Substance use and gambling patterns among adolescents: differences according to gender and impulsivity

Abstract

Although alcohol, tobacco and cannabis are the most prevalent drugs used by adolescents, gambling is a growing concern due to its increasing popularity. To date there have been few studies exploring the existing patterns of concurrent use of drugs and gambling in adolescents. This study aims to identify subpopulations of adolescents using different substances and gambling activities, to explore gender differences and to examine impulsivity as a predictor of class membership. A cross-sectional survey was carried out in 22 high-schools, and 1,644 adolescents were assessed (54.1% males; mean age = 15.21 years, SD = 0.75). Participants reported their last-year frequency of using alcohol, tobacco and cannabis, as well as bingo, poker, other casino games, sports betting, lottery, scratch tickets and electronic gaming machines. Problem drinking was evaluated with the Rutgers Alcohol Problems Index, and gambling severity with the South Oaks Gambling Scale for Adolescents. Impulsivity was assessed using a Delay Discounting task, the Barratt Impulsiveness Scale and the Impulsive Sensation-Seeking Scale. Based on a latent class model of drugs and gambling activities, four subpopulations of males and five of females were found. General impulsivity and sensation seeking were the most consistent predictors of class membership. These novel findings support the need to consider specific groups of adolescents engaging in different patterns of addictive behaviors when implementing selective prevention strategies.

Keywords: Alcohol; Tobacco; Cannabis; Gambling; Impulsivity

Introduction

Gambling among adolescents has been raised as a concern due to its increasing prevalence worldwide (Calado et al. 2016; Elton-Marshall et al. 2016; Gonzalez-Roz et al. 2017). This fact combined with the high prevalence of alcohol, tobacco and cannabis use (European Monitoring Center for Drugs and Drug Addiction 2016; Swendsen et al. 2012) represents an important public health issue due to their potential negative consequences (Delfabbro et al. 2016; Tanaree et al. 2017).

Individuals using drugs and gambling differ in the specific substance or activity used, in the pattern engaged in, and in the range of concurrent substances and gambling activities used (EMCDDA 2009; Johnston et al. 2017; Volberg et al. 2010). For instance, most adolescents report low use of alcohol in the absence of other drugs (Su et al. 2018), while others use only tobacco and cannabis (Lamont et al. 2014) or present polydrug use (Kelly et al. 2015). Some patterns are also gender-specific (Choi et al. 2018; Shin et al. 2010). Finally, gamblers can be either strategic (i.e., activities emphasizing individual skills such as poker or sport betting), non-strategic (i.e., games involving chance) or both (Grande-Gosende et al. in press; Moragas et al. 2015). As not all substance use or gambling is related with negative consequences (Kelly et al. 2015; Studer et al. 2016), it is possible that only certain combination of substances and gambling activities or specific patterns of use are associated with negative psychosocial consequences among adolescents. Thus, prevention specialists would benefit from an accurate identification of vulnerable subpopulations presenting these high-risk patterns.

According to the Syndrome Model of addiction, gambling and substance use dependence are not separate disorders but different expressions of common underlying

processes related to shared biopsychosocial factors accounting for the etiology, symptomatology and recovery (Rash et al. 2016; Shaffer et al. 2004). Despite cross-sectional associations between substance use and gambling problems (Messerlain et al. 2007; Miguez and Becoña 2015), evidence suggests that both problems develop in parallel, hence supporting the notion of common risk factors accounting for both substance use and gambling problems (Mutti-Packer et al. 2017).

Besides other factors such as emotional regulation (Jauregui et al. 2016), impulsivity is one of the intra-individual factors most consistently associated with substance-use and gambling severity. Different facets of self-reported and behavioral impulsivity have been associated with alcohol abuse and tobacco and cannabis use (Mitchell and Potenza 2014). Increases in observed impulsivity from early adolescence also predict gambling severity in late adolescence (Liu et al. 2013). However, this evidence is based on the use of limited impulsivity measures, blurring the association of specific facets with substance or gambling problems. Consequently, research examining whether different facets of impulsivity predict concurrent use of drugs and gambling among adolescents is still needed.

A relatively new person-centered approach to address this goal is the Latent Class Analysis (LCA; see Lanza and Rhoades 2013). This type of finite mixture model uses empirical data derived from actual participants' responses to identify exclusive and exhaustive subgroups, thus overcoming limitations of *a priori* theory-based or *a posteriori* frequency-based classifications. Despite the extensive use of LCA among adolescent substance users (Su et al. 2018; Tomczyk et al. 2016), it has been scarcely used in adolescent gambling research (Boldero et al. 2010; De Luigi et al. 2018; Kong et al. 2014). The first study addressing this topic (Boldero et al. 2010) found six subgroups of adolescent gamblers

and a recent study found eight different classes (De Luigi et al. 2018). Despite these contrasting findings, three common subgroups were reported (i.e., low-risk classes of 'rare' and 'lottery & scratch' gamblers and a high-risk class of 'heavy' gamblers). Evidence is still lacking regarding patterns of concurrent use of drugs and gambling among adolescents.

The present study sought to address the aforementioned gaps in the literature by 1) identifying subpopulations of adolescents using different substances and gambling activities, 2) exploring gender differences in the class membership, and 3) examining several impulsivity facets as predictors of class membership.

Method

Participants

A community-based sample of 1,691 adolescents (mean age = 15.22, *SD* = 0.76; 54.5% males) were surveyed on their use of different substances and gambling activities. The inclusion criteria were to be currently attending the last grade of secondary education, and attending class on the assessment day. After excluding participants with intellectual disability (n = 2) or presenting random responses (n = 45), the final sampled comprised 1,644 participants (see Table 1 for sample characteristics).

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Sample design

A total of 22 out of 103 high schools located in six different cities/towns were selected following a random stratified and convenience procedure. Before data collection, letters were mailed to the parents of students enrolled in the last grade of secondary education (equivalent to U.S. 9th grade) in order to obtain their written informed consent. In accordance with the

school principals, two experimenters visited each center and surveyed all the students enrolled in the last grade who were attending class. After giving guarantees of total confidentiality and anonymity, participants were assessed in their own classrooms at regular school times using digital devices (Samsung Galaxy Tab2 10.1) comprising computerized versions of all instruments, which allowed for individualized response. Participants filled in the survey sitting at individual desks and under the supervision of two experimenters to avoid interactions between them. Before de assessment, the experimenters provided instructions about how to complete the questionnaires and how to response to the behavioral task. The study procedure was carried out in accordance with the Declaration of Helsinki. The Institutional Review Board of the University of XXX, the local educational authorities and the participating schools approved this study. No parent refused permission.

Measures

Demographical data. Data regarding age, sex, country of birth, family structure (i.e., no parents, mono-parental family, two-parent family), most frequent academic grade in the past semester (i.e., outstanding, notable, good, failing) and amount of weekly allowance (i.e., €0-5, €6-10, €11-15, €16-20, ≥€21) were collected.

Control variables. For detecting random responses, the Oviedo Infrequency Scale (Fonseca-Pedrero et al. 2009) was used. Participants rated 12 different obvious statements (e.g., 'I have sometimes watched films on TV') on a 5 point scale (1 = totally disagree, 5 = totally agree). Authors' guidelines recommend excluding participants scoring three or more.

Substance use. Using items from the ESPAD (European School Survey Project on Alcohol and Other Drugs 2007) participants reported the frequency of use of alcohol, tobacco and

cannabis in the past year (none, 1-2 times, 3-5 times, 6-9 times, 10-19 times, 20-39 times, + 40 times).

Gambling behavior. Participants were also asked to report their frequency of engagement in seven different gambling activities over the past year, either land-based or online: bingo, poker, other casino games (OCGs), sports betting, lottery, scratch-tickets and electronic gaming machines (EGMs).

Severity of alcohol use and gambling. The Spanish adaptations (Becoña 1997; López-Nuñez et al. 2012) of the Rutger's Alcohol Problem Index (White and Labouvie 1989) and the South Oaks Gambling Screen – Revised for Adolescents (Winters et al. 1993) were used to assess alcohol use and gambling severity, respectively. While the former offers a cut-off of seven for problem drinking and possible dependence, the latter classified gamblers into three categories: non-problem gambler (score of 0 or 1), at-risk gambler (from 2 to 3) and problem gambler (4 points or more). Cronbach's alpha in this sample was .88 for the RAPI and .67 for the SOGS-RA.

Self-reported impulsivity. Two different questionnaires were used to assess different impulsivity facets. The Spanish adaptation (Martinez-Loredo et al. 2015) of the adolescent version of the Barratt Impulsiveness Scale (BIS-11-A; Fossati et al. 2002) comprises 30 Likert-type items and provides two subscales assessing general (BIS-g, $\alpha = .80$) and non-planning (BIS-np, $\alpha = .73$) impulsivity. The Impulsive Sensation Seeking scale (ImpSS; Zuckerman et al. 1993) contains 19 dichotomous items grouped into two subscales: impulsivity (Imp) related with lack of premeditation and sensation seeking (SS). In the present study the Spanish adaptation (Fernandez-Artamendi et al. 2016) showed good internal consistency (Imp $\alpha = .76$; SS $\alpha = .75$).

Delay Discounting. Impulsive choice was assessed by means of a Delay Discounting task (DD). DD was implemented using an adjusting-amounts procedure in which participants were presented with multiple choices between a hypothetical amount of €1,000 available after seven fixed delays versus different amounts available immediately. The DD rates were calculated through the log-transformed *k* values (log*k*; Mazur 1987).

Statistical analysis

Descriptive and bivariate analyses were performed to explore sample characteristics and gender differences in those variables. Considering the low frequency of gambling, participants' answers regarding gambling behavior were dichotomized and at-risk and problem gambling categories of the SOGS-RA were merged following previous studies (Potenza et al. 2011). Considering the low prevalence of high frequency use of some substances, responses were recoded from the original 7 point to a 6 point scale (i.e., none, 1-2 times, 3-5 times, 6-9 times, 10-19 times, 20 times or more).

A multi-group Latent Class Analysis (LCA) with covariates was performed to obtain subgroups of participants engaging in different patterns of substance use and gambling. Based on participants' response patterns, the LCA assigns each individual to one of the exclusive subgroups based on the probability of being a member of such a subpopulation. Parameters were estimated by maximum likelihood using the expectation maximization (EM) procedure with Newton-Raphson incorporated into the estimation of regression coefficients for covariates (Lanza et al. 2015). Assessment of the LCA performance followed the methodological recommendations of a recent systematic review (Tomczyk et al. 2016).

First, the goodness of fit of several baseline models without any grouping variable or covariate was explored to identify an optimal baseline model. Each model estimation was

replicated using different random starting values for the rho (ρ) parameters with 500 sets of random starting values to ensure model identification (Lanza et al. 2007). The number of latent classes was selected based on 1) the incremental model fit via Akaike's Information Criteria (AIC) and the sample-adjusted Bayesian Information Criterion (SABIC) and 2) on the quality of classification via entropy. Due to the unknown distribution of the log-likelihood G^2 test when using indicators with several alternatives (Lanza et al. 2012), this general model fit index yields results of limited utility for model selection; accordingly, it was not being used in the present study. Considering class sample size and interpretability of each class, a smaller AIC, SABIC and entropy suggest a better model fit and parsimony (Lanza and Rhoades 2013).

After choosing the optimal model, gender differences in class membership were explored by adding sex (males = 1, females = 2) as a grouping variable and testing for measurement invariance. Models with free and constrained estimation of ρ parameters were compared by performing a likelihood ratio test on the differences between G^2 statistics of each model. A significant *p*-value suggests that the assumption of measurement invariance is violated, thus requiring a separate LCA for each sex.

Finally, to examine if individuals' class membership depends on any impulsivity facet, these variables were included as covariates and separate multiple multinomial logistic regressions by sex were performed. The values of the variance inflation factor (VIF) and the tolerance (TOL) for both males (VIF $\leq$ 2.17; TOL > 0.46) and females (VIF < 2.07; TOL > 0.48) suggested the absence of multicollinearity (Bowerman and O'Connell 1990; Menard 1990). All impulsivity measures were standardized to facilitate the interpretation. All analyses were performed using PRO LCA 1.3.2 for SAS 9.4.

Results

Substance use and gambling prevalence

A total of 71.6%, 28.2% and 21.7% of the participants reported use of alcohol, tobacco and cannabis in the past year, respectively. Regarding gambling activities, lottery was the most prevalent with 17.7% of participants reporting use in the past year, followed by sports betting (15.6%), scratch tickets (14.7%), bingo (10.6%), poker (8.6%), EGMs (5.5%) and OCGs (1.8 %). The mean RAPI and SOGS-RA scores were 2.26 (*SD* = 5.50) and 0.65 (*SD* = 1.31), respectively, and represented 12.6% and a 5.2% of problem drinking and gambling, respectively.

Latent class model of addictive behaviors

Comparison of baseline models

The incremental model fit criteria and the quality of the classification via entropy suggested that the 5-class model had the best fit. However, only 59.2% of random starting values for the ρ parameters were associated with the best fit, what suggests a poor model quality. To improve model identification and the potential replication of results, the 4-class model was selected (LL = -9,028.87, AIC = 3,108.37, SABIC = 3,328.95, entropy = .81; 90% of starting values associated with the model). Latent class sizes were 9.53%, 52.77%, 18.38% and 19.32%, suggesting the relevance of each class. Before interpreting each class, gender differences in class membership were explored and measurement invariance between item-response probabilities were tested.

Gender differences and measurement invariance

After running models with free and constrained estimation, the likelihood ratio test yielded significant differences (change in $G^2 = 222.69$, df = 96, $p <. 001$), suggesting that measurement invariance across sexes was not constant. This result indicates that different measurement models should be applied to male and female participants, so separate LCAs were performed for each sex.

Considering the goodness of fit criteria, the size of the classes, the percentage of random starting values associated with the best fitted model and the theoretical interpretation, a 4-class model was selected in males (see Table 2). Based on the item-response probability patterns associated with each class (see Table 3), they were labelled as follows: class 1) 'smokers with alcohol abuse' (17.53% of the male participants, n = 156); class 2) 'exclusively gamblers' (18.43%, n = 164); class 3) 'non-users' (53.93%, n = 480); and class 4) 'broad users' (10.11%, n = 90).

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The 'smokers with alcohol abuse' class was characterized by frequent alcohol and tobacco use in the absence of gambling. This class yielded a significant probability of presenting problem drinking and cannabis experimentation. Adolescents in the 'exclusively gamblers' group had a high probability of gambling in lottery, sports and scratch tickets and a low probability of use any substance. The 'non-users' group was comprised of adolescents with low probability of use of any substance or gambling activity. Lastly, 'broad users' had a high probability of using alcohol, tobacco and cannabis (ATC) together with poker, sports betting, lottery, scratch tickets and EGM. Consistently, these adolescents were more likely to experience problem drinking and gambling.

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Among females, the 5-class model was selected (see Table 2). Following the same criteria as with male participants, latent classes among females were labelled as follows (see Table 3): class 1) 'exclusively alcohol users' (13.26% of the female participants, n = 100); class 2) 'broad users' (6.5%, n = 49); class 3) 'non-users' (55.70%, n = 420); class 4) 'alcohol and gambling users' (8.89%, n = 67); and class 5) 'smokers with alcohol abuse' (15.65%, n = 118).

Females within the 'exclusively alcohol users' class showed high probability of alcohol use and tobacco experimentation in the absence of cannabis use or gambling. The 'broad users' class included females with frequent ATC use and high probability of problem drinking. Although these participants took part in several gambling activities (mainly lottery and scratch tickets) the presence of problem gambling was not likely. 'Non-users' females had low probability of use of tobacco, cannabis and gambling activities but a significant probability of alcohol experimentation. 'Alcohol and gambling users' included females with moderate frequency of alcohol use, and high probability of gambling in lottery and scratch tickets. Finally, the 'smokers with alcohol abuse' class presented the same pattern as the males (i.e., high probability of alcohol and tobacco use, cannabis experimentation and problem drinking in the absence of gambling).

Impulsivity as predictor of class membership

In order to explore the role of impulsivity in predicting specific patterns of addictive behaviors among participants, five different facets [(impulsive choice (DD), general impulsivity (BIS-g), non-planning (BIS-np), lack of premeditation (Imp) and sensation seeking (SS)] were included in the model as covariates. Separate multiple multinomial

logistic regressions were performed for males and females. The reference group for each model was the 'non-users' class (Class 3 in both sexes). As covariates were standardized, the odds ratio represented the change in odds of having any particular pattern of use (relative to being a non-user) corresponding to a one standard deviation change in each impulsivity facet.

In males, the overall model showed the BIS-g [Change in log-likelihood (ΔLL) = 44.06, degree of freedom (df) = 3, $p < .001$], BIS-np (ΔLL = 14.15, df = 3, $p = .003$), Imp (ΔLL = 8.67, df = 3, $p = .034$) and SS (ΔLL = 40.40, df = 3, $p < .001$) to be significant predictors of the class membership (Table 4). Specifically, and although a higher BIS-g and SS increased the probability of having any pattern of use, these facets were greatly associated with the 'broad users' class, followed by the 'smokers with alcohol abuse' class. BIS-np was negatively associated with the 'exclusively gamblers' class. DD was not a significant predictor of any class (ΔLL = 2.54, df = 3, $p = .469$).

The overall model among females also showed the BIS-g (ΔLL = 15.27, df = 4, $p = .004$], BIS-np (ΔLL = 11, df = 4, $p = .027$) and SS (ΔLL = 90.12, df = 4, $p < .001$) as significant predictors of class membership. DD (ΔLL = 1.37, df = 4, $p = .850$) and Imp (ΔLL = 1.97, df = 4, $p = .742$) did not reach significant levels (see Table 4). A higher SS was associated with an increased probability of having any pattern of use, especially among 'broad users' and 'exclusively alcohol users'. A higher BIS-g increased the odds of being 'broad users' and 'smokers with alcohol abuse'.

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Discussion

This study extends previous evidence regarding the heterogeneity of addictive behaviors among adolescents by exploring concurrent patterns of substance use and gambling for the first time. Three important results from the analysis were: 1) three common latent classes were found in both sexes ('non-users', 'broad users' and 'smokers with alcohol abuse'); 2) additional classes of 'exclusively gamblers' in males and of 'exclusively alcohol users' and 'alcohol and gambling users' in females were found; 3) although SS and BIS-g predicted class membership in both sexes, the magnitude of these associations differed.

Common latent classes across sex

Consistent with previous evidence (Boldero et al. 2010; De Luigi et al. 2018; Tomczyk et al. 2016; Su et al. 2018), most adolescents of either sex did not engage in any addictive behavior (i.e., 'non-users' class) and a minority of them reported concurrent use of different substances or gambling activities (i.e., 'broad users' class). Although a small subgroup of 'smokers with alcohol abuse' has been previously found (Lamont et al. 2014; Maldonado-Molina et al. 2007; Maldonado-Molina and Lanza 2010), a higher proportion of adolescents in the present study exhibited such a pattern of use. This divergence may be explained by recent epidemiological data showing an increase in tobacco use and in the proportion of adolescents drinking heavily (Plan Nacional Sobre Drogas 2018).

The identification of gender-specific gambling activities associated with ATC use among the 'broad users' represents a novel finding. While males using ATC also bet on poker, sports and are more likely to experience problem gambling, females had a high probability of lottery and scratch ticket use but an absence of gambling problems (thus opting to label this class as 'broad' instead of 'heavy' users). Interestingly, female 'broad users' also

presented significant probabilities of no use and experimental use of cannabis. This finding is consistent with a recent research highlighting the association between cannabis, drunkenness episodes and problem gambling (Buja et al. 2017), which suggests that female 'broad users' are a heterogeneous group which needs further research. Some potential common factors have been reported that account for a broad engagement in addictive behaviors such as higher levels of experienced loneliness (Nordmyr et al. 2016) and poor emotional regulation (Estevez et al. 2017). Further, differences in gambling severity may be explained by differences in the structural characteristics (e.g., event and bet frequency, event duration, in-play betting and payout interval) of the activities engaged in (Goodie 2015; Griffiths and Auer 2012). In this sense, some features such as the occasions of in-play betting, the payout interval or the influence of media advertising (Hing et al. 2018) may be important targets for prevention strategies.

Gender-specific latent classes

A subgroup of males bet on lotteries, sports and scratch tickets without using any drug. This class is similar to the 'lottery & sports' class found by De Luigi et al (2018). The overrepresentation of males in sports-related gambling activities (Marchica et al. 2017) and the high prevalence of lottery and scratch tickets use among adolescents (Gonzalez-Roz et al. 2017) contribute to this finding. Adolescents using several gambling activities or wagering a large amount of money may have less available resources to also purchase substances, thus explaining the absence of drug use by this subgroup. Nonetheless, the increased accessibility and bet frequency, and the shorter payout interval derived from online venues may increase the risk associated with this pattern of gambling (De Luigi et al. 2018; Lopez-Gonzalez et al. 2018).

Similarly, a female class mainly comprised of gamblers (i.e., 'alcohol and gambling users') was found. In contrast with the male gamblers class, these females reported some degree of alcohol use and bet primarily on lottery, scratch tickets and bingo. As females suffering from dysphoric/depressed mood tend to gamble in order to escape or avoid emotional painful situations (Ledgerwood and Petry 2010), it is possible that part of this subpopulation gambles on non-strategic games to cope with negative emotions (Moragas et al. 2015). Non-strategic games are prevalent among individuals gambling for social motives (Grande-Gosende et al in press), who are mostly women (Stewart and Zack 2008). Finally, the 'exclusively alcohol users' class exhibited a similar pattern to the 'non-users', except for the presence of alcohol use and tobacco experimentation. In line with epidemiological data (PNSD 2018), this finding suggests that alcohol use is a cross-cutting characteristic among females that does not offer valuable information for detecting at-risk populations.

Impulsivity as predictor of class membership

Despite SS and BIS-g being significant predictors of class membership across subpopulations, they were more relevant for some groups than others. A higher SS was particularly associated with broad use in both sexes and with exclusive alcohol use in females. These results are consistent with previous studies suggesting SS is an important risk factor for persistent (Balevich et al.2013; Peeters et al. 2014) and problem (Whelan et al. 2014) alcohol and gambling (Smith et al. 2007). Some SS-related traits such as experience or novelty seeking and boredom susceptibility predict problem gambling (Del Pino-Gutierrez et al. 2017; Harris et al.2015). Thus, it is possible that alcohol, tobacco, lottery and scratch tickets for females and cannabis, poker and sports betting for males are particularly effective activities at providing new and stimulating experiences. A higher general impulsivity was

also greatly associated with broad use in males. This finding is consistent with the previously reported association between impulsivity and problem drinking (Di Nicola et al. 2017; Lawrence et al. 2009) and gambling (Chamberlain et al. 2017; Lawrence et al. 2009), providing additional support to the role of impulsivity in the association between the use of certain substances and gambling severity (Buja et al. 2017). Individuals with greater impulsivity are more vulnerable to engaging in substance use patterns characterized by loss of control and immediate rewards and stimulation (Deleuze et al. 2015). Thus, wagering in poker and sports in addition to ATC use may represent an increased risk for substance use and gambling problems.

Limitations

Some limitations should be considered when interpreting the present findings. Adolescent gamblers reported a low frequency of betting precluding the identification of different patterns of gambling within activities. Furthermore, only measures of alcohol and gambling severity were included. Future research needs to explore subgroups accounting for frequency of use, mode of access, and nicotine and cannabis dependence. Lastly, some relevant facets such as urgency were not included in the present study. However, the comprehensive assessment conducted allows clarification of the role of several facets in predicting different patterns of addictive behaviors among adolescents.

Conclusions

The present study reports novel findings supporting the parallel development of different addictive behaviors and the important role of different impulsivity facets in predicting such patterns. Both environmental prevention strategies and personality-targeted

prevention programs should consider gender differences between subpopulations of adolescents and the gender-specific characteristics of 'broad users'.

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Table 1

Sociodemographic characteristics of the final sample

	Males (n = 890)		Females (n = 754)		χ^2/t	p	Effect size
	n	%	n	%			
Country of birth					.517	.472	-
Spain	796	54.5	665	45.5			
Other	94	51.4	89	48.6			
Family Structure					.026	.987	-
Living with no parents	16	53.3	14	46.7			
Monoparental family	236	53.9	202	46.1			
Two-parent family	638	54.3	538	45.7			
Academic mark					32.43	<.001	.140 ‡
Failing grade (from F to D+)	144_a	60	96_b	40			
Good (from C- to C+)	386_a	60.7	250_b	39.7			
Notable (from B- to B+)	283_a	48.2	304_b	51.8			
Outstanding (A and A+)	77_a	42.5	104_b	57.5			
Weekly allowance					8.032	.09	
€0 - 5	194	53	172	47			
€6 - 10	239	52.6	215	47.4			
€11 – 15	159	51.1	152	48.9			
€16 – 20	184	55.3	149	44.7			
+€20	114	63.3	66	36.7			
Age*	15.26 (0.77)		15.15 (0.72)		2.99	.003	0.147 †

Note. Subscripts indicate between-group differences. Groups with the same subscript did not differ significantly from each other.

* Years (Standard deviation)

† Cohen's d

‡ Cramer's V

Table 2

Latent class models for substance use and gambling by sex

	LL	AIC	SABIC	Entropy
Males				
Class = 2	-5,307.33	2,608.31	2,687.46	0.90
Class = 3	-5,172.30	2,388.25	2,507.80	0.81
Class = 4	**-5,078.51**	**2,250.66**	**2,410.58**	**0.81**
Class = 5	-5,025.01	2,193.66	2,393.97	0.81
Class = 6	-4,986.80	2,167.25	2,407.95	0.85
Females				
Class = 2	-3,995.80	1,799.61	1,870.66	0.91
Class = 3	-3,889.67	1,637.36	1,744.66	0.85
Class = 4	-3,819.05	1,546.12	1,689.67	0.85
Class = 5	**-3,767.47**	**1,492.96**	**1,672.75**	**0.85**
Class = 6	-3,734.41	1,476.84	1,692.89	0.85

Note. Best fitting models shown in bold. LL = log-likelihood estimator for model convergence. AIC = Akaike information criterion. SABIC = sample-adjusted Bayesian information criteria.

Table 3

Item-response probabilities for substance use and gambling according to latent class membership

Variable	Males				Females				
	Class 1	Class 2	Class 3	Class 4	Class 1	Class 2	Class 3	Class 4	Class 5
Alcohol use									
No	.014	**.304**	**.481**	.000	.000	.000	**.445**	.142	.000
1-2 times	.056	.218	.224	.024	.064	.019	**.256**	**.221**	.037
3-5 times	.096	.207	.130	.014	.156	.015	.155	**.294**	.079
6-9 times	.097	.107	.075	.062	.179	.083	.100	**.208**	.129
10-19 times	**.350**	.114	.059	.167	**.452**	**.285**	.024	.098	.088
≥ 20 times	**.388**	.051	.031	**.733**	.150	**.598**	.021	.037	**.667**
Tobacco use									
No	.253	**.893**	**.980**	.095	**.527**	.089	**.982**	**.846**	.015
1-2 times	.167	.064	.018	.100	**.457**	.033	.007	.089	.000
3-5 times	.055	.027	.002	.014	.000	.059	.007	.000	.164
6-9 times	.097	.006	.000	.027	.000	.062	.005	.065	.059
10-19 times	.064	.005	.000	.119	.067	.146	.000	.000	.088
≥ 20 times	**.365**	.006	.000	**.645**	.000	**.612**	.000	.000	**.674**
Cannabis use									
No	**.284**	**.955**	**.997**	.164	**.819**	**.245**	**.994**	**.967**	.217
1-2 times	**.287**	.021	.002	.187	.135	**.247**	.006	.000	**.269**
3-5 times	.090	.017	.000	.059	.038	.100	.000	.033	.156
6-9 times	.093	.000	.000	.089	.000	.102	.000	.000	.073
10-19 times	.052	.000	.000	.073	.000	.102	.000	.000	.115
≥ 20 times	.194	.007	.000	**.427**	.008	**.205**	.000	.000	.171
Bingo	.058	.240	.026	**.283**	.061	**.338**	.066	**.392**	.018
Poker	.035	.233	.043	**.596**	.032	.173	.000	.026	.021
OCG	.023	.029	.004	.1501	.000	.056	.000	.026	.000
Sports betting	.082	**.510**	.081	**.453**	.151	**.330**	.023	**.350**	.000
Lottery	.068	**.580**	.047	**.409**	.048	**.636**	.049	**.674**	.024
Scratch tickets	.052	**.418**	.029	**.376**	.131	**.575**	.036	**.567**	.043
EGM	.014	.063	.007	**.351**	.038	**.264**	.008	**.214**	.021
SOGS-RA	.000	.214	.000	**.281**	.000	.168	.000	.144	.000
RAPI	**.368**	.006	.000	**.542**	.150	**.695**	.000	.000	**.376**

Note. Item-response probabilities higher than .25 for males and .20 for females are shown in bold. OCG: other casino games. EGM: electronic gaming machines. SOGS-RA: South Oaks Gambling Screen – Revised for Adolescents. RAPI: Rutger's Alcohol Problem Index.

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Table 4

Multinomial logistic regressions to predict latent class membership

	Males						Females							
	Smokers with alcohol abuse		Exclusively gamblers		Broad users		Exclusively alcohol users		Broad users		Alcohol and gambling users		Smokers with alcohol abuse	
	β	OR	β	OR	β	OR	β	OR	β	OR	β	OR	β	OR
DD	-0.14	0.86 (0.68-1.10)	0.07	1.07 (0.85-1.34)	0.05	1.05 (0.81-1.37)	0.18	1.20 (0.88-1.64)	0.06	1.06 (0.72-1.56)	0.03	1.03 (0.78-1.37)	0.09	1.09 (0.86-1.40)
BIS-g	0.71	**2.03 (1.46-2.83)**	0.46	**1.59 (1.17-2.15)**	0.99	**2.68 (1.91-3.77)**	0.03	1.03 (0.69-1.54)	0.54	**1.72 (1.13-2.61)**	0.06	1.06 (0.71-1.59)	0.50	**1.66 (1.21-2.26)**
BIS-np	0.20	1.23 (0.92-1.64)	-0.37	**0.69 (0.53-0.90)**	-0.07	0.94 (0.68-1.29)	0.26	1.29 (0.89-1.87)	0.23	1.26 (0.82-1.92)	-0.34	0.71 (0.50-1.02)	0.24	1.27 (0.96-1.68)
Imp	-0.27	0.76 (0.54-1.08)	0.26	1.30 (0.95-1.78)	0.20	1.22 (0.84-1.78)	-0.15	0.86 (0.57-1.30)	-0.02	0.98 (0.57-1.30)	0.06	1.06 (0.69-1.62)	-0.20	0.82 (0.59-1.15)
SS	0.61	**1.83 (1.38-2.43)**	0.45	**1.57 (1.21-2.02)**	0.84	**2.32 (1.66-3.23)**	1.23	**3.43 (2.21-5.33)**	1.75	**5.78 (3.0-11.16)**	0.79	**2.21 (1.49-3.27)**	0.91	**2.49 (1.75-3.53)**

Note. Reference latent class for both sexes: Non-users. Significant odds ratio shown in bold. OR: odds ratio (95% confidence interval). DD: Delay Discounting. BIS-g = general subscale of the Barratt Impulsiveness Scale (BIS). BIS-np: non-planning subscale of the BIS. Imp: impulsivity subscale of the Zuckerman–Kuhlman Personality Questionnaire (ZKPQ). SS: sensation seeking subscale of the ZKPQ.