



## Cigarette smoking, problem-gambling severity, and health behaviors in high-school students



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### ABSTRACT

**Introduction:** Smoking and gambling are two significant public health concerns. Little is known about the association of smoking and gambling in adolescents. The current study of high-school adolescents examined: (1) smoking behavior by problem-gambling severity and (2) health-related variables by problem-gambling severity and smoking status.

**Methods:** Analyses utilized survey data from 1591 Connecticut high-school students. Adolescents were classified by problem-gambling severity (Low-Risk Gambling [LRG], At-Risk/Problem Gambling [ARPG]) and smoking status (current smoker, non-smoker). Analyses examined the smoking behavior of ARPG versus LRG adolescents as well as the smoking-by-problem-gambling-severity interactions for health and well-being measures (e.g., grades, substance use). Chi-square and logistic regression analyses were used; the latter controlled for gender, race/ethnicity, school grade, and family structure.

**Results:** More adolescents with ARPG than LRG reported regular smoking, heavy smoking, early smoking onset, no smoking quit attempts, and parental approval of smoking. ARPG and LRG adolescents who smoked were more likely to report poor grades, lifetime use of marijuana and other drugs, current heavy alcohol use, current caffeine use, depression, and aggressive behaviors and less likely to report participation in extracurricular activities. The association between not participating in extracurricular activities and smoking was statistically stronger in the LRG compared to the ARPG groups. Post-hoc analyses implicated a range of extracurricular activities including team sports, school clubs, and church activities.

**Conclusions:** Smoking was associated with poorer health-related behaviors in both ARPG and LRG groups. Interventions with adolescents may benefit from targeting both smoking and gambling.

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## 1. Introduction

Smoking and gambling are two significant public health concerns for adolescents. More than 5 million deaths of adults across the globe, and 480,000 deaths of adults in the U.S. every year are attributable to smoking (USDHHS, 2014; WHO, 2012). More than half of U.S. high-school students have tried smoking, and 15.8% report current cigarette smoking (CDC, 2012), and rates of smoking increase through adolescence (Baker, Brandon, & Chassin, 2004). The majority of adult smokers report consuming their first cigarette prior to age 18

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(Lantz, 2003; Schoenborn, Adams, & Peregoy, 2013; USDHHS, 2014). Adolescent smoking is associated with the development of heavy regular smoking (Colder et al., 2001; Ellickson, Tucker, & Klein, 2008; Stanton, Flay, Colder, & Mehta, 2004), continued smoking in young- and later-adulthood (Chassin, Presson, Rose, & Sherman, 1996; Patton, Coffey, Carlin, Sawyer, & Wakefield, 2006; Van De Ven, Greenwood, Engels, Olsson, & Patton, 2010), and other substance use and deviant or violent behavior (Audrain-McGovern et al., 2004; Ellickson, Saner, & McGuigan, 1997; Orlando, Tucker, Ellickson, & Klein, 2004; Stanton et al., 2004).

Gambling is also a serious concern among adolescents. Up to 86% of adolescents report some form of gambling, with 4–8% of adolescents reporting a serious gambling problem (Jacobs, 2000; Kristiansen & Jensen, 2014; Splevins, Mireskandari, Clayton, & Blaszczynski, 2010). Further, some data suggest that gambling behavior among adolescents has increased over time (Jacobs, 2000). Gambling in adolescents is associated with anxiety, depression, low self-esteem, poorer coping skills, difficulty in school, and suicidal ideation and attempts (Blinn-Pike, Worthy, & Jonkman, 2010; Jackson, Dowling, Thomas, Bond, & Patton, 2008; Jacobs, 2000; Langhinrichsen-Rohling, Rohde, Seeley, & Rohling, 2004; Lynch, Maciejewski, & Potenza, 2004; Ólason, Skarphedinsson, Jonsdottir, Mikaelsson, & Gretarsson, 2006; Petry & Tawfik, 2001; Splevins et al., 2010; Yip et al., 2011). Adolescent gambling is also associated with more severe medical and psychiatric problems in adulthood (Burge, Pietrzak, Molina, & Petry, 2004; Burge, Pietrzak, & Petry, 2006; Lynch et al., 2004), and adolescent problem gamblers are more likely than their non-gambling and non-problematic gambling counterparts to be involved in delinquency and crime and to report co-morbid use of alcohol and other drugs (Blinn-Pike et al., 2010; Jacobs, 2000; Petry & Tawfik, 2001; Splevins et al., 2010; Yip et al., 2011).

Little is known about the relationship between gambling and smoking in adolescents. Adults who gamble are more likely to report smoking than adults who do not gamble (Black, Shaw, McCormick, & Allen, 2013; Hayatbakhsh, Clavarino, Williams, Bor, & Najman, 2012; Lorains, Cowlishaw, & Thomas, 2011; McGrath & Barrett, 2009; Morasco et al., 2006). While fewer studies have explored the relationship between adolescent gambling and smoking, there is evidence for similar patterns in adolescents and adults, with adolescents who gamble reporting higher smoking rates (Jackson et al., 2008; Jacobs, 2000; Kong et al., 2013; Splevins et al., 2010; Yip et al., 2011). For example, a review found that youth who reported serious gambling-related problems used tobacco at twice the rate of their non-problem gambling counterparts (Jacobs, 2000). Together, data show that gambling in both adults and adolescents is associated with high rates of smoking. The association of gambling to other aspects of adolescent smoking behavior such as amount of daily smoking, age of smoking onset, and quit attempts has not yet been studied systematically in adolescents.

There is an association between problem-gambling severity and both psychiatric symptoms and substance use in adults. Current smoking in adult gamblers has been associated with greater anxiety, depression, drug and alcohol use, and treatment for psychiatric and substance-use disorders (Grant, Kim, Odlaug, & Potenza, 2008; Odlaug, Stinchfield, Golberstein, & Grant, 2013; Petry & Oncken, 2002; Potenza et al., 2004). Notably, one study of 465 U.S. adult pathological gamblers found that those who smoked were less likely to meet criteria for a mood disorder than gamblers who did not smoke (Grant et al., 2008). How smoking in adolescent gamblers might associate with health-related behaviors such as alcohol and other substance use, dysphoria/depression, aggression, and academic-related variables (e.g., grades, participation in extra-curricular activities) has not yet been systematically investigated.

### 1.1. Aims of the current study

Given the multiple adverse outcomes associated with both adolescent gambling (particularly with at-risk or problematic

gambling — ARPG) and tobacco use and the relationship between smoking and greater substance use and psychiatric concerns in adult gamblers, the aims of the current study were to examine (1) the smoking behavior and (2) differences in health measures by smoking status in a sample of 1591 Connecticut high-school students who reported different levels of problem-gambling severity. With regard to the first aim of the study, it was hypothesized that greater problem-gambling severity would be associated with more severe smoking behaviors. Specifically, we expected that adolescents who reported ARPG as compared to those reporting low-risk gambling (LRG) would be more likely to report smoking and would be more likely to report heavier daily smoking, an earlier onset of smoking, a lower number of smoking quit attempts, and more lenient perceived parental perceptions regarding smoking. With regard to the second aim of the study, it was hypothesized that across problem-gambling-severity groups, adolescents who smoke would report greater adverse measures of health and well-being compared to adolescents who do not smoke. Specifically, we expected that ARPG and LRG adolescents who smoke as compared to those who do not smoke would be less likely to report participating in extracurricular activities and would be more likely to report poor grades, current alcohol, marijuana, drug, and caffeine use, depressed mood, and aggressive behaviors. Finally, we hypothesized that there would be an interactive relationship between smoking and problem-gambling severity such that a significantly stronger relationship between smoking and poor health measures would be observed in adolescents with at-risk/problem gambling compared to adolescents with low-risk gambling.

## 2. Materials and methods

### 2.1. Participants

Participants were public high-school students in the state of Connecticut. Of the 4523 adolescents who took the survey, 2030 reported past-year gambling and completed all questions targeting DSM-IV criteria for pathological gambling. Of those adolescents, 1591 students reported that they were current or non-smokers, as defined above, and were included in the current study.

### 2.2. Measures

#### 2.2.1. Demographic and health/well-being measures

The 154-question survey assessed multiple demographics (e.g., age, gender, race/ethnicity, grade in school, family structure, current age) and health and well-being measures (e.g., extracurricular activities, grade average, use of marijuana, alcohol caffeine, other drugs, mood, aggression). Classification of these variables into groupings/categories was consistent with previous work (Potenza et al., 2011; Yip et al., 2011) and can be seen in Tables 1 and 3. With regard to academic variables, participants who endorsed that they do at least one of the following “on a regular basis” were classified as a positive endorsement of “any extracurricular activities”: community service/volunteer work, team sports, school clubs, or church activities. Grade point average was classified as “As and Bs,” “Mostly Cs,” and “Ds or lower.” Substance-use variables included lifetime use of marijuana (Yes/No), endorsement of “ever” taking a sip of alcohol (Yes/No), current use of alcohol (never a regular user of alcohol, light use, moderate use, heavy use), and lifetime use of other drugs (e.g., ecstasy, cocaine, heroin; Yes/No). Current caffeine use was classified as “none,” “1–2 caffeine drinks per day,” and “3 or more caffeine drinks per day.” With regard to mood, participants were classified as endorsing dysphoria/depression if they reported that they felt “so sad or hopeless almost every day for two weeks or more in a row that [they] stopped doing some usual activities” in the past 12 months (Yes/No). Two items assessed aggression: whether the participant got into “a physical fight in which [they] were injured and had to be treated by a doctor or

**Table 1**  
Demographics for the Full Sample and by Problem-Gambling Severity.

	Full sample (N = 1591) %	Low-Risk gambling (LRG; N = 1053) %	At risk/problem gambling (ARPG; N = 538) %	$\chi^2$	p-value
Gender				93.36	<0.001
Male	61.8	53.4	78.2		
Female	38.2	46.6	21.8		
Race/ethnicity					
Caucasian				3.73	0.053
Yes	72.5	74.0	69.4		
No	27.5	26.0	30.6		
African-American				16.41	<0.001
Yes	11.9	9.5	16.5		
No	88.1	90.5	83.5		
Asian				0.54	0.46
Yes	4.8	4.5	5.4		
No	95.2	95.5	94.6		
Hispanic				3.95	<0.05
Yes	17.3	16.0	20.0		
No	82.7	84.0	80.0		
Other				0.003	0.96
Yes	17.3	17.3	17.4		
No	82.7	82.7	82.6		
Grade				5.49	0.14
9	32.7	31.5	35.1		
10	25.9	26.9	24.0		
11	24.7	25.8	22.6		
12	16.7	15.8	18.3		
Family structure				13.96	<0.001
One parent	23.4	24.7	20.8		
Two parents	69.7	70.0	69.1		
Other	6.9	5.3	10.1		
Current age				5.89	0.053
≤14 years	17.6	18.2	16.5		
15–17 years	68.1	69.2	65.9		
18+ years	14.3	12.6	17.6		
Type of gambling					
Bought scratch lottery tickets	28.9	22.5	40.9	59.70	<0.001
Bought other lottery tickets	13.5	8.1	24.3	78.66	<0.001
Received scratch lottery tickets as a gift	51.2	46.9	57.9	17.30	<0.001
Received other lottery tickets as a gift	29.1	23.0	40.3	52.56	<0.001
Played bingo at a church, synagogue or other public place	33.9	31.8	37.5	5.23	<0.05
Played slot machines, poker machines, or other gambling machines	24.3	18.0	36.3	65.86	<0.001
Played cards (not at a casino)	93.7	92.1	94.7	3.69	0.06
Gambled on the Internet	19.7	11.8	35.1	121.77	<0.001
Gambled at school	38.4	25.5	62.7	211.49	<0.001
Placed a bet with a bookie	12.4	5.3	26.2	144.19	<0.001
Bet with a friend for money	78.6	72.5	88.2	51.46	<0.001
Bet on video or arcade games	37.3	27.6	55.9	122.22	<0.001
Bet on dice (craps) outside of a casino	24.3	14.9	42.4	147.04	<0.001
Bet on pool or other games of skill	50.0	39.6	69.2	125.67	<0.001
Gambled at a casino	10.6	5.4	20.7	88.96	<0.001
Done any other kind of gambling	45.4	35.0	56.1	130.39	<0.001

nurse” in the past 12 months (Yes/No) and whether the participant carried a weapon (e.g., gun, knife, or club) for 1 day or more in the past 30 days (Yes/No).

### 2.2.2. Gambling measures

Participants were classified into one of two groups defined by problem-gambling severity: (1) low-risk gambling (LRG) or (2) at-risk/problem gambling (ARPG). The categorizations of the two gambling groups were based on DSM-IV diagnostic criteria and assessed, as done previously (Potenza et al., 2011), using items from the Massachusetts Gambling Screen (MAGS; Shaffer & Hall, 1996), a validated measure of DSM-IV pathological gambling criteria. Participants who reported gambling in the past year but who did not meet any DSM-IV criteria were classified as LRG. Participants who endorsed one or more DSM-IV criteria were classified as ARPG. Non-gamblers were excluded from the current study. Participants were also asked to report whether they engaged in any of the following types of gambling behaviors (Yes/No): buying scratch lottery tickets; buying other lottery tickets; receiving scratch lottery tickets as a gift; receiving other lottery tickets as a gift; playing

bingo at a church, synagogue, or other public place; playing slot machines, poker machines, or other gambling machines; playing cards (not at a casino); placing bets on the Internet; gambling on school grounds; placing bets with a bookie; betting with a friend for money; betting on dice (craps) outside of a casino; betting on pool or other games of skill; gambling at a casino, or performing any other types of gambling.

### 2.2.3. Smoking measures

Cigarette-smoking responses were grouped into one of two distinct categories: current smokers and non-smokers. Non-smokers were defined as participants who responded ‘never’ (n = 1059) or ‘once or twice’ (n = 316) in response to ‘have you ever smoked a cigarette?’ Current smokers consisted of individuals who endorsed smoking ‘regularly now’ (n = 239). Participants who reported that they smoked ‘regularly in the past’ (n = 107), ‘occasionally but not regularly’ (n = 217), or had missing smoking data (n = 92) were excluded from the analyses. Additional questions regarding smoking behavior included the number of cigarettes per day (CPD) smoked during the

**Table 2**  
Smoking behavior by problem-gambling severity.

	Full sample (N = 1591) %	Low-risk gambling (LRG; N = 1053) %	At risk/problem gambling (ARPG; N = 538) %	$\chi^2$	p-value
Smoking history				18.43	<0.001
Smoked two times or fewer in lifetime	85.2	87.9	79.9		
Smoke regularly now	14.8	12.1	20.1		
Cigarettes per day during past 30 days <sup>a</sup>				20.52	<0.001
None/Light (<1–7 per day)	30.9	37.5	23.2		
Moderate (8–22 per day)	35.2	41.4	27.8		
Heavy (23+ per day)	33.9	21.1	49.0		
Onset of daily smoking <sup>a</sup>				12.52	<0.01
Never daily smoker	3.0	1.6	4.6		
Earlier (12 years old or younger)	37.7	28.9	48.2		
Later (13 years old or older)	59.3	69.5	47.2		
Number of times tried to stop smoking <sup>a</sup>				14.74	<0.001
None	34.5	23.8	47.2		
Once or twice	35.3	38.9	31.1		
Three or more times	30.2	37.3	21.7		
Smoking partners <sup>ab</sup>					
Friends	96.1	98.1	93.4	2.50	0.11
Family	92.0	97.2	87.2	2.57	0.11
Strangers	92.8	91.2	93.9	0.22	0.64
Smoke alone	97.1	97.9	95.6	0.60	0.44
Parental view of smoking <sup>a</sup>				47.09	<0.001
Strongly disapprove/disapprove	74.1	81.7	62.0		
Neither approve nor disapprove	15.9	13.6	19.5		
Approve/strongly approve	10.0	4.7	18.5		

<sup>a</sup> Among participants reporting current regular smoking (n = 236).

<sup>b</sup> Percentages denote a “yes” response to each category, participants could respond “yes” to more than one category.

past 30 days, age of onset of daily smoking, number of quit attempts, smoking partners, and parental view of smoking (Table 2).

### 2.3. Procedures

Recruitment procedures, sampling characteristics, and consent procedures for the present study have been described previously (Cavallo et al., 2010; Potenza et al., 2011; Schepis et al., 2011; Schepis et al., 2008; Yip et al., 2011). All public high schools in the state of Connecticut were invited to participate in the study via letters. Subsequent targeted recruitment was conducted to ensure appropriate representation of all geographic regions of the state within the sample. The final study sample included schools from each geographical region of Connecticut, as well as from each of the three tiers of the state's district reference groups to ensure adequate socioeconomic representation. While not a random sampling of Connecticut high school students, demographics of the present sample were consistent with those reported in the 2000 Census of Connecticut residents aged 14–18 years. All study and consent procedures were approved by the participating schools as well as by the Institutional Review Board (IRB) of the Yale University School of Medicine. This study was carried out in accordance with the Declaration of Helsinki.

### 2.4. Statistical analysis

All data from the surveys were double-entered into an electronic database. Random spot-checks were performed to ensure accuracy of data. The SAS system (Cary, NC) was used to perform all statistical analyses. Pearson chi-square tests were used to examine between-group differences on demographics and smoking behavior by gambling (ARPG versus LRG). All comparison tests were two-tailed. Models examined main effects of smoking (current smoking versus non-smoking) within the two gambling groups and the interactive associations of smoking and gambling on health and well-being measures adjusting for grade, race, and gender. Current age was not included as a covariate in models due to multicollinearity with grade. Logistic regression models were used to examine variables

with two levels and multinomial logistic regression models were used for those with more than two levels.

## 3. Results

### 3.1. Demographic characteristics (Table 1)

Results of chi-square analyses for demographic characteristics among the full sample and stratified by problem-gambling severity are presented in Table 1. Nearly two-thirds of the sample was male and nearly three-quarters of adolescents identified as Caucasian. The majority of adolescents reported living with two parents and being between the ages of 15 and 17. Compared to LRG adolescents, a greater percentage of ARPG adolescents were male, African-American, and Hispanic and reported living in a family situation that was “other” than living with 1 or 2 parents. Compared to LRG adolescents, a lower percentage of ARPG adolescents self-identified as Caucasian. See Table 1 for the types of gambling behaviors endorsed by the full sample and for LRG versus ARPG adolescents. The most common forms of gambling reported by the full sample were playing non-casino card games, betting with friends for money, receiving scratch lottery tickets as gifts, and betting on pool or other games of skill. The least commonly endorsed forms of gambling were casino gambling, placing bets with bookies, buying non-scratch lottery tickets, and placing bets on the Internet. Significantly more ARPG adolescents endorsed engagement in each type of gambling than LRG adolescents except for non-casino card games (see Table 1).

### 3.2. Smoking behavior (Table 2)

Smoking behavior for the full sample and by problem-gambling severity is presented in Table 2. Nearly 15% of surveyed adolescents reported current cigarette use with more ARPG adolescents reporting current smoking compared to LRG adolescents. More ARPG adolescents than LRG adolescents reported heavy smoking (i.e., 23 or more cigarettes per day), an earlier onset of smoking, never attempting to quit smoking, and parental approval of smoking.

**Table 3**  
Main and interactive effects of smoking status and problem-gambling severity on health and well-being measures.

Variable/category	Low-risk gambling (LRG; N = 1053)		At risk/problem gambling (ARPG; N = 538)		Gambling status by smoking status interaction	
	Current smokers versus non-smokers <sup>a</sup>		Current smokers versus non-smokers <sup>a</sup>		ARPG versus LRG <sup>a</sup>	
	OR	95% CI	OR	95% CI	Interaction OR <sup>b</sup>	95% CI
<i>Academic/extracurricular</i>						
Any extracurricular activities	0.23	0.15, 0.34	0.48	0.29, 0.79	1.93	1.02, 3.65
Grade average						
As and Bs	Ref	–	Ref	–	–	–
Mostly Cs	3.67	2.27, 5.93	1.75	1.00, 3.07	0.50	0.24, 1.04
Ds or lower	11.16	6.25, 19.92	4.94	2.76, 8.85	0.47	0.21, 1.05
Substance use						
Marijuana, Lifetime <sup>c</sup>	40.88	19.46, 85.86	38.13	14.94, 97.33	0.89	0.27, 2.93
Alcohol, sip <sup>c</sup>	6.59	1.68, 28.70	3.52	1.23, 10.06	0.47	0.08, 2.73
Alcohol, current						
Never regular	Ref	–	Ref	–	–	–
Light	2.32	1.06, 5.09	1.71	0.60, 4.84	0.69	0.19, 2.51
Moderate	7.41	3.58, 15.32	2.86	1.06, 7.70	0.36	0.11, 1.22
Heavy	12.49	5.55, 28.11	9.57	3.44, 26.64	0.71	0.19, 2.57
Other drug, lifetime <sup>cd</sup>	47.69	24.43, 93.09	38.40	18.88, 78.12	0.70	0.28, 1.74
Caffeine use						
None	Ref	–	Ref	–	–	–
1–2 drinks per day	1.16	0.62, 2.15	1.08	0.53, 2.11	0.99	0.39, 2.53
3+ drinks per day	3.14	1.68, 5.85	3.08	1.57, 6.04	1.00	0.40, 2.48
Mood <sup>d</sup>						
Dysphoria/depression	2.39	1.49, 3.83	3.51	2.07, 5.96	0.96	0.69, 1.34
Aggression <sup>c</sup>						
Serious fights	5.77	3.01, 11.04	10.76	5.74, 20.16	0.88	0.55, 1.41
Carry weapon	3.00	1.84, 4.90	5.55	3.25, 9.50	1.77	0.88, 2.63

OR, odds ratio; CI, confidence interval.

<sup>a</sup> Model covariates include: gender, race/ethnicity, grade, family structure.<sup>b</sup> Interaction OR reflects ARPG versus LRG.<sup>c</sup> Analyses reflect a “yes” response to each category compared to a “no” response, participants could respond “yes” to more than one category.<sup>d</sup> “Other drugs” included endorsement of use of designer drugs (e.g., ecstasy, GHB, meth), cocaine/crank, and heroin.

### 3.3. Health and well-being measures (Table 3; Supplementary Table 1)

#### 3.3.1. Academics

ARPG smokers and LRG smokers were more likely to report lower grade averages than non-smokers and less likely to report participating in extracurricular activities.

#### 3.3.2. Substance use, mood, and aggression

Adolescent ARPG and LRG gamblers who smoked were more likely to report lifetime use of marijuana and other drugs, both lifetime use of alcohol and current heavy alcohol use, and current heavy caffeine use than adolescent gamblers who did not smoke. Similarly, adolescent ARPG and LRG gamblers who smoked were more likely to report depression, getting into serious fights, and carrying weapons.

#### 3.3.3. Interactions

The relationship demonstrating lower odds of participation in extracurricular activities in smokers was statistically stronger in LRG as compared with ARPG adolescents (Table 3). The problem-gambling-severity-by-smoking interactions were not significant for

other variables suggesting similar relationships with smoking and these variables among LRG and ARPG adolescents.

#### 3.3.4. Post-hoc analyses

To understand better the extracurricular activities driving the observed interaction, we conducted post-hoc analyses examining in LRG and ARPG adolescents the relationships between smoking and participation in individual extracurricular activities. With regard to specific extracurricular activities, LRG smokers were less likely than LRG non-smokers to report participating in team sports, school clubs, and church activities while ARPG smokers were less likely than ARPG non-smokers to report participating in team sports (Table 4). LRG smokers were more likely than LRG non-smokers to report participating in community service or volunteer work (Table 4).

## 4. Discussion

To our knowledge, this current study is the first to investigate health behaviors in a large sample of adolescent high-school students who were classified by both smoking status and problem-gambling severity. As predicted, higher problem-gambling severity was associated with

**Table 4**  
Analysis of Specific extracurricular activities by smoking status and problem-gambling severity.

Academic/extracurricular activities	Low-risk gambling (LRG; N = 1053)				At risk/problem gambling (ARPG; N = 538)			
	Current smokers (n = 129) %	Non-smokers (n = 938) %	$\chi^2$	p-value	Current smokers (n = 110) %	Non-smokers (n = 437) %	$\chi^2$	p-value
Type of extracurricular activities <sup>a</sup>								
Community service/volunteer work	48.4	32.6	6.36	<0.05	34.7	26.4	2.11	0.15
Team sports	56.5	70.4	5.24	<0.05	62.7	77.5	7.28	<0.01
School clubs	22.6	39.7	7.13	<0.01	30.7	27.0	0.42	0.52
Church activities	9.7	21.5	4.86	<0.05	24.0	25.3	0.05	0.82

<sup>a</sup> Percentages reflect a “yes” response to each category, participants could respond “yes” to more than one category.

more severe smoking behavior. Also as expected, both LRG and ARPG adolescents who smoked demonstrated differences in health and well-being behaviors compared to nonsmokers in the respective gambling groups. While it was predicted that the association between smoking and health behaviors would be stronger for ARPG adolescents compared to LRG adolescents, smoking was similarly associated with negative health measures in both low- and high problem-gambling-severity groups. Differences in strengths of associations with smoking in the LRG and ARPG groups were limited to participation in extracurricular activities with LRG versus ARPG adolescents demonstrating a stronger relationship between smoking and non-participation in activities.

Adolescents who reported ARPG were more likely to report smoking than were adolescents with LRG, consistent with previous research demonstrating higher rates of smoking among adolescent gamblers (Jackson et al., 2008; Jacobs, 2000; Splevins et al., 2010) and adult (Black et al., 2013; Hayatbakhsh et al., 2012; Lorains et al., 2011; McGrath & Barrett, 2009; Morasco et al., 2006). The study extended this previous work to show that adolescents with ARPG reported greater smoking behavior as evidenced by heavier smoking, earlier onset of smoking, and fewer smoking cessation attempts. Earlier onset of smoking is associated with heavier smoking (Baker et al., 2004) and difficulty quitting smoking (Khuder, Dayai, & Mutgi, 1999) suggesting that these adolescents may need more intensive services to help them achieve abstinence. The current analyses also found that more permissive attitudes toward smoking were associated with greater problem-gambling severity while previous analyses of data from this survey found that adolescent perception of more permissive parental attitudes toward gambling was associated with heavy smoking as well as the use of alcohol and other drugs (Leeman et al., 2014). Together, these two sets of analyses highlight the relationship between perceived parental attitudes and adolescent risky behaviors. Targeting parental permissive attitudes has shown to impact alcohol consumption in young adults (Fairlie, Wood, & Laird, 2012; Turrisi et al., 2013) and may also be a useful target for gambling and smoking behaviors, although more research is needed to investigate this possibility.

The relationship between gambling and smoking may occur for multiple reasons including biological vulnerabilities (i.e., risk taking or impulsivity; Baker et al., 2004; Willoughby, Good, Adachi, Hamza, & Tavernier, 2013). For example, impulsivity has been associated with both with smoking and gambling in adolescents (Bloom, Matsko, & Cimino, 2015; Chambers & Potenza, 2003; Vitaro & Wanner, 2011) and may underlie the relationship between smoking and more severe gambling in adolescents. Other factors may also link the behaviors; e.g., tobacco use and gambling have each been linked to depression, and factors relating to mood dysregulation may also link smoking and gambling (Desai & Potenza, 2008; Potenza, Xian, Shah, Scherrer, & Eisen, 2005). More work is needed to better understand the mechanisms of the association between smoking behaviors and gambling in adolescents.

Adolescents who both gambled and smoked, compared to adolescents who gambled but did not smoke, reported a range of poorer health behaviors including lower grades, less participation in extracurricular activities, more substance use and depression, and a greater likelihood of fighting and carrying weapons. Contrary to expectation, the relationships between smoking and poorer health behaviors were seen across problem-gambling-severity categories and were of statistically similar magnitudes for most behaviors apart from participation in extracurricular activities. Previous research with adults demonstrated greater mental-health and substance-use issues for adult gamblers who smoked compared to adult gamblers who did not smoke (Grant et al., 2008; Odlaug et al., 2013; Petry & Oncken, 2002; Potenza et al., 2004). Past research in adolescents also demonstrated independent relationships between smoking or gambling with poorer health behaviors such as lower grades, substance use, and aggressive behaviors (e.g., Barnes, Welte, Hoffman, & Tidwell, 2011; Bradley & Greene, 2013; Fergus &

Zimmerman, 2005; Khuder, Price, Jordan, Khuder, & Silvestri, 2008; Potenza et al., 2011; Simantov, Schoen, & Klein, 2000; Yip et al., 2011). The current study is the first to demonstrate the greater level of poor health behaviors in adolescents who both gamble and smoke are greater than in adolescents who engage only in gambling. Future research is needed to better understand the variables underlying the association between smoking and poorer health behaviors in adolescent gamblers that might be targeted through intervention or prevention efforts.

In the current study, adolescents who both gambled and smoked reported poorer health behaviors regardless of problem-gambling severity; however, the relationship between smoking and participation in extracurricular activities was stronger for LRG adolescents compared to ARPG adolescents. Follow-up analyses found that LRG smokers were less likely than LRG non-smokers to participate in three out of four of the assessed extracurricular activities (i.e., team sports, school clubs, and church activities) while ARPG smokers were less likely than ARPG non-smokers to report participating in only one of the activities, team sports. These differences may be due to the type of extracurricular activity and associated variables such as peer behaviors. Fujimoto and Valente (2013) found that use of alcohol by peers in extracurricular activities was associated with participant alcohol use and that this relationship varied based on type of extracurricular activity (i.e., drinking among peers in club activities had a greater impact than drinking among peers on a sports teams). Future research is needed to examine types and aspects of adolescent extracurricular activities (e.g., peer engagement in smoking and/or gambling) and their relationships with gambling and smoking. It should also be noted that LRG adolescents who smoke reported *greater* participation in community service and volunteer activities than LRG adolescents who do not smoke. It is difficult to interpret this finding due to a lack of information regarding the activities that the adolescents were referring to when they endorsed this category, and closer examination of this finding in future studies is warranted.

There are few studies of treatments for smoking or gambling in adolescents (Grant & Potenza, 2010; Karpinski, Timpe, & Lubsch, 2010) and no known studies that look at interventions designed to target both gambling and smoking among adolescents or, importantly based on the current results, to target a range of health behaviors. Currently, school prevention programs like the D.A.R.E. program focus on tobacco and drug use, although it should be noted that efforts to address adolescent gambling are increasing (Messierian, Derevensky, & Gupta, 2005). Given the relationship between gambling and smoking for adolescents, it may be beneficial both from efficiency and targeted population perspectives to incorporate gambling education into already existing tobacco awareness and prevention programs and to include smoking cessation considerations in gambling programs for adolescents. In addition, our finding of heavier smoking and fewer quit attempts among individuals with greater problem-gambling severity suggests that smoking interventions with this group of adolescents might benefit from including motivational enhancement techniques and more intensive treatments for smoking (e.g., Naar-King & Suarez, 2010).

As described above, the association of parental attitudes to adolescent risk behaviors suggests that interventions may benefit from including or targeting parents of adolescents regarding their views and behaviors around both adolescent gambling and smoking. The decreased participation of adolescent gamblers who smoke in a range of extracurricular activities may indicate another area to target for at-risk adolescents, especially those who smoke and demonstrate lower risk gambling. Participation in extracurricular activities is positively associated with academic achievement and negatively associated with multiple harmful behaviors (e.g., alcohol use, marijuana use, delinquency) including smoking (e.g., Darling, 2005; Simantov et al., 2000; see Farb & Matjasko, 2012 for a review). Longitudinal data suggest that smoking and extracurricular activity

participation have a reciprocal relationship (Bohnert & Garber, 2007) so increased involvement in extracurricular activities could lead to reduced smoking as well as benefits in other areas of the adolescents' lives (e.g., academics, self esteem; Farb & Matjasko, 2012). For example, among students with poor academic performance and/or behavior problems, those who participated in extracurricular activities were less likely to drop out of high school and be arrested as young adults (Mahoney, 2000; Mahoney, 2014). Interventions that target success in school and increased participation in activities may have a beneficial impact on motivating adolescents to quit smoking for multiple reasons including those relating to exposure to non-smoking peers and for health reasons (e.g., increasing stamina when playing team sports). Targeting increased engagement in church and team sports may be especially beneficial for LRG adolescents who smoke who reported the lowest involvement in these activities. Few studies have empirically tested how extracurricular activities may be used to intervene with adolescents who smoke. One study of an intervention to prevent smoking that included extracurricular activities to promote non-smoking (Brown et al., 2002) reported lower rates of 9th and 10th grade smoking for boys in schools who participated in the program in 8th grade compared to boys from schools in a control condition. It should be noted that there were no differences in 9th and 10th grade rates of smoking by condition for girls or for children who had ever smoked. No study was identified that investigated extracurricular-based interventions for gambling in adolescents. More research is needed to determine the best way to encourage increased extracurricular activity participation among adolescent smokers and non-smokers who gamble including the involvement of peers and the types of activities with the greatest benefits on reduced smoking and gambling.

Finally, the association of smoking with poorer grades, greater aggressive behaviors, and greater substance use among ARPG and LRG groups suggest that programs for adolescents may benefit from addressing a range of health behaviors in addition to smoking and gambling. Research is needed to determine the type and scope of interventions that would have the greatest impact on reducing the consequences of negative health behaviors in adolescents. For example, studies should examine whether greater benefits may come from interventions that address a range of health behaviors or from interventions focused on certain key behaviors (e.g., smoking, gambling), where changes in these behaviors could have positive benefits on other health behaviors (e.g., grades, aggression).

#### 4.1. Strengths and limitations

There are multiple strengths of the current study. While previous studies of adolescent gambling have stratified samples by levels of problem-gambling severity (i.e., LRG versus ARPG; Potenza et al., 2011; Yip et al., 2011), the current study extends this work to be the first to also examine adolescent gambling behavior by current smoking status. The use of MAGS-based DSM-IV criteria for pathological gambling to classify groups of gamblers in the present study is another strength, as is the assessment of a wide range of other risk behaviors.

The current study includes limitations typically found in survey research (e.g., possible response biases). Due to the illegal or sensitive nature of some of the variables assessed (e.g., gambling, smoking, alcohol use, illicit drug use), participants may have under- or over-reported engagement in some of these activities. Another potential limitation lies in the restricted generalizability of the findings; while the sample adequately represented adolescents aged 14–18 years within the state of Connecticut, the extent to which the findings accurately represent other adolescents remains unclear. This study utilized a cross-sectional design which does not allow the ability to follow behaviors over time or make inferences about causality. Some research indicates that the onset of gambling in adolescence precedes the onset of other risk behaviors, including cigarette smoking (Gupta & Derevensky, 1998; Jacobs, 2004). Longitudinal research is necessary to

examine temporal relationships among smoking, gambling, and health variables. Finally, several variables previously shown in the adult literature to relate to smoking and gambling (e.g., anxiety, use of alcohol or other drugs specifically while gambling) were not assessed in the survey and therefore could not be analyzed in the present investigation.

#### 4.2. Conclusions

In the current study, more severe gambling was related to more severe smoking behavior in adolescents. Further, smoking was associated with poorer health-related behaviors in adolescents of both low and high problem-gambling severity. Smoking may be important to consider in prevention and intervention efforts with adolescent gamblers.

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#### Contributors

Drs. Potenza, Franco, and Weinberger conceived the study. Dr. Weinberger wrote the first draft of the manuscript. Drs. Pilver and Hoff conducted the statistical analysis. Drs. Weinberger, Franco, Hoff, Pilver, Steinberg, Rugle, Wample, Cavallo, Krishnan-Sarin, and Potenza contributed to the writing of the paper and approved the final manuscript. All authors had full access to all data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

#### Conflict of interest

The authors report no conflicts of interest with respect to the content of this manuscript. Dr. Potenza has served as a consultant or advisor to Boehringer Ingelheim, Somaxon, Lundbeck, Ironwood, Shire, INSYS, RiverMend Health, various law offices, and the federal defender's office in issues related to impulse control disorders. He has received research support from the National Institutes of Health, Veteran's Administration, Mohegan Sun Casino, the National Center for Responsible Gaming, Psyadon, Forest Laboratories, Ortho-McNeil, Oy-Control/Biotie, and GlaxoSmithKline. He has participated in surveys, mailings, or telephone consultations related to drug addiction, impulse control disorders, or other topics. He has provided clinical care in the Connecticut Department of Mental Health and Addiction Services Problem Gambling Services Program. He has performed grant reviews for the National Institutes of Health and other agencies. He has guest-edited journal sections, has given academic lectures in grand rounds, continuing medical education events, and other clinical and scientific venues, and has generated book or book chapters for publishers of mental health texts. Drs. Weinberger, Franco, Desai, Steinberg, Rugle, Wample, Cavallo, and Krishnan-Sarin report no potential conflicts of interest.

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