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Gambling transitions among adult gamblers: A multi-state model using a Markovian approach applied to the JEU cohort

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HIGHLIGHTS

- The status of adult problem gamblers is unstable over time.
- The status of adult non-problem gamblers is stable over time.
- We have to research gambling problems in people with an anxiety disorder or ADHD.
- Middle age and a current ADHD may support the persistence of gambling problems.

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ABSTRACT

Introduction: The aim of this paper is to study transitions between two states of gambling in adulthood (problem gambling and non-problem gambling) and to identify factors that might influence these transitions.
Methods: Data for this 2-year long longitudinal study were collected in a French Outpatient Addiction Treatment Center, in gambling establishments and through the press. Both problem gamblers and non-problem gamblers were evaluated using a structured interview and self-report questionnaires. The statistical analysis was carried out using a Markovian approach.
Results: The analyzed cohort consisted of 304 gamblers with 519 observed transitions. Participants with no past-year gambling problems (based on the DSM-IV) had a probability of about 90% of also having no past-year gambling problems at the following assessment, whereas the observed percentage of problem gamblers transitioning to non-problem gambling was of 48%. We reported (i) vulnerability factors of transitioning to problem gambling (such as an anxiety disorder or an Attention Deficit Hyperactivity Disorder (ADHD) during the childhood), (ii) protective factors for non-problem gamblers, (iii) recovery factors (such as ongoing treatment and younger age) and (iv) persistence factors of a gambling problem (such as a persistent ADHD).
Conclusions: The status of problem gambler is unstable over time, whereas we found stability among non-problem gamblers. Our findings suggest the existence of vulnerability and protective factors in gambling. These results lead to think about preventive actions and adaptive care, such as cognitive-behavioral therapy or researching gambling problems in people with an anxiety disorder or ADHD.

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1. Introduction

Gambling disorders are an important public health concern, for they lead to a poorer quality of life (Cowlishaw & Kessler, 2016). Research on gambling development seems necessary in order to trigger preventive actions and adaptive care. Most of the studies carried out among adult gamblers have adopted a cross-sectional design, limiting the ability to draw conclusions about normative gambling development.

Only a few longitudinal studies exist on gambling activities and problems in adolescents and young adults, which allowed us to identify different gambling trajectories in males aged 11 to 16 (Vitaro et al., 2004) or in adolescents aged 10 to 15 (Betancourt et al., 2012). The methods they used provided with a flexible approach for identifying clusters of individual developmental trajectories within the population, and for describing the characteristics of the individuals within the clusters. However, evidence suggests that, over time, gambling behaviors do not follow a smooth continuous curve, but have a considerable intra-individual variability with discontinuous changes between discrete states. Recent studies used different methods to consider the effects of protective or risk factors on gambling behavior transitions (Winters et al., 2002; Goudriaan et al., 2009; Bray et al., 2014; Abbott, Williams, & Volberg, 2004; Billi et al., 2014). Among those is, for example, the study of Bray et al., which aimed at examining naturalistic transitions in past-year gambling participation and identifying factors that might influence these transitions, using Markov modeling (Bray et al., 2014). The authors concluded that transition rates between gambling states (i.e. "gamblers" and "non-gamblers") were relatively stable over time from late adolescence into emerging adulthood. Another interesting study – The Victorian Gambling Study 2008–2012 – employed a Markov model too, with several objectives, including the investigation of the gambling pathways and their predictors (Billi et al., 2014). The Markov modeling-based approach provides with a way to describe and predict movement between different clinical status. Its scope is wide, with several applications (e.g. cost-effectiveness analysis or prognostic analysis) to different chronic diseases (e.g. HIV, cancer, renal transplantation or asthma) (Chen et al., 2016; Gillaizeau et al., 2015; Jahn et al., 2015; Mathews et al., 2014). Despite the obvious advantages of this dynamic method, it is more rarely used in the addictions field (Guillou Landreat et al., 2014; Mayet et al., 2011).

Thus, there is a literature void when it comes to discrete transitions in gambling behavior over time, particularly among adult gamblers. To our knowledge, no study has tried yet to clearly identify the risk or protective factors that could predict the transition from one state to another (i.e. "non-problem gambling" or "problem gambling") in a follow-up with more than two assessments. However, there are very few studies of the long-term evolution of gambling practice, even though this study design is the only one which can identify protective and risk factors for PG. Although these studies are particularly interesting for understanding the gambling trajectory, they have several limitations (for a detailed description, see the article of Challet-Bouju et al. (Challet-Bouju et al., 2014)), and they failed to demonstrate the correlates of key state changes in the gambling trajectory.

The aim of this study was to describe and examine transitions in past-year gambling behavior over three assessments, by estimating the prevalence of each state at each assessment as well as the rates of transitions from one state to another, and by examining the factors that may have influenced these transitions in the context of a predictive model.

2. Methods

2.1. Participants and data collection

The multicenter JEU cohort was established in 2009. It was designed to overcome the limitations of previous cohort studies on PG. Particular attention was paid to recruit enough participants in the initial groups that covered a wide variety of gamblers, to observe these rare changes. For this purpose, a longitudinal case–control cohort was designed, which was divided in two phases. Phase 1 aimed at constituting a large sample of gamblers: Non Problem Gamblers (NPG), be they occasional or regular gamblers, and Problem Gamblers (PG), be they without treatment (WT) or seeking treatment (ST) during previous 6 months. Three groups were initially formed: NPG (N = 251), PGWT (N = 169), and PGST (N = 203). Their mean "PG" DSM-IV scores were respectively 0.75/10 (+/−1.1), 5.2/10 (+/−1.2) and 6.5/10 (+/−1.9). This phase consisted of a baseline assessment. Phase 2 (still ongoing) is the key step of the study which aims at exploring, during a five year follow-up, the differential development of NPGs and PGs on the long course. An illustration of the study design is given in Fig. 1.

Data was collected in seven French Outpatient Addiction Treatment Centers, in gambling establishments and through the press, in order to obtain the broadest possible range of gambling severity levels and gambling activities. We were interested in a heterogeneous population which reflected the diversity of gamblers and could highlight transitions. Exclusion criteria included cognitive impairment and difficulties in reading and writing French. The local Research Ethics Committee approved this study, and all subjects provided written informed consent.

All participants underwent a semi-structured interview and completed self-report questionnaires. Well-trained and experienced staff members performed this assessment which took roughly two hours.

For the analysis presented here, we focused on data gathered during the enrollment phase and the two follow-up visits (12 and 24 months). Efforts were made to reduce the dropout rate, such as phone reminder calls and incentives (gift certificates). Due to financial constraints, only a part of the PGST was followed (namely those from the coordinating center).

The participants were categorized as follows, based on the DSM-IV Pathological Gambling section at inclusion:

- 251 NPGs (number of diagnostic criteria <3).
- 320 PGs (number of diagnostic criteria ≥3), including PGWTs (n = 156) and PGSTs (n = 164).

3. Measures

3.1. Socio demographic characteristics

We collected information about age, gender, marital status, graduation, professional activity, and income level.

3.2. Gambling characteristics

3.2.1. DSM-IV

Inclusion in the JEU cohort was determined by an interview based on the DSM-IV 10 diagnostic criteria for Pathological Gambling (APA, 1994). The presence of at least 5 DSM-IV diagnostic criteria is required to confirm the diagnosis of pathological gambling, but the presence of 3 or 4 criteria is enough to suggest an "at risk gambling" or "problem gambling". We used a non-standard threshold of 3 instead of 5 in order to include subclinical forms of PG, which could be considered as forms of "gambling abuse" similar to the notion of substance abuse. Previous literature supports the relevance of this categorization (Toneatto & Millar, 2004; Toce-Gerstein, Gerstein, & Volberg, 2003; Potenza, Maciejewski, & Mazure, 2006). Both pathological and problem gamblers require care, which explains the choice of the 3 criteria threshold.

3.2.2. Gambling habits

We collected information about the gambling course, the experience of abstinence for one month or more, and the self-perception of having gambling problems, over the previous year. The favorite type of game was identified according to the classification proposed by Boutin (Boutin, 2010) i.e. "*pure chance games*" (lottery games, slot machines,

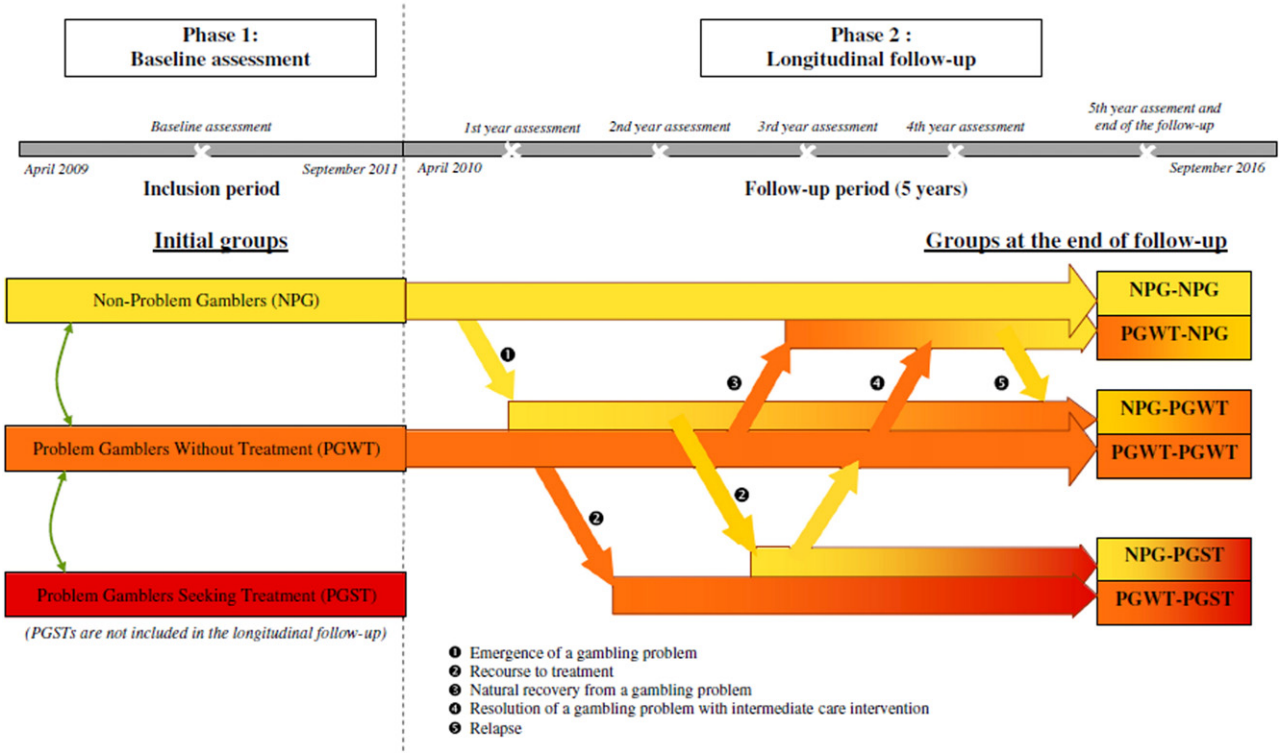

Fig. 1. JEU study design.

scratch cards, etc.), "*chance games with pseudo-skills*" (sports or horse-racing bets, black jack), "*chance games with elements of skills, but without the opportunity for long-term gains*" (poker including Texas Hold'em poker).

3.2.3. GABS

The Gambling Attitude and Beliefs Survey (GABS) is a 35-item self-report questionnaire, which assesses irrational beliefs and attitudes about gambling in a unidimensional perspective (Breen & Zuckerman, 1999). We used the shorter multidimensional version (GABS-23) (Bouju et al., 2013), which includes 5 dimensions: "strategies", "within-session chasing", "attitudes", "luck", and "emotions".

3.2.4. Ongoing treatment

Participants were asked if they had sought treatment for their gambling problems during the previous 6 months.

3.3. Clinical profile

3.3.1. MINI

The Mini International Neuropsychiatric Interview (MINI) is a short diagnostic structured interview that explores the main axis-I psychiatric disorders (as well as current risk of suicide and antisocial personality disorder) defined in the DSM. It includes an assessment of major anxiety disorders, mood disorders, addictive disorders and, to a lesser extent, psychotic syndrome (Lecrubier et al., 1997). Current comorbidities were taken into account.

3.3.2. WURS-C

The Wender-Utah Rating Scale-Child (WURS-C) is a self-report questionnaire that has been validated to evaluate in retrospect a childhood Attention Deficit Hyperactivity Disorder (ADHD) in adults. Its specificity (89.1%) is good. It is designed to assess ADHD symptoms represented by 25 items on 5-point Likert scales. The authors thought that a score greater than or equal to 46 /100 would allow the patient's diagnosis.

3.3.3. ASRS

The Adult ADHD Self-Report Scale (ASRS) is based on the 18 diagnostic criteria of the DSM-IV-TR (APA, 1994), scored according to their frequencies. We used the ASRS screener, which consists of 6 out of these 18 questions that were selected based on stepwise logistic regression to optimize concordance with the clinical classification (Kessler et al., 2005). Some authors concluded that the ASRS-v1.1 screener was a simple screening tool that was useful and had acceptable validity for the identification of ADHD among addicted patients (Daigre et al., 2009).

3.3.4. TCI −125

The shorter 125-item version of the Temperament and Character Inventory (TCI) is frequently used to rapidly assess personality traits (Cloninger, 1992). It measures seven dimensions through four temperaments and three characters. The dimensions related to temperament (genetic and stable tendencies of personality) were assessed only at baseline, whereas the dimensions related to character (acquired under the influence of apprenticeship, experience and environment) were assessed at all three assessment phases.

For more information, Challet-Bouju et al. presented the JEU cohort study design (Challet-Bouju et al., 2014).

4. Statistical analyses

4.1. Descriptive analysis of the cohort

All continuous variables are described in terms of means and standard deviations whereas qualitative variables are described in terms of percentages. The estimated proportion of each state at each assessment and the rates of transition from one state to another took dropouts into account.

The changes for each variable between the three assessments were estimated using a logistic or linear mixed model with a random effect

to transcribe the interdependence between the observations of each participant.

4.2. IPCW: inversed probability censoring weighted

Obtaining a complete follow-up on all subjects is difficult with longitudinal data. If the variable is informatively right censored, the obtained parameter estimations could be biased. To avoid this effect, we used the IPCW method. With this method, the weight of each observation is computed in order to give more weight to participants with dropout characteristics.

4.3. Markov model-based approach

The Markov model-based approach was used to examine longitudinal changes in gambling within individuals. This approach accommodates frequent discrete transitions between NPG and PG, which are our two qualitative states of interest and do not require modeling behavior as a smooth function of time. It provides with a way of describing movement between the two states. We worked on discrete times because we had no information on patient state between two assessments. We assumed that the transition probabilities were constant over time. As the observations were not independent, the effects of predictors were estimated via a jointed mixed-effect binomial logistic regression with a shared random effect. We performed univariate and multivariate analyses of the variables used in the model (type I error is set at 5%).

Analyses were conducted using Stata v13 (Stata Corp, College Station, Texas, 2014).

5. Results

5.1. Description of the participants at each assessment

The participants' socio-demographic characteristics at the three waves of assessment are presented in Table 1. Their gambling characteristics are shown in Table 2. Lastly, specific clinical characteristics, namely comorbid psychiatric or addictive disorders, and temperament and character dimensions, are described in Table 3.

5.2. Description of the dropouts

As shown in Fig. 2, 267 participants (47%) dropped out after the first wave of assessment and 89 participants (29%) after the second. We described the dropout population after Time 1 (i.e. assessed at the first two waves) and the non-dropout population after Time 1 (i.e. assessed at all 3 waves). Significant differences are shown in Table 4.

5.3. Description of the transitions

We analyzed the results of the participants who were assessed at least twice (304 participants, 51%).

The Fig. 2 illustrates both transitions from NPG to NPG or PG, and transitions from PG to PG or NPG, through the 3 waves of assessment.

Overall, 519 transitions were observed. The most represented gambling state was the NPG state, with 307 events versus 212 for the PG state. Transition from NPG to NPG was the most frequent (273 events, meaning 89% of observed transitions), whereas transition from NPG to PG was the rarest (34 events, meaning 11% of observed transitions). The rates of transition from PG to PG and from PG to NPG were each of 52% and 48%.

5.4. Analyses of transitions

The results are presented in Table 5.

The risk of transitioning from NPG to PG decreased for participants earning at least the minimum wage (OR = 0.16, p = 0.012), and for participants who experienced at least one month of gambling abstinence (OR = 0.11, p = 0.002), so these variables seemed to be protective factors against transition to problem gambling.

In contrast, the risk of transitioning from NPG to PG increased for participants with a current anxiety disorder (OR = 16.27, p = 0.003) or a history of ADHD in childhood (OR = 10.19, p = 0.011), as well as for those perceiving themselves as having a problem gambling (OR = 6.85, p = 0.013).

Similarly, this self-perception could predict that a PG would remain a PG (OR = 0.12, p = 0.009). The other risks of remaining PG were having symptoms consistent with a current ADHD (OR = 0.24, p = 0.037) and being aged 35 to 50 years (OR = 0.23, p = 0.029).

Finally, a PG with ongoing treatment was more likely to transit to NPG (OR = 18.15, p < 0.001).

6. Discussion

The aim of this study was to describe and examine transitions and to identify vulnerability factors that could predict transitions from one state to another (PG and NPG) in the context of a predictive model.

6.1. Transitions

In general, NPGs had a high stability from year to year, meaning that participants who reported no past-year gambling at Time t had a high probability of reporting no past-year gambling at Time t + 1.

On the opposite, we observed a high rate of transitions from PG to NPG, confirming the instability of the PG status over time and of the gambling trajectory, due to intra-individual variability (Bray et al., 2014; Slutske, 2006; Slutske, Jackson, & Sher, 2003). Even though this

Table 1
Description of the participants' socio-demographic characteristics at each wave of assessment.

Variable	TIME 0 n = 571		TIME 1 n = 304		TIME 2 n = 215		
	NA	Mean (sd) or n (percentage)	NA	Mean (sd) or n (percentage)	NA	Mean (sd) or n (percentage)	P-value**
Sex (% males)	0	383 (67%)	0	180 (59%)	0	125 (58%)	NC
Age (years)		43.7 (13.7)		47.0 (12.9)		47.6 (12.9)	NC
Age (by categories)							
18 to 35 years old	0	175 (31%)	0	63 (21%)	0	41 (19%)	NC
≥35 to 50 years old	0	176 (31%)	0	99 (33%)	0	72 (33%)	
≥50 years old	0	220 (38%)	0	142 (46%)	0	102 (48%)	
Marital status (% single, divorced, widowed)	1	286 (50%)	1	150 (49%)	1	100 (47%)	NC
Educational attainment (% ≤ 12 years)	2	270 (47%)	1	129 (42%)	1	97 (45%)	0.14
Work status (% without any job)	1	247 (43%)	1	24 (8%)	1	11 (5%)	<0.001
Level of income ≤ minimum wage	1	173 (30%)	4	81 (27%)	2	62 (29%)	0.18

NA: Not Available; NC: Not Converged; sd: Standard Deviation; *P-value for mixed logistic regression and mixed linear regression and multinomial logistic regression.

Table 2
Description of the participants' gambling characteristics at each wave of assessment.

Variable	Time 0 n = 571		Time 1 n = 304		Time 2 n = 215		
	NA	Mean (sd) or n (percentage)	NA	Mean (sd) or n (percentage)	NA	Mean (sd) or n (percentage)	P-value*
Age at the initiation of gambling	2	20.5 (10)	0	20.9 (9)	0	20.5 (9)	NC
Problem gambling perceived by the participant	1	312 (55%)	0	116 (38%)	3	60 (28%)	<0.01
Ongoing treatment	1	164 (29%)	8	47 (15%)	3	15 (7%)	<0.001
Gambling-free period > 1 month	4	350 (61%)	43	113 (37%)	8	89 (41%)	<0.001
Favorite type of game							
"pure chance games"	11	328 (57%)	3	195 (64%)	2	141 (66%)	NC
"chance games with pseudo-skills"		160 (28%)		77 (25%)		53 (25%)	
"chance games with elements of skills"		72 (13%)		29 (10%)		19 (9%)	
Usual medium of game							
Offline	49	459 (80%)	28	243 (80%)	20	173 (80%)	0.99
Online		63 (11%)		33 (11%)		22 (10%)	
GABS-23 total score	22	42.2 (18.5)	23	36.2 (19.4)	7	37.5(19.3)	<0.001
GABS "luck" score	21	36.8 (23.6)	22	32.9 (23.7)	7	35.7(24.6)	0.008
GABS "chasing" score	22	39.6 (26)	22	29.3 (24.5)	7	29.6(23.2)	<0.001
GABS "emotions" score	21	38.3 (25.3)	23	33.2 (23.6)	7	33.3(23.5)	<0.001
GABS "attitudes" score	21	52.1 (23.1)	22	52.2 (25.8)	7	52.9(24.8)	0.045
GABS "strategies" score	21	40.9 (25.5)	22	33.7 (24.4)	7	35.9(24.5)	<0.001
Bet money won	0	465 (81%)	23	205 (67%)	5	154 (72%)	0.006
Recouped bet money ≥ 50%	5	404 (71%)	25	186 (61%)	6	136 (63%)	0.24
Money spent in gambling ≥ 20%	18	241 (42%)	32	55 (18%)	4	35 (16%)	<0.001
Money spent in leisure ≥ 20%	55	292 (51%)	21	151 (50%)	6	100 (47%)	0.16

NA: Not Available; NC: Not Converged; sd: Standard Deviation; *P-value for mixed logistic regression and mixed linear regression and multinomial logistic regression.

result is in conflict with others studies which had showed that the rate of problem gambling remained stable over time (Winters et al., 2002; Billi et al., 2014), the study led by Billi et al. had found that 28.6% of PGs did not remain stable (Billi et al., 2014). Nevertheless, it is difficult to compare our results with other studies because of different approaches and populations.

6.2. Predictors

6.2.1. Predictors of remaining a NPG

Our results showed that earning at least the minimum wage, thus having a stable situation and being socioeconomically integrated, seemed to protect an NPG from transitioning to PG. Having a higher income can be now considered as a protective factor. Moreover, individuals with low income and thus financial pressure have an increased risk of getting into a gambling situation for they could expect to get money out of it, which had already been demonstrated in cross-sectional studies (e.g. (Costes et al., 2011)).

Furthermore, having experienced at least one month of abstinence in the previous year seemed to be a protective factor for NPGs. This suggests that we have to be vigilant regarding NPGs reporting no actual perception of gambling problems but being unable to report a significant period of abstinence in the previous year. This is reminiscent of WHO guidelines regarding alcohol use disorders, which recommendations for a "safe consumption of alcohol" suggest at least 1 day per week without alcohol. We could therefore discuss the interests of such a recommendation regarding gambling (like "one month per year without gambling").

Table 3
Description of the participants' clinical variables at each wave of assessment.

Variable	Time 0 n = 571		Time 1 n = 304		Time 2 n = 215		
	NA	Mean (sd) or n (percentage)	NA	Mean (sd) or n (percentage)	NA	Mean (sd) or n (percentage)	P-Value*
Comorbidities (MINI, WURS-C, ASRS)							
Current mood disorder	0	79 (14%)	0	16 (5%)	0	9 (4%)	<0.001
Suicide risk	0	138 (24%)		42 (14%)		36 (17%)	<0.001
Current anxiety disorder	0	102 (18%)	0	21 (7%)	1	19 (9%)	<0.001
Current substance or alcohol use disorder	0	121 (21%)	0	35 (12%)	0	28 (13%)	0.001
Eating disorder (AN and BN)	0	9 (2%)	0	0 (0%)	0	1 (0.5%)	NC
Psychotic syndrome	0	19 (3%)	0	5 (2%)	0	2 (1%)	0.083
ADHD							
ADHD in childhood	22	117 (20%)	3	30 (20%)	1	44 (18%)	0.86
Symptoms consistent with current ADHD	0	120 (21%)	0	61 (20%)	0	46 (21%)	0.83
Temperament and character (TCI)							
Reward dependence	25	59.7 (18.1)	4	60.4 (18.4)	1	61.2 (17.7)	NC
Novelty seeking	25	52.1 (18.0)	4	49.6 (17.9)	1	48.3 (18.0)	NC
Persistence	25	55.8 (28.8)	4	55.1 (29.2)	1	55.2 (29.0)	NC
Harm avoidance	25	45.0 (23.5)	4	45.6 (24.1)	1	44.8 (24.4)	NC
Self-directedness	25	67.5 (20.5)	21	73.3 (18.7)	6	73.7 (18.7)	<0.001
Cooperativeness	25	73.8 (15.6)	21	76.3 (14.7)	6	75.9 (14.9)	<0.001
Self-transcendence	25	34.5 (24.0)	21	33.0 (25.1)	6	32.6 (25.4)	<0.001

NA: Not Available; NC: Not Converged; sd: Standard Deviation; *P-value for mixed logistic regression and mixed linear regression and multinomial logistic regression; ADHD: Attention Deficit Hyperactivity Disorder; AN: Anorexia Nervosa; BN: Bulimia Nervosa.

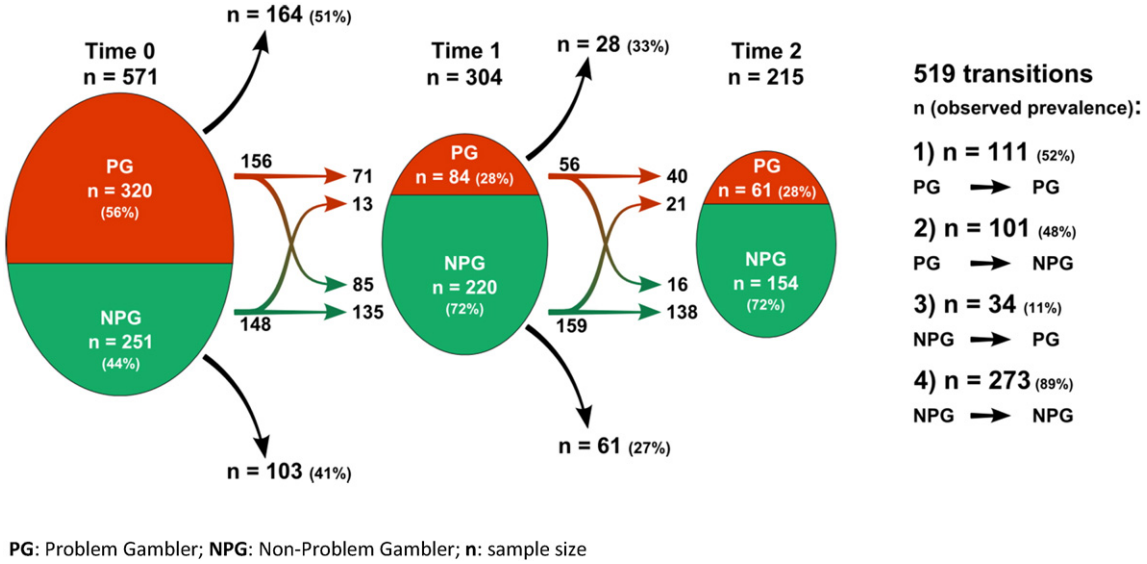

Fig. 2. Representation of the transitions between problem gambling and non problem gambling through the 3 waves of assessment PG: Problem Gambler; NPG: Non-Problem Gambler; n: sample size.

6.2.2. Predictors of transitioning from NPG to PG

A gambler which was characterized as "NPG" according to the DSM-IV, but who perceived his gambling practice as a problem, was more likely to become a PG. This highlighted the impact of the chosen DSM-IV threshold since a gambler could be considered as having an NPG practice while considering him/herself as having a PG practice, leading to a classification bias. This also showed the relevance of the DSM-5 in which the diagnostic threshold has been lowered from five to four criteria.

We found that a current anxiety disorder could be considered as a vulnerability factor for transitioning to PG. This supported the results of other studies which reported the extent to which anxiety disorders co-exist with other pathologies, particularly problem gambling, the last of which could arise from other long-term pathologies (Abdollahnejad, Delfabbro, & Denson, 2014).

In general, individuals with ADHD tend to be involved in a greater proportion of risky situations in their everyday lives (Groen et al., 2013). For instance, ADHD during childhood is a risk factor for nicotine, alcohol, marijuana, and cocaine use disorders and for gambling disorders later in life (Breyer et al., 2009; Lee et al., 2011), and is associated with factors of severity among PGs (Grall-Bronnec et al., 2011) as well as now a higher risk of transitioning from NPG to PG.

It seems relevant to look for gambling practices in people with current anxiety disorder or ADHD during childhood, to ensure that this practice would not become problematic later on.

6.2.3. Predictors of remaining a PG

Regarding the age groups, middle-aged participants (35 to 50 years old) were more likely to remain PGs than young adults (18 to 35 years old), although we were unable to highlight a significant difference concerning the 50 + age group. Considering age as a vulnerability factor for remaining a PG is supported by the concept of "natural recovery" (that is with no formal treatment) reported for late adolescence and emerging adulthood periods (Bray et al., 2014; Slutske et al., 2003).

It also seemed important to take into account gamblers' self-perception of their gambling practices, for a PG who perceived his/her gambling practice as a problem tended to have persistent gambling problems. Perhaps they suffered from a more severe disorder or have

Table 4
Significant differences between populations who did and did not drop out after Time 1 (T1).

Variable	Drop outs after T1 n = 89		No drop out after T1 n = 215		
	Mean (sd) or n (percentage)		Mean (sd) or n (percentage)		P-value*
Socio-demographic characteristics					
Work status (% active)	1	71 (83%)	0	208 (95%)	0.001
Gambling characteristics					
PG based on DSM-IV	0	27 (31%)	0	57 (26%)	0.30
GABS-23 score	12	32.3 (20.2)	11	37.6 (19.0)	0.043
GABS "luck" score	11	28.1 (23.4)	11	34.6 (27.7)	0.043
GABS "strategies" score	11	28.6 (24.5)	11	35.5 (24.2)	0.036
PG perceived by the participant	0	55 (64%)	0	61 (28%)	<0.001
Ongoing treatment	2	26 (30%)	0	22 (10%)	<0.001
TCI: Novelty seeking	1	53.1 (17.3)	1	48.3 (17.9)	0.037

NA: Not Available; sd: Standard Deviation; *P-value for student test or chi^2 test; PG: Problem Gambling.

Table 5
Predictors of transitions (multivariate model: a joint binomial regression weighted model with a shared random effect).

Variables	NPG-PG			
	Coefficient	OR	IC	P-value*
Level of income ≥ minimum wage	−1.80	0.16	[0.04–0.68]	0.012
Gambling-free period > 1 month	−2.17	0.11	[0.03–0.45]	0.002
Problem gambling perceived by participant	1.92	6.85	[1.49–31.39]	0.013
Current anxiety disorder	2.79	16.27	[2.58–102.45]	0.003
ADHD during childhood	−1.44	10.19	[1.71–60.73]	0.011
Variables	PG-NPG			
	Coefficient	OR	IC	P-value
Problem gambling perceived by participant	−2.15	0.12	[0.02–0.58]	0.009
35 < Age < 50 years old	−1.48	0.23	[0.06–0.86]	0.029
Ongoing treatment	2.90	18.15	[4.08–80.75]	<0.001
Symptoms consistent with current ADHD	−1.44	0.24	[0.06–0.92]	0.037

ADHD: Attention Deficit Hyperactivity Disorder; NPG: Non Problem gambler; OR: Odds Ratio; PG: Problem Gambler; Variance of the random effect: 3.95; [95% C.I.]: Confidence Interval of 95%.

been convinced that they were unable to solve their deep-rooted gambling problems.

Finally, our study highlighted the importance of looking for a potential psychiatric disorder and particularly a current ADHD among PGs seeking treatment, in order to treat it.

6.2.4. Predictors of transitioning from PG to NPG

Finally, we found that a PG with ongoing treatment is 1.9 times more likely to transit to NPG. This supported the efficacy of a treatment focusing on this particular addiction, so far confirmed by randomized clinical trials (Cowlishaw et al., 2012; Achab & Khazaal, 2011).

6.3. Drop outs

We had a significant number of dropouts. Participants who dropped out had lower GABS scores and an increased perception of their gambling problem, and they were mostly with an ongoing treatment. We may assume that the ongoing treatment (especially restructuring cognitive therapy focused on gambling related cognitions) mitigated the denial of the gambling disorder on the one hand, and had a significant and positive impact on the cognitive distortions on the other hand. They also presented with a high novelty-seeking score. Previous studies carried out among treatment-seeking PGs found quite similar results, with drop outs being characterized by impulsivity (Leblond, Ladouceur, & Blaszczynski, 2003) or sensation-seeking traits (Smith et al., 2010). Another one concluded that novelty seeking predicted poorer smoking cessation treatment retention among treatment-seeking smokers, i.e. another addicted population (Lopez-Torrecillas et al., 2014).

We must also keep in mind that the participants were assessed through 3 successive interviews at one-year intervals. Gamblers, *a fortiori* PGs, usually have a neurocognitive functioning marked by delay discounting, which describes a reinforcement value decline as the delay of that reinforcement increases (Madden et al., 2011). A shortened delay between two waves of assessment and/or the promise of a more valuable reward could improve the retention rate.

The potential impact of the drop outs on the results of the transitions' predictors could be an underestimation of the odds-ratio concerning the influence of the self-perception of having a problem gambling in the transition between NPG to PG, and of the odds-ratio concerning the influence of the ongoing treatment in the transition between PG to NPG. Our estimations of the prevalences and of the ORs may be biased. It is noteworthy that our large confidence intervals (95%) indicate a low precision and that we only estimated observed prevalences.

6.4. Strengths and weaknesses of the study

These results must be viewed in the context of several limitations. Firstly, we used several self-reports, which are a source of recall and social desirability bias, although this was reduced by standardized interviews and the complementary use of clinical face-to-face interviews. Our analyses were performed in the context of a predictive, therefore not etiologic, model. Furthermore, the ORs were estimated using the observed gambling problem prevalence depending on the participants' recruitment. Since mixing up the sample was an original method, between an epidemiological survey and a study among pathological gamblers seeking treatment, we remained cautious in generalizing findings to the whole population of gamblers.

However, these limits were compensated by the strength of the study. The Markov model allowed us to take into account repeated measures and a random shared effect, which we improved in our study by right censoring. We were also able to collect longitudinal data on gambling and psychiatric disorders, which is not always available.

7. Conclusion

In conclusion, this study provides important information about transitions in gambling behavior among a population of adult gamblers The PGs' status is unstable over time whereas we found stability among NPGs. According to our findings, being middle-aged and having a current ADHD may encourage the persistence of gambling problems. Moreover, current anxiety disorders, ADHD during childhood, and an unstable situation seem to be vulnerability factors for PGs. Therefore, we need to think about preventive actions and adaptive care for vulnerable people. Finally, it would be interesting to repeat these analyses when all five waves are completed.

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