs were attributed to the next time point within the core—that is, if the E-cigarettes module was administered between the tobacco use and alcohol consumption modules, breakoffs for the E-cigarettes module were attributed to the alcohol consumption time point. For all optional modules added after the core questions, a single, final time point was defined. For our analyses, the first time point was the combined 3 questions on veteran status, employment status, and the number of children aged <18 years in the selected household because that is the first potential breakoff point for which they are considered partially complete interviews. The final time point was for the combined optional modules added after the core questions. We created the 18 time points for 2018 and the 15 time points for 2019 and event variables to indicate breakoffs to represent the last questions answered and for complete and partial completes respectively.

We programmed the data set used for the survival analysis using observations of complete records and breakoff complete records after the demographic section (partially complete) in the 2018 to 2019 data sets. We performed data management to retain the last nonmissing record together with the core variables.

We used the Kaplan−Meier method to estimate the cumulative probability as well as the conditional risk of breakoffs. To examine the potential factors associated with breakoffs, we applied a proportional hazard model that included demographic variables (age, sex, race/ethnicity, education, marital status, home ownership), medical insurance coverage, indicators of health-related quality of life, and state as covariates, which were collected from respondents who answered questions up to the homeownership question in the demographic section. Because all states decided the use of optional modules after the core, this analysis assessed the risk of breakoff up to the end of the core only. We also applied a log-rank test to examine whether the insertion of additional survey questions or optional modules before the end of the core questionnaire affected breakoff. We performed all analyses using SAS 9.4.

## RESULTS

Table 1 shows the conditional probability of breakoff at each time given that respondents completed interviews in the previous time and the cumulative probability of breakoff at the end of each time in 2018 and 2019. About half of breakoffs occurred in core questions, between the veteran status question and an HIV/AIDS question. The cumulative probability of breakoff up to the end of the core questions was 7.03% (95% CI=6.95, 7.11%) in 2018 and 9.56% (95% CI=9.46, 9.66%) in 2019. The states that inserted additional questions or optional modules before the end of the core questionnaire had a higher cumulative probability of breakoff up to the end of the core than those that did not (7.26% vs 6.40% [$p<0.001$] in 2018 and 9.66% vs 8.70% [$p<0.001$] in 2019).

In 2018, the highest conditional probabilities of breakoffs in the core occurred in questions of veteran status, employment status, and the number of children (0.84%) and in colorectal cancer screening questions (0.89%). In 2019, the highest conditional probabilities of breakoffs occurred in the section on physical activity (2.85%); questions of veteran status, employment status, and the number of children (1.32%); and in the immunization section (1.01%). The conditional probability was 0.97% in the section on vegetable intake and 0.54% in the section on fruit intake. The cumulative probability of breakoffs for the entire questionnaire in 2019 was higher than in 2018 (17.17% vs 14.36%).

Cumulative probabilities of breakoff up to the end of the core survey ranged from 1.32% to 13.20% with a median of 6.77% among 53 states in 2018 and from 3.30% to 24.88% with a median of 8.82% among 52 states in 2019 (Figure 1). Proportional hazard modeling showed that the association between breakoff up to the end of the core and its potential risk factors was similar in 2018 and 2019 (Table 2). A large variation of breakoff was also seen among states with a median risk ratio of 5.70 (95% CI=4.72, 6.88) in 2018 and 3.01 (95%

**Table 1.** Kaplan–Meier Estimates of Conditional Probability (%) and Cumulative Probability (%) of Breakoff at Survey Section/Question, BRFSS, 2018 and 2019

| Order of survey section[a] | 2018 | | | | | 2019 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | n | $p_{cond}$[b] | $SE(p_{cond})$[c] | $p_{cum}$[d] | $SE(p_{cum})$[e] | n | $p_{cond}$[b] | $SE(p_{cond})$[c] | $p_{cum}$[d] | $SE(p_{cum})$[e] |
| Veteran, employment, number of children | 3,689 | 0.84 | 0.01 | 0.84 | 0.01 | 5,516 | 1.32 | 0.02 | 1.32 | 0.02 |
| Income | 2001 | 0.46 | 0.01 | 1.30 | 0.02 | 1933 | 0.47 | 0.01 | 1.79 | 0.02 |
| Weight | 707 | 0.16 | 0.01 | 1.46 | 0.02 | 804 | 0.20 | 0.01 | 1.98 | 0.02 |
| Height | 1570 | 0.37 | 0.01 | 1.82 | 0.02 | 1417 | 0.35 | 0.01 | 2.32 | 0.02 |
| Pregnancy | 613 | 0.14 | 0.01 | 1.96 | 0.02 | 0 | 0.00 | - | 2.32 | - |
| Disability: hearing, vision | 1620 | 0.38 | 0.01 | 2.33 | 0.02 | 1904 | 0.47 | 0.01 | 2.78 | 0.03 |
| Disability: cognitive, mobility | 1370 | 0.32 | 0.01 | 2.65 | 0.02 | 1355 | 0.33 | 0.01 | 3.10 | 0.03 |
| Disability: self-care, independent living | 1773 | 0.42 | 0.01 | 3.05 | 0.03 | 1705 | 0.42 | 0.01 | 3.51 | 0.03 |
| Tobacco use | 2,381 | 0.56 | 0.01 | 3.60 | 0.03 | 2156 | 0.54 | 0.01 | 4.03 | 0.03 |
| Alcohol consumption | 2,549 | 0.61 | 0.01 | 4.18 | 0.03 | 1,117 | 0.28 | 0.01 | 4.30 | 0.03 |
| Physical activity | | | | | | 11,365 | 2.85 | 0.03 | 7.02 | 0.04 |
| Fruit intake | | | | | | 2072 | 0.54 | 0.01 | 7.52 | 0.04 |
| Vegetable intake | | | | | | 3,745 | 0.97 | 0.02 | 8.42 | 0.04 |
| Immunization | 1654 | 0.40 | 0.01 | 4.56 | 0.03 | 3,844 | 1.01 | 0.02 | 9.34 | 0.05 |
| Falls/injury | 379 | 0.09 | 0.00 | 4.65 | 0.03 | | | | | |
| Seat belt use | 1973 | 0.47 | 0.01 | 5.10 | 0.03 | | | | | |
| Breast and cervical cancer screening | 1831 | 0.44 | 0.01 | 5.52 | 0.03 | | | | | |
| Prostate cancer screening | 1299 | 0.32 | 0.01 | 5.82 | 0.04 | | | | | |
| Colorectal cancer screening | 3,665 | 0.89 | 0.01 | 6.65 | 0.04 | | | | | |
| HIV/AIDS | 1638 | 0.40 | 0.01 | 7.03 | 0.04 | 912 | 0.24 | 0.01 | 9.56 | 0.05 |
| All optional modules after the core questionnaire | 32,026 | 7.88 | 0.04 | 14.36 | 0.05 | 31,755 | 8.42 | 0.05 | 17.17 | 0.06 |

[a]Survey section consists of ≥1 survey questions.
[b]The conditional probability of breakoff given that respondents completed interviews in the previous time (i.e., survey section/question).
[c]The SEs of $p_{cond}$.
[d]The cumulative probability of breakoff.
[e]The SEs of $p_{cum}$.
BRFSS, Behavioral Risk Factor Surveillance System.

CI=2.65, 3.42) in 2019 relative to the state minimum. Men, younger adults, and people from racial and ethnic minority groups were associated with a higher risk of leaving the survey than women, older adults, and non-Hispanic White adults, respectively. Survey participants with less than a high school education, not owning their home, and who did not have medical insurance were more likely to terminate interviews early. Fair or poor self-rated health and 14 or more self-reported physically unhealthy days and mentally unhealthy days were associated with breakoff as well.

## DISCUSSION

Among BRFSS respondents, about 7% in 2018 and 10% in 2019 did not complete the core questionnaires. Increasing breakoff in BRFSS must be addressed so that BRFSS can continue to provide important information.

A strength of our study is that we used data from the world's largest population-based telephone survey sample. We provide useful information on rarely studied breakoffs in telephone surveys. Treating questions in which breakoffs occurred as a time of event onset allowed us to apply survival analysis techniques. This method enhanced our exploration of breakoff behaviors and characteristics.

There was a large variation in breakoffs among all states, which could be related to variations in the quality of interviewers and implementation of operational protocols. In addition, some states inserted state-added specific questions and/or optional modules to meet their state-specific needs into the core questionnaire rather than after the core questionnaire. Breakoff rates up to the end of the core questionnaire were higher among the states that inserted questions or modules into the core than among those that did not. For both 2018 and 2019,
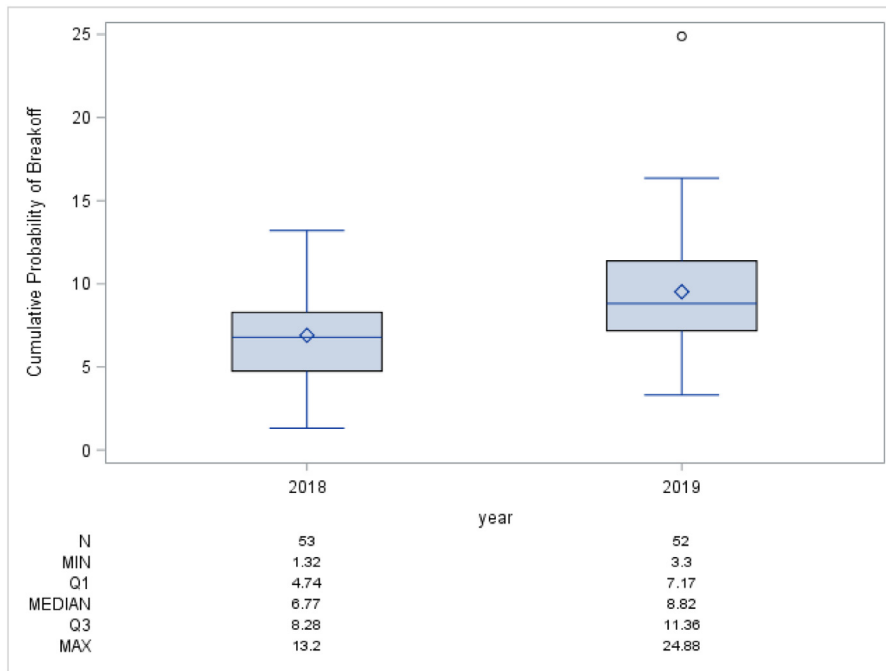
**Figure 1.** Box plot of state cumulative probability (%) of breakoff up to the end of the core survey, BRFSS, 2018 and 2019.
BRFSS, Behavioral Risk Factor Surveillance System; Max, maximum; Min, minimum; Q, quartile.

when states added optional models after the core questionnaire, the number of breakoffs greatly increased—about half of breakoffs occurred during state-added/optional modules added after the core questionnaire. Increasing the length of the questionnaire increases respondent burden, which may result in a compromise between including more questions wanted by the state and breakoffs. Other surveys have also found that greater length is associated with greater breakoff.[3]

Although conditional probabilities of breakoffs in the common questions and sections were similar between 2018 and 2019, the cumulative probability of breakoffs in 2019 was higher than in 2018. This might be caused by the questions that were present in 2019 but not in 2018. In the 2019 survey, the physical activity section ($p_{cond}$=2.85%) included 8 questions, of which 6 required recall about frequency, duration, and types of physical activities—more questions than for other risk factors. The fruit (2 questions, $p_{cond}$=0.54%) and vegetable (4 questions, $p_{cond}$=0.97%) intake section required recollection of the amount and kinds of fruits and vegetables consumed. The greater cognitive complexity of these recall questions may increase the rate of nonresponse, even if they do not increase the length of the survey, as shown by Subar et al.[9] These recall questions, although necessary for a survey of physical activity and nutrition, increased the chances that some interviewees left the interviews.

Differing locations of survey questions in the survey might also affect breakoffs. The questions on immunizations were identical in 2018 and 2019; however, the conditional probabilities were very different (2018 $p_{cond}$=0.40%; 2019 $p_{cond}$=1.01%). This might be caused by the location of the immunization questions. In 2018, they were placed right after the annual core questions (administered in both years) and before the rotating core questions. In 2019, they were placed after the rotating core questions—physical activity and fruit and vegetable intake—near the end of the survey. Fatigue may have contributed to greater breakoff when the immunization questions were later in the survey.[9]

Factors previously associated with nonresponse in health surveys include being male,[3,10,11] a younger[9,11,12] or older[10,11] adult, from racial and ethnic minority groups,[3,11] and of lower SES.[10,11] These are also some of the factors associated with breakoffs in our study—those who did not complete the core questionnaire were more likely to be men, to be younger, to be from racial and ethnic minority groups, or to have a lower level of education and home ownership, but unlike in studies of unit nonresponse, we also found that the poorer the respondent's health was, the higher the chance of breakoffs. It is worth noting that self-rated health is one of the key variables in BRFSS and should be taken into

**Table 2.** Risk of Breakoff up to the End of Core, According to Selected Factors Influencing Risk, BRFSS, 2018 and 2019

| Factor | 2018 | | | | | 2019[b] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Risk ratio[a] | (95% CI) | df | $\chi^2$ | *p*-Value | Risk ratio[a] | (95% CI) | df | $\chi^2$ | *p*-Value |
| State (in percentile) | | | 52 | 6,316.5 | <0.001 | | | 51 | 9,021.3 | <0.001 |
| Max | 10.58 | (8.79, 12.74) | | | | 9.09 | (8.05, 10.27) | | | |
| 75% | 7.22 | (5.93, 8.79) | | | | 4.14 | (3.67, 4.69) | | | |
| 50% | 5.70 | (4.72, 6.88) | | | | 3.01 | (2.65, 3.42) | | | |
| 25% | 4.00 | (3.27, 4.88) | | | | 2.56 | (2.25,.92) | | | |
| Min | 1.00 | | | | | 1.00 | | | | |
| Race/ethnicity | | | 5 | 421.8 | <0.001 | | | 5 | 391.8 | <0.001 |
| NH White | 1.00 | | | | | 1.00 | | | | |
| NH Black | 1.22 | (1.19, 1.26) | | | | 1.23 | (1.19, 1.26) | | | |
| AI/AN | 1.32 | (1.24, 1.40) | | | | 1.31 | (1.24, 1.40) | | | |
| Asian | 1.43 | (1.37, 1.50) | | | | 1.36 | (1.30, 1.43) | | | |
| Hispanic | 1.11 | (1.08, 1.15) | | | | 1.08 | (1.05, 1.12) | | | |
| Other | 1.13 | (1.08, 1.19) | | | | 1.11 | (1.06, 1.16) | | | |
| Sex | | | 1 | 113.5 | <0.001 | | | 1 | 54.1 | <0.001 |
| Women | 1.00 | | | | | 1.00 | | | | |
| Men | 1.10 | (1.08, 1.12) | | | | 1.06 | (1.05, 1.08) | | | |
| Age (in years) | | | 2 | 1,792.7 | <0.001 | | | 2 | 1,982.6 | <0.001 |
| 18−44 | 1.69 | (1.65, 1.74) | | | | 1.70 | (1.66, 1.74) | | | |
| 45−64 | 1.17 | (1.15, 1.20) | | | | 1.21 | (1.18, 1.23) | | | |
| ≥65 | 1.00 | | | | | 1.00 | | | | |
| Education | | | 2 | 200.9 | <0.001 | | | 2 | 314.5 | <0.001 |
| <High school | 1.18 | (1.14, 1.22) | | | | 1.22 | (1.18, 1.26) | | | |
| High school | 1.13 | (1.11, 1.16) | | | | 1.16 | (1.14, 1.18) | | | |
| >High school | 1.00 | | | | | 1.00 | | | | |
| Marital status | | | 2 | 122.3 | <0.001 | | | 2 | 78.3 | <0.001 |
| Married | 1.13 | (1.10, 1.15) | | | | 1.09 | (1.07, 1.11) | | | |
| Previously married | 1.03 | (1.00, 1.05) | | | | 1.01 | (0.99, 1.04) | | | |
| Other | 1.00 | | | | | 1.00 | | | | |
| Own home | | | 1 | 611.4 | <0.001 | | | 1 | 445.8 | <0.001 |
| Yes | 1.00 | | | | | 1.00 | | | | |
| No | 1.31 | (1.28, 1.33) | | | | 1.24 | (1.22, 1.27) | | | |
| Have medical insurance | | 1 | 14.1 | <.001 | | | | 1 | 17.2 | <.001 |
| Yes | 1.00 | | | | | 1.00 | | | | |
| No | 1.06 | (1.03, 1.09) | | | | 1.06 | (1.03, 1.08) | | | |
| Self-reported health | | | 1 | 15.2 | <0.001 | | | 1 | 15.8 | <0.001 |
| Excellent, very Good, good | 1.00 | | | | | 1.00 | | | | |
| Fair, poor | 1.06 | (1.03, 1.08) | | | | 1.05 | (1.03, 1.08) | | | |
| Physically unhealthy days | | | 1 | 14.1 | <0.001 | | | 1 | 6.7 | 0.010 |
| <14 days | 1.00 | | | | | 1.00 | | | | |
| 14−30 days | 1.06 | (1.03, 1.09) | | | | 1.04 | (1.01, 1.07) | | | |
| Mentally unhealthy days | | | 1 | 8.8 | 0.003 | | | 1 | 7.4 | 0.007 |
| <14 days | 1.00 | | | | 1.00 | | | | | |
| 14−30 days | 1.04 | (1.02, 1.07) | | | | 1.04 | (1.01, 1.06) | | | |

*Note:* A proportional hazard model adjusted for all covariates included in the table is shown.

[a]Risk ratio of breakoff.

[b]New Jersey did not collect enough BRFSS data to meet the minimum requirements for inclusion in the 2019 annual aggregate data set.

AI/AN, American Indian/Alaska Native; BRFSS, Behavioral Risk Factor Surveillance System; Max, maximum; Min, minimum; NH, non-Hispanic.

account when reweight is implemented to correct biases in estimation. Breakoffs are also different from item nonresponse for questions. Peytchev evaluated both breakoff and unit nonresponse across surveys and found different patterns for the 2 measures.[3] Sensitive questions, such as those about income, are one of the major causes of nonresponse. In our study, the conditional probability of breakoff occurring at a question of income was only 0.46% for 2018 and 0.47% for 2019.

Breakoff is a growing problem in BRFSS. Although this is a preliminary study, recommendations based on the findings of this study will benefit BRFSS and similar future surveys. First, interviewers' training on retaining interviewees in the survey, especially on risk behavior questions, including tobacco use, alcohol consumption, physical activities, and fruits and vegetables intake, should be strengthened. Techniques of both building rapport with interviewees and reminding interviewees of the importance of their participation are needed. Because there was a large variation of breakoffs among states, survey protocol should be strictly implemented. Second, because of fatigue, a long questionnaire should be avoided. In addition, when a question is included every year, the question should be placed in the same order. Third, when reweighting is considered to correct bias introduced by breakoffs, age, sex, race/ethnicity, SES, and self-rated health should be used to develop the adjustment factor.

### Limitations

There were 3 limitations to our study. First, we used an assumption that a time of breakoff was independent of skip patterns in telephone surveys, but our assumption can be only a proxy of an actual situation. Second, information about breakoffs occurring before the demographic section was not included in the release data, so we based our analysis on available breakoff information only; this may mean that studied breakoffs were underreported. Third, we could not study state-specific interview information, such as interviewers' experience, because it was not included in our aggregated data. Despite the limitations, our study provided useful information about total survey errors, from the relatively less-studied perspective of breakoff, for designing future BRFSS-like surveys, especially using the telephone mode. In addition, our results are also informative for analysis of variables with higher breakoff rates in BRFSS data. BRFSS data are weighted, so all respondents (completes and partial completes) are representative of the state populations. However, estimates for variables with high breakoff rates are no longer necessarily representative

of the population,[11] and reweighing using appropriate techniques should be considered.

In future studies of breakoff in BRFSS, individual states could use their own data to detect state-specific factors that affect breakoff. Such research, including looking at innovation in questionnaires and survey protocols, could enable states to reduce the breakoff rate and retain interviewees in future BRFSS.[13] Because more costs are added to the survey budget to address decreasing response rates in BRFSS, it is even more important to reduce the number of respondents who agree to participate but drop off before the survey ends.[14]

## CONCLUSIONS

Breakoff was associated with the length of questionnaire, the extent of recollection, and the location of questions. In BRFSS, breakoff varied among states and was increased by states inserting additional questions and/or optional modules into or after the core questionnaire. Breakoff is not an ignorable component of total survey error and should be considered in BRFSS data analyses when variables have higher breakoff rates. Our findings, which explain one component of total survey error, will aid in future BRFSS implementation and can be applied to other similar telephone surveys of behavioral risk factors.

## CREDIT AUTHOR STATEMENT

Jason Hsia: Conceptualization, Formal analysis, Methodology, Writing — original draft, Writing — review & editing. Madison Gilbert: Data curation, Writing — review & editing. Guixiang Zhao: Data curation, Writing — review & editing. Machell Town: Writing — review & editing. Seidu Inusah: Data curation, Writing — review & editing. William Garvin: Writing — review & editing.

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