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Inclusion of mobile phone numbers into an ongoing population health survey in Australia using an overlapping dual frame design: description of methods, call outcomes and acceptance by staff and respondents.

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Abstract

Background

In Australia telephone surveys has been the method of choice for ongoing population health surveys. Although it was estimated in 2011 that 20% of the population were mobile phone only persons the inclusion of mobile only phone users into these existing landline population health surveys has not occurred. This paper is part of a project that is looking in detail at the inclusion of mobile phone numbers into an ongoing population health survey in Australia. This paper describes the methods used, the call outcomes and acceptance by the population, supervisors and interviewing staff.

Methods

In order to include mobile only phone users into this existing RDD landline health survey an overlapping dual frame design was chosen. Data collection was kept consistent where possible with the previous years' RDD landline only surveys and between frames. All interviewers and supervisors were asked to provide feedback on incorporating mobile phones into the survey. Operational and interview data for the survey were downloaded and the operational and demographic profiles of the frames were then compared.

Results

In the first quarter of 2012, 3395 interviews were completed with 2171 (64%) from the landline frame (17.6% landline only) and 1224 (36%) from the mobile frame (25.8% mobile only). Supervisors and interviewing staff found calling mobile phones easier than expected. The biggest challenge was no geography on the mobile frame which resulted in more time spent calling ineligible interstate numbers. For the combined frame: response rate was 33.1% (RR3), cooperation rate was 72.2% (CR3), refusal rate was 12.8 % (RR2) and the contact rate was 65.1% (CR2). As expected, the demographic profile of the mobile only persons was very different (more people who were young, males, Aboriginal, overseas born, and single) to the profile of respondents from the landline frame. However the profile of respondents from the two frames combined was most similar to the latest NSW population profile (Census 2011).

Conclusions

The inclusion of the mobile only phone users did not impact negatively on interviewing staff, response rates or data collection and did improve the representativeness of the sample compared to the NSW population.

Keywords

Sample survey, mobile phone, sampling frame

Background

Because of increasing numbers of mobile only phone users worldwide, currently estimated to be 36% in the USA [1], 13% in Canada [2], 14% - 19% across the UK countries [3] and 19% in Australia [4], it has become increasingly difficult to produce unbiased estimates from random digit dialling (RDD) surveys that only target landlines [5-9]. Consequently there is now substantial international literature on conducting RDD surveys with mobile phone augmentation [10-17] and the American Association for Public Opinion Researchers (AAPOR) Cell Phone Task Force recommended in their latest report (2010) [17]: “Random digit dialling (*RDD*) surveys without cell phone augmentation should in their methods report how they have produced unbiased estimates without the cell phone only segment”.

In Australia landline telephone surveys has been the method of choice for ongoing population health surveys [18-23]. Although the rate of mobile phone only persons was estimated to be nearly 20% in 2011 the inclusion of mobile only phone users into these existing landline population health surveys has not occurred. Studies describing the demographic, socio-economic and health profile of mobile phone only persons have been conducted and have shown that the demographic, socio-economic and health profile of mobile phone only respondents was different to those who had access to a landline using face to face survey data [24,25] and internet panel data [26].

Two pilots have also been conducted in Australia by Pennay [27] in 2010 (700 respondents) and Lui et al [28] in 2011 (335 females respondents aged 18 to 39 years) using a dual frame designs. Pennay [27] provided particularly useful statistics for planning this study including: the expected numbers of telephone numbers required to get an interview in each of the frames (landline 12 numbers and mobile 25 numbers), response rates (landline 46.3% and mobile 52%) and the expected percentage of interviews with persons from landline phone only households in the landline frame (14.5%), and percentage of interviews with mobile only persons from the mobile phone frame (27.6%).

This paper describes the methods used for the inclusion of mobile only phone persons into the NSW Population Health Survey (PHS), an existing ongoing landline RDD health survey in Australia [29]. This paper also describes the call outcomes and acceptance by the population, supervisors and interviewing staff.

Methods

Survey methodology

Since 2002 the health and wellbeing of the NSW population has been monitored using the NSW Population Health Survey. A representative sample of approximately 15,000 persons are interviewed each year, with equal numbers from each of the strata (health administrative areas) using RDD landline computer assisted telephone interviewing (CATI). The survey has approval from the NSW Population and Health Services Research Ethics Committee [29].

In order to include mobile only phone users into this existing RDD landline health survey an overlapping dual frame design was chosen, rather than just screening for mobile only persons, because although the relative costs are similar, [30] persons selected through mobile frames (even if they have both mobile and landlines) have been shown to differ to persons selected through a landline frame. [9, 30]

We generated the RDD landline sample frame for each of the administrative strata using “best fit” postcodes for the geography (exchange district and charge zone) associated with the Australian Communications and Media Authority (ACMA) phone number ranges for NSW [31]. The sample was then randomly ordered within each strata and forwarded to Sampleworx for them to use their proprietary software to test each number to identify valid and invalid numbers [32]. The resulting valid numbers were used for the study. The RDD mobile sample frame was developed by Sampleworx using all known Australian mobile prefixes and then using their proprietary software each number was tested to identify valid and invalid numbers [33]. A random sample of valid mobile numbers was then provided for the study.

Data collection using SAWTOOTH WinCati version 4.2 was kept consistent, where possible, with the previous years' RDD landline only surveys and between frames [34]. Trained interviewers from the in-house NSW Ministry of Health's CATI facility rang the randomly ordered landline numbers consecutively to try and contact households and convince the household and the respondent to participate in the survey. When a household was reached one person from the household was randomly selected to participate in the survey. If the selected respondent was a child under the age of 16 years, a parent or carer completed the interview on their behalf.

The randomly ordered mobile phone numbers were also rung consecutively to try and contact the owner of the phone. If the owner was not a resident of NSW or a child under the age of 16 years they were coded as ineligible. However if the owner of the mobile phone also had children in their NSW household and was also a parent they were asked at the end of the interview if they or the main carers would agree to being contacted at a later date to undertake an interview about one of their children chosen at random. Because mobile numbers could be located anywhere in Australia initial calls were timed to accommodate different time zones across Australia.

For both sample frames up to 12 attempts were made to establish contact and if possible secure an interview with the selected respondent within a household (landline frame) or the mobile phone holder (mobile phone frame). Outcomes (Table 1) for each attempt of a selected number were recorded using the in-house disposition codes. Once the target sample size was achieved no new numbers (numbers with no prior attempt to contact) were dialled. The call protocol, to make contact, and to contact the selected respondent, was completed for each number that had already been dialled at least once. This 'dialling out' process ensured that respondents who required many phone calls for contact and/or interview (typically young adults who are rarely at home) were not differentially excluded from the sample.

The questionnaire included questions on: health behaviours, health status, social determinants, demographics and phone ownership (number of and listing of residential phone and mobile phones personally have). The actual questions in the questionnaire are available on the survey website. [29]

Supervisor and Interviewer feedback

All interviewers and supervisors were asked to provide feedback on incorporating mobile phones into the survey. These responses were collated and common themes identified. Specifically they were asked to make notes on their expectations and experiences.

Call outcomes

Operational data for the survey were downloaded using SAWTOOTH WinCati version 4.2. The data included telephone number, number of attempts, details of each attempt and final disposition. Although the final disposition codes used for the survey are site specific, as shown in table 1, they can be easily mapped to the AAPOR standard definitions [35]. These final dispositions were then entered into the AAPOR outcome rate calculator [36] and all AAPOR levels of response, cooperation, refusal and contact rates were calculated from the groupings of the final dispositions. Overall rates were then calculated by multiplying these rates by the appropriate overlap adjustments using the formula below which was derived from the methods described in Nonresponse in RDD Cell phone surveys chapter of the AAPOR Cell Phone Task Force Report [17]

$$\text{Overall rate} = (R_A * (P_a + \lambda P_{ab}^A)) + (R_B * (P_b + \lambda P_{ab}^B))$$

where

R rate

P population proportion

λ adjustment factor for overlap

A landline sample frame

B denotes mobile sample frame

a landline only persons

b mobile phone only persons

ab denotes both mobile phone and landline

[Insert Table 1 here disposition codes]

Demographic parameter comparisons

Interview data for the survey were downloaded using SAWTOOTH WinCati version 4.2. The data included a unique identifier, sample frame, strata, and responses to the health behaviours, health status and demographic questions. Demographic information from the mobile frame sample, landline frame sample, and the combined landline sample with the mobile only sample was compared to the NSW demographic profile from the 2011 census using a χ^2 test [37].

Results

In the first quarter of 2012, 3395 interviews were completed with 2171 (64%) being from the landline frame of which 382 (17.6%) were landline only and 1224 (36%) being from the mobile frame of which 316 (25.8%) were mobile only. In response to questions in the survey 5% (in both frames) of responders stated that their mobile phone numbers were listed in directories and 68% of respondents from the landline frame and 47% from the mobile frame stated that their landline phone numbers were listed in directories.

The landline frame, compared to the mobile frame, required fewer telephone numbers to obtain a contact (1.9 v 2.1), eligible contact (7.0 v 10.5) and an interview (9.8 v 14.4). With the majority of ineligible contacts being businesses numbers in the landline frame (68%) and persons residing outside of NSW in the mobile frame (63%) . The numbers and percentage of respondents for the total sample and for each of the sampling frames are provided by administrative area (strata for the landline frame) in Table 2.

[Insert Table 2 here]

Supervisor and Interviewer feedback

The major themes that came from the supervisors and interviewers comments were interviewer perceptions, respondent cooperation, mobile frame, questionnaire, line quality and fieldwork. Specific comments are provided in Table 3 by the themes. Generally interviewers found it easier than they originally thought.

[Insert Table 3 here Interviewer comments]

Call outcomes and respondent acceptance

Levels of response, cooperation, refusal and contact rates calculated as per AAPOR definitions for each frame and overall are provided in table 4. The latest ACMA figures for Australia were used in the combined call outcome calculations (5% landline only persons, 19% mobile phone only persons, and 74% both mobile phone and landline) and $\lambda=0.5$ as the overlap adjustment. This gave an overall response rate of 33.1% (RR3) cooperation rate of 72.2% (CR3), refusal rate of 12.8 % (RR2) and contact rate of 65.1% (CR2).

[Insert Table 4 here Call outcomes]

Sample characteristics

Table 5 shows respondent demographic profiles for each of the frames alone, mobile only, the combined frames (using $\lambda=0.5$ as the overlap adjustment), the landline frame with the mobile only respondents from the mobile frame and the NSW demographic profile from the 2011 census [37].

The NSW demographic profile was significantly different to respondents: from the landline frame for age group, sex, country of birth, marital status and income; who only had mobile phones for age group and marital status; from the combined frame for age group; from the landline frame plus mobile only for age group, marital status and income.

[Insert Table 5 here Sample characteristics]

Discussion

The inclusion of the mobile only phone users was logistically very challenging. Of particular difficulty was incorporating the mobile only phone users into an ongoing landline health survey with minimal impact. Supervisors and interviewing staff found calling mobile phones easier than expected. The biggest challenge was the lack of geography on the mobile frame which resulted in more time spent calling ineligible numbers

and additional sample management to get similar overall numbers across each of the strata. Although expecting substantially lower response rates, cooperation rates, contact rates and higher refusal rates the rates were very similar.

As expected the profile of the mobile only respondents was very different (more people who were young, male, Aboriginal, overseas born, and single) compared to the profile of respondents from the landline frame which had been used in previous years. However the respondent profile from the combined frames (using $\lambda=0.5$) was the most similar to the latest NSW demographic profile.

Because of the opt-in directory listing for mobile phone numbers the percentage of the population with their mobile phones listed in directories is very low (5% in this study) and so the use of listed mobile phone numbers (either directly or to produce list assisted RDD numbers or for last digit substitution) should be avoided when developing sample frames.

This paper is part of a project that is looking in detail at the inclusion of mobile phone numbers into an ongoing population health survey in Australia using an overlapping dual frame design. Subsequent work is being undertaken on costing (including recommendations on the most efficient sample frame mix), weighting strategies and an examination of the impact on the time series.

Conclusions

The inclusion of the mobile only phone users did not impact negatively on interviewing staff, response rates or data collection. The respondent profile from the combined frames was most similar to the latest NSW demographic profile.

List of abbreviations

AAPOR	American Association for Public Opinion Researchers
ACMA	Australian Communications and Media Authority
CATI	Computer assisted telephone interviewing
RDD	Random digit dialling

Competing interests

Nil

Authors' information

MLB is a PhD student with the Centre for Statistical and Survey Methodology, University of Wollongong, Wollongong, Australia

Authors' contributions

MLB developed the overall concepts and planned the study; undertook the analysis and co-wrote the methods and results, wrote the introduction and discussion and finalised the manuscript. JJVR developed and managed the data collection, co-wrote the methods and results, and commented on drafts of the manuscript. DGS provided development and analysis advice and commented on drafts of the manuscript. SVT provided overall support for the study and commented on drafts of the manuscript. All authors read and approved the final manuscript.

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List of Tables

Table 1: Study disposition codes and their mapping to AAPOR codes and categories

AAPOR categories	NSW summary	AAPOR codes
Interview (I)	Complete interviews	1.1
Refusal (R)	Respondent refusal	2.112
	Household refusal and breakoff	2.1
Non contact (NC)	Respondent never available away for duration of survey	2.2 2.21
	Respondent physically or mentally unable to complete interview	2.32
Other (O)	Non-translated language	2.333
	Other non-refusal : hang up said nothing; Terminated by interviewer; technical problems	2.3
	Engaged busy	3.12
Unknown Household (UH)	No answer	3.13
	always answering machine	3.14
	Fax data line	4.2
Not eligible (NE)	Non-working number	4.3
	unusual tone	4.31
	Business, government office, other organizations	4.51
	Non-eligible respondent not in NSW/mobile owned/answered by child)	4.7

Table 2: Number and percentage of respondents for each strata (health administration areas) by frame

Strata (health administration area)	Contact method				Total	
	Landline		Mobile		n	Strata %
	n	% within strata	n	% within strata		
Sydney	170	54%	144	46%	314	9.2%
South Western Sydney	146	48%	160	52%	306	9.0%
South Eastern Sydney	65	30%	155	70%	220	6.5%
Illawarra Shoalhaven	113	65%	60	35%	173	5.1%
Western Sydney	123	45%	148	55%	271	8.0%
Nepean Blue Mountains	143	71%	58	29%	201	5.9%
Northern Sydney	133	44%	168	56%	301	8.9%
Central Coast	165	78%	47	22%	212	6.2%
Hunter New England	204	66%	105	34%	309	9.1%
Northern NSW	108	77%	32	23%	140	4.1%
Mid North Coast	316	94%	21	6%	337	9.9%
Southern NSW	206	86%	34	14%	240	7.1%
Murrumbidgee (incl. Albury LGA)	84	59%	58	41%	142	4.2%
Western NSW	97	82%	21	18%	118	3.5%
Far West	98	98%	2	2%	100	2.9%
missing			11	100%	11	0.3%
TOTAL	2171	64%	1224	36%	3395	

Table 3: Supervisor and interviewer feedback about inclusion of mobile phone numbers in the NSW population Health Survey.

Themes	Comments
Interviewer perceptions	<ul style="list-style-type: none"> ● Though mobiles were more personal ● Thought easier to convince someone to participate when on a landline ● Worry about being unprofessional ringing people interstate ● People were unexpectedly cooperative. ● Enjoyed doing the child survey from the mobile as parent has already agreed ● Mobile phone interview seem to be quicker ● People seem surprisingly unperturbed to be called on their mobile, must be used to getting work calls etc even seen less protective of their privacy than on their home phone ● Respondent may be more angry when called on the mobile ● Worry about people picking up mobile phone while driving – seems to happen more in evening ● Mobile dialling, I think it has more pros than cons as young people seem to be more willing to participate ● I think it is invasive for us to call on mobile ● New experience ringing mobile phones ● Bit challenging because worried would be too personal ● Prefer to work on either landline or mobile frame not both together
Respondent cooperation	<ul style="list-style-type: none"> ● Some respondents commented that their privacy has been invaded. ● Commented they would have cooperated if it they had been called on landline phone ● Lots of positive comments from mobile respondents. Glad they could help. Bit of a novelty. ● Some people were on the train or bus and though it would be no harm doing it. ● Some office workers enjoyed the chance to do the survey rather than their boring job ● Some refused because they felt uncomfortable or did not want to talk out (like at the pub) and so refused. ● Some people were very co-operative ● People seem to be slightly more aggressive/short on the mobile phone
Mobile frame	<ul style="list-style-type: none"> ● More enquiries from mobile respondents on how did you get my number ● Would like location information on mobile phone frame so they don't need to call so many ineligible numbers ● Need for timing changes to accommodate possible calls to WA (3 hours behind during daylight saving EST) ● Need to establish NSW resident more quickly in mobile frame ● Not too many numbers were unknown because of quality of the sample frame ● Need to establish location very quickly although respondent not always willing to provide ● Most people seem to have landlines as well

Themes	Comments
Questionnaire	<ul style="list-style-type: none"> ● Needed to change household questions to the end of the questionnaire for the mobile frame ● Survey good length and easy questions for mobile phones ● Some difficulty with definition of mobile phone for personal use and business phones ● Respondents questioned relevance of the questions about whether the telephone numbers were listed in the white pages ● What has listing of phone number got to do with health survey
Line quality and other issues	<ul style="list-style-type: none"> ● Line quality and/or background noise with problem with some mobile phones ● Mobile phones sometimes cut out during the call ● Calling people at work and when driving so understand why they refuse ● Had a number of unusual situations when called mobile phones (student in lecture and professor giving a lecture) ● More interruptions and distractions for mobile phone respondents
Fieldwork	<ul style="list-style-type: none"> ● Would like less calls to mobile phones to secure an interview as suspect not very productive and we don't want to look like we are "stalkers" ● May be better to only call mobiles in the evening so not calling people at work (although do set up call-backs for the evening) ● Opportunity to convert inbound calls (ringing back to see who called them happens more with mobile phones) with mobile phones ● Caller ID more likely to show on mobile phones ● Ability to call back on most suitable number good

Table 4: Call outcome information and rates for by sample frame and combined

	Landline frame	Mobile frame	Total
T=Total phone numbers used	21350	17534	
I=Complete Interviews (1.1)	2171	1224	3395
<i>Adults</i>	1865	1085	2950
<i>Children</i>	306	139	445
R=Refusal and break off (2.1)	868	457	
NC=Non Contact (2.2)	660	238	
O=Other (2.0, 2.3)	1163	767	
e: estimated proportion of cases of unknown eligibility that are eligible.	0.29	0.22	
UH=Unknown Household (3.1)	4553	5450	
UO=Unknown other (3.2-3.9)			
NE=Not eligible	11935	9462	
<i>Fax data line</i>	1352	33	
<i>Non-working number unusual tone</i>	2390	2637	
<i>Business, government office, other organizations</i>	8100	826	
<i>Not in NSW/mobile owned/answered by child</i>	93	5966	
Response Rates			
Response Rate 1: $I/(I+P) + (R+NC+O) + (UH+UO)$	23.1%	15.0%	18.6%
Response Rate 2: $(I+P)/(I+P) + (R+NC+O) + (UH+UO)$	23.1%	15.0%	18.6%
Response Rate 3: $I/((I+P) + (R+NC+O) + e(UH+UO))$	35.1%	31.5%	33.1%
Response Rate 4: $(I+P)/((I+P) + (R+NC+O) + e(UH+UO))$	35.1%	31.5%	33.1%
Cooperation Rates			
Cooperation Rate 1: $I/(I+P)+R+O$	51.7%	50.0%	50.7%
Cooperation Rate 2: $(I+P)/((I+P)+R+O)$	51.7%	50.0%	50.7%
Cooperation Rate 3: $I/((I+P)+R)$	71.4%	72.8%	72.2%
Cooperation Rate 4: $(I+P)/((I+P)+R)$	71.4%	72.8%	72.2%
Refusal Rates			
Refusal Rate 1: $R/((I+P)+(R+NC+O) + UH + UO)$	9.2%	5.6%	7.2%
Refusal Rate 2: $R/((I+P)+(R+NC+O) + e(UH + UO))$	14.0%	11.7%	12.8%
Refusal Rate 3: $R/((I+P)+(R+NC+O))$	17.9%	17.0%	17.4%
Contact Rates			
Contact Rate 1: $(I+P)+R+O / (I+P)+R+O+NC+ (UH + UO)$	44.6%	30.1%	36.5%
Contact Rate 2: $(I+P)+R+O / (I+P)+R+O+NC + e(UH+UO)$	68.0%	62.9%	65.1%
Contact Rate 3: $(I+P)+R+O / (I+P)+R+O+NC$	86.4%	91.1%	89.1%
Call Efficiency			
Calls to get a contact: $T/(I+R+NE+B)$	1.9	2.1	
Calls to get an eligible contact: $T/(I+R)$	7.0	10.5	
Callso to get an interview: T/I	9.8	14.4	

Notes:

e = the estimated proportion of cases of unknown eligibility that are eligible. This estimate is based on the proportion of eligible units among all units in the sample for which a definitive determination of status was obtained (a conservative estimate)

Overall rate = $(R_A * (P_a + \lambda P_{ab}^A)) + (R_B * (P_b + \lambda P_{ab}^B))$ where R = rate; P = population proportion; λ =overlap (set to 0.5); A = landline sample frame; B denotes mobile sample frame; a = landline only persons; b = mobile phone only persons; ab denotes both mobile phone and landline

Table 5: Sample comparisons to the latest population profile for NSW

Demographic group		Landline frame			Mobile frame			Land-line plus mobile only	Both frames combined *	2011 Census
		Land-line only	Both	Total	Mobile only	Both	Total			
		%	%	%	%	%	%			
Age groups	0-15	6.0	15.8	14.1	8.5	12.3	11.4	13.4	12.1	20.5
	16-24	0.5	4.9	4.1	17.1	10.8	12.4	5.8	7.3	11.6
	25-34	1.6	6.4	5.6	41.8	16.6	23.1	10.2	13.2	13.6
	35-44	5.2	8.0	7.6	12.3	16.0	15.0	8.2	9.9	14.1
	45-54	7.3	14.3	13.0	10.1	19.3	16.9	12.7	13.4	13.8
	55-64	16.8	22.6	21.6	7.3	14.9	12.9	19.8	17.4	11.7
	65-74	23.3	17.3	18.4	2.5	7.9	6.5	16.4	14.1	7.8
	75-high	39.3	10.6	15.6	0.3	2.2	1.7	13.5	12.5	6.9
Sex	Male	42.9	38.0	38.9	48.4	48.3	48.4	40.1	42.8	49.3
	Female	57.1	62.0	61.1	51.6	51.7	51.6	59.9	57.2	50.7
Aboriginality	Aboriginal	2.4	2.2	2.2	5.1	1.8	2.6	2.6	2.6	2.5
	Non-Aboriginal	97.6	97.8	97.8	94.9	98.2	97.4	97.4	97.4	97.5
Birthplace	Australia	76.6	80.1	79.4	60.8	79.4	64.9	77.1	73.4	68.6
	Overseas	23.4	19.9	20.6	39.2	20.6	35.1	22.9	26.6	31.4
Marital status	Married	45.3	56.0	54.1	31.3	61.8	54.0	51.3	51.5	49.4
	Widowed	28.7	10.5	13.7	1.9	3.5	3.1	12.2	11.1	5.8
	Separated	3.4	4.1	4.0	3.5	3.2	3.3	3.9	3.7	3.1
	Divorced	10.8	12.6	12.3	7.4	7.0	7.1	11.7	10.2	8.3
	Never married	11.8	16.8	15.9	55.8	24.5	32.5	20.9	23.5	33.4
Income**	< \$20,000	46.8	19.7	24.0	19.0	9.9	12.0	23.4	21.9	13.7
	\$20,001-\$40,000	24.5	18.9	19.8	14.7	15.7	15.4	19.2	18.5	19.8
	"\$40,001-\$60,000	9.3	16.2	15.1	16.8	14.3	14.9	15.3	14.7	16.9
	\$60,001-\$80,000	4.1	11.5	10.4	14.2	13.9	14.0	10.8	11.2	19.8
	\$80,000 plus	15.2	33.7	30.8	35.3	46.3	43.7	31.3	33.7	29.8

Note: *Adjustment for the combined estimates: mobile only plus landline only plus 0.5 multiplied by both for each frame.

**Census income information was converted from weekly income to annual income for the comparison.