Factors related to an increase of cannabis use among adolescents in Chile: National school based surveys between 2003 and 2017

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ABSTRACT

Background: Cannabis is the most commonly used illicit substance worldwide. In Chile, the prevalence of cannabis use among adolescents is the highest in the Americas. Our aim was to identify prevalence trends of cannabis use and associated factors in adolescents.
Methods: We performed multivariate logistic regression analyses of 416,417 cross-sectional school-based surveys of adolescents from 8th to 12th grade conducted between 2003 and 2017 in Chile. Cannabis use was the dependent variable. Age, gender, socio-economic variables, and factors on the individual, school and family level were assessed as independent variables.
Results: The prevalence of cannabis use in the past year increased from 13.6% in 2003 to 31.3% in 2017 in a linear trend ($F(df:1,6) = 27.6$; $R^2 = 0.79$; $p < 0.01$). The strongest association with cannabis use was seen for *having friends who regularly use cannabis*, and *low perceived risk of cannabis use*. Between 2003 and 2017, the strength of association between the variable *having friends who regularly use cannabis* and cannabis use decreased from $OR = 6.2$ to $OR = 2.9$, in a significant linear trend ($F(df:1,6) = 60.5$; $R^2 = 0.89$; $p < 0.01$); whereas the OR for *low parental rejection of cannabis use* with cannabis use increased in a linear trend ($F(df:1,6) = 22.8$; $R^2 = 0.75$, $p < 0.01$) from $OR = 1.2$ to $OR = 2.1$.
Conclusions: Increasing cannabis use of adolescents in Chile requires adjustments of prevention strategies. Prevalence factors identified here constitute potential targets for interventions.

1. Introduction

Cannabis is the most commonly used illicit substance worldwide (Peacock et al., 2018; United Nations Office on Drugs and Crime, 2018b). Adverse mental health and social outcomes of cannabis use have been reported for individuals and societies (Nora D. Volkow, Baler, Compton, & Weiss, 2014). Cannabis use was associated with the use of other drugs (Degenhardt, Stockings, Patton, Hall, & Lynskey, 2016), difficulties to reach life goals (Hall & Lynskey, 2016; Silins et al., 2014), adverse educational outcomes in adolescents (Meier, Hill, Small, & Luthar, 2015; Stiby et al., 2015), legal issues, and traffic accidents (Hall & Lynskey, 2016). On the one hand, there are genetic and neurodevelopmental risk factors (Koob & Volkow, 2016; N. D. Volkow, Koob, & McLellan, 2016); on the other hand, there are potentially modifiable environmental risk factors of cannabis use (Chadi, Bagley, & Hadland, 2018; Harrop & Catalano, 2016). Parenting styles (neglectful vs. authoritative), substance use of parents and peers, academic and school related factors (truancy vs. school attendance, school cluster effects), and risk perception have been described as relevant psychosocial risk factors (Chadi et al., 2018; Harrop & Catalano, 2016).

In 2016, a global estimate by UNODC based on data from 130 countries estimated that 5.6% of the population aged 15–16 years had used cannabis at least once in the past year (United Nations Office on Drugs and Crime, 2018b). In different regions of the world, the sale of cannabis has been legalized, leading to renewed interest in how this may affect cannabis use and associated factors (Ammerman, Ryan, Adelman, the Committee on Substance Abuse, & the Committee on Adolescence, 2015; Carliner, Brown, Sarvet, & Hasin, 2017; Doran, Shi, Lenzi, & An, 2015; Pardo, 2014). In Chile, a law is currently under discussion in Congress aiming to legalize home cannabis cultivation for personal recreational and/or medical use. In the past decade, there has been a public debate about legalization and important changes in legal practice to decriminalize cannabis cultivation. An increase of the prevalence of adolescent cannabis use in Chile was reported for the year 2013 compared to the years 2001–2011 (Castillo-Carniglia, 2015). The prevalence of adolescent cannabis use in Chile was reported to be the

highest in the Americas (Organization of American States (OAS)/Inter-American Drug Abuse Control Commission (CICAD), 2019). In line with the normalization theory (Measham, Newcombe, & Parker, 1994), adolescents in countries with high prevalence of substance use are less likely to report risk factors than in countries with low prevalence (Sznitman et al., 2013). Therefore, risk and protective factors may have changed in prevalence and/or strength of association constituting new challenges for targeting prevention. Risk and protective factors of substance use had been reported to be consistent between 1976 and 1997 in the US (Brown, Schulenberg, Bachman, O'Malley, & Johnston, 2001): several variables such as religiosity, political beliefs, truancy, and frequent evenings out were consistently linked to substance use over time among high school students. However, in the current context of marked changes of prevalence in adolescent cannabis use in Chile, the assessment of prevalence factors and their effect size over time may allow reaching a better understanding of the factors underlying the process in which the substance use is changing over time and then contributing to adjust prevention strategies and exploring if the factors associated to substance use vary across years. Factors associated with substance use in adolescents had been reported from Chile for one single year (Gaete & Araya, 2017), but how these factors vary over time and in their strength of association with the prevalence of cannabis use has not been previously addressed. In Argentina, Chile and Uruguay, an increase of cannabis use in adolescents in recent years has been reported, and the association between risk perception and use has decreased. Meanwhile, perceived availability remained strongly associated with cannabis use, but other potential risk factors have not been investigated (Schleimer et al., 2019). The quantification of potential risk factors and their trends over time may allow targeting prevention strategies (Harrop & Catalano, 2016).

The aim of the present research was to identify prevalence trends and associated factors of cannabis use in the past years among adolescents, and to assess trends of associated factors and the strength of association over time.

2. Methods

2.1. Sample and design

Study participants were adolescent high-school students. The Chilean National Service of Drugs and Alcohol Use Prevention and Rehabilitation (Servicio Nacional para la Prevención y Rehabilitación del Consumo de Drogas y Alcohol, SENDA) carries out the nationwide school-based survey in students from 8th to 12th grade every two years, with a probabilistic, representative at regional (15 regions in Chile) and nationwide level, stratified (region, socio-economic level and by level of education), multistage sampling design in clusters (type of school funding, and class). The rate of reached sample was around 80% of the theoretical sample size. The detailed methodology is presented by SENDA in each survey report available online (https://www.senda.gob.cl/observatorio/estudios/poblacion-escolar/) with stability across the years from 2003 to 2017 and minimal variations. We obtained data from SENDA for the years 2003 to 2017 (Servicio Nacional para la Prevención y Rehabilitación del Consumo de Drogas y Alcohol (SENDA), 2018). SENDA offers the option of a self-administered questionnaire and a face-to-face interview. In the self-administered version, the students are supervised by a surveyor. Once the schools and classes were defined, random samples of 20 students were selected from each classroom to participate in the survey (Organization of American States (OAS)/Inter-American Drug Abuse Control Commission (CICAD), 2019).

2.2. Survey and variables

The survey questions included socio-demographic data, several types of substance use (cannabis, cocaine, tranquilizers, inhalants,

opioids, and others), tobacco and alcohol, perceived risk of substance use, satisfaction with school, school attendance, grades, relations with peers, teachers, and parents and extracurricular activities among others.

We selected items that were consistently present across the years, relevant in practice and representing different areas of risk. The following variables were included in the analyses: 1) Cannabis use in the past year (the variable was assessed with the question, "When was the last time you used cannabis?" and dichotomized); 2) Funding of the school: public (municipal) vs. private or mixed (with state subsidies); 3) gender; 4) age; 5) Use of alcohol in the past month (the variable was assessed with the question, "On how many days did you drink alcohol in the past 30 days?" and dichotomized); 6) Use of tobacco in the past month (the variable was assessed with the question "On how many days did you smoke cigarettes in the past 30 days?" and dichotomized); 7) Age at first use of alcohol; 8) Age at first use of tobacco; 9) Unexcused absence from school (truancy) in the past year (the variable was dichotomized as never in the past year and having had any unexcused absence from school in the past year); 10) School performance based on self-report was dichotomized as low (under 5.5 on a scale from 1 to 7) vs. high; 11) Sport activities, as the number of days per week doing sports as extracurricular activity; 12) Educational level of parents with three alternative categories: uncomplete secondary level, complete secondary level (twelfth grade) and complete higher education; 13) Marital status of the parents; 14) Parental acquaintance with friends was assessed with the question, "In general, would you say that your parents (or one of your parents) know your closest friends very well, fairly well or little?" (the answers were dichotomized as low, "little", and high, any of the other answers); 15) Parental rejection of alcohol use (the variable was assessed with an incomplete phrase "If your father/mother surprised you having had too much alcohol, they would be…". The sentence could be completed in five different ways: "indifferent", "a little bit annoyed", "somewhat annoyed", "fairly annoyed" or "very much annoyed". Parental rejection was coded as present when at least one of the parents would be somewhat, fairly or very much annoyed); 16) Parental rejection of cannabis use (the variable was assessed with the incomplete sentence "If your father/mother found out that you were smoking marihuana, they would be…" The sentence could be completed in five different ways: "indifferent", "a little bit annoyed", "somewhat annoyed", "fairly annoyed" or "very much annoyed". Parental rejection was coded as present when at least one of the parents would be somewhat, fairly or very much annoyed); 17) Having friends who regularly use alcohol (determined with the question "How many of your friends regularly use alcohol? Let us say every weekend or more often." Answer options were 1. None, 2. Less than half, 3. About half, 4. More than half, 5. All or almost all. The answers were dichotomized as none and any of the others); 18) Having friends who regularly use cannabis (determined with the question "How many of your friends regularly smoke marijuana? Let us say every weekend or more often." Answer options were 1. None, 2. Less than half, 3. About half, 4. More than half, 5. All or almost all. Answers were dichotomized as none and any of the other answers); 19) Perceived risk of cannabis use (assessed with the question, "What you think is the risk for someone who smokes marijuana once or twice to week?". The answer options were "none", "mild", "moderate" or "big" or "don't know").

2.3. Statistical analysis

Descriptive statistics were calculated for each year of the surveys, and for the variables: gender, age, school funding, cannabis use prevalence, alcohol and tobacco use prevalence; 95% confidence intervals (CI) were calculated for prevalence rates.

Mixed effects logistic regressions were performed for data at individual level, with data nested at the school level (identity of schools as factor), and nested at the level of funding source of the schools

(private, public, mixed both public and private). The multilevel logistic binomial regressions were conducted with cannabis use in the past year as dependent variable for each year separately. Adjusted odds ratios were calculated for each variable.

The variables at the individual level were: Gender; age; age at first alcohol use; age at first tobacco use; alcohol use in the past month; tobacco use in the past month; perceived cannabis use risk; school performance; truancy; days of sport activities in a week; friends regularly using alcohol; friends regularly using cannabis; educational level of father and mother; parents' marital status; parental acquaintance with friends; parental alcohol use rejection; parental cannabis use rejection. Intraclass correlation coefficients were calculated from a null model for both the school level clusters and school funding level clusters. The command glmer of the lme4 package was used in R software to estimate the mixed effects logistic regressions. Variables with odds ratios on average higher than 1.5 across the entire time series were retained for further analyses. This threshold was introduced due to the large size of the data set and to avoid retaining significant odds ratios close to 1.0 that may be clinically irrelevant and irrelevant for prevention planning. Odds ratios smaller than 1.5 can be considered as small effect size and larger than 1.5 as moderate or large effect size (Chen, Cohen, & Chen, 2010).

Adjusted odds ratios were calculated for the retained variables for each year of data collection to assess changes of the association over time.

Also, interactions between year and each one of the retained variables were analyzed by multilevel mixed effects logistic regressions for all pooled data to assess how the associations between variables and outcomes were affected by time in each survey cycle, using the first year of the series as reference.

The prevalence of the retained variables was described as trends over time. Trends of prevalence data and odds ratios over time were plotted for the retained variables and each trend was tested for its fit to linear or higher models, and the F-statistic, degrees of freedom (Stanaway et al., 2018), R-squared and p values were reported.

As quality control, before the analyses, data points of participants who answered in at least two occasions in an inconsistent way for each substance were eliminated (n = 6141; 1.27% of the whole sample), for instance, inconsistent answers about date of last use of cannabis, lifetime use and/or use in the past month.

2.4. Ethics

SENDA applies an informed assent to students and a passive informed consent to the parents of the students before participation. The data obtained from SENDA were anonymized. SENDA approved the access to the databases for the present research. Confidentiality was protected at every stage of the investigation.

3. Results

3.1. Descriptive statistics of socio-demographics and substance use

The pooled database for the years 2003 to 2017 contained 416,417 observations corresponding to individual school-based surveys of students from eighth to twelfth grade. The mean age was 15.5 years (SD 1.6), 50.7% were girls; 17% of the schools were privately funded, 44% were privately and publicly funded and 39% publicly funded. Table 1 describes the socio-demographic characteristics of the participants and the prevalence of cannabis, alcohol and tobacco use for each year.

3.2. Trends of cannabis use

The prevalence of cannabis use in the past year increased from 13.6% in 2003 to 31.1% in 2017 in a linear trend (F(df:1,6) = 27.6; R^2 = 0.79; p < 0.01), Fig. 1.

3.3. Variables related with cannabis use

Table 2 shows the odds ratios for all variables in every survey year between 2003 and 2017 using mixed effects logistic regressions.

The intraclass correlation coefficient for the school level was on average 13.4% for the entire time series indicating the proportion of variation in the outcome explained by the schools; and the intraclass correlation coefficient for the school funding level was on average 0.2%.

Prevalence factors of cannabis use in the past year measured as odds ratios of 1.5 or higher on average over time, were: *having friends who regularly use cannabis, low perceived risk of cannabis use, tobacco use in the past month, alcohol use in the past month, truancy in the past year*, and *low parental rejection of cannabis use*.

3.4. Interaction between prevalence factors of cannabis use and year of data collection

The interaction of each one of the retained prevalence factors and year of data collection was calculated, with the year 2003 as reference. Specific differences over time in the association of each factor with cannabis use were observed. For the *use of alcohol in the past month*, we observed a significant negative interaction from 2007 to 2017 showing a decrease of the association with cannabis use over time. For the *use of tobacco in the past month*, a similar pattern of negative interactions was observed between 2007 and 2015. For the factor *friends who regularly use cannabis*, we observed negative interactions from 2007 to 2017. For truancy, negative interactions were seen from 2009 to 2017. For low cannabis risk perception, the interaction for 2009 was negative, but thereafter positive. In contrast, low parental cannabis rejection was the only factor that showed positive interactions from 2007 over time until 2017 (with the exception of 2009, which was non-significant).

Table 3 shows the interactions observed between years and prevalence factors.

3.5. Trends over time of variables related with cannabis use

The prevalence of having friends who regularly use cannabis increased over time from 33.0% in 2003 to 56.8% in 2017, in a significant linear trend (F(df:1,6) = 46.9; R^2 = 0.87; p < 0.01). The proportion of adolescents who perceived low risk of cannabis use increased from 5.9% in 2003 to 17.8% in 2017 in a significant linear trend (F (df:1,6) = 16.5; R^2 = 0.69; p < 0.01). Tobacco use in the past month showed a decrease from 48.3% in 2003 to 23.2% in 2017 in a significant linear trend (F(df:1,6) = 58.2; R^2 = 0.89; p < 0.01). Alcohol use in the past month did not show any significant trend over time (F (df:1,6) = 5.0; R^2 = 0.36; p = 0.07). The proportion of adolescents whose parents do not reject cannabis use decreased from 10.1% in 2003 to 4.7% in 2017 in a significant linear trend (F(df:1,6) = 11.0; R^2 = 0.59; p = 0.02). Truancy prevalence has not changed over the years. Fig. 2 shows the trends for the prevalence of variables related with cannabis use. (See Fig. 3.)

3.6. Trends for the strength of association between the related variables and cannabis use over time

An important decrease of odds ratios was seen for the variable *having friends who regularly use cannabis*, which was OR = 6.2 (95% CI: 5.6–6.8) in 2003 and OR = 2.9 (95% CI: 2.6–3.2) in 2017, in a significant linear trend (F(df:1,6) = 60.5; R^2 = 0.89; p < 0.01). Low parental rejection of cannabis use increased the strength of association with cannabis use from OR = 1.2 (95% CI: 1.0–1.4) in 2003 to OR = 2.1 (95% CI: 1.7–2.5) in 2017, in a significant linear trend (F (df:1,6) = 22.8; R^2 = 0.75, p < 0.01). Truancy showed a decrease of the strength of association with cannabis use from OR = 1.9 (95% CI: 1.8–2.1) in 2003 to OR = 1.3 (95% CI: 1.2–1.4) in 2017, with a

Table 1

Prevalence of cannabis, alcohol and tobacco use among 8th to 12th grade secondary school students in Chile: data from nationwide school-based surveys between 2003 and 2017.

| Year	2003	2005	2007	2009	2011	2013	2015	2017
Number of participants	58,192	59,689	50,914	47,528	33,172	57,641	54,084	55,197
Boys (%)	49.3	49.1	49.1	48.6	49.4	49.3	50.0	49.9
Age (years ± SD)	15.6 ± 1.6	15.2 ± 1.6	15.4 ± 1.5	15.5 ± 1.6	15.5 ± 1.6	15.6 ± 1.6	15.6 ± 1.6	15.5 ± 1.6
School funding								
Private (%)	22.3	15.7	12.2	14.2	23.3	16.9	15.8	17.5
Public and private (%)	39.7	42.4	39.6	36.7	32.8	38.8	40.0	43.9
Public (%)	38.0	42.0	48.2	49.1	43.9	44.3	44.2	38.5
Cannabis use in the past year (%)	13.6	14.2	15.3	14.9	17.9	29.0	33.4	31.1
(95% CI)	(13.4–13.9)	(14.0–14.5)	(15.0–15.6)	(14.6–15.2)	(17.5–18.3)	(28.6–29.3)	(32.6–33.4)	(29.8–30.6)
Alcohol use in the past month (%)	55.1	41.8	47.3	45.6	43.7	44.2	44.3	39.7
(95% CI)	(54.6–55.5)	(41.4–42.2)	(46.9–47.8)	(45.1–46.0)	(43.1–44.2)	(43.8–44.6)	(43.9–44.8)	(39.3–40.1)
Tobacco use in the past month (%)	48.3	39.3	39.8	39.2	29.2	30.3	28.4	23.2
(95% CI)	(47.9–48.7)	(38.9–39.7)	(39.4–40.2)	(38.8–39.7)	(28.7–29.7)	(29.9–30.6)	(28–28.8)	(22.8–23.5)
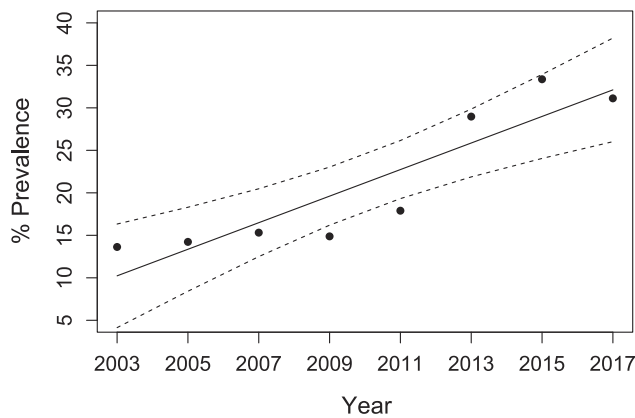
Fig. 1. The prevalence of cannabis use in the past year among adolescents in 8th to 12th grade of secondary school in Chile; data from school based national surveys between 2003 and 2017.

significant linear trend (F(df:1,5) = 25.2; R^2 = 0.8; p < 0.01). Alcohol use in the past month showed a significant decrease in the strength of association with cannabis use from OR = 1.9 (95% CI: 1.7–2.2) in 2003 to OR = 1.8 (95% CI: 1.7–1.9) in 2017 in a linear trend (F(df:1,6) = 8.4; R^2 = 0.51; p = 0.03). Tobacco use in the past month showed a significant decrease in the strength of association with cannabis use from OR = 2.8 (95% CI: 2.5–3.2) in 2003 to OR = 2.4 (95% CI: 2.3–2.6) in 2017 in a linear trend (F(df:1,6) = 6.7; R^2 = 0.45; p = 0.04). The relationship between risk perception of cannabis use and cannabis use did not significantly change in magnitude of association over the years.

4. Discussion

4.1. Main findings

Our research showed that cannabis use among adolescents increased substantially from 2003 to 2017. We identified the factors most strongly associated with adolescent cannabis use and present prevalence estimates over time for those prevalence factors. Furthermore, we inform the strength of association over time for each of the most important factors. Although having friends who regularly use cannabis decreased in the strength of association with cannabis use, the variable continued to have the strongest effect size. An important increase in the magnitude of association with cannabis use was seen for low parental rejection of cannabis use.

Interaction analyses for each year with each of the factors associated with cannabis use, showed trends since 2007 with a decrease of the association between cannabis use and the factors alcohol use in the past

month, tobacco use in the past month, cannabis use in friends, and since 2009 for truancy. However, we observed an increase in the association between cannabis use and low parental cannabis rejection since 2007. Overall, the most important prevalence factors show significant changes in the strength of association since 2007 compared to the reference year 2003. Interestingly, this precedes the major increase in the prevalence of cannabis use observed between 2011 and 2013.

4.2. Strengths and limitations

This study comprised nationwide survey data of more than a decade with large sample sizes. We show for the first time trends for the prevalence and the strength of association with cannabis use of possible risk factors in a Latin American country. The study also has limitations: even though the surveys were presented in a consistent way over the years, the data were based on self-reporting. Repeated cross-sectional data do not allow establishing causal links between the increase of cannabis use and the associated variables. The variables assessed in this research were mainly on the individual level and limited to the items continuously included in the national surveys over the years.

4.3. Comparison with the literature

In the US, the prevalence of cannabis use among adolescents in the past year increased between 1991 and 2015, while the prevalence of alcohol use decreased, and the prevalence of any other illicit substance use also decreased (Peiper, Ridenour, Hochwalt, & Coyne-Beasley, 2016). In Europe from 2000 to 2015, the prevalence of cannabis use in the past month among adolescents showed heterogeneous trends in different regions: decrease in Northern Europe in linear trends, increase in Southern Europe in linear trends, decrease in Eastern Europe in a concave trend and increase in the Balkans in a convex trend. In Western Europe, the prevalence of cannabis use in boys decreased in a significant linear trend (Kraus et al., 2018).

In this study, the school level explained 13.4% of the outcome, which is in line with previous research (Gaete & Araya, 2017), but the school funding level explained only 0.2%, which in Chile could be seen as a proxy for the family's income situation. Families with higher income tend to have their children in private schools. For Europe and North America, cannabis use in adolescents became less characteristic for countries with high gross domestic product per capita and in families with high affluence, whereas it became more characteristic for boys with an increasing gender gap (ter Bogt et al., 2014).

Adolescents are especially sensitive to peer influence, social environments and social cues (Koob & Volkow, 2016). Perceived availability and peer contacts were strongly associated with cannabis use in North America and Europe (ter Bogt et al., 2014). In our study, having friends who regularly use cannabis was the most important factor

Table 2

Multivariate regression analyses of factors associated with cannabis use in adolescents using nationwide representative school based survey data of the years 2003 to 2015 in Chile shown as odds ratios (OR) with 95% confidence intervals (CI).

	2003		2005		2007		2009		2011		2013		2015		2017	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Individual level																
Gender																
Girls	1	–	1	–	1	–	1	–	1	–	1	–	1	–	1	–
Boys	1.27	1.17–1.38	1.30	1.19–1.42	1.43	1.32–1.55	1.19	1.09–1.29	1.38	1.24–1.53	1.4	1.30–1.51	1.15	1.07–1.24	1.32	1.22–1.42
Age (years)	1.23	1.19–1.27	1.37	1.32–1.41	1.17	1.14–1.21	1.15	1.12–1.19	1.15	1.10–1.20	1.1	1.07–1.14	1.06	1.03–1.09	1.04	1.01–1.06
Age (years) at first use of alcohol	0.98	0.96–1.01	0.95	0.93–0.98	0.98	0.96–1.00	0.99	0.96–1.01	0.98	0.95–1.01	0.99	0.97–1.01	1.00	0.98–1.02	1.03	1.01–1.08
Age (years) at first use of tobacco	0.91	0.88–0.93	0.90	0.88–0.93	0.91	0.89–0.93	0.92	0.90–0.94	0.92	0.89–0.95	0.94	0.92–0.97	0.98	0.96–1.00	0.96	0.94–0.99
Alcohol use in the past month																
No	1		1		1		1		1		1		1		1	
Yes	1.94	1.71–2.19	1.99	1.77–2.25	1.84	1.65–2.04	1.73	1.56–1.93	1.77	1.56–2.01	1.65	1.53–1.79	1.61	1.49–1.74	1.79	1.65–1.94
Tobacco use in the past month																
No	1		1		1		1		1		1		1		1	
Yes	2.84	2.54–3.17	3.03	2.71–3.39	2.75	2.50–3.03	2.64	2.38–2.92	2.23	1.99–2.50	2.69	2.50–2.90	2.41	2.24–2.59	2.44	2.26–2.64
Perceived risk of cannabis use																
High	1		1		1		1		1		1		1		1	
Low	2.70	2.38–3.06	2.79	2.40–3.24	2.63	2.38–2.91	2.13	1.93–2.35	3.05	2.57–3.63	3.09	2.82–3.36	2.70	2.48–2.94	2.67	2.44–2.93
School performance																
High	1		1		1		1		1		1		1		1	
Low	1.21	1.12–1.32	1.27	1.16–1.39	1.19	1.10–1.29	1.25	1.15–1.35	1.26	1.14–1.40	1.2	1.12–1.30	1.17	1.09–1.26	1.19	1.10–1.29
Truancy																
No	1		1		1		1		1		–		1		1	
Yes	1.89	1.75–2.05	1.73	1.58–1.88	1.96	1.81–2.12	1.69	1.56–1.84	1.46	1.31–1.62	–	–	1.37	1.27–1.47	1.25	1.16–1.36
Days of sport activities in a week	0.98	0.96–1.00	0.98	0.96–1.00	0.97	0.95–0.99	0.98	0.96–1.00	1.01	0.99–1.04	1.02	1.00–1.04	1.01	0.99–1.02	–	–
Friends regularly using alcohol																
No	1		1		1		1		1		1		1		1	
Yes	1.33	1.13–1.57	1.36	1.16–1.60	1.14	0.97–1.33	1.17	0.98–1.39	0.76	0.64–0.91	0.93	0.83–1.04	0.73	0.65–0.82	1.10	0.98–1.24
Friends regularly using cannabis																
No	1		1		1		1		1		1		1		1	
Yes	6.16	5.63–6.75	5.37	4.90–5.90	5.49	4.98–6.05	5.52	4.99–6.12	3.92	3.48–4.43	3.98	3.63–4.36	3.48	3.15–3.84	2.91	2.64–3.21
Educational level of father																
Uncompleted secondary level	1		1		1		1		1		1		1		1	
Completed secondary level	0.96	0.86–1.06	0.94	0.84–1.05	1.05	0.95–1.16	0.97	0.88–1.08	1.07	0.93–1.24	1.14	1.04–1.26	1.03	0.94–1.13	1.01	0.92–1.12
Completed higher education	0.98	0.86–1.10	0.93	0.82–1.06	1	0.89–1.13	0.97	0.86–1.09	0.95	0.81–1.11	1.11	0.99–1.25	0.98	0.88–1.10	1.09	0.97–1.22
Educational level of mother																
Uncompleted secondary level	1		1		1		1		1		1		1		1	
Completed secondary level	1.14	1.03–1.27	0.99	0.89–1.11	1.08	0.98–1.18	1.02	0.93–1.13	0.94	0.82–1.08	1.1	1.00–1.21	1.07	0.97–1.17	1.11	1.00–1.23
Completed higher education	1.15	1.02–1.30	0.94	0.82–1.07	1.03	0.92–1.17	0.95	0.84–1.08	0.93	0.79–1.10	1.05	0.93–1.18	1	0.89–1.11	1.01	0.90–1.13
Marital status of the parents																
Parents living together	1		1		1		1		1		1		1		1	
Separated parents	1.28	1.15–1.42	1.17	1.05–1.30	1.26	1.14–1.38	1.18	1.07–1.29	1.14	1.01–1.29	1.15	1.06–1.25	1.16	1.07–1.26	0.87	0.71–1.06
Single	1.34	1.13–1.57	1.18	0.97–1.43	1.11	0.90–1.36	1.24	1.03–1.49	–	–	1.27	1.03–1.55	0.87	0.76–1.00	1.17	1.07–1.27
Widow(er)	1.10	0.86–1.40	1.03	0.75–1.43	0.95	0.73–1.23	0.96	0.75–1.23	0.91	0.69–1.21	–	–	0.96	0.79–1.16	1.03	0.89–1.20
Other	1.09	0.89–1.34	1.12	0.87–1.44	0.98	0.81–1.19	1.19	0.99–1.43	1.08	0.87–1.34	1.11	0.96–1.29	0.86	0.71–1.05	1.08	0.87–1.34
Parental acquaintance with friends																
High	1		1		1		1		1		1		1		1	
Low	1.19	1.07–1.32	1.22	1.08–1.37	0.98	0.89–1.09	1.06	0.95–1.17	1.09	0.95–1.26	0.93	0.85–1.03	1.05	0.95–1.16	1.03	0.93–1.15
Parental rejection of alcohol use																
High	1		1		1		1		1		1		1		1	
Low	1	0.89–1.12	0.97	0.85–1.10	0.99	0.88–1.12	1.14	1.00–1.29	1.29	1.04–1.59	1.04	0.89–1.20	0.99	0.86–1.14	0.95	0.82–1.11
Parental rejection of cannabis use																
High	1	–	1	–	1	–	1	–	1	–	1	–	1	–	1	–

Table 2 (*continued*)

	2003		2005		2007		2009		2011		2013		2015		2017	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Low	1.19	1.04–1.36	1.06	0.92–1.24	1.31	1.14–1.51	1.28	1.10–1.49	1.96	1.40–2.76	1.97	1.59–2.43	1.77	1.49–2.10	2.07	1.73–2.49
Intraclass correlation coefficient																
Schools	0.155		0.197		0.153		0.121		0.109		0.121		0.105		0.114	
Funding of the schools	0.001		0		0		0.001		0.007		0.004		0.004		0.002	

Table 3

Interaction effects between year and the effect size of prevalence factors of adolescent cannabis use in Chile.

|	2003	2005		2007		2009		2011		2013		2015		2017	
		β	P Value	β	P Value	β	P Value	β	P Value	β	P Value	β	P Value	β	P Value
Alcohol use in the past month	Reference	0.07	0.11	−0.25	< **0.001***	−0.25	< **0.001***	−0.35	< **0.001***	−0.35	< **0.001***	−0.36	< **0.001***	−0.24	< **0.001***
Tobacco use in the past month	–	0.03	0.54	−0.18	< **0.001***	−0.15	**0.004***	−0.23	< **0.001***	−0.08	0.06	−0.09	**0.045***	0.03	0.48
Friends regularly using cannabis	–	−0.06	0.23	−0.15	**0.001***	−0.19	< **0.001***	−0.71	< **0.001***	−0.63	< **0.001***	−0.81	< **0.001***	−0.63	< **0.001***
Low cannabis risk perception	–	0.10	0.11	0.03	0.56	−0.31	< **0.001***	0.26	< **0.001***	0.19	< **0.001***	0.14	**0.004***	0.16	**0.001***
Low parental cannabis rejection	–	−0.04	0.60	0.16	**0.023***	0.10	0.18	0.45	< **0.001***	0.53	< **0.001***	0.52	< **0.001***	0.61	< **0.001***
Truancy	–	−0.05	0.22	−0.06	0.17	−0.16	< **0.001***	−0.37	< **0.001***	–	–	−0.39	< **0.001***	−0.41	< **0.001***

* p < 0.05
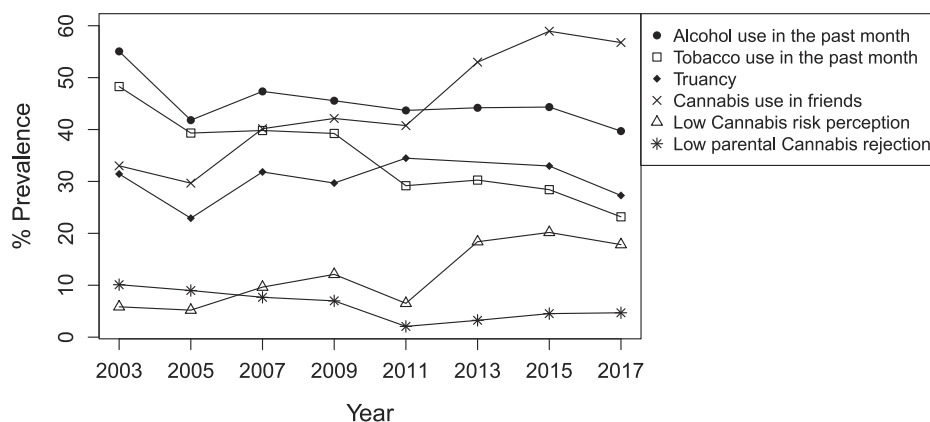
Fig. 2. Prevalence of variables associated with cannabis use in adolescents in 8th to 12th grade of secondary school in Chile; data from school based national surveys between 2003 and 2017.

associated with cannabis use. In line with the increase of prevalence in cannabis use, the use among friends also increased, so that a normalization of cannabis use may have occurred among adolescents. A majority of adolescents had friends who regularly use cannabis.

Parental rejection has increased in contrast with the normalization hypothesis, the strength of association with cannabis use in adolescents has also increased. This could indicate that cannabis use is normalized among adolescents, while there is broad consensus among parents in Chile that cannabis use is not good for their adolescent children. Parental rules limiting cannabis use and support were associated with less cannabis use among adolescents in the literature (Vermeulen-Smit, Verdurmen, Engels, & Vollebergh, 2015). In Europe, time spent with parents has been described as a potential protective factor for lifetime cannabis use (Kristjansson, Sigfusdottir, & Allegrante, 2013). The international literature shows that the substance use of family members and parents increased the risk of use among teenagers (Hall & Lynskey, 2016), which may reflect in low parental rejection.

Low risk perception has widely been associated with cannabis use in adolescents. Low risk perception could predict the new incidence of cannabis use in the following year in the United States (Parker & Anthony, 2018). Interventions aimed to promote the perception of harm of cannabis use may be useful for prevention among adolescents.

Attitudes in the community, among parents and peers reciprocally influence the prevalence of cannabis use among adolescents over time (Guttmannova et al., 2018). Further factors associated with the use of substances have been studied, such as, socioeconomic status, academic performance, parental monitoring, peer use, sports and leisure time activities among others (Chadi et al., 2018; Cleveland, Feinberg, Bontempo, & Greenberg, 2008; Guttmannova et al., 2018; Parker &

Anthony, 2018; Vermeulen-Smit et al., 2015). There may be common risk factors for the use of several substances in adolescents (Chadi et al., 2018). However, the prevalence of different substances can show opposite trends. Therefore, it is necessary to address each substance specifically. The increase of cannabis use, while tobacco use decreased, and a positive association between the use of both substances, might indicate a trend that cannabis use is replacing tobacco use among adolescents. This may be related to more legal regulations in place restricting tobacco use among adults, while new regulations propose legalization of cannabis sales in Chile. This is in line with international trends to more permissive legislations regarding cannabis use in recent years (Doran et al., 2015; Hall & Kozlowski, 2018). International recommendations orienting national policies do not encourage those policies to decriminalize cannabis use taking into consideration the risks especially for adolescents (Strang et al., 2012; United Nations Office on Drugs and Crime, 2018a).

4.4. Conclusions and implications

The prevalence of adolescent cannabis use has more than doubled in Chile and exceeds the rates in all other countries of the Americas in line with the normalization hypothesis. This has come with important changes of prevalence and strength of association in factors associated with cannabis use. Adolescents now are more exposed to friends who use cannabis, which remains the single most important risk factor. Adolescents more often have low risk perception of cannabis use. Parental rejection of cannabis use remains high, but low parental rejection is increasingly associated with cannabis use. These findings may inform new prevention strategies.
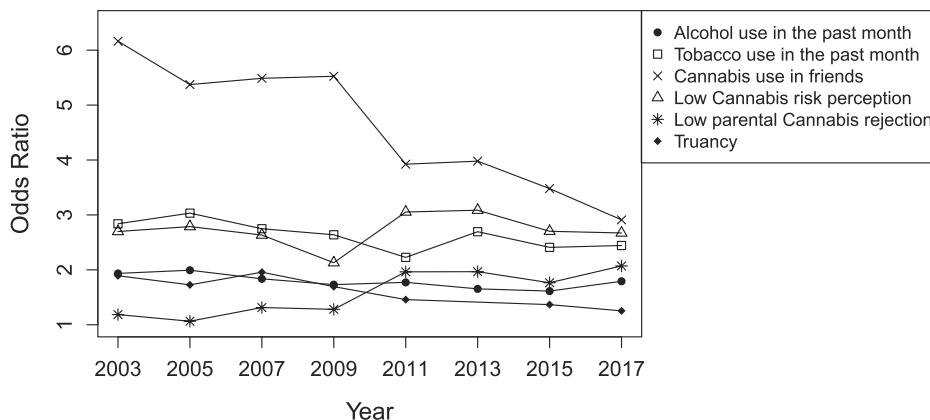

Fig. 3. Odds ratios of variables associated with cannabis use over time in adolescents in 8th to 12th grade of secondary school in Chile; data from school based national surveys between 2003 and 2017.

Author disclosures

Declaration of Competing Interest

There is no conflict of interest for any of the authors.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.abrep.2020.100260.

References

Ammerman, S., Ryan, S., Adelman, W. P., the Committee on Substance Abuse, & the Committee on Adolescence. (2015). The impact of marijuana policies on youth: clinical, research, and legal update. Pediatrics, 135(3), e769-785. doi: 10.1542/peds.2014-4147.

Brown, T. N., Schulenberg, J., Bachman, J. G., O'Malley, P. M., & Johnston, L. D. (2001). Are risk and protective factors for substance use consistent across historical time?: National data from the high school classes of 1976 through 1997. *Prevention Science, 2*(1), 29–43.

Carliner, H., Brown, Q. L., Sarvet, A. L., & Hasin, D. S. (2017). Cannabis use, attitudes, and legal status in the U.S.: A review. *Preventive Medicine, 104*, 13–23. https://doi.org/10.1016/j.ypmed.2017.07.008.

Castillo-Carniglia, A. (2015). Large increase in adolescent marijuana use in Chile. *Addiction, 110*(1), 185–186. https://doi.org/10.1111/add.12765.

Chadi, N., Bagley, S. M., & Hadland, S. E. (2018). Addressing Adolescents' and Young Adults' Substance Use Disorders. *Medical Clinics of North America, 102*(4), 603–620. https://doi.org/10.1016/j.mcna.2018.02.015.

Chen, H., Cohen, P., & Chen, S. (2010). How Big is a Big Odds Ratio? Interpreting the Magnitudes of Odds Ratios in Epidemiological Studies. *Communications in Statistics - Simulation and Computation, 39*(4), 860–864. https://doi.org/10.1080/03610911003650383.

Cleveland, M. J., Feinberg, M. E., Bontempo, D. E., & Greenberg, M. T. (2008). The Role of Risk and Protective Factors in Substance Use Across Adolescence. *Journal of Adolescent Health, 43*(2), 157–164. https://doi.org/10.1016/j.jadohealth.2008.01.015.

Degenhardt, L., Stockings, E., Patton, G., Hall, W. D., & Lynskey, M. (2016). The increasing global health priority of substance use in young people. *The Lancet Psychiatry, 3*(3), 251–264. https://doi.org/10.1016/s2215-0366(15)00508-8.

Doran, C. M., Shi, Y., Lenzi, M., & An, R. (2015). Cannabis Liberalization and Adolescent Cannabis Use: A Cross-National Study in 38 Countries. *PLoS ONE, 10*(11), e0143562. https://doi.org/10.1371/journal.pone.0143562.

Gaete, J., & Araya, R. (2017). Individual and contextual factors associated with tobacco, alcohol, and cannabis use among Chilean adolescents: A multilevel study. *Journal of Adolescence, 56*, 166–178. https://doi.org/10.1016/j.adolescence.2017.02.011.

Guttmannova, K., Skinner, M. L., Oesterle, S., White, H. R., Catalano, R. F., & Hawkins, J. D. (2018). The Interplay Between Marijuana-Specific Risk Factors and Marijuana Use Over the Course of Adolescence. *Prevention Science.* https://doi.org/10.1007/s11121-018-0882-9.

Hall, W., & Kozlowski, L. T. (2018). The diverging trajectories of cannabis and tobacco policies in the United States: Reasons and possible implications. *Addiction, 113*(4), 595–601. https://doi.org/10.1111/add.13845.

Hall, W., & Lynskey, M. (2016). Evaluating the public health impacts of legalizing recreational cannabis use in the United States. *Addiction, 111*(10), 1764–1773. https://doi.org/10.1111/add.13428.

Harrop, E., & Catalano, R. F. (2016). Evidence-Based Prevention for Adolescent Substance Use. *Child and Adolescent Psychiatric Clinics of North America, 25*(3), 387–410. https://doi.org/10.1016/j.chc.2016.03.001.

Koob, G. F., & Volkow, N. D. (2016). Neurobiology of addiction: A neurocircuitry analysis. *The Lancet Psychiatry, 3*(8), 760–773. https://doi.org/10.1016/s2215-0366(16)00104-8.

Kraus, L., Seitz, N.-N., Piontek, D., Molinaro, S., Siciliano, V., Guttormsson, U., ... Hibell, B. (2018). 'Are The Times A-Changin'? Trends in adolescent substance use in Europe. *Addiction, 113*(7), 1317–1332. https://doi.org/10.1111/add.14201.

Kristjansson, A. L., Sigfusdottir, I. D., & Allegrante, J. P. (2013). Adolescent substance use and peer use: A multilevel analysis of cross-sectional population data. *Subst Abuse Treat Prev Policy, 8*, 27. https://doi.org/10.1186/1747-597X-8-27.

Measham, F., Newcombe, R., & Parker, H. (1994). The normalization of recreational drug use amongst young people in north-west England. *British Journal of Sociology, 45*(2), 287–312.

Meier, M. H., Hill, M. L., Small, P. J., & Luthar, S. S. (2015). Associations of adolescent cannabis use with academic performance and mental health: A longitudinal study of upper middle class youth. *Drug and Alcohol Dependence, 156*, 207–212. https://doi.org/10.1016/j.drugalcdep.2015.09.010.

Organization of American States (OAS)/Inter-American Drug Abuse Control Commission (CICAD). (2019). Report on Drug Use in the Americas 2019 Retrieved 26.12.2019, from http://www.cicad.oas.org/oid/Report on Drug Use in the Americas 2019.pdf.

Pardo, B. (2014). Cannabis policy reforms in the Americas: A comparative analysis of Colorado, Washington, and Uruguay. *International Journal of Drug Policy, 25*(4), 727–735. https://doi.org/10.1016/j.drugpo.2014.05.010.

Parker, M. A., & Anthony, J. C. (2018). A prospective study of newly incident cannabis use and cannabis risk perceptions: Results from the United States Monitoring the Future study, 1976–2013. *Drug and Alcohol Dependence, 187*, 351–357. https://doi.org/10.1016/j.drugalcdep.2018.03.012.

Peacock, A., Leung, J., Larney, S., Colledge, S., Hickman, M., Rehm, J., ... Degenhardt, L. (2018). Global statistics on alcohol, tobacco and illicit drug use: 2017 status report. *Addiction, 113*(10), 1905–1926. https://doi.org/10.1111/add.14234.

Peiper, N. C., Ridenour, T. A., Hochwalt, B., & Coyne-Beasley, T. (2016). Overview on Prevalence and Recent Trends in Adolescent Substance Use and Abuse. *Child and Adolescent Psychiatric Clinics of North America, 25*(3), 349–365. https://doi.org/10.1016/j.chc.2016.03.005.

Schleimer, J. P., Rivera-Aguirre, A. E., Castillo-Carniglia, A., Laqueur, H. S., Rudolph, K. E., Suarez, H., ... Cerda, M. (2019). Investigating how perceived risk and availability of marijuana relate to marijuana use among adolescents in Argentina, Chile, and Uruguay over time. *Drug & Alcohol Dependence, 201*, 115–126. https://doi.org/10.1016/j.drugalcdep.2019.03.029.

Servicio Nacional para la Prevención y Rehabilitación del Consumo de Drogas y Alcohol (SENDA). (2018). Estudio Nacional de Drogas en Población Escolar 2015 Retrieved 21.02.2019, from http://www.senda.gob.cl/observatorio/estudios/enpe-2015/.

Silins, E., Horwood, L. J., Patton, G. C., Fergusson, D. M., Olsson, C. A., Hutchinson, D. M., ... Mattick, R. P. (2014). Young adult sequelae of adolescent cannabis use: An integrative analysis. *The Lancet Psychiatry, 1*(4), 286–293. https://doi.org/10.1016/s2215-0366(14)70307-4.

Stanaway, J. D., Afshin, A., Gakidou, E., Lim, S. S., Abate, D., Abate, K. H., ... Murray, C. J. L. (2018). Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990–2017: A systematic analysis for the Global Burden of Disease Study 2017. *The Lancet, 392*(10159), 1923–1994. https://doi.org/10.1016/s0140-6736(18)32225-6.

Stiby, A. I., Hickman, M., Munafò, M. R., Heron, J., Yip, V. L., & Macleod, J. (2015). Adolescent cannabis and tobacco use and educational outcomes at age 16: Birth cohort study. *Addiction, 110*(4), 658–668. https://doi.org/10.1111/add.12827.

Strang, J., Babor, T., Caulkins, J., Fischer, B., Foxcroft, D., & Humphreys, K. (2012). Drug policy and the public good: Evidence for effective interventions. *The Lancet, 379*(9810), 71–83. https://doi.org/10.1016/s0140-6736(11)61674-7.

Sznitman, S. R., Kolobov, T., Bogt, T. T., Kuntsche, E., Walsh, S. D., Boniel-Nissim, M., & Harel-Fisch, Y. (2013). Exploring substance use normalization among adolescents: A multilevel study in 35 countries. *Social Science and Medicine, 97*, 143–151. https://doi.org/10.1016/j.socscimed.2013.08.038.

ter Bogt, T. F., de Looze, M., Molcho, M., Godeau, E., Hublet, A., Kokkevi, A., ... Pickett, W. (2014). Do societal wealth, family affluence and gender account for trends in adolescent cannabis use? A 30 country cross-national study. *Addiction, 109*(2), 273–283. https://doi.org/10.1111/add.12373.

United Nations Office on Drugs and Crime. (2018a). UNODC/WHO International Standards on Drug Use Prevention, Second updated edition Retrieved 21.02.2019, from https://www.unodc.org/unodc/en/prevention/prevention-standards.html.

United Nations Office on Drugs and Crime. (2018b). World Drug Report Retrieved 21.02.2019, from https://www.unodc.org/wdr2018/.

Vermeulen-Smit, E., Verdurmen, J. E. E., Engels, R. C. M. E., & Vollebergh, W. A. M. (2015). The role of general parenting and cannabis-specific parenting practices in adolescent cannabis and other illicit drug use. *Drug and Alcohol Dependence, 147*, 222–228. https://doi.org/10.1016/j.drugalcdep.2014.11.014.

Volkow, N. D., Baler, R. D., Compton, W. M., & Weiss, S. R. B. (2014). Adverse Health Effects of Marijuana Use. *New England Journal of Medicine, 370*(23), 2219–2227. https://doi.org/10.1056/NEJMra1402309.

Volkow, N. D., Koob, G. F., & McLellan, A. T. (2016). Neurobiologic Advances from the Brain Disease Model of Addiction. *New England Journal of Medicine, 374*(4), 363–371. https://doi.org/10.1056/NEJMra1511480.