RESEARCH REPORT

Comorbid problem gambling in substance users seeking treatment

Sean Cowlishaw

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Victorian Responsible Gambling Foundation

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A Victoria free from gambling-related harm

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Executive Summary

Pathological and problem gambling refer to a class of impulse control or addictive disorders that may be common comorbidities in substance use treatment. This class of disorders include those meeting criteria for a psychiatric diagnosis of 'pathological gambling', and others comprising a broader spectrum of severity defined by significant personal and social harm, and described in terms of 'problem gambling'. This project was comprised of two parts and was intended to address limitations of existing evidence. It was also intended to: (a) provide rigorous estimates of the prevalence of pathological and problem gambling in treatment for substance use problems; and (b) explore data on associations between gambling comorbidities in substance use treatment and clinical covariates.

Part A of the project comprised a systematic review of studies of the prevalence of gambling disorders in substance use treatment. This review identified 26 eligible studies, which were based mostly in the United States (US) and considered treatment contexts including inpatient or residential services, methadone maintenance therapy (MMT), and general outpatient treatment for alcohol and illicit drug use. Results from 25 studies (total n = 11,470) suggested around 14% of patients that demonstrated comorbid pathological gambling. Results from 18 studies (total n = 8,089) suggested approximately 23% that suffered conditions along the spectrum of problem gambling. The analyses also identified high levels of statistical heterogeneity across studies, suggesting estimates of pathological gambling that varied meaningfully across studies and contexts. Although there were trends suggesting potential differences across studies according to clinical factors (e.g., studies of MMT tended to produce higher estimates than studies of inpatient or general outpatient settings) and methodological factors (e.g., studies relying on self-report tools tended to produce higher estimates than studies using the Diagnostic and Statistical Manual of Mental Disorders (DSM) based interviews), these differences were not statistically significant. As such, the observed variability across studies remains unexplained. Funnel plots produced tentative evidence of publication bias in results, such that studies reporting lower estimates were seemingly less likely to be observed in the published literature. This suggests that available studies may provide an upwardly bias selection of findings.

Part B comprised a secondary analysis of data from wave 1 (2000-2001) and wave 2 (2004-2005) of the US National Epidemiological Survey on Alcohol and Related Conditions (NESARC). Analyses were based on data from n = 272 participants reporting past year treatment for substance use problems, and considered links between symptoms of pathological gambling and various outcomes including mental and physical health, substance usage and psychosocial difficulties. Results failed to support expected associations with symptoms of pathological gambling and current Axis I disorders, as well as overall mental and physical health status, substance usage and healthcare utilisation. Rather, the findings suggested more specific associations with certain *lifetime* Axis I disorders (e.g., major depression) and Axis II disorders, as well financial and interpersonal difficulties. Symptoms of pathological gambling were associated prospectively with subsequent diagnoses of major depression.

Overall, results highlight limitations of available evidence, including unexplained heterogeneity across published studies, and a dearth of empirical data from outside the US. Notwithstanding a concomitant need for caution when interpreting the findings, this project provides evidence to suggest that gambling disorders comprise a prevalent class of comorbidities in substance use treatment. It suggests that where pathological gambling symptoms are observed in substance use treatment they may reflect a pervasive form of underlying psychopathology which manifests through development of multiple psychiatric problems across the lifetime. These may include

gambling problems as well as affective and personality disturbances. Although pathological gambling symptoms may have modest independent associations with many clinical covariates (given high levels of psychiatric severity that define treatment seeking samples overall), there are specific psychosocial difficulties associated with pathological gambling. These include interpersonal problems at work and financial crises, which can exacerbate pre-existing mental health problems like major depression. This report concludes with a discussion of strategies for identifying and responding to pathological and problem gambling in the context of substance use treatment.

Introduction

Large studies of patients in treatment for substance use problems document high rates of co-occurring conditions, with data suggesting between 40% and 70% of patients that demonstrate one or more additional psychiatric diagnoses (Brooner, King, Kidorf, Schmidt & Bigelow, 1997; Castel, Rush, Urbanoski & Toneatto, 2006). The term diagnostic comorbidity is used commonly to refer to such co-occurring disorders, and subsumes conditions that occur simultaneously (i.e., current comorbidity), and disorders that occur independently in time (i.e., lifetime comorbidity; Petry, 2005). High rates of comorbidity in substance use treatment may reflect several factors, including natural levels of co-occurrence in the community (Kessler, Chiu, Demler & Walters, 2005), as well as selection effects, whereby multiple conditions increase likelihood of seeking treatment (Castel et al., 2006). Given these selection effects that partly determine the composition of clinical samples (see Galbaud Du Fort, Newman & Bland, 1993), studies of patients in treatment do not necessarily indicate associations among disorders (whereby one condition increases risk of another; Kreuger & Markon, 2006). Rather, they highlight potentially important secondary conditions, including mood and personality disorders (Brooner et al., 1996; Miller, Klamen, Hoffman & Flaherty, 1996), which may adversely affect treatment and risk of relapse (Hasin, Liu, Nunes, McCloud, Samet & Endicott, 2002). Notwithstanding this, there remains limited awareness of certain disorders that occur at low rates in the community, and are frequently assumed to occur at negligible levels in clinical settings as well. These assumptions contrast with findings from small studies of presumably rare conditions (e.g., impulse control disorders; Lejoyeux, Feuche, Loi, Solomon & Ades, 1999), which indicate additional comorbidities that can affect many substance users in treatment, but often go unrecognised.

Pathological and problem gambling refer to one class of impulse control or addictive disorders that affect around 0.5% to 2.0% of the community across western countries (Hodgins, Stea & Grant, 2011). These disorders are commonly comorbid with other psychiatric diagnoses (Lorains, Cowlishaw & Thomas, 2011), and are characterised generally by “persistent and recurrent maladaptive gambling behaviour” (American Psychiatric Association, 1994; p. 615) that leads to significant personal and social harm (e.g., financial difficulties, relationship breakdown). Despite a lack of consistent nomenclature, the term pathological gambling is used commonly in clinical settings, and describes conditions that meet full criteria for a formal psychiatric diagnosis under the *Diagnostic and Statistical Manual of Mental Disorders (DSM)* (American Psychiatric Association, 1994). The term problem gambling is used frequently in public health or policy contexts, and may refer to a broader spectrum of conditions (Neal, Delfabbro & O’Neil, 2005) that range in severity from moderate difficulties (meeting some but not all diagnostic criteria) to extreme levels of harm that could otherwise be classified as pathological gambling (although, for alternative usages, see Hodgins et al., 2011). Various other terms have been used to encompass this range of gambling conditions, including disordered gambling (Shaffer & Martin, 2011), compulsive gambling (Blume, 1988) and Level 2 (subclinical) or Level 3 (severe) gambling (Shaffer, Hall & Vander Bilt, 1998). Community studies suggest that gambling disorders across a range of severity are associated with adverse outcomes, including individual mental and physical health problems (Morasco, Pietrzak, Blanco, Grant, Hasin & Petry, 2006), and significant psychosocial difficulties (e.g., relationship breakdown; Shaw, Forbush, Schlinder, Rosenman & Black, 2007).

There are several reasons to suggest that pathological and problem gambling may be important considerations in treatment for substance use disorders. Although these comorbidities have been widely overlooked in the largest relevant investigations (e.g., Brooner et al, 1997; Compton, Cottler, Phelps, Abdallah, & Spitznagel, 2000; Miller et al, 1996), there are smaller studies which indicate rates that are elevated relative to the community, and as high as 50% in some instances

(see for example, Weinstock, Blanco, & Petry, 2006). Such findings are consistent with evidence of associations between gambling and substance use problems (Petry, 2005), and theoretical literature describing an addiction syndrome and common aetiology underlying some substance and behavioural addictions (the latter of which may include gambling disorders; Shaffer, LaPlante, LaBrie, Kidman, Donato & Stanton, 2004). Studies also suggest potential associations between gambling disorders and clinical outcomes in substance use treatment (e.g., substance usage during therapy; Cunningham-Williams, Cottler, Compton, Spitznagel, & Ben-Abdallah 2000), and thereby indicate possible impacts of such comorbidities on treatment effectiveness and risk of relapse.

The literature suggests that pathological and problem gambling are both common and influential in treatment for substance use problems. However, the available evidence remains subject to two primary limitations, such that these conclusions remain premature. First, studies on rates of gambling comorbidities in substance use treatment have produced widely varying results, with estimates ranging from around 3% (Tomasson & Vaglum, 1995) to above 50% (Weinstock et al., 2006). Such variation is currently difficult to interpret. On the one hand, most studies are characterised by small samples, such that apparent discrepancies may be explained by random variation (i.e., sampling error) alone. Alternatively, it may be that rates genuinely vary across contexts. For example, the occurrence of comorbid conditions is associated with severity of presenting problems (Angst, Sellaro, & Merikangas, 2002; Brooner et al, 1997), and it may be that gambling comorbidities are encountered mostly in inpatient treatment, relative to outpatient programs where patients have lower psychiatric severity (Finney, Hahn & Moos, 1996). Inconsistent findings may also explained by methodological differences, with some studies (e.g., using self-selected samples) overestimating rates of pathological and problem gambling. A second primary limitation of existing evidence is the scarcity of studies of covariates of gambling disorders in substance use treatment. This number is small, especially once randomised trials (that use strict inclusion and exclusion criteria to yield homogenous and atypical samples; e.g., Hall, Carriero, Takushi, Montoya, Preston & Gorelick, 2000) are excluded. The remaining studies have considered a limited range of variables, and suffer from reliance on geographically localised convenience samples and cross-sectional designs. As such, the research lacks stringency and does not illuminate links with outcomes across many domains of clinical importance.

The current project

The current project is intended to address these limitations of evidence and has two main aims:

1. To provide rigorous estimates of the prevalence of pathological and problem gambling in treatment for substance use problems; and

2. To conduct an evaluation of associations between gambling comorbidities in substance use treatment and a range of clinical covariates.

The research is comprised of two parts. First is a systematic review of published studies of the prevalence of comorbid pathological and problem gambling in treatment for substance use problems. Although prior narrative reviews have addressed literature on gambling comorbidity (e.g., Crockford & el-Guebaly, 1998; Petry, 2007), these have focussed on severe levels of pathological gambling and provided cursory consideration of clinical contexts. In contrast, the current review will focus exclusively on substance use treatment, and evaluate the continuum of problem gambling, as well as pathological gambling. It will use systematic search strategies to identify available evidence, and conduct meta-analyses to provide weighted mean estimates of

prevalence as well as variability across studies. The review will examine potential factors explaining this between-study variability, as well as potential publication bias in the available literature.

The second part is an investigation of clinical covariates of pathological gambling in substance use treatment, based on a secondary analysis of data from wave 1 (2000-2001) and wave 2 (2004-2005) of the US National Epidemiological Survey on Alcohol and Related Conditions (NESARC) (Grant et al., 2004). Although a US project in its entirety, NESARC is the largest epidemiological study of its kind (total *n* = 43,093), and provides a unique source of representative data on groups of special interest that are observed infrequently in the community. This includes pathological and problem gamblers, who are typically excluded from consideration in population studies because of insufficient numbers for analysis. The current analyses will consider NESARC participants who reported past-year treatment for alcohol or drug use, and consider concurrent (2000-2001) and prospective (2000-2001 to 2004-2005) links between pathological gambling symptoms and outcomes including mental and physical health, substance usage and psychosocial difficulties.

The following sections of this report present the empirical components of the project. Part A presents the systematic review of prevalence studies. It begins with a summary of specific aims, before describing the review methodology and findings. Part B presents the secondary analysis of NESARC data. This section also begins with a summary of aims, and describes the NESARC methodology; including the current analytic sample. It then describes the measures and data analysis methods, before summarising the main findings. The final section of the report comprises a general discussion of results in light of prior research, theory, and methodological limitations, as well as a summary of implications.

Part A: Systematic Review of Prevalence Studies

Overview

Part A the project comprises a systematic review of studies of the prevalence of pathological and problem gambling in substance use treatment. This part of the research is associated with four specific aims:

1. To provide weighted mean estimates of the prevalence of pathological and problem gambling in substance use treatment, based on all available evidence;

2. To examine heterogeneity across studies and identify contexts where this comorbidity may be more versus less common;

3. To evaluate methodological factors that may also explain variability in results; and

4. To evaluate publication bias in available literature.

The following section describes the review methodology, and comprises an outline of the systematic search strategy, inclusion and exclusion criteria, and data analysis methods. It then summarises the results of the systematic review and meta-analysis. A general discussion of review findings, including conclusions and summaries of limitations will be presented in the final section of the report.

Method

Search strategy

A systematic search was conducted to identify all available studies providing estimates of the prevalence of pathological or problem gambling in adult patients seeking treatment for substance use problems. Electronic searches of databases (Medline, PsycInfo and EMBASE) were conducted using a combination of keywords and wildcards relating to gambling and comorbidity, addiction and alcohol or substance use. A selection of relevant journals that were not indexed in these databases were searched manually; including *Gambling Research* (2003 onwards), *International Gambling Studies* (2001-2003), and the *Journal of Gambling Issues* (2000-2006). Finally, the reference lists of included studies were searched manually. The search was restricted to articles published in peer-reviewed journals, from January 1990 to August 2012.

Inclusion criteria

Patients were required to be adults over 18 years recruited from specialised substance use (illicit drug or alcohol) treatment programs. These included inpatient and outpatient programs and general addiction treatment centres (on condition that patients with gambling as a primary presenting problem were excluded). It was also required that pathological and problem gambling were identified using recognised measurement instruments. These included self-administered scales such as the South Oaks Gambling Screen (SOGS) (Lesieur & Blume, 1987). The SOGS is a widely used 20-item questionnaire based on DSM-III criteria, which was developed to screen for pathological gambling in clinical populations. Consistent with other self-administered scales, the

SOGS does not provide formal diagnoses of pathological gambling, but rather, is associated with cut-off criteria that identify likely subclinical gambling problems (3-4 symptoms) and probable pathological gambling (5+ symptoms) (Lesieur & Blume, 1993). Recognised measurement instruments also included interview measures (e.g., based on DSM-IV criteria) that may provide formally recognised diagnoses of pathological gambling. Studies were excluded if they used significant inclusion or exclusion criteria during recruitment (including clinical trials), drew patients from involuntary (e.g., court ordered) treatment, or were not published in English. There were no restrictions placed on region or location of treatment services.

Data extraction

Data were extracted on descriptive features of studies, including year of publication, sample characteristics (e.g., gender distribution), sample size, as well as the number (or proportion) of participants classified as pathological gamblers or problem gamblers. Other characteristics included treatment setting (e.g., inpatient, general outpatient), recruitment strategy (e.g., random sampling, invitations to participate), and methods of measurement. Two independent raters extracted the data from each study with 93% inter-rater agreement. Any discrepancies were resolved through discussion until consensus was achieved.

Data analysis

Random effects meta-analyses were conducted to estimate the prevalence of pathological and problem gambling along with 95% Confidence Intervals (CI) using the Comprehensive Meta-Analysis (CMA) software (Borenstein, Hedges, Higgins & Rothstein, 2009). For the primary analyses, estimates based on self-administered and interview based measures of gambling problems were combined. The random effects model assumes different true effect sizes and estimates the *average* effect from a distribution with a mean and variance. It partitions the variance into: (a) chance variation attributed to sampling error; and (b) additional differences reflecting true heterogeneity. The I^2 statistic indicates the amount of variation due to true differences, and is expressed as a proportion of total variance with values of 25%, 50% and 75% representing low, moderate and high levels of heterogeneity, respectively (Higgins, Thompson, Deeks & Altman, 2003).

Assuming heterogeneity across studies, sub-group analyses were conducted to explore factors explaining this variability (Thompson & Sharp, 1999). These included clinical factors, such as timeframe of gambling comorbidity (current, lifetime) and type of treatment (inpatient, outpatient, methadone maintenance therapy; MMT), as well as methodological factors associated with risk of bias. These latter factors included recruitment methodology (representative, self-selected samples) and method of gambling measurement (self-report, DSM based interview). Studies were organised into groups according to shared characteristics, before a weighted mean and confidence interval were calculated for each informative group. Estimates are thus reported separately across levels of clinical and methodological factors (e.g., studies using self-report scales, such as the SOGS, versus interview measures based on DSM criteria). Non-overlapping confidence intervals indicate significant differences (Hunter & Schmidt, 2004).

Finally, funnel plots (Egger, Smith, Schneider & Minder, 1997) were produced to evaluate potential publication bias in available studies. These scatter plots display the relationship between study size (as reflected in precision of study estimates, with larger studies having greater precision) on the y-axis, and effect size (as reflected in the logit event rate, with increasingly negative values indicating estimates closer to zero) on the x-axis. Assuming no publication bias, the distribution of effects is expected to approximate a ‘funnel’ shape, with larger studies at higher values of the y-

axis clustering around the mean effect, and smaller studies at lower values of the y-axis having more spread owing to greater sampling error. Given the absence of bias, the distribution of effects is also expected to be approximately symmetrical, such that studies with smaller samples and reporting smaller effects have equal probability when compared to smaller studies demonstrating larger effects. Asymmetry in the plot is apparent if smaller studies with small effects are less likely to be observed in the literature, such that there is a bias towards publication of studies with large effects. This pattern is commonly interpreted as reflecting publication bias (Egger et al., 1997).

Results

Search results

Once duplicate records were removed, the search produced 4,620 citations. The title and abstract of each was independently reviewed for eligibility by two reviewers, yielding a pool of 128 studies for which full text articles were examined. This pool included many studies that were not relevant to the review, including those that were clinical trials (e.g., Hall et al., 2000), used significant inclusion or exclusion criteria (for example, excluding participants manifesting severe levels of substance dependence) (Sellman, Adamson, Robertson, Sullivan & Coverdale, 2002), or involved treatment that was not focussed on substance use (for example, one study provided vocational and life skills training to homeless persons with a history of substance abuse, but did not clearly address substance use or associated problems) (Shaffer, Freed & Healea, 2002). Excluding these left 26 eligible studies that were reported in 31 articles (including duplicate publications). See Figure 1 for PRISMA flow diagram of search results.

Characteristics of studies

Characteristics of included studies are shown in Table 1. Sample sizes ranged from 62 to 2,588 (median = 199), and most (57.7%) were based in the US. Studies recruited variously from inpatient or residential services (23.1%), MMT programs (23.1%), general outpatient treatment (15.4%), or multiple settings (19.2%). Other studies (19.2%) failed to clearly report on the treatment context. The largest proportion of programs (42.3%) were described as treating both alcohol and illicit drug users, while other services focussed mainly on opiate (26.9%) or alcohol users (11.5%), respectively. Eighteen studies reported on problem gambling, using various standards to classify problems and arrive at estimates. Most used the SOGS (83.3%) and identified sub-clinical problems if participants endorsed three or four symptoms (66.7%). Twenty-five studies reported on pathological gambling, typically using the SOGS (80.0%) and a score of 5+ symptoms (76.9%). Four studies used interviewer administered measures based on DSM criteria. A majority of studies (53.9%) did not indicate whether estimates of pathological or problem gambling referred to current or lifetime disorders. The remaining studies reported lifetime (26.9%) and then current diagnoses (15.4%). One study provided both current (i.e., 6-month) and lifetime estimates; the latter of which was considered in the primary analyses to compare most with other studies.

Figure 1. PRISMA flow diagram of systematic search results. Flow diagram derived from Moher, Liberati, Tetzlaff and Altman (2009).

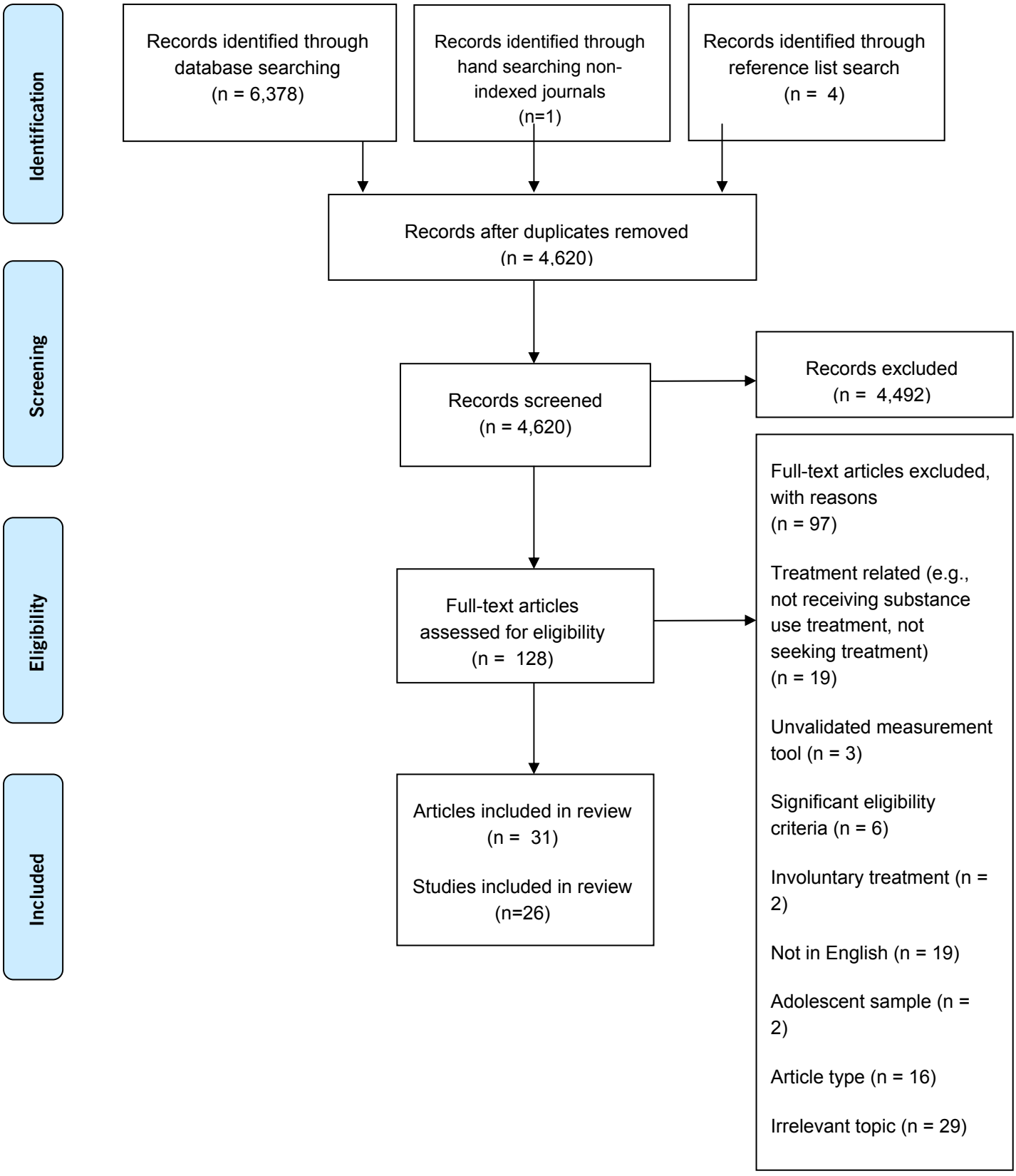

Table 1. **Characteristics of included studies.**

Study	n	Country	% male	Measurement tool[a]	Cut-off (problem)	Cut-off (pathological)	Comorbidity timeframe	Substance of addiction	Treatment setting	Recruitment methodology
Adamson et al. (2006)	105	New Zealand	68	SOGS	-	5+	Current	Alcohol and illicit drugs	Outpatient	Random selection
ANPAA et al. (2011)	2,588	France	73	DEBA-game	2+	6+	12-months	Alcohol	Not reported	Consecutive admissions
Baldo et al. (2006)	113	Italy	79	SOGS	1+	5+	Not reported	Alcohol and illicit drugs	Not reported	Consecutive admissions
Cardone et al. (1997)	1,345	US	Not reported	SOGS	Not reported	Not reported	Not reported	Not reported	Outpatient	Not reported
Ciarrocchi (1993)	467	US	60	SOGS	3+	5+	Not reported	Not reported	Outpatient	Consecutive admissions
Cunningham-Williams et al. (2000)	512	US	65	DIS	1+	DSM-III-R (4+)	Lifetime	Alcohol and illicit drugs	MMT, outpatient, residential	Not reported
Daghestani et al. (1996)	276	US	Not reported	SOGS	-	5+	Not reported	Not reported	Inpatient	Consecutive admissions invited
de Carvalho et al. (2005)	74	Brazil	89	SOGS	3+	5+	Not reported	Alcohol and illicit drugs	Outpatient, N.A.[b]	Invitations to participate
Elia & Jacobs (1993)	85	US	100	SOGS	3+	5+	Not reported	Alcohol	Inpatient	Invitations to participate
Feigelman et al. (1995)	220	US	67	SOGS	3+	5+	Not reported	Opiates	MMT	Invitations to participate

Table 1 (cont.)

Study	n	Country	% male	Measurement tool[a]	Cut-off (problem)	Cut-off (pathological)	Comorbidity timeframe	Substance of addiction	Treatment setting	Recruitment methodology
Gambino et al. (1993)	93	US	92	SOGS	3+	5+	Not reported	Alcohol and illicit drugs	Outpatient	Invitations to participate
Hendriks (1990)	152	Netherlands	80	DIS	-	DSM-III (4+)	6-months & Lifetime	Opiates	Inpatient	Consecutive admissions
Langenbucher et al. (2001)	372	US	83	SOGS	-	5+	Not reported	Not reported	Not reported	Not reported
Ledgerwood & Downey (2002)	62	US	50	SOGS	3+	5+	3-months	Opiates	MMT	Not reported
Lejoyeux et al. (1999)	79	France	61	MIDI	-	DSM-IV (5+)	Not reported	Alcohol	Inpatient	Consecutive admissions invited to participate
Mathias et al. (2009)	147	Brazil	86	SOGS	3+	5+	Not reported	Alcohol and illicit drugs	Inpatient, outpatient	Convenience
McCormick (1993)	2171	US	98	SOGS	-	5+	Not reported	Alcohol and illicit drugs	Not reported	Not reported
Nelson & Oehlert (2008)	292	US	98	SOGS	3+	5+	Not reported	Alcohol and illicit drugs	Not reported	Consecutive admissions
Peles et al. (2010a)[c]	178	Israel	66	SOGS	3+	5+	Lifetime	Opiates	MMT	Random selection
Peles et al. (2010b)[c]	113	US	64	SOGS	3+	5+	Lifetime	Opiates	MMT	Not reported

Table 1 (cont.)

Study	n	Country	% male	Measurement tool[a]	Cut-off (problem)	Cut-off (pathological)	Comorbidity timeframe	Substance of addiction	Treatment setting	Recruitment methodology
Rupcich et al. (1997)	328	Canada	67	SOGS	Not reported	Not reported	Not reported	Not reported	Residential, day treatment	Not reported
Spunt et al. (1996)	462	US	61	SOGS	2-6[d]	5+	Lifetime	Opiates	MMT	Random selection
Tomasson & Vaglum (1995)	351	Iceland	71	DIS	-	DSM-III (4+)	12-months	Alcohol and illicit drugs	Inpatient	Multiple (random sampling, not reported)
Toneatto et al. (2003)	853	Canada	66	SOGS	3+	5+	Lifetime	Alcohol and illicit drugs	Inpatient	Consecutive admissions
Weinstock et al. (2006)	167	US	54	SOGS	-	5+	Lifetime	Opiates	MMT	Invitations to participate
Wickwire et al. (2008)	157	US	100	NODS	3+	5+	Lifetime	Alcohol and illicit drugs	Inpatient, day treatment	Consecutive admissions

[a] DIS = Diagnostic Interview Schedule; MIDI = Minnesota Impulse Control Disorders Interview; NODS = NORC DSM Screen; SOGS = South Oaks Gambling Screen.

[b] N.A. = Narcotics Anonymous.

[c] Data from two studies were presented in the same published report. Accordingly, there is one citation in the reference list (Peles et al., 2010) that refers to multiple studies (Peles et al., 2010a; Peles et al., 2010b) in this table.

[d] From aggregate dimensions reflecting loss of control, emotional, family/social, job/school, financial, and legal.

Meta-analysis

Table 2 summarises results from included studies. As can be seen, estimated levels of pathological gambling varied across *k* = 25 studies (total *n* = 11,470), with figures ranging from 3% to 53%. Meta-analysis produced a weighted mean estimate of 13.7% (95% CI = 10.8 to 17.3). There were also varying estimates of rates of problem gambling across *k* = 18 studies (range = 10% to 43%, total *n* = 8,089), with a weighted mean of 22.8% (95% CI = 19.5 to 26.4). The I^2 statistic (see Table 2) indicated high levels of statistical heterogeneity across studies, suggesting that while weighted means provided single estimates of prevalence across studies, there were also contexts where gambling disorders would be more versus less common. As such, sub-group analyses were conducted to examine factors explaining this variability. Given that there were no strong reasons for expecting different patterns of results across pathological and problem gambling, as well as the larger number of studies providing data on levels of pathological gambling, the analyses focussed on this outcome only. A selection of results is shown in Table 3.

Trends suggested higher rates of pathological gambling in studies evaluating lifetime gambling disorders, relative to current comorbidities, as well as studies recruiting from MMT programs, relative to inpatient and general outpatient programs. Trends also suggested higher rates of pathological gambling in studies relying on self-administered tools (mainly the SOGS), relative to interview measures based on DSM criteria, as well as studies relying mainly on self-selected participants, relative to random selection or recruitment of all admissions. However, in each instance these differences across sub-groups of studies were associated with overlapping confidence intervals. As such, it was not possible to discount the likelihood of no differences. Further analyses (not shown) examined variability according to sample gender distribution (i.e., percent male) and decade of publication, with no evidence of meaningful differences according to these characteristics.

Table 2. **Study estimates and meta-analysis results.**

Study	*n*	Prevalence (%)	
		Problem gambling	Pathological gambling
Adamson *et al.* (2006)	105	-	11.0
ANPAAS *et al.* (2011)	2,588	18.5	6.5
Baldo *et al.* (2006)	113	43.4	15.0
Cardone *et al.* (1997)	1,345	22.9	14.5
Ciarrocchi (1993)	467	10.7	4.5
Cunningham-Williams *et al.* (2000)	512	22.0	10.0
Daghestani *et al.* (1996)	276	-	33.3
de Carvalho *et al.* (2005)	74	29.7	18.9
Elia & Jacobs (1993)	85	29.4	12.9
Feigelman *et al.* (1995)	220	10.0	7.0
Gambino *et al.* (1993)	93	31.3	17.3
Hendriks (1990)	152	-	14.5
Langenbucher *et al.* (2001)	372	-	13.2
Ledgerwood & Downey (2002)	62	29.0	17.7
Lejoyeux *et al.* (1999)	79	-	8.9
Mathias *et al.* (2009)	147	34.7	21.8
McCormick (1993)	2,171	-	13.0
Nelson & Oehlert (2008)	292	14.7	-
Peles *et al.* (2010a)[a]	178	27.0	21.9
Peles *et al.* (2010b)[a]	113	16.8	8.8
Rupcich *et al.* (1997)	328	25.3	14.3
Spunt *et al.* (1996)	462	30.3	21.4
Tomasson & Vaglum (1995)	351	-	2.8
Toneatto *et al.* (2003)	853	14.3	10.4
Weinstock *et al.* (2006)	167	-	52.7
Wickwire *et al.* (2008)	157	24.6	15.9
Weighted mean		22.8	13.7
(95% CI)		(19.5 to 26.4)	(10.8 to 17.3)
I^2		0.91	0.95

[a] Data from two studies were presented in the same published report. Accordingly, there is one citation in the reference list (Peles et al., 2010) that refers to multiple studies (Peles et al., 2010a; Peles et al., 2010b) in this table.

Table 3. **Selected sub-group analyses.**

Study characteristic	*k*	Mean estimate (%)	95% CI	
			LB	UB
Comorbidity timeframe[a]				
Current[b]	5	10.9	7.5	15.6
Lifetime	7	15.2	8.0	27.2
Treatment setting[c]				
Inpatient[d]	6	11.5	5.7	21.9
General outpatient	4	10.7	5.9	18.6
MMT	6	18.8	9.9	32.8
Recruitment methodology[e]				
Representative[f]	11	13.0	9.0	20.0
Self-selected[g]	6	19.0	9.0	36.0
Gambling measurement[h]				
Self-report	20	15.0	12.0	19.0
DSM based interview	4	8.0	4.0	14.0

[a] Studies failing to indicate consideration of current versus lifetime gambling disorders were excluded.
[b] Included current, 3-month, 6-month and 12-month timeframes. Data on current estimates from one study that reported both current and lifetime disorders were used in this analysis.
[c] Studies sampling from multiple settings (k = 5) or not clearly reporting on treatment settings (k = 4) were excluded.
[d] Included treatments described as inpatient or residential.
[e] Studies using multiple sampling strategies (k = 1) or not clearly reporting a strategy (k = 7) were excluded.
[f] Included studies relying on random sampling and recruitment of all consecutive admissions.
[g] Included studies using invitations to participate or strategies otherwise referred to as convenience sampling.
[h] One study was excluded that did not indicate whether self-report or interviewer administered versions of the NODS instrument was used.

Publication bias

A funnel plot display of the relationship between study size and magnitude of estimates of prevalence of pathological gambling is shown in Figure 2. Each clear circle indicates an estimate from a single study, with the precision of this estimate indicated along the y-axis. The magnitude of the prevalence estimate (in terms of logit event rate) is shown along the x-axis, whereby increasingly negative values indicate estimates closer to zero. The filled circles shown in Figure 2 indicate simulated studies that were not observed, but would be (hypothetically) required to create a genuinely symmetrical distribution that was not characterised by bias. Although the expected 'funnel' shape is somewhat difficult to ascertain in Figure 2, given the small number of large studies at higher values of the y-axis, the simulated studies all have extreme negative locations

along the x-axis. The values for the simulated (unpublished) studies indicate estimates that are all closer to zero, and suggest possible bias towards publication of studies reporting larger estimates of the prevalence of pathological gambling.

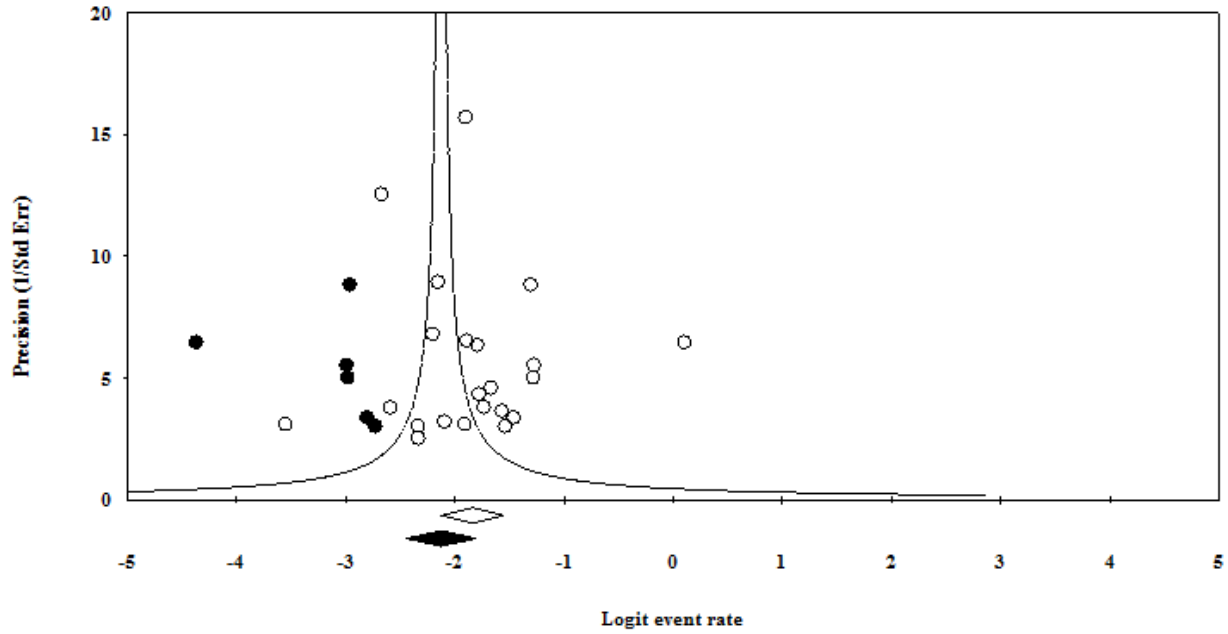

Figure 2. Funnel plot display of study estimates of prevalence of pathological gambling (logit event rate) and study size (precision).

Summary

The systematic search identified 26 studies that reported the prevalence of pathological or problem gambling in substance use treatment. Most were based in the US and considered treatment contexts including inpatient or residential services, methadone maintenance therapy (MMT), and general outpatient treatment for alcohol and illicit drug use. Results from 25 studies (total *n* = 11,470) suggested around 14% of patients across clinical contexts that demonstrated comorbid pathological gambling. Results from 18 studies (total *n* = 8,089) suggested approximately 23% that suffered conditions along the broader spectrum of problem gambling. The analyses identified high levels of statistical heterogeneity across studies, and produced trends suggesting potential differences across groups of studies; for example, indicating higher rates of pathological gambling in studies using self-administered measurement tools, relative to interview measures based on DSM criteria. However, these differences were not statistically significant, such that the observed statistical heterogeneity remains largely unexplained. Funnel plots produced tentative evidence of publication bias in the results, suggesting that available studies may also provide an upwardly bias selection of findings. Notwithstanding the concomitant need for caution when interpreting results, the findings suggest that pathological and problem gambling may be relatively common comorbid disorders in substance use treatment. Admittedly, such data on prevalence do not indicate whether these comorbidities are also *influential* (through demonstration of meaningful relations with significant outcomes), and should thus be important clinical considerations. This was the focus of Part B of the current project and the next section.

Part B: Secondary Analysis of NESARC data

Overview

Part B of this project comprised a secondary analysis of data derived from wave 1 (2000-2001) and wave 2 (2004-2005) of the US National Epidemiological Survey on Alcohol and Related Conditions (NESARC) (Grant et al., 2004). The primary aim of this analysis was to examine the associations between symptoms of pathological gambling in substance use treatment and covariates; including indicators of mental health, physical health and psychosocial difficulties. The next sections present the methodology that provided the bases of this examination. They describe the NESARC sampling procedures, as well as the analytic sample, measures and data analyses. The subsequent section presents the results of these analyses. As with Part A, a general discussion of findings is contained in the final section of this report.

Method

Sample and procedure

Wave 1 of the NESARC study was a nationally representative survey of US adults (≥ 18 years) residing in non-institutionalised settings. It was based on a multi-stage stratified sampling design (for a fuller description, see Grant et al., 2004), with Census primary sampling units (PSUs) (stratified by socio-demographics), households, and members of households sampled in succession. Black and Hispanic households were oversampled. Respondents residing in group living arrangements, including dormitories, boarding houses and group homes were also sampled. One person from each household (or group living arrangement) was randomly selected to participate, with potential respondents aged 18-24 years having greater probability of selection. Once respondents were identified and provided consent to participate, data were collected through face-to-face interviews with a total of 43,093 respondents. This was based on a response rate of 81%. Wave 2 of the NESARC was conducted three years later, based on attempts to re-contact wave 1 respondents; excluding those who were ineligible (e.g., because of death, incapacity, or active duty with the armed forces). A total of 34,653 interviews were conducted at wave 2, reflecting 86.7% of the eligible sample.

Data for the current analyses were derived from wave 1 participants who reported treatment for alcohol or substance use in the previous 12 months. These participants were identified through a screening question asking whether they had ever gone anywhere, or seen anyone, for reasons related to drinking or medicine or drug use. For drinking and substances, participants indicating ‘yes’ were read a list of community agencies and professionals and asked for each whether they had attended in the last 12 months. For the purposes of this study, participants were classified as having sought treatment for drinking or substance use if, in the previous year, they had attended any of the following: (a) alcohol or drug detoxification ward or clinic; (b) inpatient ward of a psychiatric or general hospital or community mental health program; (c) outpatient clinic, including outreach programs and day or partial patient programs; (d) alcohol or drug rehabilitation program; or (e) a methadone maintenance program. Based on these criteria, a total of n = 272 participants were identified. This included n = 201 who reported treatment for alcohol, and n = 129 who sought treatment for substance use (with n = 58 seeking treatment for both alcohol and substance use).

Measures

Socio-demographic measures considered at wave 1 (with categorisation of variables in parentheses) included sex (male, female), age (18-29, 30-44, 45-64, ≥ 65), race (white, non-white), relationship status (married/cohabitating, separated/divorced/widowed, never married), education (less than high school, high school, some post-school education or higher), employment status (employed, unemployed, not in labour force), and annual personal income (USD $0-19 999, $20 000-34 999, $35 000-69 999, ≥ $70 000).

The Alcohol Use Disorder and Associated Disability Interview Schedule-DSM-IV Version (AUDADIS-IV) (Grant, Dawson, Stinson, Chou, Kay & Pickering, 2003) was used in wave 1 to measure gambling symptoms and other disorders. The AUDADIS-IV is a structured diagnostic tool that can be administered by lay interviewers. It measures the ten diagnostic criteria for pathological gambling, referencing both lifetime and past year timeframes. These were administered to participants who reporting gambling at least five times in any one year. This measure can be utilized to derive diagnoses of pathological gambling (see Petry, Stinson & Grant, 2005), but has also been used to measure the broader continuum of problem gambling (see, for example, Desai, Desai & Potenza, 2007). Additional Axis I disorders evaluated by the AUDADIS-IV (see Grant et al., 2004) included substance use disorders (comprising alcohol and drug-specific abuse and dependence), mood disorders (major depression, dysthymia, mania, hypomania) and anxiety disorders (panic disorder with and without agrophobia, social phobia, specific phobia, generalised anxiety disorder). The AUDADIS-IV also provides diagnoses of Axis II disorders (avoidant, dependent, obsessive-compulsive, paranoid, schizoid, histrionic and antisocial personality disorders). The psychometric properties of the AUDADIS-IV are empirically supported (see Grant et al., 2003).

A range of variables were considered as covariates of pathological gambling symptoms. Wave 1 measures of substance usage included frequency of drinking (1 = *1 or 2 times in the last year*, 10 = *Every day*) and heavy drinking (defined as having consumed > 5 drinks in one sitting, with responses scored from 1 = *Never in the last year* to 11 = *Every day*), and usage of marijuana or other drugs in the past year. The number of substances was calculated as an indicator of polydrug use. Scores from subscales of the Short Form-12 (SF-12; Ware, Kosinski & Keller, 1996) provided measures of mental health (Mental Health Component Score) and physical health (Physical Health Component Score) status. The number of medical conditions was derived as another measure of physical health, based on a checklist of professional diagnoses of common conditions including arteriosclerosis, hypertension, liver disease, heart disease, gastritis and arthritis. Measures of health service utilisation included number of stays (overnight or longer) in a hospital, and times receiving care in a hospital emergency room. Items addressing past year occurrence of several life events were considered as psychosocial problems, including troubles with work colleagues, termination of a steady relationship, financial crises (e.g., bankruptcy, being repeatedly unable to pay bills), and criminal or legal difficulties. Wave 2 variables included diagnoses of Axis I disorders since last interview, and psychosocial problems in the past year.

Data Analysis

Data analyses were conducted using STATA Release 12.1 MP for Unix (StataCorp, 2011). Weighted percentages were calculated to indicate the prevalence of lifetime and past year pathological gambling symptoms, estimated across a continuum of severity. This included no problems (0 symptoms), low severity (1-2 symptoms), sub-clinical problems (3-4 symptoms), and pathological gambling (5+ symptoms). Negative binomial regression models estimated relationships among the number of pathological gambling symptoms and covariates. Negative

binomial regression belongs to a class of statistical models that are appropriate for analysis of 'count' variables (i.e., characterised by non-negative integer values that reflect the number of occurrences of an event; see Coxe, West & Aiken, 2009). These include variables defined by low base-rate events and distributions with a low mean and heavy skew (such as symptom counts). In contrast with techniques that require transformations or categorisation of underlying distributions, count regression techniques model the distribution in its natural multinomial form, while providing an appropriate error structure that better maintains nominal Type 1 error rates (see Coxe et al., 2009). In the current analyses, a series of models were used to estimate associations between pathological gambling symptoms and clinical covariates, holding constant socio-demographic variables including sex, race, relationship status, education, employment, and income. Each sequential model regressed pathological gambling symptoms on one covariate (e.g., lifetime major depression), and socio-demographic controls. Parameter estimates and standard errors for each covariate were thus produced, controlling for socio-demographics. Incidence-rate ratios (IRRs) were produced to indicate the magnitude of associations. An alpha level of $p < .05$ was used as the criteria for statistical significance, although trends that were significant at more liberal levels ($p < .10$) were identified. All results were adjusted to control for Primary Sampling Unit (PSU) using the survey data (svy) commands in STATA. Given the large number of strata with singleton PSUs (which lead to model convergence difficulties), it was not possible to include additional adjustments for survey stratification of sampling units.

Results

Descriptive analyses

Socio-demographic characteristics of the sample (including weighted percentages and raw numbers) are shown in Table 4. As can be seen, the sample was predominantly male, white, and less than 65 years of age. Around half the sample were employed, but most also fell in the lowest income bracket. There was no evidence of large differences across treatment for alcohol use and substance use. Given the non-independence of many observations, statistical tests of such differences were not conducted.

Table 4 also shows weighted estimates of lifetime and past-year gambling symptoms. As can be seen, around 85% of the sample demonstrated no lifetime problems. This group comprised respondents who had gambled less than five times in any one year (and were not administered the measure of gambling symptoms), as well as respondents who gambled more frequently but reported zero symptoms. The remaining respondents typically demonstrated low severity problems, with only around 4% demonstrating pathological gambling. The prevalence of problem gambling (combining subclinical difficulties and pathological gambling) was 6.2% (SE = 1.72). When past-year problems were considered, gambling problems were less frequent with only around 1% demonstrating pathological gambling and 2.1% (SE = 0.94) demonstrating conditions along the spectrum of problem gambling. There was no evidence of large differences across alcohol and substance use treatment, respectively.

Clinical covariates

Negative binomial regression analyses were conducted to examine associations between gambling symptoms and clinical covariates, controlling for socio-demographics[1]. For these

[1] Results from bivariate tests (excluding socio-demographic control variables), including model fit statistics and parameter estimates, are provided in the Appendices (Tables A4-A8).

analyses, participants reporting treatment for alcohol and substance use problems were combined, while lifetime gambling symptoms were considered. Table 5 shows associations between pathological gambling symptoms and past-year and lifetime Axis I diagnoses and Axis II diagnoses. Social phobia (past year), hypomania (past year and lifetime), and dependent personality disorder were not considered because of low rates of occurrence (< 10%), and insufficient variability. Model fit statistics and values of the dispersion parameter (α) with 95% CIs are presented in the Appendices (Tables A1 – A3).

There were no significant associations between pathological gambling symptoms and past-year Axis I disorders. However, there were trends ($p < .10$) suggesting increased likelihood of specific phobia and generalised anxiety disorder. When considering lifetime diagnoses, pathological gambling symptoms were significantly associated with major depression. The IRR indicated that substance users with lifetime major depression reported around four times the number of gambling symptoms than respondents without, holding socio-demographics constant. Several trends approached significance ($p < .10$) and suggested associations with panic disorder, specific phobia, dysthymia, and generalised anxiety disorder. Pathological gambling symptoms were significantly associated with several Axis II diagnoses. The strongest relationships involved borderline, avoidant, and antisocial personality disorders. Substance users with any such diagnoses reported at least four times the number of pathological gambling symptoms than those without.

Table 6 shows cross-sectional associations between symptoms of pathological gambling and additional covariates. There was no evidence of associations with alcohol or substance usage, and mental or physical health status. Symptoms of pathological gambling were unrelated to medical utilization. In contrast, there were significant associations with interpersonal troubles at work and financial crises. There was a trend ($p < .10$) suggesting an association between symptoms of pathological gambling and criminal or legal difficulties.

Results from prospective analyses (wave 1 to wave 2) are shown in Table 7. Due to non-participation in wave 2, the sample size was $n = 205$ in these analyses. Low levels of variability in covariates at wave 2 limited the variables considered. These consisted of Axis 1 disorders reported since last interview, and psychosocial difficulties in the past year[2]. All analyses included socio-demographic controls[3].

Results suggested that pathological gambling symptoms were associated with subsequent major depression, while there was a trend suggesting a relationship with mania. Symptoms of pathological gambling were significantly associated with reports of major financial crises and termination of a steady relationship. Given the relatively small amount of variability in this latter variable (around 13% of the sample reported ending a steady relationship), the magnitude of the IRR (which suggests a large relationship) should be interpreted cautiously (95% CI from 2.97 to 45.32).

[2]Given that the timeframe of occurrence of symptoms or events was built into the design of wave 2 measures of Axis 1 symptoms (since last interview) and psychosocial difficulties (since last year), it was deemed unnecessary to also incorporate information on temporal status into the statistical model by including wave 1 scores as covariates.

[3] Due to a small number of participants aged 65+ years in the prospective analyses ($n = 205$), the upper age categories were collapsed (45+ years) for inclusion in the regression models. Given the reduced the number of age categories in these analyses, there were also fewer degrees of freedom.

Table 4. **Socio-demographic characteristics and rates of pathological and problem gambling.**

Variable	Any treatment				Alcohol use treatment				Substance use treatment			
	n =	272	95% CI		n =	201	95% CI		n =	129	95% CI	
	%	(n)	LB	UB	%	(n)	LB	UB	%	(n)	LB	UB
Sex												
Male	0.69	(175)	0.62	0.75	0.75	(141)	0.68	0.82	0.57	(70)	0.47	0.68
Age (years)												
18-29	0.27	(62)	0.20	0.34	0.25	(42)	0.16	0.33	0.32	(36)	0.21	0.42
30-44	0.42	(113)	0.34	0.49	0.43	(87)	0.35	0.52	0.37	(50)	0.28	0.47
45-64	0.27	(87)	0.21	0.34	0.29	(65)	0.21	0.37	0.28	(40)	0.18	0.37
65+	0.04	(10)	0.01	0.07	0.03	(7)	0.01	0.06	0.03	(3)	-0.02	0.08
Race												
White	0.70	(154)	0.62	0.78	0.72	(119)	0.63	0.81	0.63	(66)	0.52	0.73
Relationship status												
Married/cohabitating	0.34	(76)	0.27	0.41	0.31	(52)	0.23	0.39	0.38	(40)	0.28	0.49
Separated/divorced/widowed	0.30	(92)	0.22	0.37	0.34	(75)	0.25	0.43	0.24	(38)	0.16	0.32
Never married	0.37	(104)	0.30	0.43	0.35	(74)	0.27	0.43	0.38	(51)	0.28	0.47
Education												
Less than high school	0.22	(59)	0.15	0.28	0.21	(41)	0.14	0.28	0.23	(31)	0.15	0.31
High school	0.37	(101)	0.30	0.45	0.36	(73)	0.27	0.45	0.36	(46)	0.27	0.44
Some post-school education or higher	0.41	(112)	0.33	0.48	0.43	(87)	0.34	0.52	0.41	(52)	0.31	0.52
Employment (past 12 months)												
Employed	0.56	(140)	0.49	0.64	0.59	(105)	0.51	0.68	0.49	(63)	0.38	0.59
Unemployed	0.11	(34)	0.06	0.16	0.10	(26)	0.05	0.16	0.15	(16)	0.06	0.24
Not in the labour force	0.32	(98)	0.26	0.39	0.30	(70)	0.22	0.38	0.36	(50)	0.27	0.46

Table 4 (cont.)

Variable	Any treatment				Alcohol use treatment				Substance use treatment			
	n =	272	95% CI		n =	201	95% CI		n =	129	95% CI	
	%	(n)	LB	UB	%	(n)	LB	UB	%	(n)	LB	UB
Annual personal income												
$0-19 999	0.74	(204)	0.67	0.80	0.70	(144)	0.62	0.77	0.79	(105)	0.70	0.88
$20 000-34 999	0.18	(39)	0.12	0.23	0.20	(31)	0.13	0.27	0.16	(17)	0.08	0.24
$35 000-69 999	0.07	(24)	0.04	0.10	0.09	(22)	0.05	0.13	0.05	(6)	0.01	0.09
≥ $70 000	0.02	(5)	0.00	0.03	0.02	(4)	0.00	0.04	0.00	(1)	0.00	0.00
Gambling symptom severity												
Lifetime												
No problems	0.86	(234)	0.81	0.91	0.87	(171)	0.81	0.93	0.82	(111)	0.73	0.90
Low severity (1-2 symptoms)	0.08	(19)	0.04	0.12	0.07	(14)	0.02	0.11	0.12	(12)	0.04	0.19
Subclinical problems (3-4 symptoms)	0.03	(7)	0.00	0.05	0.03	(6)	0.00	0.06	0.04	(3)	0.00	0.09
Pathological gambling (5+ symptoms)	0.04	(12)	0.01	0.06	0.03	(10)	0.01	0.06	0.02	(3)	0.00	0.06
Past year												
No problems	0.93	(254)	0.90	0.97	0.94	(187)	0.90	0.98	0.93	(122)	0.88	0.99
Low severity (1-2 symptoms)	0.05	(11)	0.01	0.08	0.03	(7)	0.00	0.06	0.07	(7)	0.01	0.12
Subclinical problems (3-4 symptoms)	0.01	(3)	0.00	0.02	0.01	(3)	0.00	0.03	-[a]	(0)	-[a]	-[a]
Pathological gambling (5+ symptoms)	0.01	(4)	0.00	0.02	0.01	(4)	0.00	0.03	-[a]	(0)	-[a]	-[a]

[a] Parameter not estimable because of zero cell counts.

Table 5. **Cross-sectional associations between symptoms of pathological gambling and Axis I and Axis II disorders, controlling for socio-demographic variables[4].**

Variable	Estimate	95% CI		*p*	IRR
		LB	UB		
Axis I disorders					
Past year					
Major depression	0.51	-0.44	1.45	0.295	1.66
Dysthymia	0.64	-0.35	1.63	0.207	1.90
Mania	0.37	-0.51	1.25	0.413	1.45
Panic disorder	-0.07	-0.99	0.84	0.873	0.93
Specific phobia	1.01	-0.13	2.15	0.082	2.75
Generalised anxiety disorder	1.09	-0.14	2.32	0.081	2.98
Lifetime					
Major depression	1.38	0.53	2.23	0.002	3.98
Dysthymia	0.92	-0.05	1.88	0.063	2.50
Mania	0.30	-0.58	1.18	0.499	1.35
Panic disorder	0.93	-0.01	1.88	0.053	2.54
Social Phobia	0.66	-0.50	1.82	0.263	1.93
Specific phobia	1.18	-0.03	2.38	0.055	3.25
Generalised anxiety disorder	1.00	-0.08	2.08	0.069	2.72
Axis II disorders					
Antisocial	1.39	0.35	2.43	0.009	4.03
Avoidant	1.41	0.45	2.36	0.004	4.09
Obsessive/compulsive	0.72	-0.12	1.57	0.094	2.06
Paranoid	0.41	-0.40	1.23	0.322	1.51
Schizoid	1.12	0.08	2.15	0.034	3.05
Histrionic	1.14	-0.13	2.41	0.078	3.13
Borderline	1.48	0.53	2.44	0.002	4.41
Schizotypal	0.10	-1.30	1.49	0.892	1.10
Narcissistic	1.20	0.11	2.28	0.031	3.31

[4] Each statistical model regressed symptoms of pathological gambling on one covariate of interest (e.g., past year major depression), as well as socio-demographic control variables. As such, estimate and IRR values indicate the association between these symptoms and one covariate, controlling for socio-demographics. Additional covariates (e.g., past year dysthymia) were evaluated in separate models.

Table 6. **Cross-sectional associations between symptoms of pathological gambling and clinical covariates, controlling for socio-demographic variables.**

Variable	Estimate	95% CI		*p*	IRR
		LB	UB		
Substance usage					
Alcohol					
Frequency of drinking any alcohol	-0.07	-0.20	0.06	0.276	0.93
Frequency of drinking ≥ 5 drinks	-0.06	-0.18	0.07	0.387	0.95
Marijuana	0.06	-0.93	1.04	0.910	1.06
Other drugs	0.07	-0.88	1.02	0.889	1.07
Polydrug use					
Number of substances	0.16	-0.18	0.49	0.364	1.17
Health status					
SF-12 Mental Health Component Score	-0.02	-0.05	0.02	0.297	0.98
SF-12 Physical Health Component Score	-0.01	-0.05	0.02	0.495	0.99
Number of medical diagnoses	0.12	-0.18	0.42	0.433	1.13
Medical utilization					
Times stayed overnight in the hospital	0.13	-0.07	0.32	0.198	1.14
Times treated in hospital emergency	0.11	-0.04	0.26	0.159	1.11
Psychosocial harm (past year)					
Trouble with boss/coworker	1.17	0.11	2.23	0.031	3.22
Problems with a neighbour/friend/relative	-0.86	-1.90	0.18	0.104	0.42
Separated, divorced, broke off a steady relationship	0.04	-1.08	1.16	0.944	1.04
Major financial crisis, bankruptcy, repeatedly unable to pay bills	1.01	0.12	1.90	0.025	2.75
Trouble with police, arrested, sent to jail	0.81	-0.05	1.67	0.064	2.26

Table 7. **Prospective associations between symptoms of pathological gambling and covariates, controlling for socio-demographic variables.**

Variable	Estimate	95% CI		*p*	IRR
		LB	UB		
Axis I disorders					
Major depression	1.60	0.48	2.73	0.005	4.98
Mania	1.53	-0.06	3.12	0.059	4.61
Specific phobia	0.35	-1.28	1.97	0.674	1.42
Psychosocial harm (past year)					
Trouble with boss/coworker	0.68	-0.91	2.26	0.401	1.97
Problems with a neighbor/friend/relative	0.83	-0.53	2.18	0.232	2.29
Separated, divorced, broke off a steady relationship	2.45	1.09	3.81	0.000	11.60
Major financial crisis, bankruptcy, or repeatedly unable to pay bills	1.15	0.18	2.12	0.020	3.16
Trouble with police, arrested, sent to jail	1.00	-0.62	2.62	0.227	2.72

Summary

The current analyses were based on data from *n* = 272 participants reporting past year treatment for substance use problems, derived from the larger NEASRC study. Results suggested that around 4% of substance use patients reported lifetime pathological gambling, and that around 6% reported lifetime problem gambling (combining subclinical difficulties and pathological gambling). Past-year gambling problems were less frequent with only around 1% demonstrating pathological gambling and around 2% demonstrating concurrent conditions along the spectrum of problem gambling. Results from negative binomial regression analyses of clinical covariates failed to support a number of expected associations with symptoms of pathological gambling, including associations with current Axis I disorders, as well as overall mental and physical health status, substance usage and healthcare utilisation. Rather, the results suggested a more specific pattern of associations between symptoms of pathological gambling and particular clinical covariates, including rates of certain lifetime Axis I disorders (e.g., major depression) and Axis II disorders (e.g., borderline personality disorder), as well financial and interpersonal difficulties, observed concurrently and prospectively over time. Symptoms of pathological gambling were also associated prospectively with subsequent diagnoses of major depression. The implications of these findings for existing research and theory, as well as implications arising from Part A of the project, are discussed more fully in the next section.

Discussion

The overall aims of this project were to provide estimates of the prevalence of pathological and problem gambling in substance use treatment, and evaluate associations with gambling comorbidities in substance use treatment and various outcomes of clinical significance. This final section provides a general discussion of results from this project in light of these aims. It begins with a summary of findings from Part A of the project, which are discussed in terms of theory and limitations of available evidence, including the preponderance of US data. It then summarises results from Part B of the project, which are discussed in light of prior research and theory on the covariates of gambling disorders and limitations of the data. The final section describes the clinical implications of the findings.

Prevalence of pathological and problem gambling in substance use treatment

Based on a systematic review of published studies, Part A of the project suggested around 14% of substance use patients that demonstrate comorbid pathological gambling, and around 23% that report conditions across the spectrum of problem gambling. These estimates were based on data from 26 studies (total *n* = 11,470) and 18 studies (total *n* = 8,089), respectively, that were identified through a broad systematic search of published literature. Brooner et al. (1997) provided comparative estimates for a range of common comorbidities (excluding gambling disorders) in opioid use treatment, and found that major depression was the most prevalent Axis I disorder, affecting around 16% of the sample. Antisocial personality disorder was the most common Axis II disorder, affecting around 25% of patients. Similar findings for these other comorbidities have been reported elsewhere (e.g., Compton et al, 2000), and suggest that pathological and problem gambling may have a similar or greater rate of occurrence in this clinical context. Gambling disorders may thus comprise a prevalent yet hidden class of comorbid illnesses in substance use treatment, where patients display no overt signs of gambling addiction, and are perhaps accustomed to concealing their behaviour from others. This may include clinicians delivering treatment for substance use problems.

Findings of high rates of gambling disorders in substance use treatment are consistent with notions of an addiction syndrome (Shaffer et al., 2004), whereby both disorders develop from shared determinants (such as common genetic vulnerabilities) (Slutske, Eisen, True, Lyons, Goldberg & Tsuang, 2000). They are also in line with assertions of inter-relations between substance use and gambling problems, such that one disorder may increase risk of the other. On the one hand, it may be that addictive substances impair judgment and promote risk-taking behaviour, thus precipitating excessive gambling (Grant, Kushner & Kim, 2002). On the other hand, it may also be that gambling symptoms carry implications for substance use and primary treatment of associated conditions (e.g., where financial losses from gambling function as psychosocial stressors that precipitate relapse in substance usage; Spunt et al., 1996). Prospective data from studies of community samples is needed to establish these influences of substance use on gambling, or reciprocal effects of gambling on substance use over time. However, analyses of retrospective reports of age of onset of these disorders (e.g., Cunningham-Williams et al., 2006; Kessler, Hwang, LaBrie, Petukhova, Sampson, Winters & Shaffer, 2008) provide initial support for both accounts. That is, substance use problems precede gambling in many instances, while gambling problems precede substance use in others (although substance use disorders overall may be more likely to predate problematic gambling in time) (Kessler et al., 2008).

The current estimates of rates of gambling disorders in substance use treatment were based on the weighted mean of results from primary studies, and thus provide single estimates that are most generalisable across clinical settings. However, the analyses also identified statistical heterogeneity across studies, suggesting contexts or characteristics of studies that may be associated with higher versus lower rates of gambling disorders. Sub-group analyses were conducted to examine factors that could explain this variability, and identified several trends suggesting meaningful difference across studies. However, the confidence intervals associated with these group-specific estimates (e.g., for MMT versus general outpatient treatment) were found to overlap, such that no effects were statistically significant. The small number of studies available for the analyses makes such effects difficult to interpret (non-significant differences may reflect the absence of true effects, or alternatively, low levels of statistical power). Accordingly, the likely influences of these factors remain unclear pending stronger tests in future research, such that observed statistical heterogeneity across studies remains largely unexplored.

Notwithstanding the previously mentioned non-significant effects, there were several substantive patterns in the sub-group analyses that warrant consideration, since they highlight important limitations of available evidence. These include limitations of data on current versus lifetime gambling comorbidities, as well as methodological limitations of studies. With regards to the former, analyses suggested higher rates of pathological gambling in studies measuring lifetime versus current conditions. Logically, measures of lifetime disorders subsume individuals with current disorders, as well as individuals with prior conditions who are no longer symptomatic. As such, rates of current disorders provide a lower bound on lifetime estimates, which should be typically higher. Despite this, the currently analyses also identified an absence of studies describing the timeframe of gambling comorbidities. Less than half the included studies provided this information and were included in these analyses. As such, it remains unclear whether estimates pertain mainly to lifetime or current conditions. Given that many studies used the SOGS to evaluate gambling problems, which was originally developed as a lifetime measure (Lesieur & Blume, 1987), it may be reasonable to assume that the data pertain mainly to lifetime conditions. These lifetime disorders may represent important clinical considerations in substance use treatment (for example, indicating risk of cross-addiction or 'addiction swapping', whereby decreases in one addictive behaviour, such as drinking, lead to compensatory increases in another, such as gambling). Notwithstanding this, the figures may overestimate rates of comorbidities that are currently influencing treatment.

With regards to methodological characteristics of studies, there were trends in the sub-group analyses suggesting higher rates of pathological gambling in studies using convenience samples, versus representative samples (including all consecutive admissions). There were also trends suggested higher estimates derived from studies using self-administered tools, versus interview measures based on DSM criteria. Although these trends failed to reach significance, they highlight the likelihood of studies relying on limited methodological designs that may have produced upwardly biased results. Part B of the project, and secondary analyses of NESARC data, provided evidence that was partly consistent with this possibility. Part B was based on a rigorous methodology (given use of systematic sampling and structured interview tools in the NESARC study), and also provided estimates of pathological gambling (around 4% and 1% for lifetime and current disorders, respectively) and problem gambling (around 6% and 2% for lifetime and current disorders), that were at the lower end of estimates derived from published studies (although they are still higher than levels observed in community samples[5]). Collectively, these results would

5 Relevant comparative figures are available from Petry et al. (2005), who report on the prevalence of lifetime pathological gambling in the larger NESARC data set. Their results indicate that 0.43% of the

suggest the need for: (a) caution in the interpretation of findings from available research (which may be upwardly biased); and (b) additional future studies based on stronger methodologies, including systematic sampling and rigorous measurement.

Limitations of Part A

Several limitations of the systematic review have been indicated, and are derived from limitations of available data. These include levels of unexplained variability across studies, and sub-group analyses that were characterised by low statistical power. Like most systematic reviews, the current review was also based on published studies and the search strategy did not identify unpublished data (given difficulties systematically identifying and accessing this literature, as well as the questionable methodological rigour of studies that have not undergone peer review). Accordingly, the current project provided initial consideration of potential publication bias; which describes a tendency for studies producing positive results to have greater likelihood of publication (relative to studies reporting negative or 'null' effects; Easterbrook, Gopalan, Berlin & Matthews, 1991). These positive results typically comprise statistically significant findings in studies of statistical associations (e.g., Pearson's correlations), but may also comprise estimates of elevated prevalence. Funnel plots provided indications of such processes in the current context, and found preliminary evidence of publication bias, such that studies with smaller samples, and lower estimates of prevalence, were seemingly less likely to be observed in the published data. Lacking more objective statistical tests of publication bias (which were not suitable given the small numbers of studies currently available), interpretations of graphical displays are subjective. There may also be other explanations for asymmetry that do not reference publication bias (Lau, Ioannidis, Terrin, Schmid & Olkin, 2006). Notwithstanding this, the current findings provided additional reasons to suggest that estimates of gambling comorbidities derived from the current review were upwardly biased, and weighted towards findings of high prevalence of pathological and problem gambling in substance use treatment.

One final limitation of available data relates to the majority of studies conducted in the US, and thus the dearth of evidence from other parts of the world, including Australia (where there were no published studies). The lack of direct Australian evidence raises questions about the likely relevance of overseas findings to substance use treatment in Australia. Given the preponderance of US studies that informed this project (including the NESARC data), it is useful to compare patterns of substance use and associated treatments in Australia versus the US.

Teeson, Baillie, Lynskey, Manor and Degenhardt (2006) provide a comparison of data across these countries, and initially emphasise important cultural similarities; English is the first language spoken by the majority of people in both countries, who also enjoy high standards of living and access to health care. Levels of substance usage (excluding alcohol) are also similar across Australia and the US, as are rates of treatment seeking for substance use difficulties (Teeson et al., 2006). Data on profiles of substance use treatment services in Australia from the Alcohol and Other Drug Treatment Services National Minimum Data Set (AODTS-NMDS) (Australian Institute of Health and Welfare, 2012) and the US from the National Survey of Substance Abuse Treatment Services (N-SSATS) (Substance Abuse and Mental Health Services Administration, 2011) are more difficult to compare because of variations in data collection methodologies. However, it

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total NESARC sample can be diagnosed with lifetime pathological gambling. They also indicate that 1.03% of participants with any alcohol use disorder, and 1.56% of participants with any drug use disorder (not limited to those seeking treatment) also demonstrated co-occurring pathological gambling. These figures are below the estimates of lifetime pathological gambling derived from the current analyses and relating to substance use treatment (4%).

seems that programs across both countries offer similar ranges of treatments, with counselling representing the predominant class of interventions, and smaller numbers of services offering additional interventions including pharmacotherapy and case management. Notwithstanding these general similarities, Teeson et al. (2006) also indicate important differences between Australia and the US. The following extract is illustrative:

1. Rates of alcohol use appear to vary between the two countries with alcohol use being more accepted and widespread in Australia than in the United States (Maxwell, 2003).

2. Legal and policy approaches towards the reduction of drug use and the avoidance of drug related harm vary...compared with a more prohibitionist stance in the United States, Australian alcohol and drug health service policy has more of a focus on harm reduction. Specific differences between the two countries include (but are not limited to) a higher legal drinking age in many of the United States (21 in USA versus 18 in Australia) and more widespread availability of needle and syringe programs in Australian than in the United States (Drucker et al., 1998).

3. Substantial differences in the organisation and funding of health care services with Australia having a universal health care system funded through taxation while the United States system relies more heavily on private funding (pg. 150).

The likely implications of these differences for expected rates of gambling disorders remain unclear. However, general data on rates of pathological and problem gambling in the community also indicate levels that vary across countries, with the limited data available[6] suggesting somewhat higher rates in Australia. Such differences may be attributed to widespread availability of gambling opportunities in Australia (Storer, Abbott & Stubbs, 2009), which may also promote higher than average rates of gambling disorders in Australian substance use treatment services. Such possibilities are clearly speculative, but may suggest that estimates derived from this review, based largely on US data, could *underestimate* rates of gambling disorders in substance use treatment in Australia.

[6] A recent review by Williams, Volberg and Stevens (2012) identified one national study of the prevalence of problem gambling that was conducted in Australia in 1999, versus two studies (in 1998 and 2000) that were conducted in the U.S. Prevalence figures were standardised to permit more valid comparisons across countries and methodologies, and suggested a past-year prevalence of problem gambling of 3.9% in Australia, versus 3.2% in the U.S.

Clinical covariates of pathological and problem gambling in substance use treatment

Part B of the project considered associations between symptoms of pathological gambling in substance use treatment and a range of clinical outcomes. Analyses were based on data from *n* = 272 participants reporting past-year treatment for alcohol or drug use, derived from the NESARC study (Grant et al., 2004). Outcomes were measured concurrently (2000-2001) and prospectively over time (from 2000-2001 to 2004-2005), and comprised indices of mental and physical health, substance usage, healthcare utilisation, as well as a range of psychosocial difficulties (e.g., interpersonal problems).

Foremost among outcomes considered in Part B were additional Axis I disorders (not including substance related and gambling disorders), as well as a range of Axis II diagnoses. Results from the cross-sectional analyses indicated a statistically significant association between gambling symptoms and lifetime major depression, and marginally significant ($p<.10$) links with lifetime panic disorder, specific phobia, and generalised anxiety disorder. There were also significant ($p<.05$) associations between pathological gambling symptoms and a range of Axis II diagnoses, including avoidant, antisocial, borderline, narcissistic and schizoid personality disorders. Substance users in treatment with any of these latter diagnoses reported up to four times the number of pathological gambling symptoms when compared to those without. In contrast, there were no significant relationships between pathological gambling symptoms and past-year Axis I diagnoses.

The contrasting pattern of associations involving lifetime Axis I and Axis II disorders, but not past year disorders, may suggest that gambling problems are unlikely to be antecedent factors in the onset of these comorbid diagnoses in substance use treatment. Rather, a model of lifetime comorbidity may better hold in this context, whereby multiple co-occurring diagnoses result from a shared underlying 'liability' (see Krueger & Markon, 2006). In the context of substance use treatment, it may be that gambling problems commonly reflect a pervasive form of underlying psychopathology, which manifests (in part) through development of multiple psychiatric problems across the lifetime. These may include substance use and gambling problems, as well as affective and personality disturbances. Given the salient links with comorbid gambling problems and Axis II psychopathology, it seems reasonable to speculate that these patients may resemble the 'antisocial impulsivist' gambler described by Blaszczynski and Nower (2002) in their conceptual typology of problem gambling. In contrast with other proposed types of problem gamblers, the antisocial impulsivity subtype is purportedly characterised by severe psychosocial interference, impulsivity and Axis II psychopathology (e.g., antisocial personality disorder), as well as a wide array of problem behaviours (e.g., substance use, gambling, criminality) and resistance to treatment. A number of studies in other contexts have also provided evidence partly consistent with this group of 'antisocial impulsivist' gamblers (for a review, see Milosevic & Ledgerwood, 2010); although certain aspects of the profile, such as treatment resistance, have not yet been empirically established.

Findings from Part B of this project failed to support several expected associations between pathological gambling symptoms and a number of clinical covariates, including substance usage, general mental or physical health, and medical utilization. Rather, the results suggested more specific patterns of association with particular psychosocial difficulties. The failure to find associations with measures including substance usage and general mental health status contrasts with findings of studies of community samples (e.g., Black, Shaw, McCormick & Allen, 2013; Morasco et al., 2006). Such discrepancies with these community studies may be explained

primarily in terms of the high levels of psychiatric severity that commonly define treatment seeking samples overall (Kessler et al, 2001; Mojtabai, Olfson & Mechanic, 2002). That is, the decision to seek treatment for substance use problems is commonly driven by high levels of substance use, psychiatric distress and functional impairment, which may result in a restricted range of severity (as observed in generally high scores on measures of such variables) in clinical settings. By way of example, there may be limited influences of gambling disorders on substance usage given that patients already misuse substances heavily, with such being implicated in reasons for seeking treatment.

Despite the apparent influences of range restriction in psychiatric severity, the current results did nonetheless suggest significant cross-sectional associations between pathological gambling symptoms and specific psychosocial consequences, including interpersonal problems at work and financial crises. There were also prospective associations with financial crises and problems in intimate relationships. These financial and interpersonal difficulties may be conceptualised as psychosocial 'harms' that are defining features of gambling disorders across many definitions (see Hodgins et al., 2011). Financial harms are associated with monetary losses from gambling, and are exacerbated by patterns of 'chasing losses' (defined generally by persistence with gambling after a series of losses in order to 'get even') (Breen & Zuckerman, 1999) that result in escalating debt. Interpersonal harms subsume threatened or actual loss of relationships because of gambling (including paid work roles), and may follow from financial debt (e.g., if members of family and social networks discover gambling and debt that was previously concealed, or must relieve financial problems caused by gambling), as well as neglect of role responsibilities because of preoccupation with gambling.

There was a final significant finding from the prospective analyses, which indicated a further association with subsequent diagnoses of major depression. The longitudinal nature of this effect provides a relatively robust test of influences of pathological gambling symptoms on depression, given that these two variables were situated prospectively in time. That is, pathological gambling was measured prior to major depression, such that the observed effects were not explained by the reverse influence of depression on pathological gambling. This is not to say that there are no reciprocal influences of depression back on gambling disorders. Rather, such effects could not be evaluated prospectively in NESARC, given that pathological gambling was not measured repeatedly over time. The observed associations may allude to the possibility that gambling related harms (e.g., financial crises, interpersonal difficulties) function as significant psychosocial stressors that can exacerbate pre-existing mental health problems, like major depression, which are commonly recognised as persistent and recurring (Richards, 2011). Gambling problems may increase the likelihood of onset of future depressive episodes, which may re-occur after leaving substance use treatment, when significant professional and social supports are less readily available.

Limitations of Part B

The findings from Part B should also be interpreted in light of limitations of the data and analyses. Although the size of the analytic sample derived from the NESARC study was close to the median of published studies (see Part A, pg. 12), the sample was small overall. As such, there were associations that were modest in magnitude that may have reached statistical significance had a larger sample size been obtained. Rates of pathological and problem gambling were lower than expected, and the lack of variability in pathological gambling symptoms may also have reduced the prospects of identifying significant covariates. The analyses of covariates focussed necessarily on lifetime symptoms of pathological gambling, and different results may have been observed if past year symptoms were considered. There was also evidence of zero-inflation in the data on

pathological gambling symptoms (reflecting a majority of participants reporting no symptoms of pathological gambling), and while more complex analyses (e.g., zero-inflated negative binomial regression) were considered to account for this, such models encountered convergence difficulties and produced unstable estimates (presumably resulting from the small sample and complexity of such models when correcting for the complex survey design, as well as sparse-data problems involving the socio-demographic controls). There was limited variability across certain variables, such that several outcomes of interest (e.g., wave 2 treatment seeking) could not be considered. The smaller sample at wave 2 also reduced the statistical power available for detecting significant effects over time.

Clinical Implications

Overall, the current project suggests that pathological and problem gambling may be common and important clinical considerations in substance use treatment. Accordingly, existing programs of substance use treatment may benefit from strategies designed to identify and manage comorbid gambling problems. Some potentially useful strategies for screening and assessment of gambling disorders, as well approaches to the treatment of substance use and gambling problems in the context of comorbidities, are presented in the following sections.

Screening and assessment

Strategies for identification of gambling disorders could initially involve use of brief tools administered to all patients during intake into substance use treatment. The NODS-CLiP (Toce-Gerstein, Gerstein & Volberg, 2009) is one such brief tool that consists of three items, and has demonstrated psychometric properties in clinical samples (Volberg, Munck & Petry, 2011). For patients who screen positive to problem gambling, further evaluation should be conducted and may involve a general clinical interview based on DSM criteria. If more structured data are desirable, then the 20-item SOGS (Leisure & Blume, 1987) contains items based on DSM criteria (with cut-off criteria for probable pathological gambling), as well as basic questions about gambling activity. The 31-item Canadian Problem Gambling Index (CPGI; Ferris & Wynne, 2001) provides an assessment of the broader spectrum of problem gambling, as well as metrics of gambling activity (including types, frequency, and expenditure on gambling) that are detailed relative to the SOGS. Should a briefer instrument be required, the problem gambling assessment of the CPGI (the Problem Gambling Severity Index; PGSI) consists of 9-items and can be used independent of the full instrument. The performances of both the CPGI and the PGSI subscale have not yet been evaluated systematically in clinical samples of substance users, such that scores on these measures should be interpreted cautiously, and in conjunction with other sources of information derived from clinical interview.

Treatment strategies

When gambling problems are identified it may be valuable to consider variations or additions to standard programs of treatment for substance use problems. Assuming that gambling problems may be indicative of a pervasive form of underlying psychopathology (whereby histories of substance use and gambling problems co-occur with affective and personality disturbances), it may be useful to consider adapted programs of treatment that have a dual focus on substance use problems and comorbidities, as well as presumed underlying etiological factors[7]. Although there

[7] Verheul (2001) summarises evidence indicating that substance use patients with Axis II psychopathology can show significant improvement following standard programs of substance use treatment (especially structural,

are currently no examples of such interventions that focus on gambling comorbidities, there are therapies for co-occurring substance use and personality psychopathologies (e.g., Dialectical Behaviour Therapy; see Pennay et al., 2011) that may provide initially useful treatment options. By way of example, Ball (1998) argues that maladaptive schemas and coping strategies may underlie the co-occurrence of substance use and personality disorders. Dual Focus Schema Therapy is presented as a program of treatment that can simultaneously address both substance use and personality problems, while also targeting underlying schemas and coping strategies that may cause these disorders (and potentially also co-occurring gambling problems). Such existing treatments can also provide suitable models for new interventions, and demonstrate how components of traditional substance use treatments (e.g., functional analysis, self-monitoring and problem solving training) may be expanded to address multiple problems simultaneously.

Given the apparent links between gambling comorbidities and psychosocial difficulties (e.g., financial and interpersonal problems), as well as mood disorders following treatment discharge, it may also be that standard programs of substance use treatment will benefit from the addition of specific components of therapy that are focussed directly on reducing gambling. There are several moderate and intensive duration psychological (mainly cognitive-behavioural) therapies, involving four or more sessions of therapy, that have demonstrated short-term efficacy in the treatment of pathological and problem gambling (see Cowlishaw, Merkouris, Dowling, Anderson, Jackson & Thomas, 2012). These could be used as adjunct interventions in substance use treatment. Given data showing only around 10% of pathological and problem gamblers that ever seek help for gambling difficulties (Slutske, 2006), it may be that substance use treatment provides a context for delivery of gambling interventions to a population that would not normally benefit from such services.

Alternatively, if there are limited resources available for intensive therapies, it may be appropriate to consider minimal or brief interventions for reducing gambling behaviour. These therapies frequently draw from principles of motivational interviewing (see Miller & Rose, 2009) and may be supplemented with self-help workbooks (e.g., Hodgins, Currie, Currie & Fick, 2009) or internet and telephone delivered components (e.g., Carlbring & Smit, 2008). Such interventions have not been considered in contexts where gambling disorders are secondary conditions, and may present challenges (e.g., difficulty ensuring adherence) in clinical settings. Notwithstanding this, such interventions could also be useful additions to substance use treatment, assuming that: (a) the goal of intervention is short term reduction in gambling behaviour; and (b) other professional supports (e.g., focussing on patients' emotional well-being and safety, as well as underlying etiological factors explaining both substance use and gambling problems) are provided in the course of primary treatment.

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behaviourally-oriented treatment approaches). As such, they caution against assumptions that these patients will not benefit from traditional therapies. However, these authors also suggest that Axis II comorbidities may increase vulnerability to relapse in substance usage following treatment discharge. Accordingly, they highlight value from considering alternative therapies that may facilitate improved long term outcomes.

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NOTE: * Indicates study included in the systematic review (Part A).

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Appendices

Table A1. **Model fit and dispersion statistics for cross-sectional multivariate models, including individual Axis I or Axis II disorders, and socio-demographic controls**

a All models associated with df(14).

Variable	Wald χ^2_a	p	Information Criteria		Dispersion Parameter		
			AIC	BIC	Estimate (α)	95% CI LB	UB
Axis I disorders							
Past year							
Major depression	33.10	0.003	1781479	1781537	9.71	5.85	16.10
Dysthymia	35.62	0.001	1779365	1779423	9.59	5.70	16.13
Mania	33.33	0.003	1782473	1782530	9.65	5.84	15.95
Panic disorder	32.59	0.003	1783833	1783891	9.79	5.93	16.18
Specific phobia	35.66	0.001	1775862	1775919	9.50	5.65	15.97
Generalised anxiety disorder	37.39	0.001	1773804	1773862	9.33	5.63	15.45
Lifetime							
Major depression	39.77	0.000	1759568	1759626	8.88	5.34	14.77
Dysthymia	38.91	0.000	1774595	1774653	9.38	5.58	15.78
Mania	32.50	0.003	1782820	1782878	9.72	5.90	16.02
Panic disorder	37.82	0.001	1773041	1773099	9.22	5.48	15.52
Social Phobia	31.96	0.004	1781103	1781161	9.66	5.86	15.92
Specific phobia	35.97	0.001	1771784	1771841	9.31	5.56	15.57
Generalised anxiety disorder	38.66	0.000	1773605	1773663	9.26	5.53	15.51
Axis II disorders							
Antisocial	45.54	0.000	1091654	1091708	10.49	5.32	20.68
Avoidant	53.60	0.000	1755113	1755171	8.75	5.25	14.59
Obsessive/compulsive	45.88	0.000	1776925	1776982	9.61	5.76	16.01
Paranoid	33.01	0.003	1781378	1781436	9.68	5.90	15.86
Schizoid	45.91	0.000	1770808	1770866	9.36	5.66	15.47
Histrionic	35.74	0.001	1774478	1774536	9.25	5.57	15.36
Borderline	46.92	0.000	1088376	1088430	10.61	5.33	21.10
Schizotypal	37.22	0.000	1105215	1105269	11.39	5.85	22.18
Narcissistic	47.82	0.000	1094609	1094663	11.03	5.63	21.60

Table A2. **Model fit and dispersion statistics for cross-sectional multivariate models, including substance usage, health status, medical utilization or psychosocial harms, and socio-demographic controls.**

Variable	Wald χ^2_a	p	Information Criteria		Dispersion Parameter		
			AIC	BIC	Estimate (α)	95% CI LB	95% CI UB
Substance usage							
Alcohol							
Frequency of drinking any alcohol	34.24	0.002	1775405	1775463	9.46	5.63	15.88
Frequency of drinking ≥ 5 drinks	34.24	0.002	1776854	1776912	9.52	5.68	15.95
Marijuana	34.03	0.002	1783846	1783904	9.77	5.93	16.12
Other drugs	34.32	0.002	1783814	1783872	9.79	5.92	16.19
Polydrug use							
Number of substances	39.64	0.000	1780810	1780868	9.74	5.88	16.15
Health status							
SF-12 Mental Health Component Score	32.39	0.004	1778578	1778636	9.61	5.81	15.91
SF-12 Physical Health Component Score	33.54	0.002	1779994	1780052	9.70	5.88	16.00
Number of medical diagnoses	34.91	0.002	1781970	1782028	9.74	5.89	16.11
Medical utilization							
Times stayed overnight in the hospital	34.43	0.002	1779240	1779297	9.58	5.75	15.95
Times treated in hospital emergency	35.41	0.001	1777987	1778044	9.46	5.66	15.83
Psychosocial harm (past year)							
Trouble with boss/coworker	44.19	0.000	1772610	1772668	9.51	5.68	15.93
Problems with a neighbor/friend/relative	34.73	0.002	1777681	1777739	9.64	5.80	16.02
Separated, divorced, broke off a steady relationship	32.55	0.003	1783872	1783930	9.78	5.93	16.14
Major financial crisis, bankruptcy, repeatedly unable to pay bills	34.63	0.002	1770414	1770472	9.32	5.66	15.34
Trouble with police, arrested, sent to jail	40.17	0.000	1775692	1775749	9.50	5.72	15.77

[a] All models associated with *df*(14).

Table A3. **Model fit and dispersion statistics for prospective multivariate models, including Axis I disorders (since last interview) or psychosocial harms (in the last year), and socio-demographic controls.**

Variable		Wald χ^2_a	p	Information Criteria		Dispersion Parameter		
				AIC	BIC	Estimate (α)	95% CI LB	95% CI UB
Axis I disorders								
	Major depression	53.46	0.000	1087355	1087409	10.32	5.07	21.03
	Mania	37.34	0.000	1097893	1097947	11.17	5.72	21.81
	Specific phobia	38.64	0.000	1104746	1104800	11.32	5.82	22.02
Psychosocial harm (past year)								
	Trouble with boss/coworker	38.08	0.000	1102634	1102688	11.34	5.83	22.08
	Problems with a neighbor/friend/relative	40.69	0.000	1101593	1101647	11.36	5.81	5.81
	Separated, divorced, broke off a steady relationship	54.50	0.000	1082937	1082991	9.84	4.78	20.24
	Major financial crisis, bankruptcy, or repeatedly unable to pay bills	42.23	0.000	1095192	1095246	11.09	5.75	21.36
	Trouble with police, arrested, sent to jail	45.44	0.000	1101115	1101170	11.28	5.79	21.98

[a] All models associated with *df*(13).

Table A4. **Unadjusted (bivariate) negative binomial regression results: Model fit and dispersion statistics, parameter estimates (with 95% CI) and effect size estimates (IRR), for models including Axis I disorders (past year and lifetime).**

Variable	Wald χ^2_a	p	Information Criteria		Dispersion Parameter			Parameter Estimate	95% CI		IRR
			AIC	BIC	Estimate (α)	95% CI LB	95% CI UB		95% CI LB	95% CI UB	
Axis I disorders											
Past year											
Major depression	0.00	0.988	1857327	1857338	12.52	7.68	20.41	-0.01	-0.78	0.77	0.99
Dysthymia	0.36	0.550	1856365	1856376	12.47	7.60	20.45	0.26	-0.58	1.09	1.29
Mania	0.49	0.483	1855902	1855913	12.44	7.64	20.25	0.31	-0.56	1.19	1.37
Panic disorder	1.09	0.296	1854670	1854681	12.37	7.51	20.37	0.45	-0.39	1.29	1.57
Specific phobia	0.20	0.655	1856867	1856878	12.49	7.62	20.49	0.20	-0.66	1.05	1.22
Generalised anxiety disorder	0.74	0.389	1855323	1855334	12.41	7.60	20.25	0.40	-0.51	1.30	1.49
Lifetime											
Major depression	1.03	0.311	1852324	1852335	12.25	7.37	20.35	0.48	-0.45	1.41	1.62
Dysthymia	0.44	0.506	1855944	1855954	12.44	7.61	20.35	0.28	-0.54	1.10	1.32
Mania	0.00	0.972	1857324	1857335	12.52	7.68	20.42	-0.02	-0.86	0.83	0.99
Panic disorder	3.31	0.069	1847156	1847167	11.96	7.15	20.00	0.74	-0.06	1.54	2.10
Social Phobia	0.35	0.555	1856657	1856668	12.48	7.67	20.32	0.27	-0.62	1.15	1.31
Specific phobia	0.49	0.483	1855955	1855965	12.44	7.59	20.41	0.31	-0.56	1.18	1.37
Generalised anxiety disorder	1.29	0.256	1853788	1853799	12.32	7.52	20.20	0.48	-0.35	1.31	1.62

[a] All models associated with *df*(1).

Table A5. **Unadjusted (bivariate) negative binomial regression results: Model fit and dispersion statistics, parameter estimates (with 95% CIs) and effect size estimates (IRR), for models including Axis II disorders.**

Variable	Wald χ^2_a	p	Information Criteria		Dispersion Parameter			Parameter Estimate	95% CI		IRR
			AIC	BIC	Estimate (α)	95% CI LB	95% CI UB		95% CI LB	95% CI UB	
Axis II disorders											
Antisocial	1.69	0.194	1152756	1152766	14.20	7.20	27.99	0.68	-0.34	1.70	1.97
Avoidant	4.64	0.031	1844013	1844024	11.78	7.17	19.36	0.92	0.08	1.76	2.51
Obsessive/compulsive	0.41	0.523	1856292	1856303	12.46	7.58	20.48	0.26	-0.54	1.07	1.30
Paranoid	0.17	0.684	1856841	1856852	12.49	7.67	20.34	0.17	-0.65	0.99	1.19
Schizoid	2.95	0.086	1851452	1851463	12.19	7.45	19.94	0.72	-0.10	1.53	2.05
Histrionic	2.15	0.143	1850572	1850582	12.14	7.40	19.92	0.79	-0.27	1.85	2.21
Borderline	1.39	0.239	1153316	1153326	14.26	7.46	27.26	0.64	-0.43	1.72	1.90
Schizotypal	0.01	0.915	1158663	1158673	14.83	7.83	28.08	-0.09	-1.66	1.49	0.92
Narcissistic	1.06	0.304	1154994	1155004	14.43	7.54	27.64	0.58	-0.53	1.70	1.79

[a] All models associated with *df*(1).

Table A6. **Unadjusted (bivariate) negative binomial regression results (cross-sectional): Model fit and dispersion statistics, parameter estimates (with 95% CIs) and effect size estimates (IRR), for models including substance usage and health status variables.**

Variable	Wald χ^2_a	p	Information Criteria		Disperson Parameter			Parameter Estimate	95% CI		IRR
			AIC	BIC	Estimate (α)	95% CI LB	95% CI UB		95% CI LB	95% CI UB	
Substance usage											
Alcohol											
Frequency of drinking any alcohol	1.01	0.314	1849736	1849746	12.16	7.41	19.96	-0.06	-0.18	0.06	0.94
Frequency of drinking ≥ 5 drinks	0.40	0.528	1852589	1852600	12.32	7.53	20.14	-0.04	-0.16	0.08	0.96
Marijuana	0.32	0.570	1856047	1856058	12.45	7.60	20.38	0.26	-0.63	1.14	1.29
Other drugs	0.05	0.830	1857140	1857151	12.51	7.69	20.36	-0.10	-0.97	0.77	0.91
Polydrug use											
Number of substances	0.01	0.912	1857289	1857300	12.52	7.67	20.44	0.02	-0.27	0.30	1.02
Health status											
SF-12 Mental Health Component Score	0.00	0.998	1852448	1852459	12.34	7.56	20.14	0.00	-0.03	0.03	1.00
SF-12 Physical Health Component Score	1.19	0.275	1847797	1847808	12.09	7.47	19.57	-0.02	-0.05	0.01	0.98
Number of medical diagnoses	0.77	0.379	1854868	1854879	12.39	7.57	20.27	0.12	-0.15	0.40	1.13

[a] All models associated with *df*(1).

Table A7. **Unadjusted (bivariate) negative binomial regression results (cross-sectional): Model fit and dispersion statistics, parameter estimates (with 95% CIs) and effect size estimates (IRR), for models including medical utilization and psychosocial harms.**

Variable	Wald χ^2_a	p	Information Criteria		Dispersion Parameter			Parameter Estimate	95% CI		IRR
			AIC	BIC	Estimate (α)	95% CI LB	95% CI UB		95% CI LB	95% CI UB	
Medical utilization											
Times stayed overnight in the hospital	3.21	0.073	1849763	1849774	12.09	7.32	19.98	0.15	-0.01	0.31	1.16
Times treated in hospital emergency	3.81	0.051	1850293	1850304	12.11	7.33	20.01	0.11	0.00	0.22	1.12
Psychosocial harm (past year)											
Trouble with boss/coworker	0.06	0.802	1857159	1857170	12.51	7.65	20.47	0.11	-0.74	0.95	1.11
Problems with a neighbor/friend/relative	1.18	0.277	1853375	1853386	12.31	7.50	20.18	-0.53	-1.50	0.43	0.59
Separated, divorced, broke off a steady relationship	0.04	0.841	1857210	1857221	12.51	7.67	20.41	0.09	-0.82	1.00	1.10
Major financial crisis, bankruptcy, repeatedly unable to pay bills	1.69	0.193	1849979	1849990	12.12	7.39	19.85	0.57	-0.29	1.43	1.77
Trouble with police, arrested, sent to jail	0.59	0.444	1855067	1855078	12.39	7.48	20.54	0.32	-0.50	1.14	1.38

Table A8. **Unadjusted (bivariate) negative binomial regression results (prospective): Model fit and dispersion statistics, parameter estimates (with 95% CIs) and effect size estimates (IRR), for models including prospective Axis I disorders and psychosocial harms.**

Variable	Wald χ^2_a	p	Information Criteria		Dispersion Parameter			Parameter Estimate	95% CI		IRR
			AIC	BIC	Estimate (α)	95% CI LB	95% CI UB		95% CI LB	95% CI UB	
Axis I disorders											
Major depression	2.40	0.121	1149676	1149686	13.88	6.88	28.00	0.83	-0.22	1.89	2.30
Mania	0.22	0.640	1157897	1157907	14.74	7.74	28.07	0.36	-1.14	1.86	1.43
Specific phobia	0.18	0.673	1158172	1158182	14.77	7.85	27.79	0.29	-1.05	1.62	1.33
Psychosocial harm (past year)											
Trouble with boss/coworker	0.28	0.599	1157698	1157708	14.72	7.70	28.15	0.39	-1.07	1.85	1.48
Problems with a neighbor/friend/relative	0.02	0.901	1158680	1158690	14.83	7.84	28.04	-0.07	-1.21	1.07	0.93
Separated, divorced, broke off a steady relationship	7.60	0.006	1137966	1137976	12.66	5.94	26.96	1.47	0.42	2.51	4.34
Major financial crisis, bankruptcy, or repeatedly unable to pay bills	0.42	0.518	1157187	1157197	14.67	7.65	28.14	0.34	-0.68	1.36	1.40
Trouble with police, arrested, sent to jail	0.93	0.336	1154696	1154706	14.40	7.51	27.58	0.77	-0.80	2.34	2.16

[a] All models associated with *df*(1).