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Association between cumulating substances use and cumulating several school, violence and mental health difficulties in early adolescents

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Abstract

Multiple substances (alcohol, tobacco, cannabis and other illicit drugs (OID)) have been frequently used in early adolescents maybe due to school, violence and mental-health difficulties. We investigated the associations between substance-use patterns and related difficulties among 1559 middle-school adolescents from north-eastern France (mean age 13.5±1.3). They completed a questionnaire including socioeconomic features, school, violence and mental-health difficulties (school grade repetition, sustained physical/verbal violence, sexual abuse, perpetrated violence, poor social support, depressive symptoms and suicide attempt; cumulated number noted $SVMD_{score}$) and the time of their first occurrence during the life course. Data were analyzed using logistic and negative binomial regression models. Alcohol, tobacco, cannabis and OID use affected 35.2, 11.2, 5.6 and 2.8% of the subjects respectively. The risk of using tobacco only, alcohol and tobacco, alcohol plus tobacco and cannabis, or all alcohol, tobacco, cannabis and OID strongly increased with the $SVMD_{score}$ (socioeconomic features-adjusted odds ratio reaching 85). The risk began in early years in middle schools and then steadily increased, more markedly for elevated $SVMD_{score}$. Exposure to several SVMDs may be a transmission vector towards the substance use, starting mostly with alcohol/tobacco, and then shifting to cannabis/OID. These findings help to understand substance-use risk patterns and identify at-risk adolescents.

Keywords: substance use; early adolescents; school difficulty; violence; mental health difficulties

1. Introduction

Early adolescence (10-16 years) is a crucial period of youth's physical, mental and cognitive development (Duke et al., 2010; Inchley et al., 2016; Swahn et al., 2012). It is a transition period from the total social and economic dependence to a relative independence. At the entrance to middle schools, early adolescents have more contacts and exchanges with peers and more access to substance use than in childhood when they may not be prepared to manage their new living environments. Youth development is needed through nurturing which results in promoting healthy self-awareness, self-care behavior, and future goal achievement (Duke et al., 2010). Unfortunately, many early adolescents use alcohol or tobacco, which is associated with using cannabis and other illicit drugs (OID), following the gateway trajectories diagram from licit to illicit drugs, a common liability to substance use or a common administration route for tobacco and cannabis (Agrawal and Lynskey, 2009; Attaiaa et al., 2016; Kandel and Jessor, 2002; Mayet et al., 2011, 2016; Ruiz-Casares et al., 2017). It should be noted that substance use in early adolescence dramatically increases the risk of substance use disorders in young adulthood and during the life course (Cross et al., 2017; Gil et al., 2004; Jordan and Andersen, 2017). Furthermore, 1% of deaths worldwide may be attributed to substance use (Worley, 2017). Some studies have reported that, in recent years, the yearly total economic cost of substance use was high ($700 billion in the United States, £57 billion in the United Kingdom, Canadian $38 billion in Canada, and €249 billion in France (Kopp and Fenoglio, 2015; Worley, 2017)). Hence, substance use in early adolescence is a public health concern in terms of morbidity, mortality and socioeconomic costs (Chau et al., 2007; Kopp and Fenoglio, 2015; Peto et al., 2006; Swahn et al., 2012).

Over recent decades, changes in society have altered the social environment of adolescents who often have to face with several socioeconomic adversities such as not living with both parents, having low parents' education, non-working parents, insufficient family income, or an immigration history (SEAs) (Organisation for Economic Co-operation and Development, 2011).

These SEAs have been found to be associated with a higher risk of substance use (Arillo-Santillan et al., 2005; Legleye et al., 2011, 2013). Some early adolescents cumulate several SEAs which weaken their living conditions and may consequently increase substantially their risk of substance use. Early adolescence is a period where a wide range of school, violence and mental health difficulties (SVMDs) (grade repetition, sustained physical/verbal violence, sexual abuse, perpetrated violence, poor social support, depressive symptoms and suicide attempt) may occur (Chau et al., 2016; Duke et al., 2010; Swahn et al., 2012) partly because of these SEAs. As these difficulties are strongly interdependent, many adolescents may suffer simultaneously from several of them. We hypothesize that substance use is not a random event but is strongly associated with the cumulative number of SVMDs, and that the exposure to several SVMDs is associated with a high risk of using several substances. As the SVMDs are generally unsolved (Chau et al., 2018; Rice et al., 2018), affected adolescents may use more substances over time. These situations may partly explain as to why, despite decades of preventive efforts have been made to prevent substance use in the population, many early adolescents use several substances regularly. Hence, there is an urgent need to better understand the substance use processes by assessing the role of exposure to multiple SVMDs and the confounding role of SEAs.

Studies on the role of the SVMDs in substance use in early adolescence have been rather scarce. The majority of the studies were focused on the trajectories and the consequences of substance use (Agrawal et al., 2009; Cross et al., 2017; Gil et al., 2004; Jordan and Andersen, 2017; Mayet et al., 2016; Swahn et al., 2012) and on the role of socioeconomic status as well as that of the risk perception of substance use and parenting styles (Choquet et al., 2008; Legleye et al., 2011, 2013; Lund and Scheffels, 2018). However, a few studies showed the role of low academic achievement and childhood mental health disorders in the risk of developing substance-related disorders but their findings were heterogeneous (Arillo-Santillan et al., 2005; Groenman et al., 2017). Despite adolescents often suffer from several SVMDs, it is surprising that the role of their cumulated number in substance use has been little addressed. In a few

studies, various risk factors were separately investigated. The risk associated with each factor may be underestimated because a subject who may not be exposed to a factor could be exposed to other factors. Hence, the results could be heterogeneous owing to study populations, risk factors investigated and methodological approaches (Gray and Squeglia, 2018). Importantly, for the subjects affected by several SVMDs (or several SEAs), investigation of various SVMDs separately (or various SEAs) may not consider their "true" at-risk situation.

This study conducted in north-eastern France aimed at exploring the associations of various SVMDs and their cumulated number with alcohol, tobacco, cannabis and OID use, using a retrospective reconstruction of life events. We further investigated using alcohol only, tobacco only, alcohol and tobacco, alcohol plus tobacco and cannabis, and alcohol plus tobacco plus cannabis and OID. The findings may help to understand the risk patterns of substance use, establish targeted prevention, and identify the subjects at risk for care in their early stages.

2. Methods

2.1. Study Design

The study population included all 1,666 early students (age range 10-18 years, 98% under 16 years) who were attending three middle schools (two public and one private schools). They were chosen as they may reflect a social gradient (various social categories are represented) in the Nancy urban area (410,000 inhabitants), the capital of Lorraine region (2,342,000 inhabitants) in north-eastern France. These schools cover a relatively large geographical area (comprising 38,000 inhabitants) and included 63 classes. The investigation was approved by the Nancy-Metz regional education authority and the *Commission Nationale de l'Informatique et des Libertés* (national review board). Written informed consent was obtained from the respondents.

The study protocol included an invitation to participate which was addressed to parents/guardians in April 2010 and data collection which was conducted in May-June 2010 using an anonymous self-administered questionnaire over a one-hour teaching period under the supervision of the research team. The completed questionnaires were put in a sealed envelope and then in a closed box by the subjects, as recommended in the main international standard protocols (Hibell et al., 2004). Details of the investigation have been published (Chau et al., 2016a, 2016b) and are provided in the Supplementary material. A total number of 1,559 participants (94%) was retained for analysis. This population was close to that from a French school-based population survey in terms of family and health-related factors (Supplementary material, Table S1).

2.2. Measures

Details have been published (Chau et al., 2016a, 2016b) and are provided in the Supplementary material.

Substance use

The substances studied were alcohol, tobacco, cannabis and OID. To focus on potential substance use, we investigated the use initiation with current use (during the last 30 days). The uses of alcohol, tobacco, cannabis and OID were dichotomized (at least once vs. none) and also categorized into three use levels: abstinence, 1-9 times, and regular use (10^+ times). The following substance use categories were considered: none, alcohol only, tobacco only, alcohol and tobacco, alcohol plus tobacco and cannabis, and alcohol plus tobacco plus cannabis and OID.

School, violence and mental health difficulties

We investigated potential SVMDs including school difficulty, sustained physical/verbal violence, sexual abuse, perpetrated violence, poor social support, depressive symptoms and

suicide attempts over the life course. School difficulty was assessed using grade repetition at primary and middle schools. Sustained physical/verbal violence was assessed with a 20-item scale (5 questions for 4 localities), perpetrated violence with a 11-item scale, and poor social support with a 9-item scale concerning the neighborhood. These scales had satisfactory Cronbach's alphas (0.71, 0.82 and 0.57, respectively). Sustained physical/verbal violence, perpetrated violence and poor social support were defined by the presence of at least one item. Sustained sexual abuse was defined by at least once. Depressive symptoms were measured with the Kandel scale which was unidimensional and had satisfactory Cronbach's alpha (0.84) allowing a single score to be calculated (range 6-18). Depressive symptoms were defined by a score≥17 (90^{th} percentile). Suicide attempt was defined by at least once.

For grade repetition(s), the years concerned were collected. For sustained physical/verbal violence, perpetrated violence and depressive symptoms, the years of the first and the last occurrences were gathered. For suicide attempt, the year of their first occurrence was gathered.

Principal component analysis showed that the SVMDs (each difficulty being dichotomized) considered were unidimensional (1^{st} eigenvalue (1.08) much higher than the 2^{nd} eigenvalue (0.30)). The Cronbach alpha was moderate 0.53, stating that the difficulties were complementary. A score of school, violence and mental health difficulties ($SVMD_{score}$) was defined as the cumulated number of SVMDs (range 0-7; the years of occurrence for each SVDM was not considered). Our research hypothesis was that a high $SVMD_{score}$ strongly increases the risk of polysubstance use.

Socioeconomic adversities

The considered SEAs included being a non-European immigrant, living in non-intact families, low parents' education, non-working parents, and insufficient family income. For family structure, three categories were considered: (a) intact families (father and mother living together), (b) parents divorced/separated and reconstructed families, and (c) single parent and

other situations (Supplementary material). For parents' occupation (best of parents), five categories were considered following the international standard classification of occupations (ISCO): managers, professionals, and intermediate professionals; craftsmen, tradesmen, and heads of firms; service workers and clerks; manual workers and other occupations; and non-working persons (unemployed/retired) (Chau et al., 2011). Perceived insufficient family income was defined as coping but with difficulties or getting into debt. Principal component analysis showed that the SEAs were unidimensional (1^{st} eigenvalue 0.67 much higher than the 2^{nd} eigenvalue 0.05). However, the Cronbach alpha was moderate (0.40) because the SEAs were complementary as stated by Messer et al. (2006). A socioeconomic-adversity score (SEA_{score}) was defined as the cumulated number of the SEAs (range 0-5).

2.3. Statistical analyses

To explore the associations between the use of each substance and each SEA or each SVMD negative binomial regression models were used to compute gender-age-adjusted risk ratios ($_{ga}RR$) and 95% confidence interval (95% CI). For each substance, only the SVMDs that had occurred before its initiation was considered. For sustained violence, sexual abuse, perpetrated violence and depressive symptoms, the exposure time was between their first and last occurrences. To evaluate the risk of shifting from using a substance (risk factor) to using another substance (outcome variable), and the confounding role of SEA_{score} and $SVMD_{score}$, three negative binomial regression models were computed: model 1 measured the $_{ga}RR$, next with further adjustment for SEA_{score} (model 2) and then with adjustment for $SVMD_{score}$ (model 3). The contributions of SEA_{score} and $SVMD_{score}$ were estimated by: $(RR_{model\ 1} - RR_{extended\ model}) / (RR_{model\ 1} - 1)$.

To assess the association of various SVMDs and $SVMD_{score}$ with various substance use categories (alcohol only, tobacco only, alcohol and tobacco, alcohol plus tobacco and cannabis,

and alcohol plus tobacco plus cannabis and OID), multinomial logistic regression models were performed to compute gender-age-SEA_{score}-adjusted odds ratio ($_{SEA}OR$). As use initiation of each substance could be seen as a generalization of survival process, the Kaplan-Meier survival estimates and log-rank test were used to compare the subjects with $SVMD_{score}$ 0-2, 3, 4 and 5^+ (the starting time of SVMDs being not considered). Two-tailed tests were used ($p < 0.05$). All the analyses were conducted using Stata (Stata Corporation, 2007).

3. Results

The sample's characteristics are shown in Table 1. The prevalences of alcohol, tobacco, cannabis and OID uses were 35.2%, 11.2%, 5.6% and 2.8%, respectively. About one quarter of subjects (26.1%) used alcohol only while between 1.7 and 3.7% of subjects used tobacco only, alcohol and tobacco, alcohol plus tobacco and cannabis, or alcohol plus tobacco plus cannabis and OID. Various SVMDs were frequent (between 4.5 and 59.5% each; 46.0%, 22.3%, 11.2% and 4.5% of subjects had 1–2, 3, 4 and 5^+ SVMDs respectively). Various SEAs were also frequent (between 3.5 and 48.7% each; 35.0%, 31.0% and 2.4% of subjects had 1, 2 and 3^+ SEAs respectively).

Table 2 shows that various SVMDs were associated with a higher risk for all substance uses, with $_{ga}RR$ greater for tobacco, cannabis and OID than for alcohol. For sustained violence, sexual abuse, perpetrated violence and depressive symptoms, only a substance use initiated between its first and last occurrences was considered. This approach may explain rather high value for some $_{ga}RR$.

Figure 1 reveals strong disparities in alcohol, tobacco, cannabis and OID use since an early age and the proportion of subjects without use steadily decreased with time according to $SVMD_{score}$ levels. The percentages of subjects free of alcohol, tobacco, cannabis and OID use at 16 years were about 27%, 42%, 67% and 80% in the $SVMD_{score}$-5^+ group; and about 45%, 75%,

87% and 90% in the $SVMD_{score}$-4 group. The $SVMD_{score}$-0–2 group was not free of substance use at 16 years.

Table 2 further shows that the various SEAs were differently associated with a greater risk of substance use: living in non-intact families with nearly all substance use, being non-European immigrant with tobacco, cannabis or OID use, having non-working parents with tobacco use only, and insufficient family income with tobacco or OID use. Boys had a greater risk of alcohol use than girls. The subjects having 2–3 and 4^+ SEAs represented 31.0% and 2.4% respectively, and they had a higher risk of tobacco, cannabis or OID ($2 < {}_{ga}RR < 7$, Supplementary material, Table S2). These results were confirmed by the Kaplan-Meier survival estimates (Supplementary material, Figure S1).

Table 3 shows that, based on ${}_{ga}RR$, we found a 4-time greater risk for shifting from alcohol to tobacco and a much greater risk was found for shifting from alcohol to cannabis or OID, from tobacco to cannabis or OID, and from cannabis to OID. This analysis did not consider successive or intermediate shifting between various substances. The SEA_{score} had a moderate confounding role (-11%<contribution<13%). The contribution of $SVMD_{score}$ was 6–10% for shifting from alcohol to tobacco or cannabis, 22% for shifting from alcohol to OID, 28% for shifting from tobacco to cannabis, and 52% for shifting from tobacco or cannabis to OID.

The percentage of subjects without substance use monotonously decreased from 84.3% for $SVMD_{score}=0$ to 26.5% for $SVMD_{score}=5^+$ whereas the risk of using tobacco only and 2^+ substances strongly increased with the $SVMD_{score}$ (Supplementary material, Table S3).

Based on ${}_{SEA}OR$, all SVMDs were associated with a higher risk of using alcohol only (except grade repetition that had ${}_{SEA}OR=0.47$ (protective role)) and a much higher risk of using tobacco only, alcohol and tobacco, alcohol plus tobacco and cannabis, and all substances (${}_{SEA}OR$

reaching 37). The risk of these substance use categories steadily increased with the $SVMD_{score}$ ($_{SEA}$OR reaching 85).

The percentage of using 1–9 times during the last 30 days steadily increased with the $SVMD_{score}$ and SEA_{score} for all substances and the trend was more accentuated for regular use (10^{+} times) (Supplementary material, Table S4).

Finally, the Hosmer-Lemeshow goodness-of-fit test showed that the various logistic regression models computed were correct ($0.18<p<0.97$, mostly >0.30).

4. Discussion

4.1. Main findings

This study shows that the SVMDs are common and could highly predict subsequent use of alcohol, tobacco, cannabis and OID among early adolescents. Furthermore, the $SVMD_{score}$ is strongly associated with using several substances: alcohol and tobacco, alcohol plus tobacco and cannabis, and alcohol plus tobacco plus cannabis and OID. This is a public health concern as those consumption habits have undesirable health effects and may carry over to adulthood. These original findings can help to understand substance use risk patterns, identify at-risk individuals, and establish targeted prevention and care.

4.2. Association between substance use and SEA_{score}

Over recent decades, changes have occurred in the social environment of adolescents who now have fewer siblings and more often live with cohabiting, divorced/separated or single parents (Organization for Economic Co-operation and Development, 2011). The poverty in households with children is rising in most countries, which is reaching 20% of children in many countries (Organization for Economic Co-operation and Development, 2011). The families with migration history generally have lower education, socioeconomic status and resources (Chau et al., 2016b). These situations may alter adolescents' mental health and increase their substance

use risk (Chau et al., 2016b; Legleye et al., 2011, 2013). We found that 33.4% of subjects had 2^+ SEAs and had a high risk of SVMDs as well as tobacco, cannabis and OID uses; while, it was found that alcohol use was not associated with the SEA_{score} (Supplementary material, Table S5). Prevention to limit substance use should consider adolescent situations, and the adolescents with no or only one SEA should not be neglected.

4.3. Association between substance use and $SVMD_{score}$

We found that adolescents often suffered from several SVMDs and this situation may act as a transmission vector of substance use. The latter may be an epidemic which sets up among vulnerable adolescents who are not well prepared to live their novel life in an environment where substances are available. The association between the $SVMD_{score}$ and substance use was robust and remained strong when controlling for the SEA_{score}. Our findings suggest that investigating various SEAs or SVMDs separately (i.e. with no consideration of their cumulated number) may not address the true level of adolescent vulnerability.

Some hypotheses may be advanced to explain how such issues have been implemented among early adolescents. Unfortunately, the SVMDs are already observed among early adolescents, and for some subjects before or in their early years in middle schools (Chau et al., 2016a; Dube et al., 2001; Duke et al., 2010; Swahn et al., 2012). Many adolescents cumulate several SVMDs and are strongly at risk for substance use. Indeed, school difficulty may lead to psychological disorders (McCarty et al., 2008) and substance use (Hill and Mrug, 2015). Sustained violence and sexual abuse can generate developmental trajectory failure, depressive and internalizing symptoms, hopelessness, violence perpetration, and suicide behaviors (Dube et al.,2001; Duke et al., 2010; Feiring et al., 2007) through child maladaptation, stress physiology, damage to cognitive development, and psychopathology development (Lynch and Cicchetti, 1998; Middlebrooks and Audage, 2008). Depression could alter executive functions, cognitive ability and work performance (Harvey et al., 2005; Lagerveld et al., 2010). Adolescent mental

health difficulties are mostly not cared, especially due to poor socioeconomic features (Chau et al., 2018; Rice et al., 2018). Some subjects use drugs to cope with their difficulties. Drug use may alter brain development, attention, memory, processing speed, and executive functioning (Cross et al., 2017; Meruelo et al., 2017; Suhrcke and de Paz Nieves, 2011), and could increase in turn living, school and mental difficulties (Suhrcke and de Paz Nieves, 2011), which may lead the subjects to intensify their consumption to cope. During adolescence, major reorganization of limbic brain regions impacts learning, memory, reward processing, increased risk taking, novelty seeking, and peer associations (Cross et al., 2017). Hence, some adolescents have little chance to avoid substance use because of their vulnerability (Arillo-Santillan et al., 2005; Brook et al., 2011; Hadland et al., 2011) and an easy access to substances via their neighborhood.

Substance use is thus an early process starting during the early years at middle school, and then increases over time according to the SVMDscore level. The subjects with $SVMD_{score}=5^{+}$ were highly affected (at 16 years about 80%, 67%, 42% and 27% of them were free of OID, cannabis, tobacco and alcohol use respectively). Those with $SVMD_{score}=4$ were also highly affected. However, those with $SVMD_{score}=1–2$ were not free of tobacco, cannabis and OID use. Increased frequency of substance use in older subjects may be explained by a longer exposure duration, an easier access to substances and a more freedom to use these. It is thus necessary to reduce the SVMDs and substance availability among early adolescents.

Note that the SEA_{score}, $SVMD_{score}$, alcohol, tobacco, cannabis and OID uses of adolescents and those of their father, mother, siblings and peers were unidimensional and had Cronbach's alpha of 0.63 (data not shown). Adolescent’s substance use is strongly associated with that of parents and peers (Arillo-Santillan et al., 2005; Capaldi et al., 2016). Hence, it may be seen as a “transmitted health-behavior disorder” which is difficult to stop when it starts in early adolescence (Cross et al., 2017; Jordan and Andersen, 2017). It may also be a harmful response of the neighborhood/society to the SVMDs of adolescents while genetic factor may also play a

role (Cross et al., 2017). One study underlined that multiple adverse relationship experiences (loneliness, low perceived parental support and partner violence) predicted increases in poorer general heath and depressive symptoms from adolescence to adulthood (Adam et al., 2011).

4.4. Why some adolescents had a relatively low substance use risk?

As adolescents often live in an environment where drugs are available, our results help to understand as to why some adolescents do not use drugs. We found that 16% of subjects had no SVMD and did not use tobacco, cannabis or OID, but 14% of them used alcohol only. Exposure to 1–2 SVMDs affected 46% of subjects and exposed them to a high risk of using all substances (Supplementary material, Table S3). One study in 15-year-old Norwegian adolescents reported that most non-drinkers were tobacco non-users, and the abstainers of both alcohol and tobacco had less unorganized and more hobby-related leisure time activities, higher risk perception for smoking and monitoring or emotionally supportive parents (Lund and Scheffels, 2018).

4.5. Advantages of investigating using several substances

In our study, as previously stated, substance use patterns mostly followed the gateway-trajectories diagram from alcohol or tobacco to cannabis and OID. Only few subjects had begun with cannabis or OID, possibly because their access was easier for them. Therefore, it was pertinent to investigate using alcohol only, alcohol and tobacco, alcohol plus tobacco and cannabis, and all substances. The other use categories (such as cannabis or OID alone, cannabis and OID, and alcohol and cannabis) represented 2.5% only. Our results may help risk pattern understanding. We observed that alcohol use had two faces: using alcohol only which was moderately associated with $SVMD_{score}$ while cumulating alcohol and another substance was strongly associated with $SVMD_{score}$. Prevention to reduce alcohol use is important and may consider these situations.

4.6. Transition between use of various substances

We found that, when alcohol was the first substance used, affected adolescents respectively had a 4-, 11- or 14-time higher risk of shifting to tobacco, cannabis or OID. The transition risk from tobacco to cannabis or OID, or from cannabis to OID was much greater. These results may explain why, as previously stated, polysubstance use and, especially gateway trajectories, are widely observed through various populations. The SEA_{score} had a modest role contrary to the $SVMD_{score}$ that had a high role (especially in the shifting from tobacco or cannabis to OID). Hence, our novel findings shed light on the role of persistent exposure to multiple difficulties as a main risk factor for polysubstance use and gateway trajectories.

4.7. Study implications

Our study shows that adolescents are often early and durably affected by several SVMDs and affected individuals have little chance to solve their problems so that their risk of substance use linearly increases over time. Despite many adolescents want to consult a physician for their health-related problems, those with mental health problems have a low access to healthcare (Chau et al., 2018). Taxation, public consumption bans, advertising restrictions, and minimum legal age are effective measures to reduce alcohol and tobacco use, but they are not available for illicit drugs (Gil et al., 2004). Despite the fact that alcohol, tobacco, cannabis and OID uses are illegal in France for <18-year-old adolescents, in practice their access is often easy via the neighborhood, or by buying themselves. As such measures to limit access to substance are relatively inefficient, our findings help to identify vulnerable early adolescents for care and monitoring. Primary care providers and school physicians play a prominent role as most adolescents consult them for health problems (Chau et al., 2018). Strengthening parent-adolescent relationships and support through communications are important to promote adolescent mental health and reduce substance use (Choquet et al., 2008; Lund and Scheffels, 2018; Ruiz-Casares et al., 2017).

Because substance use in early adolescence strongly increases the risk of substance use disorders in adulthood (Cross et al., 2017; Gil et al., 2004; Jordan and Andersen, 2017), the $SVMD_{score}$ may be a precocious risk indicator of substance use disorders. Studying the role of $SVMD_{score}$ is important as these difficulties and substance use may increase in parallel in late adolescence and adulthood. These perspectives underscore the importance of reducing the SVMDs and their effect on substance use among early adolescents.

4.8. Strengths and limitations

Our study had a high participation rate. The respondents' anonymity was guaranteed. The various instruments were used in many countries (Brunet et al., 2014; Hibell et al., 2004; Swahn et al., 2012). By investigating substance use initiation with last-30-day use and cumulating several SVMDs and SEAs, we studied the vulnerability level of adolescents. The behavior and health-related difficulties of the sample were similar to those of France. The study was cross-sectional with a retrospective reconstruction of life events, based on widely used self-reported data (Hibell et al., 2004; Swahn et al., 2012). Adolescents would know the socioeconomic situations of their family. Most tests were significant at the 0.001 level, with high odds ratios estimates.

5. Conclusion

The present study among early adolescents shows that the SVMDs are common and can highly predict subsequent uses of alcohol, tobacco, cannabis and OID, which mainly followed the gateway-trajectories diagram. The $SVMD_{score}$ played a strong role while the SEA_{score} played a moderate confounding role. Instead of receiving targeted cares, multiple substance use may act as a main response of the neighborhood and the society to adolescent SVMDs. Our findings may help to understand the substance use risk patterns, identify at-risk individuals and establish appropriate prevention, interventions and care.

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Table 1. Characteristics of adolescents (N=1,559)

	% or mean (standard deviation)	Median age at onset (range), year
Substance use [a]		
Alcohol	35.2	11 (5 to 16)
1–5 drinks	28.3	
> 6 drinks	6.9	
Tobacco	11.2	12 (5 to 19)
Cannabis	5.6	13 (5 to 16)
Other illicit drugs	2.8	12 (5 to 15)
Use of several substances		
None	61.4	
Alcohol only	26.1	
Tobacco only	2.5	
Alcohol and tobacco	3.7	
Alcohol plus tobacco and cannabis	2.2	
Alcohol plus tobacco plus cannabis and other illicit drugs	1.7	
Others	2.5	
School, violence and mental health difficulties		
Grade repetition	14.7	11 (7 to 16)
Sustained physical/verbal violence	53.4	11 (5 to 16)
Sexual abuse	3.7	10 (1 to 15)
Perpetrated violence	59.5	11 (5 to 16)
Poor social support	53.8	
Depressive symptoms	13.3	10 (5 to 19)
Suicide attempt	9.9	12 (5 to 15)
Cumulated number difficulties (range 0 to 7)		
0	15.9	
1	20.1	
2	25.9	
3	22.3	
4	11.2	
5 or more	4.5	
Demographic/socioeconomic features		
Boys	49.9	
Age, year	13.5 (1.3)	13.4 (10 to 19) (98% <16 years)
Nationality		
French	93.1	
European immigrants	3.5	
Non-European immigrants	3.5	
Family structure		
Intact family	63.0	
Divorced/separated parents and reconstructed family	25.1	
Single parent and others	11.9	
Low parents' education (baccalaureate or lower)	48.7	
Parents' occupation		
Managers, professionals, and intermediate professionals	54.0	
Craftsmen, tradesmen, and firm heads	13.1	
Service workers and clerks	7.1	
Manual workers and other occupations	19.9	
Not working (unemployed or retired)	5.9	
Insufficient family income	17.7	
Cumulated number of poor situations [b] *(range 0 to 5)*		
0	31.6	
1	35.0	
2–3	31.0	
4–5	2.4	

[a] Use initiation with last 30-day use.
[b] Including being non-European immigrant, living in non-intact families, having a low parents' education, a father being a manual worker/non-working and insufficient family income.

Table 2. Associations of demographic/socioeconomic features and school, and mental health-related difficulties with use initiation of various drugs (N=1,559): gender-age-adjusted risk ratio (gaRR) and 95% confidence interval (CI)

	Substance use initiation with last-30-day use							
	Alcohol		Tobacco		Cannabis		Other illicit drugs	
	gaRR	95% CI	gaRR	95% CI	gaRR	95% CI	gaRR	95% CI
Number of person-years	*19,301*		*20,748*		*21,019*		*21,080*	
School, violence and mental health-related difficulties								
Grade repetition	1.08	0.77–1.50	1.88**	1.20–2.96	2.74***	1.60–4.71	4.34***	2.11–8.92
Sustained physical/verbal violence	1.90***	1.49–2.42	1.96***	1.32–2.90	3.84***	2.44–6.07	3.72***	1.94–7.16
Sexual abuse	2.55**	1.36–4.77	7.27***	3.92–13.5	8.38***	3.84–18.3	19.11***	8.39–43.5
Perpetrated violence	2.12***	1.63–2.75	3.35***	2.32–4.85	6.21***	4.00–9.65	8.09***	4.38–14.9
Poor social support	1.38***	1.16–1.64	2.37***	1.68–3.35	2.13**	1.33–3.42	2.75**	1.35–5.60
Depressive symptoms	11.94***	8.34–17.1	34.94***	21.7–56.3	71.85***	39.4–131	151.73***	66.6–346
Suicide attempt	2.47***	1.54–3.95	5.92***	3.68–9.55	9.21***	5.34–15.9	13.38***	6.72–26.6
Demographic/socioeconomic features								
Boys	1.20*	1.01–1.42	0.84	0.63–1.14	1.51	0.98–2.31	1.45	0.79–2.66
Family structure								
Intact family	1.00		1.00		1.00		1.00	
Divorced/separated parents and reconstructed family	1.43***	1.18–1.72	3.02***	2.18–4.20	2.08**	1.28–3.38	2.05*	1.01–4.17
Single parent and others	1.22	0.94–1.57	2.38***	1.55–3.67	3.05***	1.78–5.22	3.70***	1.77–7.76
Low parents' education	0.79**	0.67–0.93	1.19	0.88–1.60	1.04	0.68–1.58	1.44	0.79–2.64
Non-European immigrants	0.73	0.45–1.21	1.98*	1.12–3.51	2.14*	1.02–4.51	3.99**	1.66–9.59
Parents' occupation								
Managers, professionals, and intermediate professionals	1.00		1.00		1.00		1.00	
Craftsmen, tradesmen, and firm heads	1.07	0.83–1.38	1.45	0.94–2.25	1.08	0.57–2.02	0.79	0.31–2.05
Service workers and clerks	0.84	0.59–1.19	0.72	0.35–1.49	0.29	0.07–1.18	– [a]	
Manual workers and other occupations	0.88	0.71–1.10	1.23	0.84–1.79	0.65	0.36–1.17	0.62	0.27–1.43
Not working (unemployed or retired)	0.70	0.47–1.04	1.72*	1.02–2.91	1.22	0.58–2.58	0.87	0.26–2.88
Insufficient family income	1.06	0.85–1.31	1.64**	1.17–2.29	1.48	0.91–2.40	2.41**	1.29–4.53

*$p < 0.05$, **$p < 0.001$, ***$p < 0.001$.

The gaRR were computed using negative binomial regression models. For school, violence and mental health-related difficulties, only those had occurred before the use initiation of the substance considered were taken into account.

[a] Non-computable.

Table 3. Transitions between using various substances and contributions of socioeconomic factors and school, violence and mental health-related difficulties (N=1,559): risk ratio (RR) and 95% confidence interval (CI)

	Explained variables								
	Tobacco use			Cannabis use			Use of other illicit drugs		
Predictors [a]	RR	95% CI	% [b]	RR	95% CI	% [b]	RR	95% CI	% [b]
Number of person-years	*20,748*			*21,019*			*21,080*		
Alcohol [a]									
Model 1	3.98***	2.92–5.44	100	10.66***	6.86–16.6	100	14.36***	7.42–27.8	100
Model 2	4.32***	3.16–5.93	–11	11.15***	7.16–17.4	–5	15.70***	8.08–30.5	–10
Model 3	3.81***	2.78–5.23	6	9.72***	6.23–15.2	10	11.41***	5.87–22.2	22
Tobacco [a]									
Model 1				35.56***	23.1–54.7	100	63.29***	33.5–120	100
Model 2				33.79***	21.8–52.3	5	55.07***	28.8–105	13
Model 3				25.78***	16.3–40.7	28	30.85***	15.8–60.4	52
Cannabis [a]									
Model 1							63.29***	33.5–120	100
Model 2							55.07***	28.8–105	13
Model 3							30.85***	15.8–60.4	52

*$p < 0.05$, **$p < 0.001$, ***$p < 0.001$.

[a] Was only considered the predictor that had occurred before (or in the same year) than the explained variable.

[b] % = Reduction (positive %) or increase (negative %) in RR computed with the formula: $(RR_{model\ 1} – RR_{extended\ model})/(RR_{model\ 1} – 1)$.

Model 1: yielded gender-age-adjusted RR computed with negative binomial regression models.
Model 2: further included socioeconomic adversities score (SEAscore).
Model 3: further included school, violence and mental health-related difficulties score (SVMDscore). The SVMDscore was here considered as a global vulnerability level by not considering the time interval of occurring for each SVMD.

Table 4. Associations of school, violence and mental health-related difficulties with using several substances: (N=1,520): odds ratio adjusted for gender, age and SEAscore [a] ($_{SEA}$OR) and 95% confidence interval (CI)

	Alcohol only		Tobacco only		Alcohol and tobacco		Alcohol plus tobacco and cannabis		Alcohol plus tobacco plus cannabis and other illicit drugs		Pseudo R^2
	$_{SEA}$OR	95% CI	$_{SEA}$OR	95% CI	$_{SEA}$OR	95% CI	$_{SEA}$OR	95% CI	$_{SEA}$OR	95% CI	
School, violence and mental health-related difficulties											
Grade repetition	0.47***	0.32–0.71	1.49	0.67–3.32	0.74	0.36–1.55	0.85	0.34–2.09	1.86	0.74–6.67	0.062
Sustained physical/verbal violence	1.43**	1.12–1.82	0.94	0.49–1.79	1.85*	1.05–3.26	2.80**	1.28–6.13	1.79	0.78–4.10	0.061
Sexual abuse	1.13	0.45–2.81	2.52	0.54–11.7	9.03***	3.60–22.7	10.67***	3.54–32.2	36.59***	13.6–98.7	0.076
Perpetrated violence	2.86***	2.18–3.74	1.93	0.95–3.92	3.75***	1.91–7.34	5.87***	2.20–15.7	20.91**	2.78–157	0.087
Poor social support	1.48**	1.16–1.89	4.03**	1.74–9.34	1.61	0.90–2.86	3.70**	1.57–8.73	2.75*	1.07–7.07	0.066
Depressive symptoms	1.73**	1.20–2.48	2.56*	1.17–5.58	3.10***	1.64–5.87	2.99**	1.33–6.73	6.01***	2.54–14.2	0.066
Suicide attempt	3.34***	2.09–5.33	13.61***	6.40–28.9	16.67***	8.67–32.1	8.65***	3.58–20.9	33.38***	13.5–82.3	0.098
Cumulated number of difficulties (SVMDscore) [b]											0.094
0 to 2 [b]	1.00		1.00		1.00		1.00		1.00		
3	1.61***	1.20–2.16	3.46**	1.59–7.52	1.57	0.73–3.36	2.55*	1.02–6.35	3.63	0.80–16.5	
4	2.26***	1.52–3.34	2.75	0.93–8.09	4.40***	2.07–9.39	3.22*	1.06–9.83	21.88***	5.66–84.6	
5–7	1.91	0.90–4.06	10.60**	3.42–32.8	12.96***	5.24–32.1	17.57***	5.92–52.1	85.41***	20.1–362	

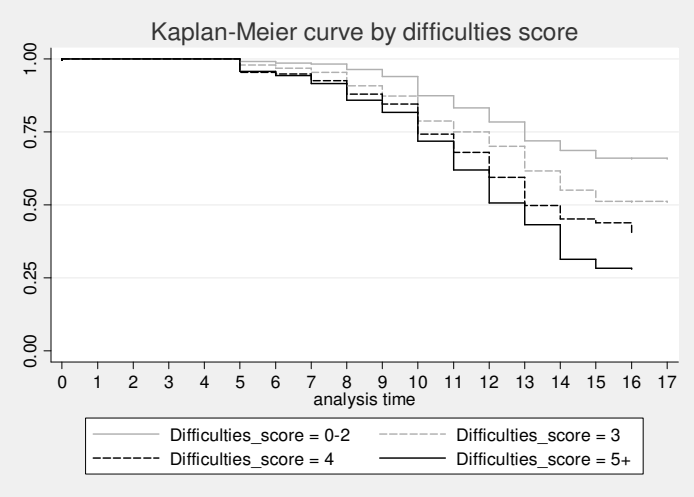
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

[a] Cumulated number of adversities including: being non-European immigrant, living in non-intact families, having a low parents' education, non-working parents, and insufficient family income.

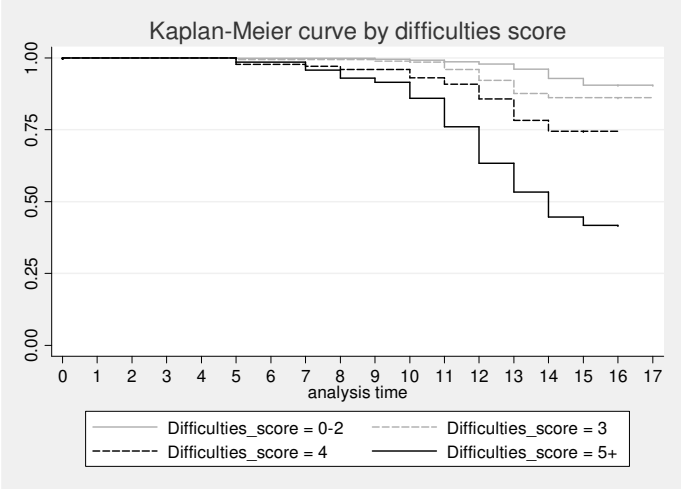
[b] The categories 0 to 2 were grouped because of a relatively small number of subjects who had used several substances.

These analyses did not consider the age at initiation for each substance and the time interval of occurring for each SVMD.

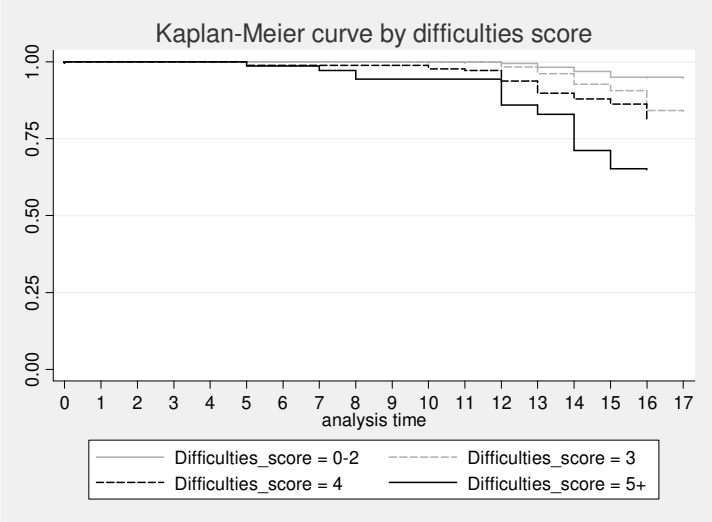
Figure 1. Frequency of subjects with 0-2, 3, 4 and 5+ difficulties having no substance (alcohol, tobacco, cannabis and other illicit drugs) use according to age (year) (N=1,559)



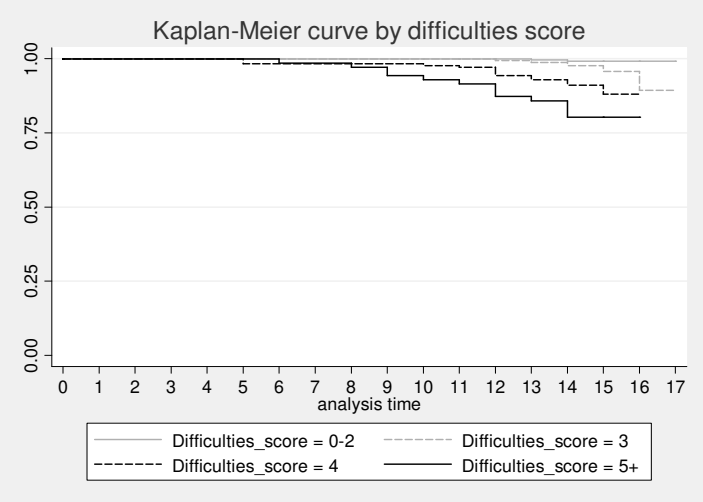
Alcohol use



Tobacco use



Cannabis use



Use of other-illicit-drugs use

Difficulties score (SVMDscore): cumulated number of grade repetition, sustained physical/verbal violence, sexual abuse, perpetrated violence, poor social support, depressive symptoms and suicide attempt (by not considering the time interval of occurring for each SVMD).
The log-rank test for equalily of survivor functions was significant for all alcohol, tobacco, cannabis and other-illicit-drugs uses with $p<0.0001$.

Figure 1