

National estimates of Australian gambling prevalence: findings from a dual-frame omnibus survey

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ABSTRACT

Background, aims and design The increase in mobile telephone-only households may be a source of bias for traditional landline gambling prevalence surveys. Aims were to: (1) identify Australian gambling participation and problem gambling prevalence using a dual-frame (50% landline and 50% mobile telephone) computer-assisted telephone interviewing methodology; (2) explore the predictors of sample frame and telephone status; and (3) explore the degree to which sample frame and telephone status moderate the relationships between respondent characteristics and problem gambling. **Setting and participants** A total of 2000 adult respondents residing in Australia were interviewed from March to April 2013. **Measurements** Participation in multiple gambling activities and Problem Gambling Severity Index (PGSI). **Findings** Estimates were: gambling participation [63.9%, 95% confidence interval (CI) = 61.4–66.3], problem gambling (0.4%, 95% CI = 0.2–0.8), moderate-risk gambling (1.9%, 95% CI = 1.3–2.6) and low-risk gambling (3.0%, 95% CI = 2.2–4.0). Relative to the landline frame, the mobile frame was more likely to gamble on horse/greyhound races [odds ratio (OR) = 1.4], casino table games (OR = 5.0), sporting events (OR = 2.2), private games (OR = 1.9) and the internet (OR = 6.5); less likely to gamble on lotteries (OR = 0.6); and more likely to gamble on five or more activities (OR = 2.4), display problem gambling (OR = 6.4) and endorse PGSI items (OR = 2.4–6.1). Only casino table gambling (OR = 2.9) and internet gambling (OR = 3.5) independently predicted mobile frame membership. Telephone status (landline frame versus mobile dual users and mobile-only users) displayed similar findings. Finally, sample frame and/or telephone status moderated the relationship between gender, relationship status, health and problem gambling (OR = 2.9–7.6). **Conclusion** Given expected future increases in the mobile telephone-only population, best practice in population gambling research should use dual frame sampling methodologies (at least 50% landline and 50% mobile telephone) for telephone interviewing.

Keywords Cellphones, dual-frame, gambling, mobile telephone, prevalence, problem gambling, sampling, surveys.

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INTRODUCTION

The standardized past-year prevalence of problem gambling averages 2.3% across countries [1]. In Australia, problem gambling estimates have plateaued, with the most recent state/territory gambling surveys [3–9] identifying rates of 61.2–73.8% for gambling participation, 0.5–0.8% for problem gambling, 1.5–2.9% for moderate risk gambling

and 3.4–8.4% for low-risk gambling using the Problem Gambling Severity Index (PGSI) [2]. Designed to explore interactive gambling, the only national prevalence survey conducted in the last 15 years [10] revealed a gambling participation estimate of 64.3%. Using the PGSI on a subsample of 1768 respondents, the rate of problem gambling was 0.6%, moderate-risk gambling was 3.7% and low-risk gambling was 7.7%.

The available studies are limited by an over-reliance on state/territory estimates, modifications to the PGSI response options [5,6,8], and the administration of the PGSI to purposive samples [4,9,10]. Moreover, most of these computer-assisted telephone interviewing (CATI) surveys have employed single sample frames of landline telephone numbers [7,8,10]. An emerging issue facing telephone survey researchers across all fields of study, however, is the increasing proportion of the population residing in 'mobile telephone-only' households. Current estimates suggest that 29% of Australian adults reside in these households [11]. The non-coverage of these households by traditional landline sampling methods is therefore a probable source of bias. Mobile telephone respondents are consistently more likely to be male, young, of indigenous status, Australian born, full-time workers, high wage-earners, employed, living in group households, living in metropolitan regions and residentially mobile than landline respondents [3,6,12–15]. They are also more likely to report psychosocial problems, such as anxiety/depression, psychological distress, alcohol use problems, binge drinking, illegal drug use, smoking, social isolation, financial stress or hardship, being a victim of crime and ethnic or religious discrimination [6,12,14,16].

There is also now growing evidence that significant differences exist in gambling behaviour between landline and mobile sample frames. This issue was first explored in two Australian dual-frame surveys (43–50% mobile frame) [12,14]. In these studies, landline frame respondents displayed significantly higher gambling participation and regular gambling rates than mobile telephone-only respondents [12], but the mobile telephone and mobile telephone-only samples both reported higher rates of problem gambling [12,14] and endorsement of specific items on problem gambling measures [12] than the landline samples. Since the publication of this research, several Australian states (South Australia and Tasmania) have adopted dual-frame methodologies in their most recent prevalence surveys (25–30% mobile frame) [3,6]. In both studies, the mobile frames displayed higher overall gambling participation and participation on specific gambling activities (horse or greyhound racing, lotteries, keno, casino table games and sporting events) than the landline frames [3,6]. There was, however, no difference in PGSI categories between sample frames [3].

Although these findings suggest that traditional landline and mobile telephone sampling approaches derive different gambling estimates, they provided relatively limited exploration of the impact of these approaches [3,6,12,14], generally failed to explore the impact of telephone status (e.g. mobile dual users and mobile-only users) [3,6,14] and did not explore the effect of sample frames on relationships between respondent characteristics and problem gambling [3,6,14]. Several also included relatively small proportions of mobile samples [3,6], only employed

data from individual states/territories [3,6], employed brief gambling measures [e.g. single items, the National Opinion Research Center at the University of Chicago (NORC) Diagnostic Screen for Gambling Disorders–Control, Lying and Preoccupation (NODS-CLiP)] [12,14] or were conducted when the proportion of mobile telephone households was much lower [6,12,14]. Given the increasing adoption of dual-frame methodologies by Australian state/territory governments [3,6] and the increasing proportion of mobile telephone-only households [11], there is a need for a more thorough exploration of the role of sample frame and telephone status in gambling estimates to determine whether dual-frame methodologies, which are more expensive than landline telephone samples [12,17], are necessary in future population gambling surveys.

The study aims are therefore to: (1) identify national gambling participation and problem gambling prevalence estimates using a dual-frame methodology; (2) explore the univariate and multivariate predictors of sample frame and telephone status; and (3) explore the degree to which sample frame and telephone status moderate the relationships between respondent characteristics and problem gambling. Although it is expected that mobile telephone respondents will display a distinct demographic profile and a higher likelihood of gambling participation, gambling problems and psychosocial problems than landline telephone respondents, the moderation aim was exploratory.

METHOD

Study design

A dual-frame sample design using CATI random digit dialling (RDD) aimed to obtain a nationally representative sample (Australia does not have a national telephone register). The 50% mobile frame, which is similar to that used by leading survey research organizations in the United States [18], was selected to minimize costs, provide a large enough sample to explore differences between telephone user groups and provide lower variance than more skewed blends.

Both the landline and mobile samples were generated by the commercial sample vendor *SampleWorx* on 22 March 2013. In Australia, the Australian Communications and Media Authority (ACMA) allocates blocks of landline and mobile telephone numbers to telecommunication carriers by way of allocating telephone number prefixes to each carrier. The numbers generated are provided to commercial sample vendors, who test them to identify working and non-working numbers. For the landline component, sample members were selected from each household using a random allocation to the 'next birthday method' or an alternative quasi-random method based on the number of eligible sample members in the household [19]. No within-unit selection routine was required for

the mobile frame, as the mobile telephone was treated as an individual, rather than a household or shared, device.

The landline frame used probability proportional to size quotas for 15 geographic strata (all capital cities and non-capital city regions of each state/territory, with the exception of the Australian Capital Territory which was treated as one stratum). The population distribution for these quotas ranged from 0.4% (rest of Northern Territory) to 20.6% (Sydney) [20]. A simple random sample was used for the mobile frame as these numbers have no geographic identifiers. Both sample frames produced geographic distributions similar to that of the population, although the mobile sample displayed a slight underrepresentation of areas outside capital cities, which is aligned with the slightly lower take-up of mobile telephones outside major cities [21].

Setting

After piloting, fieldwork was conducted from 25 March to 23 April 2013. The average interview length was 14.3 minutes. The study was approved by the University of Queensland's Behavioural and Social Sciences Ethical Review Committee (2011001133).

Response rate

The American Association of Public Opinion Research (AAPOR) response rate 3 [29] was 19.5% (21.7% landline; 17.8% mobile), the cooperation rate was 43.1% (38.0% landline; 49.7% mobile) and the refusal rate was 33.0% (42.0% landline; 24.4% mobile). An extended call cycle was employed for the landline frame, while a truncated call cycle, in which no more than four unanswered calls were made per week, was employed for the mobile frame. Most interviews (90% landline, 100% mobile) were obtained within 10 calls. Calls for both samples were made at different times and on different days, including weekends. Other response maximization strategies included the operation of a 1800 number, leaving messages on answering machines/voicemail, refusal conversion interviewing, and interviewing in languages other than English.

Participants

The in-scope population was Australian residents aged 18 years and over, contactable by either a landline or mobile telephone. The sample comprised 2000 respondents (1000 landline, 1000 mobile) across all states/territories.

Measures

Past-year gambling participation was measured using single items for multiple gambling activities and internet gambling (to play casino games or poker for money) [6].

The nine-item PGSI [22] using the standard scoring [23] measured past-year problem gambling severity. Scores were classified into non-problem (score of 0), low-risk (scores of 1 or 2), moderate-risk (scores between 3 and 7) or problem (scores of 8 or higher) gambling. The PGSI has good psychometric properties [2,22], with very good internal consistency in the current sample ($\alpha = 0.88$). Consistent with the binge drinking definition in the Australian National Health and Medical Research Council guidelines [24], respondents were required to indicate how frequently they drank five or more alcoholic standard drinks in the previous 3 months. Respondents were also asked to indicate their smoking status. The six-item Kessler-6 (K6 [25]) was employed to measure psychological distress in the past 4 weeks. Scores were classified into low (scores of 6–11), moderate (scores of 12–19) or high (scores of 20–30) psychological distress [26]. The K6 is effective at screening for serious mental disorders [27–29] and had excellent reliability in the current study ($\alpha = 0.81$). Finally, the Short Form general health status question (SF11 [30]), which is an accurate predictor of future health care use, mortality and morbidity [30], was employed as a general indicator of physical and mental health.

Statistical weights

A two-stage weighting approach involved the calculation of: (a) a post-stratification weight using a raking approach to adjust for the disproportionate nature of the sample and differential survey response rates across age, gender, educational attainment [31], country of birth [32] geographical location [33] and telephone status [21] using independent population benchmarks, and (b) a design weight for each frame that included typical adjustments relating to the number of in-scope people in each household and the number of landline telephone connections per household. An additional pre-weight was calculated to adjust for the overlapping chances of selection for persons with both landline and mobile telephones into both sample frames by adjusting for the telephone status of sample members to population parameters [34] (19% mobile telephone-only users, 72% dual users, 9% landline telephone-only users [21]).

Data analysis

Due to the negligible amount of missing data, single items and PGSI/K6 items with more than 30% missing data were deleted pairwise. For respondents with less than 30% missing PGSI data, a single imputation approach was employed using an Expectation Maximization Likelihood algorithm [35] based on their available PGSI data. All analyses were conducted in Stata version 13. The unweighted demographic sample frame estimates were compared to

population benchmarks using single-sample proportion tests. The remainder of the analyses employed weighted data, which was analysed using robust linearized standard errors implemented in Stata's 'svy' toolbox. Univariate predictors (respondent characteristics) of sample frame (landline frame versus mobile frame) and telephone status (landline frame [reference category] versus mobile dual users and mobile-only users) were examined using binary and multinomial logistic regression analyses, respectively. Given the large number of characteristics, three separate multivariate models were estimated in which all the significant univariate demographic, psychosocial and gambling characteristics (except individual PGSI items) ($P < 0.05$) were entered as predictors, respectively. All significant predictors ($P < 0.05$) in these models were retained as predictors in the final binary and multinomial multivariate models. Finally, separate ordinal logistic regression models with simple slopes analyses were employed to explore the degree to which sample frame (landline frame versus mobile frame) and telephone status (landline frame versus mobile-only users) moderate the relationships between each respondent characteristic and problem gambling category.

RESULTS

Dual-frame national gambling estimates

The dual-frame national gambling estimates (Table 1) reveal a rate of 63.9% [95% confidence interval (CI) = 61.4–66.3] for gambling participation, 0.4% (95% CI = 0.2–0.8) for problem gambling, 1.9% (95% CI = 1.3–2.6) for moderate-risk gambling and 3.0% (95% CI = 2.2–4.0) for low-risk gambling.

Univariate predictors of sample frame and telephone status

Demographic characteristics (Table 2)

Comparison to population benchmarks. Compared to population benchmarks, the landline frame under-represented male, aged 18–39 years, and Aboriginal and Torres Strait Islander (ATSI) respondents and over-represented 50+ year-old, Australian-born and university-educated respondents. In contrast, the mobile frame under-represented 65+ year-old, ATSI and Australian-born respondents and over-represented male, 18–39-year-old, capital city-residing and university-educated respondents. The dual frame sample under-represented male, 25–39-year-old and ATSI respondents and over-represented 50+ year-old, capital city-residing and university-educated respondents.

Sample frame. Relative to landline frame, the mobile frame was significantly more likely to be male, aged 18–39 years, residing in capital cities, renting, living with parents, living in a group household, in an ongoing relationship,

university-educated and earning \$60 000–100 000; and significantly less likely to be aged 50+ years, Australian-born, residentially stable, home owners, living as a couple, living alone and earning less than \$60 000.

Telephone status. Relative to the landline frame, both mobile dual users and mobile-only users were significantly more likely to be male, aged 18–39 years, residing in capital cities, renting, living in a group household, in an ongoing relationship and university-educated; and significantly less likely to be 65+ years, Australian-born, residentially stable and home owners. However, only the mobile-only users were significantly less likely to be aged 50–64 years, paying a mortgage and living as a couple with children. In contrast, only the mobile dual users were significantly more likely to be living with parents, and earning \$60 000–100 000; and significantly less likely to be living as a couple without children, living alone and earning less than \$60 000.

Psychosocial characteristics (Table 3)

Sample frame. Relative to the landline frame, the mobile frame was significantly more likely to report moderate psychological distress, binge drinking, daily smoking and excellent/good health; and significantly less likely to report low psychological distress.

Telephone status. Relative to the landline frame respondents, both mobile dual users and mobile-only users were significantly more likely to report excellent/good health. However, only the mobile-only users were significantly more likely to report binge drinking and daily smoking and significantly less likely to report low psychological distress.

Gambling characteristics (Table 1)

Sample frame. Relative to the landline frame, the mobile frame was significantly more likely to gamble on horse or greyhound races, casino table games, sporting events, private games and the internet; significantly less likely to gamble on lotteries; and significantly more likely to gamble on five or more activities, be classified as problem gamblers and to endorse several PGSI items.

Telephone status. Relative to the landline frame, both mobile dual users and mobile-only users were significantly more likely to gamble on casino table games, sporting events and the internet; significantly less likely to gamble on lotteries; and significantly more likely to gamble on five or more activities, be classified as problem gamblers and to endorse several PGSI items. However, only the mobile-only users were significantly more likely to gamble on EGMs and private games and endorse several PGSI items; and significantly less likely to gamble on instant scratch tickets.

Table 1 Estimates of gambling participation and problem gambling by sample frame and telephone status.^a

Gambling characteristic	Dual-frame			Landline frame			Mobile telephone frame			Sample frame (binary Logistic regression results) ^b		Telephone status (multinomial logistic regression result ^b)	
	(n = 2000) %	Total (n = 1000) %	Dual-user (n = 817) %	Landline only (n = 183) %	Total (n = 1000) %	Dual-user (n = 647) %	Mobile telephone only (n = 380) %	Landline Total versus mobile Total (OR)	Landline Total versus mobile dual (RRR)	Landline Total versus mobile telephone only (RRR)			
Gambling participation													
Electronic gaming machines	20.7 (18.8, 22.7)	18.9 (16.2, 22.0)	19.8 (17.2, 22.7)	17.6 (12.4, 24.3)	22.5 (19.9, 25.3)	20.7 (17.7, 24.1)	24.6 (20.4, 29.4)	1.2 (1.0, 1.6)	1.1 (0.9, 1.5)	1.4* (1.0, 1.9)			
Horse or greyhound races	15.9 (14.2, 17.7)	13.9 (11.6, 16.5)	16.4 (13.9, 19.1)	9.9 (5.9, 15.9)	18.0 (15.7, 20.6)	17.6 (14.9, 20.8)	18.4 (14.7, 22.8)	1.4* (1.0, 1.8)	1.3 (1.0, 1.8)	1.4 (1.0, 2.0)			
Instant scratch tickets	22.0 (20.1, 24.1)	23.8 (20.9, 27.0)	26.6 (23.6, 29.8)	19.4 (14.1, 26.1)	20.1 (17.7, 22.8)	21.7 (18.7, 25.1)	18.1 (14.4, 22.5)	0.8 (0.6, 1.0)	0.9 (0.7, 1.1)	0.7* (0.5, 1.0)			
Lottery tickets	49.2 (46.7, 51.7)	54.7 (50.9, 58.5)	56.2 (52.7, 59.6)	52.3 (44.0, 60.5)	43.3 (40.2, 46.5)	48.8 (44.9, 52.7)	36.5 (31.7, 41.7)	0.6** (0.5, 0.8)	0.8* (0.6, 1.0)	0.5** (0.4, 0.6)			
Keno	7.2 (6.0, 8.6)	7.5 (5.7, 9.8)	7.7 (6.1, 9.8)	7.1 (3.7, 13.1)	6.8 (5.4, 8.6)	6.6 (4.9, 8.8)	7.1 (4.8, 10.3)	0.9 (0.6, 1.3)	0.9 (0.6, 1.3)	0.9 (0.6, 1.6)			
Table games at a casino	5.9 (5.0, 7.1)	2.2 (1.4, 3.3)	3.1 (2.1, 4.6)	0.6 (0.1, 4.3)	10.0 (8.2, 12.1)	9.5 (7.4, 12.1)	10.5 (7.7, 14.1)	5.0** (3.1, 8.1)	4.8** (2.9, 7.9)	5.3** (3.1, 9.2)			
Bingo at a club or hall	3.0 (2.4, 3.8)	2.8 (2.0, 4.0)	3.6 (2.5, 5.2)	1.5 (0.6, 3.7)	3.2 (2.3, 4.5)	3.3 (2.2, 5.0)	3.1 (1.7, 5.5)	1.1 (0.7, 1.9)	1.2 (0.7, 2.0)	1.1 (0.6, 2.2)			
Sporting event	5.7 (4.8, 6.8)	3.8 (2.8, 5)	5.7 (4.3, 7.6)	0.6 (0.2, 2.4)	7.8 (6.3, 9.7)	7.1 (5.3, 9.3)	8.8 (6.2, 12.2)	2.2** (1.5, 3.2)	1.9** (1.3, 3.0)	2.5** (1.5, 4.0)			
Private games	3.1 (2.4, 4.0)	2.2 (1.5, 3.3)	3 (2.0, 4.4)	0.9 (0.2, 3.9)	4.1 (3.0, 5.6)	3.3 (2.1, 5.1)	5.1 (3.2, 8.0)	1.9* (1.1, 3.3)	1.5 (0.8, 2.8)	2.4** (1.3, 4.5)			
Internet including mobile devices	1.5 (1.1, 2.2)	0.4 (0.2, 1.0)	0.7 (0.3, 1.7)	0.0 (0.0, 0.0)	2.7 (1.8, 4.0)	2.2 (1.3, 3.6)	3.4 (1.9, 5.9)	6.5** (2.5, 17.1)	5.1** (1.8, 14.5)	8.2** (2.8, 23.5)			
Any gambling activity	63.9 (61.4, 66.3)	65.1 (61.3, 68.7)	67.3 (64.0, 70.5)	61.6 (53.1, 69.3)	62.6 (59.4, 65.6)	64.1 (60.3, 67.8)	60.6 (55.4, 65.6)	0.9 (0.7, 1.1)	1.0 (0.8, 1.2)	0.8 (0.6, 1.1)			
Number of gambling activities													
0	36.1 (33.7, 38.6)	34.9 (31.3, 38.7)	32.7 (29.5, 36.0)	38.4 (30.7, 46.9)	37.4 (34.4, 40.6)	35.9 (32.2, 39.7)	39.4 (34.4, 44.6)	1.1 (0.9, 1.4)	1.0 (0.8, 1.3)	1.2 (0.9, 1.6)			

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Table 1. (Continued)

Gambling characteristic	Dual-frame		Landline frame		Mobile telephone frame			Sample frame (binary Logistic regression results) ^b		Telephone status (multinomial logistic regression result ^b)	
	(n = 2000) %	Total (n = 1000) %	Dual-user (n = 817) %	Landline only (n = 183) %	Total (n = 1000) %	Dual-user (n = 647) %	Mobile telephone only (n = 380) %	Landline Total versus mobile Total (OR)	Landline Total versus mobile dual (RRR)	Landline Total versus mobile telephone only (RRR)	
1	25.9 (23.7, 28.2)	27.0 (23.6, 30.7)	24.3 (21.5, 27.4)	31.4 (24.1, 39.7)	24.7 (22.1, 27.5)	24.7 (21.5, 28.2)	24.6 (20.4, 29.4)	0.9 (0.7, 1.1)	0.9 (0.7, 1.1)	0.9 (0.7, 1.2)	
2-4	34.9 (32.6, 37.3)	36.2 (32.7, 39.9)	40.0 (36.6, 43.4)	30.2 (23.4, 38)	33.6 (30.6, 36.6)	35.7 (32.1, 39.5)	30.9 (26.3, 35.9)	0.9 (0.7, 1.1)	1.0 (0.8, 1.2)	0.8 (0.6, 1.0)	
5+	3.0 (2.4, 3.9)	1.8 (1.2, 2.7)	3.0 (2.0, 4.4)	0.0 (0.0, 0.0)	4.3 (3.2, 5.8)	3.7 (2.4, 5.5)	5.1 (3.2, 8.0)	2.4** (1.4, 4.0)	2.0* (1.1, 3.7)	2.9** (1.5, 5.4)	
PGSI category											
Non-gambling/ non-problem gambling	94.7 (93.5, 95.7)	95.6 (93.7, 96.9)	95.7 (94.0, 96.9)	95.4 (90.7, 97.8)	93.9 (92.1, 95.3)	94.3 (92.1, 95.8)	93.4 (90.3, 95.6)	0.7 (0.5, 1.1)	0.8 (0.5, 1.3)	0.7 (0.4, 1.2)	
Low-risk gambling	3.0 (2.2, 4.0)	2.8 (1.8, 4.4)	2.4 (1.5, 3.8)	3.4 (1.4, 7.7)	3.1 (2.2, 4.5)	2.7 (1.6, 4.3)	3.7 (2.2, 6.3)	1.1 (0.6, 2.1)	1.0 (0.5, 1.9)	1.3 (0.6, 2.8)	
Moderate-risk gambling	1.9 (1.3, 2.6)	1.5 (0.9, 2.7)	1.7 (1.0, 2.9)	1.2 (0.3, 4.8)	2.2 (1.4, 3.4)	2.4 (1.4, 3.9)	2.0 (1.0, 4.1)	1.5 (0.7, 3.0)	1.6 (0.7, 3.5)	1.3 (0.5, 3.4)	
Problem gambling	0.4 (0.2, 0.8)	0.1 (0.0, 0.5)	0.2 (0.0, 0.8)	0.0 (0.0, 0.0)	0.8 (0.4, 1.6)	0.7 (0.3, 1.7)	0.9 (0.3, 2.6)	6.4* (1.3, 30.8)	5.8* (1.1, 30.2)	7.2* (1.2, 43.5)	
PGSI item endorsement ^c											
Bet more than could really afford to lose	3.8 (2.8, 5.1)	2.3 (1.3, 4.1)	1.9 (1.0, 3.4)	3.0 (1.1, 8.2)	5.4 (3.8, 7.5)	5.5 (3.6, 8.2)	5.3 (2.9, 9.3)	2.4* (1.2, 4.8)	2.5* (1.2, 5.1)	2.4* (1.0, 5.5)	
Gamble with larger amounts for same excitement	2.7 (1.9, 3.8)	1.7 (0.9, 3.1)	2.0 (1.1, 3.6)	1.0 (0.1, 6.8)	3.9 (2.6, 5.9)	3.7 (2.2, 6.1)	4.3 (2.2, 8.0)	2.4* (1.1, 5.3)	2.3 (1.0, 5.2)	2.7* (1.1, 6.8)	
Gone back another day to win back lost money	3.2 (2.3, 4.4)	1.9 (1.0, 3.6)	1.8 (1.0, 3.3)	2.0 (0.5, 7.7)	4.6 (3.2, 6.7)	3.8 (2.3, 6.1)	5.7 (3.3, 9.8)	2.5* (1.2, 5.5)	2.1 (0.9, 4.8)	3.2* (1.3, 7.7)	
Borrowed or sold something to get money to gamble	1.0 (0.6, 1.8)	0.3 (0.1, 1.1)	0.5 (0.2, 1.7)	0.0 (0.0, 0.0)	1.8 (1.0, 3.3)	1.4 (0.6, 3.1)	2.4 (1.0, 5.6)	5.4* (1.5, 19.9)	4.1 (1.0, 16.8)	7.2** (1.7, 30.7)	
Have a problem with gambling	2.5 (1.7, 3.6)	1.8 (0.9, 3.7)	1.9 (1.1, 3.5)	1.5 (0.2, 10.0)	3.3 (2.1, 5.0)	3.6 (2.1, 5.9)	2.9 (1.3, 6.2)	1.8 (0.8, 4.4)	2.0 (0.8, 5.0)	1.6 (0.5, 4.8)	

(Continues)

Table 1. (Continued)

Gambling characteristic	Dual-frame			Landline frame			Mobile telephone frame			Sample frame (binary Logistic regression results) ^b		Telephone status (multinomial logistic regression result) ^b	
	(n = 2000) %	Total (n = 1000) %	Dual-user (n = 817) %	Landline only (n = 183) %	Total (n = 1000) %	Dual-user (n = 647) %	Mobile telephone only (n = 380) %	Landline Total versus mobile Total (OR)	Landline Total versus mobile dual (RRR)	Landline Total versus mobile telephone only (RRR)			
Gambling caused health problems	2.2 (1.4, 3.3)	1.6 (0.7, 3.6)	0.8 (0.3, 2.1)	3.0 (1.0, 9.0)	2.8 (1.8, 4.5)	3.6 (2.1, 5.9)	1.9 (0.7, 5.0)	1.8 (0.7, 4.8)	2.3 (0.8, 6.2)	1.2 (0.3, 4.4)			
People criticized gambling	2.1 (1.4, 3.1)	1.3 (0.6, 2.8)	1.3 (0.6, 2.7)	1.5 (0.3, 6.3)	3.0 (1.9, 4.7)	3.0 (1.7, 5.2)	2.9 (1.3, 6.2)	2.2 (0.9, 5.4)	2.3 (0.9, 5.9)	2.2 (0.7, 6.5)			
Gambling caused financial problems	1.4 (0.9, 2.2)	0.4 (0.2, 1.1)	0.6 (0.2, 1.7)	0.0 (0.0, 0.0)	2.5 (1.5, 4.0)	2.5 (1.4, 4.5)	2.4 (1.0, 5.6)	6.1** (2.0, 18.8)	6.2** (1.9, 20.2)	5.9** (1.5, 22.5)			
Felt guilty about gambling	4.5 (3.5, 5.9)	3.7 (2.5, 5.7)	4.5 (3.0, 6.7)	2.5 (0.8, 7.8)	5.4 (3.9, 7.6)	5.9 (4.0, 8.7)	4.8 (2.6, 8.6)	1.5 (0.8, 2.6)	1.6 (0.9, 3.0)	1.3 (0.6, 2.8)			

^aWeighted data. ^bRegression significance: **P < 0.01; *P < 0.05. ^cOf those who endorsed any gambling activity (n = 1287). OR = odds ratio; RRR = relative risk ratio; PGSI = Problem Gambling Severity Index.

Multivariate predictors of sample frame and telephone status

Sample frame

The final multivariate model (Table 4) revealed that younger age, residential mobility, renting, casino table gambling, internet gambling and having excellent/good health were significant independent predictors of the mobile frame relative to the landline frame.

Telephone status

The final multivariate model (Table 4) revealed that only younger age and casino table gambling were significant predictors of both mobile dual users and mobile-only users relative to the landline frame. However, residential mobility, renting, lower lottery participation, binge drinking and excellent/good health were significant independent predictors of only mobile-only users; and internet gambling was the only significant independent predictor of only mobile dual users.

Moderation by sample frame and telephone status

Sample frame

Sample frame had a significant interaction with gender [b = 1.05, standard error (SE) = 0.47, P = 0.027, 95% CI = 0.12–2.00, odds ratio (OR) = 2.86] in predicting PGSI category (see Fig. 1 for simple slopes illustration). Males had a lower probability of being classified as a non-problem gambler relative to the higher-risk categories than females, but only for those in the mobile frame.

Telephone status

Telephone status had a significant interaction with gender (b = 1.52, SE = 0.67, P = 0.023, 95% CI = 0.21–2.84, OR = 4.59), relationship status (b = -2.03, SE = 0.95, P = 0.032, 95% CI = 0.17–3.89, OR = 7.63) and excellent or good health (b = 1.31, SE = 0.61, P = 0.032, 95% CI = 0.11–2.51, OR = 3.71) in predicting PGSI category (see Figs 2 to 4 for simple slopes illustrations). Males and respondents in a relationship had a lower probability of being classified as a non-problem gambler relative to the higher-risk categories than females and those not in a relationship, but only for those in the mobile-only user group (P = 0.010 and P = 0.039, respectively). In contrast, excellent/good physical health was associated with a higher probability of being classified a non-problem gambler than poor/fair/good health, but only for those in the landline frame (P = 0.003).

Table 2 Sample demographic profile by sample frame and telephone status.^a

Demographic characteristic	Population Benchmarks		Mobile telephone frame				Sample frame (binary logistic regression results) ^c		Telephone status (multinomial logistic regression results) ^c	
	Dual frame (n = 2000) %	Landline frame (n = 1000) %	Dual-user (n = 817) %	Landline only (n = 183) %	Total (n = 1000) %	Dual-user (n = 647) %	Mobile telephone only (n = 353) %	Landline Total versus Mobile Total (OR)	Landline Total versus mobile dual (RRR)	Landline Total Telephone only (RRR)
Gender (male)	44.5 ^b (42.3, 46.7)	36.5 ^b (33.6, 39.5)	37.2 (34, 40.6)	33.3 (26.9, 40.5)	52.5 ^b (49.4, 55.6)	50.9 (47.0, 54.7)	55.5 (50.3, 60.6)	1.9** (1.6, 2.3)	1.8** (1.5, 2.2)	2.2** (1.7, 2.8)
Age group (years)										
18–24	11.8 (10.4, 13.3)	4.9 ^b (3.7, 6.5)	5.4 (4.1, 7.2)	2.7 (1.1, 6.4)	18.6 ^b (16.3, 21.1)	16.0 (13.3, 19.0)	23.4 (19.3, 28.2)	4.4** (3.2, 6.1)	3.7** (2.6, 5.2)	5.9** (4.0, 8.6)
25–39	23.6 ^b (21.8, 25.5)	16.2 ^b (14.0, 18.6)	18.3 (15.8, 21.2)	6.6 (3.8, 11.3)	31.0 ^b (28.2, 33.9)	24.2 (21, 27.6)	43.4 (38.3, 48.7)	2.3** (1.9, 2.9)	1.7** (1.3, 2.1)	4.0** (3.0, 5.2)
40–49	17.3 (15.7, 19.0)	17.4 (15.2, 19.9)	20.0 (17.3, 22.8)	6.0 (3.4, 10.6)	17.2 (15.0, 19.7)	18.4 (15.6, 21.6)	14.9 (11.5, 19.0)	1.0 (0.8, 1.2)	1.1 (0.8, 1.4)	0.8 (0.6, 1.2)
50–64	27.2 ^b (25.3, 29.2)	30.3 ^b (27.5, 33.2)	30.9 (27.8, 34.2)	27.5 (21.5, 34.4)	24.1 (21.6, 26.9)	29.5 (26.1, 33.1)	14.3 (11.0, 18.4)	0.7** (0.6, 0.9)	1.0 (0.8, 1.2)	0.4** (0.3, 0.5)
65+	20.2 ^b (18.5, 22.0)	31.2 ^b (28.4, 34.1)	25.4 (22.5, 28.5)	57.1 (49.8, 64.2)	9.1 ^b (7.5, 11.1)	11.9 (9.7, 14.7)	4.0 (2.4, 6.6)	0.2** (0.2, 0.3)	0.3** (0.2, 0.4)	0.1** (0.1, 0.2)
Region (capital city)	68.9 ^b (66.8, 70.8)	63.8 (60.8, 66.7)	63.9 (60.5, 67.1)	63.4 (56.1, 70.1)	73.9 ^b (71.1, 76.5)	74.5 (71.0, 77.7)	72.8 (67.9, 77.2)	1.6** (1.3, 1.9)	1.7** (1.3, 2.1)	1.5** (1.2, 2.0)
Aboriginal & Torres Strait Islander status	1.2 ^b (0.8, 1.8)	1.3 ^b (0.8, 2.2)	1.1 (0.6, 2.1)	2.2 (0.8, 5.7)	1.1 ^b (0.6, 2.0)	0.9 (0.4, 2.1)	1.4 (0.6, 3.4)	0.8 (0.4, 1.9)	0.7 (0.3, 1.9)	1.1 (0.4, 3.1)
Birthplace (Australia)	65.2 (63.1, 67.3)	69.6 ^b (66.7, 72.4)	72.7 (69.5, 75.6)	56.3 (49.0, 63.3)	60.7 ^b (57.6, 63.7)	61.2 (57.3, 64.9)	59.9 (54.6, 64.9)	0.7** (0.6, 0.8)	0.7** (0.6, 0.8)	0.7** (0.5, 0.8)
Time in neighbourhood (more than 5 years)	60.2 (58.0, 62.3)	72.7 (69.9, 75.4)	70.1 (66.8, 73.1)	84.6 (78.6, 89.2)	47.6 (44.5, 50.7)	59.6 (55.7, 63.3)	25.6 (21.3, 30.4)	0.3** (0.3, 0.4)	0.6** (0.4, 0.7)	0.1** (0.1, 0.2)
Home ownership										
Own home	36.6 (34.3, 38.8)	47.7 (44.5, 50.9)	44.0 (40.5, 47.6)	64.2 (56.6, 71.2)	24.8 (22.1, 27.8)	34.3 (30.4, 38.4)	8.3 (5.7, 11.9)	0.4** (0.3, 0.4)	0.6** (0.5, 0.7)	0.1** (0.1, 0.2)
Paying mortgage	30.8 (28.7, 33.0)	32.5 (29.5, 35.6)	37.1 (33.7, 40.6)	11.5 (7.5, 17.4)	29.0 (26.1, 32.1)	34.1 (30.3, 38.2)	20.0 (15.9, 24.8)	0.8 (0.7, 1.0)	1.1 (0.9, 1.3)	0.5** (0.4, 0.7)

(Continues)

Table 2. (Continued)

Demographic characteristic	Population Benchmarks			Mobile telephone frame				Sample frame (binary logistic regression results) ^c		Telephone status (multinomial logistic regression results) ^c	
	Dual frame	Landline frame		Dual-user		Total	Dual-user	Mobile telephone only	Landline Total versus Mobile Total (OR)	Landline Total versus mobile dual (RRR)	Landline Total Telephone only (RRR)
	(n = 2000) %	Total (n = 1000) %	Dual-user (n = 817) %	Landline only (n = 183) %	Total (n = 1000) %	Dual-user (n = 647) %	Mobile telephone only (n = 353) %				
Paying rent	32.7 (30.5, 34.9)	19.8 (17.4, 22.6)	18.9 (16.2, 21.8)	24.2 (18.3, 31.4)	46.2 (42.9, 49.5)	31.6 (27.8, 35.6)	71.7 (66.5, 76.5)	3.5** (2.8, 4.3)	1.9** (1.5, 2.4)	10.3** (7.6, 13.8)	
Living arrangements With parents/guardians	7.9 (6.8, 9.2)	4.4 (3.3, 5.9)	4.6 (3.4, 6.3)	3.4 (1.5, 7.4)	11.5 (9.6, 13.7)	14.3 (11.7, 17.2)	6.3 (4.1, 9.5)	2.8** (1.9, 4.0)	3.6** (2.5, 5.3)	1.4 (0.8, 2.5)	
Couple only	26 (24.0, 28.0)	28.3 (25.5, 31.2)	28.5 (25.5, 31.7)	27.4 (21.3, 34.5)	23.6 (21.0, 26.4)	23.7 (20.5, 27.2)	23.4 (19.1, 28.2)	0.8* (0.6, 1.0)	0.8* (0.6, 1.0)	0.8 (0.6, 1.0)	
Couple with children	31.8 (29.8, 33.9)	33.2 (30.3, 36.3)	35.9 (32.6, 39.3)	21.1 (15.7, 27.8)	30.4 (27.5, 33.4)	35.4 (31.8, 39.3)	21.0 (16.9, 25.7)	0.9 (0.7, 1.1)	1.1 (0.9, 1.4)	0.5** (0.4, 0.7)	
One parent family	6.8 (5.8, 8.1)	6.6 (5.2, 8.3)	6.5 (5.0, 8.5)	6.9 (3.9, 11.7)	7.1 (5.6, 8.9)	7.2 (5.4, 9.5)	6.9 (4.6, 10.2)	1.1 (0.8, 1.5)	1.1 (0.7, 1.6)	1.0 (0.6, 1.7)	
Group household	9.1 (7.9, 10.5)	3.4 (2.4, 4.7)	3.4 (2.3, 4.9)	3.4 (1.5, 7.4)	14.9 (12.8, 17.3)	10.3 (8.1, 12.9)	23.7 (19.4, 28.5)	5.0** (3.4, 7.4)	3.3** (2.1, 5.0)	8.8** (5.7, 13.5)	
One person household	18.3 (16.7, 20.1)	24.1 (21.5, 26.9)	3.4 (2.3, 4.9)	3.4 (1.5, 7.4)	12.5 (10.6, 14.8)	10.3 (8.1, 12.9)	23.7 (19.4, 28.5)	0.5** (0.4, 0.6)	0.3** (0.2, 0.4)	0.7 (0.5, 1.0)	
Relationship status (in ongoing relationship)	25.7 (22.9, 28.7)	19.6 (16, 23.8)	24.0 (19.4, 29.2)	6.2 (2.8, 13.2)	30.8 (26.8, 35.1)	29.9 (24.7, 35.6)	32.0 (25.9, 38.8)	1.8** (1.3, 2.5)	1.7** (1.2, 2.5)	1.9** (1.3, 2.8)	
Education (Bachelor's degree or higher)	32.6 ^b (30.5, 34.7)	26.9 ^b (24.2, 29.8)	30.2 (27.2, 33.5)	11.4 (7.5, 17.1)	38.3 ^b (35.3, 41.4)	38.9 (35.2, 42.7)	37.2 (32.2, 42.5)	1.7** (1.4, 2.0)	1.7** (1.4, 2.1)	1.6** (1.2, 2.1)	
Household income Less than \$60 000	49.0 (46.5, 51.5)	52.8 (49.2, 56.3)	47.4 (43.5, 51.2)	79.8 (72.0, 85.9)	45.1 (41.7, 48.7)	41.7 (37.5, 46.1)	51.3 (45.4, 57.1)	0.7** (0.6, 0.9)	0.6** (0.5, 0.8)	0.9 (0.7, 1.2)	
\$60 000 to less than \$100 000	25.1 (23.0, 27.3)	22.4 (19.6, 25.5)	24.5 (21.4, 28.0)	11.6 (7.1, 18.4)	27.8 (24.8, 31.1)	29.0 (25.2, 33.2)	25.6 (20.8, 31.1)	1.3* (1.1, 1.7)	1.4** (1.1, 1.8)	1.2 (0.9, 1.6)	
\$100 000 or more	25.9 (23.8, 28.2)	24.8 (21.9, 28.0)	28.1 (24.8, 31.7)	8.5 (4.8, 14.8)	27.0 (24.0, 30.3)	29.2 (25.4, 33.4)	23.1 (18.5, 28.4)	1.1 (0.9, 1.4)	1.3 (1.0, 1.6)	0.9 (0.7, 1.3)	

^aUnweighted data. ^bUnweighted proportion is significantly different from population benchmark using single sample proportion tests ($P < 0.05$).

^cRegression significance: ** $P < 0.01$; * $P < 0.05$. OR = odds ratio. RRR = relative risk ratio.

Table 3 Estimates of psychosocial characteristics by sample frame and telephone status.^a

Psychosocial characteristic	Dual-frame (n = 2000) %			Landline frame (n = 1000) %			Mobile telephone frame (n = 1000) %			Sample frame (binary logistic regression results) ^b			Telephone status (multinomial logistic regression results) ^b		
	Total (n = 1000) %	Dual-user (n = 817) %	Landline only (n = 183) %	Total (n = 1000) %	Dual-user (n = 647) %	Mobile telephone only (n = 380) %	Total (n = 1000) %	Dual-user (n = 647) %	Mobile telephone only (n = 380) %	Landline Total versus Mobile Total (OR)	Landline Total versus Mobile dual (RRR)	Landline Total versus mobile telephone only (RRR)			
K6 psychological distress															
Low	73.4 (71.2, 75.6)	75.8 (72.3, 79.0)	73.6 (65.6, 80.2)	71.0 (68.0, 73.8)	72.1 (68.4, 75.4)	69.7 (64.7, 74.3)	0.8* (0.6, 1.0)	0.8 (0.6, 1.1)	0.7* (0.5, 1.0)						
Moderate	22.7 (20.7, 24.9)	20.5 (17.6, 23.9)	21.8 (15.7, 29.4)	25.0 (22.4, 27.9)	24.9 (21.7, 28.5)	25.2 (21.0, 30.0)	1.3* (1.0, 1.6)	1.3 (1.0, 1.7)	1.3 (1.0, 1.8)						
High	3.8 (2.9, 5.0)	3.7 (2.4, 5.6)	4.6 (2.1, 9.9)	4.0 (2.9, 5.4)	3.0 (2.0, 4.7)	5.1 (3.2, 8.0)	1.1 (0.6, 1.9)	0.8 (0.4, 1.5)	1.4 (0.7, 2.7)						
Drank 5 or more standard drinks in one session at least twice per week in past 3 months	9.5 [8.2, 11.0]	7.1 (5.5, 9.1)	5.9 (3.1, 10.7)	12.1 (10.1, 14.3)	9.1 (7.1, 11.6)	15.7 (12.3, 19.9)	1.8** (1.3, 2.5)	1.3 (0.9, 1.9)	2.4** (1.6, 3.6)						
Daily smoking															
SF-1 health (excellent or very good)	13.7 [12.1, 15.4] 54.5 [52.0, 57.0]	10.6 (8.6, 12.9) 50.4 (46.5, 54.2)	9.8 (6.2, 15.1) 40.4 (32.6, 48.8)	16.9 (14.7, 19.5) 58.9 (55.8, 62.0)	13.9 (11.4, 16.8) 57.0 (53.1, 60.8)	20.7 (16.8, 25.2) 61.3 (56.0, 66.2)	1.7** (1.3, 2.3) 1.4** (1.2, 1.7)	1.4 (1.1, 1.9) 1.3* (1.0, 1.6)	2.2** (1.6, 3.1) 1.6** (1.2, 2.0)						

^aWeighted data. ^bRegression significance: **P < 0.01; *P < 0.05. OR = odds ratio; RRR = relative risk ratio.

Table 4 Multivariate predictors of sample frame and telephone status.^a

	Sample frame (binary logistic model)			Telephone status (multinomial logistic model)			Landline telephone frame respondents (ref) versus mobile telephone only users		
	Landline telephone frame (ref) versus mobile telephone frame			Landline telephone frame respondents (ref) versus mobile telephone dual users			Landline telephone frame respondents (ref) versus mobile telephone only users		
	Odds ratio	95% CI	P	Odds ratio	95% CI	P	Odds ratio	95% CI	P
Age	0.96	(0.95, 0.97)	.000	0.97	(0.96, 0.97)	.000	0.95	(0.94, 0.96)	.000
Time in neighbourhood (+5 years)									
No	1 (ref)			1 (ref)			1 (ref)		
Yes	0.61	(0.47, 0.8)	.000	0.79	(0.6, 1.06)	.115	0.40	(0.27, 0.58)	.000
Home ownership									
Own home	1 (ref) ²			1 (ref)			1 (ref)		
Paying mortgage	0.96	(0.7, 1.31)	.791	0.91	(0.66, 1.26)	.580	1.52	(0.87, 2.63)	.138
Paying rent	2.06	(1.47, 2.89)	.000	1.19	(0.83, 1.71)	.348	5.84	(3.38, 10.07)	.000
Electronic gaming machines									
No	NA ^b			1 (ref)			1.29	(0.77, 2.15)	.329
Yes				1.00	(0.69, 1.46)	.989			
Lottery tickets									
No	1 (ref)			1 (ref)			1 (ref)		
Yes	0.71	(0.49, 1.03)	.074	0.90	(0.59, 1.38)	.639	0.51	(0.3, 0.85)	.009
Table games at a casino									
No	1 (ref)			1 (ref)			1 (ref)		
Yes	2.94	(1.62, 5.31)	.000	3.03	(1.64, 5.58)	.000	2.57	(1.24, 5.35)	.012
Sporting event									
No	1 (ref)			1 (ref)			1 (ref)		
Yes	1.02	(0.59, 1.77)	.935	1.08	(0.6, 1.94)	.805	1.03	(0.52, 2.06)	.931
Internet including mobile devices									
No	1 (ref)			1 (ref)			1 (ref)		
Yes	3.47	(1.19, 10.09)	.022	3.57	(1.14, 11.21)	.029	3.36	(0.91, 12.38)	.069
Number of gambling activities									
0	1 (ref)			1 (ref)			1 (ref)		
1	1.11	(0.74, 1.66)	.612	0.95	(0.6, 1.49)	.820	1.29	(0.75, 2.22)	.366
2-4	1.10	(0.71, 1.71)	.674	0.98	(0.57, 1.68)	.931	1.08	(0.54, 2.16)	.834
5+	0.68	(0.28, 1.62)	.383	0.54	(0.18, 1.6)	.262	0.67	(0.19, 2.43)	.546

(Continues)

Table 4. (Continued)

	Sample frame (binary logistic model)			Telephone status (multinomial logistic model)			Landline telephone frame respondents (ref) versus mobile telephone only users		
	Landline telephone frame (ref) versus mobile telephone frame	95% CI	P	Landline telephone frame respondents (ref) versus mobile telephone dual users	95% CI	P	Odds ratio	95% CI	P
	Odds ratio			Odds ratio			Odds ratio		
Drank 5+ standard drinks in one session at least twice per week in past 3 months									
No	1 (ref)			1 (ref)			1 (ref)		
Yes	1.43	[0.97, 2.12]	.073	1.18	[0.77, 1.82]	.447	1.98	[1.2, 3.27]	.008
Daily smoking									
No	1 (ref)			1 (ref)			1 (ref)		
Yes	1.39	[0.99, 1.95]	.057	1.29	[0.89, 1.88]	.182	1.54	[0.98, 2.4]	.060
SF-1 health (excellent or very good)									
No	1 (ref)			1 (ref)			1 (ref)		
Yes	1.33	[1.04, 1.69]	.022	1.22	[0.95, 1.58]	.118	1.53	[1.09, 2.16]	.014

^aWeighted data. ^bNot significant in preliminary logistic models and thus not used as predictor in final logistic model. CI = confidence interval.

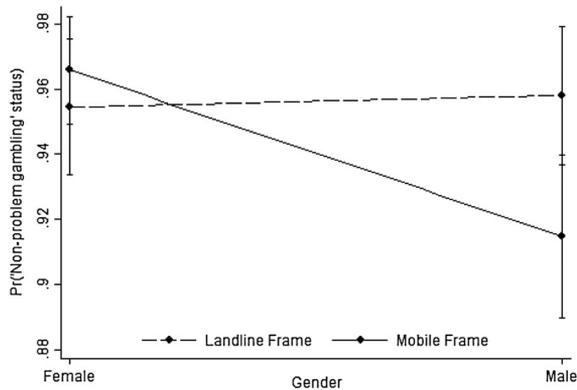


Figure 1 Interaction effect of gender and sample frame (landline telephone frame versus mobile telephone frame) in predicting Problem Gambling Severity Index (PGSI) category. Data are presented only for the probability associated with non-problem gambling status for males and females across sample frame. The simple slope for the mobile telephone frame was significant [$b = 0.97$, standard error (SE) = 0.30, $P = 0.002$, 95% confidence interval (CI) = 0.37–1.57], but the simple slope for the landline telephone frame was not significant ($b = -0.08$, SE = 0.36, $P = 0.817$, 95% CI = -0.80–0.63)



Figure 3 Interaction effect of relationship status and telephone status (landline telephone frame respondents versus mobile telephone-only users) in predicting Problem Gambling Severity Index (PGSI) category. Data are presented only for the probability associated with non-problem gambling status for respondents in and not in a relationship across telephone status. The simple slope for the mobile telephone-only users was significant [$b = 1.04$, standard error (SE) = 0.50, $P = 0.039$, 95% confidence interval (CI) = 0.06–2.02], but the simple slope for the landline telephone frame respondents was not significant ($b = 0.99$, SE = 0.80, $P = 0.216$, 95% CI = -2.56–0.58)

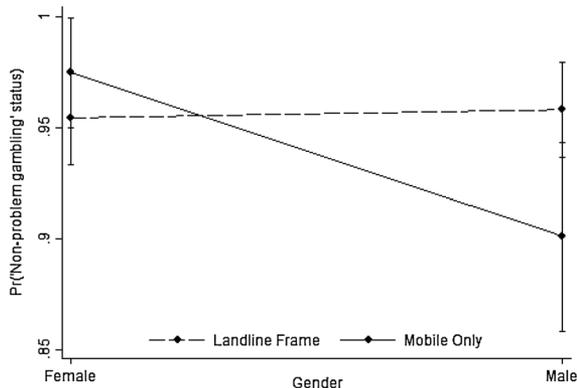


Figure 2 Interaction effect of gender and telephone status (landline telephone frame respondents versus mobile telephone-only users) in predicting Problem Gambling Severity Index (PGSI) category. Data are presented only for the probability associated with non-problem gambling status for males and females across telephone status. The simple slope for the mobile telephone-only users was significant [$b = 1.44$, standard error (SE) = 0.56, $P = 0.010$, 95% confidence interval (CI) = 0.34–2.54], but the simple slope for the landline telephone frame respondents was not significant ($b = -0.08$, SE = 0.37, $P = 0.816$, 95% CI = -0.80–0.63)

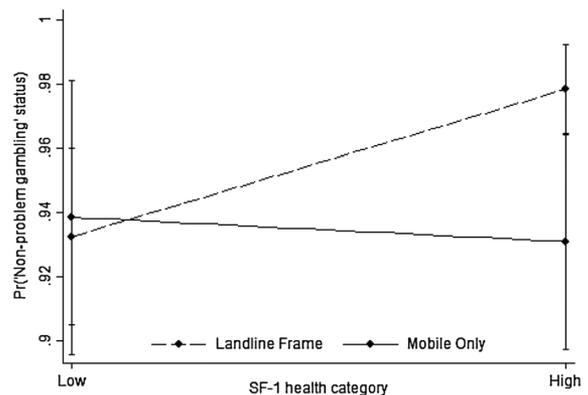


Figure 4 Interaction effect of health category and telephone status (landline telephone frame respondents versus mobile telephone-only users) in predicting Problem Gambling Severity Index (PGSI) category. Data are presented only for the probability associated with non-problem gambling status for respondents reporting low health (poor/fair/good) and high health (very good/excellent) across telephone status. The simple slope for the landline telephone frame respondents was significant [$b = -1.19$, standard error (SE) = 0.40, $P = 0.003$, 95% confidence interval (CI) = 1.98–0.40], but the simple slope for the mobile telephone-only users was not significant ($b = 0.12$, SE = 0.46, $P = 0.787$, 95% CI = -0.78–1.03)

DISCUSSION

In this first Australian national dual-frame gambling study, the gambling participation and problem gambling rates are at the low end of recent estimates [10,20]. Although the extant dual-frame literature reports somewhat inconsistent findings with respect to specific gambling behaviours, the higher participation on many gambling activities [3,6], problem gambling [12,14] and PGSI item endorsement

[12] by mobile frame respondents compared to landline frame respondents is consistent with previous research. The finding in relation to higher gambling involvement is new, and the finding in relation to higher internet gambling is inconsistent with previous literature [6,12], due probably to differences in the measurement of internet gambling across studies. The findings therefore add to the

growing evidence that there are differences in gambling behaviour between landline and mobile telephone sample frames. Only casino table gambling and internet gambling, however, were associated independently with an increased odds of mobile frame membership, suggesting that many of the gambling behaviour differences between sample frames are accounted for by respondent characteristics, such as younger age, residential mobility, living in a rental property and good health.

There is concern that traditional landline sampling approaches exclude the growing mobile telephone-only population. Importantly, the mobile telephone-only sample seems to include respondents characterized by characteristics deemed typically 'hard to reach' by conventional landline sampling approaches. They also display demographic [10,20,36] and psychosocial [10,12,14,16,37,38] profiles that are associated typically with problem gambling. Indeed, the finding that the mobile-only sample reported higher rates of problem gambling [12,14] and endorsement of problem gambling measure items [12] suggest that the gambling field has been omitting the exact population most likely to endorse gambling problems. Only casino table gambling and lower lottery participation, however, were significant independent predictors of mobile telephone-only users, suggesting that many of the gambling behaviour differences between these telephone users are accounted for by other respondent characteristics, such as younger age, residential mobility, living in a rental property, binge drinking and good health.

There is also some concern about the differential non-response by dual users who predominantly use their mobile telephones. The findings of this study confirm that compared to respondents in the traditional landline frame, mobile telephone dual users were more likely to report a distinct demographic profile and higher gambling participation and problem gambling. Again, casino table gambling and internet gambling were significant independent predictors of mobile telephone dual users. These findings suggest that profile differences produced from the sample frames are not wholly explained by the differences in sample coverage and that dual-frame methodologies have the added benefit of contacting dual users who predominantly use their mobile telephones.

Males and younger respondents were under-represented in the landline frame and over-represented in the mobile frame, while older and Australian-born respondents were over-represented in the landline frame and under-represented in the mobile frame. These findings imply that the inclusion of a mobile frame will probably increase the representativeness of a population sample, particularly in relation to gender, age and country of birth. Despite these promising findings, both sample frames under-represented ATSI respondents and over-represented university educated respondents, suggesting that there

remain other 'hard-to-reach' subpopulations, even with the use of dual-frame methodologies. Moreover, the 50/50 dual-frame sample still under-represented males and younger respondents and over-represented older respondents. It is therefore of concern that the recent dual-frame Australian gambling surveys have adopted relatively low proportions of mobile telephone sampling (25–30%) [3,6]. Future gambling surveys could achieve additional sample representativeness by adopting a higher proportion of mobile telephone sampling, particularly given expected increases in the size of the mobile telephone-only population.

The moderation analyses revealed that being female [39] and not in a relationship was protective for the development of gambling problems, but only for respondents in the mobile frame or mobile-only user group. In contrast, good health was protective only for landline frame respondents. These buffering effects extend the implications of the findings beyond gambling prevalence estimates by indicating that the sample frame employed and the telephone status of respondents can affect the ability of particular characteristics to predict problem gambling development. It is therefore recommended that sample frame and telephone status be taken into consideration in any future examination of these factors in the general population.

Limitations of the current study include a relatively small sample size, moderate response rates, a cross-sectional design and a reliance upon self-report measures. This study was, however, the first to explore comprehensively the impact of dual-frame sampling approaches in a nationally representative sample with standard measures of gambling participation and problems. The results suggest that traditional landline sampling approaches create biases for gambling surveys due to their non-coverage of mobile telephone-only users and a differential non-response by dual users who predominantly use their mobile telephones. While it is of concern that the gambling research field has been excluding the one-third of the population that is most likely to display the greatest rate of gambling problems, it is unlikely that the existing body of gambling knowledge needs to be reconsidered, because the growth of this subgroup has been only during the last several years [11]. Given the expected future increases in this population, however, dual-frame population sampling methodologies are recommended despite their increased expense.

Declaration of interests

The authors declare that the material has not been published in whole or in part elsewhere; the paper is not currently being considered for publication elsewhere; all authors have been personally and actively involved in substantive work leading to the report, and will hold

themselves jointly and individually responsible for its content; all relevant ethical safeguards have been met in relation to patient or subject protection, including, in the case of all clinical and experimental studies review by an appropriate ethical review committee and written informed patient consent. The Problem Gambling Research and Treatment Centre at the University of Melbourne, with which several co-authors were affiliated when the data were collected, was previously supported by the Victorian Responsible Gambling Foundation. The Victorian Responsible Gambling Foundation had no involvement in the current publication.

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