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ORIGINAL ARTICLE

The Global Prevalence of Problem and Pathological Gambling and Its Associated Factors Among Individuals with Substance Use Disorders: A Meta-analysis

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Abstract
The present systematic review and meta-analysis assessed the prevalence, sociodemographic factors, mental health disorders, and type of drug use disorders associated with problem/pathological gambling among individuals with substance use disorders (SUDs). Published studies before January 1, 2023, were reviewed. Out of 8351 papers initially identified, 61 studies remained for meta-analysis. The findings indicated that among individuals with SUDs there was a lifetime pooled prevalence rate of 23% for at-risk gambling disorder (GD), 19% for problem gambling, and 17% for pathological gambling. The pooled lifetime prevalence of SUDs among individuals with problem/pathological gambling was 18%. The findings indicated that individuals with SUDs who were male, had depressive and mood disorders, and had alcohol, tobacco, and cannabis use disorders were more likely to report problem and/or pathological gambling. Consideration of type of substance use and individuals' mental health disorders during primary treatment could be useful for reducing GD among individuals with SUDs.

Keywords Problem gambling · Pathological gambling · Alcohol use disorders · Opioid use disorders · Substance use disorders

Introduction

Gambling disorder (GD) – previously known as 'pathological gambling' – has been defined as *"persistent and recurrent problematic gambling behavior leading to clinically significant impairment or distress"* (American Psychiatric Association [APA], 2013). It can result in devastating impacts on the different aspects of the individual's life (APA, 2013). The term 'problem gambling' is used as a more general term to describe various patterns of damaging gambling behavior (Griffiths et al., 2022).

According to the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5), GD is the first behavioral (non-chemical) addiction (APA, 2013). Among the general population approximately five in every 1000 individuals may develop GD in their lifetime (Potenza et al., 2019). However, GD prevalence can be as high as 28%-50% among individuals with substance use disorders (SUDs) (Lesieur et al., 1986; Welte et al., 2001). These statistics demonstrate that GD and SUDs are common comorbid conditions and that the prevalence of GD is much higher among those with SUDs compared to the general population (Zhai et al., 2020). Both behaviors also share similar etiologies which supports the idea that they shared risk factors contribute to the development of both SUD and GD (Martínez-Loredo et al., 2019). GD has many similarities with SUDs in terms of symptoms as well as diagnostic features, genetic bases, and comorbidities (Rash et al., 2016). A significant common diagnostic characteristic is the preoccupation or fixation on the addictive behavior (Rash et al., 2016). For GD, this behaviors encompass the act of revisiting past gambling experiences, contemplating future gambling endeavors, and devising methods to finance gambling activities (Alcaro et al., 2021). In SUDs, they involve dedicating a significant amount of time to acquiring, consuming, or recovering from alcohol use disorders aligns with specific planning aspects observed in the item related to gambling disorders (Rash et al., 2016).

GD and SUDs share similarities at the biological, psychological, and social levels. At a biological level there are similarities in dopamine and reward pathways. For example, the mesocorticolimbic dopamine pathway regulates the rewarding value associated with addictive substances and behaviors such as GD (Koob & Volkow, 2016). It has also been reported that GD and SUDs can lead to changes in brain structure and function (Balodis & Potenza, 2020). These changes can result in a heightened craving for the activity (gambling or substance use) and

difficulty in exercising self-control (Cheung, 2014). At a psychological level there are similarities such as impulsivity. More specifically, individuals with GD and SUDs often exhibit higher levels of impulsivity (Rash et al., 2016). They may act without thinking of the long-term consequences, leading to impulsive and risky behaviors (Grant et al., 2014). There are also similarities in craving (i.e., a strong desire to engage in the activity) (Alessi et al., 2022) and withdrawal symptoms when they try to cut down or quit their gambling or substance use, making it challenging to stop these behaviors (Rash et al., 2016). They also face similar financial and social difficulties such as financial debt and loss of assets (Russell et al., 2022). Additionally, GD and SUDs can strain personal relationships (Estévez et al., 2022). There is a high rate of co-occurrence between GD and SUDs. Individuals with one condition are more likely to have or develop the other, suggesting shared underlying vulnerabilities (Rash et al., 2016). Research has shown a significant relationship between various mental, mood, and personality disorders and problem gambling (Dowling et al., 2015; Karaca et al., 2017). Also, there is a positive and significant relationship between pathological gambling and drug use, anxiety, and personality problems (Petry et al., 2005). Despite the need for more extensive studies to delineate the relationship between various comorbidities (e.g., psychiatric and substance use disorders) and problem gambling (Hartmann et al., 2018), there appears to be considerable variation between co-occurring psychiatric and/or SUDs and GD. For example, GD is distinguished from SUDs by being acknowledged as a disorder primarily rooted in cognition, constituting a notable distinction between the two conditions (Jazaeri et al., 2012). A previous study has determined that individuals with problematic gambling tendencies typically exhibit fundamental cognitive distortions within their belief systems concerning their capacity to achieve success in gambling (Joukhador et al., 2003). In addition to harboring cognitive distortions regarding their winning potential, some gamblers also possess distorted perceptions about their

requirement for excitement (Jazaeri et al., 2012). They firmly believe that they cannot function adequately without the thrill derived from gambling (Jazaeri et al., 2012).

Furthermore, some studies of substance abusers in treatment have concluded that approximately 10% of pathological gamblers seek treatment (Lorains et al., 2011; Slutske, 2006). Therefore, what is not yet well understood is whether individuals suffering from problem gambling and pathological gambling may be at greater risk of using some substances than others (for example, are those with gambling problems more likely to abuse alcohol than opioids or more likely to abuse opioids than other types of drug?). The answer to such questions would be helpful because problem gambling and pathological gambling have different adverse consequences (because of their different severities), and those with different comorbidities will require specific and more individualized treatment approaches.

To the best of the present authors' knowledge, the reported prevalence estimates of problem/pathological gambling among individuals with SUDs are inconsistent and often very diverse within the studies. There is only one previous meta-analysis that has assessed problem/pathological gambling among individuals with SUDs receiving treatment (Cowlishaw et al., 2014). According to a previous meta-analysis, approximately 14% of patients exhibited comorbid pathological gambling, while approximately 23% experience conditions within the wider range of problem gambling (Cowlishaw et al., 2014). As well as being almost a decade old, the study (i) only included individuals with SUDs who received treatment as participants (not all individuals with SUDs), (ii) only reported the pooled prevalence rate of pathological and problem gambling (i.e., it did not report the pooled prevalence rate of pathological and problem gambling by type of substance use disorder), (iii) did not carry out subgroup analyses by age, time of publication, geographical region, sample size or diagnostic criteria for SUDs (they only carried

out subgroup analysis based on the type of treatment setting [e.g., general inpatient setting, methadone maintenance clinic] and type of gambling assessment [e.g., self-report, DSM interview]), (iv) did not carry out any meta-regression to identify the source of heterogeneity, and (v) did not report any pooled odds ratio for determinants associated with pathological/problem gambling. In addition, no previous systematic reviews or meta-analyses have been conducted concerning the prevalence of problem/pathological gambling in terms of age and type of substance use disorders.

There are several key reasons for examining the prevalence of co-occurring GD among individuals with SUDs: (i) *treatment and intervention:* recognizing the co-occurrence of these disorders allows for the development of integrated treatment approaches that address both conditions simultaneously; (ii) *public health impact:* understanding the extent of the overlap between GD and SUDs is crucial for public health planning and resource allocation; and (iii) *risk factors and prevention strategies:* identifying the co-occurring nature of these disorders helps in identifying common risk factors and shared underlying mechanisms. Therefore, the present systematic review and meta-analysis assessed the prevalence, sociodemographic factors, mental health disorders, and type of drug use disorders associated with problem/pathological gambling among individuals with SUDs.

Methods

Search strategy

The present study was designed according to the Protocols of Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021). The literature involved identifying relevant studies published before January 1, 2023, in the *PubMed, Scopus, Web of Science* and

Cochrane Library databases, which were independently reviewed by two of the co-authors (RM and BA) using Medical Subject Headings (MeSH terms) fields. The following keywords were used: "(substance use disorders), (substance-related disorders), (drug abuse), (substance abuse, intravenous), (gambling), (pathological gambling), (gambling disorders)". Finally, to identify any further relevant studies, the bibliography lists of the included studies were manually reviewed (**Supplementary File 1**).

Inclusion and exclusion criteria

PECOS (population, exposures, comparison, outcome, and study design) criteria were used for study selection. More specifically, the "population" was individuals with SUDs or individuals requiring specialist addiction treatment (e.g., methadone, buprenorphine, naloxone) who were adults and/or adolescents and/or individuals with problem/pathological gambling; the "exposures" were positive or negative associations with sociodemographic characteristics, mental health disorders, and type of drug use among individuals with SUDs on lifetime problem/pathological gambling; the "comparison" group was individuals with SUDs without any problem/pathological gambling; the "outcome" was lifetime problem/pathological gambling among individuals with SUDs or individuals requiring specialist addiction treatment (e.g., methadone, buprenorphine, naloxone) or lifetime SUDs among individuals with problem/pathological gambling; and "study designs" comprised cross-sectional, cohort or case-control studies. Studies such as qualitative studies, secondary studies without primary data, systematic reviews, and meta-analysis were excluded. Quantitative papers exhibiting significant heterogeneity compared to other studies prior to the analysis (e.g., studies reporting very high/low odds ratios with wide/narrow confidence intervals compared to other studies) were also excluded.

Screening and data extraction

The entire process of screening and data extraction was conducted independently by two individuals, and in cases of any disagreements, a third person was involved to reach a resolution. First, duplications were evaluated and omitted by the reviewers (89% agreement) using unweighted kappa score. The level of agreements including poor, slight, fair, moderate, substantial, or almost perfect level were represented by the values 0, 01–0.02, 0.021–0.04, 0.041–0.06, 0.061–0.08, or 0.081-1.00, respectively (Landis et al., 1977). An independent researcher of the team (EA) was asked to resolve any disagreements. Second, the full texts of the papers were reviewed by the two same co-authors (RM and BA) considering the PECOS and the exclusion criteria. Data was gathered using *Microsoft Excel* software. The following data were extracted from the studies: publication year, the study location, the first author's name, country, the design of the study, the study sample size, data collection source, diagnostic criteria used to assess key variables, key statistics, and any outcome measure. The references were managed using *EndNote X7* software (*Thomson Reuters*).

Risk of bias assessment

To assess the risk of bias of the included studies, the Newcastle-Ottawa Scale (NOS) was used (Peterson et al., 2011) which has three domains: (i) the selection domain comprises various aspects, such as the representativeness of the exposed group, the selection of the non-exposed group, and the ascertainment of exposure (three items for cross-sectional studies; four items for cohort and case control studies), (ii) the comparability domain comprises assessing the comparability of groups, which is determined by factors such as the study design or the analysis conducted (one item for both cross-sectional studies and cohort and case control studies), and (iii) the exposure/outcome domain comprises the evaluation of the outcome (one item for cross-sectional studies and three items for cohort and case control studies). Each criterion that was met

scored one point. The maximum score for cross-sectional studies was 5 and the maximum score for the quality of cohort/ case-control studies was 8. Cross-sectional studies that had a total score of 0–2, 3, 4 and 5 points were considered as "unsatisfactory," "satisfactory," "good," or "very good" respectively, and cohort and case-control studies had a total score of 0–3, 4, 5-6 and 7-8 points as "unsatisfactory," "satisfactory," "good," or "very good" respectively (**Supplementary File 2**).

Data synthesis and statistical analysis

In the present meta-analysis, the pooled odds ratios (ORs) with 95% confidence intervals (CIs) regarding factors related to problem/pathological gambling among individuals with SUDs were calculated. The summary effect sizes were computed by an inverse variance weighting. These values were computed from regression coefficients for the multivariate analyses. The studies with random effects models had different effect sizes. Therefore, for model selection and computing publication bias, a random-effects model with restricted maximum likelihood (REML) was used to conduct the meta-analysis.

Within-study sampling error and between-study variance were considered as the uncertainty sources. Large Cochran's Q statistics with small *p*-values and large I^2 statistics to consider the heterogeneity in true effect sizes of the studies were applied. Furthermore, the prediction interval was computed using the methodology proposed by (Borenstein et al., 2017) which represents the range within which the true pooled prevalence rate of a future study is likely to lie in 95% of populations.

Subgroup analyses considering sample size and geographic regions were conducted to recognize the sources of heterogeneity. Data from at least two studies were needed to explain the variable under consideration within each stratum. A univariate meta-regression was applied to

identify more causes of heterogeneity involving covariates, including age, sample size, year of publication of the study, country, diagnostic criteria for SUDs and problem/pathological gambling, type of drug use, and treatment (yes/no).

Also, a multivariate meta-regression to determine the influence of potential covariates on the pooled prevalence was performed. Categorical moderator variables were pre-defined for each study, encompassing age, sample size, year of publication, country, diagnostic criteria for SUDs and GD, type of drug use, and treatment. Sensitivity analysis and Baujat plots were performed to identify influential effects. Effects on the right-hand side showed studies with more heterogeneity. The studies that had the most contributions to heterogeneity were removed following the sensitivity analysis. Funnel plots, trim-and-fill analysis, and Rosenthal's fail-safe number were performed to assess the publication bias in the studies. The analysis carried on by R 3.5.1 software *'Meta'* package.

Results

Study selection process

Initially, 8,351 papers were found through the four database searches. After paper duplicates were excluded (n=4,786), the title and abstracts of 3,565 papers were screened. Of these, 854 were found related to the aim of study. After a full text review, 793 studies were excluded. A total of 88 studies were excluded because they did not meet the quality appraisal score (11%), and the remaining 705 studies (89%) were excluded for various methodological and/or statistical reasons. These included (i) using a non-quantitative methodology, (ii) not reporting parametric measurements such as prevalence of problem/pathological gambling, (iii) not reporting odds ratios of relative risks of determinants of study outcomes, (iv) studies not reporting the prevalence of GD, (v) published studies using the same population, (vi) not having participants with SUDs, (vi)

studies only reporting a beta coefficient and/or (vii) or reporting determinants which were insufficient to include in the final analysis (such as psychotic disorders and lack of sleep). Following exclusions, 61 studies remained for meta-analysis (Abdollahnejad et al., 2014; Adamson et al., 2006; Anpaa et al., 2011; Baldo et al., 2006; Barnes et al., 2015; Bonnaire et al., 2017; Brewer et al., 2014; Bussu et al., 2015; Cardone et al., 1997; Castrén et al., 2015; Chou et al., 2011; Ciarrocchi, 1993; Cunningham-Williams et al., 2000; Daghestani et al., 1996; de Carvalho et al., 2005; Dufour et al., 2016; Duhig et al., 2007; Elia et al., 1993; Feigelman et al., 1995; Ford et al., 2020; Gambino et al., 1993; Geisner et al., 2016; Griffiths, 1994; Griffiths et al., 2010; Håkansson et al., 2018; Jun et al., 2021; Knaebe et al., 2019; Langenbucher et al., 2001; Lawrence et al., 2009; Ledgerwood et al., 2002; Leino et al., 2021; Lejoyeux et al., 1999; Lesieurl et al., 1988; Lind et al., 2019; Lopes et al., 1996; Manning et al., 2017; Martínez-Loredo et al., 2019; Mathias et al., 2009; McCormick, 1993; Mills et al., 2020; Nelson et al., 2008; Peles et al., 2009; Peles et al., 2010; Petry et al., 2005; Rodriguez-Monguio et al., 2017; Rudd et al., 2016; Rupcich et al., 1997; Rush et al., 2008; Sarkar et al., 2018; Shaffer et al., 2002; Shepherd, 1996; Sherba et al., 2015; Slutske et al., 2000; Spunt et al., 1996; Tómasson et al., 1995; Toneatto et al., 2003; Weinstock et al., 2006; Welte et al., 2001; Wickwire Jr. et al., 2008; Widinghoff et al., 2019; Xian et al., 2014) **(Figure 1).**

Figure 1

Study characteristics

Selected studies were from four World Health Organization regions (33 from the America region [n=186,702 participants], 19 from the European region [n=48,097 participants], eight from the Western Pacific region [n=16,622 participants] and one from South-East Asia region [n=114 participants]). The USA had the highest number of included studies with 29 studies (n=146,370).

Considering country income level, 56 studies were conducted in high-income countries (n=236,338), two in upper-middle-income countries (n=224) and three in lower-middle-income countries (n=16,152). Final sample size had a mean of 4,158 participants, with 62 being the lowest sample size (Ledgerwood et al., 2002), and 43,903 being the largest sample size (Brewer et al., 2014). Response rates between studies varied from 46% to 100%, which referred to the number of individuals who participated in a study divided by the total number of individuals that were targeted or contacted. Participants had a mean age of 30.2 years and were more likely to be male (mean 68.26%), varying from 41% to 100%. Almost all studies (k=57) were cross-sectional (93%). Roughly half of them were published between 2010 and 2021 (44%).

Twenty-three studies (43%) used the *Diagnostic and Statistical Manual of Mental Disorders* as diagnostic criteria for assessing SUDs. Approximately two-third of studies' participants had alcohol and/or drug use disorders (59%). Thirty studies used the South Oaks Gambling Screen to assess GD (47%). Approximately one-quarter of individuals were treated for SUDs (54,873). Twenty-three studies assessed both problem and pathological gambling as the outcomes (38%) while, 43 studies assessed problem gambling only (70%). Problem gambling was assessed in different ways. For example, it was defined as a total score between 3 and 7 out of 27 on the Problem Gambling Severity Index (PGSI) and scores between 3 and 4 out of 20 on the South Oaks Gambling Screen (SOGS). Forty studies evaluated pathological gambling only (62%) and this was also assessed in different ways. For example, it was defined as a total score of 8 or more out of 27 on the PGSI, and a total score of 5 or more out of 20 on the SOGS. Nine studies assessed at-risk GD (14%) and was defined as a total score of 1 or 2 out of 27 on the PGSI (1 or 2 out of 9 or 10 on the National Opinion Research Center DSM Screen for Gambling Problems [NODS], or 1 or 2 out of 20 on the SOGS). Among the 61 studies included in the meta-analysis,

12 reported sociodemographic variables among individuals with SUD, five reported mental health disorders, and 11 reported type of drug use (**Table 1**).

Table 1

Prevalence of problem and pathological gambling among individuals with SUDs

Among individuals with SUDs, the meta-analysis showed a life-time pooled prevalence rate of 23% for at-risk for GD (95% CI, 6%-40%, prediction interval: 0%-86%), 19% for problem gambling (95% CI, 14%-25%, prediction interval: 0%-54%), and 17% for pathological gambling (95% CI, 12%-21%, prediction interval: 0%-47%) (**Figures 2-4**).

Figures 2, 3 and 4

Prevalence of SUDs among individuals with problem/pathological gambling

The life-time pooled prevalence of SUDs among individuals with problem/pathological gambling was 18% (95% CI, 6%-30%, prediction interval: 0%-65%). (**Figure 5**).

Figure 5

Sociodemographic characteristics, mental health disorders, and type of drug use associated with problem and/or pathological gambling among individuals with SUDs

Individuals with SUDs who were male were 3.33 times more likely than females to report lifetime problem and/or pathological gambling (OR=3.33, 95%CI=3-3.70, prediction interval: 2.92%-3.79%). The overall heterogeneity was 0%. Individuals with SUDs who had depressive and mood disorders, compared to those who had not, were 2.04 (OR=2.04, 95%CI=1.29-3.24) and 3.61 (OR=3.61, 95%CI=2.05-6.36) times more likely to report lifetime problem and/or

pathological gambling. The overall heterogeneity was 84% and 41% for depressive and mood disorders, respectively. Finally, individuals with SUDs primarily using tobacco or alcohol, compared to individuals with SUDs but without these primarily drugs, were 2.44 (OR=2.44, 95%CI=1.40-4.27, prediction interval: 0.29%-20.55%), and 2.33 (OR=2.33, 95%CI=1.83-2.97, prediction interval: 1.31%-4.16%) times more likely to report lifetime problem and/or pathological gambling. The overall heterogeneity was 94% and 17% for tobacco and alcohol use disorders, respectively **(Figures 6 and 7)**.

Figures 6 and 7

Sensitivity analysis

The sensitivity analysis removed heterogeneity between studies for almost all variables (i.e., being male, depressive disorders, tobacco use disorders) except for alcohol use disorders after identifying the studies that had the most significant contribution to the heterogeneity. It was shown that one study (Castrén et al., 2015) made the most significant contributions to heterogeneity of being male associated with lifetime problem and/or pathological gambling. The study by Petry et al. (2005) had the greatest impact on heterogeneity concerning depressive disorders associated with lifetime problem and/or pathological gambling. Two studies (Mills et al., 2020; Petry et al., 2005) had the most significant contribution to heterogeneity regarding tobacco use disorders associated with lifetime problem and/or pathological gambling. Finally, two studies (Ford & Håkansson, 2020; Petry et al., 2005) had the most significant contribution to heterogeneity concerning alcohol use disorders associated with lifetime problem and/or pathological gambling (**Supplementary Files 3-10**).

Subgroup analysis

Several subgroup analyses were conducted to identify the main source of heterogeneity on pooled prevalence of problem and pathological gambling taking into account age, sample size, year of publication of studies, geographic region, diagnostic criteria for SUDs and GD, type of drug use, and treatment. However, no heterogeneity was detected. Therefore, non-evaluated variables such as participants' gender and other variables may have been sources of heterogeneity **(Supplementary Files 11-26)**.

Subgroup analyses of life-time pooled prevalence of problem and pathological gambling by age of participants among individuals with SUDs

It has been established on in a previous study that most addicts "mature out" of addiction over the age 40 years (Menninger, 2002). Therefore, a subgroup analysis was run based on age of participants, categorizing the participants into two groups: (i) ≤ 40 years and (ii) > 40 years. The results showed that life-time pooled prevalence of problem gambling was higher among older individuals (>40 years old) 27% (95% CI, 18%-37%, prediction interval: 0%-73%) compared to those who were ≤ 40 years old 12% (95% CI, 0%-15%, prediction interval: 0%-27%) while life-time pooled prevalence of pathological gambling was higher among younger individuals (≤ 40 years) 20% (95% CI, 12%-26%, prediction interval: 0%-55%) compared to those who were >40 years old 11% (95% CI, 5%-17%, prediction interval: 0%-36%) **(Supplementary Files 13 and 14).**

Subgroup analyses of life-time pooled prevalence of problem and pathological gambling by type of drug use among individuals with SUDs

Additionally, another subgroup analysis was performed based on type of drug use, categorizing the participants into three groups: (i) alcohol use disorder, (ii) opioid use disorder,

and (iii) other drug use disorders. The results showed that life-time pooled prevalence of problem gambling was higher among individuals with opioid use disorders 29% (95% CI, 20%-41%, prediction interval: 0%-73%) compared to those with alcohol use disorder 12% (95% CI, 5%-18%, prediction interval: 0%-36%) and other drug use disorders 18% (95% CI, 12%-25%, prediction interval: 0%-54%), while life-time pooled prevalence of pathological gambling was higher among individuals with alcohol use disorders 23% (95% CI, 6%-41%, prediction interval: 0%-89%) compared to those with opioid use disorder 17% (95% CI, 11%-23%, prediction interval: 0%-39%) and other drug use disorders 13% (95% CI, 0%-18%, prediction interval: 0%-34%) **(Supplementary Files 23 and 24).**

Meta-regression analysis

In order to investigate the effects of potential contributing factors on the heterogeneity of studies on life-time pooled prevalence of problem and pathological gambling, a meta-regression was performed. The multivariate meta-regression showed that 27% of the variance in prevalence of problem gambling was explained by participants' age and type of drug used. Being aged above 40 years and opioids as the main type of drug used were associated with a higher problem gambling prevalence and was statistically significant ($p < 0.05$). Additionally, 15.91% of the variance in prevalence of pathological gambling was explained by year of publication of studies and sample size. Sample sizes of more than 1000 participants were associated with a lower pathological gambling prevalence and was statistically significant ($p < 0.05$) **(Supplementary Files 27 and 28)**.

Moderator analysis

Subgroup analyses confirmed that age, country and type of drug use were statistically significant moderators for pooled prevalence of problem gambling while, sample size and year of

publication of studies were statistically significant moderators for pooled prevalence of pathological gambling. Multivariate meta-regression analysis found age and type of drug use were statistically significant moderators for pooled prevalence of problem gambling. Those who were older than 40 years old had higher problem gambling prevalence (β= 0.16, 95%CI= 0.07 to 0.26) compared to those 40 years old or younger. Participants who had opioid use disorders had higher problem gambling prevalence (β= 0.18, 95%CI= 0.02 to 0.34). Multivariate meta-regression also found that sample size was statistically significant moderator for pooled prevalence of pathological gambling. Studies that had ≥ 1000 participants had lower pathological gambling prevalence (β= -0.10, 95%CI= -0.21 to -0.00).

Publication bias

To identify potential publication bias, the Egger's and Begg's tests were performed. Considering the symmetry assumption, there was no significant publication bias for all variables which were assessed (e.g., gender, alcohol use disorders) (p>0.05) **(Supplementary File 29-31)**.

Discussion

This meta-analysis aimed to determine pooled prevalence, sociodemographic characteristics, mental health disorders, and type of drug use associated with problem and/or pathological gambling among individuals with SUDs. The findings indicated that individuals with SUDs who were male, had depressive and mood disorders, and had alcohol, and/or tobacco use disorders were more likely to report problem and/or pathological gambling. The analysis produced two novel findings that have never been previously reported. The first novel finding was that the pooled prevalence rate of being at at-risk for GD, problem gambling, and pathological gambling were 23%, 19% and 17% respectively. Based on the prediction interval, future studies with similar

characteristics may have a proportion of GD ranging from 0% to 86% for being at at-risk for GD, from 0% to 54% for problem gambling, and from 0% to 47% for pathological gambling. No pooled prevalence for problem/pathological gambling has ever previously been reported among individuals with SUDs. Although, this was quite similar to the results of another sample of individuals with SUDs seeking treatment (Cowlishaw et al., 2014). The pooled prevalence rate of SUDs among individuals with problem/pathological gambling reported in the present study was lower than that of the previous meta-analysis, which reported a pooled prevalence rate of 57.5% for SUDs among individuals with problem/pathological gambling (Lorains et al., 2011). A possible reason for this difference could be due to variations in individual profiles and study context (such as studies being carried out in different countries with different participants). Heterogeneity may have also potentially accounted for these differences. However, despite conducting subgroup analyses, the sources of heterogeneity remained unidentified.

The finding of the present study showed that lifetime prevalence of problem gambling was higher among younger individuals (aged 40 years or younger) while prevalence of pathological gambling was higher among older individuals (aged over 40 years). A possible explanation could be the fact that younger gamblers may have cognitive immaturity relating to illusions of control over outcomes (Chambers et al., 2003), and poor understanding of statistical probability (Delfabbro et al., 2006). These types of issues can be addressed more easily in therapeutic situations than variables such as personality disorders and other comorbid disorders. Moreover, such factors may simply resolve themselves over time and through maturity (Betancourt et al., 2012). Consequently, problem gambling among younger gamblers may not progress to pathological gambling (i.e., gambling disorder) (Betancourt et al., 2012). Previous studies have also reported that older individuals with pathological gambling show higher obsessive passion

toward gambling activities compared to those who are not (Philippe et al., 2007; Tse et al., 2012). Moreover, pathological gambling may be higher among older individuals simply because they are older and there has been a longer amount of time for serious problems to accumulate over an individual's lifetime (Southwell et al., 2008). Another potential explanation could be that gambling provides a type of intrinsic social support for older gamblers, while their exposure to social isolation or loneliness renders them more susceptible to increased involvement in gambling (Zaranek et al., 2005). According to one study, reduced self-control resulting from age-related decline in executive functioning was identified as a potential factor contributing to GD among older gamblers (von Hippel et al., 2009).

The second novel finding of the present study was that problem gambling was more prevalent among individuals with SUDs who had opioid use disorders whereas, pathological gambling was higher among individuals with SUDs who had alcohol use disorders. However, since little is known about the mechanism of each substance or the exact mechanism of substance use on GD, more studies are needed. Additionally, opioids are powerful pain-relieving drugs that can create a sense of euphoria and pleasure, which may increase the likelihood of engaging in impulsive behaviors (Green et al., 2022), such as gambling. Also, pathological gambling and alcohol use disorder have common features such as loss aversion, referring to the underestimation of the negative consequences in decision-making (Genauck et al., 2017). Alcohol use disorder can impair judgment and self-control (Field et al., 2010), making individuals more prone to engage in risky behaviors such as gambling.

A possible reason for this finding may be due to neurological mechanisms (Potenza, 2013). Since problem gambling may decrease the dopamine or serotonin and the sensitivity to dopamine through reductions in the number of dopamine receptors on the neurons, individuals are more

likely to use alcohol to feel normal by increasing the release of these hormones (Campbell-Meiklejohn et al., 2011). Another explanation may be due to that individuals experiencing problem or pathological gambling are more likely to use alcohol to cope with the stress caused by gambling (Steinberg, 2009). Another possible explanation might be due to environmental reasons, such as the presence of alcohol in places where gambling activities may take place (such as bars, casinos), which makes individuals more prone to engage in risky behaviors such as gambling (Leino et al., 2017).

Also, pathological gambling was higher among other substance use disorders. This may be explained by the fact that some research suggests individuals with a gambling pathology have lower levels of norepinephrine (Roy et al., 1988). Therefore, such gamblers use opioid to compensate the lower levels of this neurotransmitter (Mick et al., 2016). Although, these aforementioned explanations may be the same for alcohol use disorder and opioid use disorder the exact mechanism of each substance on gambling behavior is not clear and needs further study.

Individuals with SUDs who were male were more likely to had problem/pathological gambling compared to women and it is consistent with previous literature (Cheung, 2014; Peles et al., 2010; Sherba et al., 2015). A possible explanation for it may be due to the fact that males are more likely than females to regularly engage in gambling and if they are more regularly engaged in gambling, they are more likely to develop problematic gambling compared to those who engage in it irregularly (Svensson et al., 2011). Additional research findings have indicated that males exhibit lower impulsive coping, engage in more risk-taking behaviors, and have higher levels of sensation seeking compared to females (Wong et al., 2013).

The present study findings indicated that those who had depressive and mood disorders were 2.04 and 3.61 times more likely to report lifetime problem and/or pathological gambling. Although some people may develop depression as a result of gambling problems, studies indicate that depression is more likely to be experienced just before gambling problems (Schluter et al., 2019) which suggests that some individuals may use gambling as a compensatory mechanism (i.e., using gambling to deal with psychological distress and depression). The relationship between mood disorders and pathological gambling often are thought to be related with depression, anxiety and/or stress (Kim et al., 2006). Indeed, depression and anxiety can alter the neurochemical balance in the nervous system, perhaps making a person more likely to take an illicit drugs to overcome the chemical instability they are experiencing (Kim et al., 2006). Additionally, it has been found that different kinds of addiction, such as gambling addiction and sex addiction, can ameliorate depression by activating the endogenous opioid system (Kim et al., 2006). Furthermore, one study reported that depression is equally likely to manifest prior to the onset of gambling problems and/or pathological as it is to occur afterwards (Hodgins et al., 2005). This suggests that some individuals might resort to gambling as an ineffective coping mechanism to alleviate negative moods, while others may experience depression as a consequence of their gambling issues (Hodgins et al., 2005).

The present study's findings indicated that individuals who had alcohol, cannabis or tobacco use disorders were more likely to report problem/pathological gambling. The findings are broadly in line with past results showing that GD is associated with alcohol, cannabis and tobacco use disorders (Caldeira et al., 2017; Mills et al., 2020; Walther et al., 2012). Considering the relationship between cigarette smoking and problem gambling, which is in line with the results of previous research associating alcohol and tobacco use disorders with problem gambling, the high prevalence of smoking and alcohol consumption is not surprising (Barnes et al., 2015). Drinking

alcohol, smoking cigarettes, and drug use appear to precede the development of a gambling problem (Lorains et al., 2011; Mide et al., 2023). One of the reasons that gambling may be subsequent to using drugs may be due to poor impulse control leading to increased risk-taking including gambling (Algren et al., 2015) although it cannot be ruled out that the relationship between gambling and psychoactive substance use may be bi-directional.

There may be shared genetic, environmental, and social predispositions that simultaneously leads individuals to simultaneous gambling and drug use disorders (Lorains et al., 2011; Slutske et al., 2005). Genetic and environmental factors lead to individual vulnerability (Slutske et al., 2000). Furthermore, a similar neurocognitive mechanisms have been reported among individuals with alcohol dependence and pathological gambling (Goudriaan et al., 2006). Some have argued that gambling may be used with substance use disorders as a way to fund their drug use (Algren et al., 2015). On the other hand, if drug use is secondary to the problem of gambling, a person may use drugs to relieve stress and anxiety caused by gambling problems and even use them to compensate for the many problems caused by gambling (Algren et al., 2015; Bonnaire et al., 2017).

Shaffer et al. (2004) reported high rates of GD among individuals with substance use disorders which may be due to their common determinants (such as genetic and biological predispositions) (Shaffer et al., 2004). In addition, because of the strong interconnection between gambling problems and substance use, one disorder may increase the risk of the other and vice versa. Moreover, impaired judgment may result from substance use and raise risk-taking behavior, and leading to problematic gambling among some individuals (Grant et al., 2002). Also, the destructive effects of problem gambling as well as substance use on family relationships can limit any social support that usually facilitate therapeutic measures (Cowlishaw et al., 2014).

Limitations

The included studies in the present systematic review and meta-analysis may have several issues of concern. First, the majority of studies were cross-sectional (94%), which makes the interpretation of causal or temporal relationships between variables impossible. Second, various approaches for assessing GD were conducted including criteria in the *International Classification of Diseases* (ninth and tenth revision), *Diagnostic and Statistical Manual of Mental Disorders* (third, fourth and fifth versions), South Oaks Gambling Screen, and Problem Gambling Severity Index (among others). Consequently, comparisons of GD using different screening instruments can be challenging. Third, various instruments for assessing SUDs were used as well such as the criteria in the *International Classification of Diseases* (ninth and tenth revision), the Alcohol Use Disorders Identification Test, and the *Diagnostic and Statistical Manual of Mental Disorders* (fourth edition). Therefore, comparisons between different types of SUDs were difficult. Fourth, the definition for SUDs varied. In some studies, a standard diagnostic criterion for SUDs were not reported, while in others, the target population comprised individuals who received treatment for substances such as methadone/buprenorphine-naloxone. Moreover, alcohol use disorder was defined differently across studies: some studies used the criteria of ≥ 4 drinks in a row for females and ≥ 5 drinks in a row for males in one day, while others defined it as 60 or more alcoholic drinks in the past month or having five or more drinks in one session. Therefore, it was determined that the target population in these studies dealt with SUDs.

Fifth, other variables of studies were not considered in the meta-analysis because there were only reported in one study (e.g., employment status, heroin use disorders, injection drug users, posttraumatic stress disorder, psychotic disorders, and lack of sleep). Studies which considered sociodemographic variables associated with problem/pathological gambling consisted

of only ten studies relating to gender. Consequently, caution should be taken in interpreting the results. Concerning mental health disorders associated with problem/pathological gambling, only three studies assessed depressive disorders and only two studies assessed mood disorders. High heterogeneity existed among studies examining depressive disorders and the observed associations may not be strong. In addition, given the few studies regarding mental health disorders, careful interpretation is needed concerning the findings. Among studies which considered drug use disorders associated with problem/pathological gambling, seven studies assessed alcohol use disorder and three studies assessed cannabis use disorder. High heterogeneity was observed among these studies. Therefore, the associations may be weak. In addition, due to low number of studies considering cannabis use disorders, more careful interpretation of the results is needed.

Finally, high heterogeneity was observed between studies. Several variables including age, sample size, year of publication of studies, geographic region, diagnostic criteria for SUDs and GD, type of drug use, and treatment were assessed in the present study. No sources of heterogeneity were found. However, variables that were not assessed may be sources of heterogeneity (e.g., such as participants' gender because the studies did not report the prevalence rates of problem/pathological gambling separately by gender, only overall prevalence rates). Although several subgroup analyses were conducted to decrease the heterogeneity, all sources of heterogeneity could not be identified since because increasing the number of subgroup analyses in each subgroup, the number of studies decreases for sub-group analyses. Consequently, subgroup analysis on variables such as gender could not be conducted and more cohort and case control studies are needed.

Implications for research and clinical practice

It is clear from the findings that additional research is needed to explore questions such as the impact of various drug types on GD and to identify which types of GD result in negative consequences comparable to the milder diagnostic forms of alcohol or substance use disorders. Examining treatment approaches, especially integrated treatments that target comorbid disorders among individuals with SUDs, emerges as another important research priority. The prevalence of comorbidity indicates a significant demand for integrated treatments in this area. With respect to clinical practice, it is advisable to conduct screenings for psychiatric disorders unrelated to gambling among individuals with SUDs who are seeking treatment for gambling-related issues. In treatment clinics for alcohol or drug use disorders, implementing regular screenings for psychiatric disorders among individuals with SUDs can potentially expedite the acquisition of necessary treatment for coexisting disorders including GD. Moreover, this approach has the potential to enhance response rates for both GD and the comorbid disorder when integrated or provided concurrently.

Conclusions

The present study is the first known meta-analysis to identify the pooled prevalence rate of problem/pathological gambling and its associated factors among patients with SUDs. Several innovative subgroup analyses were conducted. Also, to the best of the authors' knowledge, this study is the first to perform meta-regression and moderator analysis to detect potential contributing factors to the heterogeneity of studies on the lifetime pooled prevalence of problem and pathological gambling. The high rates of comorbidity suggest integrated treatments as having a great potential to be considered. Previous studies indicate that psychological therapies comprising four or more sessions of cognitive-behavioral therapy have short-term efficacy in GD treatment (Cowlishaw et al., 2012). Where there are limited professional resources, minimal or brief

interventions with short-term effects may be beneficial (Carlbring et al., 2008; Hodgins et al., 2009). These interventions may be useful to substance use treatment, considering short-term reduction in gambling behavior as the target, and other professional support such as focusing on patients' mental health disorders, as well as considering etiological factors of substance use and gambling problems during primary treatment.

Regarding clinical practice, the higher prevalence of GD among individuals with SUDs indicates that frequent monitoring of gambling problems may be useful (Leavens et al., 2014; Rash et al., 2016). GD has many common characteristics with other domains of SUDs, suggesting a syndrome model of addiction, which results the etiological overlap between various manifestations of addiction (e.g., uncontrolled use, chasing, or passion). These common co-occurring conditions should be considered when conceptualizing psychopathology for research designs, as well as for clinical symptomatology, and planning treatment. In addition, frequent monitoring of psychiatric disorders among individuals with SUDs may be useful in providing treatment for comorbid disorders and may ameliorate the response to both GD and the comorbid disorder while offering concurrent or integrated treatments.

Abbreviations

Confidence intervals (CIs)

Gambling disorder (GD)

Gambling Severity Index (PGSI)

Medical Subject Headings (MeSH terms)

Newcastle-Ottawa Scale (NOS)

Odds ratios (ORs)

Population, exposures, comparison, outcome, and study design (PECOS)

Protocols of Systematic Reviews and Meta-Analyses (PRISMA)

The fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5)

The National Opinion Research Center DSM Screen for Gambling Problems (NODS)

The South Oaks Gambling Screen (SOGS)

Substance use disorders (SUDs)

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References with an asterisk denote the studies that were included in the meta-analysis

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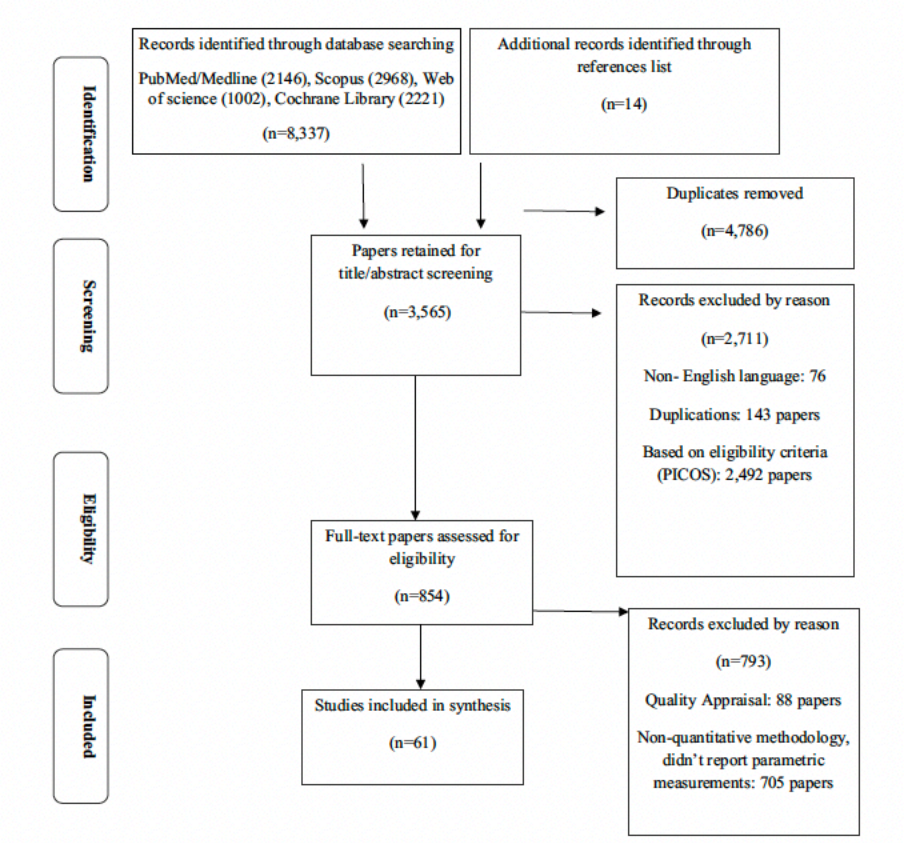

Fig. 1 PRISMA flow diagram

Table 1 Characteristics of studies for problem/pathological gambling among individuals with substance use disorders (SUD)

Authors (year of publish)	Years (y.) of data collections (number)	Country	Sample at baseline	Final sample (response rate%)	Study design	Data collection source	Diagnostic criteria used (SUD) or patients requiring specialist addiction treatment	Mean age	M %	F %	Type of drugs	Diagnostic criteria used for gambling	Cut-off ATG[ac]	Cut-off PrG[ad]	Cut-off PaG[ae]	ATG[ac]	PrG[ad]	PaG[ae]
Jun et al. (2021)	1994–2018 (10y.)	USA	8282	8282 (100)	Cross-section	Survey	DSM-IV [a]	21	45	55	Alcohol	SOGS[u]		3–4	5 +		√	
Leino et al. (2021)	2008–2017 (10y.)	Norway	4388	4388 (100)	Cross-section	Survey	ICD-10 [b]	42	81	19	Alcohol and other drugs	ICD-10[b]					√	
Ford and Håkansson (2020)	2019 (1y.)	Sweden	2170	2038 (94)	Cohort	Administrative data base	AUDIT [c]	54	45	55	Alcohol and other drugs	NODS-CLiP[v]	1–2	3–4	5 +		√	
Mills et al. (2020)	2020 (1y.)	Canada	1621	1621 (100)	Cross-section	Survey	ASSIST [d]	20.55	46	54	Alcohol and other drugs	CPGI[w]					√	
Martínez-Loredo (2019)	2019 (1y.)	Spain	1691	1644 (97)	Cross-section	Survey	ESPAD [f]	15.21	54	46	Alcohol and other drugs	SOGS[u]	2–3	4+			√	
Widinghof et al. (2019)	2010–2012 (3y.)	Sweden	421	270 (71)	Cohort	Survey	DSM-IV [a]	22.3	100	0	Alcohol and other drugs	SCID-I[x]					√	
Knaebe et al. (2019)	2014 (1y.)	Australia	411	385 (93)	Cross-section	Survey	AUDIT [c]	45.1	69	31	Alcohol	PGSI[y]	1–2	> 8			√	
Lind et al. (2019)	2017–2018 (2y.)	Finland	96	96 (100)	Cross-section	Survey	AUDIT [c]	37	57	43	Alcohol and other drugs	BBGS[z]			1 +		√	

Table 1 (continued)

Authors (year of publish)	Years (y.) of data collections (number)	Country	Sample at baseline	Final sample (response rate%)	Study design	Data collection source	Diagnostic criteria used (SUD) or patients requiring specialist addiction treatment	Mean age	M %	F %	Type of drugs	Diagnostic criteria used for gambling	Cut-off ATG[ac]	Cut-off PrG[ad]	Cut-off PaG[ae]	ATG[ac]	PrG[ad]	PaG[ae]
Håkansson and Ek* (2018)	2015–2016 (2y.)	Sweden	129	129(100)	Cross-section	Survey	Naltrexone treatment	54	68	32	Alcohol	NODS-CLiP[v]	1–2	3–4	5 +		√	
Håkansson and Ek* (2018)	2015–2016 (2y.)	Sweden	129	129(100)	Cross-section	Survey	Opioid maintenance treatment	54	68	32	Opioid	NODS-CLiP[v]	1–2	3–4	5 +		√	
Sarkar et al. (2018)	2018 (1y.)	India	114	114 (100)	Cross-section	Survey	DSM-5 [g]	32.3	100	0	Alcohol and other drugs	SOGS[u]		1–4	4 +	√	√	√
Rodriguez-Monguio et al.*. (2017)	2009–2013 (5y.)	USA	981	869 (88)	Cohort	Administrative data base	ICD-9 [h]	41.5	71	29	Alcohol	ICD-9[h]						√
Rodriguez-Monguio et al.*. (2017)	2009–2013 (5y.)	USA	981	869 (88)	Cohort	Administrative data base	ICD-9 [h]	41.5	71	29	Alcohol and other drugs	ICD-9[h]						√
Manning et al. (2017)	2015–2016 (2y.)	Australia	1528	837 (55)	Cross-section	Survey	AUDIT [c]	38	51	49	Alcohol and other drugs	PGSI[y]	1–2	3–7	8–27	√	√	√
Bonnaire et al. (2017)	2009–2010 (2y.)	France	27,653	25,647 (92)	Cross-section	Survey	AUDIT [c]	50	48	52	Alcohol and other drugs	CPGI[w]		3+				
Dufour et al. (2016)	2011–2014 (4y.)	Canada	424	424 (100)	Cohort	Survey	SDS [i]	40.46	87	23	Alcohol and other drugs	PGSI[y]	1–2	8–27		√		

Table 1 (continued)

Authors (year of publish)	Years (y.) of data collections (number)	Country	Sample at baseline	Final sample (response rate%)	Study design	Data collection source	Diagnostic criteria used (SUD) or patients requiring specialist addiction treatment	Mean age	M %	F %	Type of drugs	Diagnostic criteria used for gambling	Cut-off ATG[ac]	Cut-off PrG[ad]	Cut-off PaG[ae]	ATG[ac]	PrG[ad]	PaG[ae]
Geisner et al. (2016)	2016 (1y.)	USA	10,062	4640 (46)	Cross-section	Survey	WHO ASSIST[J]	19.8	41	59	Alcohol and other drugs	SOGS[u]		3–4	5 +		√	
Rudd and Thomas (2016)	2013 (1y.)	Australia	280	266 (95)	Cross-section	Survey	ICD-10[b]	34	66	34	Alcohol and other drugs	ICD-10[b]					√	
Sherba and Martt (2015)	2011–2012 (2y.)	USA	634	412 (64)	Cross-section	Survey	DSM-IV[a]	31.81	58	42	Alcohol and other drugs	SOGS[u]		3 +	5 +		√	√
Castrén et al. (2015)	2014 (1y.)	Finland	224	144 (64.3)	Cross-section	Survey	Opioid maintenance treatment	35.5	62	38	Opioid	BBGS[y]		1 ≤				
Barnes et al. (2015)	2011–2013 (3y.)	USA	2963	2963 (100)	Cross-section	Survey	DSM-IV[a]	45	49	51	Alcohol and other drugs	DSM-IV[a]			5 +		√	
Bussu and Detotto (2015)	2004–2005 (2y.)	Italy	1315	709 (54)	Cross-section	Survey	DSM-5[g]	48	83	17	Alcohol and other drugs	SOGS[u]			5 +		√	
Abdollahnejad et al. (2014)	2014 (1y.)	Australia	140	140 (100)	Cross-section	Survey	AUDIT[c]	47	42	58	Alcohol	NODS-SA[aa]	1–2	3–4	5–10	√	√	√
Xian et al. (2013)	2013 (1y.)	Vietnam	7869	7869 (100)	Cross-section	Survey	DSM-III-R[k]	42	100	0	Alcohol and other drugs	DIS[ab]					√	

Table 1 (continued)

Authors (year of publish)	Years (y.) of data collections (number)	Country	Sample at baseline	Final sample (response rate%)	Study design	Data collection source	Diagnostic criteria used (SUD) or patients requiring specialist addiction treatment	Mean age	M %	F %	Type of drugs	Diagnostic criteria used for gambling	Cut-off ATG[ac]	Cut-off PrG[ad]	Cut-off PaG[ae]	ATG[ac]	PrG[ad]	PaG[ae]
Chou and Afifi (2011)	2000–2001 and 2004–2005 (4y)	USA	34,653	33,231 (86.7)	Cross-section	Survey	AUDADIS-IV [l]	42	65	35	Alcohol	DSM-IV[a]		3+	5+			√
Anpaa et al. (2011)	2009 (1y.)	France	3135	2790 (88)	Cross-section	Survey	AUDIT [c]	42.6	73	27	Alcohol and other drugs	DSM-IV[a] and SOGS[u]	1 or less	2–5	6–24			√
Peles et al.**. (2010)	2007 (1y.)	Israel	178	178 (100)	Cross-section	Survey	DSM-IV [a]	37.6	66	34	Opioid	SOGS[u]		3+	5+		√	√
Brewer et al. (2010)	2001–2002 (2y.)	USA	53,201	43,093 (81)	Cross-section	Survey	AUDADIS-IV [l]	45.5	42	58	alcohol	DSM-IV[a]				√	√	
Peles et al.**. (2010)	2007 (1y.)	USA	112	112 (100)	Cross-section	Survey	DSM-IV [a]	44.4	64	36	Opioid	SOGS[u]		3+	5+		√	√
Mathias et al. (2009)	2006 (1y.)	Brazil	150	147 (98)	Cross-section	Survey	ASI [m]	NR [e]	85	15	Alcohol and other drugs	SOGS[u]		3–4	5+		√	√
Peles et al. (2009)	2006 (1y.)	USA	300	154 (51)	Cross-section	Survey	DSM-IV [a]	38.1	65	35	Opioid	SOGS[u]		3+	5+			√
Lawrence et al. (2009)	2009 (1y.)	UK	63	63 (100)	Cross-section	Survey	AUDIT [c]	37	100	0	Alcohol	SOGS[u]		5+				√

Table 1 (continued)

Authors (year of publish)	Years (y.) of data collections (number)	Country	Sample at baseline	Final sample (response rate%)	Study design	Data collection source	Diagnostic criteria used (SUD) or patients requiring specialist addiction treatment	Mean age	M %	F %	Type of drugs	Diagnostic criteria used for gambling	Cut-off ATG[ac]	Cut-off PrG[ad]	Cut-off PaG[ae]	ATG[ac]	PrG[ad]	PaG[ae]
Nelson and Oehlert (2008)	2003–2004 (2y.)	USA	316	316 (100)	Cross-section	Survey	MCMI-III [n]	48.34	98	2	Alcohol and other drugs	SOGS[u]		3+	5+		√	
Griffiths et al. (2008)	2006–2007 (2y.)	UK	9003	9003 (100)	Cross-section	Survey	DSM-IV [a]	17	NR [e]	NR [e]	Alcohol and other drugs	DSM-IV[a]		3	5		√	
Rush et al. (2008)	2002 (1y.)	Canada	36,984	36,885 (99)	Cross-section	Survey	DSM-IV [a]	37	45	55	Alcohol and other drugs	PGSI[y]	1–2	3–7	8–27	√	√	
Wickwire et al. (2008)	2008 (1y.)	USA	157	157 (100)	Cross-section	Survey	DSM-IV [a]	46.5	100	0	Alcohol and other drugs	DSM-IV[a]		3+	5+		√	√
Duhig et al. (2007)	1998 (1y.)	USA	534	534 (100)	Cross-section	Survey	NHSDA [o]	16	48	52	Alcohol	DSM-IV[a]			5+			√
Baldo et al. (2006)	2001 (1y.)	Italy	127	113 (89)	Cross-section	Survey	DSM-IV [a]	48.9	79	21	Alcohol and other drugs	SOGS[u]			5+			√
Weinstock et al. (2006)	2006 (1y.)	USA	167	167 (100)	Cross-section	Survey	DSM-IV [a]	39.9	54	46	Alcohol and other drugs	SOGS[u]			5+			√
Adamson et al. (2006)	2006 (1Y.)	New Zealand	105	105 (100)	Cross-section	Survey	CADS [p]	32.7	68	32	Alcohol and other drugs	SOGS[u]			5+			√

Table 1 (continued)

Authors (year of publish)	Years (y.) of data collections (number)	Country	Sample at baseline	Final sample (response rate%)	Study design	Data collection source	Diagnostic criteria used (SUD) or patients requiring specialist addiction treatment	Mean age	M %	F %	Type of drugs	Diagnostic criteria used for gambling	Cut-off ATG[ac]	Cut-off PrG[ad]	Cut-off PaG[ae]	ATG[ac]	PrG[ad]	PaG[ae]
Petry et al. (2005)	2001–2002 (2y.)	USA	53,201	43,093 (81)	Cross-section	Survey	AUDADIS-IV [l]	52	52	48	Tobacco	DSM-IV[a]		5+				√
de Carvalho et al. (2005)	2005 (1y.)	Brazil	74	74 (100)	Cross-section	Survey	DSM-IV and SADD [q]	29.3	89	11	Alcohol and other drugs	SOGS[u]		3+	5+		√	√
Toneatto et al. (2003)	2003 (1y.)	Canada	853	853 (100)	Cross-section	Survey	Drug maintenance treatment	33.8	65	35	Alcohol and other drugs	SOGS[u]		3+	5+		√	√
Shaffer et al. (2002)	1998–2000 (3y.)	USA	171	164 (95)	Cross-section	Survey	DSM-IV [a]	35.99	53	47	Alcohol and other drugs	DSM-IV[a]		3–4	5+		√	√
Ledgerwood and Downey (2002)	2002 (1y.)	USA	62	62 (100)	Cross-section	Survey	DSM-IV [a]	49.9	50	50	Opioid	SOGS[u]		3+	5+		√	√
Langenbucher et al. (2001)	2001 (1y.)	USA	372	372 (100)	Cross-section	Survey	DSM-IV [a]	35.35	83	17	Alcohol	SOGS[u]			5+			√
Welte et al. (2001)	1999–2000 (2y.)	USA	4036	2638 (65.4)	Cross-section	Survey	DSM-IV [a]	40	49	51	Alcohol	SOGS[u]			5+		√	
Cunningham-Williams et al. (2000)	1989 (1y.)	USA	512	512 (100)	Cross-section	Survey	ICD [r]	21	65	35	Alcohol and other drugs	DIS[m] and DSM-III[t]		1+	4+		√	√

Table 1 (continued)

Authors (year of publish)	Years (y.) of data collections (number)	Country	Sample at baseline	Final sample (response rate%)	Study design	Data collection source	Diagnostic criteria used (SUD) or patients requiring specialist addiction treatment	Mean age	M %	F %	Type of drugs	Diagnostic criteria used for gambling	Cut-off ATG[ac]	Cut-off PrG[ad]	Cut-off PaG[ae]	ATG[ac]	PrG[ad]	PaG[ae]
Slutske et al. (2000)	2000 (1y.)	Vietnam	10,253	8169 (80)	Cross-section	Survey	DSM-III-R[k]	42	100	0	Alcohol	DIS[m] and DSM-III[l]			3 +			√
Lejoyeux et al. (1999)	1997 (1y)	France	79	79 (100)	Cross-section	Survey	MAST[a]	43.1	61	39	Alcohol	DSM-IV[a]						√
Lesieur et al. (1988)	1985 (1y.)	USA	100	100 (100)	Cross-section	Survey	DSM-III[t]	17	81	19	Alcohol and other drugs	SOGS[n]		3_4	5 +		√	√
Cardone et al. (1997)	1996 (1y)	USA	1345	1345 (100)	Cross-section	Survey	DSM-IV[a]	20	68	32	Alcohol and other drugs	DSM-IV[a]	NR	NR	5 +	√	√	√
Rupcich et al. (1997)	1997 (1y.)	Canada	328	328 (100)	Cross-section	Survey	Drug maintenance treatment[t]	NR[e]	67	33	Opioid	SOGS[n]		NR	NR		√	√
Spunt et al. (1996)	1993–1994 (2y.)	USA	500	462 (93)	Cross-section	Survey	Methadone maintenance treatment	39	61	39	NR[e]	SOGS[n]			5 +			√
Shepherd (1996)	1996 (1y.)	UK	93	93 (100)	Cross-section	Survey	Methadone maintenance treatment	NR[e]	NR[e]	NR[e]	NR[e]	SOGS[n]		3–4	5 +		√	√
Daghestani et al. (1996)	1996 (1y.)	USA	276	276 (100)	Cross-section	Survey	Drug maintenance treatment	NR[e]	NR[e]	NR[e]	NR[e]	SOGS[n]			5 +			√
Feigelman et al. (1995)	1995 (1y.)	USA	220	220 (100)	Cross-section	Survey	DSM-IV[a]	35	67	33	Opioid	SOGS[n]		3+	5 +		√	√

Table 1 (continued)

Authors (year of publish)	Years (y.) of data collections (number)	Country	Sample at baseline	Final sample (response rate%)	Study design	Data collection source	Diagnostic criteria used (SUD) or patients requiring specialist addiction treatment	Mean age	M %	F %	Type of drugs	Diagnostic criteria used for gambling	Cut-off ATG[ac]	Cut-off PrG[ad]	Cut-off PaG[ae]	ATG[ac]	PrG[ad]	PaG[ae]
Tomasson and Vaglum (1995)	1995 (1y.)	Iceland	351	351 (100)	Cross-section	Survey	DSM-III[s]	42	71	29	Alcohol and other drugs	DIS[ab]			DSM-III[s] (4+)			√
Griffiths (1994)	1989 (1y.)	UK	456	210 (46)	Cross-section	Survey	DSM-III[s]	NR[e]	NR[e]	NR[e]	NR[e]	NR[e]					√	
McCormick et al. (1993)	1993 (1y.)	USA	2171	2171 (100)	Cross-section	Survey	DSM-III-R[k]	38.62	98	2	Alcohol and other drugs	SOGS[u]			5+			√
Elia and Jacobs (1993)	1991 (1y.)	USA	85	85 (100)	Cross-section	Survey	DSM-III-R[k]	45.6	100	0	Alcohol	SOGS[u]		3+	5+	√	√	
Gambino et al. (1993)	1993 (1y.)	USA	93	93 (100)	Cross-section	Survey	ASI[m]	43.5	92	8	Alcohol and other drugs	SOGS[u]		3+	5+		√	√
Ciarrocchi et al. (1993)	1987 (1y.)	USA	467	467 (100)	Cross-section	Survey	Drug maintenance treatment	21	60	40	NR[e]	SOGS[u]		3+	5+		√	√
Hendriks (1990)	1990 (1y.)	Netherlands	152	152 (100)	Cross-section	Survey	ASI[m]	27.25	80	20	Alcohol and other drugs	DIS[ab]			DSM-III[s] (4+)			√

*Studies presented two different data in the same published report

[a]Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition

[b]International Classification of Diseases, Tenth Revision

[c]Alcohol Use Disorders Identification Test

[d]A subset of questions from the modified version of Alcohol, Smoking, and Substance Involvement Screening Test

Table 1 (continued)

[e] Not reported

[f] European School Survey Project on Alcohol and Other Drugs

[g] Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition

[h] International Classification of Diseases, Ninth Revision

[i] Severity of Dependence Scale

[j] World Health Organization's (WHO) Alcohol, Smoking, and Substance Involvement Screening Test

[k] Diagnostic and Statistical Manual, Third Edition-Revised

[l] Alcohol Use Disorder and Associated Disabilities Interview Schedule—DSM-IV Version

[m] Addition Severity Index

[n] Millon Clinical Multiaxial Inventory, Third Edition

[o] National Household Survey on Drug Abuse

[p] Community Alcohol and Drug Services

[q] DSM-IV criteria and Short Alcohol Dependence Data

[r] International Classification of Disease

[s] Michigan Alcohol Screening Test

[t] Diagnostic and Statistical Manual of Mental Disorders, Third Edition

[u] South Oaks Gambling Screen

[v] NORC Diagnostic Screen for Gambling Disorders, loss of Control, Lying, and Preoccupation

[w] Canadian Problem Gambling Index

[x] Structured Clinical Interview for DSM-IV Axis I Disorders

[y] Problem Gambling Severity Index

[z] Brief Biosocial Gambling Screen

[aa] NORC DSM-IV Screen Self-Administered

[ab] Diagnostic Interview Schedule

[ac] At-risk for gambling disorders

[ad] Problem gambling

[ae] Pathological gambling

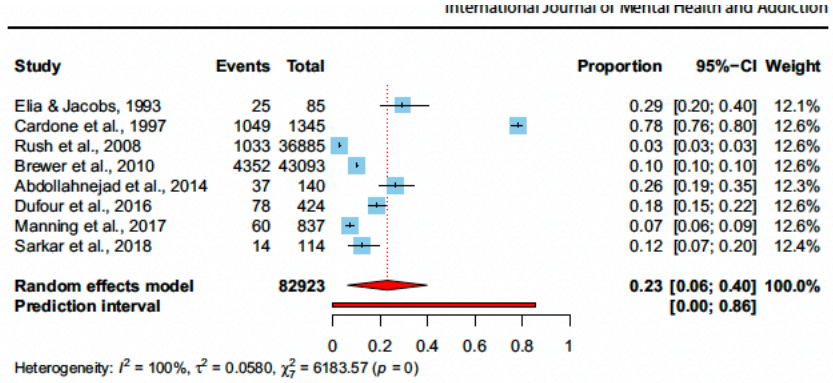

Fig. 2 Pooled prevalence rate of at-risk gambling disorders among individuals with substance use disorders

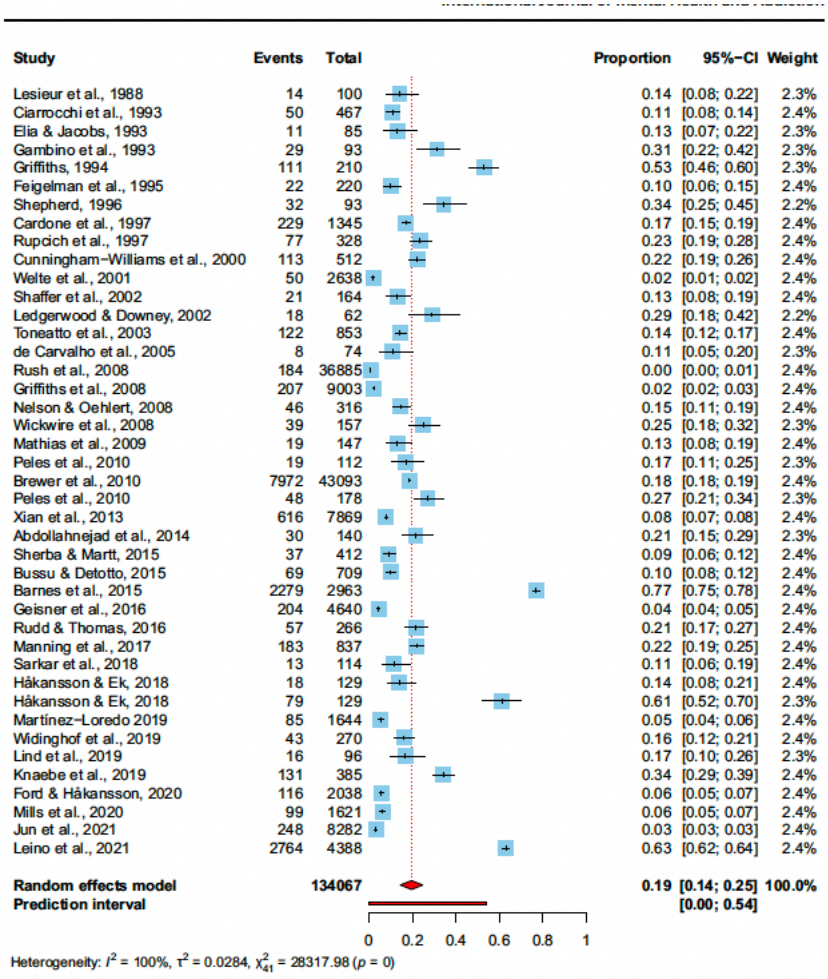

Fig. 3 Pooled prevalence rate of problem gambling among individuals with substance use disorders

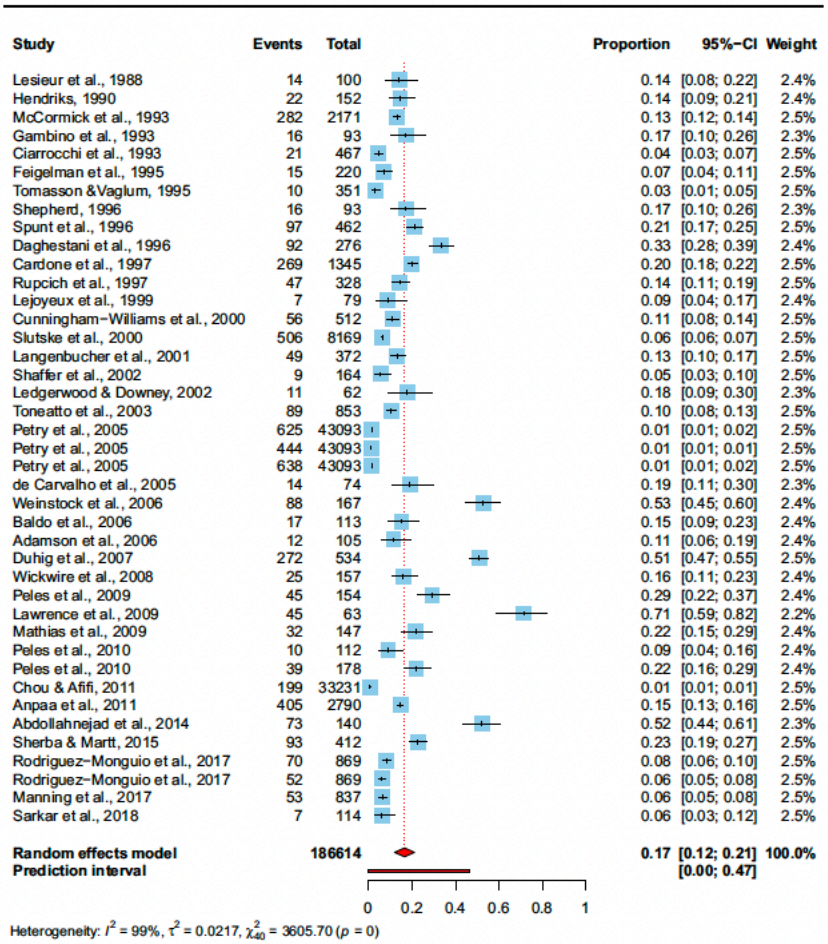

Fig. 4 Pooled prevalence rate of pathological gambling among individuals with substance use disorders

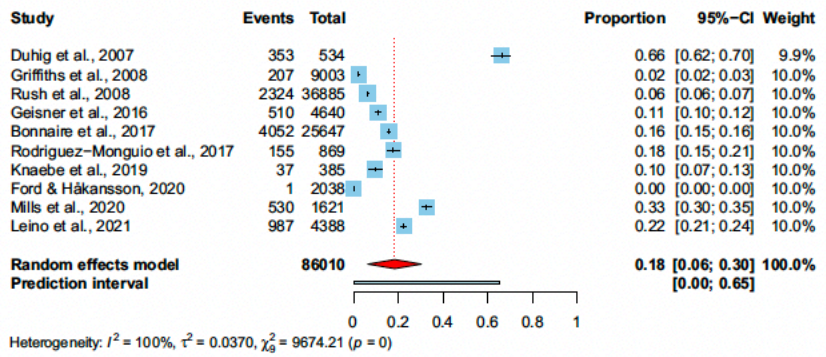

Fig. 5 Pooled prevalence rate of substance use disorders among individuals with problem/pathological gambling

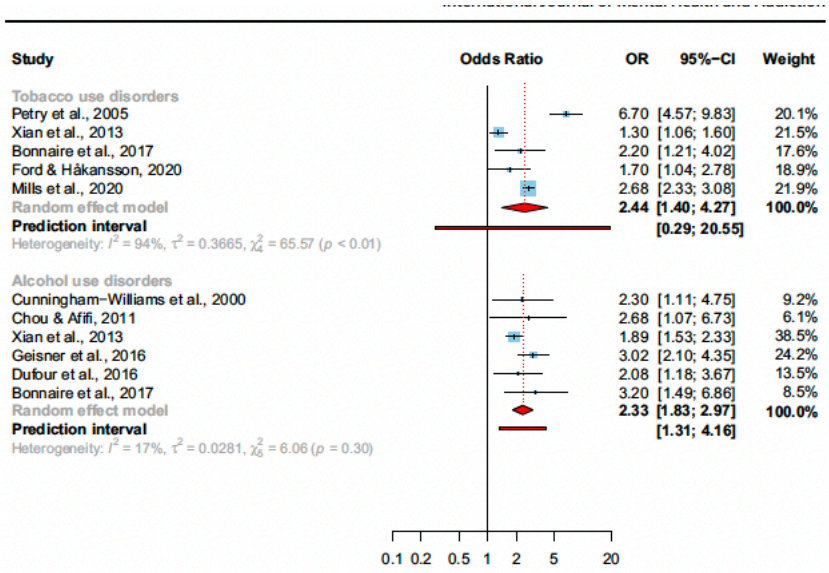

Fig. 7 Pooled odds ratio of type of drug use associated with problem/pathological gambling among individuals with substance use disorders

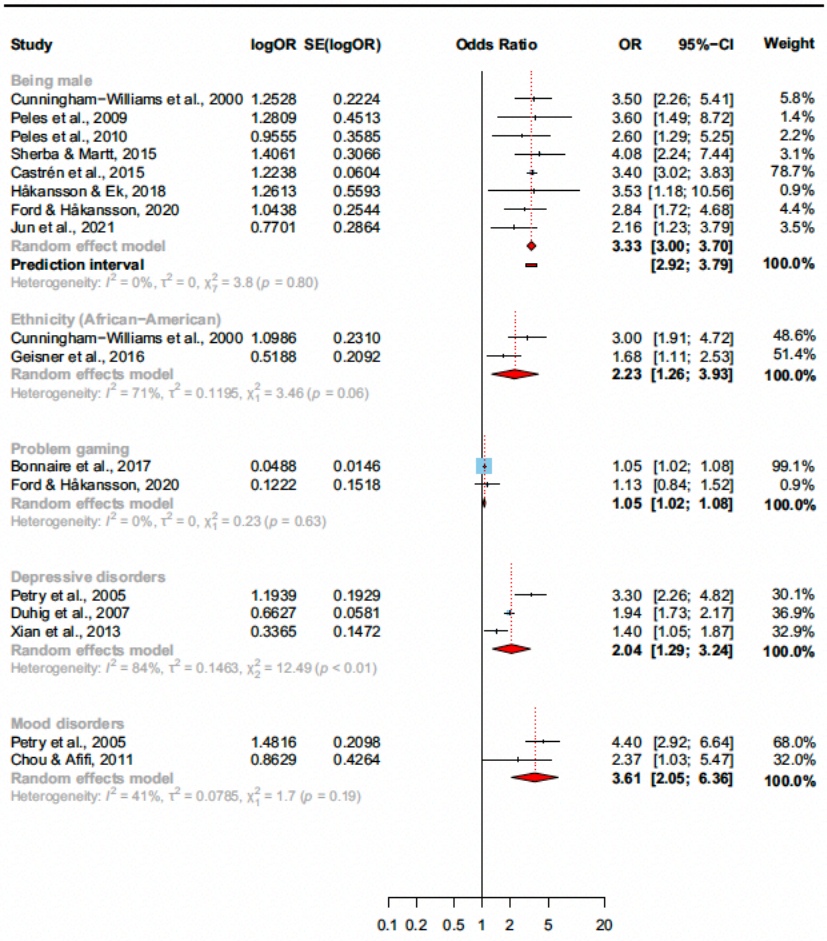

Fig. 6 Pooled odds ratio of sociodemographic and mental health disorders associated with problem/pathological gambling among individuals with substance use disorders