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Suicidality Among Individuals With Gambling Problems: A Meta-Analytic Literature Review

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Gambling problems have consistently been linked to suicidality, including suicidal ideation, attempts, and suicide. However, the magnitude of the relationship has varied significantly across studies and the potential causal link between gambling problems and suicidality is currently unclear. A meta-analytic literature review was conducted to (a) synthesize pooled prevalence rates of suicidality among individuals with gambling problems; (b) determine if individuals with gambling problems had an increased likelihood of reporting suicidality compared to individuals without gambling problems; and (c) review evidence on causality and directionality. A search in Web of Science, APA PsycInfo, APA PsycNet, Medline, CINAHL, ProQuest, Embase, and Google Scholar electronic databases identified 107 unique studies (N = 4,691,899) that were included for review. Studies were included if they were available in any European language and provided sufficient data for the calculation of prevalence rates or effect sizes. Two researchers extracted the data independently using a predefined coding schema that included the Newcastle–Ottawa Quality Assessment Scale. Random-effects meta-analyses yielded pooled prevalence rates of 31.6% (95% CI [29.1%, 34.3%]) for lifetime suicidal ideation and 13.2% (95% CI [11.3%, 15.5%]) for lifetime suicide attempts. Individuals with gambling problems had significantly increased odds of reporting lifetime suicidal ideation (OR = 2.17, 95% CI [1.90, 2.48]) and lifetime suicide attempts (OR = 2.81, 95% CI [2.23, 3.54]) compared to individuals without gambling problems. Two studies reported that individuals with pathological gambling had an increased risk of dying by suicide. Metaregression analyses suggested that the risk of study bias was positively related to the prevalence rates of suicidal ideation. Sex proportions were found to moderate the odds of suicidal ideation, but the direction of the effect was inconsistent. For suicide attempts, psychiatric comorbidity and sample size were positively and inversely, respectively, associated with prevalence rates. The synthesis indicates that suicidality is common among individuals with gambling problems and hence should be addressed by help agencies. Inferences on causality and directionality are hampered by a lack of longitudinal studies.

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Author Note

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Abstract

Gambling problems have consistently been linked to suicidality, including suicidal ideation, attempts, and suicide. However, the magnitude of the relationship has varied significantly across studies and the potential causal link between gambling problems and suicidality is currently unclear. A meta-analytic literature review was conducted (a) to synthesize pooled prevalence rates of suicidality among individuals with gambling problems; (b) to determine if individuals with gambling problems had an increased likelihood of reporting suicidality compared to individuals without gambling problems; and (c) to review evidence on causality and directionality. A search in Web of Science, PsycINFO, PsycNet, Medline, CINAHL, ProQuest, Embase, and Google Scholar electronic databases identified 107 unique studies (*N* = 4,691,899) that were included for review. Studies were included if they were available in any European language and provided sufficient data for the calculation of prevalence rates or effect sizes. Two researchers extracted the data independently using a pre-defined coding schema that included the Newcastle-Ottawa Quality Assessment Scale. Random-effects meta-analyses yielded pooled prevalence rates of 31.6%, 95% CI [29.1%, 34.3%] for lifetime suicidal ideation and 13.2%, 95% CI [11.3%, 15.5%] for lifetime suicide attempts. Individuals with gambling problems had significantly increased odds of reporting lifetime suicidal ideation (*OR* = 2.17, 95% CI [1.90, 2.48], and lifetime suicide attempts (*OR* = 2.81, 95% CI [2.23, 3.54]) compared to individuals without gambling problems. Two studies reported that individuals with pathological gambling had an increased risk of dying by suicide. Meta-regression analyses suggested that the risk of study bias was positively related to the

prevalence rates of suicidal ideation. Sex proportions were found to moderate the odds of suicidal ideation, but the direction of the effect was inconsistent. For suicide attempts, psychiatric comorbidity and sample size were positively and inversely, respectively, associated with prevalence rates. The synthesis indicates that suicidality is common among individuals with gambling problems and hence should be addressed by help agencies. Inferences on causality and directionality are hampered by a lack of longitudinal studies.

Keywords: Pathological gambling, gambling disorder, suicide, self-harm, meta-analysis.

Public Significance Statement

This meta-analytic literature review of 107 studies shows that lifetime suicidal ideation and suicide attempt(s) are commonly reported among individuals with gambling problems and that individuals with gambling problems have an increased likelihood of reporting lifetime suicidal ideation, suicide attempt(s), and dying by suicide compared to the general population. The observed increased likelihood of suicidality should be noted and addressed by help agencies and policymakers. Little is known about the directionality and mechanisms underlying this relationship which needs to be investigated in future high-quality longitudinal research.

Suicidality Among Individuals with Gambling Problems: A Meta-Analytic Literature Review

Gambling is a common leisure activity in most cultures and includes, among others, lottery playing, sports betting, slot machine gambling, and casino gambling, in which the individual can engage in either land-based (or offline) or online gambling. While gambling is an exciting and social pastime activity for most individuals, a minority of gamblers experience difficulties controlling their gambling behavior, resulting in gambling-related problems. Gambling problems may encompass several domains including, but not limited to, financial problems, psychological- and emotional distress, and adverse functional outcomes such as relationship problems or job loss (Langham et al., 2016; Potenza et al., 2019). An extensive body of literature has also shown a link between gambling problems and suicidality, including suicidal ideation, suicide attempts, and suicide (Bischof et al., 2015; Karlsson & Håkansson, 2018). For instance, recent meta-analyses have suggested that 31% and 16% of individuals with gambling problems report having experienced lifetime suicidal ideation and suicide attempt(s), respectively (Armoon et al., 2023), and that individuals with gambling problems have an increased likelihood of reporting suicidality compared to individuals without gambling problems (Edson et al., 2022). However, the magnitude of the relationship has varied significantly across studies and the observed between-study variance currently remains unexplained. Moreover, the potential causal link between gambling problems and suicidality is currently unclear. A systematic meta-analytic review could significantly add to the literature by synthesizing the scientific evidence and quantifying the strength of the relationship between gambling problems and suicidality across studies. Moreover, meta-analyses present the opportunity to investigate sources of between-study variance that could identify potential risk factors associated with suicidality among individuals with gambling problems. Against this backdrop, a meta-analytic review of the published literature was conducted to synthesize the results from the current evidence base and to investigate potential sources of between-study variance.

Gambling Problems

Various terms have been used to describe the condition in which gambling becomes problematic. "Pathological gambling" (F63.0) is listed in the 10th edition of the *International Classification of Diseases* (ICD-10; World Health Organization, 1993) describing a disordered pattern of frequent, repeated episodes of gambling that dominate the patient's life, causing detriments to social-, occupational-, and marriage/family functioning. In the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5; American Psychiatric Association, 2013), "Gambling disorder" is categorized as a behavioral addiction characterized by persistent and recurrent problematic gambling behavior leading to clinically significant impairment or distress over 12 months. However, one may experience (severe) gambling-related problems without fulfilling the diagnostic criteria specified by the diagnostic manuals. Therefore, "problem gambling" has been widely used as an overarching term referring to any gambling behavior that is associated with harmful effects (Blaszczynski et al., 2004). Consistent with the latter, the present review uses the term *gambling problems* to indicate any level of gambling-related harm. More specifically, *individuals with gambling problems* will in line with the aforementioned operationalization include persons who experience clinical- or sub-clinical gambling problems that can be identified through clinical interviews, validated self-report measures, and/or self-categorization/self-diagnosis. The prevalence of gambling problems varies, but most studies report that 0.12 – 5.8 percent of adults experience gambling problems to some degree across cultures (Calado & Griffiths, 2016).

Suicidality

Suicide is a major cause of death, each year claiming over 700,000 lives worldwide (World Health Organization, 2021). Suicidal ideation and non-fatal suicide attempts are common precursors to suicide, but the relationships between suicidal ideation, suicide attempts, and suicide are complex. For example, there are considerably more individuals who have experienced suicidal ideation and/or have attempted suicide than there are individuals who die by suicide (Klonsky et al., 2016). The

prevalence rates of suicidal ideation and suicide attempts have varied significantly across epidemiological studies. However, a recent meta-analysis synthesized a lifetime prevalence rate of suicidal ideation of 9.1% and pooled lifetime prevalence of suicide attempts of 2.9% among adults in the general European population (Castillejos et al., 2021). Suicidal ideation, suicide attempts, and suicides, usually involve a great deal of harm to the individual (e.g., serious injuries), those close to him or her (e.g., worry or loss of significant other), and society (e.g., medical costs, productivity loss) (Salim et al., 2006; Shepard et al., 2016; Stanford et al., 2007; Verrocchio et al., 2016). Therefore, identifying and investigating factors associated with suicidal ideation, suicide attempts, and suicide, are important to prevent and treat these outcomes. Important risk factors for suicide include suicidal ideation and previous attempts, life stress (e.g., financial problems or relationship problems), being of older age, and being male (Klonsky et al., 2016; World Health Organization, 2021; Yoshimasu et al., 2008). However, while men account for two-to-four times the number of suicides than women (Klonsky et al., 2016), women have a higher risk of suicidal ideation and -attempts compared to men (Canetto & Sakinofsky, 1998; Schrijvers et al., 2012). Furthermore, suicidal ideation, suicide attempts, and suicide are all strongly associated with mental health disorders (Barrigon & Cegla-Schvartzman, 2020; Favril et al., 2022). More specifically, mood disorders (e.g., depression and bipolar disorder), personality disorders, psychotic disorders, substance use disorders, and addictive disorders are important predictors of suicidal ideation, suicide attempts, and suicide (Favril et al., 2022; Klonsky et al., 2016; Yoshimasu et al., 2008).

Different nomenclature and definitions have been used to categorize and describe suicide-related behaviors and constructs (Goodfellow et al., 2018). The definitions employed in the present paper derive from the *Columbia Classification Algorithm for Suicide Assessment* (C-CASA; Posner et al., 2007). Accordingly, *suicidal ideation* is defined as "passive thoughts about wanting to be dead or active thoughts about killing oneself, not accompanied by preparatory behavior". S*uicide attempts* are defined as "a potentially self-injurious behavior, associated with at least some intent to die, as a result of the act", while *suicide* is defined as "a self-injurious behavior that resulted in fatality and was

associated with at least some intent to die as a result of the act" (Posner et al., 2007). Finally, throughout the present paper term *suicidality* is used as an umbrella term referring to the combined constructs of ideation, suicide attempts, and suicide, although the constructs are distinguished when relevant.

The Relationship Between Gambling Problems and Suicidality

The mechanisms underlying the relationship between gambling problems and suicidality are currently not fully understood. Hufford (2001) proposes that the risk for suicidality can be understood as an aggregation of stable risk factors, so-called "distal risk factors" (e.g., mental health disorders, other illnesses, negative life events with long-term consequences), and more acute "proximal risk factors" (e.g., intoxication, psychosocial crisis). Proximal risk factors play a role in determining the timing of suicidality as they increase the risk in the immediate moments before engaging in suicidal ideation and/or self-injurious behavior. In line with this framework, the association between gambling problems and suicidality is considered to include both distal and proximal factors of which negative gambling-specific consequences such as big losses or relationship breakdowns are potential proximal factors that could trigger suicidal ideation and suicide attempts (Conner et al., 2003; Hufford, 2001). In another vein, the Interpersonal Theory of Suicide (Joiner, 2005) postulates that accumulated distress may increase the individual's feeling of thwarted belongingness and perceived burdensomeness and that the risk of suicide is highest when these perceptions are simultaneously present. According to Joiner (2005), whether suicidal ideation is put into action depends on the individual's capability to engage in suicidal behavior. Consequently, as the level of gambling problems increases (e.g., accumulating unmanageable financial debts), gamblers may begin to feel socially isolated and perceive themselves as a burden to their close ones, believing that they would be better off without them (Gray et al., 2021).

Hufford's (2001) and Joiner's (2005) frameworks could both indicate possible pathways through which gambling problems could increase the risk of suicidality. Still, consistent with the Self-

medication Hypothesis of Addictive Disorders (Khantzian, 1985, 1997), the directionality may be the reverse. For instance, individuals contemplating taking their life by suicide may possibly develop gambling problems as they withdraw to gambling to cope with/escape from distress related to their suicidality. Another possibility is that the relationship between gambling problems and suicidality is explained by common third factors like comorbid mental disorders, personality traits, sex, and/or genes (Gray et al., 2021). Yet, it is most likely that the relationship between gambling problems and suicidality constitutes a complex and multifaceted interplay between all of the abovementioned causal pathways causing a spiraling effect of distress that could ultimately result in suicide.

The Present Meta-Analytic Review

Previous Reviews

At present, there have been two attempts to quantitatively meta-analyze findings on the relationship between gambling problems and suicidality, both of which were published recently (Armoon et al., 2023; Edson et al., 2022). Armoon et al.'s (2023) meta-analysis of 39 studies yielded overall prevalence rates of 31%, 95% CI [23%, 39%] for suicidal ideation (*k* = 26) and 16%, 95% CI [0.12%, 0.20%] for lifetime suicide attempt(s) (*k* = 30). Edson et al. (2022) extracted adjusted effect sizes from a pool of 21 primary studies, yielding overall odds ratios (*OR*) of *OR* = 1.76, 95% CI [1.14, 2.72] for suicidal ideation (*k* = 10) and *OR* = 2.35, 95% CI [1.30, 4.46] for suicide attempt(s) (*k* = 10). However, these effects were all based on cross-sectional studies and the overall effect was reduced to non-significant after adjusting for the effect of possible publication bias. Subsequently, the authors concluded that a definitive empirical effect of gambling problems on suicidal ideation and suicide attempts could not be demonstrated (Edson et al., 2022).

The two aforementioned reviews have some important limitations. First, both studies reported high levels of between-study variance (heterogeneity) in their syntheses. Yet, the authors were not able to identify any predictor variables that could significantly account for the variance in the prevalence rates or odds ratios of suicidality using univariate meta-regression and sub-group analyses.

As Edson et al. note, this result might be attributed to a lack of statistical power due to a relatively small number of studies included in the specific meta-analyses. Consequently, the variables moderating the relationship between gambling problems and suicidality are at present unknown. Another limitation is that neither review included unpublished studies (e.g., conference proceedings or gray literature) and included only manuscripts published in the English language. This restricts the pool of studies and may further lead to bias in the estimates (Borenstein et al., 2021). Finally, no previous reviews have at present synthesized the evidence regarding the prevalence rates of suicide among individuals with gambling problems (and comparisons with individuals without gambling problems), which arguably is the most important/serious of the suicidality outcomes.

Potential Moderators of the Relationship Between Gambling Problems and Suicidality

The between-study variance in prevalence rates of suicidality among individuals with gambling problems has previously been attributed to heterogeneity between samples and methodological characteristics (Ronzitti et al., 2017). However, these potential moderating effects have previously not been investigated empirically using a multivariate meta-regression approach. Sample characteristics that may act as moderators in the relationship between gambling problems and suicidality include sex, age, and psychiatric comorbidity. Consistent with suicidology research in general, several studies among individuals with gambling problems have reported higher prevalence rates of suicidal ideation and suicide attempts among women compared to men (e.g., Carr et al., 2018; Pavarin et al., 2022; Ronzitti et al., 2017), albeit not consistently (Darbeda et al., 2020; e.g., Weinstock et al., 2014). Other studies have reported age to be an influential factor, where some studies have found younger age to be associated with increased risk for suicidality among individuals with gambling problems (Kausch, 2004; Karlsson & Håkansson, 2018; Leung & Tsang, 2011). Moreover, individuals with gambling problems often suffer from other mental health disorders in addition to their maladaptive gambling, of which the most frequent psychiatric comorbid conditions include mood disorders such as depression and bipolar disorder, anxiety, and substance use disorders; all of which are conditions that

are well-known risk factors for suicidality more generally (Favril et al., 2022; Håkansson et al., 2018; Klonsky et al., 2016; Yoshimasu et al., 2008). Consequently, psychiatric comorbidity within samples of individuals with gambling problems could serve as a potential moderator because it could increase the total symptom level and related impairment, therefore possibly leading to a greater psychological burden and as such increasing the risk of suicidality (Angold et al., 1996; Foley et al., 2006).

Regarding potential methodologically related moderators, differences in operationalizations of gambling problems (e.g., "at-risk problem gambling" vs. a clinical diagnosis of "pathological gambling" [F63.0]) across studies could potentially moderate prevalence rates of suicidality because different operationalizations could yield samples with different levels of gambling severity, which in turn could likely affect estimates of suicidality rates. Other potential moderating effects could derive from characteristics of the wide range of different ways of assessing suicidality (Klonsky et al., 2016). For instance, assessments often vary in terms of the timeframe (e.g., current-, last 12 months-, or lifetime occurrence) which affects prevalence rates because individuals are more likely to report a lifetime occurrence of suicidality than reporting suicidality within the past year. Lastly, while several standardized self-report measures of suicidality for research purposes are available (Batterham et al., 2015), studies on suicidality still seem too often to rely on single-item assessments which have rarely been psychometrically investigated (Millner et al., 2015). The use of non-validated assessments could increase the risk of misclassification of participants resulting in different prevalence rates compared to the rates found in studies using assessments that have demonstrated good psychometric properties (Chen et al., 2021; Millner et al., 2015). Against this backdrop, the present review extracted and investigated sex, age, psychiatric comorbidity, operationalization of gambling problems (strict versus lenient), the timeframe of suicidality (last 12 months versus lifetime), and use of validated (versus non-validated) suicidality instruments as moderators in multivariate meta-regression analyses.

Research Questions

Gambling problems and suicidality are both normally associated with substantial distress and suffering for those affected (Potenza et al., 2019; Verrocchio et al., 2016). The harms related to these conditions also extend beyond the individual, placing a significant emotional and economic burden on the family, kin, colleagues, and society as a whole in terms of costs to healthcare services as well as productivity loss due to reduced or lost work capacity (Black et al., 2015; Hofmarcher et al., 2020; Klonsky et al., 2016). Therefore, comprehensive, consolidated, and updated knowledge of the relationship between the two constructs is important to increase awareness and inform clinicians, researchers, and policymakers. Moreover, if the link between gambling problems and suicidality reflects a causal relationship, it would suggest that increasing efforts towards prevention and/or treatment of gambling problems could be a promising strategy to reduce suicidality, or vice versa. Three research questions (RQs) were developed to aid the present review process: *What is the prevalence rate of suicidality (i.e., suicidal ideation, suicide attempts, and suicides) among individuals with gambling problems?* (RQ1); *Do individuals with gambling problems have a different likelihood than individuals without gambling problems to experience suicidality and what is the possible magnitude of this difference?* (RQ2); and *What does the current evidence suggest regarding the causality and directionality between gambling problems and suicidality?* (RQ3).

Method

Transparency and Openness

The current meta-analytic review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines for systematic reviews (Page et al., 2021) and the Meta-analytic Reporting Standards (MARS; Appelbaum et al., 2018). All data and research materials are available on the OSF repository (https://osf.io/vqf9b/; Kristensen et al., 2023). The current review project was pre-registered on PROSPERO (CRD42022296929).

Eligibility Criteria

Studies were deemed eligible if they: (a) addressed gambling problems specifically; (b) addressed suicidal ideation, suicide attempts, and/or suicide specifically; (c) were reported in any European language; and (d) provided original empirical data on prevalence rates, or comparisons against individuals without gambling problems, on suicidal ideation, suicide attempts, and/or suicide among individuals with gambling problems (or sufficient data to calculate prevalence rates/effect sizes). Abstracts and meeting proceedings (e.g., from conferences) were included if they provided sufficient data and original empirical findings. Studies were excluded if they: (a) reported findings on unproblematic/normal gambling behavior or behaviors that may cover gambling problems but are not limited to gambling problems specifically (e.g., internet addiction); (b) reported findings concerning self-harm without lethal intent (i.e., non-suicidal self-injury); and (c) reported current risk/threat of suicide rather than suicidal ideation, suicide attempts, or suicide specifically. Case studies, qualitative studies, literature reviews/meta-analyses, and animal studies were not included. No further restrictions on study designs were enforced.

Information Sources and Search Strategy

Literature searches without time constraints were conducted in Web of Science (Core Collection; 1945-2023), APA PsycINFO (1806-2023), APA PsycNet (unknown-2023), Medline (Ovid; 1946-2023), CINAHL (EBSCO; 1979-2023), ProQuest (all databases; 1634-2023), and Embase (1974-2023). Also, a literature search was conducted on Google Scholar (unknown-2023), of which we reviewed the first 30 pages due to a large number of results (over 12,000 hits). All literature searches were completed on April 1, 2023. Search items were: “probl* gambl*” OR “gambling problem*” OR “gambling addiction” OR “pathological gambl*” OR “compulsive gambl*” OR “gambling disorder” OR “disordered gambl*” OR ludomania AND suic* OR self-inflicted OR self-harm OR parasuicide. See Supplementary Material 1 for the full search strategies for each database. To identify possible relevant studies that did not appear in the formal search strategy, the reference lists of the included reports were examined, and investigated to see whether the located study had been previously included in

the formal search- and screening process. However, no additional studies were identified for further investigation using this process. Additionally, in instances in which studies reported insufficient data on the outcome variable (i.e., suicidality), the corresponding authors were contacted to obtain the required data.

Selection Process

Two authors (JHK and JB) independently screened the identified reports' titles and abstracts to identify potentially eligible studies. After completion of the individual title and abstract screening, the reviewers reconvened and resolved discrepancies through discussion. The level of agreement between the reviewers in the title/abstract screening process was high (88%). The full texts of the potentially eligible studies were then independently assessed against the inclusion and exclusion criteria. Again, discrepancies were resolved by discussions (level of agreement before discussion = 94%). Reports that presented results based on the same data material were excluded to avoid inappropriate weighing of the studies in the quantitative syntheses. In these cases, the study with the largest number of participants (*N*) were retained.

Data Collection Process and Coding Procedures

The outcomes of interest were gambling problems and suicidal ideation, suicide attempts, and suicide, assessed by self-report, clinical- or lay interview, or objective measurements. Data were extracted independently by two authors (JHK and JB) using a coding schema made for the present study. The coding scheme encompassed information regarding study characteristics, methods, and results. The full coding scheme can be found in Supplementary Material 2. The study selection and data extraction/coding process were both conducted within the Covidence Systematic Review software (Veritas Health Innovation, n.d.). Inter-reviewer reliability was calculated separately for the coding and extraction processes for moderator variables and results. This process yielded an agreement of 76% and 85%, respectively. All discrepancies were resolved by discussions and consulting the original reports.

Prevalence rates and/or effect sizes on the comparisons of individuals with- and without gambling problems on suicidality outcomes were extracted directly from the studies' reports or manually calculated when not directly provided by the report. Several studies categorized their samples into subgroups based on the severity of gambling problems (e.g., no risk, low risk, moderate risk, and problem gambling according to the Problem Gambling Severity Index [PGSI]). In these cases, the prevalence rates and moderator data from all subgroups were collapsed, adjusting for the number of individuals in each subgroup, to capture any severity level of gambling problems. If the report only provided calculated effect sizes among subgroups, the data were collapsed by calculating a mean effect size using a fixed-effect model ensuring that the control/contrast groups were not counted more than once. Similar procedures were performed for studies reporting findings on subgroups based on other variables (e.g., sex). Some reports provided both lifetime and current/past 12 months of suicidality. In these cases, only data on lifetime suicidal ideation/suicide attempts was entered in the quantitative meta-analysis. Also, in cases where the report only provided data on suicidal ideation and suicide attempts as one collapsed outcome, these were coded as suicidal ideation because it was assumed that most individuals who have experienced a suicide attempt would also have experienced suicidal ideation. Finally, when extracting data on the prevalence of psychiatric comorbidity within samples of individuals with gambling problems, studies varied greatly in terms of the conditions they assessed and reported. Therefore, data were extracted for all reported comorbid psychiatric conditions but only included the prevalence rate of the most frequently reported condition as a moderator variable in the analyses.

Risk of Bias Assessment

The risk of bias in the individual studies was assessed independently by two authors (JHK and JB) using an adapted version of the Newcastle-Ottawa Quality Assessment (NOS; Herzog et al., 2013; Wells et al., 2000; available in Supplementary Material 2). The NOS assesses the risk of bias in the studies across three domains; (a) the sample collection process; (b) comparability between groups;

and (c) the ascertainment of the results. The level of agreement between the reviewers in the risk of bias assessment was 69%. Discrepancies were resolved by discussions. The higher the score of the NOS the lower the risk of bias.

Meta-analytic Strategy

A series of meta-analyses were conducted aiming (a) to estimate pooled prevalence rates of suicidality among individuals with gambling problems and (b) to synthesize pooled odds ratios for comparisons of odds related to individuals with- and without gambling problems for each suicidality outcome (i.e., suicidal ideation, suicide attempts, and suicide). It was expected that studies providing comparisons of individuals with- and without gambling problems would vary in terms of reporting unadjusted or adjusted effect sizes or both. Accordingly, the research team a priori planned to conduct two sets of meta-analyses for these studies, of which the first set was based on unadjusted estimates only, and a second set based on adjusted effect sizes in which the effect sizes adjusted for the largest number of variables by the individual study was included. Further, seven studies that compared individuals with- and individuals without gambling problems (Cunningham-Williams et al., 2007; Feigelman et al., 2006; Haydock et al., 2015; Jolly et al., 2021; Jones et al., 2015; Manning et al., 2015; Valenciano-Mendoza et al., 2021) included individuals with other mental health disorders (e.g., substance use disorders) as a contrast. To reduce heterogeneity, the research team chose to not include these effect sizes in the quantitative analyses on comparisons but to include these in separate meta-analyses, because most studies providing comparisons employed non-clinical samples from the general population as contrasts.

Given that significant study heterogeneity (between-study variance) was expected due to variability in participants' characteristics and the measurement tools used in the included studies, random-effects models were selected a priori to be conducted for each suicide outcome that yielded five or more studies. If the given suicidality outcome was reported by less than five individual studies, meta-analysis was not performed because random-effects models in such cases could yield an

inappropriate estimation of the between-study variance. The presence of heterogeneity was assessed by Cochran *Q*, and the I^2-statistic was calculated to quantify the total amount of variability in the sets of prevalence rates/effect sizes that reflected "true" differences between the studies as opposed to sampling errors. An I^2- percentage of 25%, 50%, and 75% can roughly be interpreted as a low, medium, and high level of true heterogeneity, respectively (Higgins & Thompson, 2002).

Random-effects model meta-regressions were conducted to investigate possible moderators that could explain the observed heterogeneity in the syntheses. Following the recommendations of including approximately 10 studies for each covariate when investigating the potential moderators by meta-regression analyses (Borenstein et al., 2021), the number of variables entered in the meta-regression models was dependent on the number of studies (*k*) included in the specific analysis. The research team selected a priori and in prioritized order to test (a) sex proportions, (b) mean age, (c) prevalence of psychiatric comorbidity (within samples of individuals with gambling problems), (d) strict vs. lenient operationalization of gambling problems, (e) lifetime suicidality vs. last 12 months, and (f) single- or created for the specific study suicidality items vs. validated assessments, as potential predictors.

Regarding strict vs. lenient operationalization of gambling problems, the operationalization was coded as strict if the study employed clinical assessment and/or a standardized and validated measurement (including self-report) of gambling problems and used the conventional cut-off value to indicate the most severe category (e.g., PGSI ≥ 8 / 4 ≥ of 9 DSM-5 criteria). The operationalization was coded as lenient if the study employed non-standardized/non-validated measurements (e.g., single item measurement, self-categorization as defined by calling helpline) and/or a lower cut-off value than the conventional cut-off when using standardized and validated measurements (e.g., PGSI > 5). Moreover, due to a high number of included studies, (*g*) risk of bias (NOS) and (*h*) sample size were chosen post-data extraction to be included as predictors in the model.

Due to missing data, the research team chose to dummy code the continuous moderators (i.e., sex proportions, mean age, prevalence of psychiatric comorbidity) into categorical variables before entering the data into the regression models. The dummy variables comprised four categories; one "unknown" category; and three categories that were based on the tertiles of the proportion of the specific variable (e.g., lower-, middle-, and higher third of reported prevalence of psychiatric comorbidity) among the studies included in the specific analysis. The "lower third" -category was set as the reference category. This approach was chosen so that studies would not be excluded from the multivariate meta-regression models if data were missing from one or more moderator variables in the specific study (this is how the Comprehensive Meta-Analysis software handles missing data.), which consequently could lead to biased results and insufficient statistical power.

Publication Bias

All meta-analyses were assessed for the influence of possible publication bias by the Egger's test (Egger et al., 1997) and Duval and Tweedie's trim and fill procedure (Duval & Tweedie, 2000b, 2000a). The Egger's test is a linear regression model in which the standardized effect size is the dependent variable, and the inverse of the standard error comprises the independent variable. Bias is considered to be present if the intercept is significantly different from zero. The trim-and-fill procedure was used to assess the magnitude of the bias of the pooled estimates. It complements the funnel plot by imputing theoretically missing studies and provides a "best estimate" adjusted for the influence of publication bias. For the meta-analyses based on group comparisons (i.e., *OR*s), publication bias was also assessed by estimating selection ratios (η) as described in the sensitivity analyses proposed Mathur and VanderWeele (2020). The η is an estimate of how more likely affirmative studies (i.e., studies reporting significant positive effects) are to be published over nonaffirmative studies (studies reporting non-significant results or inverse effect sizes) that would bring the overall effect estimate to null or shift the confidence intervals to include 0. Larger η-values indicate stronger robustness to

publication bias, of which an η-value above 3.5 can be considered to reflect a relatively robust synthesis (Mathur and VanderWeele, 2020)[1].

Selection ratios were estimated using the *PublicationBias* package (version 2.3.0; Braginsky et al., 2023) for R (R Core Team, 2023), based on the robust cluster specification and assuming that publication bias would favor studies yielding positive significant effect sizes. All other statistical meta-analytic procedures were conducted using the Comprehensive Meta-Analysis software, version 3 (Biostat Inc., 2014).

Results

A flowchart diagram summarizing the results of the literature search strategy, and the study screening and selection process is presented in Figure 1. After removing duplicate records (*N* = 810), the remaining 1,070 papers were screened on titles and abstracts resulting in 260 records for full-text review. From this pool, 107 unique studies met the inclusion criteria and were included in the present review. A list of records that did not meet the inclusion criteria after full-text review, with reasons for exclusion, is available in Supplementary Material 4. In total, 79 studies reported data on suicidal ideation and 86 studies reported data on suicide attempts. In addition, two studies (Karlsson & Håkansson, 2018; Pavarin et al., 2021) reported data on the relationship between pathological gambling and suicide.

[Please insert Figure 1 about here]

Descriptive Characteristics of the Included Studies

[1] In the pre-registration of the present review, it was specified that publication bias would also be investigated by estimating Orwin's fail-safe *N* (Orwin, 1983) for all meta-analyses. The research team chose post-data extraction to replace Orwin's fail-safe *N* with selection ratios (η; Mathur and VanderWeele, 2020) to include newer developments in publication bias assessment. The procedure and results regarding Orwin's fail-safe *N* are available in Supplementary Material 3. The research team also chose post-data extraction to include two additional predictor variables in the meta-regression analyses, as described in the "Meta-Analytic Strategy"-section of the present paper. No other significant deviations were made from the pre-registration.

A table summarizing the characteristics and key findings of the individual studies is available in Supplementary Table 1. From the pool of 107 studies, 99 were peer-reviewed research papers, while four manuscripts comprised doctoral theses (Afifi, 2008; Bulcke, 2008; Kaufman, 2002; Lane, 2021), and four (Andronicos et al., 2010; Carmassi et al., 2020; Hashimoto & Nishimura, 2015; Soyata et al., 2015) were conference abstracts. The included studies were published within the timeframe of 1987 to 2023. The sample sizes of the individual studies ranged from 24 to 4,027,731 participants, yielding a summarized pool of 4,691,899 participants. The proportions of individuals with gambling problems varied from 0.13% to 100% between studies, and a total of 114,402 participants were classified as having gambling problems of some severity according to self-report measures, self-diagnosis/categorization, or clinical assessment. The samples originated from 25 different countries, with the majority of samples deriving from North America (*k* = 47) and Europe (*k* = 33), while 14 came from Asia, eight from Oceania, four from Central- and South America, and one from the African continent (see Supplementary Table 1). Mean participant age varied from 14.4 to 71.6 years old, and the distribution of women ranged from 0% to 100% (see Supplementary Table 1).

The vast majority of studies were cross-sectional (*k* = 92), of which three studies (Black et al., 2015; Ciarrocchi, 1987; Sundqvist & Wennberg, 2021) employed a retrospective case-control design. Additionally, two studies (Cunningham-Williams et al., 2007; Schwarz & Lindner, 1992) were based on (cross-sectional) data collected in experimental studies (i.e., clinical interventions). Moreover, 11 studies (Chaput et al., 2007; Darbeda et al., 2020; Feigelman et al., 2006; Jeannot et al., 2023; Jolly et al., 2021; Karlsson & Håkansson, 2018; Ledgerwood et al., 2013; Morefield et al., 2014; Pavarin et al., 2021; Pavarin et al., 2022; Slutske et al., 2022) employed longitudinal designs, including four studies (Karlsson & Håkansson, 2018; Pavarin et al., 2021; Pavarin et al., 2022; Slutske et al., 2022) that employed a longitudinal cohort study design. Yet, only one of the longitudinal studies (i.e., Slutske et al., 2022) provided longitudinal associations on the relationship between gambling problems and suicidality.

Most participants were recruited from a treatment setting (*k* = 40), followed by random population sampling (*k* = 19), educational institutions (i.e., students; *k* = 12), while 13 studies were based on medical records or health registries, 10 studies employed data from gambling helplines, and the remaining 13 studies used various types or combinations of convenience sampling (see Supplementary Table 1 for references).

Assessment of Gambling Problems

Gambling problems were most commonly assessed by instruments administrated through clinical- or lay interviews (*k* = 43) or self-report questionnaires (*k* = 40), while 14 studies were based on self-categorization (e.g., calling a helpline or seeking treatment as an indication of gambling problems; see Supplementary Table 1), six studies (Andronicos et al., 2010; Jolly et al., 2021; Karlsson & Håkansson, 2018; Pavarin et al., 2022; Pavarin et al., 2021; Ronzitti et al., 2019) were based on clinical diagnoses found in medical records or health registries (e.g., ICD-9/10 codes), two studies (Hodgins et al., 2006; Petry & Kiluk, 2002) employed a combination of self-report questionnaire and clinical assessment, one study (Morefield et al., 2014) combined referral and a self-report questionnaire, and one study (Jeannot et al., 2023) combined self-referrals and referrals by healthcare personnel to a treatment facility. Among the studies which employed validated measures of gambling problems, the most frequently used instrument were variations of the South Oaks Gambling Screen (SOGS; *k* = 28), the full- or the PGSI-section of the Canadian Problem Gambling Index (CPGI; *k* = 11), the National Opinion Research Center DSM Screen for Gambling Problems (NODS; *k* = 8), and various assessments based on the DSM-III/DSM-IV/DSM-5-criteria (*k* = 25; see Supplementary Table 1 for references).

Assessment of Suicidality

Data on suicidal ideation and suicide attempts were mostly collected through self-report questionnaires (*k* = 51) or clinical-/lay interviews (*k* = 47), while eight studies (Andronicos et al., 2010; Hashimoto & Nishimura, 2015; Jolly et al., 2021; Karlsson & Håkansson, 2018; Komoto, 2014; Lee et al., 2011; Pavarin et al., 2022; Ronzitti et al., 2019) employed data collected from medical records or

health registries. The studies varied greatly regarding the timeframe covered by their measurements of suicidality, ranging from current (i.e., at admission/data collection) to lifetime occurrence. For suicidal ideation, 47 studies assessed lifetime occurrence, 32 assessed suicidal ideation somewhere within the past 12 months, and four studies (Beaudoin & Cox, 1999; Kausch, 2004; Maccallum & Blaszczynski, 2003; Ronzitti et al., 2017) assessed both lifetime and past 12 months suicidal ideation (see Supplementary Table 1). Similarly, 73 studies assessed the lifetime occurrence of at least one suicide attempt, 12 studies assessed suicide attempt(s) within the past 12 months, and one study (Ladd & Petry, 2003) reported both last month- and lifetime occurrence of suicide attempt(s) (see Supplementary Table 1). Only six studies (Battersby et al., 2006; Carmassi et al., 2020; Hodgins et al., 2006; Maccallum & Blaszczynski, 2003; Morefield et al., 2014; Stefan et al., 2022) assessed suicidality using specific and psychometrically tested multi-item instruments of suicidality, while most studies employed either only a single-item measure without prior validation (*k* = 46) or items specifically assessing suicidality taken from validated multi-item assessments which included items assessing suicidality, but where this was not the primary outcome/construct (*k* = 46). Both studies which reported data on the relationship between gambling problems and suicide (Karlsson & Håkansson, 2018; Pavarin et al., 2021) collected their data by linking patient register data with data from the cause of death registries.

Risk of Bias Assessment

Detailed results from the risk of bias assessment are provided in Supplementary Table 2. The total NOS score in the individual studies ranged from 2 to 10 stars, with a mean NOS score of 5.79 and a standard deviation of 2.15. The largest sources of risk of bias were related to the selection of respondents, including issues related to the representativeness of the sample and the comparability of respondents and non-respondents.

What is the Prevalence rate of Suicidality Among Individuals with Gambling Problems (RQ1)?

Lifetime Prevalence of Suicidal Ideation

A forest plot on the lifetime prevalence rate of suicidal ideation among individuals with gambling problems is available in Supplementary Figure 1. The random-effects model (k = 76) yielded a pooled prevalence rate of 31.6%, 95% CI [29.1%, 34.3%]. The Q-statistic was significant, Q = 2963.6, df = 75, $p < 0.001$, suggesting heterogeneity across the prevalence rates. The I^2- statistic showed a high percentage of true between-study variance, I^2 = 97.5%. Regarding publication bias, the result of the Egger's test was not statistically significant, b = 0.54, 95% CI [-1.22, 2.31], t = 0.61, two-tailed p = 0.54. However, the trim and fill procedure (Supplementary Figure 2) indicated that 12 studies were missing to the right of the mean, suggesting that publication bias was present. When imputing these 12 studies and their hypothetical prevalence rate of suicide ideation, the pooled estimate increased to 36.5%, 95% CI [33.4%, 39.6%]. The results from the random-effects meta-regression model on suicidal ideation are shown in Table 1. The regression model was statistically significant, Q = 34.43, df = 14, $p < 0.002$), and suggested that risk of bias (NOS) (b = -0.115, p = 0.001) was inversely related to the prevalence of suicidal ideation among individuals with gambling problems (a graphical representation of the moderating effect of risk of bias is available in Supplementary Figure 3.). Yet, the R^2 -analog was 0.0 (computed value was -0.21). There was still significant unexplained variance, Q = 1105.09, df = 61, $p < 0.001$.

[Please insert Table 1 about here]

Lifetime Prevalence of Suicide Attempts

Supplementary Figure 4 displays a forest plot for the lifetime prevalence rate of suicide attempts. The random-effects model (k = 83) yielded a pooled prevalence rate of 13.2%, 95% CI [11.3%, 15.5%]. There was significant heterogeneity, Q = 2119.4, df = 82, $p < 0.001$, with a high percentage of true variance, I^2 = 96.1%. The Egger's test was statistically significant, b = 2.28, 95% CI [0.25-4.31], t = 2.23, two-tailed $p < 0.05$, suggesting the presence of publication bias. The trim and fill procedure (Supplementary Figure 5) suggested that nine studies were missing to the right of the mean, and when imputing these studies, the pooled prevalence estimate was adjusted to 15.4%, 95% CI [12.8%, 18.3%].

The results from the random-effects regression model of suicide attempts are shown in Table 2. The model was statistically significant, $Q = 39.85$, $df = 14$, $p < .001$, R^2-analog = 0.40. A higher prevalence of psychiatric comorbidity was found to be positively related, and sample size ($b = -0.0002$, $p < 0.001$) was inversely related to the prevalence of suicide attempts (see Supplementary Figures 6 and 7). However, there was still unexplained variance, $Q = 803.7$, $df = 68$, $p < 0.001$.

[Please insert Table 2 about here]

Prevalence of Suicide

Two studies provided data on the relationship between gambling problems and suicide. Following the threshold of at least five studies reporting data on the specific suicidality outcome, a quantitative meta-analysis on suicide as an outcome was not performed. Therefore, the findings from these two studies are summarized qualitatively.

Karlsson and Håkansson (2018) linked register data from the Swedish National Patient Registry with data from the Swedish Cause of Death Registry to investigate mortality and suicide rates within the whole population of Swedish individuals diagnosed with pathological gambling (F63.0 according to the ICD-10; *N* = 2,099) in the time period of 2005 to 2016. Within this time period, 77 individuals with pathological gambling died of which suicide accounted for 31% of the deaths (*N* = 21) – making suicide the most common cause of mortality within this diagnostic group. The 11-year prevalence rate of suicide was 1% among Swedish individuals diagnosed with pathological gambling. Pavarin et al. (2021) linked medical records from the Emilia-Romagna region of Italy with data from local death registries in the time period of 1992 to 2018. Within the cohort of 826 individuals diagnosed with pathological gambling (F63.0), 39 individuals died during the study period. Suicide was the cause of mortality in 5% of the deaths (*N* = 2). The prevalence rate of suicide over 27 years was 0.24%.

Do Individuals with Gambling Problems have a Different Likelihood than Individuals Without Gambling Problems to Experience Suicidality and what is the Possible Magnitude of this Difference (RQ2)?

Comparison of the Lifetime Prevalence of Suicidal Ideation

A forest plot on the comparison of individuals with gambling problems and individuals without gambling problems on suicidal ideation is available in Supplementary Figure 8. The random-effects model (k = 32) yielded an overall effect size of OR = 2.17, 95% CI [1.90, 2.48], indicating that individuals with gambling problems had an increased likelihood of reporting lifetime suicidal ideation compared to individuals without gambling problems. The Q-statistic was significant, Q = 278.20, df = 31, p < 0.001, and the I^2–statistic showed a high percentage of true between-study variance, I^2 = 88.9%. The result of the Egger's test was not statistically significant, b = -0.55, 95% CI [-1.86, 0.75], t = 0.86, two-tailed p = 0.39. The sensitivity analysis (Mathur & VanderWeele, 2020) showed that no amount of publication bias (η > 200) could sufficiently attenuate the overall effect to null, and that a selection ratio of η = 7.73 favoring affirmative- over non-affirmative studies would be needed to shift the confidence interval to include 0, indicating a robust synthesis. Yet, the trim and fill procedure (Supplementary Figure 9) suggested that six studies were missing to the left of the mean, and imputing these hypothetical studies adjusted the overall effect to OR = 1.93, 95% CI [1.69, 2.21]). Sex proportions, mean age, and prevalence of psychiatric comorbidity (i.e., psychiatric comorbidity within samples of individuals with gambling problems) were tested as possible predictors in the meta-regression (see Table 3 for the results). The higher proportion of women in the sample was found to be inversely related to the odds of reporting lifetime suicidal ideation (see also Supplementary Figure 10). However, the regression model was not statistically significant, Q = 13.39, df = 9, p = 0.14, R^2-analog = 0.00, and there was still some unexplained variance, Q = 120.39, df = 22, p < 0.001.

[Please insert Table 3 about here]

Comparison of the Lifetime Prevalence of Suicide Attempts

A forest plot on the comparison of individuals with gambling problems and individuals without gambling problems on lifetime suicide attempts is available in Supplementary Figure 11. The random-effects model (k = 31) showed an overall effect size of OR = 2.81, 95% CI [2.24, 3.54], indicating that

individuals with gambling problems had an increased likelihood of reporting a lifetime suicide attempt compared to individuals without gambling problems. The *Q*-statistic was significant, $Q = 227.45$, $df = 30$, $p < 0.001$, and the I^2–statistic showed a high percentage of true between-study variance: $I^2 = 86.8\%$. The result of the Egger's test was statistically significant, $b = 2.28$, 95% CI [0.09, 4.49], $t = 2.13$, two-tailed $p < 0.05$. The sensitivity analysis suggested that no value of η could sufficiently attenuate the overall effect to null and that a selection ratio of $\eta = 112.54$ would be needed to shift the confidence interval to include 0. However, the trim and fill procedure (Supplementary Figure 12) suggested that four studies were missing to the left of the mean, and when imputing these, the overall effect was adjusted to *OR* = 2.40, 95% CI [1.87, 3.08]. Sex proportions, mean age, and prevalence of psychiatric comorbidity were tested as predictors in the meta-regression. None of the variables were found to be statistically significant predictors. The model was not statistically significant, $Q = 15.35$, $df = 9$, $p = 0.08$, R^2-analog = 0.30, and there was still unexplained variance, $Q = 109.45$, $df = 21$, $p < 0.001$.

Comparison of Suicide Rates

Karlsson and Håkansson (2018) compared the mortality rates of suicide among to individuals with pathological gambling against the mortality rate of suicide in the general Swedish population. The authors reported a standardized mortality ratio (SMR) of 15.1 (95% CI 8.7, 21.6), suggesting that the cohort of individuals with pathological gambling had a 15-fold increase in the risk of dying by suicide compared to the general population. Additional analyses suggested that SMRs were higher among individuals with pathological gambling who were 20-49 years old (SMR = 19.3, 95% CI [9.8, 28.7]), among women (SMR = 16.1, 95% CI [6.5, 33.5]), and that having a comorbid diagnosis of depression was a statistically significant predictor of suicide (Hazard ratio = 5.45, 95% CI [1.57, 18.93]). Similarly, Pavarin et al. (2021) reported an SMR of 3.32 (95% CI [0.83, 13.26]) when comparing morality rates of suicide with the general population in the Emilia-Romagna region of Italy. Still, the increased risk was not statistically significant. Additionally, there was a higher risk of suicide among women with pathological gambling (SMR = 22.91, 95% CI [3.23, 162.61]) compared to men with pathological

gambling (SMR = 1.79, 95% CI [0.25, 12.69]). However, only one woman with pathological gambling died by suicide, suggesting that this finding, although statistically significant, is not robust.

What does the Current Evidence Suggest Regarding the Causality and Directionality Between Gambling Problems and Suicidality (RQ3)?

A total of 14 of 37 studies that reported comparisons of individuals with- and without gambling problems on suicidal ideation provided effect sizes adjusted for possible confounding variables (see Supplementary Table 1). The most common variable adjusted for was age (*k* = 13) followed by sex (*k* = 11), educational level (*k* = 7), marital status (*k* = 6), psychopathology/psychiatric comorbidity (*k* = 4), alcohol/substance use (*k* = 4), income (*k* = 5), and employment status (*N* = k; see Supplementary Table 1 for references). Eleven of 14 studies reported statistically significant different risk/odds between individuals with- and without gambling problems in the fully adjusted models. For most studies reporting both unadjusted and adjusted effect sizes (*k* = 10), the effect generally attenuated but remained statistically significant in the fully adjusted models. One study (Cook et al., 2015) reported the opposite, i.e., an increased *OR* in the adjusted model after adjusting for age and sex. For another study (Afifi, 2008) the effect attenuated to non-significant in the fully adjusted model, and two studies (Cowlishaw & Kessler, 2016; Cunningham-Williams et al., 1998) only reported adjusted effect sizes, both of which were non-significant.

A random-effects model was conducted for adjusted effect sizes on suicidal ideation for those studies sufficiently reporting such data (*k* = 12; see Supplementary Table 1 for the specific adjustments by each individual study). The model yielded an overall effect of *OR* = 1.71, 95% CI [1.48, 1.98]). The *Q*-statistic was significant, *Q* = 21.06, *df* = 11, *p* = 0.03, and the I^2–statistic showed a moderate percentage of true between-study variance, I^2 = 47.7%. The result of the Egger's test was statistically significant, *b* = 1.12, 95% CI [0.39, 1.86], *t* = 3.40, two-tailed $p < 0.01$. However, no value of η could sufficiently attenuate the overall effect to null and a selection ratio of $\eta = 38.81$ would be needed to shift the CI to include 0. The trim and fill procedure suggested that 6 studies were missing to the left of the mean

and adjusted the overall effect to *OR* = 1.48 (95% CI [1.28, 1.71]). Due to the low number of studies included in the analysis, only sex proportions were tested as a predictor in the meta-regression. The middle third of (female) sex proportions in the sample was found to be positively related to the odds of reporting lifetime suicidal ideation, while the upper-third was found to be inversely related (see Table 4 for the results). The regression model was significant, $Q = 17.20$, $df = 2$, $p < 0.001$, and explained all of the variance (R^2-analog = 1.00). Therefore, there was no unexplained heterogeneity, $Q = 3.86$, $df = 9$, $p = 0.92$.

[Please insert Table 4 about here]

For suicide attempts, 15 of 35 studies that compared individuals with- and individuals without gambling problems adjusted their estimates for confounding variables (see Supplementary Table 1). The most common variable adjusted for was age (*k* = 14) followed by sex (*k* = 12), psychopathology/comorbidity (*k* = 9), alcohol/substance use (*k* = 9), educational level (*k* = 8), marital status (*k* = 6), income (*k* = 6), socioeconomic status (*k* = 3), employment status (*k* = 4), and study location/living area (*k* = 3; see Supplementary Table 1 for references). Nine of 14 studies reported statistically significant differences between groups in the fully adjusted models. For five of the 13 studies, which provided both unadjusted and adjusted effect sizes (Cook et al., 2015; Newman & Thompson, 2007; Nower et al., 2004; Ronzitti et al., 2021; Rossen et al., 2016), the effect decreased but remained statistically significant in the fully adjusted models. One study (Stefanovics et al., 2017) reported a slightly increased *OR* after adjusting for confounding variables, while six studies (Afifi, 2008; Newman & Thompson, 2003; Park et al., 2010; Slutske et al., 2022; Stefanovics, 2022; Sundqvist & Wennberg, 2021) found the effect attenuated to non-significant. In addition, Manning et al. (2015), which utilized a clinical sample of individuals with a substance use disorder (other than gambling) as contrast, reported an effect size that changed from non-significant in the unadjusted estimate to significant in the fully adjusted model, indicating that individuals with gambling problems had a lower likelihood of reporting a suicide attempt compared to individuals with a substance use disorder.

A random-effects model was run for adjusted effect sizes on suicide attempts for those studies sufficiently reporting such data (k = 14; see Supplementary Table 1 for the specific adjustments in each individual study). The model yielded an overall effect of OR = 2.32, 95% CI [1.70, 3.16]). The Q-statistic was significant, Q = 39.4, df = 13, $p < 0.001$, and the I^2–statistic showed a moderate percentage of true between-study variance, I^2 = 67.4%. The result of the Egger's test was not statistically significant, b = 0.76, 95% CI [-2.23, 3.76], t = 0.55, two-tailed p = 0.59. No value of η could sufficiently attenuate the overall effect to null and a selection ratio of η = 10.07 would be needed to shift the confidence interval to include 0, thus indicating a robust synthesis. The trim and fill procedure suggested that three studies were missing to the right of the mean and adjusted the overall effect to OR = 2.77, 95% CI [1.98, 3.86]. Sex was tested as a possible predictor in the meta-regression analysis but was not found to be a statistically significant predictor. The model was not significant, Q = 3.33, df = 3, p = 0.34, R^2-analog = 0.00, and there was still significant heterogeneity: Q = 32.84, df = 10, $p < 0.001$.

Only one study included in the present review provided data allowing for inferences on the temporal directionality. Slutske et al. (2022) reported the results from a large-scale scale longitudinal discordant twin-study. Longitudinal associations showed that participants who reported suicidal thoughts (OR = 2.58, 95% CI = [1.79, 3.71]), and attempts (OR = 2.41, 95% CI = [1.23, 4.72]) at Phase 1 were more likely to meet the lifetime criteria for gambling disorder approximately eight years later at Phase 2. However, the effects attenuated to non-significant when adjusting for psychiatric comorbidity (OR = 1.36, 95% CI = [0.91, 2.03] and OR = 0.89, 95% CI = [0.41, 1.92] for suicidal ideation and suicide attempts, respectively.). Slutske et al. (2020) also employed multilevel discordant-twin analyses to investigate the potential causal influence of disordered gambling versus common genetic/family environmental factors in the relationship between gambling disorder and suicidal ideation and suicide attempts. In summary, the results suggested that similarities in suicidal ideation within twin pairs were mainly due to genetic or shared environmental influences that varied between twin pairs. The opposite finding was found for suicide attempts, indicating that this association was mainly due to unique environmental influences (possibly disordered gambling) that varied between twin pairs. Sex

differences were found indicating that the (between-pair) association between disordered and suicidal ideation was (non-causally) explained by common genetic factors among women, but not for men. For suicide attempts, the (within-twin-pairs) association with disordered gambling was larger and only significant among men, indicating a possible causal impact of disordered gambling on suicide attempts among men but not women in this population (Slutske et al., 2022).

Discussion

The present synthesis supported findings from previous reviews (Armoon et al., 2023; Edson et al., 2022) indicating that suicidal ideation (31.6%) and suicide attempts (13.2%) are commonly reported among individuals with gambling problems (RQ1). Moreover, the results suggested that individuals with gambling problems have increased likelihood of experiencing suicidality (RQ2) including lifetime suicidal ideation (*OR* = 2.17) and lifetime suicide attempt(s) (*OR* = 2.81) compared to individuals without gambling problems (RQ2). The studies of Karlsson and Håkansson (2018; *SMR* = 15.1) and Pavarin et al. (2021; *SMR* = 3.3 [non-significant]) suggested that individuals diagnosed with pathological gambling had an elevated risk of suicide compared to the general population.

Interpreting the magnitude of *OR*s is challenging because the interpretation of *OR*s is dependent on the generic prevalence rate of the outcome (Chen et al., 2010). This is further complicated by the issue that studies concerning prevalence rates of suicidality are often limited to quite specific populations and are not even available for all countries (World Health Organization, 2021). Yet, by applying the calculations proposed by Chen et al. (2010) and using the lifetime prevalence rates of suicidality among the adult European general population (Castillejos et al., 2021) as a reference, an *OR* = 2.17 for suicidal ideation would approximately correspond to Cohen's *d* = 0.37 and an *OR* = 2.81 on suicide attempts would approximately correspond Cohen's *d* = 0.51, which could be interpreted as a small to moderate- and a moderate effect size, respectively (Cohen, 1988). Effect sizes of smaller magnitudes could be considered important if the outcome variable is of practical or theoretical relevance (Prentice & Miller, 2016). Suicidality has severe detrimental consequences to the

individual, those close to the individual, and the overall society - making the objective of identifying possible determinants of suicidality (e.g., gambling problems) of great societal importance. Therefore, although the *OR*s observed in this synthesis are in the range of small to moderate, these findings might be considered to be both practically important and clinically meaningful.

A subsequent question is whether suicidality is more or less frequent among individuals with gambling problems compared to individuals with other mental health conditions. To explore this issue, two ad hoc random-effects meta-analyses were conducted based on the studies that compared individuals with gambling problems with contrast groups comprising individuals with other mental health conditions on suicidal ideation (k = 6) and suicide attempts (k = 6). Results indicated that individuals with gambling problems had an increased likelihood of reporting lifetime suicidal ideation compared to individuals with other mental health conditions (i.e., patients with substance use disorder, bipolar disorder, or major depression), *OR* = 1.49, 95% CI [1.10, 2.01]. No statistically significant differences were found on suicide attempts, *OR* = 1.20, 95% CI [0.87, 1.64] (for further details on these results, see Supplementary Material 5.). This pattern has potential practical implications because the results may suggest that clinicians should be especially attentive to symptoms of suicidal ideation among clients with gambling problems. Yet, due to a limited number of studies included in these meta-analyses, as well as the fact that the specific condition used as contrasts varied between these studies, these findings should be interpreted with some caution.

Moderating Effects

Significant heterogeneity was found in all meta-analyses. Mean age, operationalization of gambling problems, time period of suicidality, and use of validated instruments of suicidality were not found to be statistically significant moderators of prevalence rates of suicidality in any of the multivariate meta-regression models. Risk of study bias (NOS) was found to be inversely associated with the prevalence rates of lifetime suicidal ideation among individuals with gambling problems. Studies are rated as having less risk of bias if they are based on representative and large samples and

employ high-quality assessments of both the exposure and outcome variables. These are all factors that could affect the prevalence estimates. More specifically, studies based on non-representative sampling could lead to aggregation of individuals who are more likely to have experienced suicidality (e.g., patients in a specific treatment institution) compared to random population samples. Also, using measures with more robust psychometric properties would improve the discrimination of false from true positives (Diamantopoulos et al., 2012; Millner et al., 2015), therefore possibly resulting in different prevalence rates than studies employing measures not psychometrically investigated. Although the overall meta-regression model was statistically significant ($p < 0.01$), the R^2-analog suggested that the proportion of the total between-study variance explained by the model was none, indicated by a R^2-analog value below zero (R^2-analog = -0.21). This somewhat counterintuitive result is likely an artifact of error when estimating the between-study variance (τ^2) which subsequently affects the estimation of the R^2-analog (Borenstein et al., 2021). Consequently, the meta-regression model statistically significantly accounted for some proportion of the variation in prevalence rates, but the true R^2-analog is most likely very low, indicating that the model holds mostly statistical significance and less practical significance.

Sex proportions were found to be a significant predictor in both meta-regressions on the comparisons (odds ratios) of lifetime suicidal ideation. However, the results were somewhat conflicting regarding the direction of the effect. Higher proportions of women in the sample were inversely associated with the unadjusted odds of reporting suicidal ideation, while the direction of the effect was inconsistent in the meta-regression analysis based on adjusted effect sizes. The former finding would suggest that men with gambling problems are more likely to report lifetime suicidal ideation compared to women, which is a somewhat surprising finding because the majority of the literature generally suggests the opposite – that is, that women are generally more likely to report suicidal ideation and mental health issues compared to men (Canetto & Sakinofsky, 1998; Klonsky et al., 2016; Schrijvers et al., 2012). Nevertheless, sex proportions explained all of the variance in the regression model based on adjusted effects, suggesting overall that sex proportions may be an important

moderator of suicidal ideation among individuals with gambling problems although the direction is currently unclear.

The meta-regression analysis on the prevalence rates of lifetime suicide attempts suggested that higher prevalence rates of psychiatric comorbidity were positively associated with increasing prevalence rates. This finding supports results from several of the single studies included in this review that reported a link between higher levels of comorbidity and increased suicidality (e.g., Bischof et al., 2016; Hodgins et al., 2006; Karlsson & Håkansson, 2018). However, it is unclear whether the comorbid condition(s) are a consequence, antecedent, or even unrelated to the individuals' gambling problems. Consequently, it is hard to determine whether the gamblers' suicidality can be attributed to their gambling problems, other conditions, or the bidirectional relationship between the two. Finally, sample size was also found to be inversely related to prevalence rates of lifetime suicide attempts, suggesting a "small study effect" (Hong et al., 2020; Sutton et al., 2000). A possible explanation for this finding is that most of the single studies based on smaller samples included in the present review comprised clinical samples as opposed to the larger studies that were more often based on random population sampling. Individuals in clinical samples would likely experience more severe gambling problems compared to individuals with sub-clinical gambling problems and would thus also be more likely to report a history of a suicide attempt.

Causality, Directionality, and Implications for Intervention

The third research question (RQ3) was addressed by pooling effect sizes adjusted for confounding variables and by narratively reviewing the evidence on the causal mechanisms and directionality. For most studies reporting both unadjusted estimates and adjusted estimates, the adjusted estimates generally attenuated after adjusting for confounding variables, although most estimates remained statistically significant. This could be interpreted to indicate the existence of underlying third factors associated with both gambling problems and suicidality that could contribute to or influence both conditions. However, studies varied greatly in what- and how many confounders they adjusted for, which makes it difficult to conclude which variable was the most influential potential confounder. Still,

significant (although somewhat attenuated) overall effects were found for suicidal ideation (*OR* = 1.71) and suicide attempts (*OR* = 2.32) in meta-analyses limited to estimates adjusted for confounding variables by the individual studies. This indicates that individuals with gambling problems consistently have increased odds of reporting suicidality and that these effects cannot be attributed to the influence of confounding variables alone. Importantly, the adjusted effect sizes remained statistically significant after considering the impact of potential publication bias. Therefore, the present findings are somewhat in contrast to Edson et al.'s (2022) review in which the effects of gambling problems on suicidal ideation and suicide attempts were concluded to be an artifact of publication bias. To investigate whether the different estimated impact of publication bias was mainly related to differential testing between the present study and Edson et al.'s review, ad hoc exploratory publication bias analyses were conducted for the present meta-analyses based on adjusted effect sizes using PET-PEESE analyses (Stanley & Doucouliagos, 2014) with the same specifications as Edson et al. The PET-PEESE analyses yielded a statistically significant overall effect size for the meta-analysis on suicidal ideation after accounting for publication bias, *OR* = 1.46, 95% CI [1.40, 1.52], $p < 0.001$. However, the overall effect was reduced to non-significant for the meta-analysis on suicide attempts, *OR* = 2.00, 95% CI [0.73, 5.48], $p = 0.159$ (a full description of the PET-PEESE procedure is available in Supplementary Material 3.). Therefore, the exploratory PET-PEESE analyses supported the existence of an (possible) underlying empirical effect of gambling problems on suicidal ideation, but still introduced some uncertainty regarding a potential causal link between gambling problems and suicide attempts. However, the non-significant finding for suicide attempts could reflect the tendency of the PET-PEESE to be overly strict in correcting for publication bias in meta-analyses with a low number of primary studies and high levels of between-study variance (Stanley, 2017), which was true for that particular meta-analysis. Nonetheless, the causal inferential value of the adjusted overall effect sizes on suicidal ideation and suicide attempts remains speculative because they are all based on cross-sectional data.

Regarding directionality, none of the studies included in this review investigated longitudinal associations indicating that gambling problems could lead to future suicidality. Slutske et al. (2022)

provided longitudinal data demonstrating the reversed directionality, suggesting that suicidal ideation and suicide attempts could predict future gambling problems. Slutske et al. (2022) also provided some early evidence that there may be sex differences in the temporal precedence and etiology of gambling problems and suicidality, which should be investigated further in future studies. However, it should be noted that the longitudinal evidence reported by Slutske et al. (2022) is severely hampered by the fact that it was only based on two time points and that the data on age of onset of both gambling problems and suicidality were exclusively based on retrospective reports which likely introduced significant recall bias. Moreover, retrospective data from the same study indicated that almost one-third (29%) of the participants with co-occurring gambling problems and suicidality reported gambling problems to precede their suicidality, but this possible directionality was not statistically investigated by longitudinal analyses. However, another recently published longitudinal study that did not endorse the inclusion criteria for the present review (Wardle et al., 2023), suggested that an increase in PGSI scores over time could significantly predict suicide attempts at Wave 2. Yet, PGSI scores at Wave 1 alone could not predict suicide attempts at Wave 2 in the fully adjusted models (Wardle et al., 2023).

In summary, the current evidence indicates an intricate relationship between gambling problems and suicidality, of which gambling problems could act as a possible antecedent and a consequence of suicidality, and that there may be underlying third factors that could contribute to both conditions. The specific causal pathway in the relationship is currently not well documented, although it is likely to vary between individuals. A plausible pathway for individuals who experience gambling problems as a consequence of suicidality is that gambling becomes a coping mechanism to relieve negative affect related to suicidality and/or other issues (Khantzian, 1985, 1997). However, this coping strategy may become detrimental because it could exacerbate further gambling-related harms such as financial- and/or interpersonal problems. Indeed, the gambling motives of escape and coping have been found to be important predictors of developing gambling problems (Grubbs & Rosansky, 2020; Hagfors et al., 2023). Such a pathway would suggest that prevention and treatment of suicidality, and/or mental health issues more generally, could have an additional positive effect on preventing

gambling problems. In this vein, Bennett et al.'s (in press) recent theoretical developments postulate that enhancing recognition, reconnection, and regulation of emotions, self-concept, and interpersonal connections may be key psychological targets for therapeutic intervention to promote recovery for individuals with suicidality. Targeting these psychological domains can also have utility for preventive work by, for example, introducing psychoeducation programs that support constructive regulation of negative affect and psychological pain (Bennett et al., in press). Nonetheless, if gambling problems and suicidality constitute a bidirectional relationship, it would suggest that increasing measures aimed at mitigating gambling problems could also be a viable strategy as it could contribute to reducing harm in both domains.

Limitations of the Included Studies and Implications for Future Research

Several methodological limitations were identified that have implications for future research initiatives. One major limitation of the current evidence base is that most studies were cross-sectional, which greatly hampers inferences on the causal directionality and mechanisms underlying the relationship between gambling problems and suicidality. As such, there is currently a pressing need for more studies utilizing designs that would allow for such inferences. Another major limitation is in the included studies' choice of instruments assessing suicidality, as most studies either employed non-psychometrically validated single-item self-report instruments or single items taken from validated multi-item assessments targeting other phenomena, for example, depression. Future studies would benefit from using validated multi-item assessments for suicidality specifically because such instruments hold better psychometric properties and also provide more detailed data on suicidality in terms of for instance severity, frequency, and intent (Batterham et al., 2015). Also, most studies did not assess to what degree the participants attributed their suicidality to their gambling problems specifically, which should be assessed in future studies. A final important limitation of the current evidence base is the dearth of studies investigating the relationship between gambling problems and

suicide. More studies investigating suicide rates among individuals with gambling problems, by for instance linking patient- and cause-of-death registries, are therefore warranted.

Limitations of the Present Review

The main limitation of the present review is high levels of observed heterogeneity, which to a limited degree could be explained by potential moderators. The unexplained heterogeneity most likely relates to the variability of study populations and methodological characteristics. Future syntheses would benefit by investigating potential moderator variables that were not assessed in the present review, such as probability versus non-probability samples, and treatment-seeking versus non-treatment-seeking samples which are likely candidates to affect prevalence rates and effect sizes. Another limitation is the fact that subgroups based on the severity of gambling problems were collapsed in the present review to cover all levels of gambling problems including clinical- and subclinical gambling problems. This strategy is likely to deflate the pooled prevalence rates/effect sizes compared to the situation where only clinical samples with higher symptom severity were included. Thus, collapsing these subgroups may have downplayed the prevalence of suicidality among the individuals with the most severe gambling problems. Further, in cases where the studies reported a collapsed prevalence rate/effect size on suicidal ideation and suicide attempts (e.g., Cunningham-Williams et al., 1998; Fröberg et al., 2013), the present study coded these data as suicidal ideation because we expected that most individuals who have experienced a suicide attempt also would have experienced suicidal ideation prior to the attempt. Still, some evidence suggests that suicide attempts are not always preceded by suicidal ideation, except in the immediate moments before the actual attempt (Simon et al., 2002). Therefore, there is a possibility that these collapsed prevalence rates and effect sizes could be somewhat inflated compared to prevalence rates and effect sizes of suicidal ideation in isolation. Another potential limitation is that the present review only included studies detected through English language searches. Consequently, the present synthesis may to some extent be influenced by a language bias because the search strategy would only have captured non-English

language reports/studies that included a title, abstract, and/or keywords in English. Finally, the presence of possible publication bias was detected for all the meta-analyses. For the overall prevalence rates of suicidal ideation and suicide attempts, the results from the trim and fill procedure suggested that studies were missing to the right of the mean for both meta-analyses. It is uncertain whether this observed skewness in prevalence rates reflects publication bias or other possible systematical differences between larger and smaller studies. More specifically, the trim and fill suggested that larger studies with higher prevalence rates were missing, possibly reflecting the tendency that the smaller study samples included in this review comprise individuals with higher symptom severity as discussed earlier. For the meta-analyses on comparisons of individuals with- and individuals without gambling problems on both suicidal ideation and suicide attempts, the trim and fill procedure indicated that studies were missing to the left of the mean, suggesting a presence of possible publication bias as smaller studies with larger effects were somewhat overrepresented. However, when adjusting for theoretically missing studies the overall effect sizes only decreased slightly and the 95% confidence interval overlapped with the original estimates, which suggests that the overall impact of bias for these syntheses was rather modest.

Conclusions

The present study contributes to the field of gambling problems and suicidality by being the most comprehensive meta-analytic review on the subject. Moreover, it is the first study to synthesize the evidence on the relationship between gambling problems and suicide, and the first study to employ multivariate meta-regression analyses to investigate sources of between-study variance. The overall synthesis suggests that suicidality is common among individuals with gambling problems and that suicidality is more commonly reported in this population than among individuals without gambling problems. This highlights the importance of the objective of reducing gambling problems, as such preventions might reduce the risk of individuals experiencing- or exacerbating symptoms of suicidality. However, the current evidence base is heavily encumbered by a lack of empirical evidence regarding

causality, directionality, and studies on suicide among individuals with gambling problems. Consequently, future studies should prioritize longitudinal designs investigating the causal links in the relationship to further advance the field.

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Figure 1.

Flowchart diagram of the study screening- and selection process

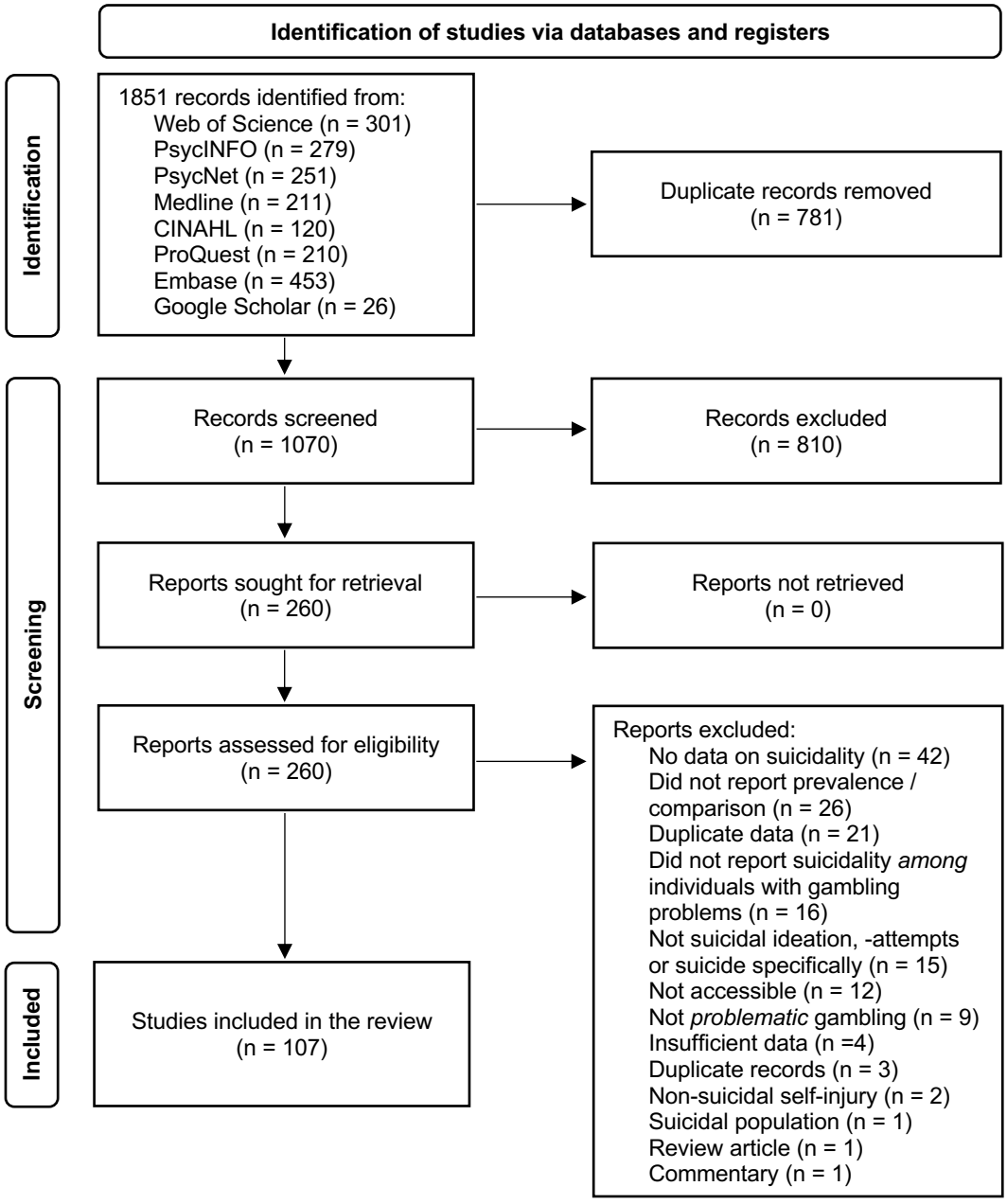

Table 1

Results of a random-effects model meta-regression on the lifetime prevalence of suicidal ideation among individuals with gambling problems

Predictor	**Coefficient***	***SE***	**95% *CI***	***Z***	**Two-tailed *p***	**Prevalence rate SI†**
Intercept	-0.486	0.310	-1.094 – 0.123	-1.57	0.118	-
Sex (unknown; *k*=13)[a]	-0.196	0.231	-0.647 – 0.256	-0.85	0.397	29.9%
Sex (middle third*; k*=21; x̄=28.1%±6.3%)[a]	-0.035	0.190	-0.408 – 0.338	-0.19	0.852	30.9%
Sex (upper third; *k*=22; x̄=52.6%±16.9%)[a]	-0.195	0.196	-0.579 – 0.189	-1.00	0.319	31.5%
Age (unknown; *k*=37)[b]	0.026	0.222	-0.410 – 0.462	0.12	0.907	27.0%
Age (middle third; *k*=12*;* x̄=40.6±1.7)[b]	0.068	0.259	-0.439 – 0.576	0.26	0.792	34.8%
Age (upper third; *k*=14; x̄=48.5±4.6)[b]	0.226	0.253	-0.269 – 0.721	0.89	0.371	39.5%
Comorbidity (unknown*; k*=21)[c]	0.373	0.200	-0.019 – 0.765	1.87	0.062	34.5%
Comorbidity (middle third; *k*=19; x̄=57.6%±7.5%)[c]	0.000	0.227	-0.444 – 0.444	0.00	0.999	30.8%
Comorbidity (upper third; *k*=18; x̄=83.1%±10.1%)[c]	0.336	0.240	-0.134 – 0.806	1.40	0.161	35.1%
Strict operationalization (*k*=39)[d]	0.159	0.189	-0.212 – 0.529	0.84	0.401	36.8%
Lifetime SI (*k*=48)[e]	0.070	0.150	-0.225 – 0.364	0.46	0.644	31.9%
Validated SI instrument (*k*=37)[f]	0.230	0.188	-0.139 – 0.598	1.22	0.222	36.0%
NOS	**-0.116**	**0.036**	**-0.186 – -0.045**	**-3.21**	**0.001**	-
Sample size	0.000	0.000	0.000 – 0.000	-0.22	0.828	-

Note. Statistically significant effects are marked in bold; SI = Suicidal ideation; NOS = Newcastle-Ottawa Quality Assessment Scale; * = logit prevalence rate; †= unadjusted overall prevalence rate of suicidal ideation for each subgroup; [a] = lower third (*k*=20; x̄=8.4%±4.8%; SI=34.3%) as the reference category; [b] = lower third (*k*=13; x̄=34.6±2.5; SI=34.4%) as the reference category; [c] = lower third (*k*=18; x̄=31.5%±0.8%; SI=26.4%) as the reference category**;** [d] = versus lenient operationalization of gambling problems (*k*=37; SI=26.7%); [e] = versus suicidal ideation last 12 months (*k*=28; SI=31.3%); [f] = versus non-validated instrument of suicidal ideation (*k*=39; SI=28.1%).

Table 2

Results of a random-effects model meta-regression on the odds of reporting lifetime suicidal ideation among individuals with gambling problems compared to individuals without gambling problems.

Predictor	**Coefficient***	***SE***	**95% *CI***	***Z***	**Two-tailed *p***	***OR*$_{SI}$**†
Intercept	1.105	0.264	0.588 – 1.621	4.19	0.000	-
Sex (unknown; *k*=4**)**[a]	**-0.678**	**0.304**	**-1.273 – -0.083**	**-2.23**	**0.026**	**2.07**
Sex (middle third*; k*=10; x̄=52.5%±1.9%)[a]	**-0.537**	**0.232**	**-0.992 – -0.083**	**-2.32**	**0.020**	**2.18**
Sex (upper third*; k*=9; x̄=66.3%±12.9%)[a]	**-0.698**	**0.232**	**-1.152 – -0.244**	**-3.01**	**0.003**	**1.76**
Age (unknown; *k*=18)[b]	0.162	0.243	-0.313 – 0.638	0.67	0.503	2.23
Age (middle third; *k=5;* x̄=21.2±4.4)[b]	-0.340	0.289	-0.906 – 0.227	-1.18	0.240	1.82
Age (upper third; *k*=5; x̄=53.5±16.4)[b]	0.001	0.329	-0.644 – 0.647	0.00	0.997	2.28
Comorbidity (unknown*; k*=14)[c]	0.119	0.214	-0.299 – 0.538	0.56	0.576	1.95
Comorbidity (middle third; *k*=6; x̄=46.1%±6.5%)[c]	0.359	0.258	-0.146 – 0.864	1.39	0.164	2.73
Comorbidity (upper third; *k*=6; x̄=70.0%±11.4%)[c]	-0.032	0.253	-0.528 – 0.463	-0.13	0.898	2.29

Note. Statistically significant effects are marked in bold; * = log odds ratio; †=unadjusted overall odds ratios of suicidal ideation for each subgroup [a] = lower third (*k*=9; x̄=32.0%±16.6%; OR_{SI}=2.82) as the reference category; [b] = lower third (*k*=4; x̄=14.9%±0.6%; OR_{SI}=2.48) as the reference category; [c] = lower third (*k*=6; x̄=29.0%±5.7%*;* OR_{SI}=2.26) as the reference category.

Table 3

Results of a random-effects model meta-regression on the lifetime prevalence of suicide attempts among individuals with gambling problems

Predictor	Coefficient*	*SE*	95% *CI*	*Z*	Two-tailed *p*	Prevalence rate SA†
Intercept	-2.242	0.424	-3.073 – -1.411	-5.29	0.000	-
Sex (unknown; *k*=11)[a]	0.225	0.280	-0.3239 – 0.773	0.81	0.420	18.2%
Sex (middle third; *k*=24, x̄=27.0%±6.5%[a]	-0.059	0.205	-0.460 – 0.342	-0.29	0.773	12.2%
Sex (upper third; *k*=23, x̄=54.1%±19.3%)[a]	-0.208	0.228	-0.655 – 0.238	-0.91	0.361	11.9%
Age (unknown; *k*=32)[b]	-0.043	0.254	-0.554 – 0.455	-0.17	0.866	13.3%
Age (middle third; *k*=19, x̄=42.0±1.2)[b]	-0.188	0.248	-0.674 – 0.298	-0.76	0.449	11.5%
Age (upper third; *k*=16, x̄=49.8±4.4)[b]	-0.413	0.266	-0.934 – 0.108	-1.55	0.120	12.0%
Comorbidity (unknown; *k*=21)[c]	**0.502**	**0.227**	**0.057 – 0.946**	**2.21**	**0.027**	**12.8%**
Comorbidity (middle third; *k*=21, x̄=55.8%±8.4%)[c]	**0.514**	**0.223**	**0.077 – 0.951**	**2.31**	**0.021**	**15.7%**
Comorbidity (upper third; *k*=21, x̄=85.3%±10.5%)[c]	**0.807**	**0.252**	**0.313 – 1.301**	**3.2**	**0.001**	**15.2%**
Strict operationalization (*k*=50)[d]	0.332	0.183	-0.027 – 0.691	1.81	0.070	15.3%
Lifetime SA (*k*=73)[e]	0.012	0.254	-0.486 – 0.510	0.05	0.963	13.5%
Validated SI instrument (*k*=47)[f]	0.186	0.171	-0.148 – 0.521	1.09	0.275	14.6%
NOS	-0.018	0.040	-0.095 – 0.060	-0.44	0.656	-
Sample size	**-0.0002**	**0.0001**	**-0.0003 – -0.0001**	**-3.41**	**0.001**	-

Note. Statistically significant effects are marked in bold; SA= Suicide attempt; NOS = Newcastle-Ottawa Quality Assessment Scale; * = logit prevalence rate; †= unadjusted overall prevalence rate of suicide attempts for each subgroup; [a] = lower third (*k*=25; x̄=9.1%±4.7%; SA=13.7%) as the reference category; [b] = lower third (*k*=16; x̄=34.6±2.5; SA=17.3%) as the reference category; [c] = lower third (*k*=20; x̄=26.8%±7.9%; SA=10.0%) as the reference category**;** [d] = versus lenient operationalization of gambling problems (*k*=33; SA=10.7%); [e] = versus suicide attempt last 12 months (*k*=10; SA=11.4%); [f] = versus non-validated instrument of suicide attempts (*k*=36; SA=11.7%).

Table 4

Results of a random-effects model meta-regression on the adjusted odds of reporting lifetime suicidal ideation among individuals with gambling problems compared to individuals without gambling problems.

Predictor	Coefficient*	*SE*	95% *CI*	*Z*	Two-tailed *p*	AOR_{SI}†
Intercept	0.564	0.093	0.382 – 0.747	6.06	0.000	-
Sex (middle third; *k*=4, x̄=52.7%±16.3%[a]	**0.506**	**0.210**	**0.095 – 0.917**	**2.41**	**0.016**	**2.92**
Sex (upper third; *k*=4, x̄=69.0%±20.8%)[a]	**-0.187**	**0.095**	**-0.373 – -0.002**	**-0.98**	**0.048**	**1.46**

Note. Statistically significant effects are marked in bold; * = log odds ratio; †= overall adjusted odds ratios of suicidal ideation for each subgroup; [a] = lower third (*k*=4; x̄=15.1%±13.0%; AOR_{SI}=1.76) as the reference category.