



Testing the cannabis gateway hypothesis in a national sample of Spanish adolescents

Ángel García-Pérez^a, Gema Aonso-Diego^{b,*}, Sara Weidberg^b, Roberto Secades-Villa^b

^a Department of Psychology, Sociology and Philosophy, University of Leon, Spain

^b Department of Psychology, University of Oviedo, Spain

ARTICLE INFO

Keywords:

Cannabis
Substances
Gateway
Adolescents
Spanish

ABSTRACT

Background: The gateway hypothesis holds that the use of legal substances (i.e., tobacco and alcohol) increases the risk of initiating in cannabis use which, in turn, increases the chances of using other illegal substances. The validity of this hypothesis has been the subject of intense debate in recent years, finding sequences with a different order. Moreover, this pattern has been scarcely studied in Spain, where characteristics related to cannabis use are meaningfully different to other countries. This study aims to examine the gateway effects of cannabis towards other legal and illegal substances in Spanish adolescents.

Material and methods: Data were obtained from the Ministry of Health in Spain, through a representative survey of addictive behaviors of 36,984 Spanish adolescents ($M_{age} = 15.7$, $SD = 1.2$, 51.4% females).

Results: Lifetime cannabis use increased the likelihood of later legal substance use, both tobacco ($OR = 2.0$; 95% CI 1.81, 2.22) and alcohol ($OR = 1.93$; 95%CI 1.61, 2.31), as well as illegal substances ($OR = 5.36$; 95%CI 4.80, 5.98) and polysubstance ($OR = 18.24$; 95%CI 14.63, 22.73). Early age of cannabis use onset significantly increased the likelihood of subsequent legal and illegal substance use (ORs between 1.82 and 2.65).

Conclusions: These findings confirm and expand the available evidence on cannabis as a gateway substance. These results can help to drive preventive strategies for substance use in Spanish adolescents.

1. Introduction

In its classical formulation, the gateway hypothesis holds that substance use is sequenced in different stages (Kandel, 1975, 2003; Kandel et al., 1992, 2006). Specifically, the initiation of substance use begins with the consumption of alcohol and tobacco, followed by cannabis use, which in turns, leads to the consumption of other illegal substances. In this context, cannabis plays an important role since it plays a mediator stage between the consumption of legal and other drugs. Thus, several studies have concluded that cannabis use is frequently associated with a significant increased risk of initiating in other illegal substances (Choo et al., 2008; Degenhardt et al., 2009; Deza, 2015; Fergusson et al., 2006, 2015; Fergusson & Horwood, 2000; Jorgensen & Wells, 2021; Lessem et al., 2006; Taylor et al., 2017; Van Ours, 2003; Wilson et al., 2021), increasing subsequent use of other illegal substances among 3.5 to 140 times (Fergusson & Horwood, 2000). Furthermore, these findings are consistent when adjusting for several confounders, such as socio-economic status, family functioning, personality traits, other drug use, etc. (Fergusson et al., 2006; Kandel et al., 1986; Lessem et al., 2006).

Despite this evidence, the role of cannabis as a “gateway drug” has been the subject of intense debate (Jorgensen & Wells, 2021; Melberg et al., 2010; Morral et al., 2002; Vanyukov et al., 2003, 2012). For instance, Degenhardt et al. (2010) found that this sequence is altered depending on the context and prevalence of use, in such a way that this sequence is altered. In this sense, research has recently been conducted that underlines potential gateway violations, so that in countries with low rates of cannabis use, such as Japan, most people use other illegal substances before cannabis. Similarly, several studies have found that a small part of the population use cannabis before other legal substances (i.e., tobacco and alcohol), and that cannabis use may increase subsequent use of legal substances (Mayet et al., 2016; Patton et al., 2005; Reed et al., 2021). The reversal of the classical sequence has important implications in terms of prevention, given that preventive efforts should be targeted at cannabis use and not just at legal substances. Several explanations have tried to account for this phenomenon, highlighting biological as well as psychological factors, such as the common liability model of vulnerability to addictions (Vanyukov et al., 2003; 2012).

On the other hand, the cannabis gateway hypothesis has been rarely

* Corresponding author at: Addictive Behaviors Research Group, Faculty of Psychology, University of Oviedo, Plaza Feijoo s/n, 33003 Oviedo, Spain.
E-mail address: aonsogema@uniovi.es (G. Aonso-Diego).

<https://doi.org/10.1016/j.addbeh.2023.107751>

Received 22 February 2023; Received in revised form 25 April 2023; Accepted 8 May 2023

Available online 14 May 2023

0306-4603/© 2023 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

studied outside the United States. However, it should be noted that although the literature in the European Union (EU) is scarce, most studies find a cannabis gateway effect (Degenhardt et al., 2010; Duarte et al., 2000; Lynskey et al., 2006; Mayet et al., 2016; Melberg et al., 2010; Van Ours, 2003). Degenhardt et al. (2010) clarified that the prevalence of each drug use in a country might impact on the order of the gateway sequence. Moreover, Melberg et al. (2010) only found the cannabis gateway effect in a subgroup they called “troubled youths” (i. e., younger age at onset of substance use, higher rates of substance use and more interpersonal problems). On the other hand, Lynskey et al. (2006) emphasized that their results (i.e., cannabis as a gateway drug) are free of familial influences (either genetic or environmental) by using a twin design. All studies mentioned found that cannabis use increases the risk of using other substances, although there are several individual and contextual factors that may mediate these associations. Therefore, the lack of studies in the EU and the complexity of this phenomenon underline the need to study in depth the role of cannabis as a gateway and the conditions that affect this relationship.

Studying this hypothesis specifically in Spain has scientific and political interest since the lifetime prevalence of cannabis use in Spain is 37.5%, only below France and Denmark in the EU (EMCDDA, 2021). Moreover, the two previous studies in the Spanish population, although they found a cannabis gateway effect, present data from 20 years ago (Degenhardt et al., 2010; Duarte et al., 2000), and Spanish lifetime prevalence of cannabis use has almost doubled in the last 20 years (National Drugs Plan (PNSD), 2022). Finally, there is currently an intense political debate on the legalization of the sale and recreational consumption of cannabis in Spain and other countries of the EU (Proposición de Ley Integral Del Cannabis, 2021; EMCDDA, 2021). Examining the role of cannabis as a gateway substance is a crucial step in understanding the etiology of substance use disorders that would help the development of more effective preventive and treatment interventions. It would also help policy makers to make correct decisions regarding the legal status of cannabis use (Aonso-Diego et al., 2022). For example, if cannabis proves to be a clear gateway to the use of other substances, increasing efforts to restrict cannabis use could be a key strategy to reduce other substance use.

The objective of this study was three-fold: 1) to describe the sequences of cannabis use with legal and illegal substances; 2) to estimate the likelihood of using any legal and illicit drug after cannabis use among a representative national sample of Spanish adolescents, and 3) to analyze the predictive effect of the age of cannabis use onset on subsequent substance use.

2. Material and methods

2.1. Participants and procedure

The current study used data from the Survey on Substance Use in Secondary Education in Spain (ESTUDES). The inclusion criteria for being eligible to complete this survey were: a) being between 14 and 18 years old; b) to be studying at 3rd and 4th year of secondary education (14–16 years old), 1st and 2nd year of baccalaureate level (16–18 years old), or 1st and 2nd year of basic and intermediate vocational training (16–18 years old); c) to be in the classroom when the survey was conducted. Therefore, those participants who were not present, who are out-of-school or who are 18 years old and are attending university are not included in this survey. This survey is standardized, self-administered, anonymous, and in paper-and-pencil format. The duration of the assessment was between 45 and 60 min. Further details of the ESTUDES survey procedures are available elsewhere (National Drugs Plan (PNSD), 2018a).

A total of 38,010 adolescents completed the survey. The present study used a subsample of 36,984 adolescents who completed the cannabis prevalence questions. Sociodemographic and substance use data of the sample is displayed in Table 1. The sample belonged to 917

Table 1
Characteristics of the sample.

| Variables | Total Sample (n = 36,984) |
|---------------------------------------|------------------------------|
| <i>Demographics</i> | |
| Age (years) ^a | 15.7 ± 1.2 |
| Sex ^b (% women) | 51.6 (19,055) |
| Nationality ^b (% Spanish) | 90.6 (33,511) |
| Subjective Social Status ^b | |
| Low | 4.1 (1,487) |
| Medium | 82.4 (30,110) |
| High | 13.5 (4,930) |
| Education level ^b | |
| Secondary education | 55.8 (20,625) |
| Baccalaureate course | 36.6 (13,542) |
| Vocational training | 7.6 (2,817) |
| Grade repetition ^b | 22.8 (8,398) |
| <i>Drug use</i> | |
| Lifetime prevalence ^b | |
| Tobacco | 39.3 (14,500) |
| Alcohol | 76.4 (28,251) |
| Cannabis | 29.2 (10,816) |
| Other illegal substances | 7.3 (2,707) |
| Other illegal polysubstance | 3.6 (1,318) |
| Age of onset ^a | |
| Tobacco | 14.2 ± 1.6 |
| Alcohol | 14.0 ± 1.5 |
| Cannabis | 14.9 ± 1.4 |
| Other illegal substances | 14.8 ± 2.1 |

Note. ^a mean ± standard deviation; ^b % (n).

educational centers (68.4% public schools), representing the entire national territory. Before conducting the survey, the school informed the families about the objectives and characteristics of the study. Previous published studies confirm the suitability of the ESTUDES survey for conducting epidemiological research on adolescent substance use (Alarcó-Rosales et al., 2019; Belzunegui-Eraso et al., 2020; Weidberg et al., 2022).

2.2. Measures

Sociodemographic variables included sex (i.e., man and woman), age, Subjective Social Status (SSS), nationality, grade repetition and current level of education (i.e., secondary education, baccalaureate, and vocational training). Regarding substance use, ESTUDES questions included lifetime alcohol, tobacco, cannabis, and other illegal substance use (i.e., cocaine, amphetamines, methamphetamine, MDMA, heroine, other non-prescription opioids (e.g., morphine), GHB, LSD, ketamine, magic mushrooms and inhalants). An example of the type of drug use prevalence questions used is the following: *Have you ever used heroin?* Response options: *Yes/No*. Age of substance use onset was determined by asking respondents about the age at which they first used each of the substances. Illegal polysubstance consisted of lifetime prevalence use of more than one illegal substance rather than cannabis.

2.3. Data analysis

Odds ratios (ORs) were calculated by dividing the odds of the first groups by the odds of the second groups. Specifically, the formula is $(a / b) / (c / d)$, where *a* is the number of participants who used lifetime cannabis and subsequently used other substances, *b* the number of participants who used lifetime cannabis and did not use any other substances, *c* the number of participants who did not use lifetime cannabis and used other substances, and *d* the number of participants who did not use cannabis nor other substances. The correspondent 95% confidence interval (95% CI) was calculated for each OR.

A set of binary logistic regressions were conducted to examine the relationship between age of cannabis use onset and the progression to the use of each of the other substances (i.e., tobacco, alcohol, illegal

substances, and polydrug) from cannabis use. Additionally, ORs were estimated as a function of sex and SSS. The statistical package used was SPSS (version 24, Inc., Chicago, IL).

3. Results

3.1. Sequence of cannabis use

Among dual users (i.e., users of cannabis and other substances), it was more common to use legal substances before cannabis (alcohol 73.2%; tobacco 54.9%), with a small number of participants starting to use cannabis before these legal substances (alcohol 5.9%, tobacco 6.7%). On the other hand, it was more frequent for adolescents to start using cannabis before any other illegal drug (61.1%) than the other way around (10.5%).

There were no differences in these patterns by sex, except for those who started using cannabis before tobacco, which was higher in males (8.7%) than in females (4.7%). With respect to SSS, it appears that people with low SSS, compared to adolescents with high SSS, were more likely to initiate cannabis use before alcohol (9.1% vs 6.1%), and less likely to initiate illicit drug use before cannabis (4.9% vs 15.9%). All this information is presented in Table S1.

3.2. Probability of using any legal or illicit drug after cannabis use

Fig. 1 depicts that the initial use of cannabis duplicated the probability of subsequent tobacco use. Similarly, the odds of progressing from cannabis to alcohol were 1.93. On the other hand, the likelihood of initiating in at least one illegal drug after cannabis use was 5.36, while the probability raised to 18.24 in the case of polysubstance use.

There were only sex differences in the likelihood of initiating tobacco use after cannabis use ($OR_{male} = 2.58$ vs $OR_{female} = 1.77$; Wald test = 11.57 [1], $p = .001$); although both point in the same direction, the probability was higher in males. No further differences were found according to sex or SSS. The specific ORs by group can be found in Table S2.

3.3. Age of cannabis use onset and substance use

Early age of cannabis use onset significantly increased the likelihood of progression from cannabis to other legal and illegal substances (see Table 2). Findings show that starting to use cannabis one year before nearly doubles the odds of progressing to other illegal substances, while more than doubles the probabilities of progressing to legal substances.

There were differences only in SSS regarding the odds of progressing to tobacco. Although all groups pointed in the same direction, adolescents with high SSS were less likely to progress to tobacco for each year of earlier initiation of cannabis use in comparison with adolescents with

Table 2

Relationship between age of cannabis use onset and subsequent substance use.

| | B | OR | 95%CI |
|-----------------------|-------|-------|--------------|
| Tobacco | 0.753 | 2.124 | 1.940, 2.325 |
| Alcohol | 0.979 | 2.663 | 2.191, 3.236 |
| Illegal substance | 0.616 | 1.851 | 1.757, 1.949 |
| Illegal polysubstance | 0.601 | 1.824 | 1.723, 1.931 |

Note. OR = odds ratio; CI = confidence interval.

low and medium SSS ($OR_{high} = 1.75$ vs $OR_{medium} = 2.19$, $OR_{low} = 2.55$; Wald test = 4.40 [1], $p = .030$). On the other hand, no further differences were found according to sex or SSS. The specific ORs by group can be found in Table S3.

4. Discussion

In a large, nationally representative sample of Spanish adolescents, we found that cannabis use duplicated the probabilities of tobacco and alcohol use and increased more than five times the likelihood of later use of other illegal drugs. Further, early cannabis use increased the probability of progression to other, both legal and illegal, substances. Finally, most of the adolescents followed the classic gateway sequence, using legal substances before cannabis, and cannabis before illegal substances. These sequences were stable across both sex and social status.

Our results, in line with previous findings, showed that the use of cannabis increases the probability of progressing to legal (Agrawal et al., 2006; Badiani et al., 2015; Mayet et al., 2016; Patton et al., 2005; Ramo et al., 2012; Secades-Villa et al., 2015) and illegal drugs (Choo et al., 2008; Deza, 2015; Fergusson et al., 2006; Jorgensen & Wells, 2021; Lessem et al., 2006; Taylor et al., 2017; Van Ours, 2003; Wilson et al., 2021). Cannabis use may precede other legal and illicit drug use because this substance can alter dopamine levels in the mesolimbic dopamine reward pathway (Agrawal et al., 2004, 2016; R. H.C. Palmer et al., 2013; Rohan H.C. Palmer et al., 2012; Young et al., 2006) and produce biochemical changes in the brain that could increase individual responsiveness to other substances (Ellgren et al., 2007; Leri et al., 2003; Schenk, 2002). Cannabis use can also be a pleasant experience and reduce the discomfort of cannabis users, and these reinforcing subjective feeling can be generalized and trigger other substance use (Baggio et al., 2015; Fergusson et al., 2003, 2006; Fergusson & Horwood, 1997). This mechanism fits with the findings from Secades-Villa et al. (2015), since the classical gateway hypothesis is more intense in individuals with psychopathological disorders, where substance use produces stronger positive and negative reinforcement. In addition, cannabis use produces negative affect (Dorard et al., 2008), which in turn can increase the likelihood of initiating other drugs to cope with these problems (Hurd et al., 2014). Finally, cannabis users are exposed to a social context that influences both favorable attitudes towards other substance use and its

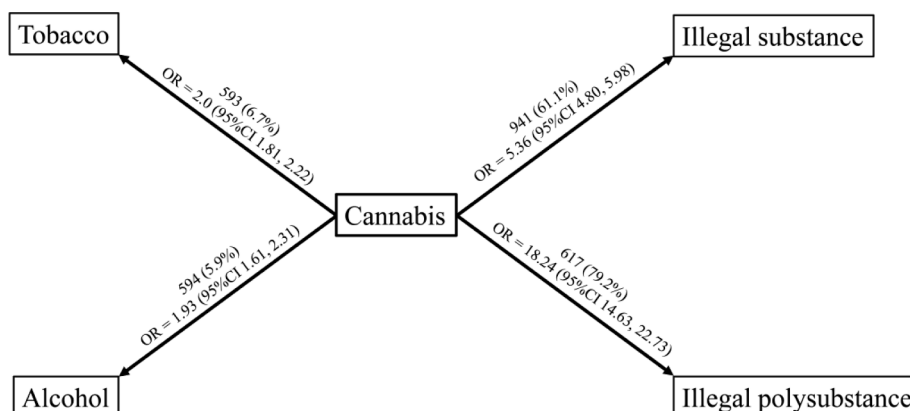


Fig. 1. Probabilities of transition from cannabis to other substances.

availability, since both the distribution channels of cannabis and the places where cannabis is smoked frequently overlap with the distribution and consumption context of other substances (Agrawal et al., 2008; Dishion & Owen, 2002; Fergusson et al., 2006; Fergusson & Horwood, 1997; Kuntsche, 2004; Mayet et al., 2010; Patton et al., 2005; Wagner & Anthony, 2002).

Our results are compatible with the common liability theory (Mayet et al., 2016; Morral et al., 2002; Van Leeuwen et al., 2011; Vanyukov et al., 2012) that describes that variation in liability to drug use can be explained by common genetic and individual factors that increase the risk of multiple substance use, regardless of the order of initiation. For example, some externalized transdiagnostic factors such as impulsivity, non-compliance with rules or aggressiveness have been related to substance use in general (Eaton et al., 2015); while other factors such as abnormal perception of reality, hopelessness, anxiety, depression and suicide attempts were associated to cannabis use in particular (Moreno-Mansilla et al., 2021). In any case, at the clinical level, this perspective highlights the importance of focusing on the application of interventions that modify transdiagnostic variables that transcend the use of specific substances (Kim & Hodgins, 2018).

We also found that early cannabis use increases the likelihood of progressing to both legal (Agrawal et al., 2006; Kokkevi et al., 2006; Mayet et al., 2016; Scholes-Balog et al., 2016) and illegal substances (Agrawal et al., 2004; Fergusson et al., 2006; Gundy & Rebellon, 2010; Lynskey et al., 2006; Morral et al., 2002; Secades-Villa et al., 2015). This finding can be explained by the same mechanisms detailed above (e.g., common liability), although it is important to emphasize that early access to the contexts where cannabis is obtained contributes to early initiation of other substances that are acquired in the same context. In addition, one possibility, given the age range of our sample (i.e., 14–18 years), is that an early onset of cannabis use is related not to a higher lifetime risk of illicit substance use, but to an earlier onset of such use (Lynskey et al., 2006).

In the current sample, most people followed the classic gateway sequence. Only a few adolescents used cannabis before legal substances (6%), and illegal substances before cannabis (10%). These results are consistent with the study by Degenhardt et al. (2010), such that in countries with a high prevalence of cannabis use, as is the case of Spain (30% lifetime in adolescents), the percentage of cannabis gateway violations is low. However, although there is not a high percentage of cannabis gateway violations, this percentage seems to have increased as the prevalence of cannabis use in Spain has increased (Aonso-Diego et al., 2022). Changes in other factors such as attitudes and the availability/accessibility of each substance may have affected the substance use sequences.

The different hypotheses on the explanatory mechanisms of the gateway hypothesis imply different legal and preventive actions (Fergusson et al., 2006). While biological and behavioral factors encourage the restriction of cannabis use, environmental factors would point to cannabis legalization for recreational use in order to remove cannabis from the context in which other illegal substances are obtained. Nevertheless, the legalization of cannabis for recreational use implies a decrease in their risk perception and greater accessibility and availability, and this could lead to an increase in cannabis use (Budney & Borodovsky, 2017; Isorna et al., 2022; Mennis et al., 2023; Sandhu et al., 2019). Another way is to harden legal regulation, since it could be closely associated with a reduction in cannabis demand by increasing its cost (Collins et al., 2014), understood comprehensively, in terms of economic, social, and time costs. Actions undertaken in this way will probably decrease both legal and illegal substance use. In any case, the fact that cannabis use increases the probability of consuming legal substances, but to a lesser extent than illegal substances, suggests that both individual and contextual factors act on the observed results. Interventions should therefore take into account both lines of action. In addition, preventive actions should focus on delaying the age of initiation of cannabis use, since this would reduce the probability of initiation

in other substances.

In the Spanish context, there are some specific preventive recommendations that should be highlighted. In Spain, there is a very low perceived risk for cannabis use (47.8% of adolescents believe that occasional cannabis use implies few or no health problems), and they also perceive a high accessibility to cannabis, as 61.1% believe that they could obtain cannabis easily or very easily (PNSD, 2022). In this sense, both educational campaigns (aimed at increasing perceived risk for cannabis use, denormalizing cannabis use, and providing healthy leisure time alternatives that can compete with drug use) and environmental actions (increasing control over cannabis trafficking, increasing control and sanctions of cannabis use on public roads -cannabis use is legal in Spain at a private level-, controlling the sale and consumption of cannabis in nightlife spaces, or regulating the sale and advertising of cannabis products that do not contain THC) may be developed in order to reduce cannabis use and, therefore, the subsequent use of other substances (Becona, 2021; PNSD, 2018b).

This study is not exempt of limitations common to most large-scale surveys. First, this is a cross-sectional study, so no causal conclusions can be obtained. Second, those adolescents who initiated in cannabis use at the same time as other legal and illegal substances were excluded from the analysis. Third, our study was based on retrospective reports, which may be subject to recall bias. Finally, those individuals who dropped-out educational system are not included, which could alter the results found.

5. Conclusions

Despite the previous limitations, this study expands the available evidence on cannabis as a double gateway drug, finding that cannabis use markedly increases the likelihood of subsequently using other legal and illegal substances. We hope these findings can be helpful for the development of preventive and treatment interventions in Spain.

Role of funding sources.

This research was supported by a Predoctoral Grant from the National Agency of Research of the Spanish Ministry of Science, Innovation and Universities (FPU17/00659). Spanish Ministry of Science, Innovation and Universities had no role in the study design, collection, analysis or interpretation of the data, writing the manuscript, or the decision to submit the paper for publication.

CRediT authorship contribution statement

Ángel García-Pérez: Conceptualization, Formal analysis, Writing – original draft. Gema Aonso-Diego: Formal analysis, Writing – original draft. Sara Weidberg: Formal analysis, Writing – review & editing. Roberto Secades-Villa: Conceptualization, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

The authors thank the Spanish National Durg Plan (Ministry of Health, Social Services and Equality) for providing the survey data.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.addbeh.2023.107751>.

References

Agrawal, A., Grant, J. D., Lynskey, M. T., Madden, P. A. F., Heath, A. C., Bucholz, K. K., & Sartor, C. E. (2016). The genetic relationship between cannabis and tobacco cigarette use in European- and African-American female twins and siblings. *Drug and Alcohol Dependence*, 163, 165–171. <https://doi.org/10.1016/j.drugalcdep.2016.04.011>

Agrawal, A., Grant, J. D., Waldron, M., Duncan, A. E., Scherrer, J. F., Lynskey, M. T., Madden, P. A. F., Bucholz, K. K., & Heath, A. C. (2006). Risk for initiation of substance use as a function of age of onset of cigarette, alcohol and cannabis use: Findings in a Midwestern female twin cohort. *Preventive Medicine*, 43(2), 125–128. <https://doi.org/10.1016/j.ypmed.2006.03.022>

Agrawal, A., Madden, P. A. F., Bucholz, K. K., Heath, A. C., & Lynskey, M. T. (2008). Transitions to regular smoking and to nicotine dependence in women using cannabis. *Drug and Alcohol Dependence*, 95(1–2), 107–114. <https://doi.org/10.1016/j.drugalcdep.2007.12.017>

Agrawal, A., Neale, M. C., Prescott, C. A., & Kendler, K. S. (2004). A twin study of early cannabis use and subsequent use and abuse/dependence of other illicit drugs. *Psychological Medicine*, 34(7), 1227–1237. <https://doi.org/10.1017/S0033291704002545>

Alarcó-Rosales, R., Sánchez-SanSegundo, M., Ferrer-Cascales, R., Albaladejo-Blázquez, N., Ruiz-Robledillo, N., Delvecchio, E., & Oltra-Cucarella, J. (2019). Relationships between problematic cannabis use and risky behaviors in Spanish adolescents. *International Journal of Environmental Research and Public Health*, 16(17), 3029. <https://doi.org/10.3390/ijerph16173029>

Aonso-Diego, G., Weidberg, S., & Secades-Villa, R. (2022). Cannabis y tabaco: Evidencias e implicaciones de la puerta de entrada inversa. In M. Isorna Folgar, F. Fariña Rivera, F. S. Pascual Pastor, & J. Fraga Ares (Eds.), *Una aproximación al panorama actual del consumo de cannabis en España* (pp. 397–406). Dykinson.

Badiani, A., Boden, J. M., De Pirro, S., Fergusson, D. M., Horwood, L. J., & Harold, G. T. (2015). Tobacco smoking and cannabis use in a longitudinal birth cohort: Evidence of reciprocal causal relationships. *Drug and Alcohol Dependence*, 150, 69–76. <https://doi.org/10.1016/j.drugalcdep.2015.02.015>

Baggio, S., Henchoz, Y., Studer, J., Deline, S., N’goran, A., Mohler-Kuo, M., Daepfen, J. B., & Gmel, G. (2015). Cannabis use and other illicit drug use: Do subjective experiences during first cannabis use increase the probability of using illicit drug? *Journal of Substance Use*, 20(4), 234–238. <https://doi.org/10.3109/14659891.2014.896955>

Becona, E. (2021). *La prevención ambiental en el consumo de drogas. ¿Qué medidas podemos aplicar?* Ministerio de Sanidad. Secretaría de Estado de Sanidad. Delegación de Gobierno para el Plan Nacional sobre Drogas.

Belzunegui-Eraso, A., Pastor-Gosálbez, I., Raigal-Aran, L., Valls-Fonayet, F., Fernández-Aliseda, S., & Torres-Coronas, T. (2020). Substance use among Spanish adolescents: The information paradox. *International Journal of Environmental Research and Public Health*, 17(2), 1–15. <https://doi.org/10.3390/ijerph17020627>

Budney, A. J., & Borodovsky, J. T. (2017). The potential impact of cannabis legalization on the development of cannabis use disorders. *Preventive Medicine*, 104, 31–36. <https://doi.org/10.1016/j.ypmed.2017.06.034>

Choo, T., Roh, S., & Robinson, M. (2008). Assessing the “gateway hypothesis” among middle and high school students in Tennessee. *Journal of Drug Issues*, 38(2), 467–492. <https://doi.org/10.1177/002204260803800205>

Collins, R. L., Vincent, P. C., Yu, J., Liu, L., & Epstein, L. H. (2014). A behavioral economic approach to assessing demand for marijuana. *Experimental and Clinical Psychopharmacology*, 22(3), 211–221. <https://doi.org/10.1037/a0035318>

Degenhardt, L., Chiu, W. T., Conway, K., Dierker, L., Glantz, M., Kalaydjian, A., Merikangas, K., Sampson, N., Swendsen, J., & Kessler, R. C. (2009). Does the gateway matter? Associations between the order of drug use initiation and the development of drug dependence in the National Comorbidity Study Replication. *Psychological Medicine*, 39(1), 157–167. <https://doi.org/10.1017/S0033291708003425>

Degenhardt, L., Dierker, L., Chiu, W. T., Medina-Mora, M. E., Neumark, Y., Sampson, N., ... Kessler, R. C. (2010). Evaluating the drug use “gateway” theory using cross-national data: Consistency and associations of the order of initiation of drug use among participants in the WHO World Mental Health Surveys. *Drug and Alcohol Dependence*, 108(1–2), 84–97. <https://doi.org/10.1016/j.drugalcdep.2009.12.001>

Deza, M. (2015). Is there a stepping stone effect in drug use? Separating state dependence from unobserved heterogeneity within and between illicit drugs. *Journal of Econometrics*, 184(1), 193–207. <https://doi.org/10.1016/j.jeconom.2014.08.005>

Dishion, T. J., & Owen, L. D. (2002). A longitudinal analysis of friendships and substance use: Bidirectional influence from adolescence to adulthood. *Developmental Psychology*, 38(4), 480–491. <https://doi.org/10.1037/0012-1649.38.4.480>

Dorard, G., Berthoz, S., Phan, O., Corcos, M., & Bungener, C. (2008). Affect dysregulation in cannabis abusers: A study in adolescents and young adults. *European Child and Adolescent Psychiatry*, 17(5), 274–282. <https://doi.org/10.1007/s00787-007-0663-7>

Duarte, R., Escario, J., & Molina, J. (2000). Drug use among the Spanish adolescents. In A. Fortier, & S. Turcotte (Eds.), *Health Education: Challenges. Issues and Impact*: Nova Science Publisher Inc.

Eaton, N. R., Rodríguez-Seijas, C., Carragher, N., & Krueger, R. F. (2015). Transdiagnostic factors of psychopathology and substance use disorders: A review. *Social Psychiatry and Psychiatric Epidemiology*, 50(2), 171–182. <https://doi.org/10.1007/s00127-014-1001-2>

Ellgren, M., Spano, S. M., & Hurd, Y. L. (2007). Adolescent cannabis exposure alters opiate intake and opioid limbic neuronal populations in adult rats. *Neuropsychopharmacology*, 32(3), 607–615. <https://doi.org/10.1038/sj.npp.1301127>

EMCDDA. (2021). *European drug report 2021: Trends and developments*. <https://www.emcdda.europa.eu/system/files/publications/13838/TDAT21001ENN.pdf>.

Fergusson, D. M., Boden, J. M., & Horwood, L. J. (2006). Cannabis use and other illicit drug use: Testing the cannabis gateway hypothesis. *Addiction*, 101(4), 556–569. <https://doi.org/10.1111/j.1360-0443.2005.01322.x>

Fergusson, D. M., Boden, J. M., & Horwood, L. J. (2015). Psychosocial sequelae of cannabis use and implications for policy: Findings from the Christchurch Health and Development Study. *Social Psychiatry and Psychiatric Epidemiology*, 50(9), 1317–1326. <https://doi.org/10.1007/s00127-015-1070-x>

Fergusson, D. M., & Horwood, L. J. (1997). Early onset cannabis use and psychosocial adjustment in young adults. *Addiction*, 92(3), 279–296. <https://doi.org/10.1111/j.1360-0443.1997.tb03198.x>

Fergusson, D. M., & Horwood, L. J. (2000). Does cannabis use encourage other forms of illicit drug use? *Addiction*, 95(4), 505–520. <https://doi.org/10.1046/j.1360-0443.2000.9545053.x>

Fergusson, D. M., Horwood, L. J., Lynskey, M. T., & Madden, P. A. F. (2003). Early reactions to cannabis predict later dependence. *Archives of General Psychiatry*, 60(10), 1033–1039. <https://doi.org/10.1001/archpsyc.60.10.1033>

Gundy, V. K., & Rebellon, C. J. (2010). A life-course perspective on the “gateway hypothesis”. *Journal of Health and Social Behavior*, 51(3), 244–259. <https://doi.org/10.1177/0022146510378238>

Hurd, Y. L., Michaelides, M., Miller, M. L., & Jutras-Aswad, D. (2014). Trajectory of adolescent cannabis use on addiction vulnerability. *Neuropharmacology*, 76(Part B), 416–424. <https://doi.org/10.1016/j.neuropharm.2013.07.028>

Isorna, M., Pascual, F., Aso, E., & Arias, F. (2022). Impacto de la legalización del consumo recreativo del cannabis Impact of the legalisation of recreational cannabis use. *Adicciones*, 20(10). <https://doi.org/10.20882/adicciones.1694>

Jorgensen, C., & Wells, J. (2021). Is marijuana really a gateway drug? A nationally representative test of the marijuana gateway hypothesis using a propensity score matching design. *Journal of Experimental Criminology*, 18, 497–514. <https://doi.org/10.1007/s11292-021-09464-z>

Kandel, D. B. (1975). Stages in adolescent involvement in drug use. *Science*, 190(4217), 912–914.

Kandel, D. B. (2003). Does marijuana use cause the use of other drugs? *JAMA*, 289(4), 482–483. <https://doi.org/10.1001/jama.289.4.482>

Kandel, D. B., Davies, M., Karus, D., & Yamaguchi, K. (1986). The consequences in young adulthood of adolescent drug involvement: An overview. *Archives of General Psychiatry*, 43(8), 746–754.

Kandel, D. B., Yamaguchi, K., & Chen, K. (1992). Stages of progression in drug involvement from adolescence to adulthood: Further evidence for the gateway theory. *Journal of Studies on Alcohol*, 53(5), 447–457. <https://doi.org/10.15288/jsa.1992.53.447>

Kandel, D. B., Yamaguchi, K., & Klein, L. C. (2006). Testing the Gateway Hypothesis. *Addiction*, 101(4), 470–476. <https://doi.org/10.1111/j.1360-0443.2006.01426.x>

Kim, H. S., & Hodgins, D. C. (2018). Component model of addiction treatment: A pragmatic transdiagnostic treatment model of behavioral and substance addictions. *Frontiers in Psychiatry*, 9, 1–17. <https://doi.org/10.3389/fpsy.2018.00406>

Kokkevi, A., Gabhainn, S. N., & Spyropoulou, M. (2006). Early initiation of cannabis use: A cross-national european perspective. *Journal of Adolescent Health*, 39(5), 712–719. <https://doi.org/10.1016/j.jadohealth.2006.05.009>

Kuntsche, E. N. (2004). Progression of a general substance use pattern among adolescents in Switzerland? Investigating the relationship between alcohol, tobacco, and cannabis use over a 12-year period. *European Addiction Research*, 10(3), 118–125. <https://doi.org/10.1159/000077700>

Leri, F., Bruneau, J., & Stewart, J. (2003). Understanding polydrug use: Review of heroin and cocaine co-use. *Addiction*, 98(1), 7–22. <https://doi.org/10.1046/j.1360-0443.2003.00236.x>

Lessem, J. M., Hopfer, C. J., Haberstick, B. C., Timberlake, D., Ehringer, M. A., Smolen, A., & Hewitt, J. K. (2006). Relationship between adolescent marijuana use and young adult illicit drug use. *Behavior Genetics*, 36(4), 498–506. <https://doi.org/10.1007/s10519-006-9064-9>

Lynskey, M. T., Vink, J. M., & Boomsma, D. I. (2006). Early onset cannabis use and progression to other drug use in a sample of dutch twins. *Behavior Genetics*, 36(2), 195–200. <https://doi.org/10.1007/s10519-005-9023-x>

Mayet, A., Legleye, S., Beck, F., Falissard, B., & Chau, N. (2016). The gateway hypothesis, common liability to addictions or the route of administration model a modelling process linking the three theories. *European Addiction Research*, 22(2), 107–117. <https://doi.org/10.1159/000439564>

Mayet, A., Legleye, S., Chau, N., & Falissard, B. (2010). The mediation role of licit drugs in the influence of socializing on cannabis use among adolescents: A quantitative approach. *Addictive Behaviors*, 35(10), 890–895. <https://doi.org/10.1016/j.addbeh.2010.06.001>

Melberg, H. O., Jones, A. M., & Bretteville-Jensen, A. L. (2010). Is cannabis a gateway to hard drugs? *Empirical Economics*, 38(3), 583–603. <https://doi.org/10.1007/s00181-009-0280-z>

Mennis, J., McKeon, T. P., & Stahler, G. J. (2023). Recreational cannabis legalization alters associations among cannabis use, perception of risk, and cannabis use disorder treatment for adolescents and young adults. *Addictive behaviors*, 138, Article 107552. <https://doi.org/10.1016/j.addbeh.2022.107552>

Moreno-Mansilla, S., Ricarte, J. J., & Hallford, D. J. (2021). Cannabis use among early adolescents and transdiagnostic mental health risk factors. *Clinical Child Psychology and Psychiatry*, 26(2), 531–543. <https://doi.org/10.1177/1359104521994637>

Morrall, A. R., McCaffrey, D. F., & Paddock, S. M. (2002). Reassessing the marijuana gateway effect. *Addiction*, 97(12), 1493–1504. <https://doi.org/10.1046/j.1360-0443.2002.00280.x>

- National Drugs Plan (PNSD). (2018a). *The national strategy on addictions 2017-2024*. Ministerio de Sanidad. Secretaría de Estado de Sanidad. Delegación de Gobierno para el Plan Nacional sobre Drogas.
- National Drugs Plan (PNSD). (2018b). *Survey on drug use in secondary education in Spain (ESTUDES), 1994-2018*. https://pnsd.sanidad.gob.es/profesionales/sistemasInformacion/sistemaInformacion/pdf/ESTUDES_2018-19_Informe.pdf.
- National Drugs Plan (PNSD). (2022). *EDADES 2022. Encuesta sobre alcohol y otras drogas en España (EDADES), 1995-2022*. https://pnsd.sanidad.gob.es/profesionales/sistemasInformacion/sistemaInformacion/pdf/2022_Informe_EDADES.pdf.
- Palmer, R. H. C., Young, S. E., Corley, R. P., Hopfer, C. J., Stallings, M. C., & Hewitt, J. K. (2013). Stability and change of genetic and environmental effects on the common liability to alcohol, tobacco, and cannabis DSM-IV dependence symptoms. *Behavior Genetics*, 43(5), 374–385. <https://doi.org/10.1007/s10519-013-9599-5>
- Palmer, R. H. C., Button, T. M., Rhee, S. H., Corley, R. P., Young, S. E., Stallings, M. C., Hopfer, C. J., & Hewitt, J. K. (2012). Genetic etiology of the common liability to drug dependence: Evidence of common and specific mechanisms for DSM-IV dependence symptoms. *Drug and Alcohol Dependence*, 123(Suppl. 1), S24–S32. <https://doi.org/10.1016/j.drugalcdep.2011.12.015>
- Patton, G. C., Coffey, C., Carlin, J. B., Sawyer, S. M., & Lynskey, M. (2005). Reverse gateways? Frequent cannabis use as a predictor of tobacco initiation and nicotine dependence. *Addiction*, 100(10), 1518–1525. <https://doi.org/10.1111/j.1360-0443.2005.01220.x>
- Proposición de Ley integral del cannabis (2021). https://www.congreso.es/public_oficiales/L14/CONG/BOCG/B/BOCG-14-B-190-1.PDF.
- Ramo, D. E., Liu, H., & Prochaska, J. J. (2012). Tobacco and marijuana use among adolescents and young adults: A systematic review of their co-use. *Clinical Psychology Review*, 32(2), 105–121. <https://doi.org/10.1016/j.cpr.2011.12.002>
- Reed, Z. E., Wootton, R. E., & Munafó, M. R. (2021). Using Mendelian randomization to explore the gateway hypothesis: Possible causal effects of smoking initiation and alcohol consumption on substance use outcomes. *Addiction*, 117(3), 741–750. <https://doi.org/10.1111/add.15673>
- Sandhu, H. S., Anderson, L. N., & Busse, J. W. (2019). Characteristics of Canadians likely to try or increase cannabis use following legalization for nonmedical purposes: A cross-sectional study. *CMAJ Open*, 7(2), E399–E404. <https://doi.org/10.9778/cmajo.20190008>
- Schenk, S. (2002). Sensitization as a process underlying the progression of drug use via gateway drugs. In D. B. Kandel (Ed.), *Stages and Pathways of Drug Involvement: Examining the Gateway Hypothesis* (pp. 318–336). Cambridge University Press. <https://doi.org/10.1017/CBO9780511499777.016>.
- Scholes-Balog, K. E., Hemphill, S. A., Evans-Whipp, T. J., Toumbourou, J. W., & Patton, G. C. (2016). Developmental trajectories of adolescent cannabis use and their relationship to young adult social and behavioural adjustment: A longitudinal study of Australian youth. *Addictive Behaviors*, 53, 11–18. <https://doi.org/10.1016/j.addbeh.2015.09.008>
- Secades-Villa, R., García-Rodríguez, O., Jin, C. J., Wang, S., & Blanco, C. (2015). Probability and predictors of the cannabis gateway effect: A national study. *International Journal of Drug Policy*, 26(2), 135–142. <https://doi.org/10.1016/j.drugpo.2014.07.011>
- Taylor, M., Collin, S. M., Munafó, M. R., MacLeod, J., Hickman, M., & Heron, J. (2017). Patterns of cannabis use during adolescence and their association with harmful substance use behaviour: Findings from a UK birth cohort. *Journal of Epidemiology and Community Health*, 71(8), 764–770. <https://doi.org/10.1136/jech-2016-208503>
- Van Leeuwen, A. P., Verhulst, F. C., Reijneveld, S. A., Vollebbergh, W. A. M., Ormel, J., & Huizink, A. C. (2011). Can the gateway hypothesis, the common liability model and/or, the route of administration model predict initiation of cannabis use during adolescence? A survival analysis of the TRAILS study. *Journal of Adolescent Health*, 48(1), 73–78. <https://doi.org/10.1016/j.jadohealth.2010.05.008>
- Van Ours, J. C. (2003). Is cannabis a stepping-stone for cocaine? *Journal of Health Economics*, 22(4), 539–554. [https://doi.org/10.1016/S0167-6296\(03\)00005-5](https://doi.org/10.1016/S0167-6296(03)00005-5)
- Vanyukov, M. M., Tarter, R. E., Kirillova, G. P., Kirisci, L., Reynolds, M. D., Kreek, M. J., Conway, K. P., Maher, B. S., Iacono, W. G., Bierut, L., Neale, M. C., Clark, D. B., & Ridenour, T. A. (2012). Common liability to addiction and “gateway hypothesis”: Theoretical, empirical and evolutionary perspective. *Drug and Alcohol Dependence*, 123(SUPPL.1), 1–30. <https://doi.org/10.1016/j.drugalcdep.2011.12.018>
- Vanyukov, M. M., Tarter, R. E., Kirisci, L., Kirillova, G. P., Maher, B. S., & Clark, D. B. (2003). Liability to substance use disorders: 1. Common mechanisms and manifestations. *Neuroscience and Biobehavioral Reviews*, 27(6), 507–515. <https://doi.org/10.1016/j.neubiorev.2003.08.002>
- Wagner, F. A., & Anthony, J. C. (2002). Into the world of illegal drug use: Exposure opportunity and other mechanisms linking the use of alcohol, tobacco, marijuana, and cocaine. *American Journal of Epidemiology*, 155(10), 918–925. <https://doi.org/10.1093/aje/155.10.918>
- Weidberg, S., Aonso-Diego, G., García-Fernández, G., & Secades-Villa, R. (2022). Prevalence and Correlates of Prescription Drug Misuse Among Spanish Adolescents. *Psicothema*, 34(2), 275–282. <https://doi.org/10.7334/psicothema2021.389>
- Wilson, J., Mills, K., Freeman, T. P., Visontay, R., Marel, C., & Sunderland, M. (2021). Weeding out the truth: A systematic review and meta-analysis on the transition from cannabis use to opioid use and opioid use disorders, abuse or dependence. *Addiction*, 117(2), 284–298. <https://doi.org/10.1111/add.15581>
- Young, S. E., Rhee, S. H., Stallings, M. C., Corley, R. P., & Hewitt, J. K. (2006). Genetic and environmental vulnerabilities underlying adolescent substance use and problem use: General or specific? *Behavior Genetics*, 36(4), 603–615. <https://doi.org/10.1007/s10519-006-9066-7>