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Are Demographics Adequate Controls for Cell-Phone-Only Coverage Bias in Mass Communication Research?

Brendan R. Watson[1], Rodrigo Zamith[2], Sarah Cavanah[1], and Seth C. Lewis[1]

Abstract

Cell-phone-only (CPO) households differ along key variables from non-CPO households, creating potential coverage biases in landline-only random-digit-dialing (RDD) surveys. Researchers have attempted to correct for this by weighting their data based on demographic differences. Previous research, however, has not examined CPO coverage biases in media-use surveys—an important oversight as cell phone use is itself a media choice. This article presents a secondary analysis of Pew's 2012 media consumption survey and concludes that demographics alone are not adequate controls for the CPO bias in media-use surveys.

Keywords

coverage bias, cell phone, mobile, surveys, online surveys, sampling, methodology

The increasing number of cell-phone-only (CPO) households poses a challenge for random-digit-dialing (RDD) telephone surveys. Among those challenges is the potential for coverage bias resulting from excluding CPO households, which researchers have found to differ along key variables from the general population. Survey researchers want to understand the differences between CPO and non-CPO respondents to reduce biases associated with undersampling CPO households, either by weighting

[1]University of Minnesota-Twin Cities, Minneapolis, USA
[2]University of Massachusetts-Amherst, USA

Corresponding Author:
Brendan R. Watson, School of Journalism & Mass Communication, University of Minnesota Twin Cities, 111 Murphy Hall, 206 Church St. SE, Minneapolis, MN 55455, USA.
Email: brwatson@umn.edu

survey data or including CPO households in the sample (or both). Previous research on this topic has primarily focused on political and health surveys (Ansolabehere & Schaffner, 2010; Blumberg, Ganesh, Luke, & Gonzales, 2013; Blumberg & Luke, 2009; Keeter, Kennedy, Clark, Tompson, & Mokrzycki, 2007; Lavrakas, Shuttles, Steeh, & Finberg, 2007; Link, Battaglia, Frankel, Osborn, & Mokdad, 2007; Mokrzycki, Keeter, & Kennedy, 2009). These studies concluded that the coverage bias associated with not including a representative number of CPO households arises from demographic differences between CPO and non-CPO respondents, which the researchers involved suggested could be controlled for by weighting the data based on those demographic differences.

As the percentage of CPO households has grown (along with the associated coverage bias), the survey research field has reached consensus that landline-only surveys cannot provide adequate coverage of the population and that telephone surveys must include cell phone sampling frames (Hill, Tchernev, & Holbert, 2012). Following this consensus, a number of sources of secondary data used in mass communication research now include cell phones. For example, Pew began using cell phone sampling frames in 2006 (Pew Research Center for the People and the Press, 2012a), and GfK (formerly Knowledge Networks),[1] which supplies lists to major surveys including the American National Election Studies Panel and the National Annenberg Election Survey, began using address-based sampling to help compensate for the CPO coverage bias in 2008, with full implementation in 2009 (Dennis & DiSorga, 2009). We reviewed 17 journals affiliated, or sponsored by, the Association for Education in Journalism and Mass Communication (AEJMC) from 2000 to 2013 to see whether the mass communication discipline has widely adopted cell phone sampling frames.[2] Of the 104 articles we identified that used sampling methods that could potentially be affected by the inclusion or exclusion of CPO households, 77% did not provide enough detail to judge whether a cell phone sampling frame was used in the study. For example, studies might have simply said, "A random national sample of 400 adults participated in telephone survey" (Avery, 2010) or "A national telephone survey using a computer-assisted telephone interviewing system was conducted" (Bobkowski, 2009). Scholars also continue to publish secondary analyses of Pew and other sources of secondary data that predate the use of cell phone sampling frames, without addressing the potential coverage bias associated with a landline-only sample (Hmielowski, 2012; Rittenberg, Tewksbury, & Casey, 2012; L. Wei & Hindman, 2011). The fact that the majority of articles do not directly address the potential coverage bias associated with CPO households suggests that this potential bias has received inadequate attention within the mass communication literature (Hill et al., 2012).

The issue of coverage bias associated with CPO households, however, should be of particular concern to mass communication researchers because cell phone use reflects a communication and media-use choice. Previous technology adoption research suggests the CPO media-use choice is also likely correlated with other patterns in CPO households' media preferences, particularly the use of a mobile phone to access news (Chan-Olmsted, Rim, & Zerba, 2013). That is, the different media preferences between CPO and non-CPO households may not necessarily be controlled for based on

demographic weighting alone. Thus, the potential coverage bias arising from CPO households should be of unique concern to those using surveys to investigate respondents' media habits. Yet there has been insufficient research on the potential for CPO coverage bias within mass communication research concerning audiences' media-use habits.

The present study fills that gap in the research by conducting a secondary data analysis of the Pew Research Center's 2012 biennial media consumption survey (Pew Research Center for the People and the Press, 2012b). The Pew study uses dual-frame, probability samples of both landline and cell phone numbers. The latter includes CPO households, which can be further parsed out. Thus, we are able to estimate the significant media-use differences of CPO and non-CPO households, and then examine whether these differences can be controlled for based on demographics alone in studies that do not contain adequate samples of CPO households.

The present study first estimates what the potential coverage biases associated with CPO households are. Then, we control for key demographic differences, drawn from the literature, between CPO and non-CPO households to assess whether they account for the difference in news media use—the use of television (TV), radio, newspapers, and Internet as a source for news—between CPO and non-CPO households. If demographics serve as adequate controls for the coverage bias associated with CPO households after controlling for the demographic differences between the two groups, CPO status should not be a significant predictor of media use. Conversely, if CPO status remains a significant predictor of media use, it would suggest that demographics alone are inadequate controls. While this study analyzes telephone survey data, the investigation is also relevant to online survey data, as the same logic that underlies weighting of telephone survey data is used to justify weighting online survey data to make them "representative" (Correa, Hinsley, & de Zúñiga, 2010; Curran, Iyengar, Lund, & Salovaara-Moring, 2009; de Zúñiga, Jung, & Valenzuela, 2012).

Literature Review

CPO Households

Coverage bias occurs when some members of a population being studied are not in the sampling frame and those excluded members differ significantly from those within the population frame, creating a bias in the population parameter (Dillman, Smyth, & Christian, 2008). The rise in the number of CPO households—in 2012, the National Center for Health Statistics estimated that 38.2% of U.S. households relied exclusively on cell phones, up four percentage points from the previous year (Blumberg et al., 2013; Blumberg, Luke, Ganesh, Davern, & Boudreaux, 2012)—creates a significant challenge for traditional landline-only, RDD surveys. Among the challenges involved in including CPO households in surveys are increased cost, federal regulations requiring that cell phone numbers be dialed manually, the increased likelihood of reaching a minor when dialing a cell phone number, and a greater percentage of users who screen calls or do not answer them (Pew Research Center for the People and the Press, 2011).

Thus, many studies are limited in their ability to include respondents who rely primarily on cell phones and opt instead to weight responses to improve the representativeness of the sample.

Data are typically weighted to match the population and demographic estimates from the U.S. Census Bureau and patterns of CPO and combined landline/cell phone households. In particular, CPO households tend to be younger, more urban, and generally non-White (Keeter, 2006; Keeter et al., 2007; Link et al., 2007; Mokrzycki et al., 2009). CPO households are also more likely to have lived in their current residence for less than a year, have rented their home, have lower incomes, be unmarried, and be childless (Ansolabehere & Schaffner, 2010). That is, CPO households are more geographically mobile and have fewer ties to a community, the latter of which is also associated with relying less on a newspaper for local public affairs information (Emig, 1995).

Previous studies of the coverage bias associated with CPO households have primarily focused on the implications for political surveys (Ansolabehere & Schaffner, 2010; Keeter, 2006; Keeter et al., 2007; Mokrzycki et al., 2009) and health surveys (Blumberg & Luke, 2009; Link et al., 2007). For example, these studies have found that individuals who live in CPO households are less likely to vote (Ansolabehere & Schaffner, 2010) and more likely to vote for Democratic candidates (Mokrzycki et al., 2009). In the health literature, CPO respondents have been found to be more likely to engage in risky health behaviors (Link et al., 2007). A key finding in these studies, however, is that this variation can be primarily attributed to demographic differences among CPO and non-CPO households—that is, that CPO households are more likely to be urban, younger, non-White, childless, and have lower incomes. Thus, weighting the data would allow a researcher to account for the coverage bias associated with CPO households.[3]

Although the problems posed by CPO households for survey researchers have been well studied within political and health contexts, the issue has received almost no attention by mass communication researchers. The exception is a study by Hill and colleagues (2012) that examined differences in political media use between survey participants reached via landline versus survey participants reached by cell phone. (The study did not separate out CPO households.) Hill et al. measured media use based on a 5-point scale that ranged from *never* (1) to *all of the time* (5). They found that compared with the landline sample, the cell phone sample more frequently accessed web news and more frequently watched MSNBC, political satire shows, and general-interest satirical TV shows (i.e., "The Simpsons"). However, once age was introduced as a control, they concluded those differences were primarily due to the fact that the cell phone sample was significantly younger. Had Hill et al. separated out individuals that could *only* have been reached by cell phone, they might have found additional differences in media use between a landline and CPO sample. In addition, it is worth noting that their survey was conducted in late 2009 and early 2010. As previously indicated, the percentage of CPO households in the United States has increased dramatically in the last several years, and there may be differences between earlier and later CPO adopters.

Thus, this study heeds Hill et al.'s (2012) call for additional research exploring the implication of a growing number of CPO households for media consumption surveys. Understanding media use is important not only for understanding the changing preferences among audiences but also for understanding how individuals access information about topics like politics (Dahlgren, 2009; Graber, 2009; McLeod, Scheufele, & Moy, 1999) and health (Noar, 2006).

Technology Adoption and Use

Previous literature on the adoption of cell phones and related technologies suggests there are distinct characteristics and motivations that distinguish CPO households from non-CPO households and that these differences extend beyond demographic variation (Leung & Wei, 2009; Rice & Katz, 2003; van Biljon & Kotzé, 2007). The literature also suggests that cell phone adoption is correlated with other types of media use, such as reading news on a mobile device (Chan-Olmsted et al., 2013). If this were the case, then simply weighting CPO respondents based on demographic characteristics would likely continue to produce biased estimates of media use.

Rice and Katz's (2003) survey of American households found that early adopters of the mobile phone were younger than late adopters and that early adopters were less likely to be married, which would suggest that demographics might be adequate controls for the CPO coverage bias. Technology adoption models, however, suggest there are influences beyond demographics that affect whether one adopts a particular technology, including the cell phone. Previous studies have shown that adoption of cell phones is related to various factors that are both intrinsic and extrinsic to the individual user, thus extending beyond demographics. Extrinsic factors include access to the infrastructure that supports use, such as access to a cell phone and to cell phone service, and design factors of the technology, such as whether it is attractive, easy to learn, and easy to use (Lu, Yu, Liu, & Yao, 2003). Intrinsic factors include the perceived ease of use of the technology, perceived usefulness of the technology, enjoyment derived from using the technology, one's desire to learn new skills, peer influence, and even one's perception of whether using mobile technologies makes personal data less secure (Conci, Pianesi, & Zancanaro, 2009).

While these studies have investigated the general use of cell phones, the decision to adopt the cell phone as one's only form of telephone access is likely to be related to intrinsic and extrinsic factors. For example, if one does not enjoy talking on a cell phone, finds a cell phone difficult to use, or does not have access to good cell service, one is not likely to rely on cell phones for sole telephone access. Furthermore, mobile phone usage is positively associated with other types of media use, including using cell phones for mobile web browsing and news consumption (R. Wei, 2008). Mobile news consumption is also associated with perceived usefulness and perceived ease of use, factors that also affect cell phone adoption (Conci et al., 2009). Indeed, as Chan-Olmsted and colleagues (2013) note, "It seems that mobile news adopters have certain distinctive media usage patterns and news preferences" (p. 127). Some of those preferences may include the use of Twitter for news consumption; of Twitter users in the

United States, 85% report getting news on Twitter via a mobile device, compared with 64% of Facebook news consumers (Mitchell & Guskin, 2013). Nevertheless, the literature is still emerging in articulating how news use via social media—for example, using social networks to "friend" and follow journalists or otherwise gather and disseminate news—might be connected to mobile media adoption and activity in particular (see, for example, Weeks & Holbert, 2013).

Overall, the technology adoption literature suggests that cell phone users differ from non-cell phone users—and presumably, CPO and non-CPO respondents—based on factors that go beyond demographics. Furthermore, previous studies of mobile media use suggest that these technology adoption factors are associated with other types of media use. Thus, one would expect that weighting survey data of CPO and non-CPO respondents based solely on demographic characteristics would not completely correct the potential coverage bias associated with not including a representative sample of CPO respondents in a study of individuals' media use.

Hypotheses and Research Questions

The previously cited literature provides two key sets of assumptions. First, that there are significant differences between CPO and non-CPO households (Keeter, 2006; Keeter et al., 2007; Link et al., 2007; Mokrzycki et al., 2009) and that those differences are not independent of media-use choices. Second, the literature on technology adoption and use indicates these differences may not be entirely accounted for by demographic differences (Rice & Katz, 2003; van Biljon & Kotzé, 2007; R. Wei, 2008). We therefore hypothesize the following:

Hypothesis 1 (H1): There will be a significant coverage bias associated with CPO households in estimating individual media use; that is, CPO status will be a significant predictor of media use.

Hypothesis 2 (H2): After controlling for demographic differences between CPO and non-CPO households, CPO status will remain a significant predictor of media use.

Method

Data Source

Data were obtained from the Pew Research Center for the People and the Press' (2012) Media Consumption Survey. This data set was chosen because the Pew biennial media consumption survey is a frequently cited source of media-use data for researchers in the social sciences. (To wit: A search for "Pew Biennial Media Consumption Survey" in Google Scholar returned more than 2,000 results.) The 2012 Media Consumption Survey data were collected by Princeton Survey Research Associates International on behalf of Pew. Between May 9 and June 3, 2012, 3,003 respondents were interviewed by telephone. These individuals were contacted through RDD of both landline

(n = 1,801) and cell phone (n = 1,202) numbers using samples provided by Survey Sampling International.

Interviews were conducted in both Spanish and English. For the landline respondents, the interviewer requested to speak with the youngest male or female—depending on a random rotation—currently present in the home. With the cell phone sample, interviews were conducted with whoever answered the phone. All interviewees had to be aged 18 years or older to participate. Response rates were 11% for landline numbers and 7% for cell phone numbers (American Association for Public Opinion Research [AAPOR], Response Rate 3 [RR3]).

As with any survey, the Pew's media consumption survey contains both measurement and representation error (Groves & Lyberg, 2010). With regard to measurement error, self-reported media use often contains a degree of measurement error (e.g., respondents often overestimate news media use; Prior, 2009). With regard to representation error, a low response rate raises particular concerns about nonresponse error. The population in the Pew survey skews older, better educated, wealthier, and more female than the population as a whole. To the extent that the goal of this article is to provide an accurate estimate of media use, these sources of error would be more problematic. Such estimation, however, is not the goal of this article. Rather, we seek to explore the differences in media use between CPO and non-CPO households within the survey's sample and whether those differences can be explained by demographic differences alone.

Independent variables. Based on the previous literature on CPO coverage bias in survey research (Ansolabehere & Schaffner, 2010; Keeter, 2006; Keeter et al., 2007; Link et al., 2007; Mokrzycki et al., 2009) in addition to whether or not the respondent lived in a CPO household, our analysis focused on seven demographic variables: age, education level, income level, marital status, parental status, race and ethnicity, and sex. Age was measured continuously, with an endpoint of 97 or older. The education level variable was measured ordinally, ranging from 0 (*less than high school*) to 7 (*postgraduate or professional degree*). The income level variable was also measured ordinally, ranging from 0 (*less than US$10,000*) to 8 (*US$150,000 or more*). Marital status was measured through six nominal categories; this variable was recoded to reflect whether an individual *had never married* (0) or *been married at some point* (1), which included widowers and those who were divorced. Parental status recorded whether a respondent was the parent or guardian of children younger than 18 currently living in his or household. Race and ethnicity were determined by Pew through a combination of questions, and we recoded to reflect whether the respondent was either *White and non-Hispanic* (1) or *in another racial or ethnic group* (0). Sex was measured as either *male* (1) or *female* (0). Last, the primary mode of telephone communication in the home was determined by Pew; this response was recoded into a CPO status variable measuring whether a respondent lived in a *CPO* (1) or *non-CPO* (0) household.

Dependent variables. We analyzed 10 media-use variables from the 2012 biennial media consumption survey (Table 2).[4] Each author independently reviewed the survey

questionnaire, and the variables were selected through group consensus. Specifically, we were looking for questions that reflected respondents' use of different types of media in the context of news. This led us to questions about the use of (a) newspapers, (b) TV, (c) radio, and (d) networked technologies and applications, thus enabling us to consider both "legacy" media as well as "new" media. Furthermore, we focused on questions about general media use, rather than the consumption of specific programs (e.g., *NBC Nightly News*), because the central contention of this article is that cell phone use is itself a media-use choice that should correlate with other general media uses. Last, to make our analysis more parsimonious, we focused the analysis on dichotomous media-use questions (e.g., "Do you happen to read any daily newspaper or newspapers regularly, or not?").

Because the purpose of this study is to examine differences between the CPO and non-CPO samples, not necessarily to generalize media use to the general population, we used Pew's unweighted survey responses.

Results

General Sample Characteristics

A total of 2,490 respondents provided responses to all of the questions associated with the independent variables. The average respondent, as measured by the sample's median, was aged 52 years, had received some college education but no degree, earned between US$40,000 and US$50,000 per year, was married, did not have a child younger than 18 years in the household, was White and non-Hispanic, and was female. As shown in Table 1, respondents in CPO households were considerably younger than non-CPO households, less educated, had a lower annual income, were less likely to have been married at some point, were more likely to have children younger than 18 in the household, were less likely to be White and non-Hispanic, and were more likely to be male. To assess each media-use variable, a subsample was taken that included only respondents who provided a response to the respective question in addition to all of the independent variables; thus, there was some variation in the sample characteristics for each media-use variable.

CPO as a Single Factor

The first hypothesis predicted that there would be a significant coverage bias associated with CPO households in estimating individual media use. To assess this hypothesis, a series of generalized linear models using a logit link were fitted to each question, using CPO status—whether someone lived in a CPO household or not—as the lone predictor. As shown in Table 2, CPO status was found to be a statistically significant predictor for 6 of the 10 media-use variables: reading a daily newspaper, watching news on TV, listening to news on the radio, reading news on Twitter, following journalists on Twitter, and reading news on general social networking sites. Thus, the first hypothesis received partial support.

Table 1. Sample Characteristics of Respondents to the 2012 Media Consumption Survey Who Responded to All Independent Variables.

	CPO (n = 535)		Non-CPO (n = 1,955)			
Variable	*M*	*SD*	*M*	*SD*	$F(1, 2488)$	Cohen's *d*
Age	38.57	15.32	54.35	17.00	377.17***	0.948
Education level	3.32	1.80	3.86	1.88	34.25***	0.286
Income level	3.20	2.42	4.30	2.41	86.91***	0.455
Marital status	0.67	0.47	0.85	0.36	88.80***	0.460
Parental status	0.47	0.33	0.25	0.44	10.63**	−0.159
Race/ethnicity	0.60	0.49	0.79	0.41	84.20***	0.448
Sex	0.61	0.49	0.44	0.50	49.70***	−0.344

Note. For education level, 3 = *some college, but no degree* and 4 = *2-year associate degree*. For income level, 3 = *US$30,000 to US$40,000* and 4 = *US$40,000 to US$50,000*. For marital status, 0 = *never married*, 1 = *married at some point*. For parental status, 0 = *does not have a child younger than 18 years living in the household*, 1 = *has child younger than 18 years living in the household*. For race/ethnicity, 0 = *some other race*, 1 = *White, Non-Hispanic*. For sex, 0 = *female*, 1 = *male*. CPO refers to cell-phone-only households.
**$p < .01$. ***$p < .001$.

Table 2. Results From Fitting Main-Effects Models Utilizing CPO Status as a Single Factor and With Control Variables.

Quest	Label	Question text	Single factor	With controls
Q3	News	Do you happen to read any daily newspaper or newspapers regularly, or not?	Yes	Yes
Q4	TV	Do you happen to watch any TV news programs regularly, or not?	Yes	Yes
Q5	Radio	Do you listen to news on the radio regularly, or not?	Yes	No
Q25	Mobile	Many national and local TV news programs are available online and on mobile devices. Did you watch any TV news programs on a computer, tablet, cell phone or other device yesterday, or not?	No	No
Q68	App	Have you ever downloaded an application or "app" that allows you to access news or news headlines on a cell phone, tablet or other mobile handheld device, or not?	No	No
Q70	Email	Did you get any news or news headlines by email *yesterday*, or not?	No	No

(continued)

Table 2. (continued)

Quest	Label	Question text	Single factor	With controls
Q75	Twitter News	Did you see any news or news headlines on Twitter *yesterday*, or not?	Yes	Yes
Q77	Twitter Follow	Do you follow any news organizations or journalists on Twitter, or not?	Yes	Yes
Q82	Social	Did you see any news or news headlines on social networking sites *yesterday*, or not?	Yes	No
Q87	Podcast	Did you watch or listen to a news podcast *yesterday*, or not?	No	No

Note. The control variables were the respondents' age, education level, income level, marital status, parental status, race and ethnicity, and sex. Question numbers refer to the original designator for the 2012 biennial media consumption survey. The label is intended to facilitate the identification of models in the manuscript and in other tables. "Yes" and "No" refer to whether CPO status was found to be statistically significant. For reasons of parsimony, we do not report the "With Controls" models for variables in which the single-factor CPO status predictor was found to be statistically insignificant. No effects were found in those models. CPO = cell phone only; TV = television.

More specifically, as shown in Table 3, the odds that a respondent in a CPO household would read the newspaper (Q3 on survey form) were 53% lower than those of a respondent in a non-CPO household; similarly, the odds of watching news on TV (Q4) and listening to news on the radio (Q5) were 54% and 24% lower, respectively, for CPO respondents. Thus, not having a representative sample of CPO and non-CPO households would likely lead to an *overestimation* of those media-use choices. In contrast, the odds that a respondent in a CPO household read news on Twitter (Q75), followed journalists on Twitter (Q77), or read news on general social networking sites (Q82) were 157%, 174%, and 42% higher, respectively, than those of a respondent in a non-CPO household. Thus, not having a representative sample of CPO and non-CPO households would likely lead to an *underestimation* of those media-use choices.

Put differently, as shown in Figure 1, the model estimated that respondents in a CPO household would respond "yes" to reading a newspaper 41% of the time (in contrast to 60% of the time for non-CPO households), to watching news on TV 63% of the time (vs. 79%), to listening to news on the radio 40% of the time (vs. 47%), to reading news on Twitter 47% of the time (vs. 25%), to following journalists on Twitter 61% of the time (vs. 36%), and to reading news on general social networking sites 45% of the time (vs. 37%). The findings thus appear to indicate that CPO households are considerably less likely to use so-called "legacy media" (e.g., newspapers and radio) and far more likely to use "new media" (e.g., Twitter and other social networking sites) for the purposes of news consumption.

It should be noted, however, that CPO status was not a statistically significant predictor for four media-use variables: watching TV news on a computer or mobile

Table 3. Presentation of Logistic Models Regressing Media Use as a Function of CPO Status (Single Factor).

	News (n = 2,482)			TV (n = 2,486)			Radio (n = 2,485)			Mobile (n = 1,000)			App (n = 1,253)			Email (n = 1,161)			Twitter news (n = 2,171)			Twitter follow (n = 238)			Social (n = 1,102)			Podcast (n = 944)		
Variable	*B*	*SE*	*Exp (B)*	*B*	*SE*	*Exp (B)*	*B*	*SE*	*Exp (B)*	*B*	*SE*	*Exp (B)*	*B*	*SE*	*Exp (B)*	*B*	*SE*	*Exp (B)*	*B*	*SE*	*Exp (B)*	*B*	*SE*	*Exp (B)*	*B*	*SE*	*Exp (B)*	*B*	*SE*	*Exp (B)*
CPO status	−0.75	0.10	0.47	−0.77	0.11	0.46	−0.27	0.10	0.76	0.24	0.19	1.27	0.03	0.13	1.03	0.01	0.15	1.01	0.94	0.29	2.57	1.01	0.29	2.74	0.35	0.14	1.42	0.23	0.18	1.25
	(p < .001)			(p < .001)			(p < .01)												(p < .01)			(p < .001)			(p < .05)					
(Intercept)	0.39	0.05	1.48	1.31	0.06	3.72	−0.14	0.05	0.87	−1.54	0.09	0.21	−0.14	0.07	0.87	−0.54	0.07	0.59	−1.07	0.18	0.34	−0.56	0.16	0.57	−0.55	0.07	0.58	−1.37	0.09	0.25
Model evaluation																														
Deviance	3350.37			2717.12			3413.60			953.30			1731.71			1529.48			289.12			315.44			1465.90			973.53		
AIC	3354.37			2721.12			3417.60			957.30			1735.71			1533.48			293.12			319.44			1469.90			977.53		
BIC	3366.01			2732.76			3429.23			967.11			1745.98			1543.60			300.07			326.39			1479.91			987.23		
Pseudo R^2																														
Adj. McFad.	.015			.016			.000			−.005			−.003			−.004			.015			.021			.000			−.005		
Efron's	.024			.022			.003			.002			.000			.000			.045			.054			.006			.002		
Nagelkerke	.031			.030			.004			.002			.000			.000			.060			.070			.008			.002		

Note. p values calculated using the likelihood ratio test statistic for the one-degree-of-freedom χ^2. p values only reported for variables with $p < .05$. Adj. McFad. refers to the Adjusted McFadden pseudo R^2. Because these models are each evaluating a different outcome variable, they should be compared with the corresponding models in Table 4, and not to one another. Subsample sizes differ because some respondents did not answer that question. CPO = cell phone only; TV = television; AIC = Akaike information criterion; BIC = Bayesian information criterion.

Table 4. Bivariate Correlation of Independent Variables.

	CPO	Age	Education	Income	Marital status	Parental status	Race/ethnicity	Sex
CPO	1.000							
Age	−.363	1.000						
Education	−.117	.078	1.000					
Income	−.184	.006	.487	1.000				
Marital status	−.186	.463	.086	.206	1.000			
Parental status	.065	−.341	.022	.109	.166	1.000		
Race/ethnicity	−.181	.259	.165	.205	.201	−.102	1.000	
Sex	.140	−.104	.010	.116	−.055	−.006	−.068	1.000

Note. The reference categories are as follows: never married (marital status); not a parent (parental status); not "White, non-Hispanic" (race/ethnicity); and female (sex). CPO = cell phone only.

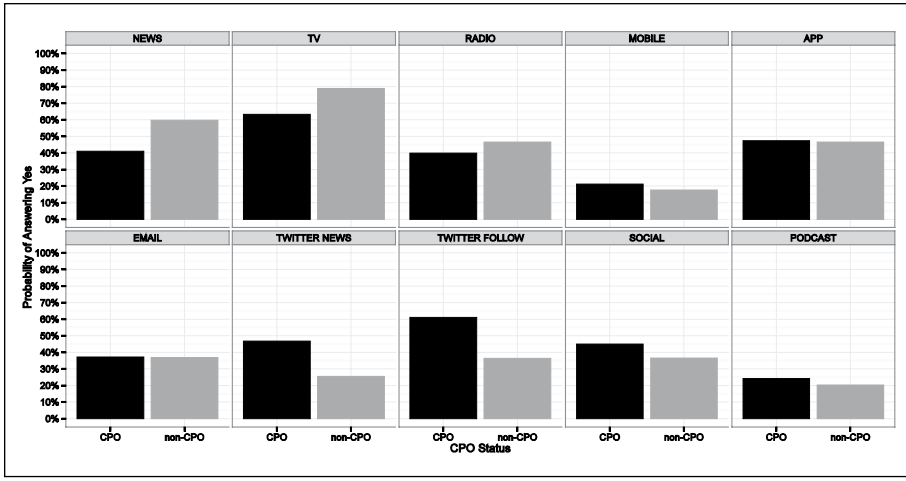

Figure 1. Predicted probability of respondents answering "Yes" to 10 media-use questions as a function of whether the respondent lives in a CPO household or a non-CPO household.
Note. CPO status was found to be a statistically significant predictor for news, TV, radio, Twitter news, Twitter follow, and social. CPO = cell phone only; TV = television.

computing device (Q25), downloading an "app" to access news on a mobile computing device (Q68), accessing news headlines over email (Q70), and listening to news on podcasts (Q87). Thus, certain media-use choices did not differ significantly across households.

Demographics as Controls

The second hypothesis predicted that, after controlling for demographic differences between CPO and non-CPO households, CPO status would remain a significant predictor of media use. To assess this hypothesis, a series of generalized linear models using a logit link were fitted to all media-use questions for which CPO status had been found to be a statistically significant predictor by itself; in contrast to the previous models, however, the demographic variables were included in the model, in addition to CPO status. As shown in Table 2, CPO status remained a statistically significant predictor for four of the six media-use variables: reading a daily newspaper, watching news on TV, reading news on Twitter, and following journalists on Twitter. Thus, the second hypothesis also received partial support.

More specifically, as shown in Table 5, even after controlling for demographic differences, the odds that a respondent in a CPO household would read the newspaper (Q3) or watch news on TV (Q4) were 29% and 25% lower, respectively, than those of a respondent in a non-CPO household. Thus, not having a representative sample of CPO and non-CPO households would likely lead to an *overestimation* of those media-use choices. In contrast, the odds that a respondent in a CPO household read news on

Table 5. Presentation of Logistic Models Regressing Media Use as a Function of CPO Status and Seven Control Variables (With Controls).

	News (n = 2,482)			TV (n = 2,486)			Radio (n = 2,485)			Twitter news (n = 2,171)			Twitter follow (n = 238)			Social (n = 1,102)		
Variable	*B*	*SE*	*Exp* (*B*)	*B*	*SE*	*Exp* (*B*)	*B*	*SE*	*Exp* (*B*)	*B*	*SE*	*Exp* (*B*)	*B*	*SE*	*Exp* (*B*)	*B*	*SE*	*Exp* (*B*)
CPO status	−0.35	0.11 ($p < .01$)	0.71	−0.28	0.12 ($p < .05$)	0.75	−0.05	0.11	0.95	0.91	0.33 ($p < .01$)	2.49	1.10	0.32 ($p < .001$)	3.00	0.14	0.15	1.15
Age	0.03	0.00 ($p < .001$)	1.03	0.04	0.00 ($p < .001$)	1.04	0.01	0.00 ($p < .01$)	1.01	0.00	0.01	1.00	0.00	0.01	1.00	−0.03	0.01 ($p < .001$)	0.97
Education level	0.18	0.03 ($p < .001$)	1.20	−0.06	0.03	0.94	0.11	0.03 ($p < .001$)	1.12	0.25	0.10 ($p < .05$)	1.28	0.15	0.09	1.16	0.15	0.04 ($p < .001$)	1.16
Income level	0.04	0.02	1.04	0.01	0.02	1.01	0.09	0.02 ($p < .001$)	1.10	0.01	0.08	1.01	0.11	0.07	1.12	−0.01	0.03	0.99
Marital status	−0.18	0.14	0.84	0.07	0.15	1.08	0.01	0.13	1.01	−0.10	0.47	0.90	−1.01	0.45 ($p < .05$)	0.37	0.21	0.20	1.23
Parental status	0.20	0.11	1.23	0.17	0.12	1.18	0.50	0.11 ($p < .001$)	1.65	0.34	0.37	1.42	0.76	0.36 ($p < .05$)	2.15	0.29	0.15	1.33
Race/ethnicity	0.12	0.10	1.13	−0.72	0.13 ($p < .001$)	0.49	−0.07	0.10	0.93	−0.20	0.34	0.82	−0.16	0.31	0.85	0.10	0.15	1.10
Sex	0.36	0.09 ($p < .001$)	1.43	−0.11	0.10	0.89	0.19	0.09 ($p < .05$)	1.21	0.71	0.31 ($p < .05$)	2.03	−0.12	0.28	0.89	−0.03	0.13	0.97
(Intercept)	−1.97	0.20	0.14	−0.21	0.22	0.81	−1.65	0.20	0.19	−2.59	0.62	0.08	−1.29	0.55	0.28	−0.25	0.27	0.78
Model evaluation																		
Deviance	3,167.53			2,500.67			3,291.55			271.80			301.16			1,415.60		
AIC	3,185.53			2,518.67			3,309.55			289.80			319.16			1,433.60		
BIC	3,237.88			2,571.03			3,361.91			321.05			350.45			1,478.64		
Pseudo R^2																		
Adj. McFad.	.065			.089			.032			.026			.022			.025		
Efron's	.093			.111			.051			.114			.110			.050		
Nagelkerke	.124			.152			.068			.154			.144			.068		

Note. p values calculated using the likelihood ratio test statistic for the one-degree-of-freedom χ^2. p values only reported for variables with $p < .05$. Models were only fitted for questions where CPO status was found to be statistically significant as the sole predictor. Adj. McFad. refers to the Adjusted McFadden pseudo R^2. The reference categories are as follows: never married (marital status); not a parent (parental status); not "White, non-Hispanic" (race/ethnicity); and female (sex). Because these models are each evaluating a different outcome variable, they should be compared with the corresponding models in Table 3, and not to one another. Subsample sizes differ because some respondents did not answer that question. CPO = cell phone only; TV = television.

Twitter (Q75) or followed journalists on Twitter (Q77) were 149% and 200% higher, respectively, than those of a respondent in a non-CPO household. Thus, not having a representative sample of CPO and non-CPO households would likely lead to an *underestimation* of those media-use choices.

Put differently, as shown in Figure 2, when holding all demographic variables constant at their mean, the model estimated that respondents in a CPO household would respond "yes" to reading a newspaper 49% of the time (in contrast to 58% of the time for non-CPO households), to watching news on TV 74% of the time (vs. 79%), to reading news on Twitter 45% of the time (vs. 24%), and to following journalists on Twitter 62% of the time (vs. 35%). After adding in the demographic variables, CPO status was no longer a statistically significant predictor for two of the media-use variables: listening to news on the radio and reading news on general social networking sites. Thus, the findings indicate that, in the majority of the cases, the differences in media-use behaviors between CPO and non-CPO households cannot be accounted for by demographic variables alone.

Discussion

This study found that there are significant differences in media use between CPO and non-CPO households. There were significant differences between CPO and non-CPO households' use of 6 of 10 media. Demographics proved to be adequate controls for only two of these variables: regularly listening to a radio news program and receiving news headlines on any social networking site within the previous day. However, even after controlling for demographic differences, CPO respondents were significantly *less* likely to regularly read a daily newspaper or watch a TV news program, and significantly *more* likely to receive news headlines on Twitter or have followed a news organization or journalist on the social networking site. The fact that demographics do not adequately control for the media-use differences between CPO and non-CPO households suggest there are additional characteristics that distinguish these two groups. It is possible additional extrinsic and intrinsic factors that influence technology (i.e., cell phone) adoption may both explain the *media choice* to rely completely on a cell phone for communication and that choice may be correlated with other media choices. The Pew survey did not probe why households rely solely on cell phones. Thus, it is not possible to use these data to further examine how the CPO choice may be related to other aspects of individuals' media use. Further research should investigate this relationship to deepen our understanding of how a CPO coverage bias uniquely affects mass communication researchers.

That said, this study did illustrate that media-use surveys that do not include a representative sample of CPO households, even if the data are weighted to approximate the demographics of a known population, are likely to *overestimate* regular daily newspaper reading and TV news program watching, and *underestimate* the use of Twitter to receive news headlines or follow news organizations or journalists. Put differently, the failure to properly sample CPO households may lead to findings that suggest that, for the purposes of news consumption, "legacy media" use is higher than it

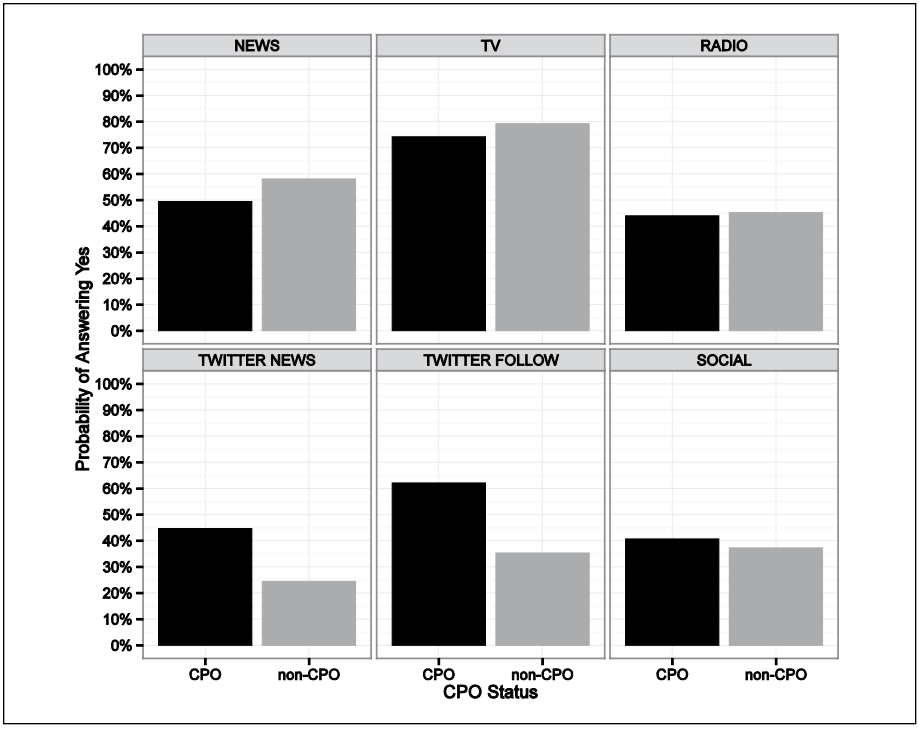

Figure 2. Predicted probability of respondents answering "Yes" to six media-use questions as a function of whether the respondent lives in a CPO household or a non-CPO household, holding demographic variables constant at their mean.
Note. CPO status was found to remain a statistically significant predictor for news, TV, Twitter news, and Twitter follow. CPO = cell phone only; TV = television.

actually is, and that some types of "new media" use are lower than they actually are. This is an important finding in light of the growing numbers of individuals—at least in the United States—who are "cutting the cord" (Blumberg et al., 2013). In particular, scholars should be very careful when considering sampling strategies and not become overreliant on statistical procedures to account for sampling deficiencies. To account for the coverage bias associated with CPO-only households, it is best to use a dual-frame design that includes a representative sample of both telephone and cell phone (including CPO) numbers.

Because of various hurdles associated with conducting RDD surveys, mass communication scholars are eschewing telephone surveys for various forms of web-based surveys. Thus, one might question how important the potential coverage bias associated with CPO households in telephone-based surveys continues to be. However, the political and health literature that has suggested that demographic weighting of survey data has been presumed to control for biases in nonrepresentative telephone samples (i.e., samples that do not include a representative number of CPO households) is also

used to rationalize weighting web survey data to achieve a "representative" sample (see, for example, Correa et al., 2010; Curran et al., 2009; de Zúñiga et al., 2012). The results of this study demonstrate that demographics alone were not adequate controls for all of the sampling biases associated with CPO households in mass media telephone surveys. Just as the choice to use a telephone or cell phone is a media choice that may be correlated with other media preferences, so is the choice to use the web. Thus, there are also likely differences in media preferences between web and nonweb samples that cannot be controlled for based on demographics alone. Establishing that this is the case is beyond the scope of this study. But because this study showed that potential CPO coverage biases pose a unique concern for mass communication scholars, the political and health communication literature on weighting telephone samples should not continue to justify weighting media-use survey data gathered online based solely on demographics to make it "representative" without further research on how different survey modes (e.g., telephone, cell phone, web, etc.) affect media-use variables.

It must be noted that this study examined one telephone survey data set. Arguably the Pew Research Center is among the most respected sources of survey data, representing the "gold standard" of telephone survey methods. Pew's biennial media consumption survey is also among the most important sources of media-use data, which is why we chose to use this data set for our study. Nonetheless, in addition to the coverage error that was the focus of this article, there are other sources of representation (i.e., how well does the sample represent the population of interest) and measurement errors (i.e., how well does the survey capture the desired construct) that are associated with any survey (Groves & Lyberg, 2010). For example, the low response rate (11% for landlines and 7% for cell phones) raises concerns about possible nonresponse error.[5] On the measurement side, our secondary analysis focused on dichotomous yes/no measures that may mask meaningful differences in the *frequency* with which cell phone and non-CPO households use different media. Furthermore, this study relies on self-reported media use, which may be overestimated, particularly for younger demographics (Prior, 2009). This study does not attempt to ignore the potential biases in self-reported data (nor does it seek to produce an accurate estimate of media use, per se). Rather, the study's findings suggests that in addition to being concerned with the accuracy of self-reported survey data, researchers should be concerned with potential biases associated with CPO households in media-use surveys. In addition, it is possible that the instructions provided to the interviewee about whom to speak with (i.e., with the youngest adult for landline surveys and the individual who answered for cell phone surveys) influenced the Pew sample, and consequently the results. Although the landline-only sample was considerably older than the CPO sample (medians of 57 and 34, respectively), it is possible that this difference in sampling procedure artificially makes the samples appear to be more similar than they actually are, thus potentially underestimating the differences found in this study.

That said, future research should seek to validate these findings by examining different data sets and different variables that extend beyond simple media use to examine, for example, using online media as tools for civic engagement, participation, and political discussion. In addition, future researchers may also wish to consider

cell-phone-*mostly* homes—that is, homes that still have a landline but rarely make use of it—as this growing phenomenon poses similar challenges for mass communication researchers and is also a media choice. It would also be helpful to examine whether demographics can control for differences in responses across multiple survey modes, including comparing RDD with landline and cell phone samples with online surveys. The present study should, however, give pause to mass media scholars who trust demographic variables alone to control for the coverage bias associated with the differences between CPO and non-CPO households.

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Notes

1. GfK Knowledge Networks is primarily known for online panels, but their lists were constructed using RDD sampling prior to 2009, when address-based sampling was added. American National Election Studies and the National Annenberg Election Survey both have incorporated Knowledge Networks samples for different individual phone-based, phone-plus-web, and face-to-face-plus-web surveys (GfK Knowledge Networks, n.d.).
2. Journals were searched for the following keywords/phrases: survey, questionnaire, panel, and secondary data.
3. Weighting involves assigning a weight, based on a known value for a population, greater than one to individuals who represent characteristics underrepresented in a sample and a weight of less than one to individuals who represented characteristics that are overrepresented in a sample. Actual weights depend on how skewed the distribution of a given sample statistic is compared with a known population parameter
4. Specifically, these questions were (using the designators from the original codebook) Q3, Q4, Q5, Q25, Q68, Q70, Q73, Q75, Q77, Q82, and Q87.
5. Cultural and linguistic differences may also be a source of nonresponse error among Hispanics, who may also be among the low-wage, transient, cell-phone-only households. While it is difficult to address the fact that some Hispanics may be wary of unknown surveyors, the Pew Research Center did conduct interviews in English *and* Spanish to overcome linguistic barriers.

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Author Biographies

Brendan R. Watson (Ph.D., North Carolina) is an assistant professor in the School of Journalism & Mass Communication at the University of Minnesota-Twin Cities. His research interests include community information needs, how digital technologies including social and mobile media are/are not changing communicaiton about public affairs issues, and quantitative communication research methods. More about his research is available at http://brendanwatson.net.

Rodrigo Zamith (Ph.D., Minnesota) is an assistant professor in the Journalism Department at the University of Massachusetts, Amherst. His research focuses on the reconfiguration of journalism in a changing media environment as well as the development of digital research methods. More about his research is available at http://rodrigozamith.com.

Sarah Cavanah is a Ph.D. student in the School of Journalism & Mass Communication at the University of Minnesota-Twin Cities. Her research interests include community news and information and scholastic journalism.

Seth C. Lewis (Ph.D., Texas) is an associate professor and Mitchell V. Charnley Faculty Fellow in the School of Journalism & Mass Communication at the University of Minnesota–Twin Cities. His research explores the digital transformation of journalism, with a focus on conceptualizing human–technology interactions associated with data, code, algorithms, and social media. More about his research is available at http://sethlewis.org.