











Changes in co-use of alcohol and cannabis among Nordic adolescents in the 21st century: Results from the European School Survey Project on Alcohol and Other Drugs study

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Abstract

Introduction: In the 21st century, there has been a decline in alcohol use among adolescents in most Nordic countries, while trends of cannabis use have diverged. We explore how alcohol and cannabis use, respectively, and co-use of the two substances, have changed among Nordic adolescents. Three hypotheses are used to frame the study: (i) cannabis use has substituted alcohol use; (ii) there has been a parallel decline in both substances; and/or (iii) there has been a ‘hardening’ of users, implying that alcohol users increasingly use cannabis.

Methods: Data from the European School Survey Project on Alcohol and Other Drugs, conducted among 15- to 16-year-olds in Denmark, Finland, Iceland, Norway and Sweden ($N = 74,700$, 49% boys), were used to explore trends of past-year alcohol and cannabis use in the period 2003–2019.

Results: The proportion of adolescents reporting alcohol use decreased significantly in all Nordic countries except Denmark. The proportion of those using cannabis only was low (0.0%–0.7%) and stable in all countries. The total number of substance use occasions declined among all adolescents in all countries but Denmark. Among alcohol users, cannabis use became increasingly prevalent in all countries but Denmark.

Discussion and Conclusions: We found no support for the ‘parallel decline hypothesis’ in alcohol and cannabis use among Nordic adolescents. Partially in line with the ‘substitution hypothesis’, cannabis use accounted for an increasing proportion of all substance use occasions. Our results suggests that the co-use of alcohol and cannabis has become more common, thus also providing support to the ‘hardening’ hypothesis.

KEYWORDS

alcohol use, cannabis use, co-use, Nordic countries, time trends

1 | INTRODUCTION

In the 21st century, alcohol use decreased among adolescents in the Nordic countries (i.e. Denmark, Finland, Iceland, Norway and Sweden) [1–4]. Similar trends have been observed in several other high-income countries [5–7]. The decline was considerable in Iceland (i.e. from 63% past-year drinkers in 2003 to 26% in 2019) and modest in Denmark (from 95% to 89%), with the other Nordic countries in between. Over the same period, the prevalence of cannabis use remained low, and no clear time trends are observed in any of the Nordic countries [8]. Possession or use of cannabis is illegal in all Nordic countries, whereas alcohol control policies, for instance with regard to minimum legal age for purchase, are less restrictive in Denmark than in the other countries. However, perceptions of harmfulness and availability of these substances may differ over time and between countries [9, 10].

Although several publications have offered descriptions and attempts to explain the recent trends in adolescents' use of alcohol [11] and cannabis [12], few studies—and only from the United States—have examined time trends in co-use (i.e. concurrent use) of both substances (e.g. in the past year) [13] and how change over time in use of one substance may impact use of the other [14, 15]. In this study, we explore the trends in past-year alcohol and cannabis use separately, as well as co-use of the substances, by employing comparative data from the Nordic countries.

There are several reasons why it is of interest to examine trends in co-use of alcohol and cannabis. First, co-use carries more risk than use of either substance alone. Co-users consume more alcohol and use more cannabis, compared to single substance users [16–18]. Among young co-users, intake usually occurs simultaneously, that is, at the same occasion [19–21]. Such simultaneous intake has immediate synergistic effects and impairs cognition and driving ability [17, 18]. Moreover, heavier co-use of alcohol and cannabis during adolescence increases the likelihood of negative outcomes in adulthood, including substance use dependence, other mental health problems, criminality and failure to complete secondary education [17, 22]. Thus, to better understand the complexity of adolescent substance use at the population level, as well as to find possible explanations for the downward trend in youth alcohol consumption, it is important to study trends in both alcohol and cannabis use.

One proposed hypothesis on the time dynamic relationship between alcohol and cannabis use is the *substitution hypothesis*, which suggests that the observed decline in alcohol use has led to a substitution of alcohol

with cannabis. In this context, the assumption is that the decline in alcohol use, which probably reflects fewer social occasions for drinking, may have caused some adolescents to turn to cannabis use as an alternative psychoactive substance. If this substitution were a predominant mechanism, we would expect an overall increase in cannabis use. This could be either in terms of an increase in prevalence of cannabis use only, an increase in frequency of use, or an increase in prevalence of co-use, or some combination of the three. If the decrease in alcohol use occasions were completely substituted by cannabis use, we would expect the sum of these substance use occasions to be approximately constant over time. Studies examining the substitution hypothesis using data from the United States before and after the legalisation of medical or recreational cannabis use in certain federal states, have generated inconsistent and generally insignificant findings [14].

An alternative hypothesis posits that the decline in alcohol use may have led to a corresponding decline also in cannabis use, and in co-use of alcohol and cannabis within the same timeframe (e.g. past-year use). This may be termed the *parallel decline* hypothesis, which suggests that drinking occasions provide opportunities for cannabis use in two ways: (i) partying or other alcohol use occasions may provide social contexts where cannabis is shared or sold; and (ii) alcohol intoxication may lower the barriers for illegal substance use. Against this background, one could assume—a priori—that the decline in alcohol use among adolescents may have resulted in fewer opportunities to use cannabis and consequently a decline in prevalence of co-use and/or a decline in frequency of cannabis use among co-users. A few studies of historic trends in alcohol and cannabis use among high school students in the United States reported that trends in co-use and single substance use were closely tied [13].

A third hypothesis is that among alcohol users, the likelihood of cannabis use depends on the prevalence of alcohol use, and furthermore, that the frequency of cannabis use among co-users also depends on the prevalence of alcohol use. The reasoning behind this assumption is that, consistent with the 'problem behaviour theory' [23], various low-prevalent problem behaviours, including cannabis use, tend to cluster and more often in individuals characterised by impulsivity and low self-control [24]. These characteristics are also associated with frequent cannabis use in adolescence [25]. As the proportion of individuals with such characteristics is likely quite stable over time, partly due to their genetic underpinning [26], we expect these characteristics to be more prevalent among co-users at times when alcohol users are few as compared to times when they are in majority [27, 28]. Thus, we may hypothesize that when alcohol use has

decreased and has become rarer and more 'deviant' from the majority: (i) the prevalence of cannabis users among alcohol users increases; (ii) the frequency of cannabis use among co-users increases and hence; (iii) the proportion of substance use occasions in which cannabis is used, increases. Thus, when alcohol use decreases, one might hypothesize a *hardening* of users, such that alcohol users to an increasing extent also are involved in other low-prevalent risk behaviours, in this case cannabis use.

Against the backdrop of declining alcohol use in the Nordic countries, we apply comparative data from adolescents in Denmark, Finland, Iceland, Norway and Sweden from the period 2003–2019 to explore the trends in alcohol use and cannabis use, and the co-use of the two. The hypothesis outlined above will be used to frame the discussion of the results.

2 | METHODS

2.1 | Data

Data for this study stem from the European School Survey Project on Alcohol and Other Drugs (ESPAD) trend database. The ESPAD survey has been conducted every fourth year since 1995 to investigate substance use and substance-use patterns among 15- to 16-year-old students [8]. We utilised ESPAD data from Denmark, Finland, Iceland, Norway and Sweden on five representative cross-sectional surveys of students (2003, 2007, 2011, 2015 and 2019). The total sample size across all surveys and countries comprised 76,786 students aged 15–16 years. The analytical sample included all students with valid answers to questions about alcohol and cannabis use during the past 12 months ($n = 74,700$). Sample characteristics by country and year, including response rates and numbers/proportions of students with valid responses (analytic samples), are described in Table S1. As shown in Table S1, there are low non-response rates across survey years in all study countries.

2.2 | Measures

The students were asked: (i) on how many occasions (if any) have you had any alcoholic beverage to drink during the past 12 months?; and (ii) 'On how many occasions (if any) have you used cannabis during the past 12 months?', with response categories '0', '1–2', '3–5', '6–9', '10–19', '20–39' and '40 or more occasions' for both questions. These two variables were combined and classified into four groups of students: non-users (neither alcohol nor cannabis); alcohol users only; cannabis users only; and co-users of both alcohol and cannabis. In

addition, we used semi-continuous measures for alcohol and cannabis use frequency in the past 12 months, where response options were recoded to mid-points for each category: '0', '1.5', '4', '7.5', '14.5', '29.5' and '40'.

The total number of substance use occasions among co-users was calculated as the sum of past-year alcohol use occasions and cannabis use occasions. These occasions can include use of either substance alone or both substances. The proportion of cannabis use occasions among all substance use occasions among co-users (in percent) was calculated as the number of cannabis use occasions divided by total number of substance use occasions multiplied by 100.

2.3 | Statistical analyses

The Cochran–Armitage test [29] was used to examine linearity in time trends for prevalence of substance use across the five survey waves in each study country. To test differences between 2003 and 2019 in mean frequency of substance use, we employed the one-way analysis of variance test.

For countries where non-proportionate stratification for sampling has been used (i.e. Denmark, Finland and Norway), data have been weighted to account for sample-specific characteristics [8]. All analyses were conducted in SAS Enterprise Guide, version 8.3 [30].

3 | RESULTS

We first examined the data for trends in the prevalence of alcohol and cannabis use. Figure 1 shows the distribution of categories of past 12-month substance use among all adolescents by survey year and country. The proportion of non-users of alcohol and cannabis increased in all Nordic countries in the period 2003–2019. In 2019, the proportion of non-users was highest in Iceland (73.7%) and lowest in Denmark (10.9%). The Cochran–Armitage tests for trends showed that the declining trend in the proportion of alcohol users only was statistically significant in all countries except Denmark. In general, the proportion of students with co-use of alcohol and cannabis was higher in Denmark than in the other Nordic countries. Between 2003 and 2019, the proportion of co-users increased in Finland, Norway and Sweden and decreased in Denmark and Iceland. The changes were statistically significant in all countries although there was fluctuation in the prevalence of students with co-use during the study period.

The proportion reporting cannabis use only was very low in all Nordic countries, varying between 0% and 0.7% in all survey years (Figure 1). Thus, in the further

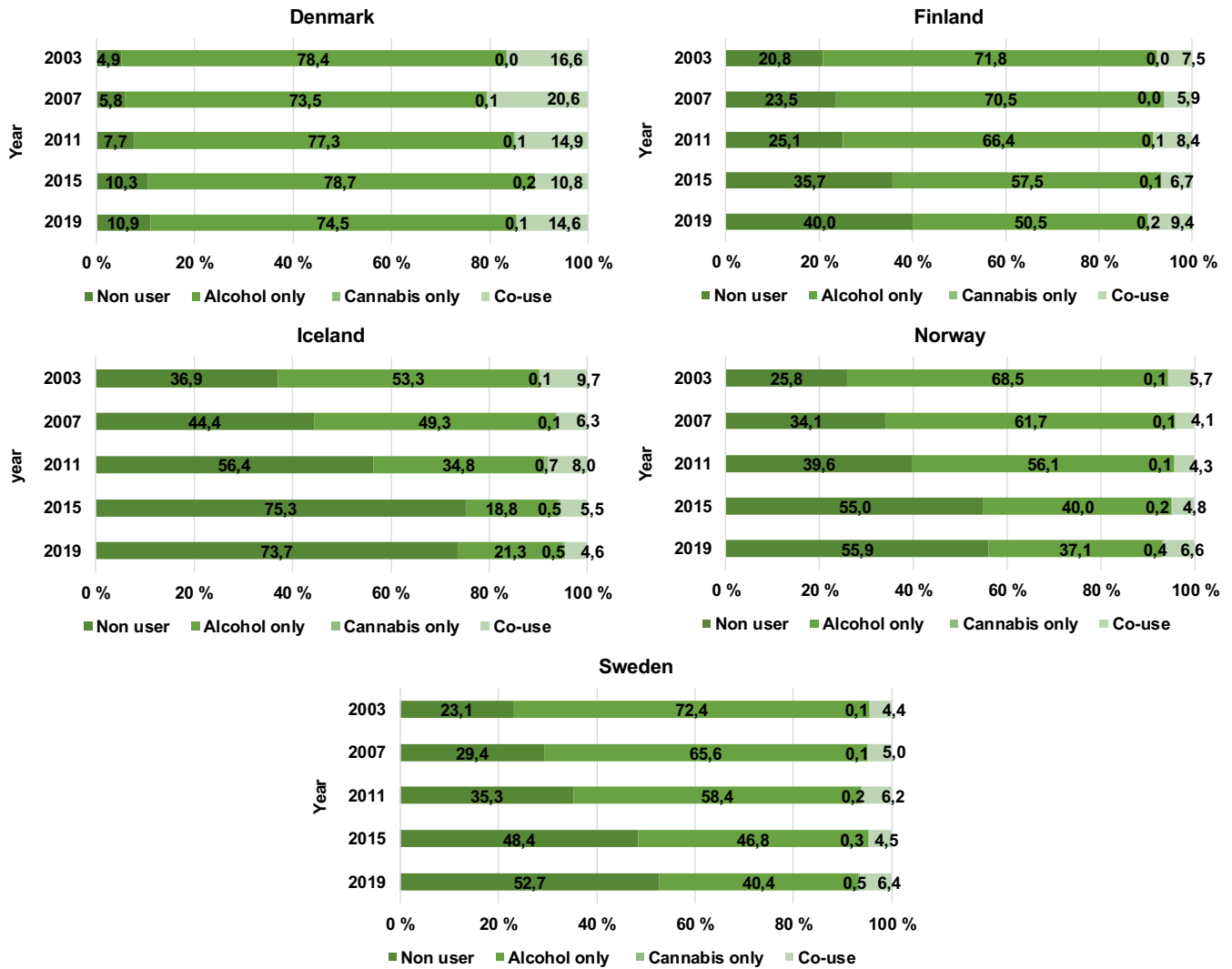


FIGURE 1 The proportions of different groups of alcohol and cannabis use during the past 12 months. By country, 2003–2019.

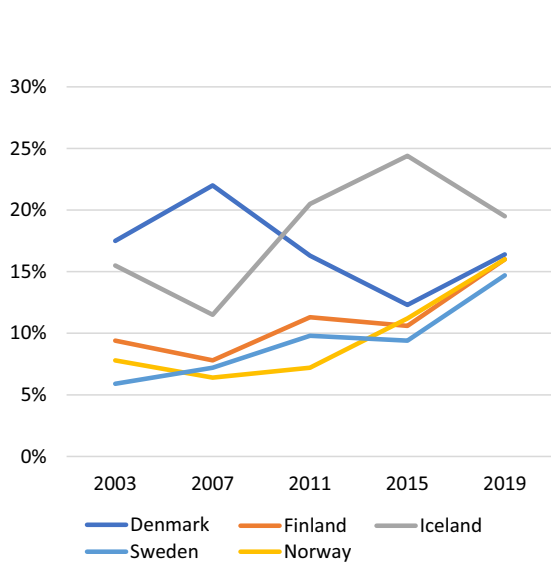


FIGURE 2 Proportion of cannabis users among alcohol users by country and year, 2003–2019.

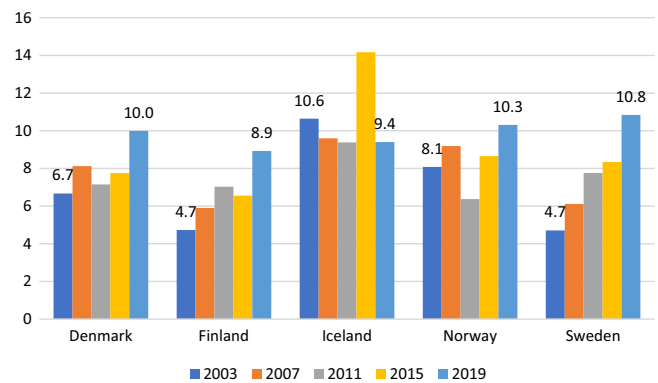


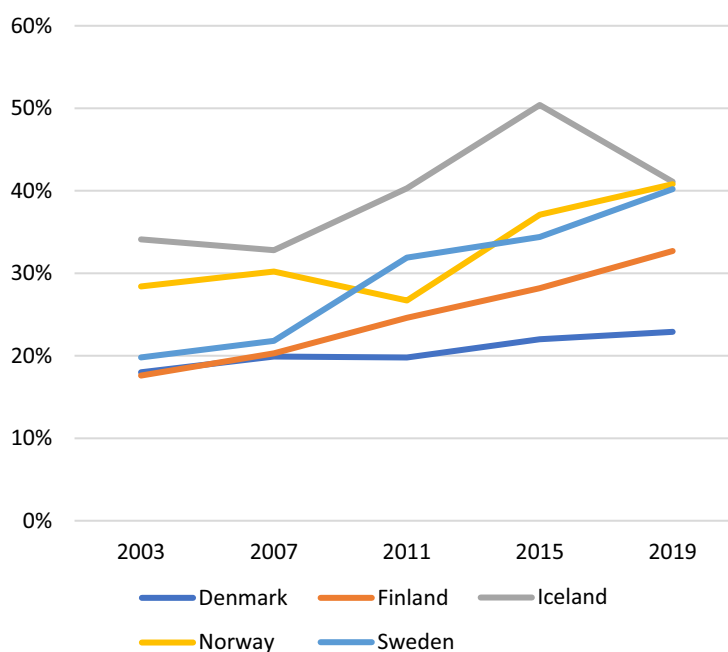
FIGURE 3 Mean frequency of cannabis use (past 12 months) among co-users of alcohol and cannabis. By country, 2003–2019.

analyses, we focused on those who had used (i) alcohol only; and (ii) alcohol and cannabis (co-users) during the past 12 months.

TABLE 1 Average number of total alcohol and cannabis use occasions. By country, 2003–2019. All adolescents and co-users of alcohol and cannabis past 12 months and one-way ANOVA test for differences between 2003 and 2019.

	2003	2007	2011	2015	2019	One-way ANOVA test for differences between 2003 and 2019
All adolescents						
Denmark	20.4	20.9	16.8	14.8	20.2	$F = 0.09, Pr(F) = 0.766$
Finland	9.0	8.0	8.3	5.2	5.7	$F = 157.44, Pr(F) < 0.0001$
Iceland	7.1	5.7	3.5	2.3	2.0	$F = 317.66, Pr(F) < 0.0001$
Norway	8.2	6.4	4.8	3.5	4.2	$F = 263.46, Pr(F) < 0.0001$
Sweden	7.5	7.2	5.8	4.0	4.1	$F = 158.64, Pr(F) < 0.0001$
Co-users of alcohol and cannabis						
Denmark	37.1	40.9	36.0	35.2	43.6	$F = 27.88, Pr(F) < 0.0001$
Finland	26.8	29.3	28.6	23.2	27.2	$F = 0.08, Pr(F) = 0.0790$
Iceland	31.2	29.3	23.3	28.1	22.9	$F = 13.79, Pr(F) = 0.0002$
Norway	28.4	30.5	23.9	23.3	25.3	$F = 2.74, Pr(F) = 0.0984$
Sweden	23.8	28.0	24.5	24.3	27.0	$F = 2.33, Pr(F) = 0.1282$

Abbreviation: ANOVA, analysis of variance.

**FIGURE 4** The proportion (%) of cannabis use occasions relative to all substance use occasions (alcohol, cannabis or both) among co-users. By country, 2003–2019.

Next, we calculated the proportion of cannabis users among alcohol users. Figure 2 shows a substantial increase in the proportions of cannabis users among alcohol users in all countries but Denmark (see Table S2, for exact figures).

Figure 3 displays the past 12-month frequency of cannabis use among co-users of alcohol and cannabis in the Nordic countries and per survey year. Only in Iceland did the frequency of use decline between 2015 and 2019.

Otherwise, there was a clear, overall increasing trend in the frequency of cannabis use.

The average number of combined past 12-month alcohol and cannabis use occasions is presented by country and survey year in Table 1. The upper half of Table 1 shows that among all adolescents, the average number of substance use occasions has been clearly higher in Denmark than in the other Nordic countries in all study years. Moreover, while this number remained stable over

time in Denmark for all adolescents ($\text{Pr}(Z) = 0.766$), it decreased substantially ($\text{Pr}(Z) < 0.0001$) over time in the other countries. Also, among co-users of alcohol and cannabis (bottom half of table), the average number of substance use occasions was higher in Denmark than in the other Nordic countries in all study years. The average number of substance use occasions among co-users in Finland, Norway and Sweden remained stable over time. In Denmark, the average number of occasions increased among co-users ($\text{Pr}(Z) < 0.0001$) whereas in Iceland there was a statistically significant decline ($\text{Pr}(Z) = 0.0002$).

Finally, we examined changes in the proportion of cannabis use occasions relative to all substance use occasions among co-users of alcohol and cannabis between 2003 and 2019. Figure 4 shows that in four of the Nordic countries (Finland, Iceland, Norway and Sweden), all of which had experienced a decline in adolescent alcohol use in the 21st century, cannabis use accounted for an increasing proportion of all substance use occasions over the study period. In Denmark, where the prevalence of alcohol use remained fairly stable and high over time, the proportion of substance use occasions accounted for by cannabis use increased only slightly (see Table S3 for exact figures).

4 | DISCUSSION

The present study utilised cross-sectional data over the period from 2003 to 2019 to examine trends in alcohol and cannabis use, and co-use of the two substances, among Nordic adolescents. To the best of our knowledge, this study is the first to explore trends in co-use of alcohol and cannabis in the Nordic countries. We found a statistically significant decline in the proportion of alcohol users only in all countries except Denmark, and among alcohol users, cannabis use became increasingly prevalent in three countries (Finland, Norway and Sweden) and displayed no clear trend in the other two. In all countries but Denmark, the total number of substance use occasions declined among all adolescents, along with the decline in alcohol use prevalence, whereas cannabis accounted for an increasingly larger proportion of all substance use occasions among co-users.

To what extent do our findings correspond with the proposed hypotheses on the association between alcohol and cannabis use? There was little support for the substitution hypothesis; although cannabis accounted for an increasingly larger fraction of all substance use occasions, there was no indication that alcohol users switched to cannabis use only. We did not find a similar declining trend in cannabis use as we saw for alcohol use in four countries. Thus, the hypothesis of a parallel declining

trend in prevalence of alcohol and cannabis use was not supported by our data. The underlying mechanisms for a parallel decline may, however, still be valid. It is possible that fewer heavy drinking occasions led to some reduction in cannabis use, but other factors, including perceptions of availability and harmfulness, may have countered this effect. Our results were more in line with the 'hardening' of alcohol users hypothesis, as we found that among users, the proportion of cannabis use occasions relative to all substance use occasions (alcohol, cannabis, or both) increased with the decline in alcohol use. In other words, if we consider low-prevalent cannabis use a deviant and norm-breaking behaviour compared to the majority, our results suggest a 'hardening of alcohol users' and that cannabis to an increasing extent has become complementary to alcohol along with the decline in alcohol use. This interpretation corresponds with that of previous studies showing that alcohol users more often reported aggressive, criminal or other low-prevalent norm-breaking behaviours in periods when alcohol use was less common [27, 28]. Notably, the concept of 'hardening' may also reflect the overall health risks from substance use, assuming that co-use of alcohol and cannabis mostly occurs simultaneously, and thereby carries a substantially elevated risk of acute health harms [17, 18].

With our data, it is not possible to identify whether the use of alcohol and cannabis occurred simultaneously. However, it seems likely that a considerable proportion of cannabis use occasions reported in our study also included intake of alcohol. Previous studies have demonstrated that there is a close link between alcohol and cannabis use and that a significant proportion of young people who use cannabis have done so in association with drinking alcohol [19, 31, 32]. Studies from Norway and Australia suggest that in approximately 80% of all cannabis use occasions, alcohol was also used [19, 33]. Swift et al. [16] also found that a high level of alcohol use is especially common among those using cannabis on a regular basis.

The trends of adolescents' alcohol and cannabis use in Denmark are markedly different from those in the other Nordic countries. Denmark is the Nordic country with the lowest age limit for purchasing alcoholic beverages, and Danish parents have far less restrictive attitudes towards offspring drinking [3], which may partly explain the higher proportion of adolescent drinkers in Denmark than the rest of the Nordic countries. Moreover, the trends in perceived availability and in parental attitudes differ between Denmark and other Nordic countries. In Finland, Norway and Sweden, the decline in perceived access to alcohol was significantly associated with the decline in youth drinking [2], whereas the decline in both drinking and perceived access to alcohol was less

pronounced in Denmark [34]. Although parental attitudes became even more restrictive in Sweden, they remained lenient in Denmark [3].

Although the cannabis policies are similar in the Nordic countries, the attitudes towards cannabis use as measured by risk perceptions during the study period have been more liberal among adolescents in Denmark compared to the other Nordic countries [34]. Although it has been shown that perceptions of low risk [9, 35], higher availability [36, 37], low parental monitoring in general [38] and parents' less restrictive cannabis rules [39] are associated with increased likelihood of cannabis use in adolescents, no studies seem to have examined whether possible changes in attitudes, availability and parental practices are associated with an increase in co-use of alcohol and cannabis among youth.

4.1 | Strengths and limitations, and avenues for future research

The strengths of this study include the use of high-quality survey data with representative samples and low non-response rates from a well-established study conducted in the five Nordic countries. Data were collected with the same methodology and survey questions throughout the study period. As the data comprised five representative cross-sections of youths, it was possible to investigate the trends in alcohol and cannabis use over time, as well as trends in the interrelationships between them. Some methodological limitations of our study should be considered. A major limitation of our study was that we did not have information on simultaneous use of alcohol and cannabis. In addition, our data are based on self-reported information on alcohol and cannabis use. The limitations of self-reported data are well known, and there is always a risk that students consciously or unconsciously do not give accurate or honest answers about substance use, as well as a risk of heavy consumers being underrepresented among respondents [40]. Exaggerated responses also occur among adolescents; to minimise this type of bias the survey was conducted in the classroom, with a strong emphasis on each student's anonymity [8]. In addition, the data were centrally cleaned, and the obvious exaggerated (outlier) responses were removed from the data set. A validity report on ESPAD [41] has shown that only a minority (1–2%) did not answer questions on substance use honestly.

The hypothesis that the association between alcohol and cannabis use depends on the extent of alcohol use among youth, draws on assumptions about changes in the distribution of characteristics of young drinkers. These changes in turn are based on alcohol use becoming

marginalised. Unfortunately, these assumptions could not be put to empirical test due to the absence of relevant measures of such characteristics. Further studies are therefore warranted, to examine whether aggregate-level changes in drinking behaviour are associated with changes in the distribution of the characteristics of drinkers. Such characteristics include personality traits, such as impulsivity and low self-control, which may affect the alcohol–cannabis association [24, 25]. Thus, to better understand the mechanisms underlying the association between alcohol and cannabis use, future studies should aim to incorporate such factors to determine their importance for drinking behaviour relative to a particular level of drinking, and to determine their possible impact on the alcohol–cannabis association. Future studies need to explore trends in co-use of alcohol and cannabis, particularly studies on the changes in simultaneous use of the two substances including measures of amounts of cannabis used. Moreover, a better understanding of why the observed trends in alcohol and cannabis use occurred among youth is needed, along with their health and social consequences.

5 | CONCLUSIONS

The findings from this study suggest that the proportion of Nordic adolescents who only use alcohol has decreased between 2003 and 2019, while cannabis use became more prevalent among alcohol users in three out of five Nordic countries. The substitution hypothesis was partially supported, and the results also lend support to the 'hardening' hypothesis; that is, we found an increase in the proportions of cannabis users among alcohol users (except in Denmark) and that the proportion of cannabis use occasions relative to all substance use occasions (alcohol, cannabis, or both) increased with the decline in alcohol use. In Denmark, the decrease in alcohol use has been less pronounced while cannabis use and the proportion of co-users have been relatively stable. Co-use of alcohol and cannabis is associated with an increased likelihood of impaired cognition among youth [17] and an increased likelihood of negative outcomes in adulthood, including substance use dependence, other mental health problems and failure to complete secondary education [17, 22]. Thus, by preventing co-use of alcohol and cannabis among youth in the Nordic countries there is a potential to limit health and social problems among youth.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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REFERENCES

1. Arnarsson A, Kristofersson GK, Bjarnason T. Adolescent alcohol and cannabis use in Iceland 1995-2015. *Drug Alcohol Rev.* 2018;37(Suppl 1):S49-57.
2. Raitasalo K, Kraus L, Bye EK, Karlsson P, Tigerstedt C, Törrönen J, et al. Similar countries, similar factors? Studying the decline of heavy episodic drinking in adolescents in Finland, Norway and Sweden. *Addiction.* 2021;116:62-71.
3. Ramstedt M, Raninen J, Larm P. Are changes in parenting related to the decline in youth drinking? Evidence from a comparison of Sweden and Denmark. *Nord Stud Alcohol Drugs.* 2022;39:124-33.
4. Rossow I, Bye EK, Moan IS. The declining trend in adolescent drinking: do volume and drinking pattern go hand in hand? *Int J Environ Res Public Health.* 2022;19:7965.
5. De Looze M, Raaijmakers Q, Bogt TT, Bendtsen P, Farhat T, Ferreira M, et al. Decreases in adolescent weekly alcohol use in Europe and North America: evidence from 28 countries from 2002 to 2010. *Eur J Public Health.* 2015;25(Suppl 2):69-72.
6. Kraus L, Seitz NN, Piontek D, Molinaro S, Siciliano V, Guttormsson U, et al. 'Are the times a-changin'? Trends in adolescent substance use in Europe. *Addiction.* 2018;113:1317-32.
7. Pape H, Rossow I, Brunborg GS. Adolescents drink less: how, who and why? A review of the recent research literature. *Drug Alcohol Rev.* 2018;37(Suppl 1):S98-S114.
8. ESPAD Group. ESPAD report 2019: results from the European School Survey Project on Alcohol and Other Drugs. Luxembourg: EMCDDA Joint Publications, Publications Office of the European Union; 2020. Available from: http://espad.org/sites/espad.org/files/2020.3878_EN_04.pdf
9. Andreas JB. Perceived harmfulness of various alcohol-and cannabis use modes: secular trends, differences, and associations with actual substance use behaviors among Norwegian adolescents, 2007-2015. *Drug Alcohol Depend.* 2019;197:280-7.
10. Benedetti E, Resce G, Brunori P, Molinaro S. Cannabis policy changes and adolescent cannabis use: evidence from Europe. *Int J Environ Res Public Health.* 2021;18:5174.
11. Vashishtha R, Pennay A, Dietze P, Marzan MB, Room R, Livingston M. Trends in adolescent drinking across 39 high-income countries: exploring the timing and magnitude of decline. *Eur J Public Health.* 2021;31:424-31.
12. Hasin D, Walsh C. Trends over time in adult cannabis use: a review of recent findings. *Curr Opin Psychol.* 2021;38:80-5.
13. Lee CM, Calhoun BH, Abdallah DA, Blayney JA, Schultz NR, Brunner M, et al. Simultaneous alcohol and marijuana use among young adults: a scoping review of prevalence, patterns, psychosocial correlates, and consequences. *Alcohol Res.* 2022;42:08.
14. Pacula RL, Smart R, Lira MC, Pessar SC, Blanchette JG, Naimi TS. Relationships of cannabis policy liberalization with alcohol use and co-use with cannabis: a narrative review. *Alcohol Res.* 2022;42:06.
15. Ball J, Gruzca R, Livingston M, Ter Bogt T, Currie C, de Looze M. The great decline in adolescent risk behaviours: unitary trend, separate trends, or cascade? *Soc Sci Med.* 2023;317:115616.
16. Swift W, Coffey C, Degenhardt L, Carlin JB, Romaniuk H, Patton GC. Cannabis and progression to other substance use

- in young adults: findings from a 13-year prospective population-based study. *J Epidemiol Community Health*. 2012;66:e26.
17. Yurasek AM, Aston ER, Metrik J. Co-use of alcohol and cannabis: a review. *Curr Addict Rep*. 2017;2017(4):184–93.
 18. Gunn RL, Aston ER, Metrik J. Patterns of cannabis and alcohol co-use: substitution versus complementary effects. *Alcohol Res*. 2022;42:04.
 19. Pape H, Rossow I, Storvoll EE. Under double influence: assessment of simultaneous alcohol and cannabis use in general youth populations. *Drug Alcohol Depend*. 2009;101:69–73.
 20. Subbaraman MS, Kerr WC. Simultaneous versus concurrent use of alcohol and cannabis in the National Alcohol Survey. *Alcohol Clin Exp Res*. 2015;39:872–9.
 21. White HR, Kilmer JR, Fossos-Wong N, Hayes K, Sokolovsky AW, Jackson KM. Simultaneous alcohol and marijuana use among college students: patterns, correlates, norms, and consequences. *Alcohol Clin Exp Res*. 2019;2019(43):1545–55.
 22. Gripe I, Danielsson A-K, Ramstedt M. Are changes in drinking related to changes in cannabis use among Swedish adolescents? A time-series analysis for the period 1989–2016. *Addiction*. 2018;113:1643–50.
 23. Jessor R, Jessor SL. *Problem behavior and psychosocial development: a longitudinal study of youth*. New York: Academic Press; 1977.
 24. Meader N, King K, Moe-Byrne T, Wright K, Graham H, Petticrew M, et al. A systematic review on the clustering and co-occurrence of multiple risk behaviours. *BMC Public Health*. 2016;16:657.
 25. Rinehart L, Spencer S. Which came first: cannabis use or deficits in impulse control? *Prog Neuropsychopharmacol Biol Psychiatry*. 2021;106:110066.
 26. Bevilacqua L, Goldman D. Genetics of impulsive behaviour. *Philos Trans R Soc Lond B Biol Sci*. 2013;368:20120380.
 27. Moan IS, Bye EK, Rossow I. Stronger alcohol-violence association when adolescents drink less? Evidence from three Nordic countries. *Eur J Public Health*. 2021;31:866–72.
 28. Pape H, Rossow I. Less adolescent alcohol and cannabis use: more deviant user groups? *Drug Alcohol Rev*. 2021;40:118–25.
 29. Agresti A. *Categorical data analysis*. 2nd ed. New York: Wiley; 2002.
 30. SAS Institute Inc. *SAS/STAT® 9.3 User's guide*. Cary: SAS Institute, Inc.; 2011.
 31. Collins RL, Ellickson PL, Bell RM. Simultaneous polydrug use among teens: prevalence and predictors. *J Subst Abuse*. 1998;10:233–53.
 32. Brière FN, Fallu JS, Descheneaux A, Janosz M. Predictors and consequences of simultaneous alcohol and cannabis use in adolescents. *Addict Behav*. 2011;36:785–8.
 33. Ritter A, Sotade O. Explaining the declining rates of past year cannabis use in Australia: a first pass. *Drug Alcohol Rev*. 2017;36:602–8.
 34. ESPAD Data Portal. Available from: <https://data.espad.org/search-questions/?field-text=alcohol>
 35. Karlsson P, Ekendahl M, Gripe I, Raninen J. Individual and school-class correlates of youth cannabis use in Sweden. *Nord Stud Alcohol Drugs*. 2018;35:131–46.
 36. Tamson M, Vorobjov S, Sokurova D, Pärna K. Cannabis use and associated factors among 15–16-year-old adolescents in Estonia 2003–2019: results from cross-sectional ESPAD surveys. *Nord Stud Alcohol Drugs*. 2021;38:293–304.
 37. Kuntsche E. When cannabis is available and visible at school—a multilevel analysis of students' cannabis use. *Drugs Educ Prev Policy*. 2010;17:681–8.
 38. Burdzovic Andreas J, Bretteville-Jensen AL. Ready, willing, and able: the role of cannabis use opportunities in understanding adolescent cannabis use. *Addiction*. 2017;112:1973–82.
 39. Vermeulen-Smit E, Verdurmen JEE, Engels RCME, Vollebergh WAM. The role of general parenting and cannabis-specific parenting practices in adolescent cannabis and other illicit drug use. *Drug Alcohol Depend*. 2015;147:222–8.
 40. Romelsjö A, Branting M. Consumption of illegal alcohol among adolescents in Stockholm county. *Contemp Drug Probl*. 2000;27:315–33.
 41. Hibell B, Molinaro S, Siciliano V, Kraus L. *The ESPAD validity study in four countries in Luxembourg*: Publications Office; 2013. Available from: <http://www.espad.org/sites/espad.org/files/ESPAD-Validity-Study.pdf>

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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