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Proximal and Distal Risk Factors for Gambling Problems Specifically Associated with Electronic Gaming Machines

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Abstract

Electronic gaming machines (EGMs) are widely used and the gambling product most commonly associated with harmful gambling. Understanding factors that increase the risk of problematic EGM play is therefore important. Previous studies into risk factors for EGM gambling have used measures of problem gambling based on an individual's total gambling activity, which therefore do not distinguish harmful gambling specifically associated with EGMs. This study used an EGM-specific measure (PGSI-EGM) to achieve its aim of identifying risk factors specifically associated with problematic EGM play. By removing nuisance effects from other gambling forms that higher-risk gamblers typically engage in, this approach provides a more accurate assessment of the determinants of EGM-related problems. An online survey was completed by 1932 at-least monthly EGM players in Australia. It measured demographics, EGM gambling behaviour, motivations, gambling urges, gambling fallacies, trait self-control, alcohol misuse, and the PGSI-EGM. A penalised regression model identified the most important proximal predictors of higher-risk EGM gambling as: higher gambling urges, higher levels of erroneous cognitions, playing EGMs more frequently, higher session expenditure, longer sessions, usually playing EGMs alone, and playing EGMs in more venues. Lower trait self control was the strongest distal determinant. Higher-risk EGM players tended to be younger, male, more educated, never married, to have higher (although still modest) incomes, and be more likely to have alcohol problems. These findings can inform interventions such as treatment, consumer education and venue interventions.

Keywords Electronic gaming machines · Poker machines · Pokies · Risk factors · Determinants · Gambling harm · Problem gambling · Gambling disorder

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Introduction

Electronic gaming machines (EGMs) are the gambling product most commonly associated with harmful gambling (Calado and Griffiths 2016; Williams et al. 2012a). In Australia where the current study was conducted, two-fifths of at-least monthly EGM players experience harm from their gambling, with 6% being problem gamblers, 17.2% moderate-risk gamblers, and 18.2% low-risk gamblers (Armstrong and Carroll 2017). These rates are even higher amongst weekly EGM players: 11.1% problem gamblers, 25.4% moderate-risk gamblers, and 20.8% low-risk gamblers (Queensland Government 2018). Approximately 20% of regular gamblers play EGMs, accounting for a disproportionate 60% of gambling expenditure, and up to 80% of gambling problems in Australia (Armstrong and Carroll 2017; Delfabbro 2012). Treatment services also confirm that EGMs are the most problematic gambling form for the majority of their clients (Dowling et al. 2005).

Many factors contribute to the heightened link between EGM play and gambling problems. Several structural characteristics of EGMs appear to encourage persistence and facilitate dependency (e.g., Dowling et al. 2005; Griffiths 1993, 1999), described by Schüll (2012) as 'addiction by design'. These include sound effects, visual cues, the mathematical underpinnings of EGM games, and price and prize structures; as well as within-game elements, such as tokenisation, features, multiline betting, near misses, and losses disguised as wins (Livingstone 2017; Parke and Griffiths 2006). Large amounts of money can be lost very quickly, escalating financial and other harms. Losses can be $1200 per hour when playing EGMs in Australia at their maximum input and speed (Productivity Commission 2010). The high event frequency and continuous nature of EGM games facilitate persistence and loss chasing, which are defining characteristics of problem gambling (Ferris and Wynne 2001).

Situational factors also facilitate engagement in EGM gambling (Griffiths 1993, 1999). EGMs are easily accessible in many jurisdictions through a wide geographical spread of numerous venues with lengthy opening hours. The gambling environment is often divorced from reality, without natural light or clocks; and advertising, promotional incentives, the availability of alcohol, and other facilities in EGM venues also encourage their use (Dowling et al. 2005). EGMs have low initial outlay, are easy for novices to engage in, and are provided in venues where women, men, and people from a diversity of cultural and socioeconomic backgrounds generally feel comfortable (Hing and Haw 2009; Productivity Commission 1999; Thomas et al. 2008). Approximately one in five Australian adults participates in EGM gambling each year (Hing et al. 2014).

Given the popularity of EGMs and their heightened association with harmful gambling, it is important to understand factors that increase the risk of problematic EGM play. While several studies have analysed various risk factors amongst problem gamblers who play EGMs (Griffiths 1995; Kweitel and Allen 2003; MacLaren et al. 2012a, b, 2015; McBain and Ohtsuka 2001; Scannell et al. 2000; Thomas et al. 2011), they have used measures of problem gambling that ask about a person's *overall* gambling. These 'general' measures, such as the Problem Gambling Severity Index (PGSI; Ferris and Wynne 2001), South Oaks Gambling Screen (Lesieur and Blume 1987), and those based on the DSM (American Psychiatric Association 2013), do not distinguish loss of control and harmful consequences experienced from the different gambling activities an individual might engage in. Problem gamblers who play EGMs typically gamble on a range of activities (Armstrong and Carroll 2017), and participation in a greater number of gambling activities is strongly predictive of problem gambling (Hing et al. 2014; Welte et al. 2004). Accordingly, using

these general measures may obscure risk factors specifically associated with harmful EGM gambling if, for example, an individual's problems arise from frequent gambling on races, sports or casino games and they play EGMs only occasionally. While these general measures are appropriate for studies estimating the prevalence of problem and at-risk gambling in a population, they are less well suited for studies seeking to understand the determinants of harmful engagement in a particular gambling form.

The current study used an EGM-specific measure of problem gambling severity to achieve its aim of identifying risk factors specifically associated with problematic EGM play. By removing nuisance effects from other gambling forms, this approach provides a more accurate assessment of the determinants of EGM-related problems. This can inform interventions aimed at reducing harmful EGM play, such as consumer messaging and safe gambling guidelines. These can be targeted towards vulnerable EGM players, those with behaviours and characteristics that increase their risk of EGM-related problems. Identifying risky aspects of EGM play can also inform venue interventions.

Common risk factors associated with problem gambling amongst EGM players, as identified mainly by general measures, are reviewed below as they informed the selection of variables for this study. As conceptualised by Williams et al. (2012b), Sharpe (2002) and Blaszczynski and Nower (2002) and others, these are presented as distal (indirect) risk factors, which create tendencies and vulnerabilities that predispose individuals to gambling problems when combined with more proximal (direct) risk factors. These proximal factors then have a more immediate impact on the likelihood of developing a gambling problem. Risk factors can also extend to co-morbidities, which may not be causally related to problem gambling, but may reinforce harmful gambling and impede recovery (Williams et al. 2012b).

Distal Risk Factors

Demographics

Population studies have consistently found that problem gambling is highest amongst males and young adults, with unemployment, lower socio-economic status, lower education, being unmarried, and minority or immigrant group status also being common predictors (Armstrong and Carroll 2017; Calado and Griffiths 2016; Williams et al. 2012a). However, women have been particularly drawn to EGMs since their widespread expansion during the 1990s (Hing et al. 2017a; Volberg 2003). One study found higher problem gambling scores amongst female EGM gamblers than male EGM gamblers (MacLaren et al. 2015). Women also experience gambling problems almost exclusively with EGMs, and tend to develop these problems later in life (Hing et al. 2017a; Productivity Commission 2010). In contrast, other gambling forms most strongly linked to problem gambling, such as race betting, sports betting and casino table games, are engaged in mainly by younger males. Thus, the conflation of all gambling activities in general problem gambling measures may obscure identification of demographic characteristics associated with gambling problems specifically relating to EGM play.

One study that did adapt a general problem gambling screen to ask specifically about EGM gambling surveyed a random sample of 3000 club members from the memberships of six clubs in Sydney Australia (Hing and Breen 2002). Higher proportions of problem EGM gamblers (n=72) were never married, divorced, separated or in de facto

relationships. However, they did not differ from non-problem EGM gamblers (n = 1807) on gender, age, education, number of pre-teen dependent children, occupation, or income. A more recent study asked respondents which was their most problematic online gambling form. Amongst those nominating EGMs, the study compared the 98 problem/moderate risk online EGM gamblers to their non-problem/low-risk counterparts (n = 68; Hing et al. 2017b). The only distinguishing demographic characteristic of the former group was lower income, with no differences for gender, age, education, work status and language spoken at home. Mixed results have been found in studies using a general measure of problem gambling in samples of EGM gamblers (Armstrong and Carroll 2017; Kweitel and Allen 2003; McBain and Ohtsuka 2001; Scannell et al. 2000). Overall, demographic risk factors for problem gambling amongst contemporary EGM players remain unclear.

Self-control

Self-regulatory failure can lead to impaired control over gambling, a key feature in progression from initial participation in gambling to problem gambling (Blaszczynski and Nower 2002; Jacobs 1986; Sharpe and Tarrier 1993). Thus, problems with self-control are considered a key cause of problem gambling, with higher-risk gamblers tending to be more deficient in trait self-control than lower-risk gamblers (Bergen et al. 2012; Corless and Dickerson 1989).

Impulsivity is often considered to relate to problem gamblers' inability to exercise self-control over their gambling and has received more research attention than self-control (Lorains et al. 2014), with higher-risk gamblers tending to be higher in trait impulsivity (Clarke 2004; Steel and Blaszczynski 1998). In assessing the differential effects of low self-control, impulsivity and sensation-seeking on problem gambling, Mishra et al. (2010) found that low self-control was a better predictor of problem gambling than impulsivity and sensation-seeking, while impulsivity and sensation-seeking were better predictors of general gambling involvement. The authors concluded that low self-control is an important, but understudied, personality trait associated with problem gambling. Its potential role as a risk factor for problem EGM gambling is therefore assessed in the current study.

Proximal Risk Factors

Gambling Behaviour

Prevalence studies consistently show a strong association between greater frequency and expenditure on EGM gambling and problem gambling (ACIL Allen et al. 2018; Queensland Government 2018; Williams et al. 2012a). For example, a prevalence study in Victoria Australia found that, on average, problem EGM gamblers play EGMs 87.6 times per year, compared to 6.6 times for non-problem gamblers (Schottler Consulting 2014). Representative Australian data indicate that EGM expenditure amongst monthly EGM players is 4.6 times higher amongst problem gamblers, compared to non-problem gamblers (Armstrong and Carroll 2017). In the one study we are aware of that used an EGM-specific measure of problem gambling, problem EGM gamblers spent over seven times more on EGM gambling than did non-problem gamblers (Hing and Breen 2002). This higher expenditure amongst problem EGM gamblers reflects greater frequency of play, longer playing sessions, and a greater tendency to bet more than one credit/coin at a time, bet on multiple

lines, and recycle large wins (ACIL Allen et al. 2018; Hing and Breen 2002; Queensland Government 2018).

Gambling Motivations

Studies have consistently found that gambling to avoid negative mood states is strongly associated with problematic EGM play (Hing et al. 2016; MacLaren et al. 2012b; Saugeres et al. 2012; Thomas et al. 2009). Reflecting the immersive qualities of EGMs that facilitate dissociation, many EGM players describe entering 'the zone' during sessions of intense play, a state of trance-like absorption where life's problems and responsibilities lose their usual importance (Livingstone 2005). Repetitive and mesmerising EGM play can meet a desire for emotional escape. Continuing play may become the primary goal, and money itself can lose any external value except as a means to sustain play and time out from reality (Schüll 2005, 2012). EGM gambling appears to particularly appeal to a subset of emotionally vulnerable problem gamblers (Blaszczynski and Nower 2002), with problem EGM gamblers tending to adopt emotion-focused or avoidance-based coping styles rather than positive problem-solving styles (McBain and Ohtsuka 2001; Scannell et al. 2000; Shepherd and Dickerson 2001). Thus, frequent EGM gamblers are at heightened risk for problem gambling if they play EGMs to self-regulate negative emotional states (MacLaren et al. 2012b).

Although likely to be a different subset of EGM gamblers than those motivated by a desire for emotional escape, EGM gamblers with higher problem gambling severity have also been found to be more motivated to gamble to win money (Hing and Breen 2002; Hing et al. 2016; MacLaren et al. 2015). Further, gambling to win money is associated with chasing losses (Lister et al. 2016). Excitement, social reasons and ego enhancement are less dominant motivations for playing EGMs amongst higher-risk gamblers (Fang and Mowen 2009).

Erroneous Cognitions

Erroneous cognitions are strongly associated with problem gambling, particularly the illusion of control (perceiving more personal control over events than is warranted), and the gambler's fallacy (the belief that after a string of one event, an alternative event is more likely; Goodie and Fortune 2013). Thus, EGM players may think they can influence the outcome of a spin by using superstitious rituals, or by pressing the button in a certain way; increase their chances of winning by playing a particular machine; or believe that a machine is 'due' to pay out if it has not done so in a while. Recently, Hahmann (2017) developed a typology of cognitive distortions amongst higher-risk EGM players, modifying Toneatto's generic typology (1999, 2002). Hahmann's categories and subcategories comprise: magnified gambling skill (hot machines, bet max, higher denomination machines), superstitious beliefs (talismanic, behavioural and cognitive superstitions), attribution biases (gambler's fallacy, representative bias, anthropomorphism), over-interpretation of cues, control over luck (aligning with luck, luck as a variable, luck as a trait, luck as contagion), illusory correlation, and karma.

Studies using the 'speaking aloud' method, whereby players verbalise their thoughts while playing EGMs, have found irrational thinking to be common amongst EGM players (Delfabbro and Winefeld 2000; Walker 1992); and more so amongst regular players (Griffiths 1994) and problem players (Moodie 2007). Using a variety of measurement

instruments, quantitative studies have consistently demonstrated a strong link between erroneous gambling cognitions and problem gambling amongst EGM gamblers (Emond and Marmurek 2010; Joukhador et al. 2004; Lambos and Delfabbro 2007; MacLaren et al. 2015).

Gambling Urges

Urges are a central feature of addiction, an anticipatory craving state experienced prior to engagement in the behaviour (Potenza et al. 2002). In gambling, the urge can be a physiological, psychological, or emotional motivational state involving a need, want or desire to gamble; and it is often associated with persistence at gambling and the development and maintenance of problem gambling (Raylu and Oei 2004). Gambling urges may be triggered by internal factors such as negative emotions or external factors such as gambling cues, and are thought to vary with a range of personal characteristics (Raylu and Oei 2002; Sharpe 2002). Gambling urges are stronger amongst people with a pre-existing gambling problem (Hounslow et al. 2011), and they can be especially triggered when exposed to gambling cues (Sodano and Wulfert 2010; Wulfert et al. 2009). Stronger reactivity to gambling cues amongst problem gamblers has also been found in EGM-specific studies (McKeith et al. 2017).

Comorbidities

Alcohol Misuse

Alcohol misuse is highly comorbid with problem gambling (Bondolfi et al. 2000; Chou and Afifi 2011; Griffiths et al. 2010; Petry et al. 2005; Welte et al. 2001), and may reflect the same risk factors that lead to problem gambling (Williams et al. 2012b). Being affected by alcohol can also contribute to impaired control while gambling, through a disinhibitory effect that may encourage uptake, persistence and greater risk-taking (Baron and Dickerson 1999; Cronce and Corbin 2010; Ellery et al. 2005; French et al. 2008). Gambling and alcohol consumption frequently co-occur, including when gambling on EGMs located in licensed venues.

Method

Recruitment and Sampling

In order to investigate EGM-specific risk factors, this study conducted an online survey, with participants recruited through a market research company that compensated them according to their internal protocols. Quotas were set to gain a reasonable representation across age categories and gender. Participants were eligible to participate if they were 18 years or older, lived in Australia, and gambled on EGMs at least monthly. They also needed to pass two attention checks inserted into the survey (e.g., 'Please select 'almost always'' for this question). Of the 11,893 potential participants who linked to the survey, 7870 were excluded because they did not play EGMs at least monthly; 23 because they were under 18 years; 1698 for failing the attention checks; 86 for providing duplicate

responses; and 284 for not completing the survey. This left a final sample of 1932 participants, which was approximately evenly balanced in terms of gender (53.1% male), with a mean age of 41.84 years ($SD = 16.46$). Based on the PGSI (Ferris and Wynne 2001) 511 (26.4%) were classified as non-problem gamblers, 349 (18.1%) as low risk gamblers, 403 (20.9%) as moderate risk gamblers and 669 (34.6%) as problem gamblers.

Measures

PGSI-EGM. We adapted the original PGSI (Ferris and Wynne 2001) to specifically ask only about EGM gambling. This was done by adding the words 'on the pokies' to each item ('pokies' is commonly-recognised Australian slang for EGMs). The survey included pictures of EGMs with the text 'Please note that these questions refer to your POKIE PLAYING ONLY' at the top of each relevant survey page. The PGSI-EGM had high reliability in this sample (Cronbach's alpha = .96) and removal of any item did not increase its reliability. An exploratory factor analysis clearly indicated a single factor solution. The first factor accounted for 77.07% of variance, and subsequent factors had eigenvalues below .5. As such, the PGSI-EGM displays similar psychometric properties to the original PGSI (Ferris and Wynne 2001).

Demographics Demographic questions were asked for: gender (male, female), age (in years), main language spoken at home (English or other), highest educational qualification, marital status (recoded as single, married/de facto/living with partner, divorced/separated/ widowed), whether the respondent has children (no, yes), and personal pre-tax income (in brackets).

Gambling participation Respondents reported participation in bingo, keno, race betting, lottery-type and instant scratch ticket gambling, casino table games, sports betting and EGMs, converted into the number of gambling activities engaged in during the past 12 months.

EGM gambling Frequency of EGM gambling was reported as: not in the last 12 months, less than once a month, once a month, 2–3 times a month, once a week, 2–3 times a week and 4 or more times a week (in line with the inclusion criteria, participants in the first two categories were excluded from the survey). Participants also reported the age at which they first gambled on EGMs, which was treated both as a continuous variable, and recoded into: under the age of 18 (the legal age in Australia)/when 18 or older. Typical session expenditure (log transformed), session length (in brackets) and preferred machine denomination were asked, as well as if they usually played EGMs alone (no, yes), and whether they have a favourite machine (no, yes). Participants also reported how far they travel to their preferred EGM venue; how many different venues they had played EGMs in during the past 12 months (log transformed); and which venues they play EGMs in (hotel/pub, club, casino, Internet via desktop/laptop/smart TV, Internet via tablet/smartphone/other device).

Gambling Outcomes Expectancies Scale (GOES; Flack and Morris 2016) This 18-item scale asked responses on a six point scale (1 = strongly disagree, 6 = strongly agree). Total scores were generated for each of five domains of gambling motivation (social, e.g., 'Gambling is a way to meet new people'; money, e.g., 'Gambling is a way to make big money'; excitement, e.g., 'Gambling is a rush'; escape, e.g., 'Gambling helps release tension'; ego enhancement, e.g. 'Gambling is about feeling like an expert'), with higher scores indicating more endorsement of that motivation. Cronbach's alpha for the five domains were .85-.93 in this sample.

Gambling Urge Scale (GUS; Raylu and Oei 2004) This scale asked responses on a seven point scale (0 = strongly disagree, 6 = strongly agree) to six items measuring thoughts and feelings about gambling urges (e.g., 'I crave a gamble right now'). Higher total scores indicate stronger gambling urges. Cronbach's alpha in this sample was .97.

Gambler's Beliefs Questionnaire (GBQ; Steenbergh et al. 2002) The GBQ asked responses to 21 items on a seven point scale (strongly agree = 1, strongly disagree = 7) to measure cognitive distortions relating to gambling. The two factors in this scale (luck/perseverance, e.g. 'In the long run, I will win more money gambling than I will lose' and illusion of control, e.g., 'My choices or actions affect the game on which I am betting') were closely related ($r = .94$) so we treated this scale as unidimensional (Cronbach's alpha = .98). All items were reverse scored, with higher scores indicating greater cognitive distortions.

CAGE (Ewing 1984) The CAGE questionnaire assessed alcohol misuse using 4 items scored 0 (no) or 1 (yes). Higher total scores indicate greater alcohol problems, with 2 + indicating clinically significant alcohol problems.

Brief Self Control Scale (BSCS; Tangney et al. 2004) This scale had 13 items measured on a five point scale from 1 (not at all) to 5 (very much), e.g. 'I am good at resisting temptation'. Nine items were reverse scored. Higher scores indicate greater self-control. Cronbach's alpha in this sample was .86.

Self-responsibility for responsible gambling Participants were asked to apportion responsibility among various parties for ensuring they gamble responsibly on EGMs: myself, my family, my friends, the venue/club/hotel/etc., the pokie manufacturer, the government, and other. Responses were required to sum to 100%. The proportion assigned to 'myself' was used in the analyses.

Data Analysis

Bivariate analysis These analyses compared non-problem/low risk gamblers (NP/LR) with moderate risk/problem gamblers (PG/MR). Binary logistic regressions were conducted between the gambler risk groups (dependent variable) and each independent variable.

Multivariate analysis Most significant variables in the bivariate models were then included in a multivariate model. However, gambling motivations, erroneous gambling cognitions, and gambling urges were highly correlated, so we included only gambling urges. Gambling underage was used instead of age of first gamble on EGMs, and CAGE categories were used instead of raw scores.

Penalised regression Because the multivariate analysis did not allow us to include all variables of interest, due to the high correlations between motivations, cognitions and urges, we also used the elastic net procedure. This procedure also considered all variables for inclusion, whether significant in the bivariate analyses or not, because they may be significant predictors when controlling for other variables. It also explores a more parsimonious multivariate model by reducing the number of predictors in the model (lasso approach) and penalising them for collinearity (ridge approach).

Distal factor model In the penalised model, none of the demographic factors were statistically significant. This is likely because any effects of these distal factors were mediated by proximal factors (gambling behaviours, cognitions and urges). We explored multiple mediation models, but the results were unclear due to the sheer number of potential mediation paths. Instead, we conducted separate multivariate models for distal and proximal factors. Identifying distal factors separately can help to inform the targeting of interventions, particularly to vulnerable demographic groups. We also explored a proximal-only

model, but the results were essentially the same as the penalised regression, so we have not reported it here.

Some variables were ordinal in nature, e.g., education, income. We found similar results when treating these variables as ordinal (a separate coefficient and test for each level of education and income) and as continuous (i.e., one coefficient for each variable). The continuous versions are reported here for easier interpretation. All analyses were conducted in R, and all variables were scaled prior to analysis, meaning reported coefficients are comparable.

Ethics

The study procedures were carried out in accordance with the Declaration of Helsinki. The Institutional Review Board of the [Central Queensland University] approved the study. All subjects were informed about the study and all provided informed consent.

Results

Bivariate Results

Table 1 reports bivariate risk factors for being a MR/PG, compared to being a NP/LR. Demographic risk factors were: younger age, male gender, higher level of education, being single, and higher income. Speaking a non-English language at home and having children were not significant risk factors.

Risk factors relating to gambling and EGM gambling behaviours were: gambling on more forms, and on EGMs more frequently, and starting EGM gambling at a younger age, including when underage. MR/PGs were also more likely than NP/LRs to: report higher EGM session expenditure and longer session length; gamble on EGMs alone; have a favourite machine; play higher denomination machines; play EGMs at more venues; and play EGMs in hotels/pubs, at a casino, and via the Internet, and less likely to play EGMs in clubs. Distance to preferred EGM venue was not significantly related to MR/PG status.

MR/PGs were more likely than NP/LRs to be motivated to play EGMs for all reasons measured: excitement, escape, social, ego enhancement, and to win money. They also scored significantly higher on the CAGE, Gambling Urge Scale and Gambling Beliefs Questionnaire, and lower on the Brief Self-Control Scale. They allocated a significantly lower amount of responsibility for their responsible gambling behaviour to themselves.

Multivariate Model

The multivariate model found the following predictors were significantly related to MR/PG status: being younger, playing EGMs more frequently, higher EGM session expenditure, longer EGM sessions, usually playing EGMs alone, playing EGMs in more venues, higher gambling urges, having alcohol problems, lower self-control, and apportioning lower responsibility to themselves for their gambling behaviour.

Table 1 Demographic, behavioural and psychological differences between non-problem and each of the risk groups

Predictor	Bivariate	Multivariate	Penalised	Distal only
Age (in years)	−0.526*** (0.048)	−0.205*** (0.090)		−0.242*** (0.064)
Gender (ref=male)	−0.121** (0.046)	−0.058 (0.071)		−0.193*** (0.056)
Main language (ref=English)	0.073 (0.048)			
Education	0.309*** (0.047)	0.025 (0.076)		0.134* (0.058)
Have children (ref=no)	−0.048 (0.046)			
Marital status (married/de facto/living with partner vs ref=never married)	−0.527*** (0.105)	−0.069 (0.168)		−0.045 (0.132)
Marital status (divorced/separated/widowed vs ref=never married)	−0.406* (0.163)	0.397 (0.258)		−0.576** (0.212)
Income	0.372*** (0.049)	−0.058 (0.078)		0.225*** (0.060)
Disposable income	0.283*** (0.047)	^		^
Self control	−1.255*** (0.065)	−0.769*** (0.082)	−0.758*** (0.080)	−1.161*** (0.067)
Frequency of playing EGMs	0.847*** (0.055)	0.323*** (0.080)	0.308*** (0.079)	
Number of other gambling forms	0.683*** (0.050)	0.128 (0.080)		
Age of first bet on EGMs	−0.202*** (0.046)			
First bet on EGMs while underage (ref=no)	0.442** (0.149)	−0.301 (0.220)		

Table 1 (continued)

Predictor	Bivariate	Multivariate	Penalised	Distal only
Session expenditure (log)	0.857*** (0.061)	0.387*** (0.098)	0.363*** (0.095)	
Session length in time	0.359*** (0.048)	0.412*** (0.091)	0.329*** (0.084)	
Usually play EGMs alone (ref = no)	0.592*** (0.048)	0.456*** (0.071)	0.436*** (0.068)	
Have a favourite EGM (ref = no)	0.959*** (0.111)	− 0.012 (0.175)		
EGM denomination usually played	0.558*** (0.050)	− 0.009 (0.080)		
Play EGMs in hotels/pubs (ref = no)	0.220* (0.096)	− 0.027 (0.074)		
Play EGMs in clubs (ref = no)	− 0.258** (0.092)	− 0.012 (0.073)		
Play EGMs in casinos (ref = no)	0.452*** (0.093)	− 0.023 (0.072)		
Play EGMs on Internet via computer (ref = no)	0.935*** (0.130)	0.014 (0.079)		
Play EGMs on Internet via device (ref = no)	0.940*** (0.139)	− 0.054 (0.082)		
Play EGMs in other venues (ref = no)	− 0.221 (0.709)			
Number of different venues in which they play EGMs (log)	0.716*** (0.064)	0.358** (0.094)	0.334*** (0.088)	
Distance to favourite EGM venue	− 0.062 (0.046)			
Motivations – excitement	1.076*** (0.059)	^		

Table 1 (continued)

Predictor	Bivariate	Multivariate	Penalised	Distal only
Motivations – escape	0.910*** (0.056)	^		
Motivations-ego	1.038*** (0.060)	^		
Motivations-money	1.057*** (0.058)	^	0.114 (0.088)	
Motivations-social	0.519*** (0.049)	^		
Gambling urges	2.019*** (0.102)	1.380*** (0.119)	1.025*** (0.134)	
Erroneous cognitions-total	1.711*** (0.081)	^	0.727*** (0.126)	
Proportion of responsibility for gambling apportioned to self	−0.869*** (0.064)	−0.387*** (0.096)		
Alcohol issues (CAGE, raw score)	0.684*** (0.056)	^		
Alcohol issues (CAGE, grouping)#	0.647*** (0.053)	0.258*** (0.078)	0.278*** (0.077)	
Constant		0.600* (0.245)	0.863*** (0.087)	0.252* (0.108)
Observations		1932	1932	1932
Log Likelihood		−703.30	−697.52	−1030.43
Akaike Inf. Crit.		1456.60	1417.03	2076.86
Bayesian Inf. Crit.		1595.76	1478.26	2121.39

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

^Removed due to collinearity concerns

#Excluded because it was unclear if alcohol issues were a distal or proximal risk factor in this context

Penalised Model

The penalised model identified the following variables as the most important predictors of MR/PG status, in order of importance: higher gambling urges, lower self control, higher levels of erroneous cognitions, usually playing EGMs alone, higher session expenditure, longer sessions, playing EGMs in more venues, playing EGMs more frequently, and having alcohol problems.

Distal Factors Only Model

When considering only distal factors (demographics and self control), MR/PGs were more likely to be younger, male, more educated, and never married, and to have higher income and lower self control.

Discussion

The analyses conducted for this study have identified the most salient risk factors for problematic gambling specifically on EGMs. The penalised regression model indicated that, in the main, proximal factors independently predicted PG/MR status, while most distal factors did not. This is consistent with the underlying logic of etiological models of problem gambling that distal factors increase the vulnerability of certain people to gambling problems, but proximal factors then have more direct impact on the likelihood of problem development (Blaszczynski and Nower 2002; Sharpe 2002; Williams et al. 2012b).

Stronger gambling urges had the strongest effect and reflect that they are an immediate precursor to engaging in EGM play and also symptomatic of a gambling addiction (Potenza et al. 2002; Raylu and Oei 2002). Urge reduction is a key goal of gambling treatments that target psychobiological states, as urges are linked to gambling persistence and relapse (Smith et al. 2015), including for EGM gambling (Giroux et al. 2013; Oakes et al. 2008, 2012). Behavioural therapies, including exposure therapy, can help problem EGM gamblers build resistance to gambling cues and reduce gambling urges. Self-help interventions, such as mobile apps, can also incorporate urge reduction techniques. Higher risk EGM gamblers in this study were also found to have lower trait self-control which presumably increases the difficulty of resisting gambling urges. This finding is consistent with the few previous studies that have examined trait self-control in gamblers and found that lower self-control is a predictor of problem gambling (Bergen et al. 2012; Corless and Dickerson 1989; Mishra et al. 2010).

Another strong risk factor identified in the current study is erroneous gambling cognitions, as found in prior research with EGM players (Emond and Marmurek 2010; Joukhador et al. 2004; Lambos and Delfabbro 2007; MacLaren et al. 2015). Erroneous cognitions may be particularly common amongst EGM gamblers because they can be fostered by certain EGM characteristics, such as near misses, ability to vary bet size, and complex win categories and combinations that stimulate illusion of control by increasing personal involvement during play (Billieux et al. 2012; Clark et al. 2009, 2012; Dowling et al. 2005). Thus, cognitive therapy for problem gambling focuses on modifying erroneous cognitions associated with gambling, such as overestimating probabilities of winning, illusions of control, the gambler's fallacy, and

memory biases that favour recalling wins (Hodgins et al. 2011). Player education can also provide information aimed at correcting erroneous gambling beliefs.

Numerous aspects of EGM gambling behaviour were also identified as risk factors for higher-risk EGM gambling. Playing EGMs more frequently, higher session expenditure, longer sessions, usually playing EGMs alone, and playing EGMs in more venues were each predictive of higher-risk EGM gambling. Low-risk gambling limits, providing personalised normative feedback, and making player activity statements available are strategies that can assist EGM players to keep track of their gambling, while pre-commitment systems can help players to limit their gambling (Currie et al. 2008, 2012; Dowling et al. 2018; Ladouceur et al. 2012; Neighbors et al. 2015). Most of these behaviours can also be observed in venues, and might be used to support decisions to intervene with a patron to offer assistance.

Compared to their lower-risk counterparts, higher-risk EGM gamblers tended to be more motivated to play EGMs for all the reasons measured: excitement, escape, social, ego enhancement, and to win money. However, none of these motivations was significant in the penalised model, which was unexpected given consistent previous findings that gambling to escape negative mood states is particularly associated with problematic EGM play (Hing et al. 2016; MacLaren et al. 2012b; Saugeres et al. 2012; Thomas et al. 2009). The lack of an independent effect of gambling motivations in the current study indicates that other proximal factors were stronger predictors of problematic EGM play.

The distal factors that were correlated with harmful EGM gambling, but were not significant in the penalised model, can illuminate target groups for inventions. These factors indicate that younger, never married, male EGM players are a logical target for interventions, such as consumer education, self-help resources, and behaviour-change apps. Surprisingly, higher risk gamblers tended to have a higher personal pre-tax income (median $50,000–$69,999), but this was still below the median full-time salary of $82,436 in Australia (ABS 2019). Higher risk EGM players in this study were also more likely to have alcohol problems, indicating that dual screening and treatment may be beneficial (Williams et al. 2012b).

The main limitation of this study relates to the convenience sample which, while large, may not be representative of all EGM players who play at-least monthly. Restricting the sample to at-least monthly players may have also obscured differences between higher risk players and lower risk players who play less frequently. Not all potential risk factors were measured, due to the need to limit participant burden. Models of gambling risk factors often include additional risk factors which may also contribute to EGM-related problems (Abbott et al. 2015; Blaszczynski and Nower 2002; el-Guebaly et al. 2008; Sharpe and Tarrier 1993; Sharpe 2002). Further, administering the original PGSI as well as the PGSI-EGM would have provided stronger grounds for demonstrating that this general measure may obscure EGM-specific risk factors by conflating problems associated with additional gambling activities undertaken. However, we opted not to include two versions of the PGSI to minimise participant burden. Nevertheless, using the PGSI-EGM does eliminate potential "noise" within this dataset.

Conclusion

This study has been novel in identifying risk factors for harmful gambling specifically associated with gambling on EGMs, which are the source of the majority of gambling-related problems throughout the world. In contrast, previous studies have used general measures that may conflate problems that may be associated with each of the multiple gambling activities that higher-risk gamblers typically engage in. Overall, the study confirmed that

several problem gambling risk factors identified in studies using these general measures also apply specifically to harmful gambling on EGMs, and also demonstrated the salience of proximal factors in predicting higher-risk gambling on EGMs. EGM-related gambling problems were predicted by higher gambling urges, higher levels of erroneous cognitions, having alcohol problems, and lower self control, and were most common amongst EGM players who are younger, male, more educated, never married, and with higher although still modest incomes. The findings can inform interventions such as treatment, consumer education and venue interventions.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Ethics approval was obtained from Southern Cross University's Human Research Ethics Committee (approval ECN-16-092) and through reciprocal approval by CQUniversity's Human Research Ethics Committee (approval H16/05-135).

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