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Combine to Conquer: Innovations in the Use of Multiple Sources of Data

Do Fences Really Make Good Neighbors? Supplementing Risk Factor Surveys Through the Use of Geofencing

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Abstract

General population surveys traditionally sample people from households because people are easy to locate where they live. However, mobile phone technology and geolocation advances have made it simple to locate people in other places. For example, most people visit a grocery or convenience store to purchase food and household items. Can sampling at these locations provide estimates comparable to traditional sampling? This paper describes a piloted method using geofenced grocery and convenience stores. The method samples mobile panel members when they entered geofenced areas around these stores, asking them to answer a few questions, and take a picture of an alcohol, tobacco, or sugar-sweetened beverage display. To evaluate the method, survey responses must be benchmarked against population control totals and a probability survey on the same topic and population. The benefits of this innovative method over traditional phone or mail surveys are quick and inexpensive administration, and the ability to capture images as data.

Key Words: Nonprobability surveys; Mobile phones; Innovative data collection methods; Nonprobability benchmarking.

1. Introduction

Nonprobability panels continue to increase in popularity and sophistication, but remain largely untested as replacements for or complements to probability samples. One of the most promising nonprobability panels on the market is MFour's geofenced *Surveys on the Go*® panel, which uses the geolocation technology on panel members' smart phones to sample them from specific locations defined by points around which a a "geofence" is drawn.

Geofences are virtual geographic boundaries that are set around real-world locations, and enable mobile phone applications to trigger an action when the device enters or leaves the area. For example, a common market research application is to pick a point of interest (e.g., a shopping center or store that wants to sample its patrons), and place a geofence around the entrance to that shopping center or store. Then, patrons who are also members of research company who set the geofence will be invited to complete a questionnaire when they trip the geofence on entry or exit. While geofenced surveys are usually used for intercept market research like this, this innovative technology can be used to capture a sample of the general population and invite them to complete a survey on any topic.

This sampling approach has several potential benefits. Logistically, it provides the opportunity to access potential respondents outside of their home and without the use field interviewers. It is also more cost- and time-efficient than probability samples or on-the-ground intercept surveys that can be used for general population surveys, recreational or environmental surveys, and surveys targeting rare or hard-to-reach populations. For example, under traditional approaches, constructing a sampling frame and obtaining a respondent pool to represent "current tobacco users who have also visited a doctor in the past month" would be very challenging, expensive, and likely result in a small analytical group. Using mobile nonprobability sampling to reach the same group of people allows access to a large

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potential respondent pool at a lower cost per eligible and per complete. In addition to sampling efficiencies, mobile panel methods offer measurement opportunities not feasible in traditional household surveys. For example, it is possible to capture details about events and behaviors while they are happening, which mitigates recall error. In a traditional survey, respondents would be asked to recall whether they had medical lab tests completed within the past year, but would likely have difficult remembering all lab tests conducted, and certainly would have trouble remembering their exact cholesterol levels from a given test. A geofenced sampling approach could sample participants during a doctor's visit while they are receiving cholesterol test results. There is also the option to collect "bonus" data elements, such as capturing images of test results or videos of interactions with doctors or the doctor's office via the mobile phone's camera. Such options are simply included as response tasks within the questionnaire.

Given these potential benefits, ICF and MFour are investigating whether sampling panelists at geofenced locations is a feasible alternative or complement to traditional survey sampling. Specifically, we are assessing whether a geofenced sample of grocery, convenience, and home improvement stores can produce useful population estimates of public health outcomes and health risk factors, and the feasibility of image capture in mobile panel surveys.

2. Proof of Concept Design

ICF and MFour have developed a rigorous proof of concept design, followed by a concept assessment plan. Although geofenced sampling may be broadly applied to any research area and as a supplement or replacement of any sampling method, this plan focuses specifically on geofenced sampling as an alternative to household sampling for local and national health behaviors and outcome statistics that are usually measured by random-digit-dial phone surveys.

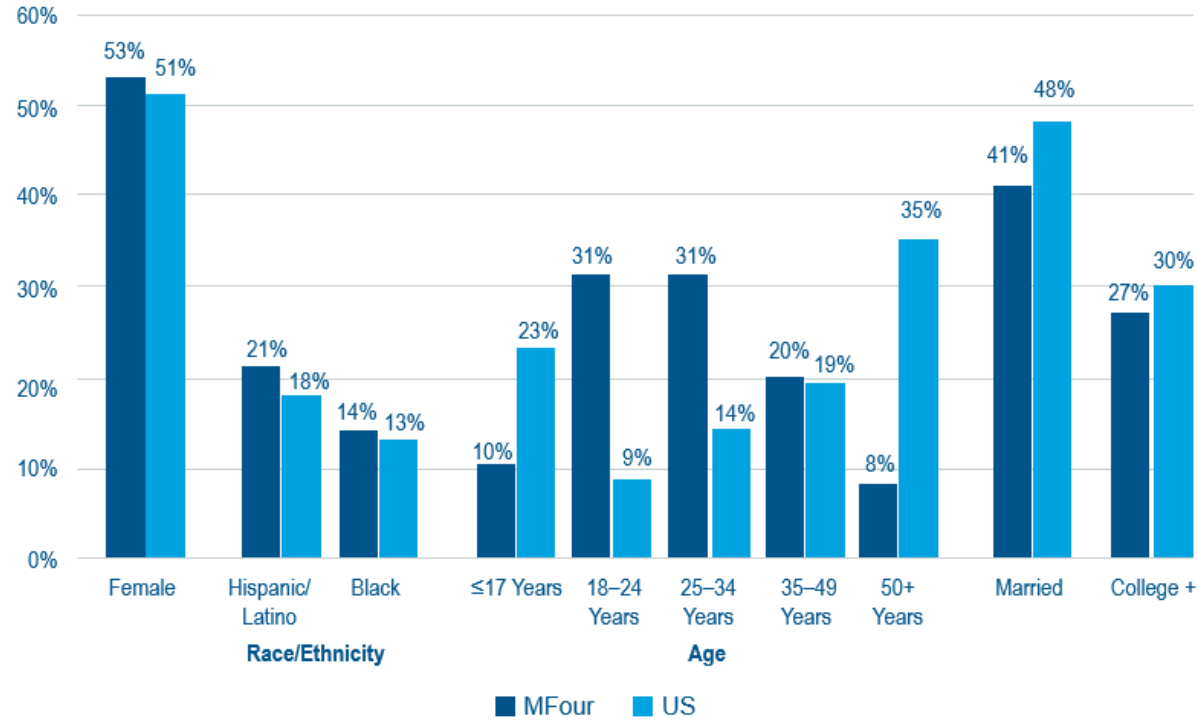
2.1 Sampling, Mode, and Fielding

The population of interest in the proposed design is noninstitutionalized adults age 18 and older. The plan described here is the United States in scope, but narrower geographic scopes, such as a single state are a simple modification.

Geofences and survey data collection are provided by MFour's *Surveys on the Go*® mobile opt-in panel, which includes approximately two million active users. MFour traditionally specializes in dairy studies; in-home measurement; advertisement, entertainment, and behavior trackers; and, more generally, in geo-targeting measurement to engage respondents in the middle of or just after completing an activity. Their panel is single-source (i.e., not combined with other Web or smartphone panels), which limits overlap with other online opt-in panels.

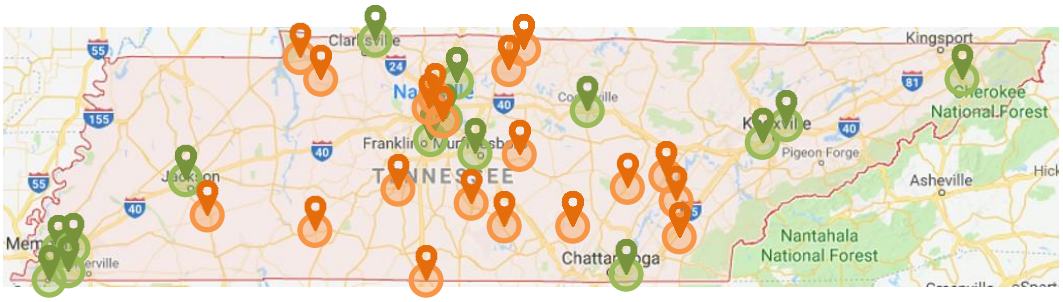
Compared to the U.S. population, the MFour panels skews younger and more single. On other demographics, such as sex, race/ethnicity, and education, the MFour panel and general population distributions are relatively similar. Figure 2.1-1 provides population and panelist breakdown on key demographics.

Figure 2.1-1
MFour panel vs. U.S. general population on key demographics



For this proof of concept, geofences with a fifty-meter radius will be drawn around grocery, convenience, and home improvement stores representing many large national chains. Figure 2.1-2 provides a visual representation of geofences in Tennessee for two store chains.

Figure 2.1-2
Representation of two geofenced stores in the U.S. state of Tennessee



Note: Geofences are not presented to scale.

Surveys on the Go® mobile panelists receive push notifications from the panel app to complete a brief survey immediately upon entering a geofence. The app produces a visual notification and, if the panel member's sound is turned on, a cash register "cha-ching" sound. The survey remains available to the panelist for a predetermined amount of time. For this study, it will be available for 48 hours from the push notification and may be completed after they leave the geofenced area. Visual and/or audible reminders will be sent at one, twenty-four, and thirty hours after the initial invitation. The survey, in general, remains in the field until a set quota of completes is obtained.

2.2 Questionnaire Topics

The brief questionnaire, estimated to take 5-6 minutes to complete, will include two components: basic demographics and health topics. Demographic information is used for eligibility determination and to compare the composition of respondents to the composition of established population surveys. These demographics include state and zip code of residence, place of residence (e.g., private, college housing), age, gender, sexual orientation, ethnicity, race, marital status, education, employment status, and the number of adults in their household by gender.

Health topic data are used to benchmark geofenced survey respondents to known, well-accepted estimates. The health topic questions are presented in Table 2.2-1. They are borrowed from the Behavioral Risk Factor Surveillance System (BRFSS) core section and collect data on tobacco, alcohol, and sugar-sweetened beverage behaviors.

Table 2.2-1
BRFSS health topic questions

Topic	Question	Response Options
Tobacco Behavior	Have you smoked at least 100 cigarettes in your entire life? Do not include electronic cigarettes (e-cigarettes, NJOY, Bluetip), herbal cigarettes, cigars, cigarillos, little cigars, pipes, bidis, kreteks, water pipes (hookahs), or marijuana. Please note that 100 cigarettes is equal to 5 packs of cigarettes.	1. Yes 2. No
Tobacco Behavior	Do you now smoke cigarettes every day, some days, or not at all?	1. Every day 2. Some days 3. Not at all
Tobacco Behavior	Do you currently use chewing tobacco, snuff, or snus every day, some days, or not at all?	1. Every day 2. Some days 3. Not at all
Alcohol Behavior	During the past 30 days, how many days per week or per month did you have at least one drink of any alcoholic beverage such as beer, wine, a malt beverage or liquor?	_____ days per: 1. Week 2. Month Don't know/Not sure
Alcohol Behavior	During the past 30 days, on the days when you drank, about how many drinks did you drink on the average? Please note: One drink is equivalent to a 12-ounce beer, a 5-ounce glass of wine, or a drink with one shot of liquor. A 40-ounce beer would count as 3 drinks, or a cocktail drink with 2 shots would count as 2 drinks.	_____ Number of drinks Don't know/Not sure
Alcohol Behavior	Considering all types of alcoholic beverages, how many times during the past 30 days did you have [IF MALE, INSERT "5 or more", ELSE IF FEMALE, INSERT "4 or more"] drinks on an occasion?	_____ Number of times None Don't know/Not sure
Alcohol Behavior	During the past 30 days, what is the largest number of drinks you had on any occasion?	_____ Number of drinks None Don't know/Not sure
Sugar-sweetened Beverage Behavior	Not including fruit-flavored drinks or fruit juices with added sugar, how often in the past 30 days did you drink 100% fruit juice such as apple or orange juice? Enter '0' if you did not drink 100% fruit juice in the last 30 days.	_____ times per: 1. Day 2. Week 3. Month

Topic	Question	Response Options
		Don't know/Not sure
Sugar-sweetened Beverage Behavior	Now, thinking about sugar-sweetened beverages including regular soda, sports drinks, energy drinks, coffee, tea, and juices that have added sugar, how often in the past 30 days did you drink sugar-sweetened beverages? Enter '0' if you did not drink any sugar-sweetened beverages in the last 30 days.	_____ times per: 1. Day 2. Week 3. Month Don't know/Not sure

2.3 Additional Data Elements

Data collection via mobile phone offers the unique opportunity to ask respondents to capture images or videos via their phone's camera during survey administration. A single image or video can provide more detail than a set of survey questions, and at less burden to the respondent. For example, in lieu of multiple sets of questions to obtain dietary intake data via food diaries, respondents can simply take a picture of their meal. To test the utility of image capture tasks, respondents in this study will be asked to take a picture of any alcohol, tobacco, or sugar-sweetened beverage displays or products at the store, or any of those products in their possession if they are complete the questionnaire at another location.

3. Concept Assessment Plans

Our concept assessment plan focuses on vetting whether geofenced nonprobability samples produce useful population estimates of public health topics, as well as the utility of image capture in mobile panel surveys. The plan includes unweighted data benchmarking, weighted data benchmarking, and review of the captured images.

3.1 Unweighted Benchmarks

To evaluate coverage and sample bias, the geofenced sample and respondent composition is compared to the composition of known probability sample surveys, including national BRFSS results and the National Health Interview Survey (NHIS). Samples and respondents will be compared on age, gender, race/ethnicity, marital status, education, and employment status. State of residence and state of survey invitation from the geofenced respondents are compared to state of residence for the probability respondents. If reasonably equitable demographic and state-specific distributions between nonprobability and probability samples are found, then it is likely that the geofenced sampling method is accurately capturing the same population as the general health survey.

3.2 Weighted Benchmarks

To evaluate geofenced panel accuracy and feasibility, the geofenced sample will be weighted using similar adjustment dimensions as those used by BRFSS. Key health behavior estimates will then be compared to known probability based estimates from BRFSS and NHIS. Geofenced respondents will start with a base weight of 1, and then iteratively raked to population control totals along demographic dimensions from the American Community Survey (ACS). Weighted panel estimates of tobacco, alcohol, and sugar-sweetened beverage consumption and other health characteristics and behaviors will be compared to the probability estimate's by assessing whether 95% confidence intervals around each survey's estimate overlap, and whether point estimates from the MFour nonprobability sample fall with in 95% confidence limits of the BRFSS and NHIS. MFour point estimates that fall within BRFSS or NHIS confidence intervals suggest that the geofenced sampling method accurately captures the health behavior or characteristic, and that the geofenced sampling method may be as good as a more expensive probability sample survey for that topic.

3.2.1 Image Capture Review

To evaluate the ease and utility of image capture during the questionnaire, pictures will be reviewed against rigorous criteria. Specifically, images will be assessed for quality (e.g., blurriness, lighting, and alignment/framing) and accuracy to the question prompt (i.e., is the image of tobacco, alcohol, or sugar-sweetened beverages). Willingness to take a picture during survey administration is also assessed. Higher willingness, image quality, and topical accuracy will all suggest that image capture can be a feasible data collection approach.

4. Conclusions and Other Applications

There are several logistical and measurement benefits to using a nonprobability sample based on geofences around grocery, convenience, and home improvement stores. They are time- and cost-efficient and may reduce measurement error. As a complement to or alternative for general population surveys, specifically, the geolocation technology on panel members' smart phones can aid in sampling potential respondents outside of their home, which has historically been the easiest place to locate individuals. As a new and innovative approach to nonprobability sampling, geofenced sampling require rigorous testing and benchmarking to probability based official surveys and other established population "gold standards". The proof of concept design described in this paper was developed with this rigorous testing in mind. The methods proposed allow us to assess various biases, as well as procedurally test image capture in mobile panel surveys. Forthcoming results will inform the potential use of geofenced panels for various, unique survey objectives and populations, including those beyond general population health surveys.

In addition to the study discussed in this paper, ICF has found several other useful applications for geofenced sampling. One application involved sampling bars and restaurants that sell hookah in New York City. For this study, small geofences (3-5 meters from the bar or restaurant entrance) were used to help ensure that only establishment patrons were sampled. A second application involved sampling panel members who had visited home improvement stores in the paths of Hurricanes Florence and Michael on the southeastern US Atlantic coast. Many people visiting home improvement stores in the days surrounding these storms were likely doing so to prepare for the storm or repair damage afterward. Using past geofence crossing activity provided a very useful sample for this application. Finally, ICF used geofences to help the New York City Department of Environmental Protection assess the awareness and impact of an anti-littering campaign. In addition to a city-wide sample, geofences were drawn around bus stations, subway entrances, and other points where the anti-littering signs had been posted, and panel members who had passed by those areas in the past year were sampled. This increased the sample size of people who were most likely to be exposed to the anti-littering signs, something that is difficult to obtain from general population samples.

Combining the proof-of-concept pilot test and other applications summarized above, geofenced sampling is bound to be useful supplement, if not replacement, to traditional sampling methods. Future research and benchmarking will determine its ability to replace probability sampling for certain topics or demographic subgroups.