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Changes in Alcohol, Cannabis, and Tobacco Use Before and After the COVID-19 Pandemic in Adolescents in Catalonia: A Repeated Cross-Sectional Study

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Highlights

What are the main findings?

- Binge drinking increased among younger adolescents after COVID-19 restrictions.
- Cannabis and tobacco use declined and remained lower post-pandemic.

What is the implication of the main finding?

- Social environments influenced substance use patterns during and after COVID-19.
- The findings highlight the need for preventive strategies and awareness campaigns.

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Abstract

This study analyzes the impact of the COVID-19 pandemic on alcohol, cannabis, and tobacco use among adolescents aged 14–19 in Central Catalonia across three periods. Data were obtained from two waves of the DESKcohort project. The first wave (n = 4641) was pre-COVID-19 and the second wave was divided into two phases: post-COVID-19 with restrictions (n = 3478) and ppost-COVID-19 without restrictions (n = 2900). The prevalence of monthly binge drinking, cannabis use in the last 30 days, and daily tobacco use was calculated. Poisson regression models estimated adjusted prevalence ratios (aPR) comparing two post-pandemic phases to the pre-pandemic baseline. Binge drinking increased during the restrictions among girls [aPR = 1.5 (95%CI: 1.1–2.1)] and boys [aPR = 1.7 (95%CI: 1.3–2.3)]. Cannabis use decreased during restrictions and remained low post-pandemic, especially among girls [aPR = 0.6 (95%CI: 0.5–0.8)] and boys in the 4th Compulsory Secondary Education (CSE) [aPR = 0.4 (95%CI: 0.3–0.6)], and girls in the 2nd Post-Compulsory Secondary Education/Intermediate-Level Training Cycles (PCSE/ILTC) [aPR = 0.7 (95%CI: 0.6–0.9)]. Daily tobacco use also dropped among boys in the 4th year of CSE [aPR = 0.5 (95%CI: 0.3–0.7)] and girls in the 2nd year of PCSE/ILTC [aPR = 0.7 (95%CI: 0.6–0.9)]. The COVID-19 pandemic has created a unique opportunity to reassess patterns of adolescent substance use in a context of sudden social disruption. The findings highlight the need to denormalize alcohol and tobacco use and promote healthier adolescent behavior through education.

Keywords: alcohol; cannabis; tobacco; binge drinking; adolescents; COVID-19; restrictions

1. Introduction

In many countries, the average age of onset of alcohol, cannabis, and tobacco use is before 15 years of age [1,2]. These behaviors primarily emerge during socialization processes and are influenced by parental consumption and social events such as community celebrations, gatherings with friends, family parties, and peer pressure [3,4]. In Catalonia, the legal age for purchasing and consuming alcohol and tobacco is 18 years. Cannabis remains illegal for recreational use, including among adults, although consumption in private settings is decriminalized under certain conditions (in cannabis clubs or at home).

The declaration of the COVID-19 pandemic in March 2020 led to the implementation of numerous public health interventions [5]. These measures significantly limited social interaction among adolescents, highlighting issues of social inequality [6]. In Catalonia, the implementation of a lockdown and other community policies led to a reduction in substances [7,8]. Reduced binge drinking, cannabis use, and daily smoking among adolescents during restraints have been linked to reduced social contact, increased parental supervision, and limited access to substances [7–9]. Despite this, the alcohol use did not disappear entirely among adolescents [10]. Binge drinking is a pattern of alcohol consumption characterized by the intake of six or more alcoholic drinks on a single occasion or within a period of approximately 2 to 4 h [11]. However, it lacks a universally accepted definition, as each country conceptualizes it differently. Due to this study being focused on the adolescent population in Spain, the criteria of the Spanish Ministry of Health to define binge drinking was adopted. In the last few years, binge drinking has become increasingly frequent among young people aged 15 to 24. Around 20% of young people in Europe, and 30% in Spain, have binge drunk in the last month [1,2].

After restrictions were lifted, alcohol consumption initially rebounded before stabilizing at typical pre-pandemic levels [12]. In contrast, some studies suggest that reductions

observed during the pandemic on cannabis and tobacco use have persisted, indicating that these substances have not returned to pre-pandemic levels and reflecting a continued downward trend seen in recent years [1,13]. Although no specific studies of changes in cannabis use by COVID-19 have been found, some suggest an increase in older adolescents who were already smoking before the pandemic [14]. Apart from the previous consumption habit, this could be associated to environments where the parents smoked (for example, at home), a fact that has facilitated the acquisition of the substance and allowed its consumption at home [15].

The implementation of the most stringent restrictive measures during the pandemic coincided with critical periods in the social development of adolescents, as well as with the typical age of substance use initiation [16]. As a result, it can be expected that these adolescents would delay the initiation of substance use, leading to lower prevalence rates of such behaviors [17]. There is a lack of studies on how COVID-19 restrictions in Central Catalonia influenced adolescent substance use. Given the region-specific measures, characterizing them is crucial to assess their impact. Understanding these effects helps determine whether the pandemic delayed initiation or increased use due to stress and isolation. The varying severity of restrictions may have affected boys and girls differently, requiring gender-specific analysis. Since the pandemic influenced their mental health and socialization distinctly, separate analyses are essential [18]. Adolescent girls, experiencing higher anxiety and depression, may have increased substance use as a coping mechanism. In contrast, boys, who are more reliant on group socialization, may have reduced consumption due to restrictions [15,19].

The aim of this study was to analyze the evolution of alcohol, cannabis, and tobacco consumption across three time points: before the restrictions (2019/2020), during the restrictions (late 2021), and after the restrictions (first half of 2022). This study focused on adolescents aged 14 to 19 years attending school in Central Catalonia, with comparisons made by sex and age group (academic year).

2. Materials and Methods

2.1. Study Design

Three cross-sections were compared corresponding to waves 1 and 2 of the DESKcohort project in which 65 (out of 91) and 84 (out of 98) schools in Central Catalonia participated during the 2019–2020 and 2021–2022 school years, respectively [20]. This study consisted of adolescents in the 4th year of Compulsory Secondary Education (CSE) (ages 14–16 years) and 2nd year of Post-Compulsory Secondary Education (PCSE) or Intermediate-Level Training Cycles (ILTC) (ages 16–19 years). For data collection, the DESKcohort questionnaire was administered to all participants. This questionnaire was developed from validated instruments used in other surveys to assess adolescent health and health behaviors [20]. The survey was anonymous, self-reported, and administered in school classrooms using Internet-enabled tablets linked to the Research Electronic Data Capture (REDCap) program.

To participate, parents, legal guardians, or the students themselves signed a consent form agreeing to participate. This study was approved by the Research and Ethics Committee of the Universitat de Vic–Universitat Central de Catalunya (UVic-UCC) (96/2019, approval date: 23 September 2019).

2.2. Study Variables

2.2.1. Dependent Variables

The dependent variables analyzed were monthly binge drinking, cannabis use in the last 30 days, and daily tobacco use.

Binge drinking was assessed by asking participants how often they consumed six or more alcoholic beverages on a single occasion, lasting approximately 2 to 4 h. For the purposes of analysis, responses were categorized into two groups: participants who reported drinking "Never" or "Less than once a month" were classified as not engaging in monthly binge drinking, while those who reported drinking "Monthly," "Weekly," or "Daily or almost daily" were classified as engaging in monthly binge drinking.

Cannabis use in the last 30 days was evaluated by asking participants if they had ever used cannabis (including hashish, marijuana, or joints). Responses were grouped to create a dichotomous variable: those who answered "No, never," "Yes, once in a lifetime," "Yes, in the last 12 months," or "Yes, in the last 6 months" were classified as not using cannabis in the last 30 days, while those who selected "Yes, in the last 30 days" were classified as cannabis users in the last 30 days. Cannabis use refers to any form of consumption, without differentiating legal status, given that in Spain, all use among minors is prohibited.

Daily tobacco use was measured by asking participants how often they smoked tobacco regularly. Responses were used to create two categories: non-daily smokers and daily smokers. Only participants who reported smoking tobacco every day were categorized as daily smokers.

2.2.2. Independent Variables

The main independent variable was the period during which the data were collected. Since, during the second wave, restrictions were progressively relaxed and the situation gradually returned to pre-pandemic conditions (in terms of social, work, leisure, and other contextual aspects), the period was analytically divided into two distinct phases according to the timeline of community-level interventions. This allows us to estimate the relationship between COVID-19 restrictions and substance use. As a result, three distinct data collection periods were defined: (1) pre-COVID-19 (October 2019 to March 2020—1st wave data of the project; n = 4641); (2) post-COVID-19, with restrictions (October 2021 to January 2022—2nd wave data of the project; n = 3478); and (3) post-COVID-19, without restrictions (February 2022 to June 2022—2nd wave data of the project; n = 2900).

Additional variables included their sex (boy; girl), academic year (4th year of CSE; 2nd year of PCSE; or 2nd year of ILTC), municipality size (of residence) (rural: <10,000 inhabitants; urban: ≥10,000 inhabitants), socioeconomic status (disadvantaged; medium; advantaged), weekly disposable money (0 EUR; 0–10 EUR; 10.01–30 EUR; more than 30 EUR), and mood (good mood; low mood). For their socioeconomic status, terciles were calculated using the participants' self-perceived socioeconomic status based on the McArthur Scale. The mood variable was derived from responses to six questions: "How often have you felt: (1) too tired to do things; (2) had trouble sleeping; (3) down, sad, or depressed; (4) hopeless about the future; (5) nervous or tense; (6) bored with things?" Each item offered five response options, ranging from 'Never' to 'Always.' Responses were categorized into two groups: 'Never,' 'Almost never,' and 'Sometimes' (score: 0), and 'Often' and 'Always' (score: 1). The scores for each item were summed and, as in other studies, a total score of ≥3 was categorized as a low mood [21,22].

2.3. Data Analysis

For the statistical analysis, we first described the sample characteristics across the three study periods, including both dependent and independent variables. To examine substance use over time, the prevalence of monthly binge drinking, cannabis use in the last 30 days, and daily tobacco use were calculated for each period, along with their corresponding 95% confidence intervals (95%CI). To investigate associations between sociodemographic or contextual factors and each substance use outcome, we conducted

multivariable Poisson regression analyses with robust variance [23,24]. This approach allowed us to obtain adjusted prevalence ratios (aPR) and 95% confidence intervals (95%CI) for each independent variable [25]. The reference period was "pre-COVID-19". Prevalences for the second and third periods ("post-COVID-19 restriction period" and "post-COVID-19 without restrictions") were compared to this baseline to examine changes potentially attributable to the pandemic context.

All analyses were stratified by sex and conducted using STATA 18 statistical software (StataCorp, College Station, TX, USA).

3. Results

Table 1 describes the sociodemographic characteristics and substance use of the total sample across the three study periods. In Supplementary Tables S1 and S2 (boys and girls, respectively), these data are presented stratified by sex. The sample size in the 1st period, "pre-COVID-19", was 4641 individuals (52.4% girls); in the 2nd period, "post-COVID-19, with restrictions", was 3478 individuals (53.3% girls); and in the 3rd period, "post-COVID-19, without restrictions", was 2900 individuals (49.1% girls). Regarding the academic year, students in the 2nd year of PCSE and 2nd year of ILTC were unified for the age equivalence criteria. The percentage of the 2nd year of PCSE students was higher in all study periods (77.5% of the 1951 in the 1st wave; 75.8% of the 1417 in the 2nd wave; and 70.4% of the 1437 in the 3rd wave).

Table 1. Sociodemographic characteristics and monthly binge drinking, cannabis use in the last 30 days, and daily tobacco use of the participants in the three study periods.

	Period of Time *			
	Pre-COVID-19 (2019/20)	**Post-COVID-19, With Restrictions (2021)**	**Post-COVID-19, Without Restrictions (2022)**	
	n (%)	*n* (%)	*n* (%)	*p*-value
Total	4.641 (42.1)	3.478 (31.6)	2.900 (26.3)	
Sex				0.002
Boys	2.209 (47.6)	1.624 (46.7)	1.475 (50.9)	
Girls	2.432 (52.4)	1.854 (53.3)	1.425 (49.1)	
Academic year				<0.001
4th CSE	2.690 (58.0)	2.061 (59.3)	1.463 (50.4)	
2nd PCSE/ILTC	1.951 (42.0)	1.417 (40.7)	1.437 (49.6)	
Municipality size **				<0.001
Rural	2.459 (54.7)	1902 (56.3)	1.325 (47.0)	
Urban	2.038 (45.3)	1476 (43.7)	1.493 (53.0)	
Socioeconomic Position ***				0.534
Disadvantaged	1.705 (36.8)	1.238 (35.6)	1.090 (37.6)	
Medium	1.561 (33.6)	1.178 (33.9)	969 (33.4)	
Advantaged	1.375 (29.6)	1.062 (30.5)	841 (29.0)	
Weekly money				<0.001
0 EUR	680 (14.7)	677 (19.5)	508 (17.5)	
0 EUR–10 EUR	1.968 (42.4)	1.345 (38.7)	1.023 (35.3)	
10.01 EUR–30 EUR	1.417 (30.5)	1.045 (30.0)	919 (31.7)	
More than 30 EUR	576 (12.4)	411 (11.8)	450 (15.5)	
Mood				<0.001
Good mood	3.571 (76.9)	2.305 (66.3)	1.910 (65.9)	
Low mood	1.070 (23.1)	1.173 (33.7)	990 (34.1)	
Monthly binge drinking				<0.001
No	4.155 (89.5)	3.068 (88.2)	2.493 (86.0)	
Yes	486 (10.5)	410 (11.8)	407 (14.0)	
Cannabis use in the last 30 days				<0.001
No	4.067 (87.6)	3.202 (92.1)	2.642 (91.1)	
Yes	574 (12.4)	276 (7.9)	258 (8.9)	
Daily smoking tobacco				0.001
No	4.136 (89.1)	3.180 (91.4)	2.585 (89.1)	
Yes	505 (10.9)	298 (8.6)	315 (10.9)	

Note: CSE = Compulsory Secondary Education. Equivalent to 10th year (15–16 years old); PCSE = Post-Compulsory Secondary, ILTC = Intermediate-Level Training Cycles. Both are equivalent to 12th year (17–18 years old). * Timing of each study period: Pre-COVID-19 (September 2019–March 2020; data from the 1st wave of the DESKcohort project); Post-COVID-19 restrictions period (October 2021–February 2022; data from the 2nd wave of the DESKcohort project); Post-COVID-19 without restrictions (February–June 2022; data from the 2nd wave of the DESKcohort project); ** Rural < 10,000 inhabitants, Urban > 10,000 inhabitants. *** Terciles obtained from McArthur Scale results, which inquired for neighborhood self-perceived socioeconomic position.

The prevalence of monthly binge drinking progressively increased between the pre-COVID-19 period (10.5%) and the post-COVID-19 period without restrictions (14.0%). In contrast, for smoked substances, the pattern of change was different, decreasing during the post-COVID-19 period with restrictions and increasing in the post-COVID-19 period without restrictions (from 7.9% to 8.9% for cannabis and from 8.6% to 10.9% for tobacco, respectively).

The increase in binge drinking (Supplementary Table S3) during the restrictions period (2nd period) among girls in their 4th year of CSE was associated with living in rural municipalities, having a medium socioeconomic position, and having a low mood. On the other hand, binge drinking significantly increase in the post-COVID-19 without restrictions period (3rd period) compared to the pre-COVID-19 period for boys in their 4th year of CSE living in rural municipalities, with a disadvantaged socioeconomic position, and with a good mood. In this case, no significant differences between the periods were observed in girls. For cannabis use in the last 30 days, the reduction during the restrictions period (2nd period) in 4th-year CSE boys was associated with all socioeconomic positions, living in a rural or urban municipality, and having a good mood (Supplementary Table S4). Finally, tobacco prevalence also decreased during the restrictions period (2nd period) (Supplementary Table S5).

Table 2 shows the main differences in substance use across periods, stratified by sex and academic year. Binge drinking increased significantly among boys in their 4th year of CSE after the lifting of restrictions, and among girls, higher levels were already observed during the restriction period and remained elevated post-COVID-19. In contrast, cannabis use decreased significantly in all groups during and after the restrictions, particularly among students in their 4th year of CSE. Daily tobacco use also declined during the restriction period, especially among boys in their 4th year of CSE and girls in their 2nd year of PCSE/ILTC. Although a slight rebound was observed after the lifting of restrictions, it was not significant, and the prevalence did not return to pre-pandemic levels. The trends in the prevalence of consumption of the three substances over the study periods for boys and girls can be seen in Figures 1 and 2.

Table 2. Adjusted prevalence ratios (aPR) of each of the dependent variables according to study period in adolescents in Central Catalonia, according to academic year.

	4th Year of CSE			2nd Year of PCSE/ILTC		
	Pre-COVID-19 (2019/2020)	**Post-COVID-19, with Restrictions (2021)**	**Post-COVID-19, Without Restrictions (2022)**	**Pre-COVID-19 2019/2020**	**Post-COVID-19, with Restrictions (2021)**	**Post-COVID-19, Without Restrictions (2022)**
Boys	PR	aPR *	aPR	PR	aPR	aPR
Binge drinking						
Prevalence (%)	22.8 [20.6–25.1]	22.5 [20.0–25.2]	29.8 [26.6–33.2]	48.0 [44.8–51.3]	42.0 [38.2–45.9]	44.9 [41.3–48.5]
Prevalence Ratio	1	1.0 [0.8–1.4]	**1.7 [1.3–2.3]**	1	1.0 [0.8–1.3]	1.0 [0.8–1.2]
Cannabis last 30 days						
Prevalence (%)	11.0 [9.4–12.8]	4.4 [3.3–5.9]	6.5 [4.9–8.5]	19.8 [17.3–22.6]	14.5 [11.9–17.5]	13.9 [11.5–16.6]
Prevalence Ratio	1	**0.4 [0.3–0.6]**	**0.6 [0.4–0.8]**	1	0.8 [0.6–1.0]	**0.6 [0.5–0.8]**
Daily Tobacco						
Prevalence (%)	7.1 [5.8–8.6]	3.2 [2.3–4.5]	6.4 [4.8–8.3]	13.3 [11.2–15.7]	11.3 [9.1–14.0]	13.1 [10.8–15.7]
Prevalence Ratio	1	**0.5 [0.3–0.7]**	1.0 [0.7–1.5]	1	0.8 [0.6–1.1]	0.8 [0.6–1.1]
Girls	PR	aPR	aPR	PR	aPR	aPR
Binge drinking						
Prevalence (%)	28.6 [26.3–31.1]	28.8 [26.2–31.6]	29.7 [26.4–33.1]	41.9 [39.0–45.0]	36.6 [33.3–40.1]	36.4 [33.0–40.0]
Prevalence Ratio	1	**1.5 [1.2–2.0]**	**1.5 [1.1–2.1]**	1	0.8 [0.6–1.0]	1.0 [0.7–1.2]
Cannabis last 30 days						
Prevalence (%)	8.4 [7.1–10.0]	5.7 [4.5–7.3]	6.1 [4.5–8.1]	12.9 [11.0–15.0]	10.1 [8.2–12.4]	9.2 [7.3–11.5]
Prevalence Ratio	1	**0.6 [0.5–0.8]**	**0.6 [0.4–0.8]**	1	**0.7 [0.6–0.9]**	**0.6 [0.4–0.8]**
Daily Tobacco						
Prevalence (%)	8.4 [7.0–10.0]	8.0 [6.5–9.8]	8.3 [6.5–10.6]	16.8 [14.7–19.2]	13.9 [11.7–16.5]	15.9 [13.4–18.8]
Prevalence Ratio	1	0.8 [0.6–1.1]	0.9 [0.6–1.2]	1	**0.7 [0.6–0.9]**	0.8 [0.6–1.0]

Note: CSE = Compulsory Secondary Education. Equivalent to 10th academic year (15–16 years old); PCSE = Post-Compulsory Secondary; ILTC = Intermediate-Level Training Cycles. Both are equivalent to 12th academic year (17–18 years old); * aPR = Adjusted model for the variables academic year, municipality of residence, socioeconomic position, weekly money, and mood.

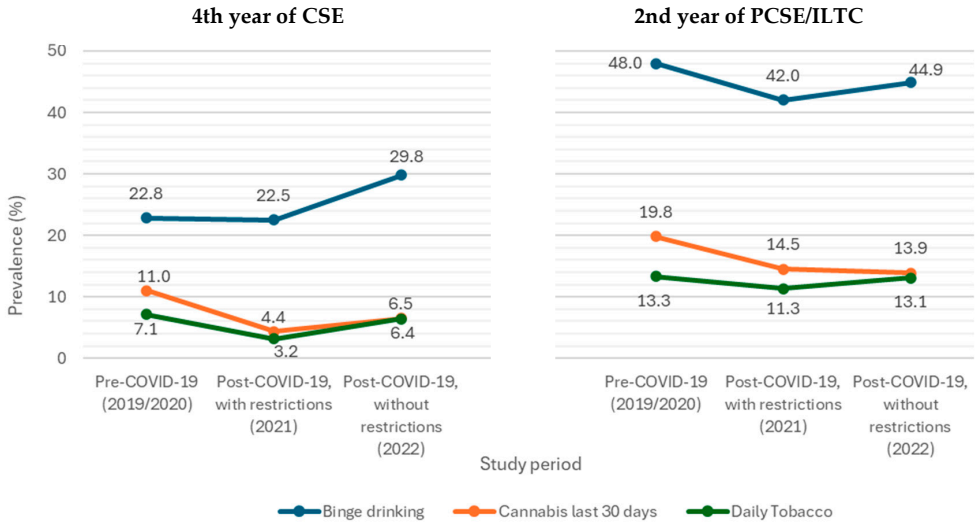

Figure 1. Evolution of the prevalence of binge drinking, cannabis in the last 30 days, and daily tobacco use over the three study periods among boys, according to academic year. Note: CSE = Compulsory Secondary Education; PCSE = Post-Compulsory Secondary; ILTC = Intermediate-Level Training Cycles.

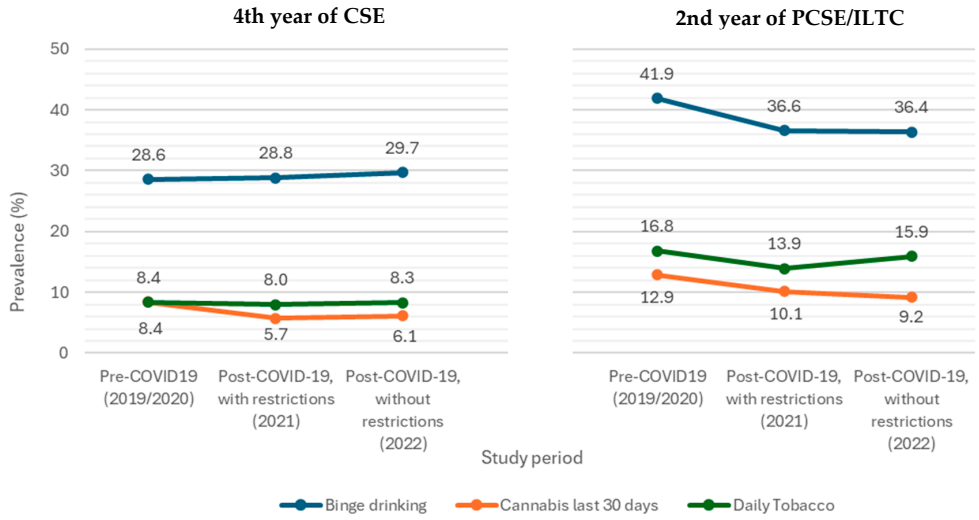

Figure 2. Evolution of the prevalence of binge drinking, cannabis in the last 30 days, and daily tobacco use over the three study periods among girls, according to academic year. Note: CSE = Compulsory Secondary Education; PCSE = Post-Compulsory Secondary; ILTC = Intermediate-Level Training Cycles.

4. Discussion

This study examines the role of social environments in adolescent substance use, emphasizing the need to track substance use trends by sex and age during COVID-19. The findings reveal an increase in binge drinking among younger adolescents after the restrictions, a decrease in cannabis use that persisted post-pandemic, and stable tobacco consumption patterns. These prevalence rates must be interpreted within the regulatory context in Catalonia, as they refer to the use of substances that are illegal for minors. This suggests that access is likely mediated by third parties who enable acquisition and consumption.

Alcohol use trends highlight the role of social and recreational settings in adolescent consumption. Differences in alcohol consumption between countries suggest that this is a culturally dependent behavior [26]. Therefore, the observed reduction during the

restriction period was expected and aligns with findings from previous studies with the Spanish population [7,12]. The decrease in alcohol consumption was attributed to limited social interactions, a reduction in social encounters conducive to early substance use, and increased parental supervision [15,19,27]. Cross-country studies have shown that in regions like Spain, strict mobility restrictions and the closure of social venues during lockdown led to a reduction in alcohol consumption, particularly due to the cultural link between drinking and socializing. In contrast, in the United Kingdom (with milder restrictions and activities outside permitted during restrictive periods), alcohol use remained stable or even increased [26,27]. So, in cultures where drinking is closely linked to social rituals, such as meeting friends at bars or restaurants, strict lockdowns may have had a stronger impact on adolescent consumption patterns.

Although boys tend to drink alcohol more regularly, girls drink more intensively. Given the contextual deprivation, a significant reduction in heavy drinking was expected [28]. Contrary, the heavy drinking prevalence increased among girls in their 4th year of CSE (14–16 years) during the restriction period, while remaining stable among boys. The fact that our study analyzed excessive alcohol consumption could explain the higher prevalence of this pattern of alcohol consumption in girls than in boys. High-frequency binge drinking is linked with coping motives while the occasional drinking with social motives [29,30]. In general, girls report poorer mental health and are more likely to use alcohol as a coping strategy [29]. This is consistent with the results of the present study, showing a significant increase in binge drinking among girls with low mood. In the COVID-19 framework, higher rates of excessive alcohol consumption among girls during restrictive periods have been related with the need to cope with emotional distress, anxiety, stress, and loneliness caused by the pandemic [13,15]. Moreover, previous research has shown that girls experienced higher levels of emotional distress than boys during the pandemic, which may further explain their greater use of alcohol as a coping mechanism [31]. Additionally, girls were more likely to drink with their parents [19,29], a behavior that may have intensified during restriction periods as a way to seek enjoyment at home. This phenomenon appears to be less prevalent among boys, whose substance use is more frequently associated with peer interactions in leisure settings and motivated by recreation, social approval, or group integration [15,19]. To sum up, while for boys, social restrictions may have limited opportunities for substance use, for girls, these circumstances might have exacerbated mental health challenges, leading to substance use as a coping mechanism or a means of social integration [15].

Despite the lack of significant results, the maintenance of binge drinking during restraint among boys and girls in their 2nd year of PCSE or ILTC is a relevant fact to be considered. Although perceiving reduced alcohol availability during the pandemic, many adolescents still found it easy to obtain [27]. Currently, alcohol is the most normalized and socially accepted illegal substance within households. In families where parents continued working in essential sectors, some adolescents may have been left unsupervised at home, providing more opportunities to engage in substance use [19].

Among girls, taking a lower academic year was associated with a higher prevalence of binge drinking during pandemic restrictions. Conversely, daily cannabis and tobacco use decreased more among younger students [9]. For alcohol, this difference could be related to two motives. First, COVID-19 disrupted the initial experiences with alcohol among younger teenagers, so they had a greater need for social interaction and use alcohol. Second, older adolescents who had previously experimented with alcohol were more focused on resuming social and recreational activities than motivated by a direct need to drink [15]. The disruption caused by the pandemic in typical initiation pathways into substance use is expected to lead to a postponement in the average age of onset. In fact,

some studies suggest that delaying alcohol consumption until after age 16 can reduce the risk of developing binge drinking habits by up to 50% [32]. Further longitudinal research is warranted to determine whether the substance use trajectories of this "COVID generation" of adolescents differ in the long term.

Moreover, for younger individuals, social and nightlife environments are the primary contexts that legitimize drinking [33]. This could explain the significant increase in binge drinking among younger students immediately after the lifting of restrictions, compared to the stabilization or even reduction observed in older students. It is also suggested that younger adolescents had fewer opportunities to consume alcohol during restrictions, and when they did consume alcohol, their use followed a more abusive pattern. Meanwhile, it seems that adolescents in upper years were less affected by restrictions, maintaining similar consumption throughout the pandemic.

As for cannabis, there are notable regional differences and most studies have focused on university populations. Studies in North America showed an increase in cannabis consumption during the pandemic among college adolescents, which is theorized to be as a coping mechanism for anxiety, emotional distress, boredom, and loneliness [19,34]. Moreover, other studies report an increase associated with living with parents [35]. Instead, in Europe, studies have reported a significant decline in cannabis use during the COVID-19 restriction period [36]. However, this pattern is not consistent across all European countries. For example, in Spain, a study evolving PCSE students reported a significantly higher prevalence of the risk of cannabis use before the pandemic compared to both the restriction and post-pandemic periods [15]. In line with these results, in the present study, we also found a decrease in cannabis use during the COVID-19 restrictions. This decline may be attributed to various factors: difficulties in acquiring the substance [37], being an occasional user, living with parents [36], reduced social contact, and decreased exposure to peer pressure and harassment [8,27,38]. Differences in cannabis use trends across countries may also relate to contextual factors such as the legal status of cannabis and the severity of the COVID-19 restrictions. In North America, cannabis is partially legal and restrictions were less stringent, so reported increases in use could be expected. Conversely, in Europe, cannabis remains largely illegal and mobility restrictions were more severe, so it is not surprising that the reduction in the prevalence is more marked than in other countries [19,39]. Despite the lack of significant results, the prevalence of cannabis use in the last 30 days rose up after the lifting of restrictions, according with other investigations [36]. Overall, cannabis consumption has remained significantly lower in the post-COVID-19 period compared to the pre-pandemic baseline [1,7,15,16].

Regarding tobacco, a reduction in the prevalence of daily use was observed among boys in the 4th year of CSE and girls in the 2nd year of PCSE or ILTC. Similar trends have been documented in other studies reporting a reduction in consumption among younger people [28], which may be explained by an increased difficulty in acquiring the substances and reduced social interactions during the restriction period [7,40]. Although tobacco is socially normalized and associated with social contexts, minors tend to avoid smoking at home if their parents are unaware of it and disapprove of its consumption. Our findings contrast with studies indicating stable or increased tobacco use during restrictions [9,19,41]. This increase has been attributed to the fact that nicotine products, such as conventional tobacco or e-cigarettes, are easier to conceal from parents when used at home during lockdowns [41].

No significant changes in daily smoking were observed between the post-COVID-19 study periods. This suggest that tobacco may be less influenced by social restrictions than alcohol and cannabis. Despite the lack of statistically significant results, our results show a return to pre-pandemic levels of tobacco consumption once the restrictions were

lifted [12,27]. This trend can be explained by two factors. First, some adolescents may have initiated tobacco use later, as their experimentation phase coincided with the full lockdown period due to COVID-19. Second, those individuals who had reduced their daily consumption during the restrictions may have acted this way due to the inability to smoke at home [7]. Evidence shows that delaying smoking initiation to age 14 increases the likelihood of higher cigarette consumption at ages 16–17 [42]. Nevertheless, in our study, this does not appear to have reduced regular tobacco use in later stages.

Our study's findings align with other research indicating higher alcohol and cannabis consumption among individuals living in rural areas compared to their urban counterparts [7]. The difference in consumption is notably pronounced during restrictions, possibly due to more relaxed adherence to public health measures in rural settings. Additionally, consumption in rural areas may be more frequent in informal spaces such as the public highway or homes, rather than in leisure settings like bars or nightclubs.

Moreover, cannabis and tobacco use during restriction periods was higher among individuals with a low mood, likely influenced by the need to cope with negative emotions and the limited availability of activities outside the home [27].

It is also worth noting the changes observed in binge drinking, cannabis use, and tobacco use among adolescents in Central Catalonia throughout the different periods of the COVID-19 restrictions. Social distancing measures led to a change in the quantity, frequency, and settings of substance use among young people. Despite those reductions, considering that these are illegal substances for minors, it is surprising that the decrease in availability during the restrictions and the environmental limitations were not proportional to the reduction in the consumption prevalence [26]. The consumption went from being linked to nightlife to a more private environment among smaller social circles [16,19]. Finally, data from some studies show an increase in consumption after the lifting of restrictions, returning to pre-pandemic levels, suggesting that this is a fluctuating behavior over time and is context-related, which should continue to be explored in subsequent periods [1,7,43].

Limitations and Future Perspectives

It is important to highlight some key considerations regarding this study. A major strength of this study is the consistent data collection methodology across the periods, enhancing the comparability and trend analysis. The stratified analysis by sex and sociodemographic factors provides a deeper insight into substance use patterns. Moreover, the inclusion of pre- and post-pandemic data offers a unique perspective on COVID-19's impact on adolescents. Another notable strength of this study is the progressive increase in participation between the 1st and 2nd wave, which enhances the validity of the sample for monitoring adolescent health behaviors. A potential limitation of this study is the division of Wave 2 into two periods, which may have introduced differences in the subgroup composition over time. However, no significant differences in participation rates across territories were observed, supporting the overall representativeness of the regional sample [20]. Moreover, statistical models were adjusted to account for and minimize the potential influence of sociodemographic differences between subgroups. Another limitation is that groups across different periods vary in characteristics such as age and sex. Nevertheless, using adjusted models that accounted for all variables included in this study helped to mitigate the impact of these differences on the results. Furthermore, both Wave 1 and Wave 2 questionnaires were self-administered in classroom settings, so answering questions about substance use in an environment with peers may have affected the response pattern, introducing social desirability bias. However, existing evidence supports the reliability of self-reported, anonymized questionnaires as a valid method for measuring substance use in adolescents [44,45]. Finally, since cannabis is illegal for recreational use in

Spain and for minors, no legal distinction was considered in the data collection or analysis. The collection of differentiated data on whether consumption is legal or not is needed to establish causal relationships between this fact and the prevalence of consumption.

5. Conclusions

The results of this study highlight the importance of denormalizing alcohol, cannabis, and tobacco consumption in the population, and the need to design awareness and education campaigns on the risks associated with these substances. Furthermore, the differentiated patterns by age and sex observed suggest that preventive strategies must be tailored to specific subgroups. As we know, parents play a key role in shaping health behaviors; thus, their substance use can precede early initiation and the development of intensive, risky patterns in adulthood [46]. Therefore, it is crucial to implement interventions that primarily target adolescents and promote a positive family environment while reducing parental alcohol consumption at home. Moreover, delaying or avoiding alcohol consumption [32], cannabis use [17], and tobacco use [42] in early adolescence has been associated with a lower risk in later stages of development. Further longitudinal research is warranted to determine whether the substance use trajectories of this "COVID generation" of adolescents differ in the long term.

Despite an overall decline in cannabis and tobacco use during the pandemic, a significant proportion of adolescents continued consuming these substances, even under restrictive conditions and despite their illegal status for minors. The post-restriction rebound suggests that stringent measures alone are insufficient to reduce the adolescent use of alcohol, cannabis, and tobacco in the long term. This underscores the need for sustained and gender-sensitive prevention strategies specifically targeting young people, which can be effectively implemented in future social and public health crises.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/future3030015/s1, Supplementary Table S1: Sociodemographic characteristics and monthly binge drinking, cannabis use in the last 30 days, and daily tobacco use of the boys participating in the three periods of this study; Supplementary Table S2: Sociodemographic characteristics and monthly binge drinking, cannabis use in the last 30 days, and daily tobacco use of the participating girls in the three periods of this study; Supplementary Table S3: Prevalence (%) and 95% confidence interval (95%CI) of monthly binge drinking among adolescents in Central Catalonia according to independent variables of this study, stratified for boys and girls and data period; Supplementary Table S4: Prevalence (%) and 95% confidence interval (95%CI) of global cannabis use in the last 30 days among adolescents in Central Catalonia, according to independent variables of this study, stratified for boys and girls and data period; Supplementary Table S5: Prevalence (%) and 95% confidence interval (95%CI) of daily smoking tobacco use among adolescents in Central Catalonia, for the independent variables of this study, stratified for boys and girls and according to data period.

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Informed Consent Statement: Written informed consent has been obtained from all subjects involved in this study.

Data Availability Statement: Data from the DESKcohort project is public and available through the project's website: https://deskcohort.cat/en/databases/ (accessed on 6 October 2024).

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Abbreviations

The following abbreviations are used in this manuscript:

CSE	Compulsory Secondary Education
PCSE	Post-Compulsory Secondary Education
ILTC	Intermediate-Level Training Cycles
aPR	Adjusted Prevalence Ratios

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