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ORIGINAL ARTICLE

# Estimated verbal IQ and the odds of problem gambling: a population-based study

**D. Rai[1,2]*, W. Hall[3,4], P. Bebbington[5], P. Skapinakis[1], A. Hassiotis[5], S. Weich[6], H. Meltzer[7]†, P. Moran[8], T. Brugha[7], A. Strydom[5] and M. Farrell[9]**

[1] *Centre for Mental Health, Addiction and Suicide Research, School of Social and Community Medicine, University of Bristol, UK*
[2] *Avon and Wiltshire Partnership NHS Mental Health Trust, UK*
[3] *UQ Centre for Clinical Research, The University of Queensland, Royal Brisbane and Women's Hospital, Queensland, Australia*
[4] *National Addiction Centre, King's College London, UK*
[5] *UCL Mental Health Sciences Unit, London, UK*
[6] *Division of Mental Health and Wellbeing, Warwick Medical School, University of Warwick, Coventry, UK*
[7] *Department of Health Sciences, College of Medicine, Biological Sciences and Psychology, University of Leicester, UK*
[8] *Institute of Psychiatry, King's College London, UK*
[9] *National Drug and Alcohol Research Centre, University of New South Wales, Australia*

**Background.** The neurocognitive deficits and other correlates of problem gambling are also observable in individuals with lower cognitive abilities, suggesting that a low IQ may be a determinant of problem gambling. There has been very little research into this possibility. This study aimed to investigate the characteristics associated with problem gambling in a large population-based study in England, with a particular focus on IQ.

**Method.** The Adult Psychiatric Morbidity Survey (APMS) 2007 comprised detailed interviews with 7403 individuals living in private households in England. Problem gambling was ascertained using a questionnaire based on DSM-IV criteria. Verbal IQ was estimated using the National Adult Reading Test (NART). Confounders included socio-economic and demographic factors, common mental disorders, impulsivity, smoking, and hazardous drug and alcohol use.

**Results.** More than two-thirds of the population reported engaging in some form of gambling in the previous year, but problem gambling was rare [prevalence 0.7%, 95% confidence interval (CI) 0.5–1.0]. The odds of problem gambling doubled with each standard deviation drop in estimated verbal IQ [adjusted odds ratio (OR) 2.1, 95% CI 1.3–3.4, $p=0.003$], after adjusting for other characteristics associated with problem gambling including age, sex, socio-economic factors, drug and alcohol dependence, smoking, impulsivity and common mental disorders. There was no strong relationship observed between IQ and non-problem gambling.

**Conclusions.** People with lower IQs may be at a higher risk of problem gambling. Further work is required to replicate and study the mechanisms behind these findings, and may aid the understanding of problem gambling and inform preventative measures and interventions.

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**Key words:** Addiction, epidemiology, gambling, impulse control disorders, intelligence, IQ.

## Introduction

Although gambling for recreation is common in many societies, some individuals develop problem gambling, which 'disrupts or damages family, personal or other recreational pursuits' (Wardle *et al.* 2011). Problem gambling is considered to lie on a continuum with pathological gambling (Shaffer & Martin, 2011; Wardle *et al.* 2011) and is classified as an impulse control disorder in DSM-IV (APA, 2000), with similarities to addiction disorders (Goudriaan *et al.* 2006; Shaffer & Martin, 2011). Gambling problems are associated with significant individual and societal costs (Bowden-Jones & George, 2011). Although causal relationships are difficult to establish, the societal and economic costs of problem gambling include those related to incurred debt and household financial stress, reduced productivity, absenteeism and unemployment, divorce, domestic violence and other criminal behaviours (Reith, 2006; Walker, 2007; Victorian Competition and Efficiency Commission, 2012). Between five and 10 individuals including family members, friends, co-workers and family members are estimated to be adversely

* Address for correspondence: Dr D. Rai, Centre for Mental Health, Addiction and Suicide Research, School of Social and Community Medicine, University of Bristol, Oakfield House, Oakfield Grove, Clifton, Bristol BS8 2BN, UK.
(Email: Dheeraj.rai@bristol.ac.uk)
† Deceased.

affected by each individual problem gambler (Reith, 2006). Such costs are difficult to quantify and have been estimated as between US$9300 and US$53 000 per annum for each problem gambler (Walker, 2007). However, it is recognized that these costs may be imprecise and underestimated and further research is required to quantify direct and indirect costs of problem gambling (Reith, 2006; Walker, 2007).

Population-based surveys have established that problem gamblers are more likely to occupy lower socio-economic positions in society (Gotestam & Johansson, 2003; Welte *et al.* 2004; Kessler *et al.* 2008; Bakken *et al.* 2009; Afifi *et al.* 2010; Tavares *et al.* 2010), have mental health problems (Petry *et al.* 2005; Kessler *et al.* 2008; Lorains *et al.* 2011), experience disabilities (Morasco & Petry, 2006) and report alcohol and substance misuse (Welte *et al.* 2004; Petry *et al.* 2005; Kessler *et al.* 2008; Lorains *et al.* 2011; Shaffer & Martin, 2011).

Mechanisms predisposing individuals to problem gambling are not well established but include a range of neurocognitive deficits and distortions (Goudriaan *et al.* 2004; Xian *et al.* 2008), such as greater impulsivity (Forbush *et al.* 2008), a preference for smaller but immediate rewards over larger delayed ones (Dixon *et al.* 2003) and an impaired ability to learn from previous experience (Goudriaan *et al.* 2005). Many of the characteristics associated with problem gambling are also observable in individuals with a lower general cognitive ability or intelligence, most commonly measured by IQ tests (Shamosh *et al.* 2008; Lubinski, 2009). It is therefore plausible that deficits in general cognitive ability (i.e. a lower IQ) may be associated with a higher risk of problem gambling. However, there is very little research testing this possibility, particularly in representative samples. Clarification of this issue may advance our understanding of the causes of problem gambling, and help to identify high-risk groups and plan protective approaches and targeted interventions. We therefore investigated correlates of problem gambling in a large population-based study in England, focusing on IQ while controlling for potentially important characteristics including socio-economic circumstances, impulsive and addictive behaviours, and mental health problems.

## Method

### *The Adult Psychiatric Morbidity Survey (APMS) 2007*

The APMS 2007 was designed to assess the mental health of a representative sample of the population aged ⩾16 years, living in private households in England. A multistage stratified probability sampling design was used. The Royal Mail's Small User Postcode Address File (PAF) was the sampling frame, with postcode sectors (comprising 2550 households on average) representing the primary sampling units. Postcode sectors were first stratified by Strategic Health Authorities (SHAs). All the primary sampling units within each SHA were then further stratified on the basis of the proportion of persons in non-manual classes, and sorted by the proportion of households without a car based on 2001 Census data. Postal sectors were then sampled from each stratum with a probability proportional to size, and 519 were thereby selected. Within these postal sectors, 28 delivery points were randomly chosen, yielding a total of 14 532 delivery points. Interviewers visited these addresses to identify private households with at least one person aged ⩾16 years. Within the potentially eligible sample of 12 694 addresses, one person from each household where contact was made was randomly chosen to take part in the survey, and 7461 (57%) individuals agreed to be interviewed (69% of those successfully contacted). The fieldwork was completed between October 2006 and December 2007. The interviews were carried out by experienced National Centre for Social Research (NatCen) interviewers, many of whom had worked previously on health-related surveys. They were briefed and trained on the administration of all modules of the survey and were provided with full sets of written instructions. As the fieldwork took place over the course of 1 year, interviewers who took a break from the survey for 4 months or more were provided with refresher sessions. A project supervisor accompanied all interviewers during the early stages of their fieldwork to ensure that the interviews were administered correctly. In subsequent interviews, routine supervision of 10% of interviewer work was carried out. Complete details of the survey methodology are available elsewhere (McManus *et al.* 2009).

### *Ascertainment of problem gambling*

A questionnaire based on the 10 DSM-IV diagnostic criteria for pathological gambling (see Table 1) was administered using computer-assisted self-interviewing. Although there is no agreed gold standard instrument to measure pathological or problem gambling, the DSM-IV screening instrument was used so that the results could be compared with those of the British Gambling Prevalence Surveys (BGPS), which use a similar methodology (Wardle *et al.* 2011). The questions related to gambling in the APMS were divided into two sections. The first section established whether the individual had spent any money on gambling in the previous year. Participants were given

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**Table 1.** *DSM-IV criteria for pathological gambling and the gambling questions included in the survey*

| |
|---|
| (1) Preoccupation with gambling<br>Are you preoccupied with gambling (e.g. preoccupied with reliving past gambling experiences or planning the next venture, or thinking of ways to get money with which to gamble)? |
| (2) Needing to gamble with increasing amounts of money<br>Do you need to gamble with increasing amounts of money to achieve the desired excitement? |
| (3) Repeated unsuccessful efforts to cut back or stop gambling<br>Have you made repeated unsuccessful efforts to control, cut back, or stop gambling? |
| (4) Feeling restless or irritable when attempting to cut down or stop gambling<br>Are you restless or irritable when attempting to cut down or stop gambling? |
| (5) Gambling as a way of escaping from problems or relieving a dysphoric mood<br>Do you gamble as a way of escaping from problems or relieving feelings of helplessness, guilt, anxiety or depression? |
| (6) After losing money, often returning to gamble in order to get even<br>After losing money gambling, do you often return another day to get even? |
| (7) Lying to conceal the extent of involvement with gambling<br>Do you lie to family members, therapists, or to others to conceal the extent of involvement with gambling? |
| (8) Committing illegal acts to finance gambling.<br>Have you committed illegal acts such as forgery, fraud, theft, or embezzlement to finance gambling? |
| (9) Jeopardizing a significant relationship, job, or opportunity because of gambling.<br>Have you jeopardized or lost a significant relationship, job, or educational or career opportunity because of gambling? |
| (10) Relying on others to provide money to relieve a desperate financial situation caused by gambling.<br>Do you rely on others to provide money to relieve a desperate financial situation caused by gambling? |

examples of gambling activities that included buying lottery tickets or scratch cards; playing games or making bets for money on the internet; playing football pools, bingo or fruit machines; playing games or making bets with friends for money; betting on races (with/without a bookmaker); and casino gaming. Participants were then asked: 'Have you spent any money on any of these things in the last 12 months?' Those who answered 'yes' were administered the problem gambling screen based on the 10 DSM-IV criteria. Those who answered 'no' were asked a check question about whether they had gambled just occasionally in the past year, such as buying a lottery ticket or scratch card. Individuals reporting occasional gambling in this additional question were also administered the problem gambling screen. The numbers of DSM-IV criteria endorsed in the screen were summed to generate a score (those who had not gambled in the past year were assigned a score of zero). As in the BGPS and other similar studies (Gotestam & Johansson, 2003; Bakken *et al.* 2009; Afifi *et al.* 2010; Brewer *et al.* 2010; Wardle *et al.* 2011), a score of $\geqslant 3$ was considered to indicate problem gambling. DSM-IV pathological gambling requires a score of $\geqslant 5$, but previous studies, including the BGPS, have generally identified too few cases for meaningful statistical analyses (Wardle *et al.* 2011).

### *Ascertainment of IQ*

The National Adult Reading Test (NART), a widely used validated measure for English speakers, was used to measure verbal IQ (Nelson, 1991; Crawford *et al.* 2001; Bright *et al.* 2002). The NART comprises a list of 50 words that respondents read out. The interviewer counts and records the number of reading errors made. A validated algorithm was used to convert this error score to a revised Wechsler Adult Intelligence Scale (WAIS-R) verbal IQ estimate [predicted WAIS-R verbal IQ = 127.4 – (1.14 × NART error score)] (Nelson, 1991). Participants whose first language was not English, and those who refused to complete the NART, were not administered the test. Respondents who indicated that they could not read the words because of poor eyesight or other problems such as dyslexia were not included in the verbal IQ calculation.

The NART is highly correlated with full-scale IQ scores on the WAIS-R and other IQ measures in clinical and non-clinical samples, and is thus a good proxy of general intellectual ability, which is particularly appropriate for large-scale population-based studies (Nelson, 1991; Crawford *et al.* 2001; Bright *et al.* 2002; Mathias *et al.* 2007; Spinks *et al.* 2009). NART scores are also largely unaffected by the presence of mental illness or neurological disorders, making them ideal for a mental health survey such as the APMS (Crawford *et al.* 2001; Bright *et al.* 2002; Ali *et al.* 2013). However, the NART scores are known to be less reliable at the extreme of the range, and it has been acknowledged that further work is required in assessing its validity in predicting IQ in individuals with borderline intellectual functioning (Nelson, 1991; Ali *et al.* 2013). For the present study, we used the verbal IQ scores in both continuous and categorical forms. For our primary analysis, we standardized the verbal IQ variable to have a mean of 0 and a standard deviation of 1. For secondary analysis, we categorized the predicted WAIS-R IQ scores into three bands (>100,

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86–100 and <85) to offset any imprecision in scores at the extremes of the IQ distribution.

### *Sociodemographic characteristics*

We included data on age (in years as a continuous variable), sex, highest education level [in three groups: (i) college or higher education, (ii) A-levels, O-levels, GCSEs or some qualifications and (iii) no qualifications]; accommodation tenure (owner occupier or living in rented accommodation); marital status [(i) married or cohabiting, (ii) single, widowed, divorced or separated] and occupational class based on the UK Registrar General's classification [coded as I/II (professionals or managerial professions), IIIa/IIIb (non-manual and manual skilled professions) and IV/V (semi-skilled or unskilled manual workers)].

### *Ethnicity*

Participants were asked to identify their ethnic group on a showcard detailing 15 ethnic groups and an additional 'other – please specify' category. For the purpose of the current study, we coded the participants into two broad categories of White and non-White because of the relatively low numbers in the groups comprising the latter category.

### *Ascertainment of a common mental disorder*

The revised Clinical Interview Schedule (CIS-R; Lewis *et al.* 1992), a structured psychiatric interview designed to be used by trained non-clinical interviewers, was used to assess the presence of a common mental disorder. The recommended threshold of $\geqslant$12 was used to identify people with enough neurotic symptoms to meet the ICD-10 diagnostic criteria (WHO, 1993) for one or more of the nine most common mental disorders including depressive, anxiety disorders and phobias (Lewis *et al.* 1992).

### *Impulsivity*

The Structured Clinical Interview for DSM-IV Axis II Disorders (SCID-II; Lobbestael *et al.* 2011) was self-completed by all participants. We identified those describing themselves as impulsive by endorsing an item 'Have you often done things impulsively' in relation to being asked to report on the 'kind of person you generally are'. Although this item seems to have good face validity, its properties in relation to other impulsivity screens is not known.

### *Ascertainment of hazardous and dependent alcohol use*

Hazardous alcohol use was identified by the Alcohol Use Disorders Identification Test (AUDIT; Saunders *et al.* 1993) using the Computer-Assisted Self-completion Interview (CASI). The AUDIT includes questions about hazardous drinking in the past year (frequency and quantity of alcohol use), indicators of harmful alcohol use (feelings of guilt or remorse related to alcohol, blackouts, alcohol-induced injury, concerns about alcohol consumption) and symptoms of dependence (impaired control over drinking, salience of drinking, morning drinking). The Severity of Alcohol Dependence Questionnaire (SADQC; Stockwell *et al.* 1994) was administered to all respondents scoring $\geqslant$10 on the AUDIT and enabled identification of alcohol dependence in the past 6 months. To capture both hazardous drinking and alcohol dependence, we combined scores from the AUDIT and SADQC to produce a variable indicating (i) no hazardous alcohol use, (ii) hazardous alcohol use but no dependence and (iii) alcohol dependence.

### *Ascertainment of illicit drug use and smoking*

Illicit drug use was also assessed using the CASI. Questions covered the past year use of eight drug types (cannabis, amphetamines, crack, cocaine, ecstasy, tranquilizers, opiates and volatile substances), followed by five questions based on the Diagnostic Interview Schedule (DIS; Malgady *et al.* 1992), designed to assess drug dependence. These included daily drug use for $\geqslant$2 weeks, a sense of need or dependence, an inability to abstain, increasing tolerance and withdrawal symptoms. We coded respondents into (i) no drug use, (ii) any drug use and (iii) dependent drug use in the past year. Participants were asked a series of questions about the amount and frequency of tobacco smoking and we divided individuals into (i) non-smokers, (ii) occasional smokers and (iii) regular smokers (>7 cigarettes/week).

### *Analysis*

All analyses were conducted using the 'survey' commands in Stata Statistical Software release 10.1 (Stata Corporation, USA). Probability weights derived by the APMS team were used to take account of the complex study design and non-response so that the results were representative in terms of age, sex, region and area characteristics of the household population aged $\geqslant$16 years in England. First, sample weights were applied to take account of the different probabilities of selecting respondents in different sized households. Second, to reduce household non-response bias, a household-level weight was calculated from a logistic regression model using interviewer observation and area-level variables (based on Census 2001 data) available for responding and non-responding households. The non-response weight for each household was

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calculated as the inverse of the probability of response estimated from the model, multiplied by the household's selection weight. Third, weights were applied using calibration weighting based on age, sex and region to weight the data to represent the structure of the national population, taking account of differential non-response between regions, and age × sex groups. The population control totals used were the Office for National Statistics (ONS) 2006 mid-year household population estimates. Complete details of the weighting procedures are available elsewhere (McManus *et al.* 2009). We used the probability weights to estimate the 1-year prevalence of non-problem and problem gambling in the general population of England. In descriptive analyses, we cross-tabulated mean IQ scores and other putative correlates with gambling status (no gambling, non-problem gambling or problem gambling in the past year).

We used multinomial logistic regression models to estimate the relationship between each standard deviation decrease in IQ score and the odds of non-problem gambling and problem gambling, compared with no gambling in the past year. The other correlates identified in previous research, or *a priori*, were included in the models irrespective of their statistical significance. Similarly, we estimated crude and adjusted estimates of associations between these other potential correlates of problem gambling. We conducted our main analysis on a dataset with complete responses on IQ and gambling variables, and included covariates with missing data in the regression models by coding an additional 'missing' category.

We repeated the analysis as follows: (1) using the categorical measure of IQ, (2) repeating analyses on males only, (3) repeating analyses by restricting the sample to individuals aged <65 years, (4) repeating all analyses on a dataset with complete data on all variables (i.e. dropping individuals with missing data in any of the covariates), and (5) repeating analyses after imputing missing values in each covariate with missing data with extreme values representing best- and worst-case scenarios for each covariate.

### *Ethical approval*

Ethical approval for use of the APMS 2007 was obtained from the Royal Free Hospital and Medical School Research Ethics Committee (Ref: 06/Q0501/71). The current paper is based on publicly available, anonymized data for research use.

## Results

Verbal IQ estimates were available for 6872 participants (92.8% of respondents). Complete data on gambling were available for 6827 of these individuals, who comprised our main analytic sample. Of this sample, 91.5% ($n$=6291) had complete data on all covariates. More than two-thirds [68.0%, 95% confidence interval (CI) 66.7–69.2] of the sample (weighted to represent the general population of England) reported some form of gambling in the previous year. However, problem gambling ($n$=36; weighted prevalence 0.7%, 95% CI 0.5–1.0) was rare, and pathological gambling rarer still ($n$=15; weighted prevalence 0.3%, 95% CI 0.2–0.5).

Table 2 shows the characteristics of problem gamblers, non-problem gamblers and people reporting no gambling in the past year. Problem gamblers had a much lower estimated mean verbal IQ (87.5) than non-problem gamblers (mean IQ=102.2) and non-gamblers (mean IQ=103.3). Problem gamblers were also more likely than non-problem gamblers or non-gamblers to be younger males with a variety of socio-economic disadvantages, to be regular smokers, to endorse often making impulsive decisions, to be hazardous drug and alcohol users, and to have a common mental disorder (Table 2).

Table 3 shows the characteristics associated with problem and non-problem gambling (compared with no past-year gambling) estimated by multinomial logistic regression models adjusted for age and sex in model 1, and all the variables in model 2. Each standard deviation drop in estimated verbal IQ was associated with a twofold increase in the odds of problem gambling [adjusted odds ratio (OR) 2.1, 95% CI 1.3–3.4, $p$=0.003]. Male sex, belonging to a social class other than I or II, White ethnicity, harmful use of alcohol, impulsivity and the presence of a common mental disorder were also associated with problem gambling in the adjusted analysis. By contrast, there was little evidence for any similar associations of non-problem gambling with lower IQ, and its associations with the other correlates were relatively weaker.

The associations between low verbal IQ and problem gambling remained robust in analysis using the categorical measure of IQ (Fig. 1). In the fully adjusted model, those with an estimated verbal IQ between 86 and 100 were four times (OR 4.1, 95% CI 1.4–12.5, $p$=0.012) and those with an IQ<85 were more than five times more likely (OR 5.6, 95% CI 1.9–16.7, $p$=0.002) to be problem gamblers than those with an IQ of>100, although the CIs were notably wide.

The associations persisted when the analysis was repeated in males only, in those aged<65 years, in a dataset with complete data on all covariates ($n$=6291), and in sensitivity analyses with missing data in covariates imputed at either extreme representing the best- or worst-case scenario (Fig. 2).

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**Table 2.** *Descriptive statistics of respondents with problem gambling, non-problem gambling and no gambling in the past year*

| | Problem gambling ($n$=36) | Non-problem gambling ($n$=4557) | No gambling ($n$=2234) | $p$ |
|---|---|---|---|---|
| Verbal IQ | | | | |
| Mean IQ (S.D.) | 87.5 (17.0) | 102.2 (14.7) | 103.3 (16.1) | <0.001 |
| IQ >100 | 15.8 | 55.2 | 59.3 | <0.001 |
| IQ 86–100 | 34.3 | 29.7 | 23.0 | |
| IQ <85 | 50.0 | 15.1 | 17.8 | |
| Age (years) | 37.8 | | 47.4 | <0.001 |
| Sex | | | | |
| Male | 84.8 | 51.5 | 40.5 | <0.001 |
| Female | 15.2 | 48.5 | 59.5 | |
| Marital status | | | | |
| Married | 46.5 | 66.0 | 57.6 | <0.001 |
| Not married | 53.5 | 34.0 | 42.4 | |
| Education | | | | |
| Degree or higher education | 13.6 | 24.2 | 31.6 | <0.001 |
| Other qualifications | 54.9 | 48.7 | 41.7 | |
| No qualifications | 30.5 | 25.6 | 25.1 | |
| Missing | 1.1 | 1.5 | 1.6 | |
| Tenure of accommodation | | | | |
| Owned occupier | 39.7 | 72.6 | 73.3 | 0.001 |
| Rented | 60.3 | 27.1 | 26.1 | |
| Missing | 0.0 | 0.3 | 0.6 | |
| Occupational class | | | | |
| I or II | 5.9 | 36.1 | 38.1 | <0.001 |
| IIIa/IIIb | 58.7 | 39.7 | 36.0 | |
| IV/V | 29.3 | 20.0 | 17.1 | |
| Missing | 6.2 | 4.2 | 8.8 | |
| Ethnicity | | | | |
| White | 98.6 | 95.7 | 92.3 | <0.001 |
| Non-White | 1.4 | 4.2 | 7.6 | |
| Missing | 0 | 0.1 | 0.1 | |
| Common mental disorder | | | | |
| Present | 48.5 | 15.1 | 17.3 | < 0.001 |
| Absent | 51.5 | 84.9 | 82.7 | |
| Endorsed impulsivity | | | | |
| Yes | 57.2 | 33.6 | 28.6 | <0.001 |
| No | 32.3 | 64.5 | 69.5 | |
| Missing | 10.5 | 1.9 | 1.9 | |
| Smoking | | | | |
| >7 cigarettes per week | 43.8 | 24.0 | 18.7 | <0.001 |
| <7 cigarettes per week | 27.0 | 45.9 | 41.1 | |
| Non-smoker | 29.3 | 30.1 | 40.0 | |
| Missing | 0.0 | 0.1 | 0.2 | |
| Alcohol use | | | | |
| Dependence | 21.3 | 6.8 | 4.5 | <0.001 |
| Hazardous use | 35.9 | 21.7 | 13.8 | |
| Non-hazardous use | 42.9 | 71.5 | 81.8 | |
| Illicit drug use | | | | |
| Dependent use | 21.7 | 3.5 | 3.3 | <0.001 |
| Non-dependent use | 9.1 | 6.3 | 5.2 | |
| No drug use | 67.8 | 90.1 | 91.3 | |
| Missing | 1.4 | 0.1 | 0.1 | |

Values given as mean (standard deviation) or weighted percentages, rounded to one decimal place.
The total $n$ (6827) represents respondents with complete data on IQ estimates and past year gambling.
Where missing data were present in a covariate, the percentage of these is reported within a separate row.

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**Table 3.** *Multinomial logistic regression models to ascertain correlates of problem gambling and non-problem gambling compared with no past year gambling*

| | Problem gambling in the past year | | Non-problem gambling in the past year | |
|---|---|---|---|---|
| | Model 1 | Model 2 | Model 1 | Model 2 |
| IQ (each S.D. decrease) | 2.5 (1.6–3.7)*** | 2.1 (1.3–3.4)** | 1.1 (1.0–1.1)* | 1.0 (1.0–1.1) |
| Age | 0.97 (0.95–0.99)** | 1.00 (0.97–1.03) | 1.00 (0.99–1.00) | 0.99 (0.99–1.00)** |
| Male sex | 8.0 (3.1–20.6)*** | 6.3 (2.2–17.7)** | 1.6 (1.4–1.7)*** | 1.4 (1.2–1.6)*** |
| Marital status | | | | |
| Married | 1.0 (Reference) | 1.0 (Reference) | 1.0 (Reference) | 1.0 (Reference) |
| Not married | 1.3 (0.5–3.2) | 0.8 (0.3–1.9) | 0.7 (0.6–0.8)*** | 0.7 (0.6–0.8)*** |
| Education | | | | |
| Degree or higher education | 1.0 (Reference) | 1.0 (Reference) | 1.0 (Reference) | 1.0 (Reference) |
| Other qualification | 2.6 (0.7–9.8) | 0.8 (0.2–3.0) | 1.5 (1.3–1.8)*** | 1.5 (1.3–1.8)*** |
| No qualifications | 4.9 (1.3–18.8)* | 0.6 (0.1–2.4) | 1.4 (1.2–1.7)*** | 1.6 (1.3–1.9)*** |
| Tenure of accommodation | | | | |
| Owner occupier | 1.0 (Reference) | 1.0 (Reference) | 1.0 (Reference) | 1.0 (Reference) |
| Rented accommodation | 3.9 (1.6–9.3)** | 2.1 (0.9–4.9) | 1.0 (0.9–1.2) | 1.1 (0.9–1.3) |
| Occupational class | | | | |
| I/II | 1.0 (Reference) | 1.0 (Reference) | 1.0 (Reference) | 1.0 (Reference) |
| IIIa or IIIb | 10.6 (2.8–41.1)*** | 5.9 (1.4–25.9)* | 1.2 (1.0–1.3)* | 1.0 (0.9–1.1) |
| IV or V | 12.6 (3.0–52.1)*** | 5.2 (1.2–22.3)* | 1.3 (1.1–1.5)*** | 1.1 (0.9–1.3) |
| Ethnicity | | | | |
| White | 1.0 (Reference) | 1.0 (Reference) | 1.0 (Reference) | 1.0 (Reference) |
| Non-White | 0.1 (0.0–0.9)* | 0.1 (0.0–0.8)* | 0.5 (0.4–0.7)*** | 0.6 (0.5–0.8)*** |
| Common mental disorder | | | | |
| Absent | 1.0 (Reference) | 1.0 (Reference) | 1.0 (Reference) | 1.0 (Reference) |
| Present | 5.4 (2.5–12.1)*** | 2.8 (1.1–7.0)* | 0.9 (0.8–1.0) | 0.8 (0.7–0.9)** |
| Impulsivity | | | | |
| Endorsed | 3.7 (1.6–8.6)** | 2.6 (1.0–6.3)* | 1.2 (1.1–1.4)*** | 1.2 (1.1–1.4)** |
| Smoking | | | | |
| Non-smoker | 1.0 (Reference) | 1.0 (Reference) | 1.0 (Reference) | 1.0 (Reference) |
| Less than 7 cigarettes/week | 0.9 (0.3–2.6) | 0.8 (0.3–2.1) | 1.5 (1.3–1.7)*** | 1.4 (1.2–1.6)*** |
| More than 7 cigarettes/week | 2.8 (1.0–7.5)* | 0.8 (0.3–1.9) | 1.7 (1.4–1.9)*** | 1.5 (1.2–1.7)*** |
| Alcohol use | | | | |
| Non-hazardous alcohol use | 1.0 (Reference) | 1.0 (Reference) | 1.0 (Reference) | 1.0 (Reference) |
| Hazardous alcohol use | 3.1 (1.1–8.5)* | 3.0 (1.1–7.9)* | 1.7 (1.4–2.0)*** | 1.6 (1.4–1.9)*** |
| Dependent alcohol use | 4.7 (1.6–13.9)** | 2.5 (0.9–6.7) | 1.6 (1.2–2.1)** | 1.5 (1.1–2.1)* |
| Illicit drug use | | | | |
| No drug use | 1.0 (Reference) | 1.0 (Reference) | 1.0 (Reference) | 1.0 (Reference) |
| Some drug use | 1.4 (0.3–5.6) | 1.4 (0.4–4.9) | 1.1 (0.8–1.5) | 1.0 (0.7–1.3) |
| Dependent drug use | 4.8 (1.3–18.6)* | 2.2 (0.5–9.1) | 1.0 (0.7–1.4) | 0.8 (0.6–1.2) |

S.D., Standard deviation.

Values given as odds ratios (95% confidence interval).

Model 1: adjusted for age and sex. Model 2: final model adjusted for all of the above variables.

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

## Discussion

In this large population-based study in England, problem gambling was strongly associated with estimates of a lower verbal IQ, and the association persisted after controlling for sociodemographic characteristics and measures of mental health, impulsivity and a range of addictive behaviours. There was a twofold increase in the odds of problem gambling with each standard deviation drop in estimated IQ.

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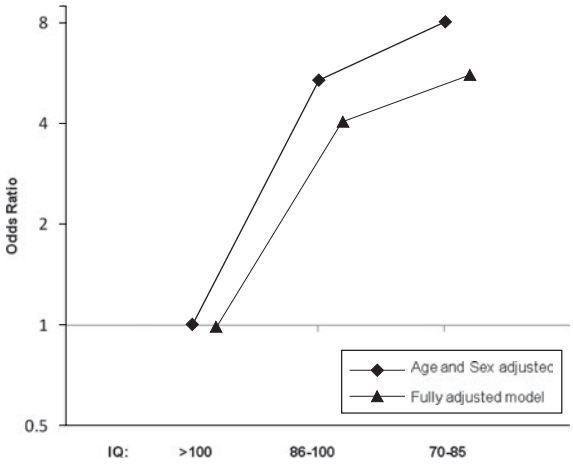


**Fig. 1.** The odds of problem gambling by IQ in three categories using multinomial logistic regression.

This association was not present in the larger proportion of the population reporting any (non-problem) gambling in the past year and remained robust in sensitivity analyses.

To our knowledge, this is the first population-based study to have assessed the association between a measure of IQ and problem gambling. Such relationships have been reported as incidental findings in two small studies in clinical populations (Forbush *et al.* 2008; Kaare *et al.* 2009) but these results were difficult to generalize because of the possibility of selection bias. Findings from an English cohort of 3750 young persons aged 17 years (the Avon Longitudinal Study of Parents and Children, ALSPAC) suggested that that an IQ of $\leqslant$85 was significantly associated with participation in regular gambling ($n$=354) (Emond *et al.* 2011). However, the numbers of individuals that could be defined as problem gamblers ($n$=9) were too low for a meaningful comparison with IQ.

Although previous population-based studies have not investigated the role of IQ, there is a growing body of literature on the other correlates of problem gambling that we investigated. Our results are consistent with previously reported associations of problem or pathological gambling with a younger age, male sex, socio-economic adversities, common mental disorders, and alcohol and substance use disorders (Kessler *et al.* 2008; Brewer *et al.* 2010; Lorains *et al.* 2011). In the present study, White individuals were more likely to report any gambling in the past year, consistent with findings from the BGPS, although the findings of problem gambling being more common in non-White ethnic groups was not replicated (Wardle *et al.* 2011). Longitudinal designs are required to clarify the direction of the reported associations because none of the above-mentioned cross-sectional studies, including ours, can make such inferences.

We found that almost two-thirds of the population reported gambling in the past year but less than 1% met the criteria for problem gambling. These estimates are consistent with those reported in the three previous BGPS that used identical criteria and a very similar methodology to our study (0.6% in 1999 and 2007 and 0.9% in 2010, with overlapping CIs) (Wardle *et al.* 2011). These results are also similar to those from other European countries (Gotestam & Johansson, 2003; Bondolfi *et al.* 2008; Bakken *et al.* 2009), but lower than lifetime and past 12-month prevalence rates in the USA (Kessler *et al.* 2008) and Canada respectively (Cox *et al.* 2005).

The main strengths of this study include the large population-based design, reducing the possibility of selection bias and ensuring high external validity of our results. Potential confounders including measures of mental health and addiction were measured using validated tools. The availability of such information is a significant advantage over the BGPS, which only collected data on demographic and socio-economic characteristics of problem gamblers (Wardle *et al.* 2011). The use of probability weights to account for the sampling and non-response ensured that the sample, irrespective of non-response, was broadly representative of the general population of England. The CASI used in the gambling and addictions modules of the face-to-face interview (whereby the respondent inputs their answers directly onto a laptop computer rather than communicating them to the interviewer) is known to encourage honest answers to sensitive questions, and would have minimized the possibility of reporting bias (Tourangeau *et al.* 2000).

Our study has several limitations. First, despite the large sample, the low prevalence of pathological gambling (0.3%) in the survey meant that, as in the BGPS, we maximized statistical power by examining the correlates of problem gambling. Even at the relaxed threshold, the low numbers resulted in relatively wide CIs, a problem common to almost all other population-based studies of problem gambling (Wardle *et al.* 2011). Second, although the problem gambling screen based upon DSM-IV criteria has been used in previous large-scale surveys, it is not clear that all who screen positive will require clinical intervention. The screen assumes that problem gambling occurs on a continuum of severity with the more severe and clinically defined category of pathological gambling. Furthermore, it is possible that individuals with lower cognitive abilities interpret and answer questions related to problematic gambling differently from those with higher intellectual abilities, although it should be noted that individuals with lower IQs were no more likely to report non-problem gambling than those with higher IQ. Third, although selective

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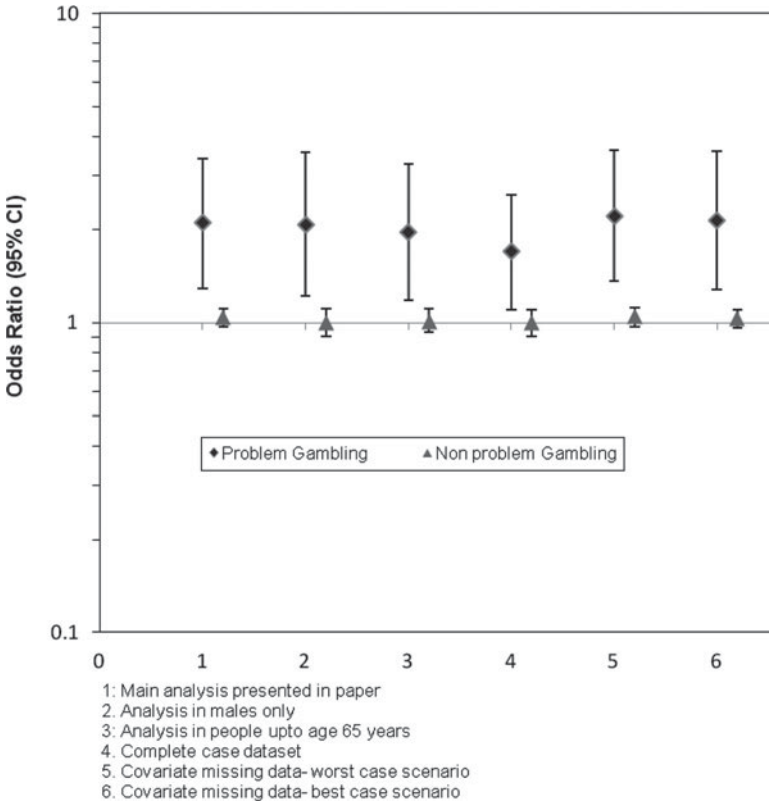


**Fig. 2.** The odds of problem gambling by each standard deviation decrease in IQ in sensitivity analyses using multinomial regression. The complete case dataset included only individuals without any missing data in any covariate ($n$=6291). In the worst-case scenario individuals with missing data in: education were considered as having no education; tenure were coded as living in rented accommodation; occupational class were considered as being in class IV/V; ethnicity were considered as being non-White; impulsivity were considered as having endorsed impulsivity; smoking were considered as smokers of <7 cigarettes/week; and illicit drug use were considered as dependent drug users. In the best-case scenario individuals with missing data in: education were considered as having a degree or higher education; tenure were coded as owner-occupiers; occupational class were considered as being in class I/II; ethnicity were considered as being White; impulsivity were considered as not having endorsed impulsivity; smoking were considered as non-smokers; and illicit drug use were considered as non-drug users. Worst- and best-case scenarios are arbitrary terms and do not reflect any value judgements. CI, Confidence interval.

non-participation of people with gambling problems is possible, it may be less likely in the APMS (where the gambling screen was a small part of a larger mental health survey) than in special purpose gambling surveys. Fourth, the NART, although highly correlated with verbal and full-scale IQ (Bright *et al.* 2002), cannot give information on any functional limitations associated with impaired cognitive abilities. Importantly, the NART itself has not been validated for individuals with intellectual disabilities; and the private household survey design and exclusion criteria for the NART may have precluded individuals with significant levels of intellectual disabilities from participating. Finally, although we had access to a large number of potential confounders including impulsivity and addictive behaviours, the possibility of residual confounding cannot be excluded. Such confounding may arise from inadequate measurement of variables such as impulsivity, which in the current study was assessed using a single item, or from other unmeasured confounders, including characteristics related to early life and development.

### *Implications and future directions*

We found a lower estimated verbal IQ to be associated with problem gambling even after accounting for several potentially confounding sociodemographic characteristics, mental health, impulsivity and other addictive behaviours. The lack of similar associations in people with non-problem gambling may point towards general cognitive abilities being a predictor of individuals at a higher risk of making a transition to problem gambling. The results warrant future research being carried out to replicate these findings, to understand the underlying mechanisms. Our findings also highlight that

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efforts should be made to validate gambling screens in individuals with lower intellectual abilities.

Neuropsychological studies have previously reported that problem or pathological gamblers are more likely to engage in impulsive behaviours (Goudriaan *et al.* 2004; Verdejo-Garcia *et al.* 2008), have impaired decision making (Goudriaan *et al.* 2004, 2005), steeper associations with delay discounting (Dixon *et al.* 2003; Goudriaan *et al.* 2004) and other deficits in cognitive reward pathways including a failure to learn from mistakes (Goudriaan *et al.* 2004). These are obvious avenues to explore in future research, ensuring cognitive abilities of individuals are accounted for when assessing potential pathways towards problem or pathological gambling.

It is known that problem gamblers rarely seek help or treatment (Bowden-Jones & George, 2011; Shaffer & Martin, 2011), but in our experience gambling problems are not usually considered in clinical practice, even when alcohol and drug misuse are the presenting symptoms. Our findings suggest that clinicians working with individuals with lower intellectual functioning should be mindful of this potential hidden vulnerability in these individuals. Conversely, IQ tests should be considered in the work-up of problem gamblers and may facilitate the appropriate and accessible delivery of interventions and enhance engagement.

Finally, gambling opportunities are widespread in many Western societies, but relatively little policy attention has been paid to preventing gambling problems. Warnings of problems associated with gambling are typically 'small print', and gambling opportunities are widely advertised and promoted in print, television, radio and the internet. Our findings, if confirmed, raise important questions about the impact of such coverage and the lack of more accessible warnings for vulnerable members of society, particularly those of more limited intellectual ability.

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We sadly report that Howard Meltzer, our co-author, colleague and friend, died on 23 January 2013.

## Declaration of Interest

None.

## References

**Afifi TO, Cox BJ, Martens PJ, Sareen J, Enns MW** (2010). Demographic and social variables associated with problem gambling among men and women in Canada. *Psychiatry Research* **178**, 395–400.

**Ali A, Ambler G, Strydom A, Rai D, Cooper C, McManus S, Weich S, Meltzer H, Dein S, Hassiotis A** (2013). The relationship between happiness and intelligent quotient: the contribution of socio-economic and clinical factors. *Psychological Medicine* **43**, 1303–1312.

**APA** (2000). *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision. DSM-IV-TR*. American Psychiatric Association: Washington, DC.

**Bakken IJ, Gotestam KG, Grawe RW, Wenzel HG, Oren A** (2009). Gambling behavior and gambling problems in Norway 2007. *Scandinavian Journal of Psychology* **50**, 333–339.

**Bondolfi G, Jermann F, Ferrero F, Zullino D, Osiek C** (2008). Prevalence of pathological gambling in Switzerland after the opening of casinos and the introduction of new preventive legislation. *Acta Psychiatrica Scandinavica* **117**, 236–239.

**Bowden-Jones H, George S** (2011). Gambling addiction. *British Medical Journal* **343**, d7789.

**Brewer JA, Potenza MN, Desai RA** (2010). Differential associations between problem and pathological gambling and psychiatric disorders in individuals with and without alcohol abuse or dependence. *CNS Spectrums* **15**, 33–44.

**Bright P, Jaldow E, Kopelman MD** (2002). The National Adult Reading Test as a measure of premorbid intelligence: a comparison with estimates derived from demographic variables. *Journal of the International Neuropsychological Society* **8**, 847–854.

**Cox BJ, Yu N, Afifi TO, Ladouceur R** (2005). A national survey of gambling problems in Canada. *Canadian Journal of Psychiatry* **50**, 213–217.

**Crawford JR, Deary IJ, Starr J, Whalley LJ** (2001). The NART as an index of prior intellectual functioning: a retrospective validity study covering a 66-year interval. *Psychological Medicine* **31**, 451–458.

**Dixon MR, Marley J, Jacobs EA** (2003). Delay discounting by pathological gamblers. *Journal of Applied Behavioral Analysis* **36**, 449–458.

**Emond A, Doerner R, Griffiths MD** (2011). Avon Longitudinal Study of Parents and Children (ALSPAC). Gambling behaviour in adolescents aged 17 years: summary of findings (www.responsiblegamblingtrust.org.uk/PDFs/ALSPACfindings2011.pdf). Accessed 1 December 2012.

**Forbush KT, Shaw M, Graeber MA, Hovick L, Meyer VJ, Moser DJ, Bayless J, Watson D, Black DW** (2008). Neuropsychological characteristics and personality traits in pathological gambling. *CNS Spectrums* **13**, 306–315.

**Gotestam KG, Johansson A** (2003). Characteristics of gambling and problematic gambling in the Norwegian

context: a DSM-IV-based telephone interview study. *Addictive Behaviors* **28**, 189–197.

**Goudriaan AE, Oosterlaan J, deBeurs E, van den Brink W** (2004). Pathological gambling: a comprehensive review of biobehavioral findings. *Neuroscience and Biobehavioral Reviews* **28**, 123–141.

**Goudriaan AE, Oosterlaan J, deBeurs E, van den Brink W** (2005). Decision making in pathological gambling: a comparison between pathological gamblers, alcohol dependents, persons with Tourette syndrome, and normal controls. *Cognitive Brain Research* **23**, 137–151.

**Goudriaan AE, Oosterlaan J, deBeurs E, van den Brink W** (2006). Neurocognitive functions in pathological gambling: a comparison with alcohol dependence, Tourette syndrome and normal controls. *Addiction* **101**, 534–547.

**Kaare PR, Mottus R, Konstabel K** (2009). Pathological gambling in Estonia: relationships with personality, self-esteem, emotional states and cognitive ability. *Journal of Gambling Studies* **25**, 377–390.

**Kessler RC, Hwang I, LaBrie R, Petukhova M, Sampson NA, Winters KC, Shaffer HJ** (2008). DSM-IV pathological gambling in the National Comorbidity Survey Replication. *Psychological Medicine* **38**, 1351–1360.

**Lewis G, Pelosi AJ, Araya R, Dunn G** (1992). Measuring psychiatric disorder in the community: a standardized assessment for use by lay interviewers. *Psychological Medicine* **22**, 465–486.

**Lobbestael J, Leurgans M, Arntz A** (2011). Inter-rater reliability of the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID I) and Axis II Disorders (SCID II). *Clinical Psychology and Psychotherapy* **18**, 75–79.

**Lorains FK, Cowlishaw S, Thomas SA** (2011). Prevalence of comorbid disorders in problem and pathological gambling: systematic review and meta-analysis of population surveys. *Addiction* **106**, 490–498.

**Lubinski D** (2009). Cognitive epidemiology: with emphasis on untangling cognitive ability and socioeconomic status. *Intelligence* **37**, 625–633.

**Malgady RG, Rogler LH, Tryon WW** (1992). Issues of validity in the Diagnostic Interview Schedule. *Journal of Psychiatric Research* **26**, 59–67.

**Mathias JL, Bowden SC, Barrett-Woodbridge M** (2007). Accuracy of the Wechsler Test of Adult Reading (WTAR) and National Adult Reading Test (NART) when estimating IQ in a healthy Australian sample. *Australian Psychologist* **42**, 49–56.

**McManus S, Meltzer H, Brugha T, Bebbington P, Jenkins R** (eds) (2009). *Adult Psychiatric Morbidity in England 2007: Results of a Household Survey*. The NHS Information Centre: Leeds, UK.

**Morasco BJ, Petry NM** (2006). Gambling problems and health functioning in individuals receiving disability. *Disability and Rehabilitation* **28**, 619–623.

**Nelson HE** (1991). *National Adult Reading Test (NART)*. NFER-NELSON: Windsor.

**Petry NM, Stinson FS, Grant BF** (2005). Comorbidity of DSM-IV pathological gambling and other psychiatric disorders: results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Journal of Clinical Psychiatry* **66**, 564–574.

**Reith G** (2006). *Research on the Social Impacts of Gambling*. Scottish Executive Social Research (ScotCen), Edinburgh.

**Saunders JB, Aasland OG, Babor TF, de la Fuente JR, Grant M** (1993). Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO Collaborative Project on Early Detection of Persons with Harmful Alcohol Consumption – II. *Addiction* **88**, 791–804.

**Shaffer HJ, Martin R** (2011). Disordered gambling: etiology, trajectory, and clinical considerations. *Annual Review of Clinical Psychology* **7**, 483–510.

**Shamosh NA, Deyoung CG, Green AE, Reis DL, Johnson MR, Conway AR, Engle RW, Braver TS, Gray JR** (2008). Individual differences in delay discounting: relation to intelligence, working memory, and anterior prefrontal cortex. *Psychological Science* **19**, 904–911.

**Spinks R, McKirgan LW, Arndt S, Caspers K, Yucuis R, Pfalzgraf CJ** (2009). IQ estimate smackdown: comparing IQ proxy measures to the WAIS-III. *Journal of the International Neuropsychological Society* **15**, 590–596.

**Stockwell T, Sitharthan T, McGrath D, Lang E** (1994). The measurement of alcohol dependence and impaired control in community samples. *Addiction* **89**, 167–174.

**Tavares H, Carneiro E, Sanches M, Pinsky I, Caetano R, Zaleski M, Laranjeira R** (2010). Gambling in Brazil: lifetime prevalences and socio-demographic correlates. *Psychiatry Research* **180**, 35–41.

**Tourangeau R, Rips LJ, Rasinski KA** (2000). *The Psychology of Survey Response*. Cambridge University Press: Cambridge, U.K.

**Verdejo-Garcia A, Lawrence AJ, Clark L** (2008). Impulsivity as a vulnerability marker for substance-use disorders: review of findings from high-risk research, problem gamblers and genetic association studies. *Neuroscience and Biobehavioral Reviews* **32**, 777–810.

**Victorian Competition and Efficiency Commission** (2012). *Counting the Cost: Inquiry into the Costs of Problem Gambling: a draft report for further consultation and input*. Victorian Competition and Efficiency Commission: Melbourne.

**Walker DM** (2007). Problems in quantifying the social costs and benefits of gambling. *American Journal of Economics and Sociology* **66**, 609–645.

**Wardle H, Moody A, Spence S, Orford J, Volberg R, Jotangia D, Griffiths M, Hussey D, Dobbie F; National Centre for Social Research, Gambling Commission** (2011). *British Gambling Prevalence Survey 2010*. National Centre for Social Research. The Stationery Office: London.

**Welte JW, Barnes GM, Wieczorek WF, Tidwell MC, Parker JC** (2004). Risk factors for pathological gambling. *Addictive Behaviors* **29**, 323–335.

**WHO** (1993). *The ICD-10 Classification of Mental and Behavioural Disorders: Diagnostic Criteria for Research*. World Health Organization: Geneva.

**Xian H, Shah KR, Phillips SM, Scherrer JF, Volberg R, Eisen SA** (2008). Association of cognitive distortions with problem and pathological gambling in adult male twins. *Psychiatry Research* **160**, 300–307.