

# Gambling and crime: An exploration of gambling availability and culture in an English prison

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## Abstract

**Background:** There is evidence that prisoners have the highest rate of problem gambling in any population, but little is known about the nature of in-prison gambling, the motives for it or how it relates to prior gambling behaviour.

**Aims:** To investigate the prevalence and type of gambling prior to prison and the prevalence, type, and reasons for gambling in prison.

**Methods:** Two hundred and eighty-two male volunteers in a Category B male prison in England completed a questionnaire which included the Problem Gambling Severity Index (PGSI).

**Results:** One hundred and twenty-six (45%) reported gambling in prison, with eighty-one (30%) of participants reporting that gambling was a normal part of prison life. Pre-prison behaviour, whether type of index offence or prior gambling, had little relationship to in-prison gambling. Frequency of gambling in prison increased with increasing PGSI risk category. The most common types of gambling in prison were card/dice games, sports and ball games, while the most common motives were entertainment, excitement or sense of challenge and to win prizes, with significant differences in motive between PGSI risk categories. Prison canteen items formed the most common currency gambled. People within the higher PGSI risk category were more likely to have borrowed items from other prisoners.

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**Conclusions:** Our research has added to existing literature by identifying high rates of gambling in prison and showing that prisoners' perceptions of gambling are as a normal part of prison life. Findings suggest that screening and support should be available to manage gambling in prison, including support to reduce gambling-related debt, particularly given associations between debt and violence in prison. Relief from boredom and need for excitement were among the most common reasons for gambling in prison, indicating that there is a need to provide a more appropriately stimulating prison environment.

**KEYWORDS**

addiction, crime, criminal behaviour, mental health, prison, problem gambling

## 1 | INTRODUCTION

In England, over half of adults (54%) gambled over a 12-month period (Public Health England, 2021). Gambling is defined as gaming, betting and/or participating in a lottery (Gambling Act, 2005). Despite being accessed on a large scale and legislated as a leisure activity, gambling is increasingly seen as a public health concern in the UK (Atherton & Beynon, 2019; McGee, 2020; Public Health England, 2021; Wardle et al., 2019). For the majority of people, gambling is a recreational activity, enjoyed without problems (Ronzitti et al., 2018), but for some, gambling can evolve into problem or disordered gambling (Wardle et al., 2012).

Disordered gambling is classified within the Diagnostic and Statistical Manual of Mental Disorders (fifth ed.; DSM-5; American Psychiatric Association, 2013) as a maladaptive behavioural addiction. The DSM-5 definition is favoured in gambling research because it includes diagnostic criteria which increase reliability over other definitions, such as in the International Statistical Classification of Diseases and Related Health Problems (ICD-11, World Health Organisation, 2019), and it is used in many countries outside of the USA (Sztainert, 2018). Disordered gambling is associated with the compromise, disruption or damage of family, social, personal or recreational pursuits (Delfabbro, 2013). While the DSM-5 uses the term "disordered" gambling, terminology used to describe problem gambling is variable (Blaszczynski & Nower, 2002). Much existing literature adopts the term "problem gambling", defined as "behaviour that creates negative consequences for the gambler and/or for others in his or her social network, or for the community" (Ferris & Wynne, 2001, p. 8). Various validated measures of problem gambling exist; one of the most widely used being the Problem Gambling Severity Index (PGSI; Ferris & Wynne, 2001). This includes items specifically relating to gambling such as needing to gamble larger amounts to feel the same excitement and borrowing money in order to gamble, as well as items relating to the consequences of gambling, including feeling guilty or being criticised about gambling. While the DSM-5 (APA, 2013) refers to gambling as 'disordered gambling' or 'gambling disorder' this article adopts the term problem gambling to align to the PGSI. Problem gambling has been linked to mental health problems (Lorains et al., 2011; Roberts et al., 2017), financial difficulties (Cowlshaw & Kessler, 2016; Grant et al., 2010), homelessness (Sharman et al., 2015), suicide (Ledgerwood & Petry, 2004), alcohol use disorders (Petry, 2005; Welte et al., 2001) and other problematic substance use (Petry, 2005, 2007).

International studies indicate that between 0.12% and 5.8% of the worldwide population experience gambling-related harms (Calado & Griffiths, 2016). In England, it is estimated that 0.5% of the general population reaches the threshold for problem gambling (Public Health England, 2021). Prisoners, however, are considered to have

the highest prevalence of gambling found in any population (Williams et al., 2005). Internationally, studies of prisoners have shown prevalence rates of problem or disordered gambling when screened within prison ranging from 8% in some areas of Australia (Marshall et al., 1997) to 40% in the USA (Westphal et al., 1998) with an average estimate across 23 studies of around 33% (Williams et al., 2005). In a more recent study of English and Scottish prisons, the prevalence of problem gambling, reported using the PGSI which asks respondents to rate their replies to the nine items for the 12 months prior to entering prison, was 12.1% (May-Chahal et al., 2017).

In England and Wales, the rules pertaining to gambling in prison are unclear, although it is noted that gambling for financial gain is prohibited (HM Prison and Probation Service, 2020). Nevertheless, it has been suggested that gambling in prison may be a significant part of prison sub-culture (Williams & Hinton, 2006). In addition, many people (up to 65%) engaged in severe problem gambling report gambling-related criminal behaviour (Turner et al., 2009) and, in Australia, 18% of prisoners reported being incarcerated due to offending behaviour which was related to their gambling problems (Riley et al., 2018). Moreover, increased gambling severity is a significant predictor of recidivism (April & Weinstock, 2017). Existing literature has indicated that offences linked to gambling are typically income-generating, such as theft, burglary, fraud, and selling drugs (Abbott et al., 2005; Abbott & McKenna, 2005; Turner et al., 2009); violent crimes are indicated but appear less frequently (Abbott & Volberg, 1999).

Similar to people experiencing problem gambling, prisoners have been found to have higher than rates of psychosocial problems than in the general population, including higher rates of mental disorders (Fazel & Danesh, 2002), suicide (Fazel et al., 2010), problem substance use (Fazel & Baillargeon, 2011), homelessness (McGrath, 2018) and financial problems (Bath & Edgar, 2010). Furthermore, problematic drug and alcohol use have been associated with a higher likelihood of gambling-related arrest (Potenza et al., 2005).

Many types of gambling exist. Within the British general population, people who gamble have been shown, on average, to engage in 2-3 different gambling activities (Wardle et al., 2011). Among treatment-seeking people who gambled, over the 15 year period from 2000 to 2015, horse racing, dog racing and lottery gambling decreased in popularity, while sports, fixed odds betting terminals (FOBT), poker and online gambling activities increased (Sharman et al., 2019). Some research has suggested that activities such as slot machines (vs. other types of 'addictive' games) and regular online gambling (vs. infrequent online gambling) are more likely to lead to problem or disordered gambling (Cholz, 2010; Petry & Weinstock, 2007). Few studies have investigated the types and frequency of gambling activity in prisons and the reasons for engaging in it; Abbott et al. (2005) and Beauregard and Brochu (2013) are exceptions. To our knowledge, the types of gambling prior to and during incarceration, and the reasons for gambling in prison and their associations with problem gambling, have not been studied.

Our aim was to close the existing gap in literature by investigating gambling within an English prison. This adds to the existing literature on the prevalence of disordered gambling within offender populations, whilst also:

1. investigating the prevalence and type of gambling occurring prior to and within prison;
2. reporting the reasons prisoners give for their gambling;
3. investigating the currency used for gambling within prison
4. reporting the prevalence of gambling-related borrowing and debt within prison.

We hypothesised that:

1. Prior to imprisonment, differing risk categories, as defined by the PGSI (non, low, moderate, problem), would be associated with different types of offending;
2. Prior to imprisonment, different risk categories would be associated with different types of within prison gambling;
3. People in problem or moderate gambling risk categories would be more likely to gamble in prison than those in lower categories;
4. In prison, different levels of gambling risk would be associated with different types of gambling activity, different reasons for gambling and utilisation of different gambling currency.
5. People in higher risk gambling categories would be more likely to have borrowed items in prison in order to gamble.

## 2 | METHOD

### 2.1 | Ethics

The research was approved by The University of Lincoln Research Ethics Committee (Reference: PSY1617416) and by HM Prisons and Probation Service National Research Committee (Reference: 2018-353).

### 2.2 | Participants

Two hundred and eighty-two volunteer participants were recruited at a category B, adult male prison located in England. It is not possible to state, with certainty, what proportion of the population within the prison at the time of data collection were sampled because the population fluctuated across data collection dates. Inclusion criteria were confined to being that men were in prison and willing to participate. Although the study was advertised about being about gambling behaviours, it was made clear that the research was open to people who did not gamble.

The category B prison chosen is local, holding about 600–650 remand and sentenced prisoners at any one time, charged with, or convicted of, a wide range of offences, with releases and receptions (arrivals) of between 0 and 10 prisoners per day. We are withholding more exact numbers so as not to identify the prison. Category B prisons are the second highest security category for adult male prisons, designed for prisoners for whom the highest security conditions are not required but for whom escape must be made very difficult (Ministry of Justice, 2020).

A prison for men only was selected because, in England and Wales, 93%–96% of the prison population are men (Ministry of Justice, 2022). Further, staff in this prison were willing to support the research. Participants were recruited by researchers who attended the residential wings, workplaces and education venues within the prison. Anyone within the prison could volunteer to participate.

### 2.3 | Measures

A self-report questionnaire which included a range of tick box and free text responses was designed specifically for this research. The survey contained the following measures:

#### 2.3.1 | Age

Provided as a free text response.

#### 2.3.2 | Offence and custody status

Participants were asked to report the crime for which they were currently in prison, whether they were on remand (pre-trial/pre-sentence - yes/no), when sentenced their current sentence length, how long they had already been in prison, whether they had been to prison before (yes/no). They were asked whether gambling was related to their current offence (yes/no). Based on Home Office crime statistics classifications (Home Office, 2011), the offence data were later coded into the following categories for analysis: violent (including murder, manslaughter, robbery, assaults, threats, breaches of restraining order, domestic violence, human trafficking and weapons offences), sexual, acquisitive (including burglary and theft), drugs (including possession, conspiracy and supply offences), fraud, and criminal damage (including arson). Where the data were unclear (e.g. where participants had just written 'conspiracy' or 'breach') this was coded as missing.

### 2.3.3 | Problem gambling

Problem Gambling Severity Index (PGSI; Ferris & Wynne, 2001): The PGSI is a 9-item self-report tool for measuring gambling problem severity. Five items about the gambling behaviour prior to prison include 'how often have you bet more than you could afford to lose?' and 'how often have you borrowed money or sold anything to get money to gamble?' The four items which relate to gambling consequences include 'how often has gambling caused you any health problems, including stress or anxiety?' and 'have you felt guilty about the way you gamble or what happens when you gamble?' Participants were asked to tick which option they felt applied to them. Each item is scored on a 0–3 scale (0 = never, 1 = sometimes, 2 = most of the time, 3 = almost always). The total score range is, thus, 0–27, whereby 0 indicates gambling but with no negative consequences; 1–2 suggests low-risk gambling, with low level problems and few or no identified negative consequences; 3–7 indicates moderate risk gambling, with experience of a moderate level of problems and some negative consequences; eight or above represents problem gambling, with negative consequences and a possible loss of control. These categories were derived from extensive development of the tool with reference to the DSM and existing gambling measures alongside clinical interviews (see Ferris & Wynne, 2001 for a more detailed discussion). Cronbach's alpha for the PGSI is as high as 0.928, the test-re-test reliability using correlation analysis is 0.78, while the criterion-related validity against the DSM-IV is 0.83 and content validity established by 12 experts during the development of the measure (Ferris & Wynne, 2001). Cronbach's  $\alpha$  was 0.96 in our study, indicating good internal consistency for this sample.

### 2.3.4 | Gambling before prison

Participants were asked to indicate their main types of gambling before prison by ticking all applicable items from the following list: none, card or dice games, horses/dogs/other animals, sports, casino, lottery games, bingo, stock market, gambling machines, online gambling, FOBT/roulette machines, other.

### 2.3.5 | Gambling in prison

Participants were asked whether they thought gambling was a normal part of prison life (yes/no), whether they had gambled in prison (yes/no), how many times per week they had gambled in prison, what currency they used for gambling (none; cigarettes; drugs; alcohol; cash; stamps; drinks; other canteen food; other canteen items e.g. toothpaste, favours/promises; services e.g. laundry, dares, other); whether they had borrowed from other prisoners in order to gamble (yes/no), whether they still owed what they had borrowed (yes/no), what types of gambling they engaged in whilst in prison (card or dice games, ball games, board games, horses/dogs/other animals, sports, other people's behaviour, other) and what reasons best described why they gambled in prison, according to a further tick box list: to win prizes/money, for excitement/challenge, curiosity, oblige or please others, pressure from others, interest/hobby, escape problems, be with people, entertainment/relieve boredom, addiction/compulsion, other). For context, prison canteen is the facility through which prisoners can purchase items such as snacks and toiletries.

## 2.4 | Procedure

Data were collected between March 2018 and February 2019 across five research visits. During each visit, the researcher attended the residential wings of the prison, the vocational skills workshops and the industries workshops to ask for volunteer participants. Participants were told the research was about gambling but that they did not have to have gambled in order to participate. Upon expressing an interest, participants were provided with a questionnaire pack containing an information sheet, consent form, questionnaire and debriefing sheet. Upon completion, the questionnaires were placed in a sealed envelope and handed back to the researcher on the same day. Where participants

wanted to complete the questionnaire but had reading or writing difficulties, they were assisted by the researcher or were allowed to ask another prisoner to assist.

## 2.5 | Analysis

Data were analysed using IBM Statistical Packages for Social Sciences (SPSS) 25.0. Response sets were separated into five groups using the PGSI which asked people to answer the items based on 'prior to prison': non-gamblers (no gambling reported), gamblers but with no reported problems (score 0), low risk gamblers (score 1–2), moderate risk gamblers (score 3–7) and problem gamblers (score 8 or above) and were compared across the remaining measures. Significant differences between groups were determined using one-way between subjects ANOVA accompanied by partial eta squared to illustrate effect size (0.01 = small, 0.06 = medium, 0.14 = large); or  $\chi^2$  tests (for categorical data) accompanied by Cramer's V to illustrate effect size (0.1 = small, 0.3 = medium, 0.5 = large), where a significant result was found. Adjusted standardised z score residuals were used to identify post-hoc differences in chi-square models using the appropriately adjusted *p*-value (Beasley & Schumacker, 1995). Fisher's Exact Test was used where cell counts were insufficient for  $\chi^2$  tests. Bonferroni corrections were applied to alpha rates as appropriate and instances of this are detailed within the results section. A McNemar test was used to assess engagement in gambling pre custody and engagement in gambling once in prison to determine if there was significant movement between the two. A significance level of 5% was adopted, unless otherwise stated in the results section. Not all participants completed all questions and therefore numbers do not invariably add up to 282.

## 3 | RESULTS

### 3.1 | General characteristics of the sample

The mean age of the all-male sample was 34.47 years (SD = 11.37). Two hundred and eight participants (74%) were convicted, with 71 (25%) on remand, awaiting sentencing. The mean sentence length was 436 weeks (SD = 1129.72), with a mean sentenced served to date of 109.5 weeks (SD = 223.91). One hundred and eleven (39%) were convicted or remanded for violent offences, 35 (12%) for acquisitive crimes, 27 (9%) for sexual offences, 34 (12%) for drug-related offences, and 2 (0.7%) and 3 (1%) for fraud and criminal damage respectively.

### 3.2 | Gambling prior to this imprisonment

One-hundred and eighty-five participants (66%) reported gambling before this imprisonment, at some stage during their lifetime. Of these, 81 (28%) were in the moderate or problem gambling risk categories. One way between subjects ANOVAs indicated no significant differences in age, nature of offence or length of sentence across PGSI categories (Table 1). Chi-squared analysis indicated no significant associations between pre-prison history of gambling and whether participants had previous experience of prison or not, nor whether their current status was under sentence or remand (Table 1). Just 9 men (4%) reported that gambling was related to their offence; all of these were in the problem gambling category. However, there was no significant association with offence type and PGSI category ( $\chi^2(20) = 17.03, p = 0.651$ ).

The most common types of gambling prior to prison are detailed in Table 2; they were gambling machines (slots) ( $n = 89, 49\%$ ), sports ( $n = 84, 46\%$ ), and horses/dogs/other animals ( $n = 76, 42\%$ ), followed by lottery ( $n = 68, 37\%$ ), casino ( $n = 65, 36\%$ ), online gambling ( $n = 61, 33\%$ ) and card/dice games ( $n = 45, 24\%$ ). Fixed odds betting terminals (FOBT), bingo and the stock market were the least popular ( $n = 25, 14\%$  for FOBT and bingo; and  $n = 12, 7\%$  for stock market). Of those who reported gambling prior to prison, 45 (24%) reported just one type of gambling while 40 (22%) engaged in two, 28 (15%) engaged in three, 18 (10%) engaged in four, 22 (12%) engaged in 5, and 23 (12%) engaged in six or more different activities. There was no indication of any clustering of activities.

TABLE 1 Sample characteristics of remanded and sentenced men in one English prison by PGSI risk group

Characteristic	PGSI group (before prison)						Effect size (Cramer's V/ Partial Eta squared $\eta_p^2$ )	
	Non-gambling	Non-problem gambling	Low risk gambling	Moderate risk gambling	Problem gambling	Test statistic (df)		p-value
Prevalence of gambling prior to prison	97 (34.4)	50 (17.7)	54 (19.1)	40 (14.2)	41 (14.5)	N/A <sup>a</sup>	N/A <sup>a</sup>	
Participant age	Gambling disclosed n (%)	36.1 (12.5)	36.9 (13.1)	32.3 (9.5)	33.0 (9.7)	32.1 (9.4)	F (4, 273) = 2.20	0.069
Previous experience of prison	Age in years mean (SD)	61 (32.2)	30 (15.9)	35 (18.5)	33 (17.5)	30 (15.9)	$\chi^2$ (4) = 6.77	0.149
	First time in prison n (%)	35 (39.3)	19 (21.3)	18 (20.2)	7 (7.8)	10 (11.2)		
	Not first time in prison n (%)							
Custody status	Sentenced n (%)	70 (33.7)	39 (18.8)	40 (19.2)	31 (14.9)	28 (13.5)	$\chi^2$ (4) = 1.85	0.764
	Remand n (%)	26 (36.7)	10 (14.1)	13 (18.3)	9 (12.7)	13 (18.3)		
Current sentence length	Sentence length in weeks mean (SD)	412.3 (1079.8)	145.0 (181.3)	574.5 (1371.3)	507.2 (1324.8)	629.8 (1324.8)	F (4, 188) = 0.98	0.420

Abbreviation: PGSI, Problem Gambling Severity Index.

<sup>a</sup>Descriptive only.

TABLE 2 Forms of gambling prior to imprisonment by gambling risk groups

Method	N (%) of those who gambled prior to prison	Non-problem gambling; N (%)	Low risk; N (%)	Moderate risk; N (%)	Problem gambling; N (%)	Test statistic (df)	p-value	Cramer's V
Gambling machines for example, slots	89 (48.6)	18 (20.2)	16 (18.00)	22 (24.7)	33 (37.1) <sup>^</sup>	$\chi^2 (3) = 28.01$	<0.001*	0.391
Sports	84 (45.9)	19 (22.6)	22 (26.2)	20 (23.8)	23 (27.4)	$\chi^2 (3) = 3.840$	0.279	0.145
Horses/dogs/animals	76 (41.5)	19 (25.0)	18 (23.7)	19 (25.0)	20 (26.3)	$\chi^2 (3) = 11.185$	0.011	0.247
Lottery	68 (37.2)	26 (38.2)	18 (26.5)	7 (10.3)	17 (25.0)	$\chi^2 (3) = 11.437$	0.010	0.250
Casino	65 (35.5)	10 (15.4)	12 (18.5)	18 (27.7)	25 (38.5) <sup>^</sup>	$\chi^2 (3) = 22.62$	<0.001*	0.352
Online gambling	61 (33.3)	9 (14.8)	16 (26.2)	12 (19.7)	24 (39.3) <sup>^</sup>	$\chi^2 (3) = 17.36$	<0.001*	0.308
Card/dice	45 (24.3)	5 (11.1)	10 (22.2)	11 (24.4)	19 (42.2) <sup>^</sup>	$\chi^2 (3) = 17.41$	0.001*	0.308
FOBT/roulette	25 (13.7)	3 (12.0)	4 (16.0)	7 (28.0)	11 (44.0)	$\chi^2 (3) = 10.803$	0.013	0.243
Bingo	25 (13.7)	6 (24.0)	4 (16.0)	6 (24.0)	9 (36.0)	$\chi^2 (3) = 4.28$	0.232	0.153
Stock market	12 (6.6)	1 (8.3)	7 (58.3)	3 (25.0)	1 (8.3)	$\chi^2 (3) = 6.74$	0.081	0.192

Significance threshold lowered to 0.005 due to number of tests.

\*Indicates significance at 0.005 level.

<sup>^</sup>Significantly higher than expected based on adjusted standardised residuals.

There were some significant associations across PGSI risk categories and gambling methods prior to prison, including gambling machines ( $\chi^2_3 = 28.01$ ,  $p < 0.001$ ,  $V = 0.391$ ); analysis of adjusted z score residuals indicates significantly more people in the problem gambling group had gambled on gambling machines ( $p = <0.006$ ). Differences were also observed for casino gambling ( $\chi^2_3 = 22.62$ ,  $p < 0.001$ ); analysis of adjusted z score residuals indicates significantly more people in the problem gambling group had gambled in a casino ( $p < 0.006$ ). Similar relationships were observed for online gambling ( $\chi^2_3 = 17.36$ ,  $p < 0.001$ ,  $V = 0.308$ ; adjusted z score residuals showing the problem gambling group accounting for most online gambling ( $p < 0.006$ ) and for card/dice games ( $\chi^2_3 = 17.41$ ,  $p = 0.001$ ,  $V = 0.308$ ; adjusted z score residuals linking problem gambling and card/dice games ( $p < 0.006$ ; Table 2).

### 3.3 | Gambling in prison

One hundred and twenty-six participants (45%) reported gambling in prison. One-hundred and sixteen (92%) of these were people who had also gambled prior to prison but there were 10 participants (8%) who had not reported gambling prior to prison but reported gambling in prison. This left 86 (30% of the overall sample) people who had not gambled before or during imprisonment. A McNemars test determined that there was a statistically significant change in the people gambling prior to prison versus during prison ( $\chi^2 = 41.65$ ,  $p < 0.001$ ). There was also a significant association between PGSI risk category prior to prison and likelihood of having gambled in custody ( $\chi^2_4 = 85.30$ ,  $p < 0.001$ ); analysis of adjusted z score residuals indicates significantly more problem



gamblers ( $p < 0.005$ ) and significantly fewer non-gamblers ( $p < 0.005$ ) had gambled whilst in prison (see also Table 3).

Eighty-one participants (30.3%) reported that gambling was a normal part of prison life. There was significant overall association between PGSI risk group and perception of gambling as a normal part of prison life ( $\chi^2(4) = 15.49$ ,  $p = 0.004$ ), however analysis of adjusted z score residuals indicates no significant differences between specific risk categories at the Bonferroni adjusted alpha value, see Table 3.

There was a significant difference in the mean frequency of gambling in prison across pre-prison PGSI risk categories ( $F(4, 237) = 97.07$ ,  $p < 0.001$ ). The frequency increased with increasing PGSI risk. Specifically, Tukey's *post hoc* testing showed there were significant differences in the frequency between non-problem gambling and problem gambling categories; low risk gambling and problem gambling categories; low risk gambling and non-gamblers; moderate risk gambling and problem gambling categories; and moderate levels of gambling and non-gambling categories (See Table 3).

### 3.4 | Types of gambling in prison

The most common types of gambling in prison were card/dice games (used by  $n = 65$ , 52%), sports ( $n = 58$ , 46%) and ball games ( $n = 27$ , 21.6%). Less common types were horses/dogs/animals ( $n = 18$ , 14%), other ( $n = 18$ , 14%; including on sexual favours, what happens on TV, time of cell unlock and 'Fight Club'), board games ( $n = 14$ , 11%) and other people's behaviour ( $n = 13$ , 10%; such as the outcome of someone smoking psychoactive substances) were also used. It is important to note that whilst it was not possible clarify the exact definition of 'fight club' in the response, this is thought to be organised fights, sometimes where prisoners are forced to fight other prisoners by their peers and this may therefore be a further indication of gambling on other people's behaviour. There were no significant associations found between PGSI risk level and type of in-prison gambling with the exception of gambling on other people's behaviour ( $\chi^2_4 = 27.22$ ,  $p = 0.001$ ,  $V = 0.313$ ) which, in *post hoc* analysis, was found to be more commonly identified by people in the problem gambling category ( $p < 0.005$ ).

### 3.5 | Reasons for gambling in prison

The most common reasons given for gambling in prison were to win prizes/money (52%), entertainment/relieve boredom (50%) and excitement/challenge (48%). Associations were found between PGSI risk categories and reasons for gambling: excitement/challenge ( $\chi^2_4 = 59.22$ ,  $p < 0.001$ ,  $V = 0.460$ ), interest/hobby ( $\chi^2_4 = 3.63$ ,  $p < 0.001$ ,  $V = 0.363$ ), to escape problems ( $\chi^2_4 = 28.72$ ,  $p < 0.001$ ,  $V = 0.320$ ) and addiction/compulsion ( $\chi^2_4 = 29.87$ ,  $p < 0.001$ ). *Post hoc* analysis indicated that each reason was significantly more likely to be given by problem gamblers (each  $p < 0.005$ ).

### 3.6 | Currency used for gambling

The most common currencies used in gambling in prison were food, with canteen food such as sweets/chocolate being the most popular (44%, 39% respectively), with some prisoners using mixed economies. Cash was used by almost a third of those who gambled ( $n = 40$ , 32%). Other canteen items ( $n = 35$ , 28%), cigarettes ( $n = 31$ , 25%), drugs ( $n = 16$ , 13%), drinks ( $n = 16$ , 13%), stamps ( $n = 0$ , 8%), alcohol ( $n = 6$ , 5%), services ( $n = 5$ , 4%), dares ( $n = 6$ , 5%) and favours/promises ( $n = 3$ , 2%) were also gambled. There were no significant associations between PGSI risk group and type of currency gambled.

TABLE 3 Prevalence of gambling in prison ( $n = 282$ )

Characteristic	PGSI group (before prison)				Moderate risk gambling	Problem gambling	Test statistic	p-value	Effect size (Cramer's V/ partial Eta squared $\eta_p^2$ )
	Non-gambling	Non-problem gambling	Low risk gambling	Moderate risk gambling					
Gambled in prison, yes $n$ (%)	10 (7.9) <sup>v</sup>	25 (19.8)	28 (22.2)	28 (22.2)	35 <sup>^</sup> (27.8)	$\chi^2$ (4) = 85.30	<0.001*	0.552	
Gambling as a normal part of prison life, yes $n$ (%)	19 (23.5)	12 (14.8)	14 (17.3)	17 (21.0)	19 (23.5)	$\chi^2$ (4) = 15.49	0.004*	0.241	
Mean gambling engagement per week in prison mean (SD)	0.07 (0.3)	0.23 (0.4)	0.83 (1.6)	0.94 (0.9)	1.89 (2.0)	$F$ (4, 237) = 19.47	<0.001*	0.247	
Borrowed in order to gamble (yes $n$ (%))	0 (0.0)	1 (4.2)	2 (7.4)	5 (7.8)	15 (45.4)	N/A <sup>^</sup>	<0.001*	N/A <sup>^</sup>	

Abbreviation: PGSI, Problem Gambling Severity Index.

\*Indicates significance at 0.005 level.

<sup>^</sup>Significantly higher than expected based on adjusted standardised residuals.

<sup>v</sup>Significantly lower than expected based on adjusted standardised residuals.

<sup>+</sup>Fishers exact test was utilised due to low cell counts.

### 3.7 | Borrowing in order to gamble

Of those who reported that they gambled in prison, 23 (19%) reported that they borrowed money from other prisoners in order to gamble. The majority of these were in the problem gambling category, where just under half had borrowed. There was a significant association between borrowing in prison and PGSI risk categories ( $p < 0.001$ ; Table 3). Of those who had borrowed in prison, 13 (57%) reported still owing what they borrowed.

## 4 | DISCUSSION

This research investigated links between problem gambling prior to entering prison, measured by the PGSI, and engagement in gambling within prison. Just under two-thirds of prisoners reported gambling prior to prison; over a quarter reported moderate gambling risk or problem gambling. Figures were lower for in-prison gambling (45%). Thus, figures for both are in line with previous research suggesting that people in prison are much more likely to have problems with gambling than the general public, where rates are 4%–6% (NHS Digital, 2019). The prevalence of problem gambling was marginally higher within prison than that suggested in previous research in English prisons (12%; May-Chahal et al., 2017).

Previous research has indicated a link between offence type and gambling overall such that people who gamble are typically non-violent and financially motivated (Abbott & McKenna, 2005; Turner et al., 2009). Our current research, however, indicated no link between the severity of gambling and likelihood of a particular offence type. All participants who indicated that gambling was related to their offence, however, were in the problem gambling group. While it is acknowledged that this was a small proportion of the overall sample, possibly due to a failure to recognise the link between gambling and offence committed (Perrone et al., 2013), this adds to previous literature that problem gambling can be related to offending behaviour (Riley et al., 2018). The findings support the notion that crime and gambling should be addressed simultaneously within prison settings, that routine screening should be undertaken on arrival at prison, and that more prevalent types of gambling (such as gambling machines, casinos and online gambling) may warrant targeted treatment.

Just under half of respondents reported gambling in prison, but this meant that over a third of those who had gambled before imprisonment did not do so inside, while some who had not previously gambled took it up. We believe our study is the first to identify such changes in prevalence from pre-custody to within custody. Further research is required to determine the underlying reasons why some people who gamble prior to custody cease gambling on entry, and whether they continue to abstain upon release, and why some people who do not gamble prior to custody commence gambling within custody only to pass the time or whether this continues post-release. Such information is likely to be useful in informing treatment or other interventions for people who gamble and become involved with the criminal justice system. There was an association of gambling in prison and prior PGSI risk group, so our third hypothesis—that prior risky gambling would increase the risk of gambling in prison is sustained.

Over 30% of participants reported that gambling is a normal part of prison life, with no association between such reporting and problem gambling risk groups. Nevertheless, the normality of in-prison gambling is supported by previous research which suggests that it may be a significant part of prison sub-culture (Williams & Hinton, 2006). Card/dice games, sports and ball games were the most common types of gambling in prison with no association with PGSI risk type. By contrast, one subtype—gambling on people's behaviour—was associated with the problem gambling risk category. It was not clear from our research whether gambling on people's behaviour was relatively benign in motivation (such as betting how long it takes for an officer to answer a cell bell or unlock a door) or had more violent connotations (such as betting on a prisoner's reaction to taking psychoactive substances, or betting on the outcome of a fight between prisoners) and this would require further research. This also tends to fit with our fourth hypothesis, that subtypes of gambling would be associated with different levels of risk. In this context, grouping by gambling risk was indicative of differential gambling behaviour and motives. Winning prizes, excitement/challenge and relieving boredom were the most common reasons

cited for gambling in prison and all were more commonly endorsed by the problem gambling category. This is broadly similar to Williams and Hinton's (2006) finding, albeit exclusively with people convicted of sexual offences, that those who gambled did so due to boredom and lack of recreation, risk and excitement. These findings suggest that providing more challenging activities and pro-social sources of competition within prisons may help to reduce gambling in prisons.

Food items and cash were most commonly gambled in prison but with no significant associations with PGSI risk categories. Basic food is freely available within prisons, but additional canteen items are purchases and so this currency may be of concern if people were getting into debt or going without food due to gambling behaviour. By contrast, gambling with cash is of considerable concern here since this either would involve illegally holding cash within the prison (prisons in the England and Wales are cashless, all monetary transactions occur electronically), or, more likely, involvement of a third party (such as a partner or other family member) to arrange bank transfers outside of the prison. Ramanauskas (2020) reported anecdotal evidence that partners of people who gamble may commit crimes in order to raise money to try to pay off gambling debts. Further research is required into the use of cash for in-prison gambling, but is likely to be difficult as where prisoners are gambling for financial gain, this constitutes a breach of prison rules in England and Wales (HM Prison and Probation Service, 2020).

One in five prisoners, mostly in the problem gambling PGSI category prior to prison, reported borrowing from other prisoners to support their in-prison gambling and, of those who had borrowed, over half had not repaid the debt (all in the problem gambling category). This supports the fifth hypothesis that borrowing would be associated with increased gambling risk category. It also raises significant concerns about the risk of victimisation as a result of outstanding gambling debts. Previous research has found evidence of violence associated with gambling related debt, as well as the accumulation of interest for unpaid debts (Williams & Hinton, 2006). In addition, having a debt and being in prison are factors which have been repeatedly, independently linked to poor mental health (e.g. Fazel et al., 2016; Fitch et al., 2011), therefore holding a debt in prison is likely to have a double burden on mental health. Previous research into suicide and self-harm in prisons (e.g. Prisons and Probation Ombudsman, 2015) does not appear to have specifically investigated the influence of gambling-related debts, and future research should explore this.

## 4.1 | Limitations

Whilst the current study provides new information about the nature of gambling in prison, it is not without limitations. The main limitation is that this was a cross-sectional study which does not allow for the inference of causation and has not allowed for the mapping of changes in gambling behaviour over the course of an individual's contact with the prison system. Longitudinal research to survey people pre-prison, on arrival at prison, and during the sentence, would be beneficial to establish change over time, and reasons for this. Secondly, the data were collected from a single prison site. Prisons vary in the diversity of their populations with regard to factors including demographics, offence type and length of stay, depending on their function and security category, and therefore the data may not be representative across prisons. Further research across a wider selection of prisons is required.

## 5 | CONCLUSIONS

Little research has attempted to chart the life course of gambling from community to prison. In a quasi-longitudinal study, in contrast to prior research we found no clear relationship between type of offending and gambling. Further, it was clear that gambling prior to imprisonment was not always associated with continued gambling in prison. We did, however, find that distinguishing between high-risk gambling—intruding into everyday life—and low risk gambling was helpful. Risk categories were related to different gambling behaviours and different gambling motives. As some in-prison gambling was associated with high risk behaviours, for example, breaching prison rules, being in debt, and

others have linked these consequences to violence, poor mental health and suicide-related behaviours, it is important to extend this research to identify those particularly at gambling risk in prison. Future research would be strengthened using a longitudinal design across multiple prison sites.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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## REFERENCES

- Abbott, M. W., & McKenna, B. G. (2005). Gambling and problem gambling among recently sentenced women in New Zealand prisons. *Journal of Gambling Studies*, 21(4), 559–581. <https://doi.org/10.1007/s10899-005-5563-5>
- Abbott, M. W., McKenna, B. G., & Giles, L. C. (2005). Gambling and problem gambling among recently sentenced male prisoners in four New Zealand prisons. *Journal of Gambling Studies*, 21(4), 537–558. <https://doi.org/10.1007/s10899-005-5562-6>
- Abbott, M. W., & Volberg, R. A. (1999). *Gambling and problem gambling in the community: An international overview and critique*. Wellington Department of International Affairs.
- American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders (DSM-5®)*. American Psychiatric Pub.
- April, L. M., & Weinstock, J. (2017). The relationship between gambling severity and risk of criminal recidivism. *Journal of Forensic Sciences*, 63(4), 1201–1206. <https://doi.org/10.1111/1556-4029.13662>
- Atherton, F., & Beynon, C. (2019). Is gambling an emerging public health issue for Wales, UK? *Journal of Public Health*, 41(4), 858–863. <https://doi.org/10.1093/pubmed/fdy164>
- Bath, C., & Edgar, K. (2010). *Time is money: Financial responsibility after prison*. Prison Reform Trust.
- Beasley, T. M., & Schumacker, R. E. (1995). Multiple regression approach to analysing contingency tables: Posthoc and planned comparison procedures. *The Journal of Experimental Education*, 64(1), 79–93. <https://doi.org/10.1080/00220973.1995.9943797>
- Beauregard, V., & Brochu, S. (2013). Gambling in prison: Addiction or leisure activity? *International Gambling Studies*, 13(2), 160–175. <https://doi.org/10.1080/14459795.2012.745162>
- Blaszczyński, A., & Nower, L. (2002). A pathways model of problem and pathological gambling. *Addiction*, 97(5), 487–499. <https://doi.org/10.1046/j.1360-0443.2002.00015.x>
- Calado, F., & Griffiths, M. D. (2016). Problem gambling worldwide: An update and systematic review of empirical research (2000–2015). *Journal of Behavioral Addictions*, 5(4), 592–613. <https://doi.org/10.1556/2006.5.2016.073>
- Cholz, M. (2010). Mobile phone addiction: A point of issue. *Addiction*, 105(2), 373–374.
- Cowlshaw, S., & Kessler, D. (2016). Problem gambling in the UK: Implications for health, psychosocial adjustment and health care utilization. *European Addiction Research*, 22(2), 90–98. <https://doi.org/10.1159/000437260>
- Delfabbro, P. (2013). Problem and pathological gambling: A conceptual review. *The Journal of Gambling Business and Economics*, 7(3), 35–53. <https://doi.org/10.5750/jgbe.v7i3.817>
- Fazel, S., & Baillargeon, J. (2011). The health of prisoners. *The Lancet*, 377(9769), 956–965. [https://doi.org/10.1016/S0140-6736\(10\)61053-7](https://doi.org/10.1016/S0140-6736(10)61053-7)
- Fazel, S., & Danesh, J. (2002). Serious mental disorder in 23000 prisoners: A systematic review of 62 surveys. *Lancet (London, England)*, 359(9306), 545–550. [https://doi.org/10.1016/S0140-6736\(02\)07740-1](https://doi.org/10.1016/S0140-6736(02)07740-1)
- Fazel, S., Grann, M., King, B., & Hawton, K. (2010). Prison suicide in 12 countries: An ecological study of 861 suicides during 2003–2007. *Social Psychiatry and Psychiatric Epidemiology*, 46(13), 191–195. <https://doi.org/10.1007/s00127-010-0184-4>
- Fazel, S., Hayes, A. J., Bartellas, K., Clerici, M., & Trestman, R. (2016). Mental health of prisoners: Prevalence, adverse outcomes, and interventions. *The Lancet Psychiatry*, 3(9), 871–881. [https://doi.org/10.1016/S2215-0366\(16\)30142-0](https://doi.org/10.1016/S2215-0366(16)30142-0)
- Ferris, J. A., & Wynne, H. J. (2001). *The Canadian Problem Gambling Index* (pp. 1–59). Canadian Centre on substance abuse.
- Fitch, C., Hamilton, S., Bassett, P., & Davey, R. (2011). The relationship between personal debt and mental health: A systematic review. *Mental Health Review Journal*, 16(4), 153–166. <https://doi.org/10.1108/13619321111202313>
- Gambling Act. (2005). c.19. Retrieved from <https://www.legislation.gov.uk/ukpga/2005/19/section/3>
- Grant, J. E., Schreiber, L., Odlaug, B. L., & Kim, S. W. (2010). Pathologic gambling and bankruptcy. *Comprehensive Psychiatry*, 51(2), 115–120. <https://doi.org/10.1016/j.comppsy.2009.04.002>
- HM Prison and Probation Service. (2020). Prison Service Instruction 01/2012 (updated) Manager Prisoner Finance. Retrieved from [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/932666/psi-01-2012-manage-prisoner-finance2.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/932666/psi-01-2012-manage-prisoner-finance2.pdf)

- Home Office. (2011). *Crime in England and Wales 2010/11*. Home Office.
- Ledgerwood, D. M., & Petry, N. M. (2004). Gambling and suicidality in treatment-seeking pathological gamblers. *The Journal of Nervous and Mental Disease*, 192(10), 711–714. <https://doi.org/10.1097/01.nmd.0000142021.71880.ce>
- Lorains, F. K., Cowlshaw, S., & Thomas, S. A. (2011). Prevalence of comorbid disorders in problem and pathological gambling: Systematic review and meta-analysis of population surveys. *Addiction*, 106(3), 490–498. <https://doi.org/10.1111/j.1360-0443.2010.03300.x>
- Marshall, M., Balfour, R., & Kenner, A. (1997). Pathological gambling: Prevalence, type of offence, comorbid psychopathology and demographic characteristics in a prison population. Retrieved from <https://www.pc.gov.au/inquiries/completed/gambling/submissions/sub116/sub116.pdf>
- May-Chahal, C., Humphreys, L., Clifton, A., Francis, B., & Reith, G. (2017). Gambling harm and crime careers. *Journal of Gambling Studies*, 33(1), 65–84. <https://doi.org/10.1007/s10899-016-9612-z>
- McGee, D. (2020). *On the normalisation of online sports gambling among young adult men in the UK: A public health perspective*. Public Health.
- McGrath, J. (2018). Home for good: Ending cycles of homelessness and prison. Retrieved from <https://www.wcmt.org.uk/sites/default/files/report-documents/McGrath%20J%20Report%202017%20Final.pdf>
- Ministry of Justice. (2020). PSI 40/2011: Categorisation and recategorisation of adult male prisoners 1<sup>st</sup> revision. Retrieved from <https://www.justice.gov.uk/downloads/offenders/psipso/psi-2011/psi-40-2011-categorisation-adult-males.doc>
- Ministry of Justice. (2022). Population bulletin: Weekly 19th August 2022. Retrieved from <https://www.gov.uk/government/publications/prison-population-figures-2022>
- NHS Digital. (2019). Health Survey for England 2018 Adult's health-related behaviours. Retrieved from <https://files.digital.nhs.uk/A3/2F03E4/HSE18-Adult-Health-Related-Behaviours-rep-v2.pdf>
- Perrone, S., Jansons, D., & Morrison, L. (2013). *Problem gambling and the criminal justice system*. Victorian Responsible Gambling Foundation.
- Petry, N. M. (2005). Comorbidity of disordered gambling and other psychiatric disorders. In N. Petry (Ed.), *Pathological gambling: Etiology, comorbidity and treatment*. American Psychological Association.
- Petry, N. M. (2007). Gambling and substance use disorders: Current status and future directions. *The American Journal on Addictions*, 16(1), 1–9. <https://doi.org/10.1080/10550490601077668>
- Petry, N. M., & Weinstock, J. (2007). Internet gambling is common in college students and associated with poor mental health. *American Journal on Addictions*, 16(5), 325–330. <https://doi.org/10.1080/10550490701525673>
- Potenza, M. N., Steinberg, M. A., & Wu, R. (2005). Characteristics of gambling helpline callers with self-reported gambling and alcohol use problems. *Journal of Gambling Studies*, 21(3), 233–254. <https://doi.org/10.1007/s10899-005-3098-4>
- Prisons and Probation Ombudsman. (2015). Learning from PPO Investigations: Self-inflicted deaths of prisoners 2013/14. Retrieved from <https://s3-eu-west-2.amazonaws.com/ppo-prod-storage-1g9rkjhjkgmw/uploads/2015/03/self-inflicted-deaths-2013-14-Final-for-publication-5.pdf>
- Public Health England. (2021). Gambling-related harms evidence review: Summary. Retrieved from <https://www.gov.uk/government/publications/gambling-related-harms-evidence-review/gambling-related-harms-evidence-review-summary>
- Ramanauskas, S. (2020). Crime and problem gambling: A research landscape. Retrieved from <https://howardleague.org/wp-content/uploads/2020/05/Crime-and-problem-gambling-research-landscape.pdf>
- Riley, B. J., Larsen, A., Battersby, M., & Harvey, P. (2018). Problem gambling among Australian male prisoners: Lifetime prevalence, help-seeking, and association with incarceration and aboriginality. *International Journal of Offender Therapy and Comparative Criminology*, 62(11), 3447–3459. <https://doi.org/10.1177/0306624x17740557>
- Roberts, A., Sharman, S., Coid, J., Murphy, R., Bowden-Jones, H., Cowlshaw, S., & Landon, J. (2017). Gambling and negative life events in a nationally representative sample of UK men. *Addictive Behaviors*, 75, 95–102. <https://doi.org/10.1016/j.addbeh.2017.07.002>
- Ronzitti, S., Soldini, E., Smith, N., Bayston, A., Clerici, M., & Bowden-Jones, H. (2018). Are treatment outcomes determined by type of gambling? A UK study. *Journal of Gambling Studies*, 34(3), 987–997. <https://doi.org/10.1007/s10899-018-9752-4>
- Sharman, S., Dreyer, J., Aitken, M., Clark, L., & Bowden-Jones, H. (2015). Rates of problematic gambling in a British homeless sample: A preliminary study. *Journal of Gambling Studies*, 31(2), 525–532. <https://doi.org/10.1007/s10899-014-9444-7>
- Sharman, S., Murphy, R., Turner, J., & Roberts, A. (2019). Trends and patterns in UK treatment seeking gamblers: 2000–2015. *Addictive Behaviors*, 89, 51–56. <https://doi.org/10.1016/j.addbeh.2018.09.009>
- Sztainert, T. (2018). *Greco Brief: Gambling in the DSM and ICD*. Greco. Retrieved from [https://www.greco.ca/Modules/EvidenceCentre/files/Sztainert%20\(2018\)%20Gambling%20in%20the%20DSM%20and%20ICD.pdf](https://www.greco.ca/Modules/EvidenceCentre/files/Sztainert%20(2018)%20Gambling%20in%20the%20DSM%20and%20ICD.pdf)
- Turner, N. E., Preston, D. L., Saunders, C., McAvoy, S., & Jain, U. (2009). The relationship of problem gambling to criminal behavior in a sample of Canadian male federal offenders. *Journal of Gambling Studies*, 25(2), 153–169. <https://doi.org/10.1007/s10899-009-9124-1>

- Wardle, H., Griffiths, M. D., Orford, J., Moodey, A., & Volbery, R. (2012). Gambling in Britain: A time of change? Health implications from the British Gambling Prevalence Survey 2010. *International Journal of Mental Health and Addiction*, 10(2), 273–277. <https://doi.org/10.1007/s11469-011-9319-4>
- Wardle, H., Moody, A., Spence, S., Orford, J., Volberg, R., Jotangia, D., Griffiths, M., Hussey, D., & Dobbie, F. (2011). *British Gambling Prevalence Survey 2010*. National Centre for Social Research.
- Wardle, H., Reith, G., Langham, E., & Rogers, R. D. (2019). Gambling and public health: We need policy action to prevent harm. *BMJ*, 365, l1807. <https://doi.org/10.1136/bmj.l1807>
- Welte, J., Barnes, G., Wieczorek, W., Tidwell, M. C., & Parker, J. (2001). Alcohol and gambling pathology among U.S. Adults: Prevalence, demographic patterns and comorbidity. *Journal of Studies on Alcohol*, 62(5), 706–712. <https://doi.org/10.15288/jsa.2001.62.706>
- Westphal, J., Rush, J., Stevens, L., Horswell, R., & Johnson, L. J. (1998). *Final report: Statewide baseline survey pathological gambling and substance abuse Louisiana adolescents (6th–12th grades school year 96–97)*. Louisiana Department of Health and Hospitals, Office of Alcohol and Drug Abuse.
- Williams, D. J., & Hinton, M. L. (2006). Leisure experience, prison culture, or victimization? Sex offenders report on prison gambling. *Victims & Offenders*, 1(2), 175–192. <https://doi.org/10.1080/15564880600626155>
- Williams, R. J., Royston, J., & Hagen, B. (2005). Gambling and problem gambling within forensic population: A review of the literature. *Criminal Justice & Behavior: An International Journal*, 32(6), 665–689. <https://doi.org/10.1177/0093854805279947>
- World Health Organisation. (2019). International statistical classification of diseases and related health problems (11th ed.). Retrieved from <https://icd.who.int/>

**How to cite this article:** Smith, L. R., Sharman, S., & Roberts, A. (2022). Gambling and Crime: An exploration of gambling availability and culture in an English prison. *Criminal Behaviour & Mental Health*, 32(6), 389–403. <https://doi.org/10.1002/cbm.2266>