

The Association of Substance Use and Antisocial Behaviours with the Probability of Gambling among Adolescents

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Keywords

Gambling · Adolescents · Substance use · Violence · Stealing

Abstract

Introduction: Gambling behaviour among adolescents is a serious public health concern. Adolescents' involvement in gambling is often related with substance use and antisocial behaviours. This study aims to examine the association of substance use and antisocial behaviours with gambling among Italian early adolescents. **Methods:** The analytical sample of the present study included 1,822 students attending 29 secondary schools in nine NHS districts of Piedmont region and the city of Rome who participated in the baseline survey of the experimental controlled trial “GAPUnplugged.” The association of lifetime cigarette smoking, alcohol drinking, drunkenness, illicit drug use, violence, and stealing with the probability of any gambling and regular gambling was estimated through multilevel mixed-effect regression models. **Results:** The prevalence of any gambling and regular gambling in the last

30 days was 36.4% and 12.7%, respectively. After adjustment for potential confounders, cigarette smoking, alcohol drinking, drunkenness, violence, and stealing were significantly associated with an increased probability of both gambling outcomes. The link of gambling outcomes with alcohol drinking and drunkenness was higher for females, whereas the association with violence and stealing was higher for males. **Conclusion:** Due to the association of gambling with other problem behaviours during early adolescence, school-based health promotion and prevention interventions should address multiple risk behaviours simultaneously. Prevention of one risk behaviour may contribute to the prevention of other risk behaviours.

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Introduction

Gambling behaviour among adolescents is a serious public health problem. According to ESPAD 2019 data, the prevalence of gambling in the last year among 15- to 16-year-old

students in 35 European countries was 22% [1]. Gambling among Italian adolescents was even more concerning, as it exceeded the European average, with a 32% prevalence of last year gambling [1]. The situation has not improved in the recent years, as the most recent ESPAD report showed that 51.5% of 15- to 17-year-old adolescents had gambled in the last year in Italy [2]. A great proportion of gambling activities involve sport and animal betting, lotteries, and card games [1, 3]. These high rates of adolescent gambling and the widespread availability of new forms of gambling on the internet raise concerns that prevalence might increase further. Indeed, despite legal prohibitions of commercial gambling for minors and the ban on advertising, gambling remains easily accessible to adolescents in Italy [4].

Modern technologies, including gaming apps and online gambling, as well as gambling advertising have increased the opportunities of gambling among adolescents and the risk of development of problem gambling behaviour [5–7]. This is particularly worrisome because the early onset of gambling is associated with a higher probability of problem gambling, severity of psychiatric disorders, family, social, and substance use problems later in life [8, 9].

Previous studies documented a cooccurrence of high-risk behaviours suggesting that problem behaviours are often interrelated. Adolescents who engage in gambling are more likely to engage in substance use behaviours such as cigarette smoking, alcohol and heavy alcohol drinking, marijuana, stimulants, and other drug use [3, 10–23]. Moreover, there is close association between adolescent substance use and gambling severity, e.g., experimentation with substances increases the probability of both gambling and severe forms of gambling compared to non-substance use [11–13, 17]. Indeed, the risk of frequent gambling increases for those who use substances frequently [11–13]. Adolescent gambling is also linked with antisocial behaviours, both violent and non-violent, e.g., physical fighting, sexual dating violence, weapon-carrying, bullying, and cyberbullying [16, 21, 23–28]. The coexistence of antisocial behaviour with gambling is a big concern for public health as it can lead to multiple harms and involvement with the criminal justice system. Also, data on aggressive and violent behaviours among adolescents are particularly worrisome: 18.3% of Italian 15- to 17-year-old adolescents reported violent behaviour in the 2019 ESPAD survey [29], and the trend is increasing [2].

Considering the significant impact of risk behaviours on adolescent and future adult well-being, a better understanding of their cooccurrence is essential for devel-

oping effective prevention strategies. As described, a number of studies investigated the overlap of risk-taking behaviours in adolescence [10–12, 16–18, 21–28]. However, most were conducted in North America, whilst in the European context only a limited number of studies explored the cross-relations, and all were conducted in adolescents aged 14 and older [3, 13–15, 19, 20]. Moreover, these studies did not investigate antisocial behaviour. Based on these gaps, our study aims to extend previous research by examining the association of substance use and antisocial behaviours with the probability of engagement in any gambling and regular gambling among Italian early adolescents.

Methods

Study Design and Sample

This study used data from the baseline survey of the experimental controlled trial “GAPUnplugged,” designed to evaluate the effectiveness of the school curriculum “GAPUnplugged” in preventing gambling among 12- to 14-year old Italian adolescents. Study design and methods of the trial are described elsewhere [30]. Due to the parallel process nature of gambling and other risk behaviours development during adolescence, the present study was designed as cross-sectional [31–33].

The survey involved 1,874 students of 29 first grade secondary schools in 9 National Health Service (NHS) districts of Piedmont region (Alessandria, Turin 3, Turin 5, Vercelli, Cuneo 1, Cuneo 2, city of Turin, Novara) and the city of Rome between November 2022 and January 2023. The analytical sample included 1,822 students who provided the answer to the question on gambling behaviour in the last 30 days.

Data Collection

A self-completed anonymous questionnaire was used to collect information on sociodemographic characteristics, substance use, gambling behaviours, antisocial behaviours (violence, stealing), normative beliefs, parental factors, school factors, skills and personal factors. Only students whose parents or caregivers have given consent to participate were involved in the study. Before the administration of questionnaires, information on the study was provided to the pupils and consent to participate was asked. The questionnaire included previously validated questions derived from the Unplugged evaluation survey (www.eudap.eu), the EDDRA data bank of EMCDDA (www.euda.europa.eu), and other international sources and projects (ESPAD, HBSC, Project

ALERT, RATING Swedish cohort, SOGS-RA Italian validated version, BSSS Italian version). To preserve confidentiality of the data a 9-digit individual code was self-generated by the student. The questionnaires were filled in by students in the classroom during the school time through an online application. In cases of lack of computers or problems of connection, the researchers administered the paper version of the questionnaire.

Measures

Individual sociodemographic information included gender, age (based on birth date) and parental income. Mother and father occupation were assessed by asking "What job does your mother do?" and "What job does your father do?". Based on the answers the student provided, we created an indicator of socioeconomic status "Parental income" categorized as "Two salaries," "One salary," and "No salary."

Gambling behaviour was investigated by asking students if they gambled (scratch cards, lottery, bingo, slot machines, sport betting, event betting, poker, cards) during the last 30 days, with response categories ranging on a scale from 0 to 13 times or more for each specific game. A unique variable of any gambling behaviour was created, and all the answers were summed up into a dichotomous indicator "Yes" and "No." A mutually exclusive variable of "Regular gambling" was defined as gambling 3 or more times in the last 30 days. Cigarette smoking, alcohol drinking, drunkenness episodes, marijuana, and other illicit drug use (amphetamines, cocaine, ecstasy, heroin, inhalants, LSD, etc.) were measured by asking students if they used any particular substance during lifetime, with possible answers "Yes" and "No."

A 5-item scale assessed episodes of violent behaviour by asking students to provide affirmative or negative answer on the following statements "Has ever happened to you?": "To hit one of your teachers," "To get into fight with someone," "To seriously hurt someone," "To threat with a weapon of any kind to get something from someone" and "To destroy on purpose someone's items." A unique variable of lifetime violent behaviour was created, summing up the answers into a dichotomous indicator "Yes" and "No."

A 2-item scale investigated stealing episodes by asking students to provide affirmative or negative answer on the following statements "Has ever happened to you?": "To steal something" and "To sell stolen items." A unique variable of lifetime stealing episodes was created, summing up the answers into a dichotomous indicator "Yes" and "No."

Statistical Analysis

Two dependent variables were studied: any gambling and regular gambling (yes/no) in the last 30 days. Descriptive data were summarized as frequency and percentage for categorical variables and as mean and SD for continuous variables. A tetrachoric correlation matrix was used to assess the correlations between risk behaviours.

The association of sociodemographic characteristics, lifetime cigarette smoking, alcohol drinking, drunkenness, illicit drug use, violence, and stealing with the probability of adolescent's gambling at least once and regularly in the last 30 days were estimated through multivariate regression models overall, and stratified by gender. Multilevel mixed-effect regression modelling was used to control for the hierarchical nature of the data, with two grouping levels: centre (NHS district) as I level, and class as II level. The LR test showed that adding the third level "school" did not make a statistically significant difference to the model, so the two-level model was used. Some categories of the variable "Centre" were merged because of contextual similarities and low numerosity, so the final variable had four levels instead of nine, i.e., Rome, Turin 3/Turin 5/Torino, Vercelli/Cuneo1/Cuneo2, and Alessandria/Novara. Categorical variables were re-coded in order to reduce the number of items included in the model, i.e., categories were merged. Marijuana use and other drug use were merged into one variable "Illicit drug use." Adjusted odds ratios (AORs) and 95% confidence interval (95% CI) were estimated as measures of association between the studied factors and the outcomes. Each factor was examined in separate model, adjusting for gender, age (continuous) and parental income. Missing data were less than 6% for all studied variables. Listwise deletion was applied to handle missing data. Statistical analysis was carried out using STATA software release 18.0 [34].

Results

Descriptive Analysis

Sociodemographic variables, substance use, and anti-social behaviours of the pupils are described in Table 1. The prevalence of last 30 days any gambling and regular gambling was 36.4% (37.9% among males vs. 33.7% among females, $p = 0.065$) and 12.7% (13.5% among males vs. 10.9% among females, $p = 0.090$), respectively. Mean age of the students was 13.1.

The prevalence of lifetime cigarette smoking was 12.8% (11.1% among males vs. 14.8% among females, $p = 0.020$),

Table 1. Characteristics of pupils who gambled regularly and gambled at least once in the last 30 days

Characteristics	Any gambling ¹ (N = 663)		p value	Regular gambling ² (N = 232)		p value
	no	yes		no	yes	
	N (%)	N (%)		N (%)	N (%)	
Age (years)			0.472			0.975
12	336 (29.0)	179 (27.0)		449 (28.2)	66 (28.4)	
13	505 (43.6)	308 (46.5)		711 (44.7)	102 (44.0)	
14	318 (27.4)	176 (26.5)		430 (27.0)	64 (27.6)	
Mean ± SD	13.1±0.8	13.0±0.5	0.356	13.1±0.8	13.0±0.3	0.438
Gender			0.065			0.090
Female	550 (49.8)	279 (45.2)		739 (48.9)	90 (42.6)	
Male	555 (50.2)	339 (54.8)		773 (51.1)	121 (57.4)	
Parental income			0.450			0.740
Two salaries	847 (73.8)	495 (75.5)		1,171 (74.3)	171 (75.3)	
One salary/no salary	300 (26.2)	161 (24.5)		405 (25.7)	56 (24.7)	
Cigarette smoking			<0.001			0.009
No	1,043 (90.0)	546 (82.4)		1,399 (88.0)	190 (81.9)	
Yes	116 (10.0)	117 (17.6)		191 (12.0)	42 (18.1)	
Alcohol drinking			<0.001			<0.001
No	854 (73.7)	415 (62.6)		1,132 (71.2)	137 (59.0)	
Yes	305 (26.3)	248 (37.4)		458 (28.8)	95 (41.0)	
Drunkenness			0.015			<0.001
No	1,137 (98.1)	638 (96.2)		1,558 (98.0)	217 (93.5)	
Yes	22 (1.9)	25 (3.8)		32 (2.0)	15 (6.5)	
Illicit drug use			0.076			0.097
No	1,144 (98.7)	647 (97.6)		1,566 (98.5)	225 (97.0)	
Yes	15 (1.3)	16 (2.4)		24 (1.5)	7 (3.0)	
Violence			<0.001			<0.001
No	596 (52.1)	229 (35.1)		768 (48.9)	57 (25.0)	
Yes	549 (47.9)	424 (64.9)		802 (51.1)	171 (75.0)	
Stealing			<0.001			<0.001
No	804 (70.2)	372 (57.1)		1,074 (68.4)	102 (44.9)	
Yes	341 (29.8)	280 (42.9)		496 (31.6)	125 (55.1)	

SD, standard deviation. Cigarette smoking, alcohol drinking, drunkenness, illicit drug use, violence, and stealing at least once in life. ¹Gambling at least once in the last 30 days. ²Gambling three or more times in the last 30 days.

alcohol drinking 30.0% (30.8% among males vs. 30.0% among females, $p = 0.705$), drunkenness 2.5% (2.9% among males vs. 2.0% among females, $p = 0.204$), illicit drug use 1.7% (2.2% among males vs. 1.3% among females, $p = 0.157$), violence 54.2% (61.7% among males vs. 45.4% among females, $p < 0.001$), and stealing 34.8% (37.0% among males vs. 32.3% among females, $p = 0.040$). Cigarette smoking prevailed among females, whereas violence and stealing prevailed among males. The other behaviours did not differ among genders.

Cigarette smoking (17.6% vs. 10.0%, $p < 0.001$), alcohol drinking (37.4% vs. 26.3%, <0.001), drunkenness (3.8% vs. 1.9%, $p = 0.015$), violence (64.9% vs. 47.9%, $p < 0.001$), and stealing (42.9% vs. 29.8%, $p < 0.001$) were significantly higher among pupils who gambled at least once in the last 30 days compared to those who did not gamble. Similarly, the same behaviours, i.e., cigarette smoking (18.1% vs. 12.0%, $p = 0.009$), alcohol drinking (41.0% vs. 28.8%, <0.001), drunkenness (6.5% vs. 2.0%, $p < 0.001$), violence (75.0% vs. 51.1%, $p < 0.001$), and stealing (55.1%

Table 2. Correlation matrix of risk behaviours

	Gambling	Cigarette smoking	Alcohol drinking	Drunkenness	Illicit drug use	Violence	Stealing
Gambling	1						
Cigarette smoking	0.2213*	1					
Alcohol drinking	0.1866*	0.6522*	1				
Drunkenness	0.1738*	0.7317*	0.3777*	1			
Illicit drug use	0.1580	0.7995*	0.4132*	0.8424*	1		
Violence	0.2616*	0.4595*	0.3419*	0.3381*	0.2942*	1	
Stealing	0.2155*	0.5088*	0.4143*	0.3533*	0.3371*	0.5828*	1

*Significance level $p < 0.05$. Gambling at least once in the last 30 days. Cigarette smoking, alcohol drinking, drunkenness, illicit drug use, violence, and stealing at least once in life.

vs. 31.6%, $p < 0.001$) were significantly higher among pupils who gambled three or more times in the last 30 days compared to those who did not (Table 1). The correlation matrix evaluating the relationships between the risk behaviours showed several significant positive correlations ($p < 0.05$) between gambling, substance use, and antisocial behaviours, suggesting co-occurrence of these behaviours (Table 2).

Multilevel Mixed-Effect Regression Models

After adjustment for potential confounders, cigarette smoking was significantly associated with more than 2-fold the probability of any gambling (OR 2.31, 95% CI: 1.68–3.18), with similar magnitude of the increase for males and females. Alcohol drinking (OR 1.95, 95% CI: 1.55–2.47) and drunkenness (OR 2.39, 95% CI: 1.26–4.54) increased the odds of any gambling, with higher OR for females than males. Violence (OR 2.05, 95% CI: 1.65–2.55) and stealing (OR 1.81, 95% CI: 1.45–2.25) were associated with about twice higher the probability of any gambling, with an amount of the increase higher for males than females. The association between illicit drug use and any gambling did not reach statistical significance (Table 3).

Similarly, after adjustment for potential confounders, cigarette smoking was associated with the probability of gambling regularly (OR 1.75, 95% CI: 1.15–2.68), and it was significant for males (OR 1.98, 95% CI: 1.05–3.74) but not for females. Alcohol drinking (OR 1.98, 95% CI: 1.43–2.76) and drunkenness (OR 4.77, 95% CI: 2.33–9.78) increased the probability of regular gambling, again with higher OR for females than males. Violence (OR 2.78, 95% CI: 1.96–3.93) and stealing (OR 2.80, 95% CI: 2.04–3.83)

were associated with similar odds of regular gambling, and in this case the association was higher for males than females (Table 3).

Discussion

The present study investigated the association of substance use and antisocial behaviours with the probability of gambling among 12- to 14-year old male and female Italian adolescents. The findings of the study are particularly important as adolescents begin to engage in multiple risk behaviours at early age. The analysis revealed several noteworthy associations, highlighting the coexistence of both any gambling and regular gambling with cigarette smoking, alcohol drinking, drunkenness, violence, and stealing. Although significant for both genders, the magnitude of the association with alcohol use and drunkenness was higher for females, whereas the association with stealing and violent behaviours was higher for males.

The 36.4% prevalence of gambling at least once in the last 30 days found in our study is higher than the 32% prevalence of last year gambling observed among 15- to 16-year-old ESPAD Italian students in 2019 [1]. It also exceeds the 34.7% prevalence of lifetime gambling observed among 15-year-old HBSC students in 2022 [35]. However, it is lower than the 51.5% last year gambling reported for 15- to 17-year-old adolescents in the most recent ESPAD report that suggests an increasing worrisome trend [2]. Considering that the adolescents in our study are younger compared to ESPAD and HBSC samples, and that indicators differ (last 30 days vs. 12 months and lifetime), the high rate of gambling

Table 3. Multilevel mixed-effect regression model of any gambling and regular gambling, by gender

Risk behaviours	Both gender		Males		Females	
	AOR (95% CI)	p value	AOR (95% CI)	p value	AOR (95% CI)	p value
Any gambling ¹						
Cigarette smoking	2.31 (1.68–3.18)	<0.001	2.35 (1.45–3.82)	0.001	2.39 (1.54–3.71)	<0.001
Alcohol drinking	1.95 (1.55–2.47)	<0.001	1.86 (1.34–2.57)	<0.001	2.19 (1.53–3.14)	<0.001
Drunkenness	2.39 (1.26–4.54)	0.008	2.17 (0.92–5.08)	0.076	2.99 (1.06–8.44)	0.038
Illicit drug use	1.96 (0.91–4.21)	0.085	2.40 (0.90–6.43)	0.082	1.42 (0.40–5.13)	0.589
Violence	2.05 (1.65–2.55)	<0.001	2.36 (1.73–3.23)	<0.001	1.92 (1.39–2.64)	<0.001
Stealing	1.81 (1.45–2.25)	<0.001	2.21 (1.64–2.99)	<0.001	1.55 (1.11–2.15)	0.010
Regular gambling ²						
Cigarette smoking	1.75 (1.15–2.68)	0.010	1.98 (1.05–3.74)	0.036	1.70 (0.93–3.11)	0.087
Alcohol drinking	1.98 (1.43–2.76)	<0.001	1.95 (1.25–3.03)	0.003	2.25 (1.34–3.77)	0.002
Drunkenness	4.77 (2.33–9.78)	<0.001	3.50 (1.28–9.60)	0.015	7.94 (2.60–24.28)	<0.001
Illicit drug use	2.14 (0.85–5.42)	0.107	2.86 (0.91–8.98)	0.072	1.40 (0.25–7.92)	0.706
Violence	2.78 (1.96–3.93)	<0.001	3.45 (2.06–5.78)	<0.001	2.40 (1.46–3.96)	0.001
Stealing	2.80 (2.04–3.83)	<0.001	3.64 (2.37–5.59)	<0.001	2.28 (1.39–3.72)	0.001

Multilevel mixed-effect models controlled for two levels: centre and class. Each factor was examined in separate models, adjusting for gender, age (continuous) and parental income. Cigarette smoking, alcohol drinking, drunkenness, illicit drug use, violence, and stealing at least once in life. AOR, adjusted odds ratios; 95% CI, 95% confidence interval. ¹Gambling at least once in the last 30 days. ²Gambling three or more times in the last 30 days.

behaviour we observed is particularly concerning. Moreover, the prevalence of adolescents who gambled regularly (3 or more times) in the last 30 days was 12.7%. These findings mark early adolescence as a critical period for the onset of gambling behaviour and emphasize the importance of developing and implementing prevention interventions as early as possible. Furthermore, modern technologies greatly contribute to escalation of the problem by increasing opportunities and accessibility to gambling [5–7]. Indeed, adolescents who are more engaged in using technology and the internet for leisure time have greater exposure to gambling activities [3, 6].

In our study, cigarette smoking was significantly associated with both any gambling and regular gambling. This finding is consistent with previous European and North American research reporting the co-occurrence of smoking and gambling behaviours [3, 10, 11, 13, 14, 16, 18, 19, 21–23]. Furthermore, our results showed also a robust association of alcohol use and drunkenness with the odds of engaging in gambling activities, consistent with what observed in European and North American adolescents [3, 10, 14, 16, 18–21]. It can be argued that adolescents who use substances need money to procure it and therefore engage in gambling activity also as a means to obtain it. On the other side, substance use may decrease the adolescents' inhibitory mechanisms and increase their tendency to gamble [19]. The magnitude of the associ-

ation was higher between cigarette smoking and any gambling, and between drunkenness and regular gambling. These findings align with previous study conducted on Italian adolescents that found a stronger link of non-problem gambling with cigarette smoking, and of problem gambling with drunkenness episodes [19].

Consistent with previous studies, experiences of any gambling and regular gambling were significantly associated with ongoing stealing and violent behaviours, including physical fighting and carrying a weapon [16, 21, 24–28]. Moreover, we observed that violence and stealing were significantly higher among pupils who gambled three or more times in the last 30 days. It is important to note that most previous studies have focused on adolescent older than 14 years, whereas our sample consists of younger individuals (12–14 years old). Given that the majority of research on co-occurring gambling and antisocial behaviours has been conducted in North America [16, 21, 24–28], the findings of this study contribute to addressing a gap in the literature by exploring cross-related risk behaviours among early adolescents from a European context.

The association of cigarette smoking and gambling was similar among genders, indicating a universal susceptibility to the co-occurrence of these behaviours. Differently, as regards alcohol use the strength of the association was unexpectedly higher for females than males,

suggesting a potentially heightened susceptibility to gambling behaviours among young girls at high risk, i.e., those who consume alcohol excessively. However, a study conducted among Finnish adolescents found a stronger association of alcohol-related outcomes and gambling among boys [20]. In order to clarify the role of gender, gender differences should be better addressed in future research. On the contrary, the magnitude of association between antisocial behaviours and gambling was higher among males. Males who exhibited violent and criminal behaviours had a higher propensity toward gambling. This aligns with previous findings that violent behaviours are more prevalent among males [25].

Adolescents who are involved in any problem behaviour are greater risk-takers, and therefore at higher risk of acquiring other risk behaviours. A well-known problem-behaviour theory explained that the coexistence of risk behaviours among adolescents can occur due to shared underlying risk factors, its interaction with social environment and organized social ecology of adolescent life [36]. In essence, there might be ecological social opportunities to co-experiment with risk behaviours. Other models emphasized shared mechanisms of addictions and overlapping patterns across different addictive behaviours [37–39]. For example, the co-occurrence of gambling with substance use and antisocial behaviours could reflect a shared pathway of common cognitive vulnerabilities, personality traits such as impulsivity and low self-control, and risk acceptance [37, 38, 40–43]. Finally, some previous studies identified common risk factors that may be important denominators linking substance use and antisocial behaviours with gambling, such as higher weekly income, low parental supervision, and affiliation with deviant friends [14, 31, 40, 41].

Moreover, several previous studies on adolescents, and those investigating youth in their transition from adolescence to young adulthood, suggested that one problem behaviour is not a risk factor for the other, but is rather part of a parallel coexisting process sharing underlying common risk factors [31–33]. Consistently, Mutti-Packer et al. [32] found a similarity in baseline levels of alcohol misuse and problem gambling, and Carbonneau et al. [33] found similar trajectories of substance use for gamblers and non-gamblers. These findings suggest a lack of mutual influence between the two risk behaviours as the development of one problem behaviour does not depend on the development of the other, i.e., gambling, substance use, stealing and violence may co-occur due to a process of co-learning.

The findings of this study underline the importance of implementing prevention actions and coordinating

strategies to address simultaneously risk-taking behaviours in early ages. In light of this, integrated intervention efforts that address multiple risk behaviours within a unified conceptual framework should be taken in consideration. Moreover, a better understanding of shared mechanisms underlying these behaviours should be further explored, as they could provide valuable insights for designing effective school-based strategies or clinical interventions. Prevention programs targeting shared mechanisms, such as life skills (problem-solving, decision making, refusal and coping skills), raising awareness on risk perceptions, fostering negative attitudes toward risk behaviours, and correcting normative beliefs may be more effective in reducing risk behaviours than interventions targeting a single behaviour.

This study has several strengths. The surveys used standardized questionnaires containing previously validated questions derived from recognized international sources, minimizing possible misclassifications related to data collection and measures. Multilevel mixed-effect regression models were performed to evaluate the association between risk behaviours and gambling, according to higher order clustering (centre/district and class). The information in the survey allowed the analysis of a large set of correlates. The sample was large. However, this study should be considered also in light of some limitations. All the information was self-reported by the students, and this could weaken the reliability of information provided; however, the anonymous administration of the questionnaire should have attenuated this risk. Missing values reduced the sample in the adjusted regression models, however, missing data were less than 6% for all studied variables; therefore, models were still run on a large sample. This is a secondary analysis of the study, i.e., the study was designed for a different purpose, and this could limit its representativeness. Moreover, the sample was not equally distributed between the nine centres; therefore, we needed to merge some centres to perform multilevel analysis.

In conclusions, the findings of this study shed light on the interrelation of substance use and antisocial behaviours with gambling among adolescents. Universal prevention interventions, and programs targeting those not only at risk of gambling, but also of substance use and antisocial behaviours, could reduce the prevalence of various risk behaviours among adolescents and their consequences on future adult health. Due to the association of gambling with other problem behaviours during early adolescence, health promotion and prevention interventions should address multiple risk behaviours simultaneously in an attempt to prevent one risk

behaviour through the prevention of the other risk behaviours. Moreover, a more comprehensive understanding of the complex relations between substance use, antisocial behaviours, and gambling is important to reduce the associated public health harms, as well as for designing prevention strategies applicable to various risk behaviours among adolescents. Finally, a particular attention should be paid to adolescents who start experimenting with risk behaviours at early age.

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Statement of Ethics

The study is being conducted following the principles of the Declaration of Helsinki. The protocol of the study including details on the study design, materials, intervention, instruments, and procedures for enrolment was submitted to the Novara Ethical Committee, and approval was obtained on 18/11/2022 (prot. 943/CE; study code CE228/2022). Small amendments to the procedures were requested and applied. Informed letters were sent to parents and written informed

consent for the participation of the children in the study was asked and obtained before the baseline survey. Students were informed about the objectives of the study and provided consent to participate before filling the baseline questionnaire. Questionnaires are anonymous.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

Federica Vigna-Taglianti and Fabrizio Faggiano designed and conceptualized the GAPUnplugged study. Marco Martorana, Erica Viola, Mariaelisa Renna, Alberto Sciutto, Emina Mehanović, and Federica Vigna-Taglianti developed the study instruments. Giulia Giraudi, Erica Viola, Alberto Sciutto, Maria Ginechesi, Claudia Vullo, Marco Martorana, Adalgisa Ceccano, and Pietro Casella implemented the study and coordinated the field work. Emina Mehanović carried out statistical analysis. Emina Mehanović, Mariaelisa Renna, and Federica Vigna-Taglianti drafted the paper. All authors provided critical revision, contributed to, and approved the final manuscript.

Data Availability Statement

The data that support the findings of this study are not publicly available due to privacy reasons but are available from the coordinator of the study, Federica Vigna-Taglianti, upon reasonable request.

References

- 1 ESPAD Group. ESPAD report 2019: results from the European school survey project on alcohol and other drugs. Luxembourg: EMCDDA Joint Publications, Publications Office of the European Union; 2020.
- 2 ESPAD Italia. ESPAD 2023: Navigare il futuro: dipendenze, comportamenti e stili di vita tra gli studenti italiani. Rapporto di ricerca sulla diffusione dei comportamenti a rischio fra gli studenti delle scuole superiori di secondo grado. Istituto di Fisiologia Clinica, Consiglio Nazionale delle Ricerche, lab. Epidemiologia e ricerca sui servizi sanitari. Pisa. 2024.
- 3 Molinaro S, Benedetti E, Scalese M, Bastiani L, Fortunato L, Cerrai S, et al. Prevalence of youth gambling and potential influence of substance use and other risk factors throughout 33 European countries: first results from the 2015 ESPAD study. *Addiction*. 2018;113(10):1862–73. <https://doi.org/10.1111/add.14275>
- 4 Decreto-Legge n. 158 – Normativa, 13 settembre 2012. Disposizioni urgenti per promuovere lo sviluppo del Paese mediante un piu' alto livello di tutela della salute.
- 5 Monaghan S, Derevensky J, Sklar A. Impact of gambling advertisements and marketing on children and adolescents: policy recommendations to minimise harm. *J Gambl Issues*. 2008;22:252–74. <https://doi.org/10.4309/jgi.2008.22.7>
- 6 King D, Delfabbro P, Griffiths M. The convergence of gambling and digital media: implications for gambling in young people. *J Gambl Stud*. 2010;26(2):175–87. <https://doi.org/10.1007/s10899-009-9153-9>

- 7 Canale N, Griffiths MD, Vieno A, Siciliano V, Molinaro S. Impact of Internet gambling on problem gambling among adolescents in Italy: findings from a large-scale nationally representative survey. *Comput Hum Behav*. 2016;57:99–106. <https://doi.org/10.1016/j.chb.2015.12.020>
- 8 Burge AN, Pietrzak RH, Petry NM. Pre/early adolescent onset of gambling and psychosocial problems in treatment-seeking pathological gamblers. *J Gambl Stud*. 2006;22(3):263–74. <https://doi.org/10.1007/s10899-006-9015-7>
- 9 Rahman AS, Pilver CE, Desai RA, Steinberg MA, Rugle L, Krishnan-Sarin S, et al. The relationship between age of gambling onset and adolescent problematic gambling severity. *J Psychiatr Res*. 2012;46(5):675–83. <https://doi.org/10.1016/j.jpsychires.2012.02.007>
- 10 Peters EN, Nordeck C, Zanetti G, O'Grady KE, Serpelloni G, Rimondo C, et al. Relationship of gambling with tobacco, alcohol, and illicit drug use among adolescents in the USA: review of the literature 2000–2014. *Am J Addict*. 2015;24(3):206–16. <https://doi.org/10.1111/ajad.12214>
- 11 Weinberger AH, Franco CA, Hoff RA, Pilver CE, Steinberg MA, Rugle L, et al. Gambling behaviors and attitudes in adolescent high-school students: relationships with problem-gambling severity and smoking status. *J Psychiatr Res*. 2015;65:131–8. <https://doi.org/10.1016/j.jpsychires.2015.04.006>
- 12 Richard J, Potenza MN, Ivoska W, Derevensky J. The stimulating nature of gambling behaviors: relationships between stimulant use and gambling among adolescents. *J Gambl Stud*. 2019;35(1):47–62. <https://doi.org/10.1007/s10899-018-9778-7>
- 13 Špolc M, Mravčík V, Drbohlavová B, Chomynová P. Problem gambling among Czech adolescents: an exploration of its relationship to early initiation of tobacco smoking. *J Behav Addict*. 2019;8(1):114–22. <https://doi.org/10.1556/2006.8.2019.04>
- 14 Buja A, Mortali C, Mastrobattista L, Minutillo A, Pichini S, Genetti B, et al. Pathways connecting socioeconomic variables, substance abuse and gambling behaviour: a cross-sectional study on a sample of Italian high-school students. *BMJ Open*. 2019;9(11):e031737. <https://doi.org/10.1136/bmjopen-2019-031737>
- 15 Buja A, Mortali C, Mastrobattista L, De Battisti E, Minutillo A, Pichini S, et al. Stimulant substance use and gambling behaviour in adolescents. *Gambling and stimulant use. Adicciones*. 2020;32(4):273–80. <https://doi.org/10.20882/adicciones.1312>
- 16 Zhai ZW, Duenas GL, Wampler J, Potenza MN. Gambling, substance use and violence in male and female adolescents. *J Gambl Stud*. 2020;36(4):1301–24. <https://doi.org/10.1007/s10899-020-09931-8>
- 17 Hammond CJ, Pilver CE, Rugle L, Steinberg MA, Mayes LC, Malison RT, et al. An exploratory examination of marijuana use, problem-gambling severity, and health correlates among adolescents. *J Behav Addict*. 2014;3(2):90–101. <https://doi.org/10.1556/JBA.3.2014.009>
- 18 Barnes GM, Welte JW, Hoffman JH, Tidwell MC. Gambling, alcohol, and other substance use among youth in the United States. *J Stud Alcohol Drugs*. 2009;70(1):134–42. <https://doi.org/10.15288/jsad.2009.70.134>
- 19 Buja A, Lion C, Scioni M, Vian P, Genetti B, Vittadello F, et al. SOGS-RA gambling scores and substance use in adolescents. *J Behav Addict*. 2017;6(3):425–33. <https://doi.org/10.1556/2006.6.2017.043>
- 20 Latvala T, Lintonen T, Raisamo S. Gambling among underage alcohol users between 2008 and 2019: a national cross-sectional study among Finnish adolescents. *J Adolesc Health*. 2023;72(5):796–802. <https://doi.org/10.1016/j.jadohealth.2022.12.001>
- 21 Potenza MN, Wareham JD, Steinberg MA, Rugle L, Cavallo DA, Krishnan-Sarin S, et al. Correlates of at-risk/problem internet gambling in adolescents. *J Am Acad Child Adolesc Psychiatry*. 2011;50(2):150–9.e3. <https://doi.org/10.1016/j.jaac.2010.11.006>
- 22 Weinberger AH, Franco CA, Hoff RA, Pilver C, Steinberg MA, Rugle L, et al. Cigarette smoking, problem-gambling severity, and health behaviors in high-school students. *Addict Behav Rep*. 2015;1:40–8. <https://doi.org/10.1016/j.abrep.2015.01.001>
- 23 Stefanovics EA, Zhai ZW, Potenza MN. Gambling in Connecticut adolescents: prevalence, socio-demographic characteristics, trauma exposure, suicidality, and other risk behaviors. *PLoS One*. 2025;20(2):e0290589. <https://doi.org/10.1371/journal.pone.0290589>
- 24 Kryszajts DT, Hahmann TE, Schuler A, Hamilton-Wright S, Ziegler CP, Matheson FI. Problem gambling and delinquent behaviours among adolescents: a scoping review. *J Gambl Stud*. 2018;34(3):893–914. <https://doi.org/10.1007/s10899-018-9754-2>
- 25 Slavin M, Pilver CE, Hoff RA, Krishnan-Sarin S, Steinberg MA, Rugle L, et al. Serious physical fighting and gambling-related attitudes and behaviors in adolescents. *J Behav Addict*. 2013;2(3):167. <https://doi.org/10.1556/jba.2.2013.009>
- 26 Cook S, Turner NE, Ballon B, Paglia-Boak A, Murray R, Adlaf EM, et al. Problem gambling among Ontario students: associations with substance abuse, mental health problems, suicide attempts, and delinquent behaviours. *J Gambl Stud*. 2015;31(4):1121–34. <https://doi.org/10.1007/s10899-014-9483-0>
- 27 Richard J, Derevensky J. Identifying the relationship between mental health symptoms, problem behaviors and gambling among adolescents. *Ann Behav Sci*. 2017;03(02). <https://doi.org/10.21767/2471-7975.100030>
- 28 Zhai ZW, Hoff RA, Magruder CF, Steinberg MA, Wampler J, Krishnan-Sarin S, et al. Weapon-carrying is associated with more permissive gambling attitudes and perceptions and at-risk/problem gambling in adolescents. *J Behav Addict*. 2019;8(3):508–21. <https://doi.org/10.1556/2006.8.2019.42>
- 29 Benedetti E, Colasante E, Cerrai S, Gerra G, Tadonío L, Pellegrini P, et al. Violent behaviours among adolescents and young adults: association with psychoactive substance use and parenting styles. *Int J Environ Res Public Health*. 2022;19(7):3756. <https://doi.org/10.3390/ijerph19073756>
- 30 Vigna-Taglianti F.D, Martorana M, Viola E, Renna M, Vadrucchi S, Sciutto A, et al. Evaluation of effectiveness of the Unplugged program on gambling behaviours among adolescents: study protocol of the experimental controlled study “GAPUnplugged”. *J Prev*. 2024;45(3):405–29. <https://doi.org/10.1007/s10935-024-00772-4>
- 31 Wanner B, Vitaro F, Carbonneau R, Tremblay RE. Cross-lagged links among gambling, substance use, and delinquency from mid-adolescence to young adulthood: additive and moderating effects of common risk factors. *Psychol Addict Behav*. 2009;23(1):91–104. <https://doi.org/10.1037/a0013182>
- 32 Mutti-Packer S, Hodgins DC, El-Guebaly N, Casey DM, Currie SR, Williams RJ, et al. Problem gambling symptomatology and alcohol misuse among adolescents: a parallel-process latent growth curve model. *Psychol Addict Behav*. 2017;31(4):447–56. <https://doi.org/10.1037/adb0000261>
- 33 Carbonneau R, Vitaro F, Brendgen M, Boivin M, Côté SM, Tremblay RE. Developmental patterns of gambling participation and substance use throughout adolescence in a population birth cohort. *J Gambl Stud*. 2023;39(1):137–57. <https://doi.org/10.1007/s10899-022-10107-9>
- 34 Corporation Stata. Stata statistical software: release 18. College Station, TX: StataCorp LLC; 2023.
- 35 HBSC Italia. La sorveglianza HBSC 2022: Health Behaviour in School-aged Children: principali risultati dello studio italiano tra i ragazzi di 11, 13, 15 e 17 anni. 2022. <https://www.epicentro.iss.it/hbsc/>
- 36 Jessor R, Jessor SL. Problem behavior and psychosocial development: a longitudinal study of youth. New York: Academic Press; 1977.
- 37 Fauth-Bühler M, Mann K, Potenza MN. Pathological gambling: a review of the neurobiological evidence relevant for its classification as an addictive disorder. *Addict Biol*. 2017;22(4):885–97. <https://doi.org/10.1111/adb.12378>
- 38 Brand M, Müller A, Wegmann E, Antons S, Brandtner A, Müller SM, et al. Current interpretations of the I-PACE model of behavioral addictions. *J Behav Addict*. 2025;14(1):1–17. <https://doi.org/10.1556/2006.2025.00020>

- 39 Brand M, Antons S, Bóthe B, Demetrovics Z, Fineberg NA, Jimenez-Murcia S, et al. Current advances in behavioral addictions: from fundamental research to clinical practice. *Am J Psychiatry*. 2025;182(2):155–63. <https://doi.org/10.1176/appi.ajp.20240092>
- 40 Vitaro F, Brendgen M, Ladouceur R, Tremblay RE. Gambling, delinquency, and drug use during adolescence: mutual influences and common risk factors. *J Gambl Stud*. 2001; 17(3):171–90. <https://doi.org/10.1023/a:1012201221601>
- 41 Barnes GM, Welte JW, Hoffman JH, Dintcheff BA. Shared predictors of youthful gambling, substance use, and delinquency. *Psychol Addict Behav*. 2005; 19(2):165–74. <https://doi.org/10.1037/0893-164X.19.2.165>
- 42 Mishra S, Lalumière ML, Morgan M, Williams RJ. An examination of the relationship between gambling and antisocial behavior. *J Gambl Stud*. 2011;27(3):409–26. <https://doi.org/10.1007/s10899-010-9217-x>
- 43 Potenza MN. The neural bases of cognitive processes in gambling disorder. *Trends Cogn Sci*. 2014;18(8):429–38. <https://doi.org/10.1016/j.tics.2014.03.007>