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Egocentric social network analysis of pathological gambling

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ABSTRACT

Aims To apply social network analysis (SNA) to investigate whether frequency and severity of gambling problems were associated with different network characteristics among friends, family and co-workers is an innovative way to look at relationships among individuals; the current study was the first, to our knowledge, to apply SNA to gambling behaviors. **Design** Egocentric social network analysis was used to characterize formally the relationships between social network characteristics and gambling pathology. **Setting** Laboratory-based questionnaire and interview administration. **Participants** Forty frequent gamblers (22 non-pathological gamblers, 18 pathological gamblers) were recruited from the community. **Measurements and Findings** The SNA revealed significant social network compositional differences between the two groups: pathological gamblers (PGs) had more gamblers, smokers and drinkers in their social networks than did non-pathological gamblers (NPGs). PGs had more individuals in their network with whom they personally gambled, smoked and drank than those with who were NPG. Network ties were closer to individuals in their networks who gambled, smoked and drank more frequently. Associations between gambling severity and structural network characteristics were not significant. **Conclusions** Pathological gambling is associated with compositional but not structural differences in social networks. Pathological gamblers differ from non-pathological gamblers in the number of gamblers, smokers and drinkers in their social networks. Homophily within the networks also indicates that gamblers tend to be closer with other gamblers. This homophily may serve to reinforce addictive behaviors, and may suggest avenues for future study or intervention.

Keywords Alcohol, egocentric, pathological gambling, social network analysis, tobacco.

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INTRODUCTION

Social factors contribute to the initiation and maintenance of gambling behavior. For example, the most frequent reason for gambling among older adults reported was to socialize with friends [1]. In a college-aged sample, social factors were the third most cited motivation to gamble [2]. Based on Becker's early studies on the initiation of drug use [3,4], Reith & Dobbie [5] argue that the social environment interacts with the individual, such that an individual learns how and where to gamble from his or her social network. Recreational gamblers and pathological gamblers (PGs) who were introduced to gambling in early life were at the greatest risk of developing gambling problems [5]. Further, as adolescents age and their gambling involvement increases they spend more time with their gambling friends, resulting in fewer close relationships with non-gambling friends [6], which may result in a pernicious cycle of a social network that reinforces gambling which, in turn, results in spending more time with gambling friends. Social factors, as well as perceptions of social norms, are also implicated during gambling. For example, participants who believe that others are gambling and winning play for longer periods, resulting in greater losses [7]. In the presence of onlookers, people place smaller bets [8], suggesting that social factors can have a considerable impact on gambling play. When students perceive that important others approve of gambling, they gamble more frequently [9]. Friends' and families' approval of gambling are also strong predictors of past year gambling frequency and severity [10].

Social network analysis

The current study utilized an established method that has been applied only recently to gambling and other addictive behaviors. Social network analysis (SNA) is an innovative technique for understanding group prevalence and structure. The current study utilized egocentric network analysis, in which the participant (referred to as 'ego') lists his or her closest friends, family members and co-workers (referred to as 'alters'), and assesses the relationships among the alters. (In a socio-centric network analysis, by contrast, information is gathered from each person, about each person, in a relatively closed network.)

A frequent focus of SNA studies is homophily, or the tendency of individuals who are similar in their beliefs, attitudes and behaviors to be linked more frequently and more closely in social networks than those who are dissimilar [11]. In his classic housing study, Festinger [12] found evidence of homophily based on propinquity, the tendency of people who live close together to be more connected. Social network analysis is also used to examine the structural characteristics of social networks. One structural characteristic that may affect addictive behavior is network density, which reflects how connected are the members of a network to each other. Dense networks make it easier for egos to observe and to replicate the behaviors of alters in their network [13].

SNA and addictive behaviors

Within the DSM-IV, pathological gambling (PG) is categorized as an impulse control disorder defined by symptoms including loss of control of gambling, preoccupation with gambling and persistence despite negative consequences [14]. The DSM-5 will most probably categorize PG under Substance Use and Addictive Disorders, reduce the diagnostic threshold from five to four symptoms and eliminate the criterion of illegal activities [15]. SNA has been utilized successfully to study substance use and abuse. For example, the proportion of drinkers and heavy drinkers in an individual's network is related positively to participants' drinking [16]. In contrast, the proportion of family members in a drinker's network is related negatively to the participants' drinking.

Homophily has been observed in the addiction domain. For example, drinkers prefer friends with the same drinking and smoking behavior [17,18]. We therefore posit that individuals who gamble, smoke and drink will be connected more frequently and more closely to others who gamble, smoke and drink, respectively. Peer group substance use has also been examined in several studies utilizing socio-centric SNA applied to samples of middle and high school students. Fang and colleagues [19] found a negative relationship between network density and substance abuse among isolates (those who are unconnected to peers; [20]), whereas Henry & Kobus [21] found greater substance abuse among those who link otherwise unconnected groups (or 'liaisons'). Liaisons have been found to smoke more than others, but are less affected by the prevalence of smoking in their networks [22]. Surprisingly, there is no effect of network position on alcohol use, but alcohol use is related to the proportion of network peers who use alcohol. As the prevalence of alcohol and marijuana use increases in peer networks, so does the frequency of an individual engaging in that behavior [22].

The present study

The primary aim of the present study was to apply SNA to PG for the first time, investigating the role of social networks in PG, in a comparison of recreational gamblers and problem gamblers. We hypothesized that, compared to non-pathological gamblers (NPGs), PGs would have social networks that were denser with gamblers and also differed structurally. However, in the absence of previous studies, no a priori hypotheses were made for specific structural indices. A second aim of the study was to investigate substance use comorbidity in PGs' and NPGs' social networks. Based on the comorbidity literature [23,24], we hypothesized that PGs' network members would gamble, drink and smoke more often than NPGs' network members. We also hypothesized that PGs would engage in all these behaviors more often than NPGs with their network members. As friends have been found to be a primary reason to gamble for older adults, we also hypothesize that they will have significant impact on gambling, smoking and drinking behavior.

METHODS

Participants

Forty frequent-gambling adult participants (75% male) were recruited from the Athens, GA community. All participants were recruited through advertisements in newspapers and buses, as well as word of mouth. Exclusion criteria were gambling less than weekly, currently living with another participant, inability to use a computer, self-reported symptoms of psychosis or age greater than 65 years. Participants were an average age of 35.25 years [standard deviation (SD) = 11.09]; 67.5% earned less than $15 000 pre-tax in the past year, and 17.5% earned between $15 000 and $30 000. Most participants were African American (72.5%), followed by Caucasian (25%) and mixed race (2.5%). Participants were compensated $20. Based on the DSM-IV Structured Clinical Interview for Pathological Gambling (SCI-PG; [25]), 18 participants met criteria for PG and 22 participants did not.

Measures

We used an egocentric network analysis approach, in which the participant ('ego') listed his or her 30 closest social associates including friends, family members, present/past romantic partners and co-workers ('alters'). The amount of structural information gained about a network increases as the number of alters increases, but begins to plateau at around 25 alters, with 35 alters providing virtually identical information to 45 alters [26]. Participants did not report difficulty listing the 30 alters, although tests of order effects revealed some significant differences in gambling or substance use between later- and earlier-named alters (reported below).

Participants indicated the sex and race of each alter, how long he or she knew each alter, how often he or she spent time with each alter, how close they were, whether they ever lived together and whether they were ever in a romantic relationship with one another. Participants also indicated how frequently each alter gambled, smoked and drank, and how often the participant gambled, smoked and drank with each alter. Each of these behaviors was assessed on a six-point Likert frequency scale that included the following levels: (i) not in the past year, (ii) less than once a month, (iii) once a month, (iv) once a week, (v) multiple times a week and (vi) daily.

Participants additionally answered questions about the relationships among the alters. Each alter pairing was rated on a scale ranging from 'very close' (5) to 'they have never met' (1). Assessment was conducted using EgoNet, a program designed for the collection of egocentric social network data [27].

Social networks were characterized structurally using the validated SNA indices of network density and betweenness centrality. Network density is the proportion of the number of actual connections relative to the number of possible connections in a network. Dense networks have many strong connections between members, whereas a less dense network has fewer and weaker connections. We also calculated the betweenness centrality of each alter, which assesses how well connected and integral each individual is to his/her network. Betweenness centrality is the degree to which the shortest paths between any pair of people in the network pass through a particular alter [28].

Data analysis

A Jonckheere–Tepstra test [29] was used to analyze differences in gambling, smoking and drinking frequency between the social networks of PGs and NPGs, as well as the frequency of joint engagement in these behaviors by ego and alter together. These use median values, with lower numbers representing higher frequencies. We dichotomized alters' gambling, drinking and smoking frequency as less than once a month or at least once a month [30]. We then used Mann–Whitney *U*-tests to compare these two categories between the networks of PGs and NPGs.

We also used a Mann–Whitney *U*-test to examine differences in network density. For other tests, we used multi-level models with a 'one-with-many' design [31], which allowed for multiple ratings of alters by a single participant. We used these to account for non-independence of alters within a participant's network and interactions between the individual and the social network. We also conducted a multi-level model with the participant's diagnostic status (PG or NPG) and the participant's gambling as fixed effects predicting homophily, and with each alter's gambling, smoking or drinking frequency as fixed effects predicting closeness or centrality. Data analysis was conducted using SPSS version 19.0, and UCINET [32] was used to generate the structural aspects of the participants' social networks. All non-dichotomized independent variables were grand mean centered.

RESULTS

Compositional social network characteristics

The number of networks members who were friends, family members, co-workers and present/past romantic partner was associated with PG status, with PGs having significantly more family members and fewer co-workers in their self-reported networks than is expected by random proportional assignment ($\chi^2 = 21.01$, d.f. = 4, $P < 0.001$). See Table 1 for full descriptive statistics.

Overall activity of alters

With each of 40 participants naming 30 members of his or her social network, we accumulated data on $40 \times 30 = 1200$ alters (660 alters named in NPGs' network and 540 alters named in PGs' network). The gambling frequency of PGs' network members (median = 2; 'less than once a month') were significantly higher than NPGs' network members (median = 1; 'not in the past year'; $Z = 4.98$, $P < 0.001$). For example, 19% of people listed in the PGs' networks gambled daily, whereas 11% of people listed in the NPGs' networks gambled daily. The PGs' networks included more alters who gambled at least once a month ($U = 202\,620$, $P < 0.001$). We also found significant differences in the networks' distribution of smoking ($Z = 2.80$, $P < 0.01$) and drinking ($Z = 3.42$, $P < 0.001$) behavior. For both comparisons, the PGs' median scores were 2 ('less than once a month'), whereas the NPGs' median scores were 1 ('not in the past year'). As revealed in Table 2, the

Table 1 Distribution of network members among relationship types, by pathological gamblers (PG) status.

		Diagnostic severity		
Relationship		*NPG*	*PG*	*Total*
Friend	Count	375	295	670
	Expected count	368.50	301.50	670
Current romantic partner	Count	20	23	43
	Expected count	23.60	19.40	43
Past romantic partner	Count	41	32	73
	Expected count	40.20	32.80	73
Family member	Count	172	176	348
	Expected count	191.40	156.60	348
Co-worker	Count	52	14	66
	Expected count	36.30	29.70	66
Total	Count	660	540	1200
	Expected count	660	540	1200

NPG: non-pathological gamblers.

Table 2 Distribution of alters' overall gambling, smoking and drinking frequency by pathological gamblers (PG) status.

	Gamble		*Smoke*		*Drink*	
Frequency	*NPG*	*PG*	*NPG*	*PG*	*NPG*	*PG*
Daily	11.06 (73)	19.07 (103)	27.73 (183)	31.85 (172)	11.82 (78)	23.52 (127)
Multiple times a week	8.33 (55)	13.15 (71)	6.67 (44)	6.85 (37)	16.36 (108)	11.11 (60)
Once a week	8.33 (55)	10.56 (57)	1.82 (12)	4.26 (23)	10 (66)	10.19 (55)
Once a month	7.27 (48)	5.93 (32)	2.58 (17)	4.44 (24)	5.76 (38)	6.85 (37)
Less than once a month	7.42 (49)	5 (27)	3.64 (24)	4.63 (25)	7.42 (49)	6.48 (35)
Not in the past year	57.58 (380)	46.3 (250)	57.58 (380)	47.06 (259)	48.64 (321)	41.85 (226)

All values are percentages. Total *n*s are given in parentheses. NPG: non-pathological gamblers.

networks of PGs had frequency distributions that were more weighted to frequent engagement in all three behaviors.

Figure 1 presents examples of PG and NPG networks, selected to be maximally illustrative of the effects in question. A line between two nodes represents a connection between alters, and darker and larger nodes represent more frequent gambling, ranging from black (daily) to white (not in the past year). Panels (a) and (b) reflect gambling in the alters of an NPG and PG participant, respectively; panels (c) and (d) depict smoking in the alters of the same NPG and PG participants; and panels (e) and (f) depict drinking in the alters of the same NPG and PG participants. In each case, the networks reveal the greater occurrence of gamblers, smokers and drinkers for the PG participant; in contrast, the NPG participant exhibits a network in which the addictive behaviors are restricted to more distinct subgroups of associates.

In addition to effects in their overall behavior, consistent with our hypotheses, we also found significant differences in alters' frequency of gambling ($Z = 3.84$, $P < 0.001$), smoking ($Z = 4.42$, $P < 0.001$) and drinking ($Z = 3.74$, $P < 0.001$) with ego, although the medians for both groups on all three behaviors were 1 ('not in the past year'), reflecting the fact that these are generally low-frequency behaviors. PGs gambled with 37% of their network members at least once a month compared with 27% in the NPGs' networks ($U = 196\,350$, $P < 0.001$). PGs smoked with 42% of their network members at least once a month compared with 29% of NPGs' networks ($U = 202\,470$, $P < 0.001$). PGs drank with 41% of the individuals in their networks at least once a month, compared with 33% of the members of NPGs' networks ($U = 192\,540$, $P < 0.01$). These effects can be seen in Table 3.

In general, the effects appeared stronger among friends as opposed to all network members, as floor effects on frequency were attenuated. Alters described as friends gambled ($U = 64\,856$, $P < 0.001$), smoked ($U = 62\,772$, $P = 0.001$) and drank ($U = 63\,254$, $P = 0.001$) more in PGs' networks than in NPGs' networks (medians = 3 and 1 for gambling, 4 and 1 for smoking and 5 and 3 for

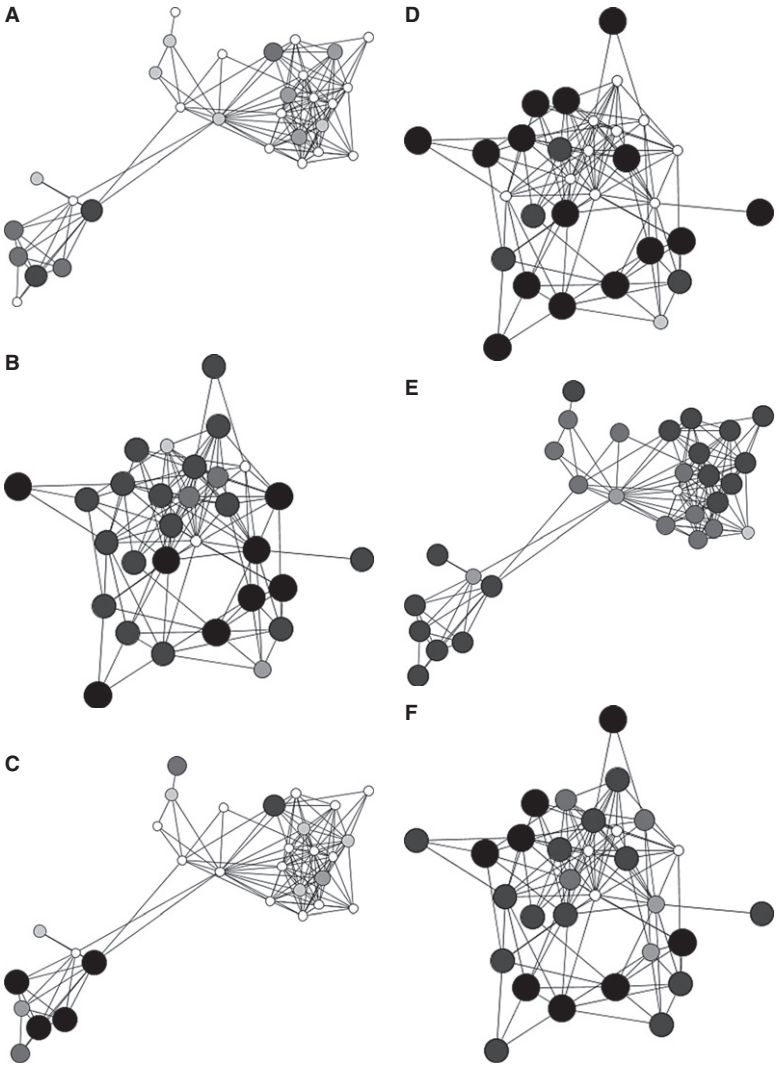

Figure 1 Structural social networks of gambling, alcohol use and tobacco use in two illustrative participants. (a) Non-pathological gamblers (NPG) network's gambling; (b) pathological gamblers (PG) network's gambling; (c) NPG network's smoking; (d) PG network's smoking; (e) NPG network's drinking; (f) PG network's drinking. The depictions are of the same two participants' networks in each case. The participant is not shown in the graphs. Darker colors and larger nodes reflect more frequent gambling, drinking or smoking behavior. In each case, the networks reveal the significantly greater occurrence of gamblers, smokers and drinkers for the PG participant; in contrast, the NPG participant exhibits a network in which the addictive behaviors are restricted to more distinct subgroups of associates

Table 3 Distribution of alters' gambling, smoking and drinking frequency with ego, by pathological gamblers (PG) status.

	Gamble with ego		*Smoke with ego*		*Drink with ego*	
Frequency	*NPG*	*PG*	*NPG*	*PG*	*NPG*	*PG*
Daily	8.03 (53)	12.41 (67)	13.79 (91)	20.93 (113)	6.06 (40)	17.96 (97)
Multiple times a week	5.15 (34)	7.96 (43)	7.88 (52)	7.96 (43)	8.64 (57)	9.81 (53)
Once a week	5.61 (37)	9.63 (52)	2.88 (19)	8.7 (47)	11.06 (73)	6.11 (33)
Once a month	7.88 (52)	6.85 (37)	4.24 (28)	4.81 (26)	7.12 (47)	7.04 (38)
Less than once a month	6.82 (45)	5.93 (32)	5.45 (36)	3.7 (20)	8.48 (56)	6.85 (37)
Not in the past year	66.52 (439)	57.22 (309)	65.76 (434)	53.89 (291)	58.64 (387)	52.22 (282)

All values are percentages. Total *n*s are given in parentheses. NPG: non-pathological gamblers.

drinking, respectively). The friends in PGs' networks also gambled (medians both = 1; $U = 64\,845$, $P < 0.001$), smoked (medians = 3 and 1; $U = 67\,133$, $P < 0.001$) and drank (medians = 3 and 1; $U = 65\,027$, $P < 0.001$) significantly more with the participant than the friends in NPGs' networks.

Structural social network characteristics

We next examined the structural characteristics of both groups' networks. There were no significant differences in density between the networks of PGs' (1.95, SD = 0.77) and NPGs' (2.10, SD = 1.00; $t_{(38)} = 0.54$). Similarly, no

significant relationships were observed between centrality and alter gambling, drinking or smoking (all $ts \leq 1.16$, all $Ps \geq 0.24$); also, when using dichotomized behaviors (less than once a month versus once a month or more), no significant relationships between centrality and alter gambling ($t_{(949)} = -0.560$, $P = 0.576$), drinking ($t_{(881)} = 0.031$, $P = 0.975$) or smoking ($t_{(1065)} = -1.085$, $P = 0.278$) were found. These findings suggest that the organizational structure of the participants' social networks do not differ significantly by PG status.

We also tested the relationship between subjective closeness and gambling severity. Participants felt subjectively closer to alters who gambled ($F_{(1,\ 1179)} = 31.27$, $P < 0.001$), smoked ($F_{(1,\ 1195)} = 6.32$, $P = 0.01$) and drank more frequently ($F_{(1,\ 1192)} = 6.43$, $P < 0.05$). There were no interactions between diagnostic severity and alters' gambling ($F_{(1,\ 1179)} = 0.97$, $P = 0.32$) or smoking ($F_{(1,\ 1195)} = 1.02$, $P = 0.32$) in predicting closeness, although NPGs felt subjectively closer to the drinkers in their networks to a greater degree than did PGs ($F_{(1,\ 1192)} = 6.49$, $P < 0.05$). Furthermore, there were no differences in friend subjective closeness ($U = 54\ 582$, $P = 0.76$) and entire network subjective closeness ($U = 170\ 782$, $P = 0.195$) with the ego between the networks of PGs and NPGs. The relationship between closeness and frequency of gambling, smoking and drinking is borne out further by associations between order of identification and all three addictive behaviors. The first 10 listed alters gambled ($U = 71\ 695$, $P < 0.01$), smoked ($U = 73\ 373$, $P < 0.05$) and drank ($U = 74\ 185$, $P = 0.05$) more frequently with the ego than did the second 10 alters listed who, in turn, did not differ from the third 10 alters listed.

Homophily was observed in the gambling behavior of alters, with a positive correlation between an alters gambling score and the average gambling scores of the other alters to whom that alter was connected ($r_{(977)} = 0.61$, $P < 0.001$). There was no evidence of differential homophily in the networks of PGs ($r_{(438)} = 0.60$, $P < 0.001$) compared with the NPGs group ($r_{(539)} = 0.61$, $P < 0.001$; $F = 1.77$, $P = 0.18$).

DISCUSSION

To our knowledge, the current study constitutes the first formal social network analysis of pathological and recreational gamblers. This is a particularly promising methodology for gambling studies, both in so far as SNA has made significant strides in other addictive behaviors [19,21], and as social factors are known to contribute substantially to PG [1,2].

Consistent with the literature on comorbidity [23,24], PGs had not only more gamblers, but also more smokers and drinkers in their networks who gambled, smoked and drank more frequently than those in a NPG's network. We also found that PGs gambled, smoked and drank more frequently with members of their networks than did NPGs. At a correlational level, as an individual's gambling severity increases, so may the importance and frequency of gambling, smoking and drinking in the network. The members of a PG's network may reinforce the addictive behavior.

Consistent with our hypotheses, PGs were found to gamble, smoke and drink alcohol significantly more often with their friends than did NPGs. We also found that in the networks of PGs, their friends gambled, smoked and drank significantly more than the friends in the NPG's network. There are two prominent theories on why social affiliates engage in similar behaviors: socialization and selection. In the former, friends' attitudes and behaviors affect the individual (conformity), while in the latter the person seeks out peers with similar beliefs and behaviors [33,34]. Research suggests that socialization is associated with closed, tight networks (e.g. military class) while selection is associated with open, looser networks (e.g. high schools; [35]). As the current study is cross-sectional, it cannot support differentially either of the two theories, but it clearly represents a methodology that, applied across time, could clarify whether individuals with PG seek out similarly affected people or whether social groups directly confer risk for developing PG.

Participants felt significantly closer to alters who gambled, smoked and drank more frequently. Surprisingly, we found that this effect was virtually identical for the PG and NPG groups in their subjective feelings of closeness to the gamblers and smokers in their networks. Furthermore, when comparing the networks of PGs and NPGs, there were no differences in subjective closeness for friends and the entire network. These results suggest that PG status does not affect closeness directly and that closeness may be defined by several other factors besides mutual interests.

We found evidence of homophily in the networks of both PGs and NPGs. Alters who gambled were more connected to others who gamble, and those who did not gamble were more connected to others who did not gamble. Consistent with these results pertaining to gambling, homophily is also found in drug-using networks [16,17]. This suggests that the networks of gamblers are similar to those of substance abusers. The absence of significant differential homophily and network density may have been due to issues of range restriction arising from the entire sample being comprised of gamblers. In a study examining heroin injectors and non-injectors, the authors found that although injectors had more friends and a larger network size, there was no significant difference in network density between the two groups [36]. Similarly, the main differences between these networks in our data were compositional, not structural. That is,

taken together, the most salient social network factors observed for PG participants were significantly more gamblers in the network, more frequent gambling among those gamblers and significantly greater joint gambling with network members. The lack of difference in density, which reflects closeness among alters and not between ego and any alters, is independent of the low social support that is associated with greater gambling severity [37].

The strengths of this study include the systematic application of an SNA approach to PG and a well-characterized sample with considerable diversity. However, the limitations include that the participants reported the behavior of others in their network, possibly resulting in a false consensus effect, an inherent limitation of egocentric SNA wherein participants project their own behavior onto others [38]. This possibility is diminished by the fact that homophily was observed across networks, and not just in alters' relationships with ego. Future research would benefit from utilizing a sociocentric network design and a longitudinal design that addresses the causal role of social influence and selection on addictive behaviors. Another limitation of this study was its relatively modest sample size, which may reduce the generalizability of the findings. We also cannot eliminate the possibility of overlapping networks, as alters were kept anonymous. Future research will be needed to establish whether the correlational effects reported here are attributable to gambling problems *per se* or to gambling frequency. Finally, the current study included higher proportions of African American and low-income individuals than is reflective of the broader US population, due probably to these demographic characteristics being more prevalent in the recruitment catchment area.

These caveats notwithstanding, the current study advances understanding of the role of the social network in addictive behavior by providing the first formal SNA of pathological gambling. Distinct and theoretically relevant differences were observed in the composition of PGs' and NPGs' networks, in the absence of structural differences. Pathological gamblers had more gamblers, smokers and drinkers in their networks in general and more individuals with whom they personally gambled, smoked and drank alcohol. These compositional differences may provide important insights into the causes and maintaining factors in PG and, ultimately, may also be leveraged to enhance treatment.

Declarations of interest

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