The Family History Method in Disordered Gambling Research: A Comparison of Reports Obtained from Discordant Twin Pairs

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The purpose of this study was to examine potential biases in family history reports of problem gambling and gambling frequency. Same-sex twin pairs discordant for a history of problem (n = 230 pairs) and pathological gambling (n = 48 pairs) and for three indexes of gambling frequency (ever gambling, monthly gambling, and weekly gambling; n = 44–517 pairs) were identified from a large Australian national twin study. The problem gambling affected twin was significantly more likely to endorse paternal problem gambling than the problem gambling unaffected cotwin (OR = 5.5), and similar findings were obtained for family history reports of gambling frequency (OR = 2.0–2.8). These results could not be explained by differences between the discordant pairs in whether they had spent time gambling with the parents; there was no association between a history of problem, monthly or weekly gambling and having gambled with the parents among discordant twin pairs. The results of this study suggest that relying solely on family history assessments of disordered gambling and gambling involvement can lead to incorrect estimates of the strength of the family history effect.

Keywords: family history, gambling, assessment, discordant twins, social modeling

The family history (FH) method, which involves the use of an informant to gather information about one or more family members, has been used to characterize the pathological gambling (PG) status of relatives of participants in a number of previous studies. The FH method can be used in a number of contexts: (a) in high-risk or family studies to characterize the risk status of family members when direct interviews are not feasible, (b) in molecular genetic studies when the affection status of an entire family pedigree must be created even in the absence of direct interviews (e.g., because the relative is estranged, unlocatable, or deceased), (c) in clinical practice to aid in diagnosis, and (d) to obtain collateral information about the status of patients in treatment studies. For instance, Black et al. (2006) studied 193 first-degree relatives of 31 probands with PG and 142 first degree relatives of 31 controls. Diagnoses for most of the relatives, 87% of the relatives of probands and 69% of the relatives of controls, were based on FH reports, presumably obtained from the index cases (that is, the probands and controls).

Although an invaluable technique, obtaining both self- and FH-report of gambling problems from the same individual can be misleading. In a landmark paper titled 'The Family History Method: Whose Psychiatric History is Measured?' Kendler et al. (1991) used the discordant twin pair design to demonstrate that family history reports may be biased by the psychiatric history of the informant. Family history reports of parental major depression, generalized anxiety disorder, and alcoholism were compared between members of female twin pairs who were discordant for the same three disorders. In every case, the twin with a history of a disorder was more likely to report that her mother or father had a history of the same disorder than her twin sister without a history of the disorder, with odds ratios ranging from 1.6 to 2.5 (note that only three of the six tests conducted were statistically significant). These findings raise the possibility that studies of the association between personal gambling problems and problems in one's family that rely on a single informant to provide both self- and FH-reports may overstate the strength of the association.

In a previous paper, data from a large community-based twin cohort were used to examine the reliability and validity of the FH method for assessing problem gambling (Ellingson et al., 2010). Three different methods were used. First, the test-retest reliability of FH reports were examined among a subsample of twins who provided FH reports on two separate occasions. Second, the interrater reliability of FH reports was examined by assessing agreement between the two members of a twin

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pair reporting on their father's and mother's history of gambling involvement. Third, the validity of the FH method was examined by assessing the agreement between the FH report of a twin informant with the self-report of the target co-twin. The primary goal of the present study was to further examine the validity of FH reports of gambling behaviors using the method employed in the classic Kendler et al. (1991) paper. From the previous study (that was based on the full twin sample), we identified twin pairs who were discordant for a history of problem gambling. The FH reports of paternal and maternal problem gambling were compared in the affected and unaffected twins from these pairs.

The FH reports were also compared for three different measures of the frequency of gambling involvement: ever gambling, ever gambling monthly, and ever gambling weekly. The inclusion of FH reports of gambling frequency and the examination of potential biases in them in this twin study was based on a number of considerations. First, there has been recent emphasis placed on including assessments of levels of gambling participation (rather than just diagnostic assessments) in studies of disordered gambling (Rodgers et al., 2009; Walker et al., 2006). Second, collateral information on the quantity and frequency of gambling involvement is often obtained in the context of PG treatment follow-up studies (e.g., Petry et al., 2006). Third, compared to the FH assessment of problem gambling and PG, the sensitivities of FH reports of monthly and weekly gambling are relatively high (Ellingson et al., 2010). Thus, FH assessments of gambling involvement may be a useful adjunct to FH assessments of disordered gambling because family members may be somewhat more aware of and able to judge the frequency of participating in gambling than they are aware of and able to judge the presence of problems. Fourth, there has been recent interest in the possibility of incorporating information on levels of use (such as weekly high-risk drinking, at least weekly use of a cannabis cigarette) into the diagnosis of alcohol (Li et al., 2007; Saha et al., 2007) and drug use disorders (Compton et al., 2009) in the DSM-V. This is presaged by earlier revisions to a problem gambling assessment for adolescents that incorporated weekly or daily gambling into the problem gambling diagnosis (Winters et al., 1993).

A secondary goal of this study was to elucidate one potential explanation for differences observed in parental reports of gambling behaviors among discordant twin pairs. The affected twin may have been more likely to have gambled with the parents than the unaffected cotwin, and therefore may have had more exposure to and knowledge of the gambling behavior in the parents.

Method

Participants

Participants were 1,461 complete same-sex twin pairs; this included 867 MZ pairs (520 female, 347 male) and 594 DZ pairs (367 female, 227 male). The twin pairs were members of the community-based Australian Twin Registry Cohort II (Slutske et al., 2009). In 2004–2007, participants completed a structured psychiatric telephone interview that included measures of gambling involvement, PG, and family history of gambling involvement and PG. Participants were 32–43 years when interviewed (M = 37.60, SD = 2.29). A small sub-sample of the participants (N = 166) were re-interviewed after several months (mean interval = 3.4 months, SD = 1.4 months, range = 1.2-9.5 months) to establish the test-retest reliability of the measures. All data collection was approved by the Institutional Review Boards at the University of Missouri and the Queensland Institute of Medical Research. Informed consent was obtained after the study was completely described to the subjects.

Measures

Family history. The FH of problem gambling and gambling involvement was assessed for the participant's father and mother. Participants were asked whether either of these individuals had ever: (1) gambled in their lifetime (mean test–retest reliability, κ = 0.61, Y = 0.72), (2) gambled at least once a month for at least 6 months (mean test–retest reliability, κ = 0.66, Y = 0.69), (3) gambled at least once a week for at least 6 months (mean test–retest reliability, κ = 0.72, Y = 0.76), and (4) had a period in their life when they had financial, legal, family, work, relationship, or emotional problems because of their gambling (mean test–retest reliability, κ = 0.74). The first three of these FH questions assessed the frequency of gambling involvement, and the fourth assessed problem gambling. The interrater reliability of these measures was examined in a previous paper, by examining the agreement between twins (Ellingson et al., 2010). For either parent, there was moderate agreement for FH reports of having ever gambled or ever gambled monthly (mean κ = 0.39; mean Y = 0.40), fair agreement for FH reports of having ever gambled weekly (mean κ = 0.27; mean Y = 0.38), and good agreement for FH reports of problem gambling (mean κ = 0.49; mean Y = 0.76).

History of gambling involvement. Self-reported PG was assessed using the NODS (NORC DSM-IV Screen for Gambling Problems; Gerstein et al., 1999). Two levels of self-reported gambling problems were examined — at least one lifetime DSM-IV PG symptom (corresponding to 'problem gambling'; test–retest reliability, κ = 0.79, Y = 0.80), and at least five lifetime DSM-IV PG symptoms (corresponding to a diagnosis of PG disorder; test–retest reliability, κ = 0.67, Y = 0.79). Three indicators of self-reported lifetime frequency of gambling were examined: ever gambled (test–retest reliability, κ = 1.00), ever gambled at least once a month for at least 6 months in a row ('gambled monthly'; test–retest reliability, κ = 0.69, Y = 0.73), and ever gambled at least once a week for at least 6months in a row ('gambled weekly'; test–retest reliability, κ = 0.77, Y = 0.78). Of the 1,461 same-sex twin pairs (574 male, 867 MZ), there were 230 pairs (129 male, 125

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MZ) discordant for lifetime problem gambling, 48 pairs (32 male, 22 MZ) discordant for lifetime PG, 44 pairs (15 male, 27 MZ) discordant for having ever gambled, 517 pairs (209 male, 266 MZ) discordant for gambling monthly, and 483 pairs (212 male, 247 MZ) discordant for gambling weekly. (All of the analyses in this article were re-run including sex or zygosity as moderating variables; none of the effects reported were significantly moderated by either sex or zygosity. In other words, there was no evidence that there were differences between men and women, or between MZ and DZ twins, in the magnitude of effects.)

History of gambling experiences with parents. Participants were asked whether they had ever gambled with their parents: (a) the first few times that they gambled, (b) during the period in their life when they were gambling the most, and (c) in the last 12 months. This was part of a larger assessment of gambling contexts (e.g., where and with whom gambling occurred). There were separate questions for each of the three time periods asking whether the participant had ever gambled with any of nine different categories of people (e.g., twin, parents, spouse, friend, office mate), or with anyone else not included in the list, or alone. For the purposes of this study, endorsements of gambling with parents during any of the three time periods were combined together into a single index of ever having gambled with one's parents. In the full sample, 33% of those who had ever gambled endorsed having gambled with their parents during at least one of these time periods.

Data Analysis

McNemar's chi-square tests (McNemar, 1947) were conducted to determine whether there were significant differences between the affected versus the unaffected twins from discordant pairs (discordant for having ever gambled, gambling monthly, gambling weekly, problem gambling) in the rates of endorsing the corresponding paternal and maternal FH items (e.g., father ever gambled, father monthly gambling, father weekly gambling, father problem gambling). The McNemar is a chi-square test for 2×2 contingency tables of dichotomous data from matched pairs of subjects. It is a test of the homogeneity of the row and column marginal frequencies in the contingency table. In the case of discordant twin pairs, the rows would represent the FH report (positive or negative) according to the affected twin and the columns would represent the FH report (positive or negative) according to the unaffected cotwin. Because the diagonal cells contribute equally to the corresponding row and column frequencies, the McNemar test is based on comparing the off-diagonal frequencies among the 'doubly-discordant' twin pairs.

Similar analyses were conducted to determine whether there were significant differences between the affected versus the unaffected twins from discordant pairs in the rates of endorsing having ever gambled with their parents. When there was a significant difference in the rates of endorsing FH items among discordant twin pairs, follow-up conditional logistic regressions were conducted to determine whether gambling with one's parents could explain (at least partially) this association.

Results

FH reports of paternal and maternal problem gambling are displayed by the diagnostic status of the members of the discordant twin pairs in Table 1. Of the 209 twin pairs that provided paternal FH problem gambling reports, 196 were in agreement — in 187 pairs both twins reported that the father did not, and in 9 pairs both twins reported that the father did, have a history of problem gambling. There were 13 twin pairs whose paternal FH problem gambling reports disagreed, that is one twin reported that the father had a history of problem gambling and the cotwin reported that the father did not. These 13 discrepant reports were not uniformly distributed across the two different types of discordant twin pairs — 11 of the 13 were positive reports of paternal problem gambling from the affected twin coupled with negative reports of paternal problem gambling from the unaffected twin. The problem gambling affected twin was significantly more likely to endorse paternal problem gambling than the problem gambling unaffected cotwin (matched-pair OR = 5.5). The difference for the maternal FH report of problem gambling was in the expected direction, but did not reach statistical significance (matched-pair OR = 2.7). There were considerably fewer twin pairs discordant for diagnoses of PG, resulting in inadequate statistical power. Nonetheless, we also present results of the analyses examining the rates of FH reports of problem gambling among twin pairs discordant for PG; the differences in endorsing the paternal and maternal FH items were in the expected direction but neither was statistically significant.

FH reports of paternal and maternal gambling frequency are displayed by the frequency of gambling involvement of the members of the discordant twin pairs in Table 2. Among discordant pairs, the twin who self-reported a particular frequency of gambling behavior was significantly more likely than the cotwin who did not endorse a particular frequency of gambling behavior to report that the father or mother had ever gambled, gambled monthly, or gambled weekly, with odds ratios ranging from 2.0 to 2.8 (note that one of six associations failed to attain statistical significance).

The frequency of gambling with parents among the members of the twin pairs discordant for problem gambling, monthly gambling, and weekly gambling are presented in Table 3. Among 210 twin pairs discordant for problem gambling, there were 107 pairs in which neither twin endorsed gambling with the parents, and 48 pairs in which both twins endorsed gambling with the parents. There were 60 pairs in

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Table 1

Family History Reports of Parental Problem Gambling Among Twin Pairs Discordant for Problem or Pathological Gambling

Twin diagnosis	Parent	Total pairs	FH of problem gambling reported by: Neither twin	Unaffected only	Affected only	Both twins	McNemar's $\chi^2(1\ df)$	OR	95% CI	*p*
Problem gambling	Father	209	187	2	11	9	6.23	5.5	1.2–24.8	.01
	Mother	219	205	3	8	3	2.27	2.7	0.7–10.1	.13
Pathological gambling	Father	45	36	1	4	4	1.80	4.0	0.4–35.8	.18
	Mother	48	45	0	2	1	2.00	—[a]	—[a]	.16

Note: FH = family history; OR = odds ratio; CI = confidence interval; [a] = not calculable.

Table 2

Family History Reports of Parental Gambling Frequency Among Twin Pairs Discordant for Three Indexes of Gambling Frequency

Twin behavior	Parent	Total pairs	FH of gambling frequency[a] reported by: Neither twin	– Twin only	+ Twin only	Both twins	McNemar's $\chi^2(1\ df)$	OR	95% CI	*p*
Ever gambled	Father	40	18	3	8	11	2.27	2.7	0.7–10.1	.13
	Mother	40	17	0	6	17	6.00	—[b]	—[b]	.01
Monthly gambling	Father	457	227	36	91	103	23.82	2.5	1.7–3.7	< .0001
	Mother	485	240	47	94	104	15.67	2.0	1.4–2.8	< .0001
Weekly gambling	Father	414	205	40	91	78	19.86	2.3	1.6–3.3	< .0001
	Mother	440	227	32	91	90	28.30	2.8	1.9–4.3	< .0001

Note: [a] = the family history report of gambling frequency in the parents corresponds to the index of gambling behavior assessed by self-report in the twins (lifetime ever gambled, gambled monthly or gambled weekly); [b] = not calculable; FH = family history; OR = odds ratio; CI = confidence interval.

which one twin had gambled with the parents and the other twin had not; 35 of these were pairs in which only the twin who had a history of problem gambling reported having gambled with the parents, and 25 of these were twin pairs in which only the twin who did not have a history of problem gambling reported gambling with the parents. The problem gambling affected twin was slightly more likely to report having gambled with the parents than the problem gambling unaffected co-twin (matched-pair OR = 1.4), although this difference failed to meet statistical significance (p = .20). There was no association between a history of monthly or weekly gambling and gambling with the parents among discordant twin pairs.

Conditional logistic regression was used to test whether gambling with parents mediated, at least in part, the effect of a personal history of problem gambling on paternal FH reports of problem gambling. Prior to adjusting for gambling experiences with parents, the odds ratio of the association between personal and paternal FH report of problem gambling was 5.5, after adjusting for gambling experiences with parents it was 5.3 — a negligible reduction. Because there was no evidence of an association between a history of monthly (matched-pair OR = 0.9) or weekly gambling (matched-pair OR = 0.9) and gambling with the parents among discordant twin pairs, conditional logistic regressions were not conducted to test mediation of the effect of a personal history of gambling on FH reports of monthly or weekly gambling.

Discussion

The beauty of the discordant twin pair design for studying potential biases in the FH method was first detailed by Kendler et al. (1991): (1) the target being assessed is the same person (the father or the mother), (2) the informants (twins) are well-matched on family background factors, so that differences in the FH reports cannot be due to differences in familial liability, that is, bias is un-confounded from a true familial effect, and (3) the discordant twins are intentionally selected for differing in their psychiatric histories. This study of discordant twin pairs extends the earlier work of Kendler et al. (1991) on FH reports of the disorders of major depression, generalized anxiety disorder, and alcohol dependence to the domain of disordered gambling. Twins with a history of problem gambling were more likely to report that the father had a history of problem gambling than was the unaffected co-twin. Volberg et al. (2008) have noted that a

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Table 3

Gambling Experiences with Parents Among Twin Pairs Discordant for Problem Gambling and Gambling Frequency

		Reported gambling with parents:							
Twin behavior	Total pairs	Neither twin	– Twin only	+ Twin only	Both twins	McNemar's χ^2(1 *df*)	OR	95% CI	*p*
Problem gambling	210	107	25	35	43	1.67	1.4	0.8–2.3	.20
Monthly gambling	442	208	72	66	96	0.26	0.9	0.7–1.3	.61
Weekly gambling	429	205	76	65	83	0.86	0.9	0.6–1.2	.35

Note: OR = odds ratio; CI = confidence interval.

'shortcoming of most research on problem gambling among family members is the reliance on respondent assessment' (Volberg et al., 2008; p. 50). This study represents the first investigation into potential biases inherent in this study design.

Twins who had ever gambled at least monthly or weekly were more likely to report that the father or mother had ever gambled at least monthly or weekly, respectively, than the cotwin who was never a monthly or weekly gambler. Although FH reports of gambling frequency are more sensitive than reports of problem or PG, they are subject to the same biases.

A number of studies have explored the bias in FH studies for other psychiatric disorders by comparing FH reports to direct interviews. Two studies have examined the overall accuracy of FH reports of alcohol dependence for informants with and without a history of alcohol dependence after controlling for the proband's diagnosis; both studies obtained odds ratios of the association between FH report and proband diagnostic status of 1.5 (Milne et al., 2009; Rice et al., 1995; although one of these was not statistically significant [Milne et al., 2009]). Studies that have more closely examined the accuracy in FH reports of psychiatric disorders have tended to find that the sensitivity of FH reports obtained from informants with a psychiatric history of the same disorder are higher than FH reports obtained from informants without such a history (Chapman et al., 1994; Vandeleur et al., 2008), but the specificity is also slightly lower (Chapman et al., 1994; Roy et al., 1994; Vandeleur et al., 2008). In other words, informants with a psychiatric disorder are more likely to report the same disorder in a relative than informants without a psychiatric disorder — whether the relative is affected (higher sensitivity) or not (lower specificity).

To our knowledge, no other studies have directly examined potential mechanisms for the higher rate of reporting of psychiatric disorder in a relative as a function of the personal history of the informant. Experts have hypothesized that this could be due to the affected informant having a heightened awareness (Kendler et al., 1991; Szatmari & Jones, 1999) or reduced reluctance to report about disorder in a relative (Kendler et al., 1991). Alternatively, the greater reporting of disorder in a relative in those who report the same disorder in themselves may be due to a general response bias to endorse problems in surveys, or to correlated errors of measurement (Kendler et al., 2002; Kendler et al., 1991).

In this study, we examined whether differential exposure to gambling in the parents might explain the discrepancies between discordant twins in the paternal and maternal FH reports of gambling behaviors and problems. Among twins discordant for problem, monthly, or weekly gambling, the 'affected' twin was no more likely to have gambled with the parents than the 'unaffected' cotwin. Thus, there was no support for the differential exposure hypothesis of FH reporting.

The failure to find a significant difference in the exposure to parental gambling in twin pairs that are discordant for gambling frequency and problems is also relevant to the social modeling hypothesis of the familial transmission of gambling behaviors (Gupta & Derevensky, 1998). This result suggests that to the extent that social modeling occurs, it is through mechanisms other than through shared gambling experiences. Another potential explanation that must be considered is that the familial transmission of gambling frequency and problems is primarily explained by genetic transmission (Slutske et al., 2009; Slutske et al., 2010), including possible gene-environment correlations and genotype × environment interactions, rather than social modeling.

Limitations

This study suffers from at least six limitations. First, the discordant twin pair design is ideally suited for studying discrepancies between parental reports because this will include nearly all twin pairs; the cost is that the results may not apply to FH reports for other family relationships. Second, the results of this study may not be generalizable beyond the heavy-gambling Australian context and culture (Slutske et al., 2009). Third, the participants were all 32-43 years of age. It is not clear the extent to which the same result would be obtained among older or younger adults, or among adolescents still living with their parents. Fourth, there were too few twin pairs discordant for DSM-IV PG disorder for adequate statistical power to detect differences in their parental FH reports. Fifth, there were no direct assessments of gambling behaviors

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and problems obtained from the parents against which to compare the FH reports provided by the twins. Sixth, the analyses presented here do not take into account potential biases in the self reports of the twins, and the extent to which self-report biases may be correlated with FH-report biases (Kendler et al., 2002). This remains a direction for future research.

Conclusions

Obtaining direct interviews from study participants and family members of those with gambling problems can be difficult. In an 11-year longitudinal study of college students, those with gambling problems were less likely than those without gambling problems to participate at later waves of the study (Slutske et al., 2003), in a twin study, those with PG-affected co-twins were less likely than those with PG-unaffected co-twins to participate in a telephone interview survey (Slutske et al., 2009), and in the family study of Black et al. (2006), the family members of PG-affected probands were less likely to participate in the study than were the family members of PG-unaffected controls. There are many possible reasons for this, but a striking example comes from a family-based association study of PG discordant sib-pairs (Lobo et al., 2007) in which the sample of sib-pairs was reduced from 230 to 140 because siblings 'refused to participate due to family and financial distress caused by the pathological gambler sibling' (Lobo et al., 2007, p. 423).

Despite the difficulty in obtaining such direct interviews, the results of this study suggests that relying solely on FH assessments of problem gambling and gambling involvement can lead to incorrect estimates of the strength of the true family history effect (Szatmari & Jones, 1999). This is because the sensitivity and specificity of FH problem gambling assessments differ in informants that are affected versus unaffected with problem gambling. The magnitude of the bias can be illustrated by comparing the prevalences of paternal and maternal problem gambling in this study obtained from affected twins versus unaffected twins *rating the same parents* (paternal: 9.6% versus 5.3%; maternal: 5.0% versus 2.7%). If the affected versus unaffected twins from discordant pairs were treated as if they were standard cases and controls in an epidemiologic study, this misclassification would result in observed odds ratios of the family history effect for paternal and maternal problem gambling of 1.9 when the true odds ratio is 1.0.

This general phenomenon, known as differential misclassification, has long been recognized in epidemiology (Bross, 1954; Goldberg, 1975). Potential solutions to the problem of differential misclassification are to use direct interviews with family members to measure familial risk, or to maximize sensitivity and specificity (especially in certain groups) when using family history assessments by incorporating assessments from multiple informants, and to avoid using family history reports obtained directly from the index cases (Chapman et al., 1994; Kendler et al., 1991; Szatmari & Jones, 1999). Statistical approaches have been developed to adjust for differential misclassification (Espeland & Hui, 1987; Lee, 2009), but most of these require precise estimates of the sensitivity and specificity of the FH measures in the subgroups of interest. More detailed studies of the reliability and validity of FH assessments of disordered gambling will ultimately be required to move the field forward.

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References

Black, D. W., Monahan, P. O., Temkit, M. & Shaw, M. (2006). A family study of pathological gambling. *Psychiatry Research, 141,* 295–303.

Bross, I. (1954). Misclassification in 2 X 2 tables. *Biometrics, 10,* 478–486.

Chapman, T. F., Mannuzza, S., Klein, D. F. & Fyer, A. J. (1994). Effects of informant mental disorder on psychiatric family history data. *American Journal of Psychiatry, 151,* 574–579.

Compton, W. M., Saha, T. D., Conway, K. P. & Grant, B. F. (2009). The role of cannabis use within a dimensional approach to cannabis use disorders. *Drug and Alcohol Dependence, 100,* 221–227.

Ellingson, J. M., Slutske, W. S. & Martin, N. G. (2010). The reliability and validity of the family history method for assessing pathological gambling and gambling involvement. *Psychology of Addictive Behaviors, 24,* 292–299.

Espeland, M. A., & Hui, S. L. (1987). A general approach to analyzing epidemiologic data that contain misclassification errors. *Biometrics, 43,* 1001–1012.

Gerstein, D., Volberg, R., Murphy, S., Toce, M. et al. (1999). *Gambling Impact and Behavior Study: Report to the National Gambling Impact Study Commission.* New York: Christiansen/Cummings Associates, 1999.

Goldberg, J. D. (1975). The effects of misclassification on the bias in the difference between two proportions and the relative odds in the fourfold table. *Journal of the American Statistical Association, 70,* 561–567.

Gupta, R. & Derevensky, J. (1998). Adolescent gambling behavior: A prevalence study and examination of the correlates associated with problem gambling. *Journal of Gambling Studies, 14,* 319–345.

Kendler, K. S., Prescott, C. A., Jacobson, K. J., Myers, J. K. & Neale, M. C. (2002). The joint analysis of personal interview and family history diagnoses: Evidence for validity of diagnosis and increased heritability estimates. *Psychological Medicine, 32,* 829–842.

Kendler, K. S., Silberg, J. L., Neale, M. C., Kessler, R. C., Heath, A. C. & Eaves, L. J. (1991). The family history method: Whose psychiatric history is measured? *American Journal of Psychiatry, 148,* 1501–1504.

https://doi.org/10.1375/twin.13.4.340 Published online by Cambridge University Press

Lee, T. (2009). Bias-adjusted exposure odds ratio for misclassified data. *The Internet Journal of Epidemiology, 6*(2).

Li, T. K., Hewitt, B. G., & Grant, B. F. (2007). Is there a future for quantifying drinking in the diagnosis, treatment, and prevention of alcohol use disorders? *Alcohol and Alcoholism, 42*, 57–63.

Lobo, D. S. S., Vallada, H. P., Knight, J., Martins, S. S., Tavares, H., Gentil, V., & Kennedy, J. L. (2007). Dopamine genes and pathological gambling in discordant sib-pairs. *Journal of Gambling Studies, 23,* 421–433.

McNemar, Q. (1947). Note on the sampling error of the difference between correlated proportions or percentages. *Psychometrika*, *12*, 153–157.

Milne, B. J., Caspi, A., Crump, R., Poulton, R., Rutter, M., Sears. M. R. & Moffitt, T. E. (2009). The validity of the family history screen for assessing family history of mental disorders. *American Journal of Medical Genetic, Part B: Neuropsychiatric Genetics, 150B,* 41–49.

Petry, N. M., Ammerman, Y., Bohl, J., Doersch, A., Gay, H., Kadden, R. et al. (2006). Cognitive-behavioral therapy for pathological gamblers. *Journal of Consulting and Clinical Psychology, 74, 555–567.*

Rice, J. P., Reich, T., Bucholz, K. K., Neuman, R. J., Fishman, R., Rochberg, N., Hesselbrock, V. M.,Nurnberger, J. I. Jr, Schuckit, M. A. & Begleiter, H. (1995). Comparison of direct interview and family history diagnoses of alcohol dependence. *Alcoholism: Clinical and Experimental Research, 19,* 1018–1023.

Rodgers, B., Caldwell, T, & Butterworth, P. (2009). Measuring gambling participation. *Addiction, 104,* 1065–1069.

Roy, M. A., Walsh, D., Prescott, C. A. & Kendler, K. S. (1994). Biases in the diagnosis of alcoholism by the family history method. *Alcoholism: Clinical and Experimental Research, 18,* 845–851.

Saha, T. D., Stinson, F. S. & Grant, B. F. (2007). The role of alcohol consumption in future classifications of alcohol use disorders. *Drug and Alcohol Dependence, 89,* 82–92.

Slutske, W. S., Jackson, K. M. & Sher, K. J. (2003). The natural history of problem gambling from age 18 to 29. *Journal of Abnormal Psychology, 112,* 263–274.

Slutske, W. S., Meier, M. H., Zhu, G., Statham, D. J., Blaszczynski, A., & Martin, N. G. (2009). The Australian twin study of gambling (OZ-GAM): Rationale, sample description, predictors of participation, and a first look at sources of individual differences in gambling involvement. *Twin Research and Human Genetics, 12,* 63–78.

Slutske, W. S., Zhu, G., Meier, M. H., & Martin, N. G. (2010). Genetic and environmental influences on disordered gambling in men and women. *Archives of General Psychiatry, 67,* 624–630.

Szatmari, P., & Jones, M. B. (1999). Effects of misclassification on estimates of relative risk in family history studies. *Genetic Epidemiology, 16,* 368–381.

Vandeleur, C. L., Rothen, S., Jeanprêtre, N., Lustenberger, Y., Gamma, F., Ayer, E., Ferrero, F., Fleischmann, A., Besson, J., Sisbane, F. & Preisig, M. (2008). Inter-informant agreement and prevalence estimates for substance use disorders: Direct interview versus family history method. *Drug and Alcohol Dependence, 92,* 9–19.

Volberg, R. A., Hedberg, E. C., & Moore, T. L. (2008). *Oregon youth and their parents: Gambling and problem gambling prevalence and attitudes*. Salem, OR: Oregon Department of Human Services.

Walker, M., Toneatto, T., Potenza, M. N., Petry, N., Ladouceur, R., Hodgins, D. C. et al. (2006). A framework for reporting outcomes in problem gambling treatment research: The Banff, Alberta Consensus. *Addiction, 101,* 504–511.

Winters, K. C., Stinchfield, R. D., & Fulkerson, J. (1993). Patterns and characteristics of adolescent gambling. *Journal of Gambling Studies, 9,* 371–386.

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