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RESEARCH REPORT

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Impact of wagering inducements on the gambling behaviors of on-line gamblers: A longitudinal study based on gambling tracking data

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Abstract

Aims: To estimate whether the use of wagering inducements has a significant impact on the gambling behaviors of on-line gamblers and describe this temporal relation under naturalistic conditions.

Design: This longitudinal observational study is part of the second stage of the Screening for Excessive Gambling Behaviors on the Internet (EDEIN) research program.

Setting: Gambling tracking data from the French national on-line gambling authority (poker, horse race betting and sports betting) and from the French national lottery operator (lotteries and scratch games).

Participants: A total of 9306 gamblers who played poker, horse race or sports betting and 5682 gamblers who played lotteries and scratch games completed an on-line survey. The gender ratio was largely male (between 87.1% and 92.9% for poker, horse race betting and sports betting, and equal to 65.1% for lotteries). Median age ranged from 35 (sports betting) to 53 (horse race betting and lotteries).

Measurements: The survey used the Problem Gambling Severity Index (PGSI) to determine the status of the gamblers (at-risk or not). Gambling tracking data included weekly gambling intensity (wagers, deposits), gambling frequency (number of gambling days), proxies of at-risk gambling behaviors (chasing and breadth of involvement) and use of wagering inducements.

Findings: The use of wagering inducements was associated with an increase of gambling intensity [β between −0.06 (−0.08; −0.05) and 0.57 (0.54; 0.60)], gambling frequency [β between 0.12 (0.10; 0.18) and 0.29 (0.28; 0.31)] and at-risk gambling behaviors [odds ratio between 1.32 (1.16; 1.50) and 4.82 (4.61; 5.05)] at the same week of their use. This effect was stronger for at-risk gambling behaviors and at-risk gamblers.

Conclusions: Wagering inducements may represent a risk factor for developing or exacerbating gambling problems.

KEYWORDS
cross-correlations, gambling disorder, gambling tracking data, generalized linear mixed models, on-line gambling, wagering inducements

INTRODUCTION

Gambling is a widespread leisure activity that involves most of the population world-wide [1]. For a proportion of gamblers, estimated to be from 0.1 to 5.8%, gambling can be addictive and have severe negative consequences [1]. The internet has been consistently found to be associated with higher rates and increased severity of gambling problems [2–6]. In France, problem gambling has increased considerably since internet gambling was legalized in 2010 [7, 8]. At the same time, the internet presents a unique opportunity to monitor real-life gambling behaviors [9]. Indeed, the use of gambling tracking data (i.e. data extracted from user accounts, which are collected routinely by on-line gambling operators on a bet-by-bet basis) has been widely acclaimed in recent years in research into on-line gambling, given their ecological nature [10, 11].

Marketing strategies used by gambling operators include wagering inducements, which are gambling incentives provided by a gambling company to a gambler conditional upon certain gambling-related actions and/or distributed in a form that encourages gambling [12] (e.g. 'in case of a losing bet, you will be reimbursed'; the refunded money is generally within a predefined limit, paid into the game account and not eligible for a cashout). Little research has investigated the effects of wagering inducements on gambling behaviors [13, 14], and mainly focuses upon a marketing perspective [14]. A qualitative study demonstrated that gamblers interpret and respond to incentives differently according to their gender and age [15]. Another study highlighted that gamblers tend to underestimate the true cost of wagering inducements [16]. Wagering inducements are indeed often conceptualized as safety bets or free money, which may cause gamblers to change their gambling habits so they can obtain them [17].

According to several qualitative studies, wagering inducements may lead to impulse in-play betting patterns, especially for problem and frequent gamblers [18], increased risk-taking [19] and strong temptations to drop resolutions of controlled gambling in treatment-seeking gamblers [20]. Using an ecological momentary assessment (EMA) design, a study on almost 600 race and sports bettors reported that more frequent and more intense betting was associated with wagering advertisements and inducements [21]. This study did not allow for causal interpretation, given that changes in betting behavior are likely to influence exposure to certain forms of wagering advertisements and inducements. Recently, an experimental study performed on 171 on-line gamblers demonstrated that inducements had no effect on time spent gambling, but had an effect on the amount of money wagered, gambling-related expectancies and perceived loss of control [22]. However, the study was based on a single gambling session and a simulation of wagering inducement, which was not conditional upon certain gambling-related actions, as is the case in the real gambling environment. As a consequence, an exploration of the impacts of wagering inducements on gambling behaviors in real-life conditions is highly needed, and gambling tracking data may offer a unique opportunity to conduct such an investigation.

To our knowledge, no study has investigated the impacts of wagering inducements based on gambling tracking data. This could be explained by the difficulty for researchers to access to gambling tracking data, but also by several methodological problems (temporality of both events [21] and specific dispersion of gambling tracking data). Regarding the temporality of event, wagering inducements attribution may depend upon gambling behavior, while gambling behavior may be influenced by wagering inducements, leading to a close dynamic interrelation between these two events [22]. As a consequence, determining the time at which an inducement has the strongest effect on gambling behavior is an important preliminary step. Regarding the distribution of gambling tracking data, they fluctuate considerably over time for a given individual and zero values are largely over-represented in the data (i.e. frequently, gamblers do not gamble at all during a given period) [23]. Therefore, it is highly important to take into account zero-inflated distributions of gambling indicators.

In the present study, we hypothesized that the use of wagering inducements is followed by a change in gambling behavior (intensity, frequency and risky behaviors) that may occur quickly after the inducement has been obtained. We thus aimed to describe the temporal relation between wagering inducements and changes in gambling behavior and determine the time lag for which the inducement has the strongest effect on gambling behavior. Moreover, we hypothesized that the use of wagering inducements lead to an increase in gambling frequency, gambling intensity and the occurrence of at-risk gambling behaviors, i.e. episodes of chasing and higher involvement [23, 24]. We thus aimed to estimate whether the use of wagering inducements impacts gambling behavior and quantify this impact. Hypotheses were preregistered prior to calculating the results [25].

METHODS

Design

This longitudinal observational study is part of the second stage of the EDEIN (Screening for Excessive Gambling Behaviors on the Internet) research program [26].

Participants

The study participants were on-line gamblers who were recruited in two different ways. Indeed, until 2020, on-line gambling was regulated differently in France depending upon the type of gambling activity. The Regulatory Authority for On-line Gambling (Autorité de Régulation des Jeux En Ligne: ARJEL) regulated only gambling activities open to competition in the on-line gambling French market, i.e. poker, horse race betting and sports betting. In parallel, the national lottery operator (Française des Jeux: FDJ) acted as a monopoly for scratch games and lotteries (both lottery draws and daily lotteries) and was regulated separately. On-line casino games were forbidden in France before 2020 and still are. The data sets used for this study were extracted before 2020, so the two samples of on-line gamblers were generated based on the relative regulation applied.

First, a large random panel (n = 840 797) of on-line gamblers with an active gambling account (i.e. with at least one bet during the past 12 months) used for poker, horse race betting and sports betting were contacted by e-mail by the ARJEL in two successive waves (November 2015 and February 2016). The e-mail included information on the study and a link to an on-line survey hosted by the ARJEL. A total of 9306 gamblers responded to the survey and had actionable data, which represents a response rate of 1.11%.

Secondly, another random panel (n = 303 000) of on-line gamblers with an active account used for lotteries and scratch games were contacted by e-mail by the FDJ in July 2019. The e-mail included information on the study and a link to an on-line survey hosted by the University Hospital of Nantes. A total of 5682 gamblers responded to the survey and had actionable data, which represents a response rate of 1.88%.

For both responders' samples, data from the on-line surveys were merged by data providers (ARJEL and FDJ) with gambling tracking data at the individual level by using an encrypted identifier, with permission from the participants.

Measures

On-line survey

The content of the on-line survey was the same for gamblers in the two data sets. The participants were asked about their gambling habits: the types of on-line gambling activities they engaged in and distribution of gambling activity both on- and off-line.

The participants also responded to the Problem Gambling Severity Index (PGSI), which is a nine-item self-report questionnaire derived from the Canadian Problem Gambling Index [27]. The nine items are scored from 0 (never) to 3 (almost always), and the total score is computed as the sum of the nine items. According to the original scoring [27], a status can be derived from the total score in terms of the risk of gambling problems: non-problem gambler (score of 0), low-risk gambler (score of 1 or 2), moderate-risk gambler (score between 3 and 7) and excessive gambler (score greater or equal to 8). One limit of the PGSI is the threshold of the moderate-risk group, which was considered too low and was thought to produce high levels of false positives [28]. Thus, a different categorization was proposed: non-problem gambler (score of 0), low-risk gambler (score between 1 and 4), moderate-risk gambler (score between 5 and 7) and excessive gambler (score greater or equal to 8) [28]. In the present study, a score of 5 was used as the threshold to define an at-risk gambler (whether moderate-risk or excessive gambling). As in the original version, the reference period for the PGSI was the past 12 months.

Gambling tracking data

Data extracted from gambling accounts included the age and gender of gamblers and gambling tracking data for the 12 months preceding response to the on-line survey. Gambling tracking data were aggregated weekly by data providers before sending to the research team for analysis. Among all the data available, we selected five indicators of gambling behavior that were deemed to be representative of gambling intensity, gambling frequency and at-risk behaviors associated with gambling problems. Moreover, gambling tracking data included the number of bets for which a wagering inducement was used. A detailed description of the two data sets is given in the Supporting information, Table S1.

Gambling intensity was measured as the weekly cumulative amount of money wagered (available for each type of gambling) and the weekly cumulative amount of deposits made to the gambling account (cumulative across all types of gambling in each data set).

Gambling frequency was measured as the number of gambling days (i.e. days when the gambler placed at least one bet) in a given week for each type of gambling.

Finally, we used two indicators to measure at-risk gambling behaviors: the number of chasing episodes and breadth of involvement, which were previously identified as being able to distinguish non-problem and problem gamblers [23, 24]. The breadth of involvement was defined as the number of different games for which at least one bet was placed during the week. The number of games played ranged from none to 10 in the ARJEL data set and from none to three in the FDJ data set. The number of chasing episodes was defined as the number of times that money was deposited into the gambling account when the following criteria were met: three or more deposits within a 12-hour period and deposits made less than 1 hour after a bet was placed [26]. These two indicators were computed globally, regardless of the type of gambling.

Analyses

The analysis plan was pre-registered [29] and divided into two steps.

First, we performed a cross-correlation analysis [30, 31], which allows measurement of the association between two time-series (here,

the use of wagering inducements and gambling behaviors) as a function of the lag of one relative to the other. Analyses were performed separately for each gambling indicator and for each type of gambling whenever that was possible (see Supporting information, Appendix S1). Gamblers who used no inducement at all during the year and those who did not have any gambling activity or had activity with no variations during the year were excluded (because cross-correlations cannot be computed under those circumstances). In order to observe the effect of wagering inducements on gambling behaviors (and not the contrary), we did not include negative time lags. We hypothesized that an increase in gambling behavior may occur quickly after an inducement; thus, we limited our analysis to five time lags: 0 (gambling behavior during the same week as the use of the inducement), +1 (gambling behavior during the week following that of the use of the inducement) and so on, to +4 (gambling behavior during the week that occurred 4 weeks after that of the use of the inducement). The time lag for which the effect was the strongest was used in subsequent analyses as the lag of interest. Cross-correlations were performed using Stata software version 16.0.

Secondly, generalized linear mixed models (GLMMs) were implemented to test the strength of the association between the use of a wagering inducement and the five indicators of gambling behavior computed at the time lag of interest, and were applied to the whole sample (with no exclusion of gamblers). Random effects were included to take into account the repeated-data design. Analyses were performed separately for each indicator and for each type of gambling whenever that was possible. As we wanted to explore the differential impact of inducements on gamblers with or without gambling problems, we included the interaction between the PGSI status and inducement in the analyses. Moreover, the previous gambling behavior (i.e. during the week before the gambling outcome) is a strong predictor of future behavior and was thus included as a confounding factor in all analyses. The type of model to be used was adapted to the specific distribution of each indicator for each type of gambling (see Supporting information, Appendix S1 and Figures S1–S5). To deal with over-representation of zeroes, the number of chasing episodes and the breadth of involvement were transformed into binary variables (i.e. the presence of at least one episode of chasing or of at least two different games played during the week). Thus, GLMMs with a logit link were used for these two indicators. The other variables (money wagered, deposits and number of gambling days) were not transformed, and specific models were implemented to deal with the over-representation of zeros: (i) for the number of gambling days, GLMM with a log-linear link or zero-inflated Poisson (ZIP) models [32–34] were used and (ii) for the amount of money wagered and deposits, two-part mixed-effects models [35, 36] were used. *P*-values were adjusted for multiple testing with the Benjamini & Hochberg correction [37]. The GLMMs were run using R Studio software version 3.6.1 (packages 'lme4', 'glmmTMB' and 'GLMMadaptive').

The analysis code used is provided in the Open Science Framework project attached to this study [38].

RESULTS

Description of gamblers and gambling behaviors

As described in Table 1, gamblers engaged in sports betting and poker were younger than gamblers engaged in horse race betting and lotteries. The gender ratio was largely in favor of males, but to a lesser extent for gamblers that played lotteries. At-risk gambling was present

TABLE 1 Description of gamblers according to the type of gambling

	Gamblers engaged in sports betting, *n* = 5163	Gamblers engaged in horse race betting, *n* = 3524	Gamblers who play poker, *n* = 4858	Gamblers who play lotteries, *n* = 5682
Gender (*n*, %)				
Male	4795 (92.9%)	3068 (87.1%)	4392 (90.4%)	3698 (65.1%)
Female	320 (6.2%)	423 (12.0%)	401 (8.3%)	1984 (34.9%)
Missing data	48 (0.9%)	33 (0.9%)	65 (1.3%)	–
Age (median, minimum–maximum)	35 (18–94)	53 (18–96)	38 (18–96)	53 (18–99)
Risk category of the gambler (*n*, %)				
Non-problem gambler (score PGSI = 0)	1379 (26.7%)	1310 (37.2%)	1377 (28.3%)	3972 (70.0%)
Low-risk gambler (score PGSI between 1 and 4)	2581 (50.0%)	1551 (44.0%)	2432 (50.1%)	1502 (26.4%)
Moderate-risk gambler (score PGSI between 5 and 7)	579 (11.2%)	327 (9.3%)	493 (10.1%)	144 (2.5%)
Excessive gambler (score PGSI greater or equal to 8)	624 (12.1%)	336 (9.5%)	556 (11.5%)	64 (1.1%)
PGSI status (*n*, %)				
At-risk gambler (PGSI ≥ 5)	1203 (23.3%)	663 (18.8%)	1049 (21.6%)	208 (3.7%)

PGSI = Problem Gambling Severity Index.

TABLE 2 Description of the five indicators of gambling behavior and use of wagering inducements depending on the type of gambling (when possible)

Indicators	Gambling type	Number of observations[a]	% Zero values	Minimum	Maximum	Q1	Q2	Q3	P90	P95	P99
At least one wagering inducement used (binary)	Sports betting	483 912	97.5								
	Horse race betting	483 912	97.8								
	Poker	483 912	94.8								
	Lottery	295 464	97.9								
Amount of money wagered (quantitative)	Sports betting	483 912	82.2	0	157 430	0	0	0	23	103	759
	Horse race betting	483 912	78.3	0	30 214	0	0	0	38	123	724
	Poker	483 912	72.1	0	155 246	0	0	0.1	82	278	1946
	Lottery	295 464	39.6	0	2903	0	5	15	34	57	178
Number of gambling days (count)	Sports betting	483 912	81.8	0	7	0	0	0	2	5	7
	Horse race betting	483 912	81.4	0	7	0	0	0	4	6	7
	Poker	483 912	83.2	0	7	0	0	0	2	5	7
	Lottery	295 464	39.4	0	7	0	1	2	3	5	6
Amount of deposits (quantitative)	Sports betting + horse race betting + poker	483 912	75.7	0	14 645	0	0	0	62	150	540
	Lottery	295 464	71.0	0	1735	0	0	10	25	45	107
At least one chasing episode (binary)	Sports betting + horse race betting + poker	483 912	91.3								
	Lottery	295 464	96.1								
Involvement (at least two different games played) (binary)	Sports betting + horse race betting + poker	483 912	76.5								
	Lottery	295 464	88.4								

Q1 = first quartile; Q2 = median; Q3 = third quartile; P90 = 90th percentile; P95 = 95th percentile; P90 = 99th percentile.

[a]The number of observations corresponds to the number of weeks observed for the total sample available for each indicator. For example, the Autorité de Régulation des Jeux En Ligne (ARJEL) data set includes 9306 gamblers, which corresponds to 9306 × 52 = 483 912 observations.

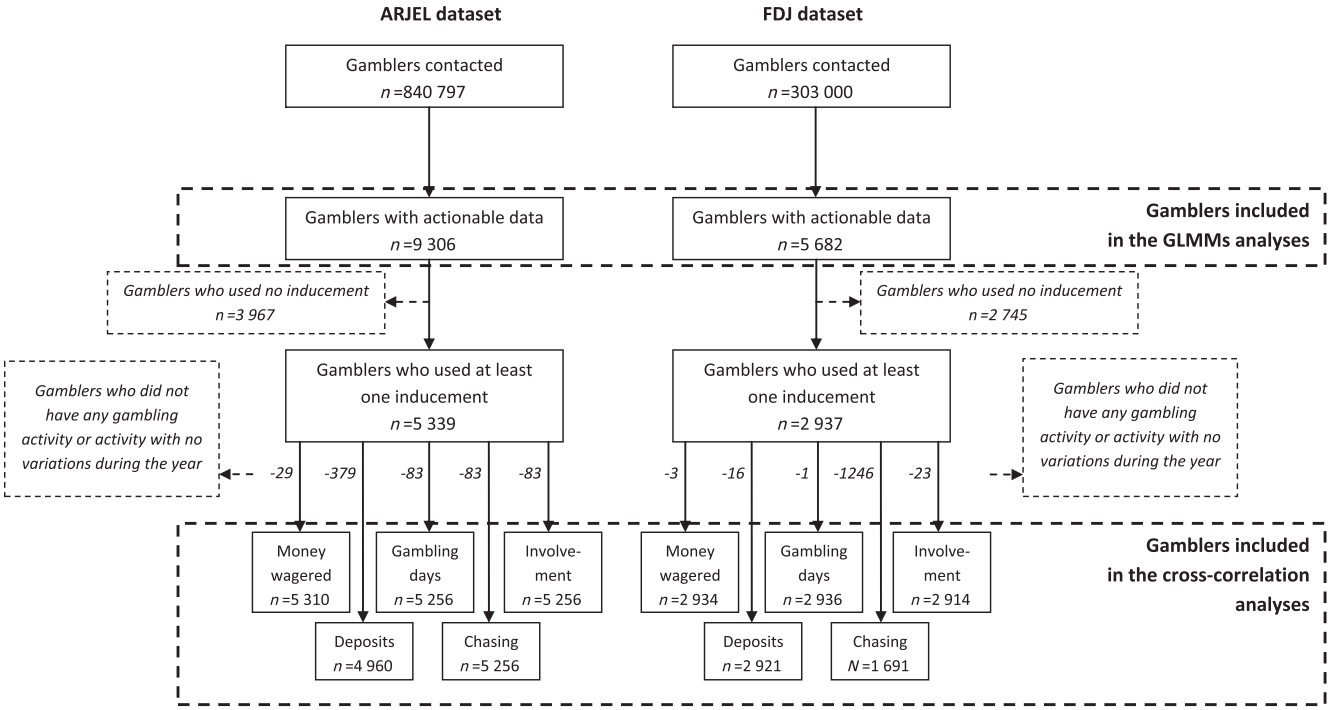

FIGURE 1 Flow-chart of the gamblers included in cross-correlations and generalized linear mixed-models (GLMMs) analyses

for approximately 20% of the gamblers engaged in sports betting, horse race betting and poker and 3.7% of gamblers playing lotteries.

As shown in Table 2, inducements were used only in 2–5% of observations, and there was a large over-representation of zeros for the five indicators due to inactive weeks. A flow-chart of the participants included in each analysis is provided in Figure 1.

Cross-correlations

The results of the cross-correlation analysis are depicted in Figure 2a–e. The effect of wagering inducements seemed to be the strongest for sports betting and poker, regardless of the indicator. For lotteries, the effect was close to zero for the deposit and chasing indicators, which indicates either no or a weak association between the use of wagering inducements and those two indicators. For the other conditions (other gambling types for the deposit and chasing indicators and other indicators regardless of the gambling type), an effect of wagering inducements was observed, with positive correlations ranging from 0.01 to 0.39. The effect was the strongest for lag0, seems to partly maintain at lag+1 and then quickly decreased for subsequent weeks.

GLMMs

Lag0 was employed as the time lag of interest for GLMMs. In addition, we included results at lag+1 as an illustration of the temporal relationship between events (i.e. effect of wagering inducements on gambling behaviors, and not the contrary). The results are provided in Table 3a–e.

Notably, the status of the gambler (PGSI ≥ 5) had the largest effect on the chasing and involvement indicators, which confirms that they are good proxies of gambling problems compared to intensity or frequency of gambling.

Wagering inducements were associated with a significant change of all indicators for all types of gambling at lag0, which mainly persists, even if lower, at lag+1. The precisions of the estimated effects, either inducements' effects or the interaction with PGSI status, were good, as the confidence intervals were tightened around the predicted value.

The use of inducements seems to be associated with a weak change in gambling intensity and frequency (effects of less than €1 for money wagered and deposits and less than 0.3 gambling days), even for at-risk gamblers. Conversely, it seems to be associated with a higher change in at-risk gambling behaviors, especially for sports betting, horse race betting and poker. Except for lotteries, the interaction inducement × PGSI ≥ 5 was significant for all indicators, with a stronger effect of inducement for participants with gambling problems (PGSI ≥ 5).

DISCUSSION

This study aimed to investigate the impact of wagering inducements on the gambling behaviors of on-line gamblers by describing the

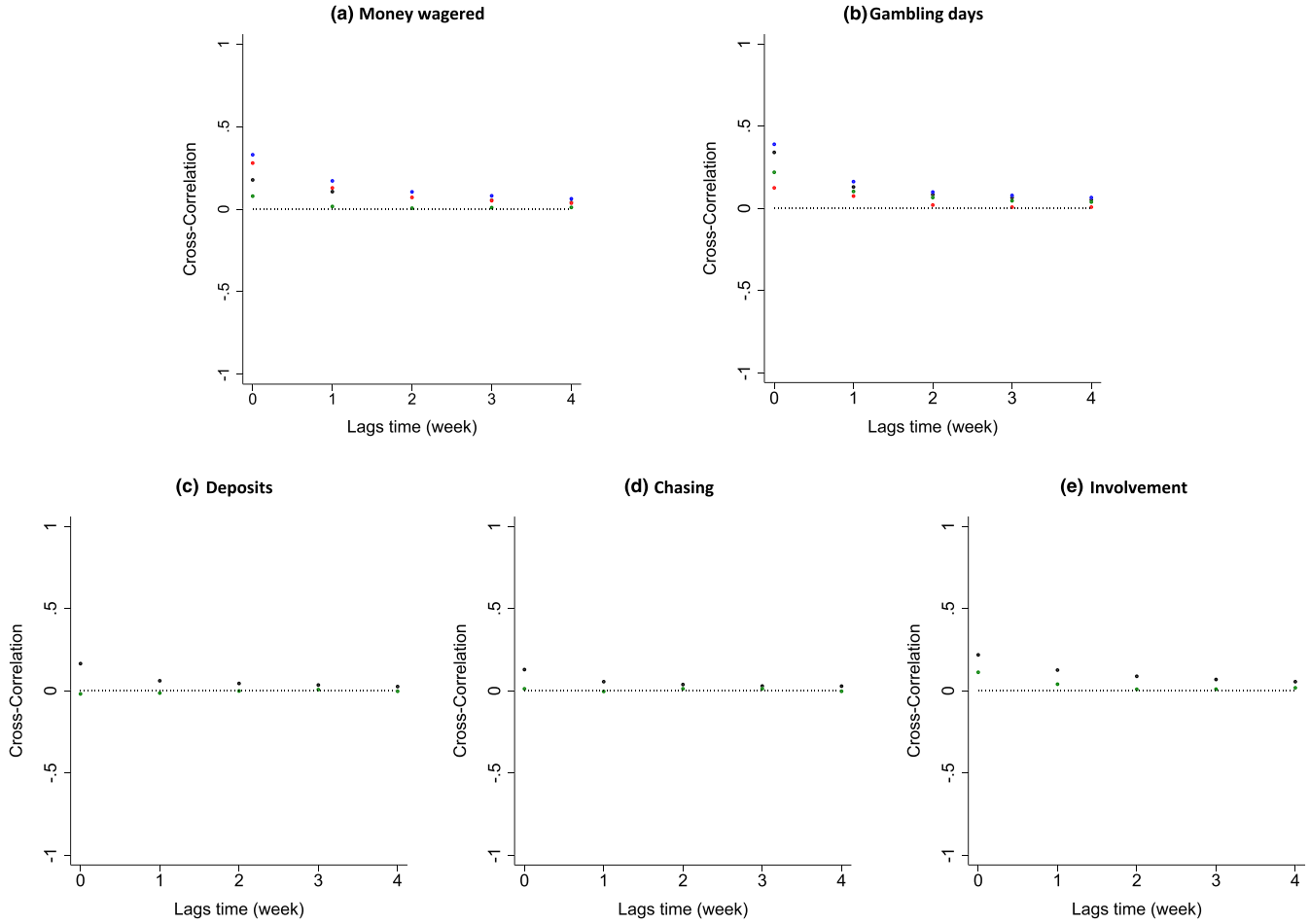

FIGURE 2 Results of the cross-correlations for the five indicators of gambling behavior

temporal relation between these two variables and quantifying this impact.

The socio-demographic characteristics of the two samples were similar to the source population described in the 2017 French prevalence survey dedicated only to on-line gambling [39]. Indeed, gamblers engaged in sports betting and poker were younger than others. Moreover, there was a global predominance of males in the two data sets. The highest proportion of females was found for lotteries, which is well known, as pure chance games are more appealing to females than skill-based games [23, 24, 40].

The effect of wagering inducements on gambling behaviors seems to occur in the same week as their use, to maintain partly after 1 week and then to quickly decrease during subsequent weeks. This result is consistent with the EMA study, which reported an effect of inducements on intended and actual betting using a 24/48-hour interval between surveys to conform to a weekly schedule [21].

The effect of wagering inducements on gambling behaviors was demonstrated for all types of gambling and all indicators with good accuracy of the estimated effects, but the strength of the effect varied. Indeed, the intensity and frequency of gambling were little impacted by the use of inducements when controlling for previous gambling behavior. On the contrary, inducements were associated with a large increase in at-risk gambling behaviors for gamblers engaged in sports betting, horse race betting and poker and, to a lesser extent, lotteries. Even if chasing episodes are quite rare events in the gambling activity of on-line gamblers [23, 24], the probability of engaging in such behaviors is multiplied by more than three times for non-at-risk gamblers engaged in sports betting, horse race betting and poker and up to 4.63 times for at-risk gamblers. The increase in the probability of the occurrence of a chasing episode was smaller [odds ratio (OR) = 1.32] for lotteries, with no difference between at-risk and non-at-risk gamblers. This result is all the more worrying, because

TABLE 3 Results of the modeling of the association between the use of a wagering inducement and the five indicators of gambling behavior at week 0 (lag time of interest) and lag+1 (persisting effects)

(a) Money wagered (two-part mixed-effects models)

		Effect at lag 0				Effect at lag+1			
		Excess of zeros (GLMMs with a logit link)		Values except excess of zeros (linear mixed-model)		Excess of zeros (GLMMs with a logit link)		Values except excess of zeros (linear mixed-model)	
Type of gambling	Effects	OR (CI 95%)	Adjusted *P*-value	β (CI 95%)	Adjusted *P*-value	OR (CI 95%)	Adjusted *P*-value	β (CI 95%)	Adjusted *P*-value
Sports betting	Inducement	0.05 (0.00; 0.11)	**< 0.001**	0.19 (0.16; 0.23)	**< 0.001**	0.11 (0.06; 0.17)	**< 0.001**	0.19 (0.15; 0.22)	**0.002**
	PGSI ≥ 5	0.78 (0.76; 0.80)	**< 0.001**	−0.16 (−0.17; −0.15)	**< 0.001**	0.76 (0.74; 0.78)	**< 0.001**	−0.18 (−0.23; −0.13)	**0.002**
	Inducement × PGSI ≥ 5	1.08 (0.95; 1.21)	0.227	0.12 (0.06; 0.18)	**< 0.001**	1.78 (1.67; 1.89)	**< 0.001**	0.02 (−0.04; 0.08)	0.570
	Previous behavior	0.98 (0.98; 0.99)	**< 0.001**	0.00 (−0.56; 0.56)	**< 0.001**	0.98 (0.98; 0.98)	**< 0.001**	0.00 (−0.00; 0.00)	0.260
Horse race betting	Inducement	0.02 (0.00; 0.14)	**< 0.001**	0.41 (0.38; 0.44)	**< 0.001**	0.13 (0.05; 0.21)	**< 0.001**	0.16 (0.08; 0.20)	**0.002**
	PGSI ≥ 5	1.97 (1.94; 2.00)	**< 0.001**	0.56 (0.30; 0.82)	**< 0.001**	1.83 (1.80; 1.85)	**< 0.001**	0.39 (0.36; 0.64)	**0.004**
	Inducement × PGSI ≥ 5	0.50 (0.25; 0.75)	**< 0.001**	0.09 (0.03; 0.16)	**0.006**	2.89 (2.70; 3.07)	**< 0.001**	−0.03 (−0.21; 0.04)	0.403
	Previous behavior	0.96 (0.96; 0.96)	**< 0.001**	0.00 (0.00; 0.00)	**< 0.001**	0.96 (0.96; 0.96)	**< 0.001**	0.00 (0.00; 0.01)	**0.002**
Poker	Inducement	0.04 (0.00; 0.10)	**< 0.001**	0.57 (0.54; 0.60)	**< 0.001**	0.10 (0.05; 0.15)	**< 0.001**	0.28 (0.26; 0.32)	**0.002**
	PGSI ≥5	1.23 (1.21; 1.25)	**< 0.001**	0.50 (0.33; 0.68)	**< 0.001**	1.17 (1.15; 1.19)	**< 0.001**	−0.01 (−0.16; 0.15)	0.937
	Inducement × PGSI ≥ 5	0.73 (0.59; 0.87)	**< 0.001**	0.20 (0.14; 0.25)	**< 0.001**	1.45 (1.35; 1.54)	**< 0.001**	0.03 (−0.02; 0.09)	0.333
	Previous behavior	0.99 (0.97; 0.99)	**< 0.001**	0.00 (−0.00; 0.00)	**< 0.001**	0.99 (0.99; 0.99)	**< 0.001**	0.00 (0.00; 0.00)	**0.002**
Lotteries	Inducement	0.15 (0.05; 0.25)	**< 0.001**	−0.06 (−0.08; −0.05)	**< 0.001**	0.56 (0.49; 0.62)	**< 0.001**	−0.03 (−0.09; −0.01)	**0.002**
	PGSI ≥ 5	1.14 (1.10; 1.19)	**< 0.001**	−0.80 (−1.04; −0.58)	**< 0.001**	1.14 (1.10; 1.19)	**< 0.001**	−0.12 (−0.16; 0.12)	0.327
	Inducement × PGSI ≥ 5	0.74 (0.17; 1.32)	0.311	0.02 (−0.06; 0.10)	0.634	0.97 (0.64; 1.30)	**< 0.001**	−0.10 (−0.44; 0.79)	**0.032**
	Previous behavior	0.74 (0.74; 0.74)	**< 0.001**	0.01 (0.01; 0.01)	**< 0.001**	0.98 (0.98–0.98)	0.849	0.01 (0.01; 0.01)	**0.002**

(b) Gambling days (GLMMs with a log–linear link or zero-inflated Poisson (ZIP) models)

		Effect at lag 0				Effect at lag +1			
ZIP models		Excess of zeros (GLMMs with a logit link)		Values except excess of zeros (GLMMs with a log-linear link)		Excess of zeros (GLMMs with a logit link)		Values except excess of zeros (GLMMs with a log-linear link)	
Type of gambling	Effects	OR (CI 95%)	*P*-value	β (CI 95%)	*P*-value	OR (CI 95%)	*P*-value	β (CI 95%)	*P*-value
Sports betting	Inducement	0.17 (0.10; 0.27)	**< 0.001**	0.12 (0.10; 0.18)	**0.002**	1.45 (1.42; 1.60)	**< 0.001**	0.04 (0.02; 0.05)	**< 0.001**
	PGSI ≥ 5	0.76 (0.52; 0.96)	**< 0.001**	0.57 (0.35; 0.89)	**0.002**	0.89 (0.83; 0.93)	**< 0.001**	0.47 (0.35; 0.59)	**< 0.001**
	Inducement × PGSI ≥ 5	0.99 (0.86; 1.26)	0.479	−0.45 (−0.89; 0.56)	0.512	1.11 (1.11; 1.37)	0.450	−0.03 (−0.06; −0.01)	**0.011**
	Previous behavior	0.87 (0.71; 0.97)	**< 0.001**	0.17 (0.14; 0.19)	**0.002**	0.11 (−0.15; 0.16)	**< 0.001**	0.11 (0.10; 0.11)	**< 0.001**

(Continues)

TABLE 3 (Continued)

(b) Gambling days (GLMMs with a log–linear link or zero-inflated Poisson (ZIP) models)

ZIP models		Effect at lag 0				Effect at lag +1			
		Excess of zeros (GLMMs with a logit link)		Values except excess of zeros (GLMMs with a log-linear link)		Excess of zeros (GLMMs with a logit link)		Values except excess of zeros (GLMMs with a log-linear link)	
Type of gambling	**Effects**	**OR (CI 95%)**	***P*-value**	**β (CI 95%)**	***P*-value**	**OR (CI 95%)**	***P*-value**	**β (CI 95%)**	***P*-value**
Horse race betting	Inducement	0.21 (0.00; 0.35)	**< 0.001**	0.16 (0.12; 0.17)	**0.002**	2.01 (1.78; 2.23)	**< 0.001**	0.04 (0.03; 0.06)	**0.002**
	PGSI ≥ 5	1.25 (1.13; 1.47)	**< 0.001**	−0.21 (−0.53; 0.17)	0.598	1.18 (0.99; 1.37)	**< 0.001**	−0.10 (−0.37; 0.17)	0.474
	Inducement × PGSI ≥ 5	1.09 (0.66; 1.44)	0.570	−0.01 (−0.05; 1.02)	0.602	0.98 (0.57; 1.40)	0.931	−0.05 (−0.09; −0.01)	**0.009**
	Previous behavior	0.25 (0.07; 0.46)	**< 0.001**	0.02 (0.02; 0.03)	**0.002**	0.08 (0.00; 0.16)	**< 0.001**	0.09 (0.08; 0.09)	**0.002**
Poker	Inducement	0.13 (0.05; 0.22)	**0.002**	0.17 (0.16; 0.18)	**0.002**	0.40 (0.32; 0.48)	**< 0.001**	−0.01 (−0.02; 0.01)	0.201
	PGSI ≥ 5	1.07 (1.02; 1.11)	**0.007**	0.08 (−0.10; 0.25)	0.376	1.02 (0.98; 1.06)	0.372	0.18 (0.02; 0.33)	**0.037**
	Inducement × PGSI ≥ 5	0.91 (0.74; 1.07)	0.232	0.02 (−0.01; 0.04)	0.376	0.87 (0.72; 1.01)	0.073	−0.05 (−0.08; −0.02)	**0.002**
	Previous behavior	0.20 (0.16; 0.24)	**0.002**	0.12 (0.11; 0.12)	**0.002**	0.20 (0.17; 0.23)	**< 0.001**	0.12 (0.12; 0.12)	**0.002**
	GLMMs with a log-linear link					GLMMs with a log-linear link			
				β (CI 95%)	*P*-value			β (CI 95%)	*P*-value
Lotteries	Inducement			0.29 (0.28; 0.31)	**< 0.001**			0.15 (0.13; 0.17)	**< 0.001**
	PGSI ≥ 5			0.32 (0.18; 0.45)	**< 0.001**			0.31 (0.17; 0.44)	**< 0.001**
	Inducement × PGSI ≥ 5			−0.03 (−0.11; 0.06)	0.546			−0.00 (−0.09; 0.08)	0.941
	Previous behavior			0.15 (0.15; 0.15)	**< 0.001**			0.15 (0.15; 0.15)	**< 0.001**

(c) Deposits (two-part mixed-effects models)

		Effect at lag 0				Effect at lag+1			
		Excess of zeros (GLMMs with a logit link)		Values except excess of zeros (linear mixed-model)		Excess of zeros (GLMMs with a logit link)		Values except excess of zeros (linear mixed-model)	
Type of gambling	**Effects**	**OR (CI 95%)**	**Adjusted *P*-value**	**β (CI 95%)**	**Adjusted *P*-value**	**OR (CI 95%)**	**Adjusted *P*-value**	**β (CI 95%)**	**Adjusted *P*-value**
Sports betting/horse race betting/poker	Inducement	0.28 (0.27; 0.29)	**< 0.001**	0.15 (0.13; 0.16)	**< 0.001**	0.44 (0.41; 0.54)	**< 0.001**	0.03 (0.01; 0.05)	**< 0.001**
	PGSI ≥ 5	0.52 (0.50; 0.55)	**< 0.001**	−1.16 (−1.29; −1.03)	**< 0.001**	0.51 (0.50; 1.01)	**< 0.001**	−0.10 (−0.25; 0.06)	0.181
	Inducement × PGSI ≥ 5	0.74 (0.74; 0.74)	**< 0.001**	0.10 (0.08; 0.13)	**< 0.001**	0.94 (0.89; 0.97)	**0.011**	0.09 (0.07; 0.12)	**< 0.001**
	Previous behavior	0.99 (0.97; 1.01)	**< 0.001**	0.00 (0.00; 0.01)	**< 0.001**	0.99 (0.99; 0.99)	**< 0.001**	0.00 (−0.00; 0.00)	**< 0.001**

(Continues)

TABLE 3 (Continued)

(c) Deposits (two-part mixed-effects models)

		Effect at lag 0				Effect at lag+1			
		Excess of zeros (GLMMs with a logit link)		Values except excess of zeros (linear mixed-model)		Excess of zeros (GLMMs with a logit link)		Values except excess of zeros (linear mixed-model)	
Type of gambling	Effects	OR (CI 95%)	Adjusted *P*-value	β (CI 95%)	Adjusted *P*-value	OR (CI 95%)	Adjusted *P*-value	β (CI 95%)	Adjusted *P*-value
Lotteries	Inducement	1.00 (0.95; 1.06)	0.917	−0.05 (−0.07; −0.03)	**< 0.001**	0.84 (0.78; 0.90)	**< 0.001**	−0.02 (−0.04; −0.01)	**0.020**
	PGSI ≥ 5	0.56 (0.52; 0.60)	**0.002**	−1.17 (−1.48; −0.86)	**< 0.001**	0.56 (0.52; 0.60)	**< 0.001**	−0.95 (−1.35; −0.56)	**0.002**
	Inducement × PGSI ≥ 5	0.79 (0.53; 1.05)	0.108	−0.02 (−0.09; 0.06)	0.672	0.37 (0.11; 0.63)	0.134	−0.06 (−0.13; 0.02)	0.139
	Previous behavior	0.99 (0.99; 0.99)	**0.002**	0.00 (−0.00; 0.00)	**< 0.001**	0.99 (0.99; 0.99)	**< 0.001**	0.00 (−0.00; 0.01)	**0.002**

(d) Chasing (GLMMs with a logit link)

		Effect at lag 0		Effect at lag +1	
Type of gambling	Effects	OR (CI 95%)	Adjusted *P*-value	OR (CI 95%)	Adjusted *P*-value
Sports betting/horse race betting/poker	Inducement	3.31 (3.16; 3.47)	**< 0.001**	1.61 (1.56; 1.66)	**< 0.001**
	PGSI ≥ 5	6.45 (5.71; 7.28)	**< 0.001**	6.27 (6.14; 6.40)	**< 0.001**
	Inducement × PGSI ≥ 5	1.32 (1.22; 1.43)	**< 0.001**	0.86 (0.78; 0.94)	**< 0.001**
	Previous behavior	2.61 (2.53; 2.69)	**< 0.001**	2.64 (2.61; 2.67)	**< 0.001**
Lotteries	Inducement	1.32 (1.16; 1.50)	**< 0.001**	1.08 (0.95; 1.22)	0.332
	PGSI ≥ 5	3.78 (2.26; 6.33)	**< 0.001**	3.75 (3.21; 4.28)	**0.002**
	Inducement × PGSI ≥ 5	1.25 (0.79; 1.97)	0.346	1.27 (1.20; 1.33)	0.336
	Previous behavior	1.42 (1.33; 1.51)	**< 0.001**	1.44 (0.96; 1.91)	**0.002**

(e) Involvement of GLMMs with a logit link

		Effect at lag 0		Effect at lag+1	
Type of gambling	Effects	OR (CI 95%)	Adjusted *P*-value	OR (CI 95%)	Adjusted *P*-value
Sports betting/horse race betting/poker	Inducement	4.82 (4.61; 5.05)	**< 0.001**	1.47 (1.43; 1.52)	**< 0.001**
	PGSI ≥ 5	2.68 (2.33; 3.09)	**< 0.001**	2.00 (1.88; 2.12)	**< 0.001**
	Inducement × PGSI ≥ 5	1.31 (1.20; 1.43)	**< 0.001**	1.01 (0.93; 1.09)	0.869
	Previous behavior	8.28 (8.10; 8.46)	**< 0.001**	8.43 (8.41; 8.45)	**< 0.001**
Lotteries	Inducement	1.99 (1.84; 2.15)	**< 0.001**	1.40 (1.32; 1.47)	**< 0.001**
	PGSI ≥ 5	6.82 (4.30; 10.83)	**< 0.001**	3.89 (3.42; 4.36)	**< 0.001**
	Inducement × PGSI ≥ 5	1.24 (0.89; 1.73)	0.213	1.95 (1.60; 2.29)	**0.024**
	Previous behavior	1.85 (1.78; 1.92)	**< 0.001**	1.49 (1.45; 1.53)	**< 0.001**

(a) Lag0: When a gambler with a PGSI score < 5 uses a wagering inducement in a specific week, the money wagered during that same week on sports betting, horse race betting and poker increases by €0.19, €0.41 and €0.57, respectively, compared to €0.31, €0.50 and €0.77, respectively, for gamblers with a PGSI score ≥ 5. When a gambler (whatever the PGSI status) uses a wagering inducement in a specific week, the money wagered during that same week on lotteries decreases by €0.06.
Lag+1: When a gambler (whatever the PGSI status) uses a wagering inducement in a specific week, the money wagered during the following week on sports betting, horse race betting and poker increases by €0.19, €0.16 and €0.28, respectively, and decreases by €0.03 for lotteries.
(b) Lag0: When a gambler (whatever the PGSI status) uses a wagering inducement during a specific week, the number of gambling days on sports betting, horse race betting, poker and lotteries increases by 0.12, 0.16, 0.17 and 0.29, respectively, during the same week.
Lag+1: When a gambler with a PGSI score < 5 uses a wagering inducement during a specific week, the number of gambling days on sports betting increases by 0.04 during the following week, compared to 0.01 for gamblers with a PGSI score ≥ 5.
When a gambler (whatever the PGSI status) uses a wagering inducement during a specific week, the number of gambling days on horse race betting and lotteries increases by 0.04 and 0.15, respectively, during the following week.
There was no effect of the use of the wagering inducement on the number of gambling days during the following week for poker.
(c) Lag0: When a gambler with a PGSI score < 5 uses a wagering inducement during a specific week, the amount of the deposits during the same week increase by €0.15 for gamblers in the ARJEL data set (i.e. sports betting, horse race betting, poker), compared to €0.25 for gamblers with a PGSI score ≥ 5.
When a gambler (whatever the PGSI status) uses a wagering inducement during a specific week, the amount of the deposits during the same week decreases by €0.05 for gamblers in the FDJ data set (i.e. lotteries).
Lag+1: When a gambler (whatever the PGSI status) uses a wagering inducement during a specific week, the amount of the deposits during the following week increase by €0.03 for gamblers in the ARJEL data set (i.e. sports betting, horse race betting, poker) and decreases by €0.02 for gamblers in the FDJ data set (i.e. lotteries).
(d) Lag0: When a gambler in the ARJEL data set (i.e. sports betting, horse race betting, poker) with a PGSI score < 5 uses a wagering inducement during a specific week, the probability of a chasing episode during the same week increases by 3.31 times, compared to 4.63 times for gamblers with a PGSI score ≥ 5.
When a gambler in the FDJ data set (i.e. lotteries) (whatever the PGSI status) uses a wagering inducement during a specific week, the probability of a chasing episode during the same week increases by 1.32 times.
Lag+1: When a gambler in the ARJEL data set (i.e. sports betting, horse race betting, poker) with a PGSI score < 5 uses a wagering inducement during a specific week, the probability of a chasing episode during the following week increases by 1.61 times, compared to 2.47 times for gamblers with a PGSI score ≥ 5.
There was no effect of the use of the wagering inducement on the occurrence of a chasing episode during the following week for lotteries.
(e) Lag0: When a gambler in the ARJEL data set (i.e. sports betting, horse race betting, poker) with a PGSI score < 5 uses a wagering inducement during a specific week, the probability of playing at least two different games during the same week increases by 4.82 times, compared to 6.13 times for gamblers with a PGSI score ≥ 5.
When a gambler in the FDJ data set (i.e. lotteries) (whatever the PGSI status) uses a wagering inducement during a specific week, the probability of playing at least two different games during the same week increases by 1.99 times.
Lag+1: When a gambler in the ARJEL data set (i.e. sports betting, horse race betting, poker) (whatever the PGSI status) uses a wagering inducement during a specific week, the probability of playing at least two different games during the following week increases by 1.47 times.
When a gambler in the FDJ data set (i.e. lotteries) with a PGSI score < 5 uses a wagering inducement during a specific week, the probability of playing at least two different games during the following week increases by 1.40 times, compared to 3.35 times for gamblers with a PGSI score ≥ 5.
Bold-type: significant *P*-values < 0.05.
ZIP = zero-inflated Poisson; 95% CI = confidence interval; GLMM = generalized linear mixed models; OR = odds ratio; ARJEL = Autorité de Régulation des Jeux En Ligne; PGSI = Problem Gambling Severity Index; FDJ = Française des Jeux.
Only significant interactions with both main effects being significant were interpreted.

chasing was previously identified as a critical indicator of gambling problems [10, 23, 41] and the most significant step in the development of gambling disorders [42–44]. Moreover, the breadth of involvement (i.e. the number of different games played by a gambler) was found to mediate the relationship between on-line gambling and gambling problems [45]. In a previous work on the early trajectories of on-line gamblers, we found that a greater breadth of involvement may be a key indicator for identifying gamblers at risk for future gambling problems [23]. In the present study, the use of inducements increased the probability of playing at least two different games by close to five times for non-at-risk gamblers engaged in sports betting, horse race betting and poker and by more than six times for at-risk gamblers. The increase in the probability of playing at least two different games was smaller (OR = 1.99) for lotteries, with no difference between at-risk and non-at-risk gamblers. Therefore, inducements seem to be associated with a diversification of gambling activity, which may represent a basis for the development of future gambling problems.

The fact that inducements had a higher effect on gambling behaviors for at-risk gamblers, except for on-line lotteries, means that problem gamblers may be particularly at risk of increasing their gambling activity due to inducements and, more worryingly, increasing their at-risk gambling behaviors. Several psychological characteristics of individuals with gambling problems can explain why at-risk gamblers may be more vulnerable to inducements. First, delay discounting is often related to problem gambling and refers to the tendency to devalue gratifications that are delayed in time compared to immediate rewards, regardless of their magnitude [46]. In a recent study, delay discounting was found to be associated with chasing [41]. As wagering inducements are immediate rewards, they may strengthen the inability to tolerate delayed rewards and thus contribute to the higher propensity to chase. Secondly, it could be hypothesized that inducements may favor the development of certain forms of gambling-related cognitive distortions in problem gamblers. Indeed, problem gamblers may conceptualize inducements as the recognition that they are good, competent, experienced gamblers, rather than as a marketing strategy. This may be especially the case for skill-based games, in which internal locus of control (i.e. attribution of wins to one's own personal skills) has been found to predict problem gambling [47]. Therefore, inducements may reinforce internal attribution and lead to an increase in at-risk behaviors.

Limitations and strengths

This study has several limitations. First, gambling tracking data were available in two independent data sets according to the types of gambling activity (sports betting, horse race betting and poker in the first data set and lotteries in the second data set). This was due to the specific regulation of on-line gambling in force in France until 2020. As a consequence, the results of this study may not apply to other forms of on-line gambling, such as that offered by on-line casinos. It would be interesting to replicate this work with data covering the whole gambling activity. Secondly, gambling problems were assessed through a self-report questionnaire, the PGSI. Although this scale is the most widely used for screening gambling problems in epidemiological studies, self-reported subjective data have been criticized given their numerous biases, including divergence between claimed and actual behaviors [48–51]. Thirdly, we had no information on the type of wagering inducements used or the distinction between inducements received and used. Future studies should further explore the differential impacts of various forms of inducements [12], as some types may convey an illusion of lower risk [21]. Moreover, it would be interesting to take into account the environment when exploring the effects of inducements, as exposure to advertising of inducements (e.g. on television) can still have an effect as a stimulus for gambling even if the inducement is not used. Fourthly, although the temporal relationship between wagering inducement and gambling behavior is clearer compared to previous studies, a causal effect could not have been tested with the current design and analyses because the reverse causal pathway (i.e. increase in gambling behavior leading to the use of wagering inducement) could not be excluded with a time lag of 0. However, the inclusion of results for time lag+1 indicate that the effect seems mainly, although partly, to maintain even after 1 week.

Conversely, this study has important strengths. First, it was based on gambling tracking data, which are currently acclaimed in gambling research because they provide access to naturalistic gambling behaviors in a real gambling environment with individuals who actually gamble [9–11]. Secondly, this study included all legal on-line gambling activities in France and a large probability sample of on-line gamblers that covers the full range of gambling practices (from recreational to excessive gambling). Thirdly, the indicators chosen to reflect gambling behaviors were not restricted to the intensity or frequency of gambling but extended to indicators revealing the propensity for gambling problems.

CONCLUSIONS AND PERSPECTIVES

This study revealed that wagering inducements may be associated with an immediate increase in gambling intensity, gambling frequency and at-risk gambling behaviors. This effect was stronger for at-risk gambling behaviors and at-risk gamblers, which indicates that inducements may represent a serious risk factor for developing or exacerbating gambling problems. From the perspective of responsible gambling, wagering inducements should be restricted, at least for gamblers who are identified as having gambling problems. More specifically, future studies should clarify the types of wagering inducements that present more risk and identify which gamblers are more affected. Moreover, wagering inducements should be accompanied by information messages regarding their potential impact on gambling intensity,

gambling frequency and at-risk gambling behaviors, such as chasing and the breadth of involvement.

CLINICAL TRIAL REGISTRATION

ClinicalTrials.gov no. NCT02415296.

DECLARATION OF INTERESTS

M.B., B.P. and J.B.-H. declare that they have no competing interests in relation to this work.

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AUTHOR CONTRIBUTIONS

Marianne Balem: Formal analysis; methodology. **Bastien Perrot:** Formal analysis; methodology. **Jean Benoit Hardouin:** Conceptualization; methodology. **Elsa Thiabaud:** Investigation. **Anaïs Saillard:** Investigation. **Marie Grall Bronnec:** Conceptualization; supervision. **Gaëlle Challet-bouju:** Conceptualization; funding acquisition; project administration; supervision.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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