

Running head: DUAL – FRAME SAMPLING IN GAMBLING SURVEY RESEARCH

Improving gambling survey research using dual - frame sampling of landline and mobile
phone numbers

Abstract

Gambling prevalence studies are typically conducted within a single (landline) telephone sampling frame. This practice continues, despite emerging evidence that significant differences exist between landline and mobile (cell) phone only households. This study utilised a dual - frame (landline and mobile) telephone sampling methodology to cast light on the extent of differences across groups of respondents in respect to demographic, health, and gambling characteristics. A total of 2,014 participants from across Australian states and territories ranging in age from 18 to 96 years participated. Interviews were conducted using computer assisted telephone interviewing technology where 1,012 respondents from the landline sampling frame and 1,002 from the mobile phone sampling frame completed a questionnaire about gambling and other health behaviours. Responses across the landline sampling frame, the mobile phone sampling frame, and the subset of the mobile phone sampling frame that possessed a mobile phone only (MPO) were contrasted. The findings revealed that although respondents in the landline sample (62.7%) did not significantly differ from respondents in the mobile phone sample (59.2%) in gambling participation in the previous 12 months, they were significantly more likely to have gambled in the previous 12 months than the MPO sample (56.4%). There were no significant differences in internet gambling participation over the previous 12 months in the landline sample (4.7%), mobile phone sample (4.7%) and the MPO sample (5.0%). However, endorsement of lifetime problem gambling on the NODS-CLiP was significantly higher within the mobile sample (10.7%) and the MPO sample (14.8%) than the landline sample (6.6%). Our research supports previous findings that reliance on a traditional landline telephone sampling approach effectively excludes distinct subgroups of the population from being represented in research findings. Consequently, we suggest that research best practice necessitates the use of a dual - frame sampling methodology. Despite inherent logistical and cost issues, this approach needs to become the norm in gambling survey research.

Keywords

Mobile phones, Cell phones, Surveys, Sampling, Problem gambling, Gambling participation

Background

In recent times, gambling prevalence studies have typically relied on the use of random digit dialling (RDD) methods or the electronic white pages to conduct computer assisted telephone interviewing (CATI) surveys. These studies have almost always utilised a single frame (landline) telephone sample. They include both national studies such as in the case of New Zealand (e.g. NZ Ministry of Health, 2009) and state or provincial surveys in Australia (e.g. Allen Consulting Group et al 2012; Queensland Gambling Policy Directorate & Office of the Government Statistician, 2002, 2006, 2008; South Australian Centre for Economic Studies, 2008; South Australian Department for Families and Communities, 2006; Victorian Department of Justice, 2009), and Canada (e.g. Ipsos - Reid & Gemini Research, 2008; Lemaire, MacKay, & Patton, 2008; Market Quest Research Group, Inc, 2005, 2009; Schrans & Schellink, 2004). Exceptions to the CATI landline - based surveys are those conducted in the UK (Wardle, Sproston, Orford, Erens et al, 2007; Wardle, Moody, Spence, Orford et al, 2010) and Singapore (Ministry of Community Development, 2005) which utilise face to face interviews.

Accurate prevalence measures of problematic gambling are important for a range of reasons. For policy makers, changes in prevalence rates may be used as an indicator of the impact of regulation and regulatory changes, such as reduction of gambling opportunity through placing of caps on gaming venue growth, or reducing accessibility through reduction in opening hours or changing age limits, for example (Jacques, Ladouceur, & Ferland, 2000). Accurate prevalence rates also enable effective service planning in terms of the targeting of prevention programs and the composition and location of treatment programs (Mason, 2006; Rush, Veldhuizen, & Adlaf, 2007). In broad terms, they also help to address issues such as the social and economic impact of gaming venue dispersal patterns (Doran & Young, 2010; Pearce, Mason, Hiscock & Day, 2008) and provide empirical data with which to address

questions relating to adaptation to gambling opportunity (LaPlante & Shaffer, 2007; Storer, Abbott & Stubbs, 2009).

A challenge facing telephone survey researchers of gambling participation and problematic gambling, however, is the increasing proportion of the population residing in 'mobile (cell) phone only' (MPO) households. Current estimates are that around 19% of adults in Australia (ACMA, 2011), 13% of adults in the UK (Ofcom, 2012), at least 24.5% of households in the US (Blumberg & Luke, 2009), 23% of households in Ireland (Morgan, McGee, Watson et al, 2008), and 36% of households in Portugal (Vincente & Reis, 2009) are mobile phone only. Residents of these households are not contactable via the traditional landline telephone interviewing methods. The non - coverage of MPO households by landline sample frames is a source of potential bias for telephone surveys and, as such, has been the subject of an emerging literature. This includes research on sample differences (Blumberg & Luke, 2009; Blumberg, Luke & Cynamon, 2006; Hu, Balluz, Bataglia & Frankel, 2011; Vincente and Reis, 2009), and non - sampling sources of bias such as response rates and measurement errors (Brick, Cervantes, Lee & Norman, 2011). These latter biases also include the assignment of respondents to the correct categories of phone usage in surveys, particularly where households report mixtures of landline and mobile usage by themselves or by multiple household users (Brick, Cervantes, Lee & Norman, 2011).

Emerging research has suggested that there are significant demographic differences between landline and MPO households. Vincente and Reis (2009) investigated the impact on survey data in Portugal, which had one of the highest European Union rates of MPO households at 36% in 2007. They found highly significant differences in relation to age (those aged 24 - 34 years were nearly four times more likely to be in a MPO household than those 45 to 54 years old); education (where the less educated more likely to be in MPO households); occupational activity (employed and unemployed workers were around six times more likely to be in MPO households than retirees); and family life cycle (single people

living alone were over three times more likely to be in MPO households than married people with children). McBride, Morgan and McGee (2012), using a dual - frame sample in the 2010 Irish Contraception and Crisis Pregnancy Service, found that more men, young adults and single people were recruited via the mobile telephone sample than the landline sample.

This issue of sample frame bias, having received little attention in Australia, was explored via a national Dual - Frame Demonstration Survey (Pennay, 2010). The objectives of this study were to: 1) Pioneer the conduct of a dual - frame telephone survey in Australia using landline and mobile phone numbers; 2) Better understand the issues involved in conducting telephone surveys using a dual - frame sampling methodology; 3) Profile the MPO population; and 4) Examine the impact of the systematic exclusion of MPO persons from traditional landline telephone surveys on population estimates. In the Demonstration Survey, a total of 700 interviews were undertaken (400 landline; 300 mobile). The major differences between the samples, all significant at the 95% confidence level, are shown in Table 1 (Pennay, 2010).

Insert Table 1 about here

The results from the demonstration survey highlighted significant and non - ignorable biases in survey estimates which are likely to compromise the accuracy of population estimates if the MPO segment of a population is excluded from participation. Further, these differences were still apparent once the survey results were weighted through a pre - weight procedure to adjust for the overlapping sampling design for persons with a mobile phone and persons without a mobile phone; and a post stratification weighting using a raking procedure (sometimes called rim weighting or iterative proportional fitting). The approach uses a number of known population parameters to iteratively construct a weight that adjusts for sampling bias. The basic premise of this approach is to weight survey estimates to marginal

totals rather than cell totals. This has the benefit of being able to include a greater number of variables in the weighting process and, in our experience, is an effective method of adjusting for known non-response biases. The population parameters adjusted for by this procedure were gender, age by educational attainment (university graduate or not), region (capital city / rest of state), telephone status (mobile only, landline and mobile, landline only) and birthplace (Australian born / overseas born from an English speaking background against overseas born from a non - English speaking background). With respect to gambling behaviour, the Dual - Frame Demonstration Survey (Pennay, 2010) found that MPO respondents were over four times more likely (landline - 1.6%, MPO - 6.6%) than the landline only respondents to endorse a one-item measure of problematic gambling, '*Have you ever had an issue with your gambling*'? (Thomas, Jackson & Piterman, 2008).

Following this demonstration of the effectiveness of a dual - frame sampling methodology for capturing higher rates of problematic gambling, a more extensive survey was undertaken. The aim of the current study was to examine whether there were differences in gambling behaviour between a landline sample and a mobile phone sample. It was hypothesised that mobile phone sampling would include a higher proportion of respondents who had gambled in the previous 12 months, gambled on the internet in the previous 12 months, and screened positive for lifetime gambling problems than landline sampling.

A question related to internet gambling was included to provide further clarification of the prevalence of interactive gambling in Australia. Although reported prevalence rates of internet gambling in Australia are low, it is estimated that expenditure in interactive gambling has more than doubled in recent years to represent approximately 4% of national gambling expenditure, while the annual growth rate of gambling expenditure has slowed to less than 1% (Productivity Commission, 2010) making estimations more complex for this medium. Dual frame methods are especially relevant here as the 2006 Tasmanian prevalence study reported that approximately 1.4% of Tasmanians had gambled on the internet in the past 12

months and that significantly more internet gamblers were young men, in full-time employment with a high school certificate (South Australian Centre for Economic Studies, 2008). Internationally, several studies examining the differences in demographic characteristics between internet and non-internet gamblers sampled from representative samples of adults (Gambling Commission, 2008; Griffiths, Wardle, Orford, Sproston, & Erens, 2009; Wood & Williams, 2009) and self-selected samples (Griffiths & Barnes, 2008; Hopley, Dempsey & Nicki, 2011) have found that internet gamblers are more likely to be male, young adult, single, well educated, in professional/managerial employment, of higher income and of non-Caucasian ancestry than non-internet gamblers. These are demographic characteristics with greater representation in MPO samples, and it was thought that the previous Australian gambling participation surveys may well have underestimated the actual levels of participation in internet gambling through a bias produced by single frame sampling.

Method

Sample Frame

Two sample frames of the Australian population (18 years and older) were used to select potential respondents. These were a landline frame, of a geographically stratified probability proportional to size quota sample, and a mobile phone frame, based on a simple random sample. Both sampling frames were provided by the commercial sample provider, *Sampleworx*, as in the demonstration survey (Pennay, 2010). For calls made to households in the landline sample, the interviewer asked to speak with the person in the household aged 18 years and over who was going to have the next birthday. For calls made to persons in the mobile phone sample, the interviewer conducted the interview with the person who answered the phone provided they were aged 18 years and over. Several strategies were used to maximise response rates; a Freecall number providing additional information about the survey, messages on answering machines / voicemail, interviews in multiple languages, and

discretionary calls to immediate hang-ups and 'soft - refusals'. There were 1,012 completed interviews from the landline sample frame and 1,002 completed interviews from the mobile phone sample frame.

A geographically stratified sample design was used in the landline frame such that probability proportional to size quotas were set for the capital city and non - capital city regions of each State / Territory, with the Australian Capital Territory being treated as one region. No geographic quotas were set for the mobile phone frame as no geographic identifiers are available for mobile phone numbers. As a result, interviews with mobile phone respondents outside the main cities were slightly under represented compared to the Australian population, although this appears consistent with the lower uptake of mobile phones outside of the major cities (Australian Communications and Media Authority, 2011).

Procedure

The Social Research Centre used CATI technology to manage the interviewing process. The CATI application dialled potential respondents and prompted the interviewer with questions. Responses were entered into the CATI system by the interviewer that was then used to manage the presentation of future questions.

Interview training, quality assurance and ethics approval

Interviewers were trained in all aspects of administering the survey, including data quality issues, call backs, and managing the refusal process. Interviewers were also trained in how to respond appropriately to sensitive situations and adverse events, and were provided with a list of appropriate referral numbers for each state and territory for respondents who requested these services. Additionally, mobile phone respondents were asked 'whether or not it is safe for you to take this call at the moment' in case their attention was needed elsewhere, e.g. while they were driving. Quality assurance measures included supervisory staff monitoring selected calls and examining the recorded responses to 'other specify' questions. All interviews were validated in accordance with the ISO standard 20252 protocol, and the

study was approved by the University of Queensland, Behavioural and Social Sciences Ethical Review Committee, clearance number 2011001133.

Call responses

A total of 76,342 calls (28,070 landline and 48,272 mobile) were placed to achieve the 2,014 completed interviews. The 28,070 calls to landline numbers were made to 6,197 unique numbers. The average number of calls made to each landline number was 4.5 and the proportion of landline numbers that received multiple calls was 75.9%. The 48,272 calls made to mobile phone numbers were made to 11,572 unique numbers. The average number of calls to each mobile phone number was 4.2 and the proportion of the mobile phone sample that received multiple calls was 74.4%.

The overall response rate for the survey was 16.1%¹, where the landline frame achieved 22.2% and the mobile frame achieved 12.7%. These rates are within expected levels based on previous dual-frame surveys. While there are no published Australian benchmarks with which to compare these response rates, they are good by US standards where typical response rates for dual-frame media polls are between 10-15% for the landline frame and 6-10% for the mobile phone frame. In the present study, the most common call outcome was no answer (40.0%), followed by 'answering machine / voicemail' outcomes (25.8%), and then 'appointments to recontact' (14.0%).

Questionnaire structure

The questionnaire comprised the following modules: health, road safety attitudes and behaviours, labour force, physical activity, sun protection, climate change, television viewing, tobacco use, alcohol and marijuana use, experience of racism, problem gambling,

¹ The method used for calculating the response rate was the method prescribed by the American Association of Public Opinion Research (AAPOR). AAPOR Response Rate 3 was used on this occasion. Refer to American Association of Public Opinion Research.2011. Standard Definitions: Final Disposition of Case Codes and Outcome Rates for Surveys. 7th Edition. (http://www.aapor.org/AM/Template.cfm?Section=Standard_Definitions2&Template=/CM/ContentDisplay.cfm&ContentID=3156)

sexual activity and pap tests, and general demographics (e.g., age, gender, household status, relationship status, education, income, etc.). Respondents were asked all questions unless they indicated non - participation in that activity, or a preference not to answer. Additionally, in the sexual activity module, respondents could request skipping the whole section. A number of demographic items were utilised for the current study, along with measures of gambling participation and problem gambling severity, alcohol consumption, and health questions.

Gambling measures

Participation. Respondents were asked two gambling participation questions: ‘In the last 12 months, how many days per week, per month or per year have you played a gambling activity for money?’, and ‘In the previous 12 months, how many days per week, per month or per year have you participated in any gambling activity over the internet for money?’.

Problem severity. Respondents were asked the NODS - CLiP (Toce – Gerstein et al., Gerstein, & Volberg, 2009), a three - item lifetime screening tool identifying harms resulting from their gambling. These items were taken from the National Opinion Research Centre Diagnostic Screen for gambling disorders (NODS; Gerstein et al., 1999), an empirically validated assessment of gambling severity (American Psychiatric Association, 2000). These three items were the highest performing combination of questions from the original scale, with a positive endorsement of at least one of the three items identifying 90% of problem gamblers and 99% of pathological gamblers. Toce - Gerstein et al. (2009) reported the NODS - CLiP to possess classification percentages of 96.2% for sensitivity (correctly identified symptoms) and 90.2% for specificity (correctly identified non - symptoms), when compared to the NODS. The NODS - CLiP questions are: ‘Have there ever been periods lasting 2 weeks or longer when you spent a lot of time thinking about your gambling experiences, or planning out future gambling ventures or bets?’, ‘Have you ever lied to family members, friends, or others about how much you gamble or how much money you lost on gambling?’,

and ‘Have you ever tried to stop, cut down, or control your gambling?’ These questions represent the constructs preoccupation, lying, and loss of control, respectively.

Alcohol

Respondents completed a modified version of the AUDIT - C, a three - item screening instrument for hazardous drinking or active alcohol use disorders (Bush, Kivlahan, McDonell, Fihn, Bradley et al., 1998), based on questions from the 10 - item AUDIT (Saunders, Aasland, Babor, De La Fuente, Grant et al., 1993). Initial data were collected utilising extended response options that were then collapsed to coincide with the response categories of the AUDIT - C. Response options for each of the AUDIT - C items range from 0 to 4, resulting in a possible maximum score of 12. Scores of 4 or more are seen as indicative of likely alcohol misuse. Alcohol dependence research has found the AUDIT - C to report 81% and 86% for sensitivity and specificity, respectively (Bradley, Bush, Epler, Dobie, Davis et al., 2003), when compared against the alcohol sections of generic alcohol and drug dependence clinical interviews (Grant et al., 1995).

Health questions

Two modified questions from the EQ-5D (EuroQol Group, 1990) were also asked. One was the anxiety / depression question, ‘Which of these best describes your health today?’ where the response categories were ‘I am not anxious or depressed’, ‘I am moderately anxious or depressed’, ‘I am extremely anxious or depressed’, ‘Don’t know’, or ‘Refused’. The other was the visual analogue scale of current health - related quality of life state, ‘Please use a scale from zero to 100 to describe how good or bad your state of health is today. What score do you give your state of health today where the best state of health you can imagine is 100 and the worst state you can imagine is zero?’ No Australian population norms exist for these questions. Previously, health research comparing the EQ-5D with similar overall quality of life measures (e.g., SF-36, Jenkinson et al., 1997), have found it to have good to

moderate classification properties, reporting 86% and 67% for sensitivity and specificity, respectively (Campbell et al., 2006).

Data weighting

Weighted data was employed for all analyses. The data were weighted by way of a two-stage process in order to adjust for the overlapping sample design and known non-response biases associated with telephone surveys. The resultant weighted survey estimates better reflect the characteristics of the population of interest. The steps were: step 1, design weight (an adjustment based on the chance of selecting an appropriate respondent based on house hold type); and step 2, a post stratification process to further weight the data to known variables that influence response rates (location, telephone status, gender, country of birth, and age x educational attainment). The weights were derived utilising national census data, e.g. Australian Bureau of Statistics, Australian Communications and Media Authority, and the Census of Population and Housing.

Data analysis

Data were analysed using IBM SPSS Version 19 statistical package. Preliminary assessment of the data was undertaken to ensure the accuracy of data entry, the nature of the data, and degree of missing values in the data set. Examination of descriptive statistics indicated within range values for all data. Many of the variables comprised nominal data which limited the type of analyses that could be undertaken and the need to conduct extensive preliminary screening of the dataset.

The level of missing data was small with only one individual variable containing missing data at a level greater than 1.1%. A total of 283 respondents (14.1%) who were asked to indicate their household's approximate income either refused to answer the question or indicated they did not know. The profile of this group generally reflected that of the larger sample in respect to remaining variables. Both the nature of the data (mostly nominal) along with the small degree of missing data precluded the need to use imputation measures to

estimate likely responses. Instead, missing data was managed via casewise exclusion within individual analyses. The one exception to this process was in the formulation of the initial data set for the study. A total of 14 people who did not supply information on gambling participation were excluded from analyses. Additional details regarding this decision and group of respondents are documented in the results section.

Most analysis was undertaken utilising chi-square to investigate whether there was a relationship between the phone sampling frame from which respondents were drawn and various specified variables of interest. When the data were suitable, independent sample t - tests were undertaken to investigate mean score differences across phone sampling frames, and / or across designated groups of interest. When group variances were not equal, the adjusted value of t was reported and used to determine the degree of statistical significance.

Analyses were undertaken with grouped data. The primary grouping reflected the respondent status in respect to the phone sampling frame from which they were drawn. Participants were either contacted from within a landline or mobile phone sample frame. However, it needs to be noted that the majority of respondents (76.7%) were dual phone users possessing both a landline and a mobile phone. Two smaller user groups were the exception, namely those possessing only a landline (8.6%) and respondents with only a mobile phone (14.6%). Analyses were conducted contrasting those contacted from within a landline or mobile phone sampling frame; in addition, the responses of landline respondents were contrasted with a subset of mobile frame respondents who only had a mobile phone. A further breakdown designating dual users and landline only respondents was not deemed necessary as both these groups would be contactable under standard sampling procedures, whereas those with MPO status would not.

A secondary grouping of the data reflected respondent status in respect to gambling behaviour. For the majority of analyses responses within the phone sampling frames were contrasted against four data groupings, namely: the overall sample; *non - gamblers*, who were

respondents reporting no gambling participation in the last 12 months; *gamblers*, who were respondents reporting having gambled in the previous 12 months; and *NODS - CLiP endorsers*, who were respondents endorsing one or more NODS - CLiP items. An additional grouping, designated those reporting gambling in the last 12 months as either irregular or regular gamblers. In delineating these two groups the gambling definition used by the Productivity Commission (2010) was employed, with respondents who reported at least weekly gambling participation designated as regular gamblers, and those reporting less frequent gambling activity as irregular gamblers.

Results

Sample characteristics

A total of 2,014 participants were asked a series of gambling, health, and demographic questions, with the aim of determining if the telephone sampling frame from which respondents were drawn would impact on responses in general and gambling questions specifically. A total of 14 people who did not supply information on gambling participation were excluded from analyses. These 14 cases were spread across the landline and mobile phone sampling frames equally with seven from each sample, with one of these cases from the MPO subset of the mobile sample. Relative to the overall sample, excluded cases were more female (71.4%), slightly older (51.8 years of age, $SD = 19.3$), and more likely to have metropolitan residency (78.6%). The resulting sample of 2,000 cases consisted of 1,005 cases from the landline sampling frame and 995 from the mobile frame. For the present analyses, a further breakdown of the mobile phone sample was undertaken, with designation of an MPO subset of 294 respondents.

Participants were drawn from across Australian states and territories and ranged in age from 18 to 96 years with a mean age for the overall sample of 47.6 years ($SD = 17.6$). Within the total sample, females were over represented (55.5% unweighted data, 50.7% weight adjusted) with the gender mix altering dramatically across sampling frame and

gambling behaviour (see Table 2). The majority of respondents were born in Australia (68.8%) and this predominance was reflected across sampling frames, ranging from 63% in the case of the mobile phone sample to 74% in the case of the landline sample.

Within the overall sample, 60.9% of respondents reported that they had participated in a gambling activity for money in the previous 12 months, with 17.7% of the overall sample reporting that they had participated regularly and 43.2% reporting that they had participated irregularly in a gambling activity. Moreover, 4.7% of the overall sample reported that they had gambled on the internet for money in the previous 12 months and 8.6% were classified as problem gamblers on the NODS-CLiP.

Insert Table 2 about here

Differences across the landline and mobile phone sampling frames

Demographic characteristics. Demographic characteristics across the phone sampling frames are contrasted with reference to the overall sample, non-gambling, gambling in the previous 12 months, and NODS - CLiP endorsement (see Table 2) with statistically significant differences being found between the landline and mobile sampling frames. In most instances, landline and mobile sampling frame differences encountered in the overall sample were reflected in subsample breakdowns, although NODS - CLiP endorsers formed a somewhat more homogeneous group, with less variation across the sampling frames being evidenced. In general, relative to landline frame respondents, mobile phone respondents were more likely to be urban based, younger, male, sharing group accommodation, residing in their locale for less than 5 years, to have completed secondary school or higher, and be generating an annual income of \$60,000 or more.

Insert Table 3 about here

Gambling participation. Gambling participation by sampling frame is detailed in Table 3, with participation contrasted across the overall sample, respondents who gambled in the last 12 months, and participants who endorsed NODS - CLiP items. As a group, MPO respondents reported less gambling participation over the last 12 months, $\chi^2(1) = 4.5, p \leq 0.05, V = 0.06$. In addition, within the overall sample, MPO respondents were also found to be significantly less likely to report gambling on a regular basis, $\chi^2(1) = 6.37, p \leq 0.05, V = 0.07$. Otherwise, irregular gambling, regular gambling, and Internet gambling were consistent across sampling frames.

Gambling problem severity. Table 4 details the extent and content of NODS - CLiP item endorsement. Positive endorsement of at least one of the NODS-CLiP items was reported by 6.6% of the landline sample, 10.7% of the mobile phone sample, and 14.8% of the MPO sample. Endorsement of at least one of the three items was more evident in the mobile sample, $\chi^2(1) = 10.61, p \leq 0.001, V = 0.07$, and the MPO subset, $\chi^2(1) = 22.31, p \leq 0.001, V = 0.13$, than the landline sample. Of those endorsing NODS - CLiP items, the majority (64.0%) endorsed just one item, 28.6% endorsed 2 items, and 7.5% endorsed 3 items. Within the overall sample, 4.6% of landline respondents endorsed one item, 6.5% of the mobile sample did, while 8.6% of MPO participants did, $\chi^2(1) = 7.82, p \leq 0.01, V = 0.08$. A small number (1.3%) of the landline sample endorsed two items, while 3.5% for the mobile sample did, and 5.1% for the MPO subsample, $\chi^2(1) = 10.28, p \leq 0.001, V = 0.07$; and $\chi^2(1) = 16.73, p \leq 0.001, V = 0.11$. The extent of 3 item endorsement was not significantly different across the sampling frames.

Insert Table 4 about here

Breakdown of NODS - CLiP item endorsement by content revealed that the most prominent issue for respondents across the sampling frames was that of control, followed by lying and finally preoccupation. Essentially, preoccupation with gambling did not vary across the sampling frames. However, relative to the landline sample, lying about gambling behaviour was more likely to occur within the mobile sample, $\chi^2(1) = 12.42, p \leq 0.001, V = 0.08$, and MPO subsample, $\chi^2(1) = 18.08, p \leq 0.001, V = 0.12$. Similarly, attempts to control their gambling behaviour was significantly more likely to be an issue for those within the mobile sample, $\chi^2(1) = 9.11, p \leq 0.01, V = 0.07$; and MPO subsample, $\chi^2(1) = 18.21, p \leq 0.001, V = 0.12$, than the landline group.

Health characteristics. A variety of participant health and mental health characteristics are contrasted by gambling status and sampling frame in Table 5. With the exception of NODS - CLiP endorsers, mean levels of anxiety / depression were found to be higher in the mobile phone sample relative to the landline sample across all groups: overall sample, $t(1991) = -4.09, p \leq 0.001$; non - gamblers, $t(778) = -2.15, p \leq 0.05$; and gamblers, $t(1211) = -3.46, p \leq 0.001$. Higher levels of anxiety / depression were also evident in the MPO subsample within the overall sample grouping, $t(1316) = 4.26, p \leq 0.001$; as well as for gamblers, $t(801) = 3.91, p \leq 0.001$. The state of health of respondents as rated by a subjective ranking from 0 to 100 did not differ between sampling frames for any groups. Mean AUDIT - C levels were significantly higher for the mobile phone sample contrasted against landline respondents in both the overall sample, $t(1991) = -5.42, p \leq 0.001$, and for gamblers, $t(1212) = -6.18, p \leq 0.001$. A higher level of problem drinking was evident in the MPO subsample compared to the levels reported by respondents in the landline sample for: the overall sample, $t(1313) = 4.41, p \leq 0.001$; amongst gamblers, $t(800) = 5.91, p \leq 0.001$; and NODS - CLiP endorsers, $t(114) = 2.48, p \leq 0.05$.

Insert Table 5 about here

Discussion

In terms of gambling behaviour, the dual - frame methodology provided a more nuanced picture than in a landline - only sample. MPO respondents (a subset of the mobile sampling frame that included dual landline and mobile users), were significantly less likely as a group to have gambled in the last 12 months, but were nevertheless significantly more likely to endorse items of problem gambling on the NODS-CLiP. Both the mobile sample as a whole, as well as MPO respondents, were more likely to endorse multiple problematic gambling items, and in nearly all instances the extent of their endorsement was significantly different from that of respondents drawn from the landline sampling frame. Across both sampling frames, the most prominent issue for respondents was that of control, followed by lying and finally preoccupation. This latter issue was equally problematic across phone sampling frames but lying and control were significantly more of an issue for the mobile sample and MPO subset. In addition, levels of anxiety, depression and hazardous drinking were also found to be higher in the mobile phone sample.

The dual sampling frame did not identify higher participation of internet gambling generally (4.7% landline; 5.0% MPO) than the latest Australian state-level prevalence survey (5.2%: Davidson & Rodgers, 2010). Although not significant, a relatively large difference in internet participation rates amongst NODS – CLiP endorsers was found between the landline and MPO samples, with nearly a quarter (24.6%) of landline respondents reporting internet gambling in the past year while only 12.7% of MPO respondents did. This is an interesting finding that indicates that the younger, male, and more residentially mobile MPO problem gamblers are less likely to gamble on the internet than problem gamblers in the landline group. Factors that may be protective in this group's internet gambling needs further exploration.

Many of the demographic differences between landline and mobile phone samples found in the earlier Dual Frame Demonstration Study (Pennay, 2010) were replicated in this study, with the MPO population significantly more likely to: be male, be aged 18 to 34, live in capital cities, be Aboriginal or born overseas, have lived in their neighbourhood for less than five years, be living in rental property and a group household, be undertaking tertiary studies, and be employed. This indicates that inclusion of a mobile phone sample produces a reliable and significantly different population estimation compared to a landline - only sample. Importantly, the MPO sample is one that includes respondents typically deemed 'hard to reach' by conventional RDD CATI surveys, such as people who are young, indigenous, and residentially mobile. This final difference is especially pertinent in the case of developmental and applied research undertakings. Sole reliance on traditional landline sampling frames would effectively exclude distinct subgroups of the population from both cross sectional, and increasingly importantly, longitudinal research.

Having noted the benefits of conducting gambling research using a dual landline and mobile sampling frame, it is important to note a number of issues arising from adoption of this recommended sampling method. In jurisdictions such as Australia, mobile phone numbers reflect the mobile carrier or service provider and not a regional designation. Implications of this are that more effort has to be made to recruit proportionately if undertaking, for example, state - wide surveys rather than national surveys.

There are, however, additional survey costs associated with mobile phone samples. For example, the average number of calls per interview for the mobile phone frame was 48.2 compared with 27.7 for the landline frame. The main reason for this difference was the much higher proportion of voicemail outcomes resulting from calls to mobile phones (32.5%) relative to the proportion of answering machine outcomes obtained when calling landlines (14.3%). In addition, mobile phone call charges are higher than those for landline calls,

resulting again, in higher survey costs. The Behavioural Risk Factor Surveillance System (Hu et al, 2011) puts this differential as three to four times the landline rate.

A third cost factor is the lack of, or limited, sample frames for mobile phones, either mobile - only or dual users. For example, Vicente and Reis (2009) noted in relation to their Portuguese study, 59.2% of the mobile phone numbers dialled were to non - attributed numbers (numbers without a specific person attributed to them), and therefore of no use, with the process of calling and verification of non - attribution taking an additional 28 hours of survey time with its attendant higher cost. Despite these cost issues, the data from the present study suggest that, especially in low prevalence conditions such as problem gambling, the methodological advantages of dual - frame sampling outweigh the logistical and cost issues, and should become the norm in gambling survey research.

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Table 1

Dual frame Demonstration Survey demographic characteristics, percentages by phone sampling frame

Demographic characteristics	Landline frame	Mobile phone frame	MPO subsample
	Total <i>n</i> = 400	Total <i>n</i> = 300	<i>n</i> = 83
Sex: males	39.8	50.7	57.8
Age: Persons aged 18-34	12.0	46.3	63.9
Region: Capital city residents	55.0	67.7	62.7
Indigenous status	1.0	3.3	8.4
Birthplace: Overseas born	25.2	39.7	48.2
Time in neighbourhood: Less than 5 years	25.5	58.3	81.9
Home ownership: Living in rental property	13.0	48.0	72.3
Living arrangements: Living in a group household	3.8	21.0	30.1
Enrolled in tertiary studies	7.0	24.3	31.1
Highest level of educational attainment: Bachelors degree or higher	24.8	31.0	36.1
Employment status: Employed	53.2	65.0	67.5

Table 2

Demographic characteristics by phone sampling frame and MPO^a subset (weighted percentages).

Demographic characteristics grouped by...	<i>n</i>	Landline frame	Mobile frame	
		Total <i>n</i> = 1,005 a	Total <i>n</i> = 995 b	MPO ^a Total <i>n</i> = 294 c
<u>Overall sample</u>	2,000			
Metropolitan residency		59.8	68.1 ^{***}	66.1 [*]
Age (Mean)		53.3	38.8 ^{***}	35.8 ^{***}
Gender - Male		40.3	57.4 ^{***}	60.5 ^{***}
Living arrangements - Group household 5 years or less in current neighbourhood		3.8	15.9 ^{***}	26.8 ^{***}
Completed secondary school or higher		22.7	51.8 ^{***}	71.2 ^{***}
Income of 60,000 or more		65.4	77.1 ^{***}	75.7 ^{***}
		48.3	57.2 ^{***}	47.1
<u>Non - gamblers</u>	824			
Metropolitan residency		64.3	75.2 ^{***}	73.9 [*]
Age (Mean)		54.2	37.8 ^{***}	35.5 ^{***}
Gender - Male		37.7	53.5 ^{***}	54.8 ^{***}
Living arrangements - Group household 5 years or less in current neighbourhood		3.2	19.5 ^{***}	29.7 ^{***}
Completed secondary school or higher		24.3	56.7 ^{***}	75.8 ^{***}
Income of 60,000 or more		67.0	83.0 ^{***}	79.5 ^{**}
		46.9	54.0	40.0
<u>Gambled in the last 12 months</u>	1,176			
Metropolitan residency		57.2	63.3 [*]	60.0
Age (Mean)		52.7	39.5 ^{***}	36.0 ^{***}
Gender - Male		41.8	60.0 ^{***}	64.7 ^{***}
Living arrangements - Group household 5 years or less in current neighbourhood		4.3	13.4 ^{***}	24.7 ^{***}
Completed secondary school or higher		21.6	48.4 ^{***}	67.8 ^{***}
Income of 60,000 or more		64.6	73.0 ^{**}	72.4 [*]
		49.2	59.2 ^{***}	52.2
<u>NODS - CLiP endorsement</u>	150			
Metropolitan residency		51.7	66.1	65.5
Age (Mean)		51.0	39.5 ^{***}	36.9 ^{***}
Gender - Male		58.3	78.6 ^{**}	80.0 [*]
Living arrangements - Group household 5 years or less in current neighbourhood		13.1	15.2	29.1 [*]
Completed secondary school or higher		27.9	51.8 ^{**}	70.9 ^{***}
Income of 60,000 or more		60.7	67.9	72.7
		31.0	45.1	40.0

n is given for the number of cases constituting specific groupings within the unweighted data. Reported data is the weighted percentage or mean of grouped respondents. Significance testing was carried out for columns b/c against a: *** $p \leq .001$, ** $p \leq .01$, * $p \leq .05$. Note: ^a MPO is a subset of respondents also contained within the Mobile phone frame

Table 3

Gambling participation by phone sampling frame and MPO^a subset (weighted percentages).

Gambling participation grouped by ...	<i>n</i>	Landline frame	Mobile frame	
		Total <i>n</i> = 1,005 a	Total <i>n</i> = 995 b	MPO ^a Total <i>n</i> = 294 c
<u>Overall sample</u>	2,000			
Gambled in the last 12 months		62.7	59.2	56.4*
Internet gambled		4.7	4.7	5.0
Irregular		43.6	42.8	43.2
Regular		19.2	16.4	13.4*
<u>Gambled in the last 12 months</u>	1,176			
Internet gambled		6.8	7.3	7.4
Irregular		69.4	72.2	76.3
Regular		30.6	27.8	23.7
<u>NODS - CLiP endorsement</u>	150			
Gambled in the last 12 months		90.2	87.5	83.6
Internet gambled		24.6	18.8	12.7
Irregular		52.7	58.2	60.9
Regular		47.3	41.8	39.1

n is given for the number of cases constituting specific groupings within the unweighted data. Reported data is the weighted percentage of grouped respondents. Significance testing was carried out for columns b/c against a: *** $p \leq .001$, ** $p \leq .01$, * $p \leq .05$. Note: ^a MPO is a subset of respondents also contained within the Mobile phone frame.

Table 4

NODS - CLiP endorsement by phone sampling frame and MPO^a subset (weighted percentages).

NODS - CLiP endorsement grouped by ...	Landline frame	Mobile frame	
	Total	Total	MPO ^a Total

	<i>n</i>	<i>n</i> = 1,005 a	<i>n</i> = 995 b	<i>n</i> = 294 c
<u>Any endorsement</u>	2,000	6.6	10.7***	14.8***
<u>Extent of endorsement</u>				
1 item		4.6	6.5	8.6**
2 items		1.3	3.5***	5.1***
3 items		0.6	0.7	1.1
<u>Content of endorsement</u>				
	150			
Preoccupied with gambling		2.0	2.3	3.7
Lied about gambling		1.7	4.5***	6.1***
Attempted to control gambling		5.3	8.7**	12.0***

n is given for the number of cases constituting specific groupings within the unweighted data.

Reported data is the weighted percentage of grouped respondents.

Significance testing was carried out for columns b/c against a: *** $p \leq .001$, ** $p \leq .01$, * $p \leq .05$

Note: ^a MPO is a subset of respondents also contained within the Mobile phone frame.

Table 5

Health characteristics by phone sampling frame and MPO^a subset (weighted percentages).

Health characteristics grouped by ...	<i>n</i>	Landline frame	Mobile frame	
		Total <i>n</i> = 1,005 a	Total <i>n</i> = 995 b	MPO ^a Total <i>n</i> = 294 c
<u>Overall sample</u>	2,000			
Level of anxiety / depression		1.2	1.3***	1.3***
State of health scaled 0 - 100		79.6	80.5	79.5
AUDIT - C		3.3	4.1***	4.2***
<u>Non - gamblers</u>	824			
Level of anxiety / depression		1.2	1.3*	1.3
State of health scaled 0 - 100		80.1	81.8	81.7
AUDIT - C		2.8	3.1	2.9
<u>Gambled in the last 12 months</u>	1,176			
Level of anxiety / depression		1.2	1.3***	1.3***
State of health scaled 0 - 100		79.2	79.5	77.8
AUDIT - C		3.7	4.7***	5.1***
<u>NODS - CLiP endorsement</u>	150			
Level of anxiety / depression		1.3	1.4	1.3

State of health scaled 0 - 100	75.7	75.1	77.9
AUDIT - C	4.1	4.9	5.5*

n is given for the number of cases constituting specific groupings within the unweighted data.

Reported data is the weighted mean of grouped respondents.

Level of anxiety / depression and state of health were assessed via the EQ - 5D.

Significance testing was carried out for columns b/c against a: *** $p \leq .001$, ** $p \leq .01$, * $p \leq .05$

Note: ^a MPO is a subset of respondents also contained within the Mobile phone frame.

Running head: DUAL – FRAME SAMPLING IN GAMBLING SURVEY RESEARCH

Improving gambling survey research using a dual - frame survey of landline and mobile

phone numbers

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