Survey Research Methods (2023)
Vol. 17, No. 4, pp. 509-517
https://doi.org/10.18148/srm/2023.v17i4.8128
European Survey Research Association

Impact of Mode Switching on Nonresponse and Bias in a Multimode Longitudinal Study of Young Adults

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Young adults are generally hard to survey, presenting researchers with numerous difficulties. They are hard to locate and contact due to high mobility. They are hard to persuade and exhibit high levels of resistance to survey participation. As a result, they pose a greater challenge for longitudinal surveys. This paper explores the role of mode of data collection in young adults' decisions to stay in a longitudinal panel. We draw on data from the National Young Adult Health Study (NYAHS). NYAHS is a longitudinal study (three annual waves and 2 brief between-wave follow-up surveys) of adults aged 18–34 initially recruited in 2019 through RDD sampling of cell phone numbers nationwide. All sampled cell phone numbers were randomly assigned to one of three experimental conditions; the conditions differed in mode of data collection used in subsequent interviews once screened in. In the first condition, young adults continue all rounds of interviews by telephone ("telephone only" condition). The second group of young adults completed one round of interview by web and the rest by telephone ("telephone mostly" condition). The last third was asked to complete three interviews online and two interviews by telephone ("web mostly" condition). We examined the impact of mode switching on young adults' likelihood of participating in later surveys and on nonresponse bias in key survey outcomes. We found that switching young adults from telephone to web had an immediate negative effect on their likelihood of participating in that web survey, but it did not have a continued negative effect. Switching them from web to telephone increased response rates and reduced nonresponse bias. The findings have important practical implications on how to survey young adults.

Keywords: mode switching; longitudinal surveys; nonresponse bias; multimode surveys

1 Introduction

Young adults are a historically challenging and resource demanding population to survey, especially for longitudinal research (Giovenco, Gundersen, & Delnevo, 2016; Gundersen, Peters, Conner, Dayton, & Delnevo, 2014; Gundersen, ZuWallack, Dayton, Echeverria, & Delnevo, 2014). They are hard to locate and highly mobile (Tourangeau, 2014)—moving at a considerably higher rate than other US adults (Benetsky, Burd, & Rapino, 2015; U.S. Census Bureau, 2021). Moreover, they have higher levels of survey resistance than other populations (Mulry, 2014; Lugtig & Luiten, 2021) and higher attrition in longitudinal surveys (Watson & Wooden, 2009; Frankel & Hillygus, 2014).

A multimode survey design is increasingly used to reduce nonresponse and costs for longitudinal studies (de Leeuw, 2018; Tourangeau, 2017). There are many ways to mix multiple modes of data collection for a longitudinal study. A typical use of a multimode survey in the longitudinal setting is to use different modes of data collection for different waves. An example is the Consumer Expenditure Interview Survey; field interviewers visit and interview sampled households in-person in the first wave and then switch to telephone interviews for the following waves. Sometimes, two or more modes of data collection can be used for different respondents at the same measurement occasion. For instance, The Hutchinson Study of High School Smoking conducted the baseline survey in school. At Wave 2, data were collected by mail and phone, whereas three modes (mail, web, and phone) were used sequentially to collect data at Wave 3 (Marek, Peterson, & Henning, 2017). Indeed, multimode data collection, whether implemented as concurrent, sequential, or a combination, is now common and perhaps becoming the norm in many applied fields to increase response and retention rates and to reduce cost. However, research on the impact of switching modes

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of data collection on sample retention and on the quality of the resultant data (e.g., attrition bias, missing data rates) is scarce. Only a few longitudinal studies examine the impact of mixing modes across waves of the study.

The United Kingdom Household Longitudinal Study (UKHLS) is a major panel survey covering a broad range of social science topics. The Innovation Panel (IP) of UKHLS serves as a test-bed for innovative research. The first four waves of the IP mainly used face-to-face interviewing only; the second wave of the IP included a mixed-mode experiment that subjected some participants to a telephone and face-to-face multimode design. Starting at Wave 5, two-thirds of households were randomly assigned to a multimode design in which panel respondents were invited to complete the questionnaire online and face-to-face interviewers followed up with nonrespondents. The remaining third still uses face-to-face interviewing. Initially, the multimode design led to lower response rates for Wave 5 and Wave 6 than the single mode group (Al Baghal, Allum, Auspurg, et al., 2014; Burton, Auspurg, Burton, Cullinance et al., 2013) and higher item nonresponse rates (Jäckle, Lynn, & Burton, 2015). However, over time the response rates for the multimode group exceeded those for the single mode group (Al Baghal, Bloom, Burton, Brooker et al., 2015; Al Baghal, Creighton, Dykema, Gaia et al., 2016; Al Baghal, Bryson, Fisher, Hanson et al., 2018; Gaia, Benzeval, Bianchi, Brewer et al. 2017). Based on these findings, the main study of UKHLS started to include a multimode design in Wave 7 by allocating some sample members to a web followed by face-to-face multimode design (Jäckle et al., 2017).

The National Child Development Study (NCDS) is a longitudinal study of cohort members born in 1958 in the United Kingdom. The NCDS Age 55 Survey was the 9th follow up survey and was conducted in 2013. The survey randomly assigned 1/7th of their sample members to a unimode telephone design and the remainder to a sequential web-to-telephone multimode design. The multimode design led to a higher response rate than the single mode design but did not decrease nonresponse bias (Brown & Calderwood, 2020). Item nonresponse rates to questions about income and wealth were higher in the multimode design than the single telephone mode design (Brown & Calderwood, 2020).

The U.S. Monitoring the Future Study (MTF) has a longitudinal component that follows a nationally representative sample of 12th grade students through adulthood. In 2014, students were randomly assigned to one of the three multimode conditions: mail followed by web ("Mail Push"), web followed by mail ("Web Push"), and web followed by mail using email for invitation ("Web Push + Email"). The response rate for the "Web Push + E-mail" condition was comparable to the standard mail-only design used by the MTF at a lower cost (Patrick, Couper, Laetz, Schulenberg, et al., 2018). Sample members were followed up with two years later in 2016 and were assigned to the same multimode design as in 2014. Response rates to the 2016 follow up did not significantly differ across the three designs (Patrick, Couper, Bohyun, Laetz, et al., 2019). However, across all three experimental conditions, respondents to the 2014 survey were much more likely to respond to the 2016 follow up survey than those who did not complete the 2014 survey, and respondents were more likely to use the same mode to complete the survey (Patrick et al., 2019).

Given the popularity of mixing modes and the paucity of research on data quality, more work is needed to understand the impact of mixing modes on response rates to each wave of data collection, attrition, and data quality in longitudinal studies, especially for young adults. Indeed, research on how to mix modes of data collection and the impact of mixing multiple modes for young adults is even scarcer. This paper extends the limited research on multimode longitudinal design and addresses two important research questions:

1. What is the impact of telephone to web and web to telephone mode switching on response rates in subsequent rounds of data collection for young adults?
2. What is the impact of mode switching on nonresponse bias in estimates from the subsequent rounds of data collection for young adults?

We take advantage of the National Young Adult Health Survey (NYAHS)—a national multimode survey—to answer both questions.

2 Data

The NYAHS is a longitudinal survey of US young adults (18–34 years of age) with 6 measurement occasions (three annual waves, each with a brief follow-up survey) across 3 years (Delnevo & Gundersen, 2023; Gundersen, Wivagg, Young, Yan, & Delnevo, 2021). All respondents were sampled via random digit dialing (RDD) of cellphone numbers and screened and recruited into the study by a live telephone interviewer. A mode experiment was included that varied the modes of data collection for the main interviews. The original study design randomized the sampling frame to one of three data collection approaches—(1) a telephone-only mode, (2) a mixed-mode, which alternated telephone- and web-modes for subsequent data collection, or (3) a web-only mode. However, all respondents in the latter two groups (the mixed-mode and the web-only mode) were switched to telephone at Wave 2 follow-up interview. Fig. 1 displays the revised design we implemented for the three groups.

Frame + Sampling		Experimental Group (cell phone numbers allocated)	Recruitment mode	Wave 1	Wave 1 follow-up	Wave 2	Wave 2 follow-up	Wave 3
RDD cell phone numbers	Randomization	Telephone only (n=45,068)	telephone	telephone	telephone	telephone	telephone	telephone
		Telephone mostly (n=45,074)		telephone	web	telephone	telephone	telephone
		Web mostly (n=27,807)		web	web	web	telephone	telephone

Fig. 1

NYAHS sampling and data collection modes

Young adults in the "telephone only" group completed all rounds of interviews by telephone, as intended by the original design. The other two groups implemented a multimode design that deviated from the original design. The group 2 respondents ("telephone mostly") completed one round of interview (Wave 1 follow-up) by web and the rest by telephone. The "web-mostly" respondents completed the first three rounds of interviews by web and then two more rounds of interviews (Wave 2 follow-up and Wave 3) by telephone.

Once screened in, respondents assigned to the "telephone only" and "telephone mostly" conditions immediately transitioned into completing the Wave 1 interview by phone, as is standard for RDD telephone surveys. Respondents assigned to the "web mostly" condition were texted the URL of the web survey. The Wave 1 survey collected information about tobacco use behaviors, awareness, and attitudes, as well as use of marijuana and alcohol and basic demographic information. The survey took 15 minutes to complete on average, and a $15 Amazon.com Gift Card was provided upon completion of the interview. At Wave 1, 831 interviews were completed between April 2018 and May 2019. The response rate (AAPOR RR3) was 6% for the "web mostly" condition (with 131 completes), 21% for the "telephone mostly" condition (339 completes), and 24% for the "telephone only" condition (361 completes). The lower response rate with the "web mostly" condition reflected the negative impact of a mode switch, consistent with the literature (e,g, Fricker, Galesic, Tourangeau, & Yan, 2005). Gundersen and colleagues (2021) described the Wave 1 data collection in detail, including screener response rate, eligibility rates, and demographic composition of the resultant sample.

Wave 1 follow-up data collection took place between October 2018 and November 2019. The survey contained 12 items and took about three minutes to complete. For the "telephone only" group, respondents were called by CATI interviewers up to seven times. Respondents were given $10 Amazon.com Gift Card upon completion of the CATI interview. Respondents assigned to other two conditions were sent an invitation to the web survey through text messages and/or emails. They were sent up to four invitations spaced about four days apart and were provided a $5 prepaid incentive (in the form of Amazon.com Gift Card).

Wave 2 data collection occurred between September 2019 and May 2020. The questionnaire used for Wave 2 was the same as in Wave 1, except demographic questions were not asked again in Wave 2. Wave 2 took about 14 minutes. Respondents assigned to the "telephone only" and the "telephone mostly" conditions were called by CATI interviewers and promised $10 Amazon.com Gift Card upon completion of the interview. Respondents assigned to the "web mostly" condition were sent an invitation to the web survey via text messages and emails and were also promised $10 Amazon.com Gift Card upon completion of the web survey.

Wave 2 follow-up was originally designed to be a telephone interview for the "telephone only" condition and a web survey for the other two conditions ("telephone mostly" and "web mostly" conditions). However, the project team decided to switch these two conditions to the phone mode as well. As a result, respondents in all three conditions were called by CATI interviewers and

offered $25 Amazon.com Gift Card for completing the telephone survey. The questionnaire used in Wave 2 follow-up was the same as the one for Wave 1 follow-up; it contained about 12 items and took about 3 minutes to complete. Data collection for Wave 2 follow-up took place between December 2020 and January 2021.

Wave 3 was originally designed to be a telephone interview for the "telephone only" and the "telephone mostly" conditions and a web survey for the "web mostly" condition. However, respondents in all three conditions were called by interviewers after the project team decided to switch all three mode conditions to the telephone at Wave 2 follow-up stage. The questionnaire for Wave 3 is the same as the one for Wave 2. Respondents were offered $25 for completing the Wave 3 questionnaire by telephone. Data collection for wave 3 took place between December 2021 and January 2022.

3 Analytical Methods

To estimate the impact of mode-switching on response rates to the subsequent waves, we compare completion rates at Wave 1 follow-up, Wave 2, Wave 2 follow-up, and Wave 3 conditional on completing Wave 1; that is, among those who completed Wave 1, we calculate the percentage that completed each of the four follow up surveys.

To address the second research question, nonresponse bias is estimated for nine key health behaviors—ever and current use of cigarettes, e-cigarettes, cigars, marijuana, and past 30 day use of alcohol using Wave 1 answers. Specifically, for each follow-up survey, respondents who completed that particular wave were compared to those who completed Wave 1 on variables of interest reported at Wave 1. For example, comparison between those who completed Wave 3 and those who completed Wave 1 on ever use of cigarettes reported at Wave 1 provides an estimate of bias in ever use of cigarettes due to nonresponse at Wave 3. To better represent nonresponse bias as a function of mode switching, we also transformed each bias estimate into an absolute relative bias by dividing the absolute value of each nonresponse bias estimate by the Wave 1 prevalence estimate and then computed an average absolute relative bias by taking an average of the absolute relative bias across all nine estimates at each round of interviews for each condition. Although there can be differential measurement error in respondents' answers by mode and the impact of panel conditioning on answers to subsequent waves, using only wave 1 answers to estimate nonresponse bias at subsequent waves prevents those sources of biases from contaminating our findings here.

All analyses are unweighted; this is because using the weights without any further adjustment would not provide adequate correction as nonresponse at follow-up surveys is likely correlated with weights.

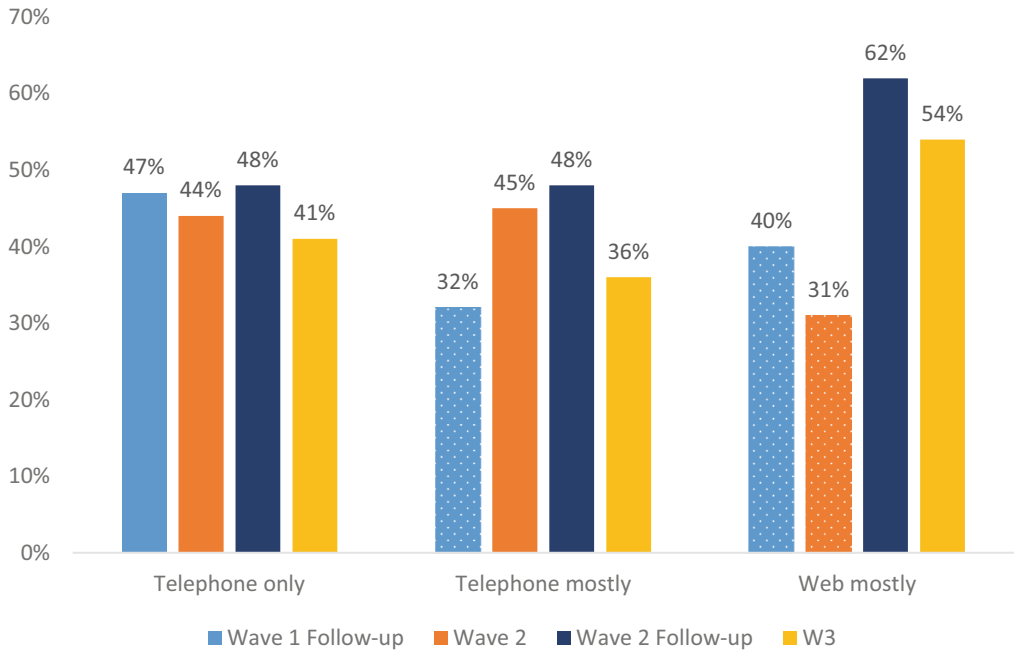

Fig. 2

Completion rates for subsequent interviews by experimental groups

Table 1

Nonresponse biases in unweighted estimates by experimental groups

	Telephone Only				Telephone Mostly				Web Mostly			
	Wave 1 follow-up (%)	Wave 2 (%)	Wave 2 follow-up (%)	Wave 3 (%)	Wave 1 follow-up* (%)	Wave 2 (%)	Wave 2 follow-up (%)	Wave 3 (%)	Wave 1 follow-up* (%)	Wave 2* (%)	Wave 2 follow-up (%)	Wave 3 (%)
Cigarette Ever Use	-8	-8	-9	-8	-8	-5	-5	-8	6	-6	-10	-10
Cigarette Current Use	-5	-5	-8	-7	-11	-5	-2	-6	2	-6	-6	-6
E-cigarette Ever Use	-1	0	-4	-3	-1	-2	6	3	0	-7	-6	-5
E-cigarette Current Use	-3	-5	-5	-3	0	-2	1	-2	0	-4	-2	-2
Cigar Ever Use	0	0	1	1	2	2	1	-1	10	9	-1	1
Cigar Current Use	-1	-1	-2	-1	0	0	0	0	3	3	-1	0
Marijuanna Ever Use	-2	-4	-4	-4	4	0	-1	3	5	4	-1	-6
Marijuanna in past 30 days	-3	-3	0	-4	2	-1	2	3	1	-12	-1	-5
Alcohol in past 30 days	4	4	5	6	2	0	6	0	-2	7	5	3

Note: * data collected by web

4 Results

4.1 Impact of mode switching on completion rates

Fig. 2 presents completion rates for subsequent data collection among those who completed Wave 1. (Solid bars represent interviews collected by telephone and dotted bars data collected on the web.) Respondents in the "telephone only" condition completed the next three surveys by telephone, and completion rates to the Wave 1 follow-up (47%), Wave 2 (44%), Wave 2 follow-up (48%) and Wave 3 (41%) surveys are very comparable.

Respondents in the "telephone mostly" condition completed Wave 1 by telephone and were switched to the web for Wave 1 follow-up, which led to a completion rate of 32%—15 percentage points lower than that for respondents in the "telephone only" condition (47%) ($p<0.0001$). This difference reflects both mode switching from telephone to web for the "telephone mostly" group and also the differences in number of contacts and incentive structure between the "telephone mostly" group and the "telephone only" group. However, when respondents in the "telephone mostly" group were once again switched back to telephone interviewing, the completion rates to Wave 2, Wave 2 follow-up, and Wave 3 are 45%, 48%, and 36%, respectively, and on the par with those for respondents in the "telephone-only" condition (44%, 48%, and 41%).

Respondents in the "web mostly" condition were switched to the web mode for Wave 1 after being recruited into the study by telephone. Wave 1 follow-up was conducted online, which was the second web survey for this group. The completion rate was 40%, higher than that for those in the "telephone mostly" condition who completed the same survey online for the first time (32%)—a difference this size or larger would be observed by chance 7% of the time if there truly are no differences and the study had been repeated a large number of times under the same conditions. Wave 2 survey was the third web survey for this group and had a completion rate of 31%, significantly lower than the completion rate for the other two groups ($p=0.01$ for comparison to the "telephone only" condition, which had a completion rate of 44%, and $p<0.01$ for comparison to the "telephone mostly" condition, which had a completion rate of 45%). However, when this group was interviewed on the telephone for Wave 2 follow-up, the completion rate was 62%, about 14 percentage points higher than the other two groups ($p<0.01$ for comparison to the "telephone only" condition with a completion rate of 48% and $p=0.01$ for comparison to the "telephone mostly" condition with a completion rate of 48%). Wave 3 was conducted over the phone and the completion rate was 54%, again significantly higher than that for the other two groups

($p=0.01$ for comparison to the "telephone only" condition with a completion rate of 41% and $p<0.01$ for comparison to the "telephone mostly" condition with a completion rate of 36%).

4.2 Impact of mode switching on nonresponse bias

Nonresponse bias in nine key outcome measures is presented in Table 1. At Wave 1 follow-up, nonresponse bias was generally small and similar across conditions, even though the "telephone mostly" group experienced a mode switch from telephone to web. A notable exception was for current cigarette use, where nonresponse bias for the "telephone mostly" condition (–11%) was greater in absolute value than for the "telephone only" condition (–5%) and for the "web mostly" condition (2%). Nonresponse bias on ever cigar use was larger for the "web mostly" condition (10%) compared to the "telephone only" condition (0%) and the "telephone mostly" condition (2%).

At Wave 2, nonresponse bias for the "telephone mostly" condition (which was switched from web back to telephone) was comparable to the "telephone only" condition, but the "web mostly" condition (which had up to three web surveys at this point) had higher nonresponse bias on ever use of e-cigarettes (–7% vs. 0%), ever use of cigars (9% vs. 0%), and past 30-day marijuana use (–12% vs. –3%) than the "telephone only" condition.

At Wave 2 follow-up, all three conditions were interviewed by the phone and the "telephone only" mode had greater nonresponse bias (in absolute value) on current e-cigarette use (–5% vs. 1% for mixed-mode and –2% for single web mode) and ever marijuana use (–4% vs. –1% for the other two modes) than the other two conditions.

At Wave 3, nonresponse biases were comparable across all three conditions for all estimates except that nonresponse bias in alcohol use in the past 30 days was much larger for the "telephone only" condition (6%) than for the other two conditions (0% for the "telephone mostly" condition and 3% for the "web mostly" condition).

We plotted, in Fig. 3, the absolute relative biases to better understand change of nonresponse bias over time and the impact of mode switching. Again, solid bars represent interviews collected by telephone whereas dotted bars represent data collected on the web. Three findings are worth noting. First, nonresponse bias increases over time for the "telephone only" condition with the average absolute relative bias at 12%, 14%, 17% and 15% at each round respectively. Second, a mode switch from web to telephone resulted in a smaller average absolute relative bias. For the "telephone mostly" group, the average absolute relative bias was 13% at Wave 1 follow-up when data were collected by web. Switching to telephone at Wave 2 brought it down to 9% and it stayed at 9% for Wave 2 follow-up and 11% at Wave 3. Similarly, for the "web mostly" group, bias increased at Wave 2 (27%) when data were collected from web for the third time. Switching to telephone brought down the bias to 14% at Wave 2 follow-up and 13% at Wave 3. Third, nonresponse bias at Wave 1 follow-up is comparable across the three conditions regardless of whether they were interviewed on phone or by web.

5 Discussion

The use of multimode survey designs is increasing for both cross-sectional and longitudinal studies. In longitudinal studies, sampled members are invited back for multiple rounds of interviews. Therefore, it is critical to understand both the immediate and the continued impact of offering multiple modes in longitudinal studies on sampled members' decision to continue participation and, thus, on survey operations and data quality. Specifically, for young adults who had a lower propensity to be contacted and to be recruited, it is important to know how mode switching affects young adults' likelihood of participating in future rounds of data collection and the extent to which mode switching affects nonresponse bias in key estimates. Taking advantage of a mode experiment, our study is among the first, if not the first, to estimate the impact of mode switching on completion rates and nonresponse bias in several health behaviors in a multi-year longitudinal survey.

The NYAHS is a longitudinal cohort study of US young adults (18–34 years of age) concerning their tobacco use behaviors, awareness, and attitudes, as well as use of marijuana and alcohol. Young adults were sampled via RDD of cellphone numbers and were randomly assigned to one of the three mode groups. For the "telephone only" group, all recruitment and data collection for subsequent waves and brief follow-up surveys were conducted via a live telephone interviewer. For the "telephone mostly" group, invitations to complete one brief follow-up survey after Wave 1 were sent via text messages (or emailed, depending on the respondent's preference) that contained a brief text identifying the survey and a link to a URL where they could access the web-survey. Recruitment and data collection for subsequent rounds (Wave 2, Wave 2 follow-up, and Wave 3) were conducted via live interviewers, identically to the "telephone only" condition. For the "web mostly" sample, invitations containing a URL to access the web survey were texted (or emailed) to each respondent for Wave 1 follow-up and Wave 2, and were interviewed by a live telephone interviewer for Wave 2 follow-up and Wave 3. The three groups differed in what mode of data collection was used first, how many times the mode of data collection switched, and other data protocol features such as the number of contacts

and incentive structure. This unique design allowed to us to track both the immediate and the continued impact of mode switching on completion rates and resultant nonresponse bias in key estimates.

We found that switching from telephone at Wave 1 to web at Wave 1 follow up—which induced changes to other important differences in data collection protocol such as the incentive strategy and the number of contact attempts—had a deleterious effect on completion rate for the "telephone mostly" condition, but with small and largely similar nonresponse bias as the other two conditions, though with some notable exceptions (such as current cigarette use). In contrast, when the data collection mode was switched from web to telephone, we observed an increase in completion rate and a reduction in nonresponse bias. Notably, we observed this for the "telephone mostly" condition at Wave 2 (when respondents were switched from web back to telephone due to high attrition) and for the "web mostly" condition at Wave 2 follow-up (when web was switched to telephone). This suggests that the switch from telephone to web (and the use of web) had an immediate negative impact on completion rates, but it did not seem to have a continued negative impact on completion rates and nonresponse bias. Indeed, the biggest consideration is on the information loss due to the smaller sample size that may be available for longitudinal analyses. Furthermore, the positive impact of switching from web to telephone is independent of baseline survey mode. As such, web surveys that are having low completion rates at follow up should consider switching to telephone, when feasible. This is encouraging for multimode longitudinal surveys.

Contrary to our expectations, young adults in our study did not seem to take advantage of the web mode even though they are more likely to have Internet access and more likely to be smartphone-dependent (Pew Research Center, 2021). We found that the use of the telephone mode was more successful than the use of the web mode for our young adults. This finding is particularly useful to researchers who survey young adults.

Of course, this study has limitations. First, the sample for this study are young adults. As a result, the findings may not be generalizable to surveys on other population groups even though they are still useful. Second, the sample size is small, especially for the "web mostly" condition. Third, we only examined completion rates and nonresponse bias for those who completed Wave 1. We did not present nonresponse bias at Wave 1 as this has been published previously and refer interested readers to Gundersen et al. (2021) for more information on Wave 1. Neither did we look into the participation behavior of those who did *not* complete Wave 1, especially those assigned to the "web mostly" condition. Fourth, we only examined nonresponse bias in later waves of data collection. We did not attempt to examine differential measurement bias by mode even though the survey questions examined in this paper are sensitive questions and prone to mode differences (see, Tourangeau & Yan, 2007;

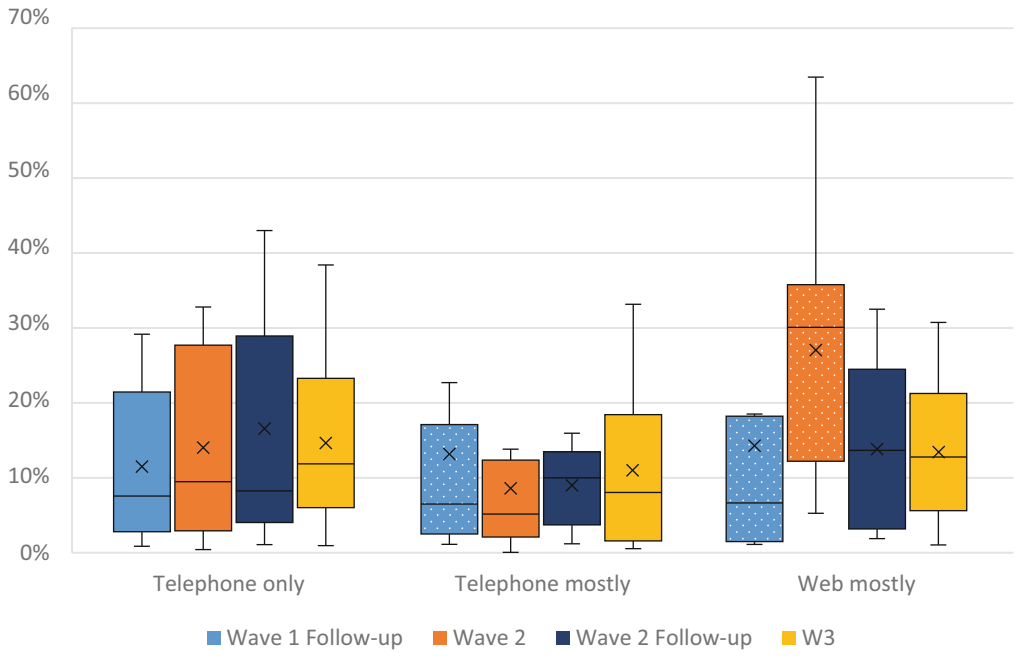

Fig. 3

Absolute relative biases by experimental groups

Yan, 2021). We also did not examine the impact of panel conditioning on measurement bias in subsequent waves. We encourage future research to examine the impact of mode switching on total survey bias, following the approach in Sakshaug and colleagues (2010). Fifth, we could not tease apart the impact of mode on complete rates and nonresponse bias from the impact of other important survey design features (such as incentive). Lastly, the analyses are unweighted. Recalibrating weights to population characteristics would reduce or eliminate nonresponse bias by design and may, for some analyses, be appropriate adjustment for non-response bias.

We encourage researchers to investigate the impact of mode switching in a multimode longitudinal study on all sources of survey error for a different target population and on a different survey topic.

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