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Are online pathological gamblers different from non-online pathological gamblers on demographics, gambling problem severity, psychopathology and personality characteristics?

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The purpose of this study was to compare online pathological gamblers (OPG) to non-online pathological gamblers (non-OPG) in terms of gambling behaviour, socio-demographic features, psychopathology and personality characteristics. A large sample of 1015 pathological gambling (PG) patients consecutively admitted to our Pathological Gambling Unit participated in the study. There were very few differences between OPGs and non-OPGs, limited to OPGs exhibiting slightly higher educational levels, higher socio-economic status and larger amounts of money spent on gambling and gambling debts. There were no differences in clinical, psychopathological and personality characteristics.

Although some research has been conducted in the general population, the current paper is one of the few attempts to analyse this topic in clinical samples who seek treatment for their gambling problem. The lack of differences between OPGs and non-OPGs found in our study may encourage further studies to analyse whether similar therapy responses might be obtained in both groups.

Keywords: behavioural addictions; online gambling; pathological gambling; personality; psychopathology

Epidemiological research shows that the prevalence of pathological gambling (PG) increased seriously during the last decades in developed countries (Carragher & McWilliams, 2011; Petry, Stinson & Grant, 2005; Shaffer & Hall, 2001; Shaffer, Hall & Vander Bilt, 1999). In addition, it is shown that the problem of gambling is manifested in many different types, both Internet-based as well as land-based: playing cards for money; betting on horses, dogs, or other animals; betting on sports; playing dice games, casinos, lotteries, bingo, slot machines or stock and/or commodities markets (Odlaug, Marsh, Kim & Grant, 2011). The increase of these problems is in line with an increase of awareness of interested groups such as policymakers, clinics or gambling researchers.

Traditionally, PG has frequently been associated with certain types of gambling: that is, not all forms of gambling seem to be as addictive as others (Griffiths, 1993; Griffiths, Wood, Parke & Parke, 2007; Griffiths, Wood & Parke, 2008; National Research Council, 1999; Odlaug et al., 2011; Parke & Griffiths, 2006; Wong & So, 2003). Slot and fruit machines seem to be top of the list of addictive games, both due to their technical and situational characteristics (Griffiths, 1999; Desai, Maciejewski, Dausey, Caldarone, & Potenza, 2004; Hing & Breen, 2002). Over the last decade, a new form of gambling has emerged on the Internet, with potential negative consequences (Griffiths, Wardle, Orford, Sproston, & Erens, 2009; Ladd & Petry, 2002; Lyk-Jensen, 2010; Petry & Weinstock, 2007) that may increase the levels of problematic gambling (Wardle et al., 2007). However, previous studies (Griffiths, 2003) suggested that Internet gambling might not be a new type of gambling but, rather, a medium through which engage in gambling behaviour (more than a 'double addiction').

Since the late 1990s an increase in online gambling has been observed. It is calculated that 10% of the European gambling market corresponds to online gambling, with an expected rise to 12% in 2012. However, no adequate global regulation of online gambling exists in the European Union (European Gaming and Betting Association [EGBA], 2011). In 2011, the Spanish government published a law for the regulation of online gambling in order to fight against fraud and prevent gambling addiction, while protecting the rights of children and adolescents and those of the online game participants (*Boletín Oficial del Estado* [*BOE*], 2011).

Although the USA and Canada have reported rates between 0.3% and 5.3% (Broda et al., 2008; Wood & Williams, 2011), studies evaluating the prevalence of Internet-based gambling are still scarce. In 2010, it was estimated that in Spain there were more than 370,000 online gamblers, a fact that suggested an increase of 33% in comparison to the last year. Taking into consideration the typology of gambling, in comparison with 2009 there was an increase of 21% in sport betting and 26% in online poker, which actually is one of the most popular gambling games in Spain (Asociación Española de Apostadores por Internet [AEDAPI], 2009).

Although these rates seem comparatively low in comparison with those observed for other types of gambling (Welte, Barnes, Wieczorek, Tidwell, & Parker, 2004), Internet gambling presents a series of unique characteristics – such as anonymity, proximity and a sense of control (LaBrie, Kaplan, LaPlante, Nelson, & Shaffer, 2008) – that suggest there will be a rapid increase in the future (Christiansen Capital Advisors, 2007).

Although several PG studies have explored online gambling (Griffiths & Barnes, 2008; LaBrie, LaPlante, Nelson, Schumann, & Shaffer, 2007; Wood & Williams, 2007), the relation among gambling symptoms and psychopathology has rarely been investigated in this group. The few studies that analysed this issue have found online gambling to be associated with being male; in a younger age group; with a higher level of education and higher occupational status (Griffiths et al., 2009; Lloyd et al., 2010a; Ko et al., 2009; Wardle et al., 2010); variable emotional and mood states (Lloyd et al., 2010a; Matthews, Farnsworth, & Griffiths, 2009); higher psychiatric co-morbidity and poor mental health (Lloyd et al., 2010b; Petry & Weinstock, 2007); dysfunctional decision-making (Sun et al., 2009); and higher impulsivity (Hopley & Nicki, 2010) and brain hyperactivation (Ko et al., 2009). In a study of gambling behaviour amongst the general population, Wood & Williams (2011) analysed 7921 people who provided comprehensive information about their gambling behaviour (1954 Internet gamblers and 5967 non-Internet gamblers), and found that the socio-demographic profile of Internet gamblers is that they are male, young and with a high economical status, when compared with non-Internet gamblers.

Additionally, they found that the former group also gamble on several types of land-based gambling and have a three to four times higher prevalence of problem gambling.

Given the current limited information in the literature of studies conducted with clinical samples, the goal of the present study was to explore this topic by recruiting a large sample of pathological gamblers from a clinical setting and to compare OPGs to non-OPGs across a broad range of socio-demographic factors, gambling behaviour, gambling problem severity, psychopathology and personality measures.

Method

Participants

The study was conducted between January 2005 and January 2009. The initial sample included 1025 pathological gambling patients who were consecutive referrals for assessment and outpatient treatment at a Pathological Gambling Unit in the Psychiatric Department of the University Hospital of Bellvitge. This public hospital, opened in 1972, is located in the city of Hospitalet de Llobregat (Barcelona). Our institution is one of the hospitals in Spain that is certified as a third-level centre, in charge of the treatment of cases with a high level of complexity. The reference population is more than two million of people in the Barcelona southern metropolitan area.

From the initial sample, 10 participants were excluded (they were both online and non-online gamblers). However, they did not show a greater severity of the disorder (measured by SOGS) when compared to the final sample. The final sample included 1015 individuals: 962 non-OPGs and 53 OPGs. The socio-demographic and clinical characteristics of both groups are represented in Table 1. In terms of gambling, the non-OPG group played the following games: 91.1% played slot machines, 13.6% played bingo, 8.1% bought lottery tickets, 5.7% played casino games and 3.2% played cards. None of the patients of this group were engaged in any type of online gambling. For the OPGs group, the types of gambling were as follows: 50.8% sports betting, 31.7% played online casino games such as slot machines and roulette, and 41.3% played online poker or other card games.

Instruments

A comprehensive assessment battery was administered that measured gambling behaviours, PG symptoms, socio-demographics, general psychopathology, and personality traits. The battery included internationally applied instruments in the PG field, such as the South Oaks Gambling Screen (SOGS; Lesieur & Blume, 1987), Stinchfield's diagnostic questionnaire for pathological gambling according to DSM-IV criteria (Stinchfield, 2003; Jiménez-Murcia, Stinchfield, et al., 2009), the Symptom Checklist – Revised (SCL-90-R; Derogatis, 2002) and the Temperament and Character Inventory – Revised (TCI-R; Cloninger, 1999).

South Oaks Gambling Screen (SOGS) (Lesieur & Blume, 1987)

The SOGS includes 20 items that produce a total score ranging from 0 to 20 (with higher values indicating more severe psychopathology); a score of five or more indicates Probable PG. The psychometric properties of the Spanish version of this questionnaire have been shown to be satisfactory. Test-retest reliability was $r = .98$ and internal consistency was .94 (Cronbach's α). Convergent validity with regard to DSM-III-R criteria for pathological gambling (American Psychiatric Association [APA], 1987) has been estimated at $r = .92$ (Echeburúa, Báez, Fernández, & Páez, 1994). Furthermore,

Table 1. Sociodemographic data of the non-online pathological gambling (non-OPG) and the online pathological gambling (OPG) groups.

Socio-demographic variables	Non-OPG ($n = 962$) Mean (SD)	OPG ($n = 53$) Mean (SD)	Comparison	
			t-test	*p*-value
Age (yrs)	40.4 (12.2)	40.4 (13.1)	− 0.03	.978
Personal income (eur/month)	1,278.4 (674.0)	1,426.1 (746.2)	− 1.48	.138
Family income (eur/month)	2,194.3 (1,106.2)	2,435.9 (1,078.1)	− 1.31	.190
Categorical variables: %	%	%	χ^2	*p*-value
Gender: males	91.8	94.3	0.44	.794
Employed	69.9	66.0	0.34	.543
Educational level *University*	4.0	13.2	16.26	**.001**
Secondary	40.7	52.8		
Primary or less	55.3	34.0		
Marital status *Divorced*	13.9	7.7	4.54	.102
Married	53.9	46.2		
Single-widow	32.2	46.2		
Socio-economic status *High*	1.5	0	14.70	**.004**
Medium-high	5.2	21.1		
Medium	15.1	23.7		
Medium-low	46.9	34.2		
Low	31.4	21.1		

Note: Bold: significant differences (.05 level).

several studies have reported satisfactory psychometric properties of the SOGS in both clinical and general population samples as an index of gambling problem severity (Alessi & Petry, 2003; Stinchfield, 2002; Strong, Lesieur, Breen, Stinchfield, & Lejuez, 2004).

Stinchfield's diagnostic questionnaire for PG according to DSM-IV criteria (Stinchfield, 2003; Jiménez-Murcia, Stinchfield, et al., 2009)

This questionnaire measures the 10 DSM-IV diagnostic criteria for PG with 19 items (APA, 1994). This scale has demonstrated satisfactory psychometric properties. Internal consistency was measured with Cronbach's alpha, which yielded values of $\alpha = 0.81$ for the general population and $\alpha = 0.77$ for a gambling treatment group. Convergent validity was estimated with a correlation with the SOGS as $r = 0.77$ for a general population sample and $r = 0.75$ for a gambling treatment sample. This scale has been adapted for the Spanish population by Jimenez-Murcia, Stinchfield, et al. (2009). It has demonstrated adequate psychometric properties. Cronbach's alpha in the present sample was very good ($\alpha = 0.90$).

Temperament and Character Inventory-Revised (TCI-R) (Cloninger, 1999)

This is a 240-item questionnaire with five-point Likert response options (Cloninger, Svrakic, & Przybeck, 1993). It measures seven dimensions of personality: four of

temperament (Harm Avoidance, Novelty Seeking, Reward Dependence and Persistence) and three character dimensions (Self-Directedness, Cooperativeness and Self-Transcendence). The Spanish version of the inventory has demonstrated satisfactory psychometric properties (Gutiérrez et al., 2001; Gutiérrez-Zotes et al., 2004).

Symptom Check List-90 Items-Revised (SCL-90-R) (Derogatis, 2002)

The SCL-90-R measures a broad range of psychological problems and symptoms of psychopathology. The questionnaire contains 90 items and measures nine primary symptom dimensions: Somatization, Obsession-Compulsion, Interpersonal Sensitivity, Depression, Anxiety, Hostility, Phobic Anxiety, Paranoid Ideation and Psychoticism. In addition, it includes three global indices: a global severity index (GSI), designed to measure overall psychological distress; a positive symptom distress index (PSDI), designed to measure symptom intensity; and a positive symptom total (PST), which are reports of self-reported symptoms. The GSI can be used as a summary of the subscales. The SCL-90-R has demonstrated satisfactory psychometric properties in a Spanish sample, obtaining a mean internal consistency of .75 (α coefficient) (Derogatis, 2002; Martínez-Azumendi, Fernández-Gómez, & Beitia-Fernández, 2001).

Additional demographic, clinical and social/family variables related to gambling were measured using a semi-structured face-to-face clinical interview described elsewhere (Jiménez-Murcia et al., 2007). As a part of the Diagnostic Interview Schedule (DIS), as described in previous studies (Forcano et al., 2009), participants were asked, in a structured clinical face-to-face interview, 'Have you ever attempted suicide?' The time frame for these questions was lifetime. A suicide attempt was defined as a self-destructive act with some degree of intent to end one's life. Thus, to be considered an attempt, the attempt was required to have two components: an action that was self-destructive and acknowledgement of intent to die.

Procedure

According to the assessment protocol and treatment model of our unit, which was manualized and published (Jimenez-Murcia et al., 2007), we followed a specific semi-structured interview and functional analysis of PG. All of this information was collected during the first interview. The remaining psychometric assessments mentioned above were administered to all subjects in a second session. Both interviews were conducted in a time frame of one week, by an experienced psychologist and psychiatrist (each having more than 15 years experience working in the field). The Ethics Committee of the University Hospital of Bellvitge (Barcelona, Spain) approved the study, and informed consent was obtained from all participants.

Statistical analysis

The statistical analysis was carried out with PASW 17 for Windows (SPSS System). Psychopathological (SCL-90), personality (TCI-R) and clinical measures (SOGS, DSM-IV criteria, and gambling questions) were compared between both groups (non-OPGs and OPG) with t-test procedures for quantitative variables and chi-square tests for categorical variables. Finner's adjustment was applied to control Type-I error (Brown & Russell, 1997). This method is used to perform more than one hypothesis test simultaneously, and it controls the family-wise error rate for the set of hypotheses at α level (.05 in this research) in a less conservative mode than the classical Bonferroni procedure.

Results

Table 1 shows the comparison of OPGs to non-OPGs on socio-demographic variables. The OPG group showed a higher educational level ($\chi^2 = 16.3$, $df = 2$, $p = .001$) and socio-economic status ($\chi^2 = 14.7$, $df = 4$, $p = .004$) than the non-OPG group. There were no statistically significant differences in age, income, gender, employment or marital status.

Table 2 shows the comparison of OPGs to non-OPGs on psychopathology as measured by the SCL-90-R, personality characteristics as measured by the TCI and suicidal attempts, and ideation as measured by the DIS. There were no statistically significant differences between OPGs and non-OPGs on any of the psychopathology or personality scales and no difference in the number of suicidal attempts or suicidal ideation.

Table 3 shows the comparison of OPGs to non-OPGs on gambling problem severity as measured by the SOGS and DSM-IV diagnostic criteria, and gambling behaviours. OPGs showed higher maximum amounts of money spent gambling, higher average amounts of money spent gambling, and higher gambling debts than non-OPGs. There were no statistically significant differences between OPGs and non-OPGs on SOGS and DSM scores, age of onset of PG, duration of PG or duration of gambling behaviour.

Table 2. Comparison of psychopathological and personality profiles between non-online pathological gambling (non-OPG) and online gambling (OPG).

Psychopathological and personality variables	Non-OPG ($n = 962$) Mean (SD)	OPG ($n = 53$) Mean (SD)	Comparison t-test	p-value
SCL: Somatization	0.92 (0.80)	0.89 (0.85)	0.23	.815
SCL: Obsess.- comp.	1.08 (0.79)	1.08 (0.69)	0.02	.981
SCL: Interp. sensitivity	0.96 (0.79)	1.06 (0.88)	−0.94	.349
SCL: Depressive	1.38 (0.89)	1.47 (0.93)	−0.66	.510
SCL: Anxiety	0.94 (0.78)	1.07 (0.94)	−1.19	.235
SCL: Hostility	0.84 (0.80)	0.91 (0.91)	−0.57	.572
SCL: Phobic anxiety	0.45 (0.63)	0.49 (0.63)	−0.45	.655
SCL: Paranoid ideation	0.83 (0.74)	0.89 (0.83)	−0.55	.579
SCL: Psychotic	0.83 (0.72)	0.92 (0.77)	−0.78	.436
SCL: GSI	0.98 (0.68)	1.05 (0.71)	−0.74	.460
SCL: PSDI	1.84 (0.58)	1.93 (0.67)	−1.14	.254
SCL: PST	44.6 (21.9)	46.87 (21.26)	−0.74	.458
TCI: Novelty seeking	109.4 (14.9)	107.5 (13.9)	0.86	.388
TCI: Harm avoidance	100.5 (17.5)	100.4 (17.9)	0.05	.962
TCI: Reward dependence	100.7 (15.7)	100.55 (14.37)	0.07	.943
TCI: Persistence	110.8 (20.7)	113.4 (21.0)	−0.86	.387
TCI: Self-directedness	127.2 (21.2)	125.3 (22.9)	0.61	.540
TCI: Cooperativeness	133.1 (17.8)	131.5 (17.5)	0.64	.520
TCI: Self-transcendence	65.7 (15.4)	67.5 (17.3)	−0.79	.432
Number of suicide attempts	0.1 (0.6)	0.0 (0.1)	0.57	*.570*
Categorical measure of suicidal ideation	%	%	χ^2	p-value
No	70.1	67.4	0.55	.759
Yes, unintentionally	29.1	32.6		
Yes, intentionally	0.7	0		

Note: SCL = Symptom Checklist; TCI = Temperament and Character Inventory.

Table 3. Comparison of clinical and gambling measures between non-online pathological gambling (non-OPG) and online gambling (OPG).

Clinical gambling variables	Non-OPG (n = 962) Mean (SD)	OPG (n = 53) Mean (SD)	Comparison	
			t-test	*p*-value
Age of onset of PG (yrs)	34.6 (11.8)	34.4 (11.7)	0.11	.911
Duration of PG (yrs)	5.6 (5.4)	5.0 (7.2)	0.69	.490
Duration of gambling behaviour (months)	14.2 (8.4)	14.9 (14.0)	− 0.36	.720
SOGS: total score	10.31 (3.16)	11.08 (2.91)	− 1.70	.089
DSM-IV: total score	7.02 (2.02)	7.15 (2.23)	− 0.46	.643
Maximum euros spent	784.9 (2,045.7)	2,578.4 (3,793.9)	− 3.11	**.003**
Median (*IQR*)	400.0 (200.0; 700.0)	1,000.0 (500.0; 2,650.0)		
Average euros spent	145.2 (315.3)	340.9 (534.1)	− 2.15	**.039**
Median (*IQR*)	70.0 (30.0; 150.0)	180.0 (50.0; 500.0)		
Debt in euros	9,806.8 (26,655.9)	21,510.9 (39,124.7)	− 2.10	**.042**
Median (*IQR*)	1,400.0 (0.0; 8,000.0)	7,000.0 (500.0; 20,000.0)		

Note: IQR = interquartile range (percentiles 25–75). Bold = significant differences (.05 level).

Discussion

The purpose of this study was to explore whether OPGs would exhibit significant differences on socio-demographics, gambling behaviour, gambling problem severity, psychopathology and personality characteristics, when compared to non-OPGs. A large sample of 1015 patients was recruited from a PG treatment program at an urban hospital in Barcelona, Spain. Of these 1015 patients, 53 were found to be OPGs while 962 were non-OPGs. There were few differences between OPGs and non-OPGs. The few differences were limited to OPGs exhibiting a slightly higher educational level, higher socio-economic status and larger amounts of money spent on gambling and gambling debts when compared with the non-OPG group. There were no differences in clinical, psychopathological and personality characteristics.

OPGs showed both higher educational levels (university or secondary studies in 66% of OPGs vs 44.7% in non-OPGs) and socio-economic status (medium/high 44.8% in OPGs vs. 21.8% in non-OPGs). It has been suggested by Griffiths et al. (2009) and Wood & Williams (2011), who reported a similar finding, that this difference may be explained in part by sociocultural and motivational factors, together with online specific characteristics such as anonymity, proximity, accessibility and sense of control (Griffiths et al., 2009; LaBrie et al., 2008). There were no significant differences on the other socio-demographic variables of gender, age, income, employment status, or marital status.

The finding that OPGs spent more money gambling and accumulated larger debts than non-OPGs is similar to that reported by others (Holtgraves, 2009; Toce-Gerstein, Gerstein, & Volberg, 2003; Wood & Williams, 2011). Spending more money on gambling and accumulating larger debts might be considered an indicator of higher gambling problem severity or of the socio-economic status of the gambler; however, there were no significant differences on SOGS or DSM-IV scores and no significant differences on personal or family income. Therefore, more research is needed to determine if these larger amounts of

money spent gambling and accumulated debt will lead to more severe consequences for OPGs.

No differences were observed between OPGs and non-OPGs in psychopathological symptoms as measured by the SCL-90-R. However, it should be noted that both OPGs and non-OPGs showed similar previously described psychopathological profiles (Crockford & el-Guebaly, 1998; Jiménez-Murcia, Granero et al., 2009; Lorains, Cowlishaw, & Thomas, 2011; Petry et al., 2005; Slutske, Caspi, Moffitt, & Poulton, 2005), characterized by emotional disturbances; somatic impairment; severe preoccupation; intrusive and undesirable thoughts; low self-esteem; and feelings of inferiority, sadness, pessimism, hopelessness, anxiety and social isolation, when compared with normative scores (Derogatis, 2002). Both OPGs and non-OPGs presented with elevated psychopathological symptoms, which suggests that PG treatment should address these psychopathological characteristics during the course of therapy or refer the patient to another health care provider for treatment of these symptoms.

No differences were observed between OPGs and non-OPGs in personality characteristics as measured by the TCI-R. However, it should be noted that both OPGs and non-OPGs exhibited similar personality profiles, characterized by high levels of novelty seeking (e.g. excitability, curiosity, impulsivity, low tolerance to routines) and low levels of self-directedness (e.g. poor goal-directed behaviour, immaturity, poor integration), when compared to Spanish normative scores (novelty seeking: mean 98.53 [SD 14.99]; self-directedness: mean 149.93 [SD 18.68]) (Gutierrez-Zotes et al., 2004). These two personality traits, novelty seeking and low self-directedness, are commonly described in individuals with PG (Fernandez-Aranda et al., 2006; Janiri, Martinotti, Dario, Schifano, & Bria, 2007; Jiménez-Murcia et al., 2007; Kim & Grant, 2001; Nordin & Nylander, 2007). Therefore, our findings do not suggest differential personality vulnerabilities between OPGs and non-OPGs.

In general, although clinical research into online gambling is relatively limited, our results are in concordance with a variety of studies that suggested few differences between non-online gamblers and online gamblers (Griffiths et al., 2008; Ladd & Petry, 2002). According to our findings, clinical, psychopathological and personality profiles did not differentiate OPG and non-OPGs, and educational level and related socio-economic status, along with larger amounts of money spent gambling and related larger debt, were the only variables that differentiated OPGs from non-OPGs.

Finally, these results have implications for clinical and public health practice: (a) the observed lack of differences between OPGs and non-OPGs may suggest nosological similarities and underlying shared psychopathological-personality styles with a resulting vulnerability to PG, independent of the gambling venue (i.e. online or non-online); (b) similar cognitive-behavioural treatment techniques that have already demonstrated effectiveness with non-OPGs might be applied with OPGs; (c) prevention and early detection strategies for OPGs should incorporate the findings that OPGs are likely to have high levels of education and socio-economic status, and also spend large amounts of money on gambling and have large debts; (d) as suggested by other authors (Wood & Williams, 2011), these findings might be of considerable benefit for policymakers, once responsible online gambling behaviour and business regulation are defined.

There are several methodological limitations to this study that need to be taken into account. First, the participants in the sample are only representative of pathological gamblers who seek treatment, and therefore the findings obtained may not apply to all individuals with PG. Since only 7% to 12% of PGs seek help for their disorder, a community sample of PG may yield different results. Second, the assessment procedure of a standardized self-administered questionnaire did not allow for in-depth evaluation of

specific Axis I and II co-morbid disorders. Third, the retrospective design to determine some gambling behaviours might be confounded by memory biases of the subjects. Fourth, although almost all types of game were represented in both groups, the distribution was not equal. OPGs were primarily sport bettors and non-OPGs were primarily slot-machine gamblers and therefore this may have introduced bias in our results. Although there is evidence that OPGs often play multiple forms of games (i.e. land-based), in our study we have just considered 'pure' cases, in order to preserve the homogeneity of the groups, a fact that could be an additional limitation Finally, the unequal sample sizes might have affected the accuracy of our results.

To summarize: for the most part, the hypothesis predicting differences between OPGs and non-OPGs was not supported by this study, as there were few statistically significant differences between OPGs and non-OPGs. This is one of the first studies to compare consecutively admitted OPGs with non-OPG patients. These findings suggest no differences between OPGs and non-OPGs regarding gambling problem severity, psychopathology and personality characteristics. The only differences were educational level, socio-economic status, amount of money spent gambling and gambling debt. Furthermore, since our results point out the lack of differences and potential similarities between OPGs and non-OPGs, future studies should explore their response to treatment, and underlying biological indices, allowing enhanced tailoring of interventions.

Acknowledgements

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