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FULL-LENGTH REPORT

Electronic gaming machine accessibility and gambling problems: A natural policy experiment

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ABSTRACT

Background: Electronic gaming machines (EGMs) are one of the most harmful forms of gambling at an individual level. It is unclear whether restriction of EGM functions and accessibility results in meaningful reductions in population-level gambling harm. *Methods:* A natural policy experiment using a large (N = 15,000) national dataset weighted to standard population variables was employed to compare estimates of gambling problems between Australian residents in Western Australia (WA), where EGMs are restricted to one venue and have different structural features, to residents in other Australian jurisdictions where EGMs are widely accessible in casinos, hotels and clubs. Accessibility of other gambling forms is similar across jurisdictions. *Results:* Gambling participation was higher in WA, but EGM participation was approximately half that of the rest of Australia. Aggregate gambling problems and harm were about one-third lower in WA, and self-reported attribution of harm from EGMs by gamblers and affected others was 2.7× and 4× lower, respectively. Mediation analyses found that less frequent EGM use in WA accounted for the vast majority of the discrepancy in gambling problems (indirect path = −0.055, 95% CI −0.071; −0.038). Moderation analyses found that EGMs are the form most strongly associated with problems, and the strength of this relationship did not differ significantly across jurisdictions. *Discussion:* Lower harm from gambling in WA is attributable to restricted accessibility of EGMs, rather than different structural features. There appears to be little transfer of problems to other gambling forms. These results suggest that restricting the accessibility of EGMs substantially reduces gambling harm.

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KEYWORDS

electronic gaming machines, gambling, gambling problems, gambling harm, accessibility, availability, gambling policy

INTRODUCTION

Problem gambling is recognised as a public health concern (Latvala, Lintonen, & Konu, 2019; The Lancet, 2017). Research has consistently found that electronic gaming machines (EGMs) are the gambling product most frequently associated with harmful gambling (M. Browne, Newall, et al., 2023; Delfabbro, King, Browne, & Dowling, 2020). A key question is whether this harm is primarily due to the product itself, or due to the product being attractive to vulnerable users. However, addressing this question is inherently difficult using traditional research methods such as surveys, experiments, and help-service data. This is because: 1) participation rates and gambling frequency vary between activities and need to be accounted for in assessments of gambling problems; 2) different gambling activities are attractive to different subgroups of people who may be more or less vulnerable to gambling harm; 3) people with gambling problems tend to gamble on multiple activities, which obscures the source of their problem; 4) experimental designs manipulating product features lack ecological validity; and 5) harmful gambling forms identified by treatment-seeking clients may not be reflective of the broader population since the former are self-selecting (Delfabbro et al., 2020; Dowling, Smith, & Thomas, 2005). To help overcome these confounds, the current study uses a natural policy experiment to compare gambling problems and harm between very similar jurisdictions, differing primarily with respect to restrictions on access to EGMs.

EGMs and gambling problems

Findings from representative surveys conducted internationally indicate that EGM gambling is the strongest predictor of problem gambling after controlling for other gambling forms. These studies include an analysis of 12 Australian gambling prevalence surveys (N > 100,000) (Delfabbro et al., 2020), an aggregated dataset of national and state-based Australian prevalence studies (N = 71,103) (M. Browne, Newall, et al., 2023), the Canadian Community Health Survey (N = 23,592) (Williams et al., 2021), and the Swedish Longitudinal Gambling Study (N = 4,991) (Binde, Romild, & Volberg, 2017). Moreover, based on a natural experiment in Norway (N = 1,293), a prospective study showed that gambling problems amongst EGM gamblers were reduced after a ban on EGMs, with little indication of product substitution (Lund, 2009). Most gambling help service clients also report EGMs as causing them most harm (Dowling et al., 2005; Rodda & Lubman, 2014). In two nationally representative Australian surveys, individuals experiencing gambling harm most frequently nominated EGMs as their most problematic gambling form (Hing et al., 2014, 2021). Overall, due to high levels of participation, and high risk conditional on participation, the evidence consistently implicates EGMs as contributing to gambling harm more than any other form.

Numerous structural characteristics of EGMs are thought to facilitate persistence and dependency, particularly the variable ratio reinforcement schedule that encourages rapid uptake and continued repetitive behaviour (Ferster & Skinner, 1957). Other EGM gambling characteristics are also associated with heightened risk, including its continuous nature, high event frequency, visual and auditory cues, price and prize structures, tokenisation, features, and losses disguised as wins (Livingstone, 2017; Parke, Parke, & Blaszczynski, 2017). However, causal evidence is relatively weak since it is difficult to evaluate these characteristics in ecologically valid settings (Blank, Baxter, Woods, & Goyder, 2021; Parke et al., 2017).

Researchers have also noted the immersive environment provided by EGMs which facilitates trance-like absorption, a state players describe as "the zone" where they may lose track of money and time spent seeking to extend time out from life's worries (Schüll, 2012). These dissociative effects can facilitate harmful EGM play, particularly amongst emotionally vulnerable individuals more prone to problem gambling (Blaszczynski & Nower, 2002). Research has consistently found higher rates of psychiatric disorders amongst gamblers (Dowling et al., 2015) and playing EGMs for emotional coping, amongst other reasons, is associated with problem gambling (MacLaren, Ellery, & Knoll, 2015).

Geographic accessibility appears to contribute to EGM-related harm. A positive relationship has been observed between the density of EGMs in an area and gambling problems (Shaffer, LaBrie, & LaPlante, 2004; South Australian Centre for Economic Studies, 2005a). However, a reduction of EGM numbers in some venues in Victoria Australia did not lead to a corresponding decrease in EGM expenditure, probably because the EGM reduction was too small to affect accessibility (South Australian Centre for Economic Studies, 2005a). Analyses examining the spatial distribution of EGMs have found residential proximity to EGM venues is independently associated with problem gambling (Young, Markham, & Doran, 2012a, 2012b). Further, in these studies, EGM venues in accessible locations and venues with more EGMs were most closely associated with gambling harm.

While it is widely assumed that increased gambling availability will increase gambling problems, this relationship is more nuanced and may depend on factors such as community vulnerability, the availability of different gambling products, and level of market saturation (Abbott, 2006, 2017; LaPlante & Shaffer, 2007). For example, the rapid expansion of EGMs and casino gambling was associated with an increased prevalence of gambling problems when these activities were newly legalised (Abbott, 2020; Shaffer, Hall, & Vander Bilt, 1999; Volberg et al., 2004). However, subsequent studies in more mature markets have challenged the linear relationship of this "exposure effect" (Abbott, 2006, 2020; LaPlante & Shaffer, 2007; Philander, 2019;

Shaffer, 2005). The "adaptation effect" suggests that individuals in an exposed population develop some resistance to gambling problems over time, due to factors including social learning, waning novelty effects and improved public health measures (LaPlante & Shaffer, 2007; Shaffer, 2005). An "adoption effect" has also been proposed, where newly introduced gambling products disproportionately attract early adopters who have a greater vulnerability to gambling problems; however, the prevalence of gambling problems amongst product users decreases over time as less vulnerable later adopters also start using the product (Hing, Rockloff, & Browne, 2023).

Although it is clear that engagement with EGMs is associated with gambling problems and harm, there is little direct evidence on whether or not reducing access to EGMs would reduce negative outcomes. A product-safety model would suggest that population gambling problems would be reduced should EGM accessibility be reduced; while a psychopathological model implies that vulnerable individuals might redirect their demand to other risky forms of gambling.

The current study

Australian jurisdictions are relatively homogenous with respect to regulation and access to gambling products. However, Western Australia (WA) is exceptional in that access to EGMs is restricted to one casino. In all other jurisdictions, a total of 192,768 EGMs can be accessed in 11 casinos, 2,953 hotels and 1,840 licensed clubs (Australasian Gaming Council, 2021). Outside of WA, placement of EGMs in hotels and clubs makes them highly accessible across metropolitan, suburban and regional geographical locations (Browne & Minshull, 2017).

In contrast, the sole casino in WA has 2,466 EGMs and 350 gaming tables (Australasian Gaming Council, 2021). It is located in the central business district of the capital city, Perth, in which approximately 79% of the state's population resides (Australian Bureau of Statistics, 2021). However, the Perth metropolitan area stretches for approximately 150 km, so many residents do not have easy access to EGMs. In contrast, most Australians in other jurisdictions live within a few kilometres of an EGM venue (Young et al., 2012a). Of importance for making this comparison is that online EGMs cannot be legally provided to Australian residents. While accessible through illegally-provided offshore operators, only 0.3% of Australian adults engage in online EGM gambling (Hing et al., 2021). Other forms of gambling in WA are similar to the rest of Australia, with only minor differences (e.g., Keno is accessible online in other jurisdictions but not WA), allowing rigorous comparisons (Hing et al., 2021). EGMs in WA have some minor structural differences to EGMs in the rest of Australia which aim to reduce their potential harm. These structural differences primarily relate to a slightly slower maximum rate of play than other jurisdictions (3–5 s in WA vs 2.14 s in Victoria) and the substitution of rotating symbols on the screen as opposed to symbols attached to virtual reels that fall vertically (Australian National Standard Working Party, 2016). The differentially low access to EGMs in WA compared to other Australian jurisdictions creates an opportunity to conduct a natural experiment to examine how reduced access to EGMs affects aggregate population gambling problems.

The primary aim of this study is therefore to examine whether restricted access to EGMs in WA is accompanied by reduced prevalence of gambling problems and harm to self and others compared to the rest of Australia. Addressing this aim indicates whether people who might otherwise experience gambling problems, but cannot easily access EGMs, will instead gamble on other forms and experience equivalent harm from them instead. Alternatively, a lower prevalence of gambling problems in WA in the context of reduced access to EGMs would indicate that EGMs contribute uniquely to gambling problems. A secondary aim of this study is to ascertain whether structural differences are reflected in lower prevalence of gambling problems amongst regular EGM players in WA compared to the rest of Australia.

METHODS

Recruitment

Exactly 15,000 respondents from all Australian jurisdictions, aged 18+, were recruited via random digit dial sampling, and completed a computer-assisted telephone interview. Mobile phone sampling was selected due to declining landline ownership in Australia (Roy Morgan, 2019), because the single frame methodology provided greater overall sample quality than a single landline or dual-frame sample. Full technical details for recruitment are published elsewhere (e.g., procedures for non-answered or engaged numbers or scheduling an appointment if the participant was busy, interviews with 66 non-English speakers, etc) (Hing et al., 2021). The cooperation rate (interviews completed when contact was made) was 10.2%, and response rate based on estimated eligibility of those who could not be contacted was 4.5%. The completion rate including calls where contact was not made was 3.8%. Completion time was approximately 10 min on average, depending on a respondent's answers and subsampling.

Measures

Demographics and weighting questions. Respondents reported their age, or age bracket, gender (male, female, other), location by postcode or broader region (e.g., Sydney, New South Wales (NSW) other than Sydney), and whether they had regular access to more than one mobile phone. Respondents also provided their marital status, country of birth, main language spoken at home, level of education, and whether they were of Aboriginal or Torres Strait Islander status.

Jurisdiction of residence was determined from postcode or broader region data, and was the main independent variable. The analyses compared WA (unweighted n = 1,440) vs

all other jurisdictions in Australia combined ("rest of Australia", unweighted n = 13,560).

Gambling behaviour. Respondents were asked whether they had taken part in each of 13 gambling forms during the preceding 12 months (see Table 1 for a list). Respondents who reported gambling on any of the 13 forms were asked if they had, in the last 12 months, used the Internet to gamble via an internet-connected device (e.g., smartphone, computer).

All past-year Internet gamblers were retained for further questions about their gambling. Non-Internet gamblers were randomly sampled for retention so that there was an approximately equal number of Internet and non-Internet gamblers in the final sample. This sampling strategy was employed for the original purposes of the data collection, which focused on understanding the prevalence of and risks associated with internet gambling (Hing et al., 2021). Respondents who had not gambled on any forms only completed further questions about gambling-related harm from gambling by others.

Problem gambling severity. Subsampled respondents (i.e., all Internet gamblers and an approximately equal number of non-Internet gamblers) completed the Problem Gambling Severity Index (PGSI) and the Short Gambling Harms Screen (SGHS, also known as the GHS-10). The PGSI (Ferris & Wynne, 2001) is a nine-item scale that assesses past-year gambling problems. Response options are never (0), sometimes (1), most of the time (2) and almost always (3). Respondents were classified based on the original cut-offs, consistent with how the PGSI is scored in Australia: non-problem gamblers (0), low-risk gamblers (1–2), moderate-risk gamblers (3–7) and 'problem gamblers' (8–27). Internal consistency was high (alpha and omega >0.85).

Gambling harms. The ten-item Short Gambling Harms Screen (M. Browne, Goodwin, & Rockloff, 2017) assesses gambling-related harms, with responses no (0) and yes (1). Item responses were summed for a total between 0 and 10. Internal consistency was high (alpha and omega >0.85). The SGHS has been criticised by Delfabbro and colleagues (Delfabbro, Georgiou, & King, 2021; Delfabbro & King, 2017), but these criticisms have been rebutted by the original authors (Latvala, Browne, Rockloff, & Salonen, 2021; Murray Boyle, Browne, Rockloff, & Flenady, 2021, 2022). The SGHS has also been shown to have strong psychometric performance (M. Browne, Delfabbro, et al., 2023), including by independent researchers (Dowling et al., 2021; Greenwood, Youssef, Merkouris, & Dowling, 2021).

Gambling harms from others. All subsampled respondents, as well as non-gamblers, were asked whether they had experienced harm from another person's gambling in the last 12 months (no/yes).

Harmful forms. Respondents who reported any problems or harm from their own gambling, or from the gambling of others, were asked which form of gambling was the most harmful for them.

Weighting

Responses were weighted to align the sample with population data from the Australian Bureau of Statistics. Weighting variables were age, gender and location. An additional consideration was the number of mobile phones owned by the respondent, to account for any selection biases. Finally, for questions that were only asked of subsampled respondents, additional weights were calculated to correct for this subsampling (Hing et al., 2021).

Data analysis

Respondents from WA and the rest of Australia were compared in terms of demographics, gambling behaviour, gambling problems, gambling harm, and harm from others' gambling, using chi-square tests of independence for categorical variables (with tests of proportions where required), or Mann-Whitney U tests for continuous variables. Mediation analyses were conducted using the lavaan package in R to determine whether the difference between WA and the rest of Australia regarding problem gambling severity was mediated by EGM participation, and participation on other common gambling forms.

Moderation analysis and simple slopes analysis were conducted to determine whether the relationship between EGM participation and problem gambling severity significantly differed between WA and the rest of Australia, and whether EGMs were associated with problem gambling severity in both WA and the rest of Australia. In addition, the moderation analysis was used to calculate the contribution of different forms to the aggregate amount of gambling problems in WA compared to other jurisdictions, using the same weights. Since gambling participation is a necessary causal element for the development of gambling problems, our first step was to construct a linear regression model of PGSI scores predicted using the frequency of participation in each form. The model intercept was excluded on theoretical grounds since gambling problems are assumed to be zero in the case of non-participation. Both PGSI and frequency (times per year) were transformed using log(x+1) to stabilise variance. Please see Appendix for skewness and kurtosis scores before and after the transformation. We re-ran analyses on non-transformed PGSI scores (not reported), to determine sensitivity to transformations, but found no substantive differences. We calculated the variance inflation factor (VIF) to test for multicollinearity. The largest VIF was for race betting (1.7), which was below conventional thresholds (~5). A nested model comparison was made with a moderation model (all gambling forms by jurisdiction) to check for non-homogenous effects of form.

Ethics

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

Table 1. Demographic, gambling behaviour and gambling problem and harm comparisons by jurisdiction

Variable	Measure	WA (n = 1,527)	Rest of Australia (n = 13,473)	Statistic	p Value	Effect size
Demographics						
Gender	% (n) female	50.4 (769)	51.0 (6,867)	$\chi^2(1) = 0.21$	0.650	
Age bracket	Median	45–49	45–49	$\chi^2(10) = -1.22$	0.213	
	Mean rank	7,407.65	7,552.24			
Marital status (n = 5,141)	% (n) married	48.1 (273)	44.0 (2,010)	$\chi^2(1) = 7.84$	0.098	
	% (n) de facto	14.4 (82)	16.4 (750)			
	% (n) widowed	2.6 (15)	3.9 (179)			
	% (n) divorced/ separated	13.2 (75)	11.5 (528)			
	% (n) never married	21.7 (123)	24.2 (1,106)			
Country of birth (n = 5,148)	% (n) not Australia	**32.3 (183)**	25.3 (1,160)	$\chi^2(1) = 12.65$	<0.001	$\varphi = 0.05$
Aboriginal or Torres Strait Islander status (ATSI) (n = 5,129)	% (n) ATSI	3.2 (18)	2.7 (123)	$\chi^2(1) = 0.44$	0.506	
Main language at home (n = 5,143)	% (n) not English	14.5 (82)	16.2 (741)	$\chi^2(1) = 1.13$		
Education (n = 5,043)	Mean rank	2,358.19	**2,521.45**	M−W U = 1,090,798.5, $Z = -2.50$	0.012	$d = 0.07$
Gambling behaviour						
Gamblers	% (n) last 12 months	**62.9 (961)**	56.3 (7,580)	$\chi^2(1) = 24.91$	<0.001	$\varphi = 0.04$
Online gamblers, amongst gamblers (n = 8,541)	% (n) last 12 months	28.6 (275)	31.0 (2,347)	$\chi^2(1) = 2.21$	0.137	
EGMs	% (n) last 12 months	8.7 (133)	**17.3 (2,322)**	$\chi^2(1) = 73.18$	<0.001	$\varphi = 0.07$
Casino games	% (n) last 12 months	**10.2 (155)**	5.6 (749)	$\chi^2(1) = 51.04$	<0.001	$\varphi = -0.06$
Lotteries	% (n) last 12 months	**52.8 (804)**	40.3 (5,424)	$\chi^2(1) = 87.44$	<0.001	$\varphi = -0.08$
Scratchcards	% (n) last 12 months	**17.8 (271)**	15.5 (2,078)	$\chi^2(1) = 5.57$	0.018	$\varphi = -0.02$
Keno	% (n) last 12 months	2.6 (40)	**8.3 (1,121)**	$\chi^2(1) = 62.54$	<0.001	$\varphi = 0.07$
Sports betting	% (n) last 12 months	10.6 (162)	9.5 (1,280)	$\chi^2(1) = 1.96$	0.162	
Race betting	% (n) last 12 months	17.2 (263)	16.8 (2,262)	$\chi^2(1) = 0.17$	0.682	
Novelty betting	% (n) last 12 months	1.7 (26)	1.6 (211)	$\chi^2(1) = 0.16$	0.687	
Poker	% (n) last 12 months	3.3 (51)	3.5 (471)	$\chi^2(1) = 0.10$	0.750	
Bingo	% (n) last 12 months	2.0 (31)	2.4 (325)	$\chi^2(1) = 0.86$	0.353	
Esports betting	% (n) last 12 months	0.7 (10)	0.6 (83)	$\chi^2(1) = 0.03$	0.854	
Fantasy sports betting	% (n) last 12 months	**1.0 (15)**	0.5 (69)	$\chi^2(1) = 5.46$	0.019	$\varphi = -0.02$
Skin gambling	% (n) last 12 months	0.5 (7)	0.5 (69)	$\chi^2(1) = 0.08$	0.779	
Gambling problems and harm						
Problem gambling severity amongst gamblers (n = 5,222)	% (n) non-problem	**85.9 (505)**	80.1 (3,713)	$\chi^2(3) = 13.30$	0.004	$\varphi = 0.05$
	% (n) low-risk	9.4 (55)	11.8 (547)			
	% (n) moderate-risk	3.9 (23)	5.7 (266)			
	% (n) problem	0.9 (5)	**2.3 (108)**			
Problem gambling severity amongst gamblers (n = 5,222)	Mean (n) (SD)	0.39 (1.45)	**0.68 (2.23)**	M−W U = 1,488,043.5, $Z = -3.59$	<0.001	$d = 0.07$
Gambling harm amongst gamblers (n = 4,191)	Mean (SD)	0.40 (1.20)	**0.55 (1.50)**	M−W U = 771,669.5, $Z = -2.16$	0.030	$d = 0.05$
Harm from own gambling caused most by (n = 712)	% (n) EGMs	15.2 (10)	**41.3 (267)**	$\chi^2(14) = 35.93$	0.001	$\varphi = 0.23$
Gambling harm from others' gambling (n = 11,540)	% (n) yes	4.3 (50)	**6.2 (645)**	$\chi^2(1) = 7.22$	0.007	$\varphi = 0.03$
Harm from others' gambling caused most by (n = 650)	% (n) EGMs	13.3 (6)	**53.9 (326)**	$\chi^2(11) = 42.69$	<0.001	$\varphi = 0.26$

Note: Bold text indicates statistically significantly higher values for WA or the rest of Australia. M−W U refers to Mann-Whitney U-tests. Omnibus test statistics are reported, with pairwise tests of independence also conducted after significant omnibus tests, for problem gambling severity and self-reported harmful forms associated with own or others' gambling. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

comparable ethical standards. Ethics approval was obtained from the CQUniversity Human Research Ethics Committee, approval number 21992.

RESULTS

Demographic characteristics

Education was significantly lower in WA, and the proportion of people born in another country was significantly higher in WA, compared to the rest of Australia (Table 1). No other statistically significant differences were observed.

Gambling participation

Table 1 shows that a significantly higher proportion of respondents from WA gambled on at least one form during the last 12 months, but no significant difference was observed in terms of online gambling prevalence. Comparisons by each gambling form show that respondents from WA were significantly less likely to gamble on EGMs and Keno, but significantly more likely to gamble on lotteries, scratchcards, casino games and fantasy sports compared to the rest of Australia.

Gambling problems and harms

Gambling problems and gambling harms were significantly lower in WA, including the proportion in the highest risk group, as well as all risk levels combined (Table 1). People who experienced problems or harm from their own gambling in WA were significantly less likely to attribute their problems or harm to EGMs (15.2%) compared to the rest of Australia (41.3%). Instead, people in WA were significantly more likely to attribute their gambling harm to lotteries (24.2% vs 13.0% in the rest of Australia), and casino table games (21.2% vs 6.8% in the rest of Australia), with no other statistically significant differences.

A significantly lower proportion of people in WA reported experiencing harm from another person's gambling, compared to the rest of Australia. In the rest of Australia, 53.9% of those harmed by another person's gambling reported that EGMs were the form that caused the most harm compared to 13.3% in WA. In WA, the reported most harmful forms to concerned significant others (CSOs) were race betting (31.1% vs 18.5% in the rest of Australia) and casino table games (22.2% vs 5.6% in the rest of Australia), both of which were statistically significant.

Mediation models

Analyses were conducted to determine whether EGM participation in the last 12 months mediated the association between living in WA (or not) and (log +1) PGSI scores (Table 2). Because the PGSI was only asked of a subsample of those who reported gambling, corrective subsampling weights were applied (N = 5,221).

Model 1 included one mediator: EGM participation (no/yes). The negative total effect of jurisdiction on PGSI

Table 2. Mediation models predicting (log +1) PGSI scores

Mediator	Jurisdiction -> mediator	Mediator -> PGSI	Indirect effect	Direct effect	Variance explained
Model 1: EGM participation				0.012 (−0.019, 0.043)	**0.281*****
EGMs	**−0.157***** **(−0.202, −0.113)**	**0.347***** **(0.318, 0.376)**	**−0.055***** **(−0.071, −0.038)**		
Model 2: All forms				0.012 (−0.028, 0.051)	**0.372*****
EGMs	**−0.157***** **(−0.202, −0.113)**	**0.265***** **(0.206, 0.325)**	**−0.042***** **(−0.057, −0.027)**		
Keno	**−0.250***** **(−0.307, −0.193)**	0.015 (−0.051, 0.082)	−0.004 (−0.021, 0.013)		
Lotteries	**0.123***** **(0.078, 0.168)**	**0.097*** **(0.022, 0.172)**	**0.012*** **(0.002, 0.022)**		
Casino games	**0.107***** **(0.063, 0.151)**	−0.043 (−0.132, 0.047)	−0.005 (−0.014, 0.005)		
Scratchcards	−0.034 (−0.075, 0.006)	**0.050*** **(0.010, 0.090)**	−0.002 (−0.004, 0.001)		
Sports betting	−0.019 (−0.058, 0.020)	**0.216***** **(0.135, 0.298)**	−0.004 (−0.013, 0.004)		
Race betting	−0.032 (−0.071, 0.007)	0.005 (−0.072, 0.082)	0.000 (−0.003, 0.002)		
Novelty betting	0.018 (−0.046, 0.083)	−0.017 (−0.102, 0.067)	0.000 (−0.002, 0.002)		
Bingo	−0.047 (−0.125, 0.032)	−0.021 (−0.090, 0.049)	0.001 (−0.003, 0.005)		
Poker	0.000 (−0.055, 0.056)	0.074 (−0.018, 0.167)	0.000 (−0.004, 0.004)		
Esports betting	−0.031 (−0.110, 0.049)	0.046 (−0.069, 0.160)	−0.001 (−0.006, 0.004)		
Fantasy sports betting	0.057 (−0.017, 0.131)	−0.045 (−0.184, 0.094)	−0.003 (−0.011, 0.006)		
Skins gambling	−0.039 (−0.133, 0.055)	**0.178*** **(0.037, 0.318)**	−0.007 (−0.024, 0.011)		

Note: Values are standardised coefficients and 95% confidence intervals (lower limit, upper limit). $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. Independent variable was jurisdiction (rest of Australia = 0, WA = 1), and mediators were participating in each form within the last 12 months (no = 0, yes = 1). Total effect for Models 1 and 2 was beta = −0.043, 95% CI = −0.072 to −0.013, $Z = -2.813$, $p = 0.005$.

scores reflected lower levels of problems in WA. EGM participation fully mediated the direct effect, indicating that the lower PGSI scores in WA were explained by lower levels of EGM participation. Controlling for country of birth and education showed similar results (see Appendix).

Model 2 included participation in all 13 forms as parallel mediators. This model found a similar indirect effect for EGM participation, and also an indirect effect of the opposite sign for lotteries participation. No other indirect effects were statistically significant.

Moderation models

Table 3 summarises two regression models predicting gambling problems from frequency of participation in each gambling form. Model 3 assumes a homogenous effect across jurisdictions conditional on participation, whilst model 4 provides for a baseline difference between jurisdictions not explained by participation, as well as differential effects of forms for WA versus the rest of Australia. Model 4 did provide a significantly better fit overall than Model 3, $F(10) = 1.306$, $p = 0.221$; and no interaction effects were significant. Accordingly, we concluded that the risk of gambling problems conditional on frequency of participation was approximately identical across jurisdictions. The riskiest form of gambling was EGMs, $B = 0.168^{*}$ (0.154, 0.182), $p < 0.001$.

DISCUSSION

This study sought to determine how restricting the accessibility of EGMs impacts on population-level at-risk and problem gambling. Because EGMs are widely accessible across Australia, apart from WA, but other forms are similarly accessible in both WA and the rest of Australia, only problems attributable to EGMs are expected to be lower in WA, and not problems attributable to other gambling products. In line with previous research (Lund, 2009), our results found that gambling problems attributable to EGMs were lower in WA when compared to the rest of the country; approximately one-third of the total per capita. Moreover, this reduction contributed largely to Western Australians having only 65.4% of the total problems experienced by people living in other jurisdictions combined.

Our findings did not support potential substitution effects, whereby people might experience more problems from other gambling forms when EGMs are less accessible. In fact, gambling problems attributable to most other products were largely similar in WA compared to other jurisdictions. The exception was greater participation in WA for popular but less harmful products, such as lottery and scratchcards. There was greater participation in casino games in WA, but this contributed only marginally to greater problems from

Table 3. Regression coefficients for models predicting gambling problems conditional on frequency of participation on each form

	DV: log(PGSI+1)	
	Model 3	Model 4
Jurisdiction: WA (0), Rest of Australia (1)		0.043*** (0.025, 0.060)
Scratchcards	0.062*** (0.047, 0.076)	0.049* (0.004, 0.094)
Sports betting	0.067*** (0.049, 0.085)	0.064* (0.007, 0.120)
Race betting	0.050*** (0.035, 0.065)	0.071** (0.024, 0.118)
Novelty betting	0.161*** (0.101, 0.221)	0.071 (−0.075, 0.217)
Bingo	0.004 (−0.030, 0.038)	−0.165 (−0.357, 0.027)
Keno	0.056*** (0.036, 0.076)	0.068 (−0.093, 0.229)
Poker	0.102*** (0.073, 0.131)	0.085 (−0.010, 0.179)
Casino games	0.149*** (0.117, 0.180)	0.163*** (0.075, 0.251)
EGMs	0.168*** (0.154, 0.182)	0.129*** (0.055, 0.204)
Scratchcards × Jurisdiction		0.003 (−0.045, 0.050)
Sports betting × Jurisdiction		−0.001 (−0.061, 0.059)
Race betting × Jurisdiction		−0.030 (−0.080, 0.020)
Novelty betting × Jurisdiction		0.107 (−0.054, 0.267)
Bingo × Jurisdiction		0.167 (−0.028, 0.363)
Keno × Jurisdiction		−0.015 (−0.177, 0.148)
Poker × Jurisdiction		0.017 (−0.082, 0.116)
Casino games × Jurisdiction		−0.017 (−0.111, 0.077)
EGMs × Jurisdiction		0.032 (−0.044, 0.109)
Observations	5,221	5,221
R2	0.379	0.383
Adjusted R2	0.378	0.381
Residual Std. Error	0.478 (df = 5,212)	0.477 (df = 5,202)
F Statistic	353.766*** (df = 9; 5,212)	170.071*** (df = 19; 5,202)

Notes: All gambling form independent variables and PGSI dependent variable transformed via log(+1). Lotteries were excluded on a theoretical basis because they were found to reduce harm. Esports betting, fantasy sports betting and skin gambling were excluded due to their low prevalence. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

this source. These results imply that it is possible to reduce gambling problems by restricting accessibility of EGMs without people substituting to other problematic forms of gambling, as long as restrictions are meaningful. For example, a study examining the removal of 406 EGMs in parts of Victoria found no meaningful impacts on EGM expenditure (South Australian Centre for Economic Studies, 2005b). This is likely because 5,088 EGMs (93%) remained in these areas. If restrictions are to have a meaningful impact, numbers of EGMs must be reduced to a point where demand outstrips supply. If people do substitute to other gambling forms, they do not experience the same level of harm from them. These findings are in line with the international literature (e.g., Lund et al., 2009).

These findings also inform an important point about the nature of gambling harm. If gambling harm is mostly a function of the personal traits of people who gamble, then we would expect to see substitution of harms to other gambling forms when EGMs are less accessible. We did not find this substitution effect, which suggests that gambling harm is more likely due to the highly addictive nature of certain gambling forms, particularly EGMs, rather than personal predispositions.

People in WA were far less likely to indicate that EGMs had caused their gambling problems (15.2%) in comparison with those answering from other jurisdictions combined (41.3%). Only about one-third as many people attributed their gambling problems to EGMs, which converged with our estimate of about one-third as many problems per capita as estimated from our regression analyses. We also found that EGMs were less likely to be identified as the most harmful form of gambling in WA affecting CSOs. Thus, gambling problems from EGMs in WA were not just associated with rates of use of EGMs, but also directly identified as a less frequent source of problems by gamblers and their CSOs.

Due to differences in regulation, some unique structural features of EGMs in WA, apart from accessibility, could theoretically result in these games being less problematic than EGMs accessible in the rest of Australia. However, our results showed no significant predictive ability for playing EGMs in WA as a factor that was protective from gambling problems. That is, the primary reason that people in WA had less harm on average than other Australians related to their lower likelihood of using EGMs. However, people who used EGMs in WA were similarly as likely to suffer from gambling problems as people using EGMs elsewhere. These results imply that the particular differing structural features of EGMs in WA compared to other jurisdictions do not meaningfully reduce harm amongst people who play them. However, this should not be taken to mean that structural differences cannot reduce harm. In Norway, devices with less harmful features and mandatory identification of players has been associated with a decrease in harm, despite all but the most harmful EGMs still being widely accessible (Rossow & Bang Hansen, 2016). Instead, these findings imply that the particular structural characteristics of EGMs in WA are not different enough to EGMs in the rest of Australia to meaningfully reduce harm.

Limitations

The present study had several limitations. Problems associated with individual gambling products were imputed by regression. This technique apportioned gambling problems as sourced from individual gambling products based on the frequency with which products were used by people with gambling related problems. Since people with problems are likely to use multiple products, some gambling harm from one product may merge into another in this process due to some multicollinearity in the predictors (i.e., the products used). For instance, people who play EGMs in WA may be more likely to also try casino games since they are both exclusively offered in the sole Casino. Thus, gambling problems associated with products are only estimates and ignore potential interactions between use of multiple products. Our convergent evidence taken from people nominating the gambling product that caused them the most harm ameliorated some concerns about our conclusions regarding the harm caused by EGMs. Nevertheless, asking people to nominate their most problematic product relies on people understanding the degree of harm each product contributes overall. Although this may seem reasonable, people with problems may have an imperfect understanding of what products contribute most to their problems. In addition, the data are drawn from self-report and may be limited based on recall and desirability biases. The low response rate raises questions about the representativeness of the data. However, the low response rate is in line with dropping response rates for telephone surveys across the world and is a limitation that is not unique to this study (Russell, Browne, Hing, Rockloff, & Newall, 2022). Further, the prevalence results for the current dataset are largely in line with previous representative samples in Australia, adding confidence to the findings (Browne et al., 2019; Hing et al., 2014; Rockloff et al., 2020). It is also unclear if the result is due to the limited number of EGMs in WA, or the fact that the EGMs are geographically isolated to one location. This is an avenue for future research.

Conclusion

The gambling environment of WA provides a unique natural experiment for analysing the potential for restriction in the accessibility of EGMs on the prevalence of gambling problems. The findings inform a broader public health debate about how accessibility of harmful gambling products relates to gambling harm. Using nationally representative data, it was found that the lower prevalence of play on EGMs was associated with a corresponding decrease in the gambling problems experienced by people living in WA relative to those living elsewhere in Australia. There was little evidence of substantial substitution of gambling behaviour to other harmful products. Consequently, this study indicates that restricting accessibility of harmful products can have a meaningful impact on decreasing the

prevalence of gambling problems in the community, inclusive of problems that occur to others in a close relationship with gamblers.

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Authors' contribution: AR devised the idea for the paper. AR and MB conducted all analyses and verified the underlying data. AR, NH, MB and MR wrote the first draft of the paper. NH led the overall project from which these data were drawn. NH, AR, MB, MR, NG, VR, MS, ND, SM, DK, HB, AHS and LW secured funding for the corresponding project. All authors were involved in the design of the overall project and survey instrument, critically edited the manuscript, and approved it for submission.

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PN is a member of the Advisory Board for Safer Gambling – an advisory group of the Gambling Commission in Great Britain, and in 2020 was a special advisor to the House of Lords Select Committee Enquiry on the Social and Economic Impact of the Gambling Industry. In the last three years PN has received research funding from Clean Up Gambling, and has contributed to research projects funded by GambleAware, Gambling Research Australia, NSW Responsible Gambling Fund, and the Victorian Responsible Gambling Foundation. In 2019 PN received travel and accommodation funding from the Spanish Federation of Rehabilitated Gamblers, and in 2020 received an open access fee grant from Gambling Research Exchange Ontario. Philip declares no conflicts of interest in relation to this manuscript.

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HB is retired and an Adjunct, Faculty of Business, Law and Arts Southern Cross University, Australia. She has had several casual work contracts with Central Queensland University, Australia. She declares no conflicts of interest in relation to this manuscript.

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Appendix

Table A1 below shows the version of the mediation models in Table 2 when controlling for demographics. As shown, the results are similar to those for Model 1, and the interpretation of the results is the same.

Table A2. Skewness and kurtosis (and standard errors) of PGSI before and after log(+1) transformation

Statistic	Original PGSI score	Transformed PGSI score
Skewness	5.02 (0.03)	2.31 (0.03)
Kurtosis	31.34 (0.07)	4.93 (0.07)

Table A1. Mediation models predicting (log +1) PGSI scores

Mediator	Jurisdiction -> mediator	Mediator -> PGSI	Indirect effect	Direct effect	Variance explained
Model 3: EGM participation plus demographics	.	.	.	0.005 (−0.025, 0.036)	**0.265*****
EGMs	**−0.160***** **(−0.205, −0.116)**	**0.320***** **(0.289, 0.351)**	**−0.051***** **(−0.067, −0.036)**	.	.

Note: Values are standardised coefficients and 95% confidence intervals. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. Independent variable was jurisdiction (rest of Australia = 0, WA = 1), and mediator was participating on EGMs within the last 12 months (no = 0, yes = 1).