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Longitudinal patterns of gambling activities and associated risk factors in college students

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Abstract

Aims—To investigate which clusters of gambling activities exist within a longitudinal study of college health, how membership in gambling clusters change over time and whether particular clusters of gambling are associated with unhealthy risk behaviour.

Design—Four-year longitudinal study (2002–2006).

Setting—Large, public university.

Participants—Undergraduate college students.

Measurements—Ten common gambling activities were measured during 4 consecutive college years (years 1–4). Clusters of gambling activities were examined using latent class analyses. Relations between gambling clusters and gender, Greek membership, alcohol use, drug use, personality indicators of behavioural undercontrol and psychological distress were examined.

Findings—Four latent gambling classes were identified: (1) a low-gambling class, (2) a card gambling class, (3) a casino/slots gambling class and (4) an extensive gambling class. Over the first college years a high probability of transitioning from the low-gambling class and the card gambling class into the casino/slots gambling class was present. Membership in the card, casino/slots and extensive gambling classes were associated with higher scores on alcohol/drug use, novelty seeking and self-identified gambling problems compared to the low-gambling class. The extensive gambling class scored higher than the other gambling classes on risk factors.

Conclusions—Extensive gamblers and card gamblers are at higher risk for problem gambling and other risky health behaviours. Prospective examinations of class membership suggested that being in the extensive and the low gambling classes was highly stable across the 4 years of college.

Keywords

College student population; gambling; gambling activities; longitudinal; risk factors

INTRODUCTION

Longitudinal gambling studies in adolescence and young adulthood

Adolescence is known as a period of high impulsivity, in which exploration of alcohol, tobacco and drug use emerge and patterns of regular use are established [1,2]. Longitudinal studies on gambling behaviours in young adults indicate that adolescence is also a period of exploring and engaging in gambling [3–5]. Only a few longitudinal studies exist on gambling activities and gambling problems in adolescence and young adulthood (for a review, see [6]), deriving from three research groups. They consist of a longitudinal study on a group of low socio-economic status (SES) boys [3], a study of two New York-based samples from a longitudinal delinquency study in males and a household survey on alcohol problems [7], and a study of adolescents in Minnesota [8]. In addition, several longitudinal studies exist on problem gambling [9,10]. These last studies are not discussed here because they did not focus upon gambling activities, the focus of this paper.

In the study of low SES boys/young men, [3–5,11,12], an early-onset gambling group and a later-onset group had higher scores on gambling frequency and problem gambling at age 17, compared to the low-gambling group [3]. This study did not include questions on different forms of gambling, and questions were dichotomized. Therefore, these reports did not address questions on level of involvement in gambling or gambling activities. A longitudinal study on gambling in adolescents and young adults (aged 17–22 years) summed gambling frequency across 11 activities [7,13,14]. Self-reported impulsivity, low parental monitoring, moral disengagement in males and peer delinquency in males and females at ages 16–19 years predicted higher gambling frequency at ages 17–21 [14]. A longitudinal three-wave panel study in Minnesota ($n = 305$) characterized gambling involvement and gambling problems in adolescents aged 16–24 [8,15]. Results indicated that at a group level both incidental and regular gambling remained stable over the measurement occasions. Card gambling, playing games of skill for money and sports gambling decreased steadily, whereas scratch-card gambling, gambling on slot machines and lottery gambling increased [8].

Cross-sectional studies of gambling activities in adolescence and young adulthood

Gambling studies indicate that in adolescents and young adults, males gamble more than females [16,17]. A recent national prevalence study among American adolescents and young adults indicates that frequent gambling increases between ages 14 and 21, and that being a student is associated with lower gambling activity [17]. Non-casino gambling activities have a higher prevalence among adolescents than casino gambling [16,18]. A comprehensive cross-sectional study on college health across more than 100 colleges in the United States (College Alcohol Study; [19]) indicated that during the past school year the most popular forms of gambling were lottery gambling (25%) and casino gambling (20%), whereas fewer students engaged in card and sports gambling (9–12%) or internet gambling (2.6%). The findings of the current study on college student gambling activities are compared to the results from this study.

Current study: defining clusters of gambling activities

In the present study we focus upon different gambling activities and changes in these gambling activities over time in a longitudinal study of college students. Ten common gambling activities were investigated: playing cards for money, betting on horses/dog races, betting on sports, playing dice games, casino gambling, lottery gambling, playing bingo, playing slot machines, playing games of skill for money and gambling on the internet. What is missing in the literature on gambling involvement among young people is a multivariate approach to the question. Currently, no consensus exists on the question of whether certain types of gambling have a stronger association with problem gambling or with risky health behaviours (for a review see:

[20]). Studies in adult populations suggest that gambling activities cluster around high or low action gambling (e.g. casino gambling versus lottery gambling) or luck-based gambling (slot machines) versus skill-based gambling, such as card games [21,22].

Therefore, in this study we investigate whether, in young adults, gambling activities cluster together according to clusters found in adult populations, and which clusters of gambling activities are associated with higher gambling involvement or problem gambling. Because most people engage in more than one gambling activity, our first research question focused upon identifying the gambling activities that tend to cluster together using latent class analysis. We then examined the extent to which gambling patterns changed over time by examining latent transitions between these latent classes.

Differences in gambling classes: gambling frequency and risk factors

The second research question addresses whether different gambling classes differ in gambling frequency, gambling versatility and with respect to different correlates or risk factors such as alcohol and drug use/abuse. Longitudinal mixed models analyses were employed to examine differences between the different gambling classes. Given the fact that epidemiological studies indicate that engaging in a greater number of gambling activities is associated with problem gambling [23], we hypothesized that gambling classes characterized by a greater number of gambling activities will be related to self-identified problem gambling.

Several risk factors were examined, as follows.

Alcohol and drug use—Higher levels of alcohol and drug use have been associated with higher levels of gambling and with problem gambling in a number of studies [13,19,24–27]. Given these findings, we hypothesized that more alcohol and drug use would be associated with gambling classes that are defined by more frequent gambling and that are engaged in more gambling activities.

Novelty seeking and conduct disorder symptoms—Several studies indicate that higher levels of behavioural undercontrol are present in gamblers compared to non-gamblers, and in problem gamblers compared to recreational gamblers [3,7,9,12,28–31]. Therefore, we hypothesized that novelty seeking and conduct disorder symptoms, measured when students first enrolled at the university, would be associated with future higher gambling involvement.

Psychosocial distress—Negative emotionality has been associated with problem gambling [32]. To study whether different gambling activities are associated with differences in psychosocial distress we compared general psychosocial distress levels between the gambling groups. It was expected that gambling groups that engage in a greater number of gambling activities and gamble more frequently would have higher psychosocial distress levels compared to lower-frequency gambling groups.

Greek membership—In the United States, fraternities or sororities serve as a collegiate dormitory for its members, and focus upon social and professional activities. In general, membership is open to undergraduate students. These are generally known as ‘Greek’ organizations, because they usually use letters of the Greek alphabet for their name. Several single-campus studies have found that students who are members of a Greek organization report higher alcohol use levels compared to non-members [33–35], and this difference in alcohol use and binge drinking was also found in a nationally representative study on alcohol use in colleges in the United States [33–36]. In the same nationally representative study of alcohol use in colleges in the United States, engaging in gambling and higher-frequency gambling were associated with fraternity/ sorority membership [19], and another study found

that this was especially true for male Greek members [37]. Gambling has been found to be associated with similar 'risky behaviours' as heavy alcohol and drug use [4,38]. We therefore hypothesized that Greek members would be over-represented in gambling classes compared to relatively low- or non-gambling classes.

Gender—Several population studies indicate that women gamble less frequently and engage in fewer gambling activities than men [16,21,22]. Studies in recreational gamblers indicate that gender differences are present in the relation between alcohol or drug use and abuse, and gambling. For example, heavy alcohol use has been linked to gambling frequency in men, but not in women [13,18]. In contrast to these findings, a study in adolescents reported that in low/non-alcohol users non-gambling women were over-represented, whereas in the heavy/moderate users no gambling differences were present between men and women [39]. Therefore, in this study, interactions of gambling and risk factors with gender were examined. Given the findings described above, it was expected that alcohol use would have a stronger relation with gambling measures in men than in women.

METHODS

Participants and data collection

The sample consisted of participants from a longitudinal study of college student health (the Intensive Multivariate Prospective Alcohol College Transitions Study—IMPACTS). At baseline (wave 0: the summer before their freshman year), all incoming students at the University of Missouri-Columbia (MU) ($n = 4266$) were asked to complete a paper-and-pencil survey assessing their substance use and health-related behaviours, but did not include any questions about gambling. Eighty-eight per cent ($n = 3720$) of all incoming students completed the questionnaire at the first data collection point. Respondents had an average age of 17.96, 46% of respondents were male and the majority was Caucasian (90.2% Caucasian, 4.8% African American, 2.9% Asian, 1.6% Hispanic, 0.5% American Indian). Surveys were administered twice a year, and students were re-contacted every semester (for details see: [40]), starting in the first semester of their freshman year. Questions on past 12-month gambling behaviour were included only once a year during the spring semester. Of the 3720 students participating in the study, differing percentages of students participated in one or more of the gambling data waves: year 1, $n = 2450$ (66%), year 2, $n = 2482$ (67%), year 3, $n = 2357$ (63%) and year 4, $n = 2250$ (60.5%), respectively. All four gambling data waves were collected during spring of each college year, from 2002 until 2006, and were administered through an online survey. Gambling data were thus collected in the first to the fourth college years. In total, 3073 different individuals participated in at least one gambling data wave, which is 82.6% of the 3720 longitudinal study participants. A total of 2526 (82%) of the 3073 gambling data collection individuals participated in at least two of the gambling data waves. The institutional review board of the University of Missouri-Columbia approved this study. All participants gave their informed consent before inclusion in the study.

To ensure that students included in the study were living in Missouri, an inclusion criterion was enrollment at MU during at least two semesters after the baseline measure of the summer preceding freshman autumn. Because reaching the legal gambling age was expected to influence gambling patterns, students who were younger than 17.5 years or older than 19.5 years at wave 0 were excluded from the study, in order to include a homogeneous student population. These criteria resulted in the exclusion of 273 participants, or 7.3% of the sample at wave 0.

In Missouri, the legal age to purchase lottery tickets is 18 and the legal age to gamble in a casino is 21. Because the questions about gambling did not ascertain the location where the gambling occurred (in Missouri, in the United States, or abroad), it was not possible to

determine whether reports about casino gambling occurring prior to age 21 represented legal or illegal gambling. Data were collected between Spring 2002 and Spring 2006, and thus all internet gambling took place before a United States federal law was enacted prohibiting credit card payment on internet gambling websites. During the 4 years of data collection, the nearest casino to the university was about 25 miles away.

Measures

Gambling—At each of the four gambling assessments, 10 questions on type of gambling were included: ‘how many times in the past year did you: (1) play cards for money, (2) bet on horses, dogs or other animals (at the track, off-track betting facility or with a bookie), (3) bet on sports, (4) play dice games, (5) gamble at the casino (legal or otherwise), (6) buy lottery tickets or play the numbers, (7) play bingo for money, (8) play slot machines, poker machines or other gambling machines, (9) bowl, shoot pool, play golf or some other game of skill for money and (10) gamble on the internet?’ (answer options: never; done, but not in the past year; 1 day; 2–5 days; 6–10 days; 11–20 days; 21–40 days; and more than 40 days). From these 10 questions, the number of different gambling activities engaged in was derived by dichotomizing the 10 gambling activities, and adding up each of the gambling activities endorsed. Further, a question on gambling frequency was included: ‘how many days have you made a bet or gambled in the past 12 months?’ (answer options: 1–10 days, 11–50 days, 51–100 days and 101–365 days). A question on self-identified gambling problems [‘do you think you ever had a gambling problem?’ (answer options: yes/no)] was also included.

Heavy alcohol use—This measure was included four times, at the same time as the gambling measures. The mean score of three items measuring (i) frequency of getting high, (ii) frequency of getting drunk and (iii) having five or more drinks in a single sitting during the past 30 days [41] was calculated for each of the 4 years. Participants responded to each item based on a 10-point scale from ‘never’ to ‘every day’. Coefficient α of this measure ranged from 0.92 to 0.93 [40].

Heavy drug use measure—This measure was included four times, at the same time as the gambling measures. The mean score of three items measuring (i) frequency of illicit drug use, (ii) frequency of getting high and (iii) frequency of getting ‘messed up’ by drugs during the past 30 days was calculated for each of the 4 years. Participants responded to each item based on a 10-point scale from ‘never’ to ‘every day’. Coefficient α of this measure ranged from 0.94 to 0.95 and was measured four times, once during each college year.

Novelty seeking—A shortened novelty seeking scale [42] of the Tridimensional Personality Questionnaire (C. R. Cloniger, unpublished) was administered once, during the first college year. This novelty seeking scale consists of 13 items ($\alpha = 0.72$). Novelty seeking is hypothesized to reflect exploratory excitability, impulsiveness and extravagance. The response options were false/true (coded 0/1), and thus the scale score ranged from 0 to 13.

Conduct disorder—A sum score of DSM-IV based conduct disorder symptoms, ever occurring before the age of 15, was derived from a 10-item yes/no scale (e.g. shop-lifting, damaging property). This measure was completed once, during the first college year.

Psychological distress—The shortened 18-item Brief Symptom Inventory (five-point rating scale) was administered [43], focusing upon past 6-month symptoms. The Brief Symptom Inventory was designed to measure psychological symptom patterns of psychiatric and medical patients. The global severity index was used, which represents overall mean endorsement across the subscale items (anxiety, depression and somatization). This measure was administered four times, once during each college year.

Greek membership—A dichotomous Greek status variable (1 = Greek member; 0 = non-Greek member) was determined from participants' responses during years 1–4. Of all participants, 92% indicated being either a Greek member or a non-Greek member at all time-points. Those who indicated Greek membership less than half the time (2% of the participants) were classified as non-Greek, whereas those indicating membership half or more than half the time (6% of the participants) were classified as Greek members.

Statistical analyses

LCA and LTA—Latent class analyses (LCAs) were employed to investigate patterns of gambling activity involvement. LCA was used instead of a latent profile analysis, because gambling data were too skewed to be treated as continuous variables. LCA is a technique used to distinguish a mixture of subgroups in a population measured by multiple categorical indicators, assuming that there are distinct latent classes among individuals underlying the observed multivariate categorical variables [44]. In this study, answers to the 10 gambling typology questions were dichotomized. The responses 'never' and 'yes, but not in the past year' were coded as zero, and all the other responses (1 to more than 40 days a year) were coded as 1.

Latent transition analysis (LTA) was used to investigate changes in group membership between latent gambling classes. LTA is a latent variable, stage-sequential model for longitudinal data. Latent statuses were extracted from unique response profiles of endorsements based on the 10 discrete observed gambling variables assessed at the 4-year point. LTA assumes measurement invariance over time, so the 10 parameters were constrained to be equal across time within a given item. The LCA and LTA were both conducted using Mplus [45].

Mixed modelling analyses of risk factors—Mixed model analyses for categorical (PROC GLIMMIX) and continuous data (PROC MIXED), using SAS version 9.1, were performed to analyse differences between gambling classes on (1) gambling involvement and (2) risk factors between the gambling classes during the 4 years, (3) the influence of gender and (4) the influence of Greek membership. SAS PROC MIXED and PROC GLIMMIX were used instead of general linear modelling or χ^2 analyses, because (1) missing data can be accommodated and (2) both gambling class and risk factors can be treated as time-varying variables. Thus 82.6% of the total study sample could be included in data analyses. Where appropriate, data were transformed to adjust for a non-normal distribution; e.g. drug use variable (inverse tangent transformation; [46]). For novelty seeking an analysis of variance (ANOVA) was performed, as this measure was administered only once. For conduct disorder symptoms a negative binomial regression was performed, as this was a left-skewed count variable with limited variability.

In all SAS PROC MIXED models, gender, Greek membership and time were included (except gender in contrasts including the extensive gambling group, where gender was excluded, as female participants accounted for only a small proportion of this relatively small gambling class). Time was included as a linear, quadratic or unstructured random factor. The time structure was chosen based on Akaike's information criterion (AIC) and the presence of a certain time effect (e.g. when AIC for the quadratic time model was lower, but no significant quadratic time effects were present in the overall model, the linear time model was chosen). Interaction effects of gambling group with time, gender or Greek membership were modelled, as were three-way interactions. To correct for multiple comparisons, main and interaction effects are reported for P -values < 0.01.

RESULTS

LCA

We fitted a series of LCAs to the gambling activity questions separately for each of the 4 years of the study. Two, three, four, five and six latent classes were extracted, using maximum likelihood estimation with standard errors and a χ^2 test that is robust to non-normality (maximum likelihood ratio). The goodness-of-fit coefficients and solutions of the latent class models for the total sample are shown in Table 1. Both four- and five-class solutions showed a good fit to the data; the four-class solution was retained due to its interpretability. In order to apply latent transition analysis for years 1–4, a four-class model was chosen for all waves in order to model changes in class membership over time.

The four classes can be defined by the distinct gambling activities they encompass (see Fig. 1a–d and Table 2). By far the largest group, the low-gambling group, consisted of students that gambled only sporadically or did not gamble at all. This group comprised 60% of the sample at years 1 and 2, 50% in year 3 and 44% in year 4. The second class was the card gambling group, which consisted of people who engaged in card gambling and other non-regulated forms of gambling (sports betting, games of skill) and lottery gambling. At year 1, 33% of the students were classified in this group, and in years 2, 3 and 4 the card gambling group comprised 33%, 17% and 6% of the sample, respectively. The third group was the casino/slot gambling group, who engaged mainly in slot machine and casino gambling. During years 1 and 2 group membership in this group was very low: 2.6% and 2.2%, respectively. In year 3, the casino/slot gambling group increased to 26% and in year 4 to 43%. The fourth group was the extensive gambling group which consisted of students engaging in all or most of the gambling activities. In years 1 and 2 the extensive gambling group comprised 5.0% of the students; in year 3, 3.2% of the sample was classified in this group; and in year 4, 1.4% of the sample was classified in this group.

LTA

To investigate the transitions of individuals between classes, a latent transition analysis was estimated using a four-class model as indicated by the results of the latent class analyses. Table 3 shows the latent transition probabilities from years 1 to 4, to indicate the stability of the latent classes from the first to the fourth college year, and from years 1 to 2, years 2 to 3 and years 3 to 4 to examine specific points where a change might have occurred. In this table, the bold numbers on the diagonals indicate the proportion of participants staying in the same group. From the first to the fourth college year (years 1–4), stability is highest for the low gambling group (0.93) and for the extensive gambling group (0.77). This means that on the extremes of gambling behaviour, i.e. those gambling sporadically, and those engaging in almost all 10 gambling activities, the type of gambling involvement stays the same from the start of college to the fourth year. The card gambling group has a stability of 0.56 from years 1 to 4, whereas stability is lowest in the casino gambling group (0.19) from years 1 to 4. The high stability observed in the low gambling group and in the extensive gambling group throughout the duration of the study, from years 1 to 4, was also present when consecutive college years were examined (i.e. years 1–2, years 2–3 and years 3–4), suggesting high stability over the entire college period. In the card gambling group stability diminishes over the college years, and this is due to a majority of college students from this group transitioning into the casino/slot gambling group. In the casino/slot gambling group, stability increases over the consecutive college years. The low stability from years 1 to 4 is due primarily to low stability from years 1 to 2, whereas in the later college years the casino/slot gambling group is more stable. Because of the number of classes, the number of measurement occasions, the low prevalences of some classes and the highly skewed gender distribution across classes, separate LTAs are not

reported for women and men; however, gender was included in the mixed general linear models below.

Risk factors analyses

For all the mixed model analyses, the following specific group contrasts were conducted: (1) in order to obtain insight into the ways that more extensive gamblers differ from less extensive gamblers, the low-gambling group was compared to: (a) the extensive gambling group, (b) the card gambling group and (c) the casino gambling group, (2) to obtain insight into whether differences emerge based on engaging in gambling in different environmental contexts, the casino/slots gambling group was compared to the card gambling group, and (3) in order to investigate the overall difference between the extensive group, with the highest versatility in gambling behaviours, and the less extensive gambling groups, the extensive gambling group was compared to the card gambling and the casino/slot gambling groups.

In Table 4, descriptive information for each of the risk factors is presented separately for all of the four classes for each of the 4 years of the study.

Gambling days/year

As expected, the low-gambling group gambled fewer days per year than either of the three other gambling groups $F_{(1,6064)} = 72.04-150.7, P < 0.0001$. The card gambling group did not differ in days gambled a year from the casino/slots gambling group; however, a group \times time interaction indicated that days gambled in the card gambling group remained stable or increased, whereas the number of days gambled in the casino/slots gambling group decreased over the years, $F_{(1,6064)} = 16.23, P < 0.0001$. Members of the extensive gambling group gambled more days per year than members of the card gambling and casino/slots gambling groups, $F_{(1,6068)} = 201.15, P < 0.0001$. A group \times time interaction indicated that days gambled increased more steeply for the card gambling group than for the low-gambling group, $F_{(1,6064)} = 26.7, P < 0.0001$. Interactions between group and gender indicated that women gambled fewer days per year in the three gambling groups, whereas no difference was present in days gambled for both genders in the low-gambling group, $F_{(1,6064)} = 5.9-26.7, P < 0.01-0.0001$. A group \times time interaction and a group \times time \times Greek membership interaction indicated that in the extensive gambling group, gambling days increased more than in the low-gambling group, and even more for Greek members in the extensive gambling group than for Greek members in the low-gambling group, $F_{(1,6064)} = 6.70, P < 0.01$.

Number of gambling activities

For the number of gambling activities engaged in, a linear time-effect fitted the data most effectively (AIC criterion). The low-gambling group engaged in a smaller number of gambling activities than either of the other three gambling groups, $F_{(1,6082)} = 254.9-1127.1, P < 0.0001$. The card gambling group engaged in more gambling activities than the casino/slots gambling group, $F_{(1,6082)} = 7.1, P < 0.01$. The extensive gambling group engaged in more gambling activities than the card gambling group and the casino/slots gambling group, $F_{(1,6082)} = 1058.2, P < 0.0001$. Group \times time interactions indicated that over time, all three gambling groups increased in gambling activities, whereas the gambling activities in the low-gambling group stayed at the same level, $F_{(1,6082)} = 180.6-283.3, P < 0.0001$. Group \times gender interactions indicated that in the gambling groups, women engaged in less gambling activities than men, whereas this difference was absent in the low-gambling group, $F_{(1,6082)} = 10.4-29.0, P < 0.001-0.0001$. Group \times Greek membership interactions indicated that in both the card gambling and the extensive gambling groups, Greek members engaged in more gambling activities than non-Greek members, whereas in the low-gambling group no differences between Greek and non-Greek members were present, $F_{(1,6082)} = 7.87-10.4, P < 0.01$. A group \times time interaction indicated that in the casino/slots gambling group, number of gambling activities engaged in

decreased over time, whereas in the card gambling group number of gambling activities remained stable, $F_{(1,6082)} = 36.6, P < 0.0001$.

Presence of self-reported life-time problem gambling

Proc GLIMMIX was used to identify differences between the gambling classes on self-identified gambling problems. In both the card gambling and the extensive gambling groups, more self-identified problem gamblers were present than in the low-gambling group, $F_{(1,6055)} = 174.6\text{--}534.5, P < 0.0001$. In the card gambling group, more self-reported problem gambling was present compared to the casino/slots gambling group, $F_{(1,6055)} = 275.6, P < 0.0001$, and in the extensive gambling group more self-reported problem gambling was present compared to both the card and the casino/slots gambling groups, $F_{(1,6055)} = 43.6, P < 0.0001$. Group \times sex interactions were present between the low-gambling group and all three other gambling groups, indicating that no differences were present in number of self-identified problem gamblers in the low-gambling group, but that in all three other gambling groups more men than women were self-identified problem gamblers, $F_{(1,6055)} = 30.2\text{--}580.6, P < 0.0001$. For the low-gambling versus the casino/slots gambling group, a group \times Greek membership interaction was found, $F_{(1,6055)} = 777.4, P < 0.0001$, indicating that in the casino/slots gambling group more Greek members than non-Greek members were self-identified problem gamblers, whereas this difference was not present in the low-gambling group.

A group \times time by Greek membership interaction indicated that Greek membership was associated with a higher increase in self-identified problem gambling over time in the gambling groups, but not in the low-gambling group, $F_{(1,6055)} = 12.7, P < 0.001$. A group \times time interaction indicated that in the card gambling group self-reported problem gambling increased, whereas in the casino/slots gambling group it decreased, $F_{(1,6055)} = 312.5, P < 0.0001$. A group \times sex interaction indicated that relatively more men in the card gambling group had a gambling problem compared to men in the casino/slots gambling group, whereas this relation was reversed for women, $F_{(1,6055)} = 522.6, P < 0.0001$. A group \times Greek membership interaction indicated that non-Greek members in the card gambling group had relatively more gambling problems than Greek members in the card gambling group, whereas this difference was not present in the casino/slots gambling group, $F_{(1,6055)} = 819.4, P < 0.0001$.

Psychological distress—For the Brief Symptom Inventory (BSI-18) sum score, a linear time-effect was chosen, based on the AIC. The low gambling group had lower psychological distress scores compared to the extensive gambling group, $F_{(1,6018)} = 66.9, P < 0.0001$. The extensive gambling group had higher psychological distress scores than both the card gambling and the casino gambling groups, $F_{(1,6036)} = 10.5, P < 0.0001$. A group \times time interaction indicated that the extensive gambling group had increasing BSI scores over time compared to stable BSI scores in the low-gambling group, $F_{(1,6018)} = 25.0, P < 0.0001$.

Heavy alcohol use—Based on the AIC, a quadratic covariance structure for the time factor was chosen. The low-gambling group had lower heavy alcohol use scores than both the card gambling and the extensive gambling groups, $F_{(1,6062)} = 19.8\text{--}21.5, P < 0.001$. The extensive gambling group had higher heavy alcohol use scores than both the card and casino/slot gambling groups, $F_{(1,6076)} = 9.9, P < 0.01$.

Heavy drug use—For drug use, a quadratic time effect was chosen. The low-gambling group had lower drug use scores compared to any of the other three gambling groups, $F_{(1,6048)} = 7.0\text{--}18.5, P < 0.01\text{--}0.0001$. The extensive gambling group had higher heavy drug use scores than both the card and casino/slot gambling groups, $F_{(1,6076)} = 10.0, P < 0.01$.

Conduct disorder symptom count—Negative binomial regressions were used to investigate overall and specific group differences for year 1. The overall between group effect was significant in year 1: the conduct disorders symptom count score was higher in the three gambling classes compared to the low-gambling class ($\chi^2_{(1,8147)} = 11.9, P < 0.001$), and was higher in the extensive gambling group compared to both the card gambling and casino/slot gambling groups, $\chi^2_{(1,7857)} = 48.5, P < 0.0001$.

Novelty seeking

ANOVA was used to analyse class differences for year 1, using contrasts. The overall between group effect was significant, $F_{(4,2236)} = 9.49, P < 0.001$. The low-gambling group had lower novelty seeking scores than the card gambling group, the casino/slots gambling group or the extensive gambling group, all P -values < 0.01 . The card gambling group had higher novelty seeking scores than the casino/slots gambling group ($P = 0.01$), and the extensive gambling group had higher novelty seeking scores than both the card gambling and casino/slots gambling groups together ($P < 0.0001$). A group \times Greek interaction indicated that non-Greek members in the card gambling, casino/slots gambling and extensive gambling groups had higher novelty seeking scores than non-Greek members in the low-gambling group, whereas Greek members had similar novelty seeking scores in all four gambling groups.

DISCUSSION

The results from this study on clustering of gambling activities in college students show that gambling activities in students do not cluster around high or low action gambling, or luck-based gambling versus skill-based gambling, as evidenced in gambling research in adults [21,22]. Rather, clustering takes place roughly around more readily available or informal gambling (card gambling, games of skill for money, sports betting) and formal gambling (casino and slot machine gambling). A small but stable cluster of extensive gamblers was found who engaged in almost all gambling activities. The increase in the number of casino/slots gamblers resulted predominantly from low-gamblers transitioning into the casino/slots gambling group, and can probably be related to students reaching 21 years, the legal age limit to gamble in casinos in Missouri. We hypothesized that groups with a higher gambling intensity would also score higher on alcohol and drug use [13,19,24–27]. This hypothesis was mostly confirmed, because higher alcohol and/or drug use was present in the card gambling, casino/slots and extensive gambling groups compared to the low-gambling group and, in turn, higher alcohol and drug use was present in the extensive gambling group compared to the casino/slot gambling and card gambling groups.

For the personality measures, we hypothesized that higher intensity gambling classes would be associated with higher scores on traits of behavioural undercontrol. Classes with higher gambling involvement had higher novelty seeking and conduct disorder scores (e.g. the extensive gambling group versus the card and casino/slot gambling group; the three gambling groups versus the low-gambling group).

A large group of students engaged only rarely in gambling activities (44–60%), but stability and membership of this low-gambling group dropped in the third and fourth college years, when regulated gambling activities such as casino and slot machine gambling became legal for these students. These findings are consistent with an earlier study from the same college, in which engaging in gambling was present in only 39% of the college student sample [10]. Compared to the gambling activities reported in the College and Alcohol Study [19], relatively more casino gambling was present in the last two college years, whereas the level of card and sports gambling was higher than in the College and Alcohol Study study in the first 2 college years. These findings suggest that it is important to include college year in studies on gambling

activities in college students, because gambling patterns change considerably during the college period.

The extensive gambling group was the most stable gambling group over the 4 college years, and also showed a high stability from the first college year to the last college year. Thus, a small predominantly male college student group (5–7%) engaged in almost all the gambling activities included in this study over the 4 college years. A large national prevalence study indicated that engaging in a greater number of gambling activities is associated with higher levels of problem or pathological gambling [26]. Our findings indicate that this risk pattern is also present in students, and that this pattern persists over 4 consecutive years. Furthermore, higher scores on alcohol and drug use, conduct disorder symptoms and psychosocial distress were present in the extensive gambling group over the 4 college years. Similar risk factors have been associated with excessive gambling in younger samples [8,9,13,47,48].

Gender

All group \times time \times gender effects indicated that women increased their gambling frequency less over time than men. Also, alcohol use was tied more strongly to gambling behaviour in male college students than in female college students, consistent with other studies that indicate a stronger relation between alcohol use and gambling in men than in women [13,18].

Greek membership

Novelty seeking interacted with Greek membership in discriminating among the low-gambling class and the other gambling classes. Whereas, in the non-Greek members, gamblers had higher novelty scores compared to low gamblers, in Greek members no differences in novelty seeking were present between gamblers and low gamblers. This could be due to a self-selection effect: Greek members in general tend to score higher than non-Greek members on personality aspects such as behavioural undercontrol [34] and Greek members are thus likely to score higher and be more homogeneous on this trait than those who elect not to affiliate with a Greek organization.

Greek members in the card gambling group and in the extensive gambling group engaged in more gambling activities than non-Greek members in these classes, whereas no differences in gambling activities were present between Greek members and non-Greek members in the low-gambling class. This indicates that card gambling and extensive gambling in Greek members is associated with higher overall gambling versatility, which could be associated with the environment in which card gambling in Greek members takes place (Greek houses), and the increasing popularity of card gambling in general (e.g. poker).

Limitations

This is a single-site study, and the gambling patterns and clusters that were found in the present study could be influenced by the local availability of gambling opportunities within Missouri, and more specifically within the immediate vicinity of the city of Columbia. Living in the vicinity of a casino has been related to higher gambling frequency and higher gambling problems [49]. In Missouri, a total of 11 casinos were present as of July 2007, one casino was within 25 miles of the city of Columbia during the entire period of the study and other opportunities for legal gambling also were available (e.g. scratch-card gambling, pari-mutuel horse racing). Although Missouri has a medium position in gambling involvement in the United States [22,26], it is likely that regulated gambling and gambling clusters will vary depending upon legality and availability of gambling in the vicinity of the specific college campuses studied.

Problem gambling was assessed with a single item on self-identified gambling problems during each gambling data collection wave. Inclusion of an official problem gambling scale during each year would have resulted in a more reliable indicator of problem gambling in this sample. Our estimate of the number of problem gambling students should therefore be interpreted cautiously as indicators of relatively 'high-risk gambling' in the different gambling classes. It cannot be used as an indication of the prevalence of problem gambling among college students, as only a minority of people who screen positively on problem gambling scales endorse this type of question [50].

This study sample was predominantly white (90%, which was representative of the student population of this university), and therefore studying gambling patterns separately for different ethnic minority groups was not possible. In addition, the gambling clusters were collapsed across gender, because some groups consisted predominantly of men (e.g. the extensive gambling group). Future research in different populations could investigate the role of ethnicity and potential differences between men and women in extensive gambling groups that consist of both genders.

The 10 gambling activities that we focused upon were ambiguous with regard to the activity versus venue. For example, casino gambling could have referred to slot machine gambling as well as to card gambling, whereas these two types of gambling were also included as separate questions. This confounding of gambling types and gambling venues could have resulted in people endorsing more than one activity for the same behaviour. Further, it was not always possible to distinguish between formal or informal gambling. For instance, card gambling for money could refer to either informal gambling (with friends) or to formal gambling (in a casino).

Of all participants who took part in the data collection during summer 2002, 83% also took part in one of the four data collection waves during which gambling questions were included. Earlier reports on attrition in this longitudinal study indicated only small effect size differences or no differences on most of the background variables [40]. The largest differences were for sex: more women were retained than men. Thus, our findings are likely to be somewhat conservative with regard to gambling involvement, as men gamble more than women [22].

Conclusions

This longitudinal study on clustering of gambling activities in college students indicates that students engage in distinct clusters of gambling activities. The major shift to casino/slots gambling when the legal age to gamble is reached indicates that the legal gambling age is effective in restricting regulated gambling in young adults under age 21, but also that regulated gambling attracts students highly. A small proportion of college students engaged in almost all gambling activities over the 4 college years, and this pattern of gambling was associated with a diversity of risk factors. This finding of prolonged heavy gambling associated with problem gambling, which was very stable over 4 college years, is at odds with problem gambling research which suggests that problem gambling is relatively unstable over time [10,15,51]. These findings suggest that regularly engaging in many different gambling activities may be a better indicator of a chronic, stable pattern of problematic gambling behaviour than the more unstable measure of symptoms of problem gambling that is typically used.

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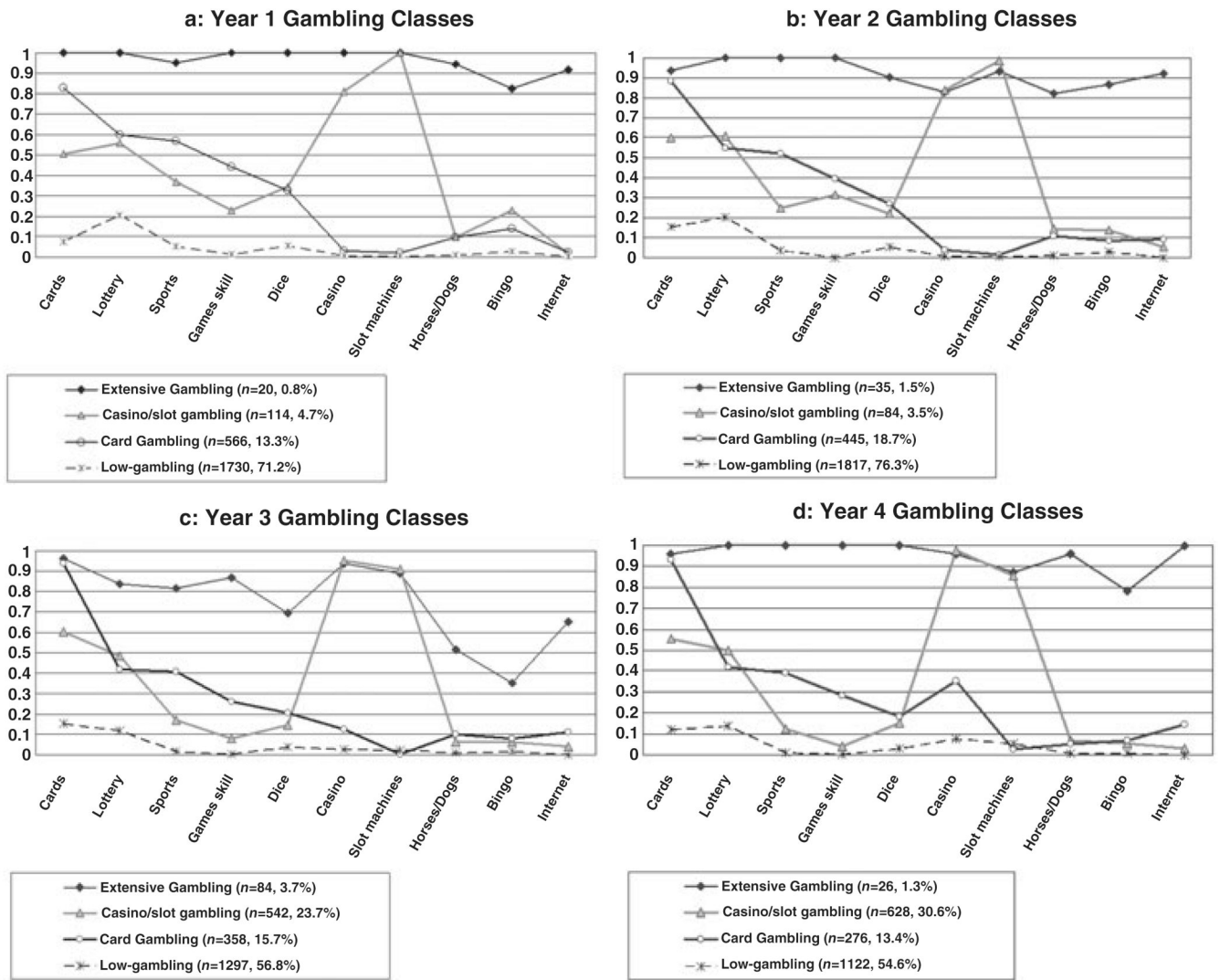


Figure 1. (a–d) Proportions of students engaging in 10 gambling activities within four latent gambling classes for the first to the fourth college years

Table 1

Summary of latent class fit indices for gambling typologies.

		Model fit indices for latent class analyses of the 10 gambling activities			
		χ^2	AIC	aBIC	Entropy
Year 1	2-Class	1968.4	14 519.9	14 574.9	0.78
	3-Class	445.7	14 091.0	14 174.8	0.84
	4-Class	263.8	13 846.1	13 958.7	0.87
	5-Class	87.2	13 779.9	13 921.3	0.76
	6-Class	45.9	13 755.5	13 925.7	0.75
Year 2	2-Class	1973.9	13 706.4	13 760.9	0.82
	3-Class	395.1	13 328.7	13 411.8	0.85
	4-Class	253.8	13 093.9	13 205.6	0.88
	5-Class	91.6	13 023.2	13 163.4	0.80
	6-Class	67.3	12 979.9	13 148.8	0.80
Year 3	2-Class	2366.6	16 367.9	16 421.5	0.83
	3-Class	635.8	15 746.6	15 828.3	0.88
	4-Class	370.0	15 393.2	15 503.1	0.85
	5-Class	85.1	15 329.2	15 467.2	0.83
	6-Class	47.1	15 303.5	15 469.6	0.77
Year 4	2-Class	2483.4	15 546.4	15 598.6	0.82
	3-Class	596.9	14 964.4	15 043.9	0.85
	4-Class	182.8	14 801.4	14 908.3	0.84
	5-Class	136.2	14 685.6	14 819.8	0.82
	6-Class	19.53	14 680.0	14 841.6	0.79

Akaike's information criterion (AIC), Akaike's Bayesian information criterion (aBIC). The four-class model was chosen over a three- or five-class model at all 4 years.

Table 2

Percentage of participants in the four gambling classes at each study year, gender percentages within each gambling class, and the number of participants within each gambling class (based on latent class analyses).

	Low-gambling	Card gambling	Casino/slot gambling	Extensive gambling
Year 1 n^a	1420	772	62	118
% of total sample (% male)	59.9 (25.9)	32.5 (55.8)	2.6 (33.9)	5.0 (84.7)
Year 2 n^a	1416	780	51	125
% of total sample (% male)	59.7 (25.4)	32.9 (55.5)	2.2 (35.3)	5.3 (88.0)
Year 3 n^a	1188	412	613	159
% of total sample (% male)	50.1 (26.4)	17.4 (57.5)	25.8 (38.3)	6.7 (84.3)
Year 4 n^a	1027	148	680	158
% of total sample (% male)	43.8 (30.8)	6.2 (64.2)	43.3 (36.6)	6.7 (81.6)

^aPercentages in Table 2 differ from percentages in Fig. 1a–d, because Table 2 encompasses students based on estimated frequencies, including estimated data of students missing at one or more data collection points, whereas the percentages in the figures represent students present in each specific year.

Table 3

Latent transition probabilities for the four gambling classes.

Transition probabilities: years 1–4.				
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
1. Low-gambling	0.93	0.04	0.02	0.01
2. Card gambling	0.35	0.56	0.07	0.03
3. Casino/slot gambling	0.22	0.49	0.19	0.11
4. Extensive gambling	0.08	0.15	0.0	0.77

Transition probabilities: years 1–2				
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
1. Low-gambling	0.90	0.07	0.01	0.01
2. Card gambling	0.11	0.83	0.04	0.03
3. Casino/slot gambling	0.28	0.55	0.10	0.07
4. Extensive gambling	0.07	0.14	0.03	0.77

Transition probabilities: years 2–3				
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
1. Low-gambling	0.77	0.05	0.16	0.02
2. Card gambling	0.06	0.50	0.39	0.04
3. Casino/slot gambling	0.11	0.18	0.64	0.07
4. Extensive gambling	0.02	0.04	0.15	0.79

Transition probabilities: years 3–4				
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
1. Low-gambling	0.72	0.01	0.26	0.01
2. Card gambling	0.14	0.35	0.49	0.02
3. Casino/slot gambling	0.21	0.04	0.73	0.03
4. Extensive gambling	0.05	0.01	0.19	0.75

Bold numbers indicate the proportion of people within a class, staying in the same class.

Table 4

Means and standard deviations (SD) for all gambling measures and risk factors for the five latent gambling classes.

Variable	Gambling class	Year 1		Year 2		Year 3		Year 4	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Days gambling/year	Low-gambling	2.15	5.86	3.31	8.42	2.49	6.66	2.81	7.42
	Card gambling	11.66	15.29	17.83	21.52	16.97	22.51	22.36	24.51
	Casino/slot	10.12	11.71	11.92	14.64	10.99	13.63	8.86	11.17
	Extensive	31.53	15.03	45.72	37.74	41.93	32.67	37.76	37.87
Number of gambling activities	Low-gambling	0	0-5	0	0-3	0	0-2	0	0-3
	Card gambling	3	1-7	3	1-7	3	1-7	5	1-9
	Casino/slot	4	1-8	4	2-8	3	2-6	3	1-6
	Extensive	10	9-10	10	4-10	7	3-10	9	4-10
Self-identified problem gambling	Low-gambling	0.9%		1.0%		0.7%		1.1%	
	Card gambling	4.7%		5.1%		5.0%		8.4%	
	Casino/slot	1%		6.3%		3.3%		1%	
	Extensive	40%		61%		25%		37%	
BSI-18 sum score	Low-gambling	8.29	9.15	8.06	9.21	7.32	8.52	7.33	9.26
	Card gambling	7.79	8.00	7.15	7.80	8.01	8.44	5.91	7.59
	Casino/slot	9.31	9.93	8.48	7.96	7.76	8.27	7.61	8.49
	Extensive	23.8	18.79	20.2	15.93	11.1	14.08	20.06	22.30

Variable	Gambling class	Year 1		Year 2		Year 3		Year 4		
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Heavy alcohol use measure	Low-gambling	1.69	2.66	2.75	3.59	2.89	3.60	3.04	3.74	
	Card	2.61	3.02	4.73	4.64	4.51	4.28	5.40	4.56	
	Casino/slot	2.40	2.71	3.88	3.82	3.93	3.69	3.73	3.41	
	Extensive	6.24	4.34	10.65	6.84	7.51	6.24	7.78	5.31	
Heavy drug use measure	Low-gambling	0.56	2.29	0.65	2.66	0.57	2.34	0.56	2.38	
	Card gambling	1.33	3.89	1.47	4.06	1.28	3.76	2.32	4.90	
	Casino/slot	1.23	3.63	1.36	3.65	0.96	3.33	0.73	2.81	
	Extensive	4.82	5.94	5.88	7.53	1.40	3.12	0.73	2.83	
		Median	Range							
Conduct disorder symptoms year 1	Low-gambling	1	(0-9)	-	-	-	-	-	-	
	Card gambling	1	(0-9)	-	-	-	-	-	-	
	Casino/slot	1	(0-9)	-	-	-	-	-	-	
	Extensive	4	(0-9)	-	-	-	-	-	-	
		Mean	SD							
Novelty seeking scores year 1	Low-gambling	4.76	2.88	-	-	-	-	-	-	
	Card gambling	5.48	2.90	-	-	-	-	-	-	
	Casino/slot	4.61	2.63	-	-	-	-	-	-	
	Extensive	7.46	1.98	-	-	-	-	-	-	

BSI-18: 18-item Brief Symptom Inventory.