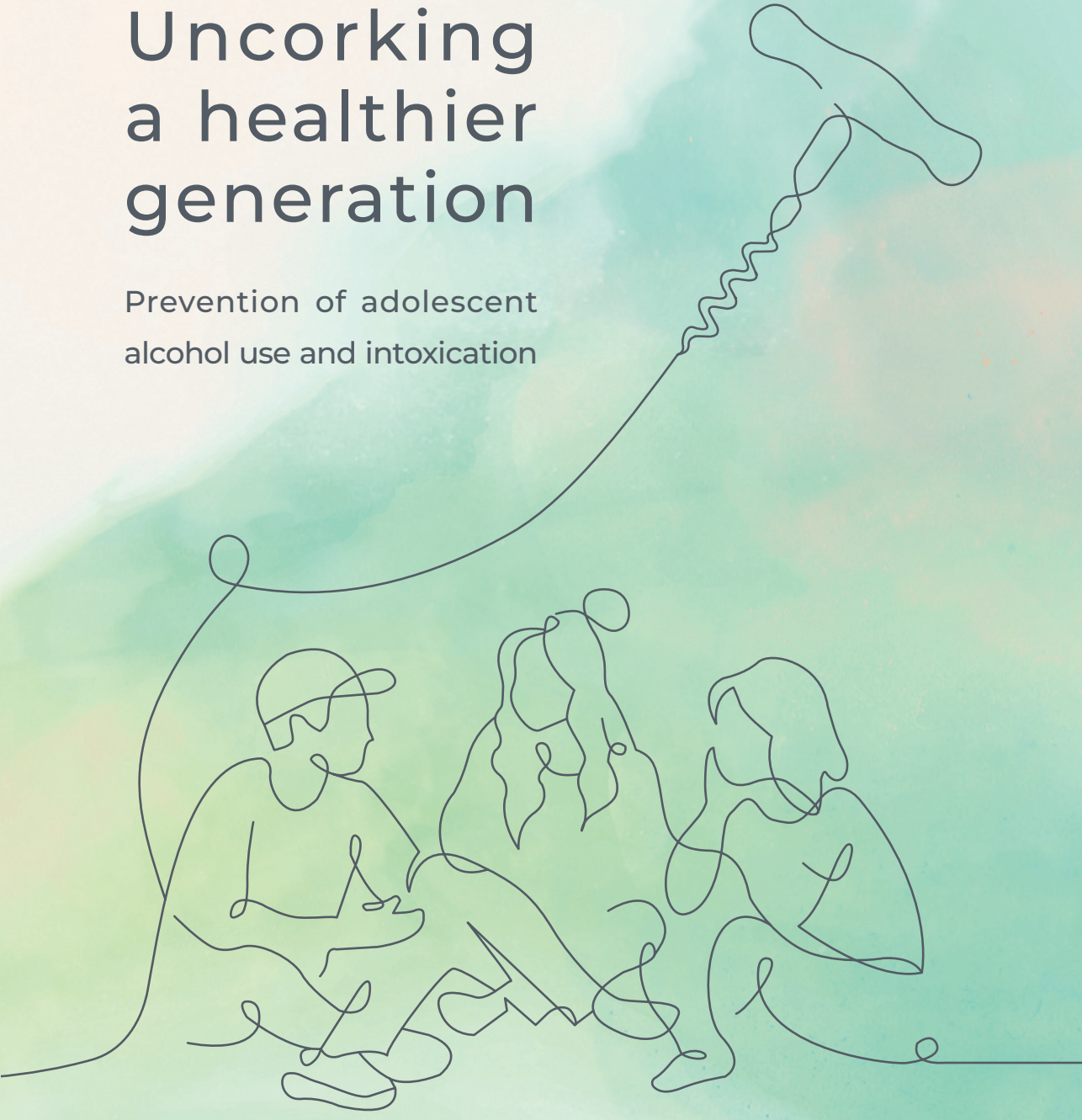
Uncorking a healthier generation

Prevention of adolescent alcohol use and intoxication



Louise Elisabeth Maria Pigeaud

Uncorking a Healthier Generation

Prevention of adolescent alcohol use and intoxication

Louise Elisabeth Maria Pigeaud

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Uncorking a Healthier Generation

Prevention of adolescent alcohol use and intoxication

Een frisse start voor de volgende generatie

Bescherm onze jeugd tegen alcoholgebruik en intoxicatie

Thesis

to obtain the degree of Doctor from the

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and in accordance with the decision of the Doctorate Board.

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Introduction

Chapter 1

General introduction & Thesis outline

Alcohol consumption among adolescents is a significant public health and societal concern, particularly in Europe. According to the World Health Organization (WHO), European countries have the highest global prevalence of alcohol consumption among adolescents aged 15 to 19 (43.8%), followed by the Americas (38.2%) and Western Pacific countries (37.9%) [1]. However, there are significant disparities in alcohol consumption among adolescents across European countries [2, 3]. Adolescents from southern and central European countries tend to report more frequent alcohol consumption, whereas those in northern European countries exhibit higher rates of intoxication [4-8]. These country variations in drinking behaviours among adolescents may be influenced by factors such as alcohol policies, drinking cultures, patterns of consumption, and drinking motives [2, 3, 9, 10].

Research indicates that alcohol consumption between the ages of 10 and 24 is a leading contributor to disability-adjusted life years [11]. Moreover, more than 10 percent of all deaths in Europe are attributable to alcohol abuse [12]. Early alcohol consumption is strongly associated with alcohol dependence or abuse later in life [13, 14]. Notably, one third of 15- to 16 year old school going children in Europe reported their first alcoholic drink at the age of 13 or younger, with boys being more likely than girls to have started drinking alcohol at an early age [15].

Another concerning trend is the high prevalence of heavy episodic drinking (HED) or binge drinking among young people, aged 15–24, as reported by WHO [1]. Binge drinking defined as consuming more than four drinks for women or five drinks for men on a single occasion [16]. Nearly half of adolescents aged 15–16 report drinking in the past month, with 30% engaging in binge drinking [15]. Such episodes of binge drinking may lead to acute alcohol intoxication (AAI), which imposes both immediate and long-term health consequences. Given these concerns, this thesis focuses on the prevention of alcohol use and intoxication in adolescents under the age of 18.

1.1 Clinical presentation and short-term effects

The clinical presentation and immediate effects of alcohol consumption in adolescents are closely related to their blood alcohol concentration (BAC). For instance, a BAC of 0.10 (0.10%) means that there is 0.10g of alcohol for every 100ml of blood, which is equivalent to 1.0 gram per litre blood (= 1 g/L) [17]. **Figure 1** illustrates the dose-dependent symptoms of alcohol ingestion in adults [18]. However, in adolescents, these symptoms manifest at lower BAC levels than in adults [19]. In addition to the amount of alcohol consumed, several other factors influence the clinical presentation of AAI in adolescents, including sex, medication use, body weight, and alcohol tolerance.

Research also suggests that the percentages of alcohol content in beverages and the duration of alcohol consumption significantly contribute to clinical impairment [20].

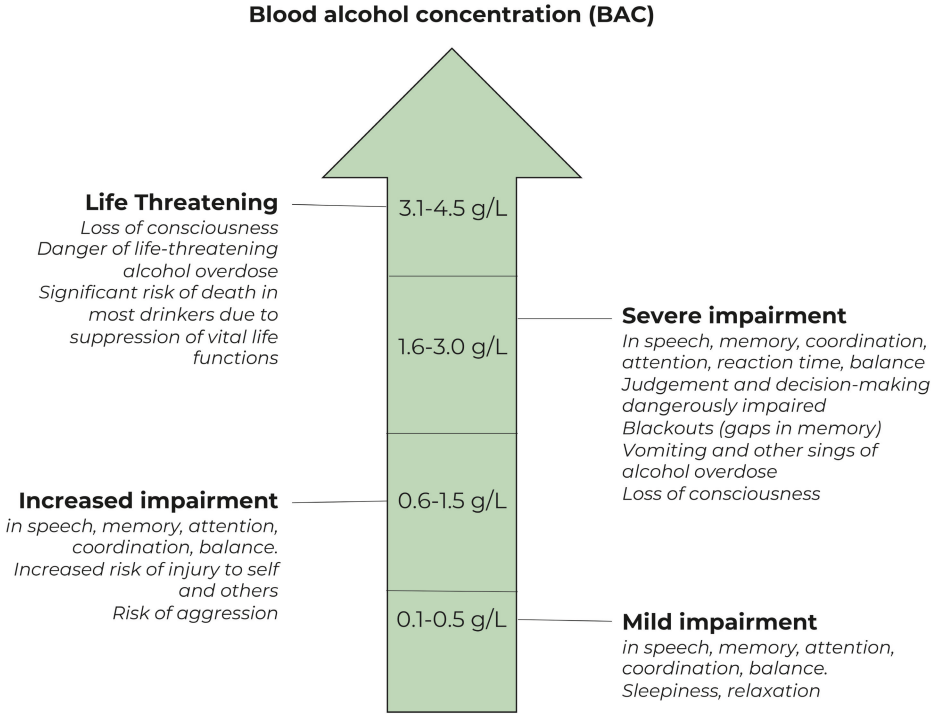


***Figure 1**. Blood alcohol concentration with symptoms in adults* [18]

Previous research indicates that the average BAC of Dutch adolescents with AAI is approximately 1.9 g/L [21]. Acute medical complications observed in this population include reduced consciousness [21], hypothermia [22], metabolic acidosis [22], electrolyte disturbances [22] and other alcohol-related problems such as secondary injuries [23]. Furthermore, research has shown that alcohol consumption during adolescence is associated with various risk factors, including smoking, substance abuse, violence, aggression, and truancy from school [24-26].

1.2 Associations with adolescent alcohol use and intoxication and long-term effects

Adolescent alcohol use is associated with a range of negative psychological, social, and physical health outcomes [27, 28]. These effects can impact various aspects of an adolescent's life, including increased susceptibility to peer pressure, involvement in risky sexual behaviour, participation in criminal activities, and a

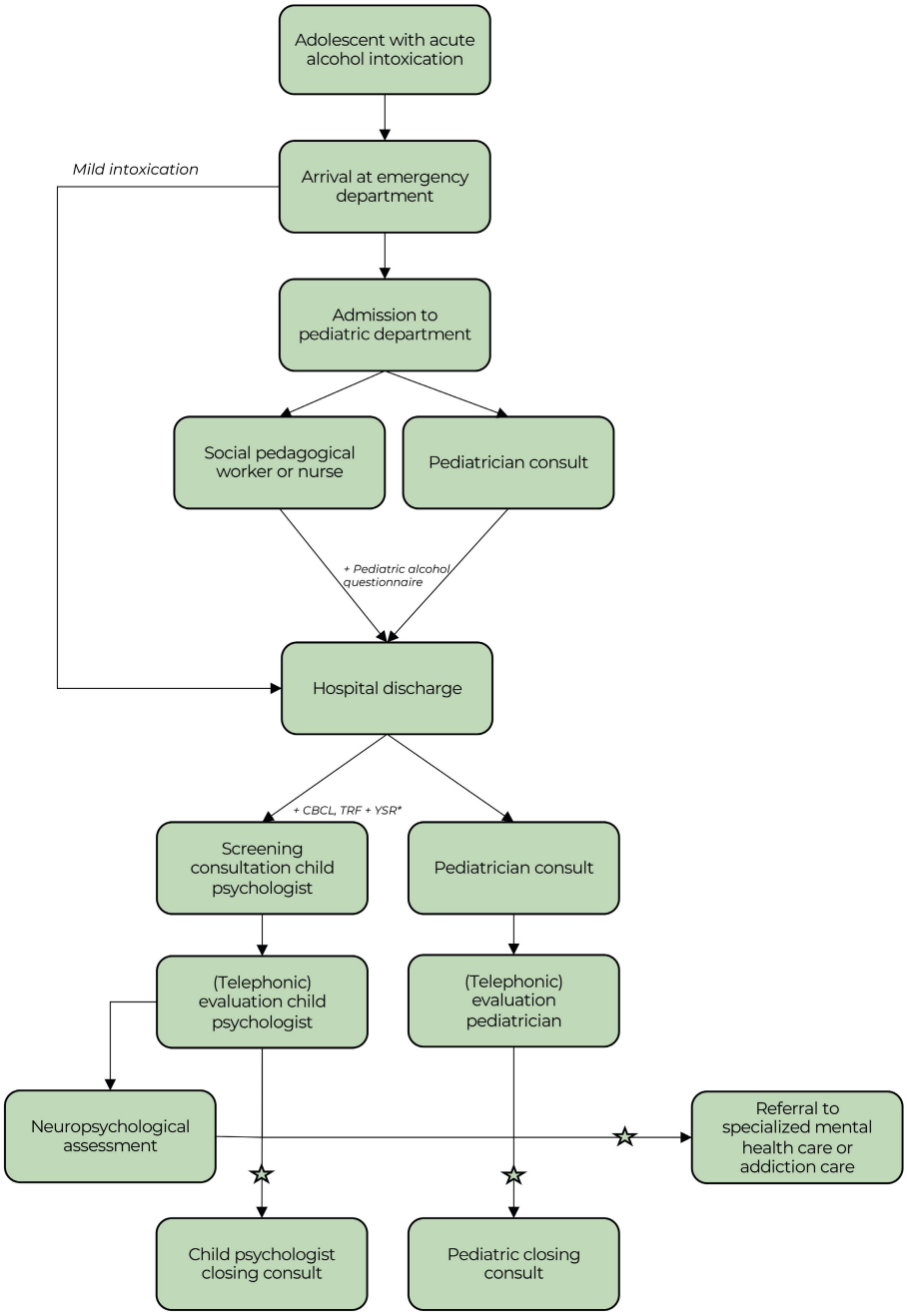
decline in academic performance [29-31]. Mental health issues commonly seen in adolescents, such as anxiety, depression, impulsivity, and feelings of shame or guilt, can both be a trigger to and a results from alcohol consumption [32-34]. Disadvantaged and vulnerable populations are particularly at risk, with higher rates of alcohol-related hospitalizations and even fatalities [35]. Most critically, alcohol consumption during adolescence can interfere with brain development [36, 37] and increase the long-term risk of developing cancer [30]. Additionally, as mentioned above, early alcohol consumption is strongly associated with alcohol dependence later in life [13, 14]. Therefore, efforts should focus on prevention to mitigate the negative effects of adolescents alcohol use.

1.3 Health care pathway: Youth and Alcohol

In the Netherlands, a dedicated outpatient clinic for 'Youth and Alcohol' was established in 2006 at the Reinier de Graaf Gasthuis in Delft. This model was later expanded to 11 other hospitals across the country. The need for a structured follow-up program for adolescents with harmful alcohol use has been repeatedly emphasized in various studies [38-40], and by the WHO (see **Figure 3**). Emergency department (ED) visits due to alcohol intoxication provide a valuable opportunity to intervene and reduce future alcohol-related harm [41].

As outlined in **Figure 2**, the health care pathway begins when an adolescent with AAI arrives at the emergency department. Upon presentation, clinical assessment, including BAC, urine screening, and anamnesis, are used to assess the severity of intoxication. Adolescents with a mild intoxication, may be discharged after brief observation at the ED. However, the majority of the cases require admittance to the paediatric department.

Before discharge from the paediatric department, in addition to receiving clinical care, patients undergo an initial intervention aimed at raising awareness about the risks of alcohol consumption. This intervention, lasting approximately 1-2 hours, is conducted by a trained nurse or social worker and includes an introduction to the outpatient clinic, an informative discussion, and an e-learning module on alcohol. With patient consent, the paediatric alcohol questionnaire is administered for research purposes, completed collaboratively by the patient and either a paediatrician, social worker or nurse. The paediatrician then assesses whether discharge is clinically appropriate and also discusses alcohol use among minors.



* = Abbreviations: CBCL = Child behaviour checklist (by parents), TRF = Teacher's report form, YSR = Youth self-report
☆ = Decision based on multidisciplinary meeting

Figure 2. *Health care pathway for adolescents < 18 y.o. with AAI, based on L. de Veld [17]*

All patients under 18 who visit the emergency department for AAI are invited to attend the 'Youth and Alcohol' outpatient clinic. A follow-up counselling session is scheduled 3 to 6 weeks after the hospital discharge, during which a paediatrician with expertise in alcohol-related issues provides a comprehensive explanation of the effects of alcohol on adolescents. The session involves both verbal and visual information, tailored to the patient's specific needs. Parents are also encouraged to participate.

Additionally, psychological interventions are offered through a screening consultation with a child psychologist. This consultation aims to identify psychological risk factors for continued binge drinking, and detect any mental health or psychosocial issues. The validated Child Behaviour Checklist (CBCL) is used, consisting of three components: CBCL/6-18 by parents, the Teacher's Report Form (TRF) and the Youth Self Report (YSR). Motivational interviewing techniques are employed, and neuropsychological assessments may be included if necessary. Based on these evaluations and multidisciplinary discussions between psychologists and paediatricians, patients may be referred to specialized mental health or addiction care, or their case may be closed (6 to 12 months after the emergency department visit). The existence of the outpatient clinic also raises awareness about the negative consequences of alcohol use among Dutch adolescents [23].

1.4 Time Trend Analysis

Understanding current trends and risk factors are essential for optimizing preventive measures. Therefore, **Section 1** of this thesis presents the characteristics and time trend analysis of adolescent AAI, focussing primarily on the Netherlands, and later extending to Italy and Belgium. The results from the paediatric alcohol questionnaire completed during admission on the paediatric ward, see **Figure 2**, are used to conduct these studies.

Dutch Alcohol Law Change

Numerous interventions have been implemented to reduce alcohol consumption among adolescents. Over the past few decades, many European countries have raised the minimum legal drinking age from 16 to 18 years, a policy that has proven effective in curbing adolescent alcohol use [42]. In the Netherlands, this policy change was enacted on January 1, 2014, when the legal minimum age for purchasing, possessing, and publicly consuming low-alcohol beverages was raised from 16 to 18 [13]). Data from previous studies on Dutch adolescents hospitalized

for AAI were instrumental in driving this legislative change. In **Chapter 2,** the characteristics of adolescents with AAI both before and after the implementation of this alcohol law change in the Netherlands were analysed.

Impact of the COVID-19 Pandemic

The COVID-19 pandemic, which coincided with the course of this thesis, has presented ongoing challenges worldwide, including in the Netherlands. In response, governments imposed national lockdowns, leading to the closure of schools, universities, offices, restaurants, and other businesses. Citizens were encouraged to stay home except for essential purposes such as purchasing goods, health-related reasons, or working in critical public service sectors.

Research indicates that the pandemic has had a profound negative impact on mental health [43-45], contributing to increased global rates of anxiety, stress, insomnia, depression, and other psychological issues [45]. Moreover, the mental health consequences of the pandemic have been linked to changes in alcohol consumption patterns. Studies from various countries, including Italy [46], Australia [47, 48], Canada [49], the USA [50, 51], Germany [52] and the UK [53], suggest that heightened stress and isolation influenced alcohol consumption during this period.

In Italy, for example, the incidence of adolescents with a severe alcohol intoxication significantly increased following the COVID-19 lockdown [46]. This trend suggested the need for emergency services to prepare for a potential rise in alcohol-related emergencies, particularly among adolescents. Therefore, in **Chapter 3,** hospital admission data of adolescents treated for AAI in Dutch hospitals were analysed, focussing on variations in ED admissions during different phases of the COVID-19 pandemic, including lockdown and reopening periods.

European Perspective

As previously mentioned, alcohol consumption is widespread among adolescents in Europe. According to the Health Behaviour in School-aged Children (HBSC) study, 57% of 15-year-olds reported having consumed alcohol at some point in their lives, and 37% had consumed alcohol in the past 30 days [54]. Furthermore, among those who drink, a significant proportion engage in heavy episodic drinking (HED), commonly referred to as binge drinking.

Binge drinking among adolescents is particularly prevalent in Europe, with the highest global rates observed in 15- to 19-year-olds (24.1%) [55]. Notably, 20% of 15-year-olds in Europe report having experienced drunkenness in their lifetime [54].

Addressing this public health challenge is crucial, and the European framework for action on alcohol, developed by the WHO [56], underscores the importance of timely interventions. To support such efforts, comprehensive data on adolescent AAI at European ED's is needed. Therefore, in **Chapter 4**, a hospital chart study was conducted using data from Italy, Belgium, and the Netherlands. This study aimed to analyse the demographic and clinical characteristics of adolescents with AAI across these European countries over time.

Psychological outpatient clinic: drinking patterns and risk factors

Previous studies have shown that adolescents with problematic alcohol use who participated in a motivational interviewing intervention demonstrated reduced alcohol consumption and fewer alcohol-related issues compared to those receiving standard care [57-59]. Furthermore, follow-up assessments of adolescents admitted for AAI indicate a temporary reduction in alcohol use shortly after the incident [60]. These follow-up assessments also provide a valuable opportunity to identify mental health disorders and determine whether referral to specialized mental healthcare is necessary [28]. **Figure 2** illustrates the psychological part of the 'Youth and Alcohol' outpatient clinic. In **Chapter 5**, the drinking patterns of adolescents participating in the outpatient clinic are evaluated over time. Moreover, key factors for adolescent alcohol use including substance use patterns, development, positive family history of substance use disorders, parental awareness and alcohol-specific parental rule-setting, are assessed and compared to the Dutch general population.

1.5 Prevention of alcohol consumption in adolescents

In **Section 2** of this thesis, the focus shifts to potential prevention strategies for adolescent alcohol consumption. Alcohol misuse is a leading cause of preventable mortality, contributing to approximately 3 million deaths annually worldwide [61]. In response, the WHO has published a cost-effective strategy, referred to as the "Best Buys", to prevent noncommunicable diseases. This strategy includes reducing harmful alcohol consumption as one of the key pillars, alongside promoting healthy diets, reducing tobacco use, addressing air pollution, and encouraging physical activity [62, 63]. Several WHO-recommended strategies for reducing harmful alcohol use are outlined below and illustrated in **Figure 3**.

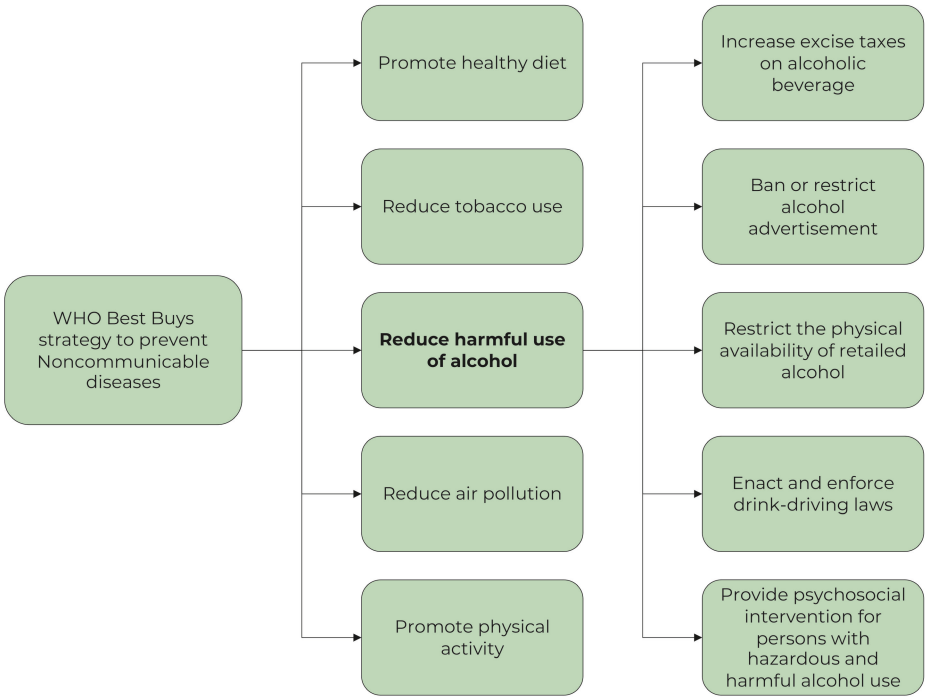


Figure 3. *World Health Organizations best buys strategy to prevent noncommunicable diseases [62]*

Increasing excise taxes on alcohol

One of the WHO's primary recommendations is increasing excise taxes on alcoholic beverages. In the Netherlands, for instance, alcohol taxes were raised by 8.4% on January 1, 2024 [64]. Similarly, in Nordic countries, alcohol taxation has played a significant role in protecting adolescents from the negative effects of alcohol. Higher alcohol taxes have been shown to reduce overall consumption and harm across society, including among adolescents. Furthermore, such taxation has been found to delay the onset of alcohol use among young people [65].

Banning or restricting alcohol advertising

The WHO also advocates for a ban or restriction on alcohol advertising. Research has demonstrated that adolescents are particularly vulnerable to alcohol advertisements and media portrayals of drinking. Exposure to such content not only encourages earlier initiation of alcohol consumption but also leads to increased consumption among young drinkers [66]. In the Netherlands, alcohol advertisements are prohibited on television and radio between 6:00 AM and 9:00 PM [67]. Norway, which implemented a complete ban on alcohol marketing as early as 1975, has seen significant and sustained reductions in alcohol sales and

consumption as a result of this policy [65]. However, online alcohol marketing, especially on social media, remains a significant concern for adolescents. On social media role models for children, such as popular influencers and artists, often speak about the positive experiences with alcohol while overlooking the negative aspects. Many European countries either lack complete bans or have partial restrictions on such advertisements [68].

Restricting the physical availability of alcohol

Another key WHO recommendation is to limit the physical availability of alcohol. In the Netherlands, the Alcohol Act permits the sale of alcohol with less than 15% alcohol content in grocery stores, while alcohol with higher alcohol concentrations can only be purchased from liquor stores. In contrast, Nordic countries have implemented a state monopoly system, where alcohol > 4.7% is sold exclusively in state-run stores with restricted opening hours. This approach has proven effective in limiting alcohol access and is recognized as a best practice in international research [65]. According to data from European School Survey Project on Alcohol and Other Drugs (ESPAD), 78% of European 15-16 y.o. students report that obtaining alcohol is easy although being underage [15]. Moreover, the Dutch overall ID verification compliance rate for alcohol sales in 2024 is 32.7%, which is significantly lower than in 2022 (39.4%) [69]. Especially grocery and meal delivery services and sport clubs are an outlet of major concern with low ID compliance rates. Thus, two-thirds of Dutch minors can buy alcohol even though it is prohibited. This indicates that there is still room for improvement in availability restrictions. Additionally, raising the minimum legal drinking age (MLDA) is another effective strategy for reducing adolescent access to alcohol [42], as results of the Dutch implementation on AAI incidence and characteristics are analysed in **Chapter 2.**

Enforcing drink-driving laws

Although drink-driving laws are less applicable to adolescents under 18 in many European countries (as drinking and driving is generally legal for those over 18 y.o.), these laws are critical for preventing alcohol-related traffic accidents in the adult population. Information and education about the dangers of alcohol and driving should be integrated into early childhood and adolescent education to foster long-term awareness.

Providing psychosocial interventions

Finally, the WHO emphasizes the importance of psychosocial interventions for individuals with hazardous or harmful alcohol use. As previously discussed, this approach is exemplified by the implementation of the Dutch “Youth and Alcohol”

outpatient clinic, detailed earlier in this introduction and illustrated in **Figure 2**. Such interventions aim to reduce alcohol misuse and its associated harm by offering targeted psychological and social support.

In **Section 2** of this thesis, four studies will be performed to add knowledge for potential prevention approaches for adolescent alcohol consumption. This includes exploring strategies within the sports sector, strategies based on drinking motives, as well as getting advice from minors who have experienced an acute alcohol intoxication (AAI) event themselves and their healthcare professionals.

Prevention within the sports sector

Sports canteens and bars have been identified as key areas of concern for adolescent alcohol consumption, often exhibiting low compliance with ID verification measures [69, 70]. Sporting adolescents may be particularly sensitive to study findings that highlight the negative impact of alcohol use on athletic performance. Therefore, research on the potential muscle-related consequences and alcohol-associated injuries could play a valuable role in shaping preventive strategies within the sports context. One such complication is rhabdomyolysis, acute muscle fibre necrosis, which has been linked to extensive alcohol consumption in adults [71-74]. However, no studies have yet explored the prevalence of rhabdomyolysis among adolescents following AAI. To address this gap, **Chapter 6** analyses the incidence of elevated creatine kinase levels among Dutch adolescents with AAI, aiming to shed light on the role of this complication in alcohol-related muscle injuries within the sports sector.

Prevention based on drinking motives

As previously mentioned, drinking motives play a significant role in adolescent alcohol consumption. These motives can be categorized based on the type of reinforcement an individual seeks—either positive or negative—related to either the psychoactive effects of alcohol (internal) or its social effects (external) [4]. Thirty years ago, a four-factor model was developed and validated to understand drinking motives among adolescents [75]. These factors include:

- Enhancement (internal positive, e.g., drinking to have fun)
- Social (external positive, e.g., drinking to be sociable)
- Coping (internal negative, e.g., drinking to forget problems)
- Conformity (external negative, e.g., drinking to fit in with a group)

These categories are illustrated in **Figure 4**. In **Chapter 7** the differences and similarities in drinking motives across 16 European countries are examined, aiming to identify trends and cultural factors that can help inform prevention efforts.

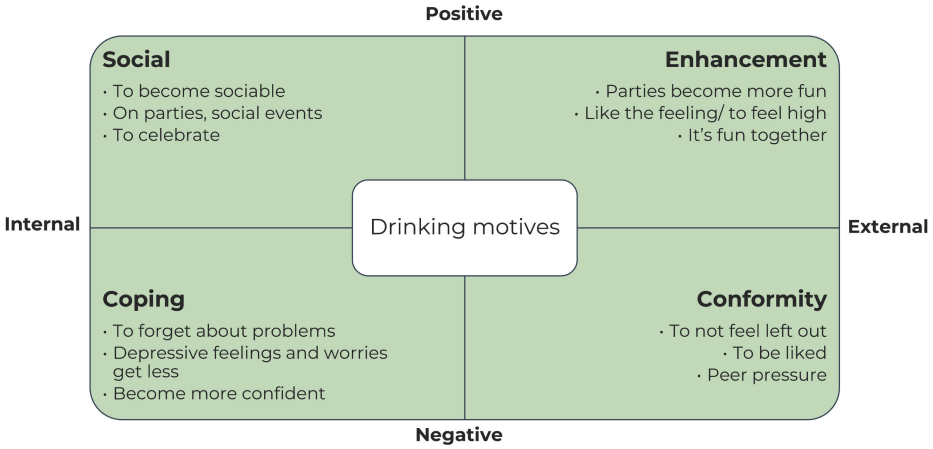


Figure 4. *Drinking motives based on E. Kuntsche et al. [10]*

Qualitative approach for prevention insights by minors

Understanding the mechanisms that influence adolescent alcohol consumption is essential for developing effective prevention strategies. A valuable perspective comes from those who have personally experienced AAI. By gathering insights from these adolescents, we gain a deeper understanding of their motivations and refine prevention programs to better address these underlying factors to adolescent alcohol consumption. In **Chapter 8** a qualitative study examines the experiences of adolescents who have undergone AAI with the goal of informing the development of more effective and tailored prevention strategies.

Qualitative approach for prevention insights by European healthcare professionals

Primary, secondary, and tertiary prevention strategies for adolescent alcohol consumption are essential for reducing alcohol-related harm, injuries, and intoxications. However, there is currently no comprehensive overview of how European countries address this issue. Therefore, **Chapter 9** compares the prevention and healthcare pathways following AAI in adolescents across three European countries: Belgium, Norway, and the Netherlands. Additionally, European paediatricians were interviewed to provide insights on potential preventive solutions tailored their respective countries.

1.6 Thesis outline

In **Section 1** the characteristics of alcohol intoxication in adolescents under 18 years old are analysed using time trend data.

- **Chapter 2** provides an overview of adolescent alcohol intoxication characteristics from 2007 - 2019, with a specific focus on the impact of the Dutch alcohol law change.
- **Chapter 3** examines the influence of the first COVID-19 lockdown and re-opening period on this Dutch population with an alcohol intoxication.
- **Chapter 4** compares European hospital admission data of adolescent alcohol intoxication in Italy, Belgium and the Netherlands.
- **Chapter 5** explores the drinking patterns and alcohol use risk factors among patients with acute alcohol intoxication who participated in the psychological outpatient clinic.

In **Section 2** of this thesis, the focus shifts to potential prevention approaches for adolescent alcohol consumption.

- **Chapter 6** investigates prevention efforts within the sports sector by evaluating muscle-related outcomes of acute alcohol intoxication.
- **Chapter 7** examines drinking motives across 16 European countries to identify trends that can inform prevention efforts.
- **Chapter 8** presents qualitative research on minors who have experienced an acute alcohol intoxication event, offering insights for potential preventive measures.
- **Chapter 9** explores perspectives from European healthcare professionals, specifically paediatricians, on prevention strategies applicable in their respective countries.

This thesis aims to provide a comprehensive understanding of adolescent alcohol intoxication and consumption and inform effective prevention strategies across different contexts.

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Section 1

Characteristics of adolescent alcohol intoxication

Chapter 2

Before and after the Dutch alcohol law change

Acute alcohol intoxication in adolescents before and after the Dutch alcohol law change

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Abstract

The present study aims to explore hospital admission data pertaining to Dutch adolescents admitted for acute alcohol intoxication between 2007 - 2019. Specific focus will be on the increase in the age limit for alcohol nationwide, from 16 to 18 years old for low alcoholic beverages, on the first of January 2014.

The data of all admitted adolescents < 18 years old with acute alcohol intoxication was collected from 12 Dutch major district general hospitals (which accounts for 35% of the adolescents with acute alcohol intoxication in the Netherlands).

In total, 2675 adolescents who were treated with symptoms of acute alcohol intoxication during this period were included in this study. The incidence of adolescents presenting with acute alcohol intoxication between 2007 and 2019 increased significantly (n = 78 (2007) vs. 279 (2019)). Moreover, the mean age of this population increased significantly over time. In 2007, 62,8% of the adolescents were < 16 years old, whereas by 2019 this had dropped to 40.2%. Furthermore, the proportion with positive drug screening results also increased significantly within patients with acute alcohol intoxication after the alcohol law change in 2014. The most common drug found in the drug screening was cannabis.

These findings are relevant for both the central government's ongoing prevention initiatives and treatment strategies within hospitals.

Keywords

Acute alcohol intoxication, Alcohol, Alcohol law, Adolescents, Characteristics, Intoxication, Minors, Preventive measures, Substance abuse.

Introduction

Prevent alcohol consumption amongst minors is a major concern for national governments. Within Europe, the World Health Organisation stated that 43.8% of 15-19 year olds (y/o) drink alcohol, often in heavy drinking sessions [1]. This is concerning because studies have shown that alcohol consumption between the age of 10-24 y/o is the most important risk factor to disability-adjusted life years [2]. Moreover, consuming alcohol at a young age is directly related to frequent alcohol use later in life [3]. Also, it might result in acute alcohol intoxication (AAI), which could lead to severe short- and long-term damage to adolescents' health [4].

To prevent these negative outcomes for minor, manifold interventions have been developed to prevent alcohol consumption by adolescents, including in the Netherlands. First, in 2006, a primary outpatient clinic for 'adolescents and alcohol' was opened in Delft (the Netherlands). This increased the awareness of the negative consequences of alcohol consumption by Dutch adolescents [5]. Secondly, on 1st January 2014, the legal minimum age for buying, possessing and publicly consuming low-alcoholic beverages (< 15%) was increased to 18 y/o in the Netherlands (previously the age limit was 16) [6]. Compliance with the legal age limit was surveyed on behalf of the Dutch Ministry of Health, Welfare and Sport and found there is room for improvement [7]. Therefore, during the increase in legal minimal drinking age also more attention has come to the enforcement of compliance with this measure. All the Dutch alcohol supplier are obligated to check ID's when estimating the alcohol buyers < 25 y/o. Also, in the Netherlands the prices of alcohol rose in 2014, when the taxes on alcoholic beverages were raised with 5.75%. From a health perspective this is positive since multiple studies show that increasing the price of alcohol products may delay alcohol initiation among young people [8-10]. Additionally, research indicates that interventions which delay the age at first alcohol use could be successful in increasing the average age that adolescents are admitted to the hospital for AAI [11].

The previously published data on adolescents hospitalised for AAI was integral for bringing about these changes. Therefore, documentation of alcohol intoxication in adolescents is important to further evaluate and hopefully manage this problem. The aim of this study is to explore hospital admission data on adolescents < 18 years with AAI between 2007–2019, with specific attention for the legislation change in January 2014.

Materials and Methods

Objectives

The primary objective of this retrospective cohort study was to estimate the incidence of adolescents with AAI admitted to the participating hospitals over time. The secondary objective was to determine whether sociodemographic characteristics (age, gender and educational level) and intoxication characteristics, such as blood alcohol concentration (BAC) and drug screening, changed over time.

Data sources and collection

In 12 major district general hospitals across the Netherlands[1], all underage (< 18 y/o) patients who were admitted to the emergency department (ED) with AAI between 2007-2019 were registered. Patients with AAI were anonymously reported by their paediatricians after giving consent (including parental consent when < 16 y/o), using the Paediatric alcohol questionnaire [12]. From 2007-2017 paediatricians reported to the Dutch Paediatric Surveillance Unit (NSCK) and after 2017 onwards to the Youth and Alcohol Foundation directly. These 12 hospitals represent 15% of all Dutch hospitals with an ED. From earlier data collection in the entire Netherlands [5], we know that these 12 hospitals account for 35% of the adolescents with acute alcohol intoxication on ED's in the Netherlands. The protocol for AAI diagnostic testing and treatment has been standardized in all these hospitals.

Statistical methods

All anonymous data were transformed in an SPSS dataset (version 25) for subsequent analyses. Descriptive statistics were used to show the baseline characteristics of the study population. When analysing differences in incidences for each year, a Poisson regression model with 95% CIs was used. This regression model was used because the Poisson regression model assumptions were met[2]. A binomial logistic regression

1 The 12 participating hospitals are: Reinier de Graaf Gasthuis Delft, Medical centre Leeuwarden, LangeLand hospital Zoetermeer, Wilhelmina hospital Assen, Van Weel-Bethesda hospital Dirksland, Maxima Medical Centre Veldhoven, Dijklander hospital Hoorn, Gelre hospital Zutphen, Admiraal de Ruyter hospital Goes, Groene Hart hospital Gouda, Zuyderland hospital Sittard and Catharina hospital Eindhoven.

2 Poisson regression assumptions: the dependent variable consists of count data, the distribution of counts follows a Poisson distribution, which means that the mean and variance of the model are identical, and that the presence of one or more independent variables and independence of the observations is ensured.

was used to examine if there were predictor variables for the presence of adolescents with AAI and positive drug screening results. Time trends were analysed using linear regression analyses for continuous variables and binomial regression analyses for dichotomous variables. The significance level was set to $p = .05$.

Ethical approval

The ethical commission of the Faculty of Behavioural, Management and Social Sciences of the University of Twente approved the method of data collection until 2017. For the remaining years, the medical ethical committee Leiden-Den Haag-Delft and the data protection officer of the Reinier de Graaf hospital both approved this manner of collection of non-identifiable patient data.

Results

Characteristics population

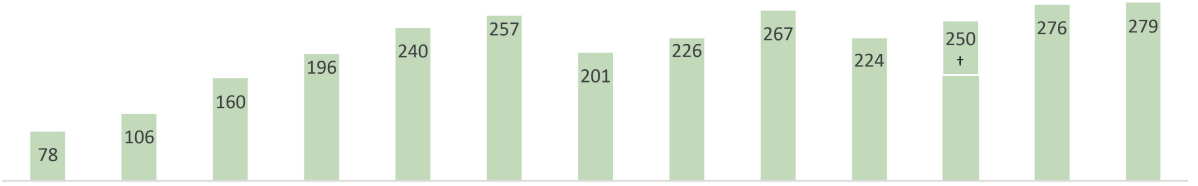
Overall, 2679 adolescents were admitted to the 12 major district general hospitals with AAI between 2007-2019. However, the exact year of hospitalisation was missing for four patients, and thus only 2675 patients were included in this study. The mean age and BAC were 15.5 years and 1.9g/L, respectively. The proportion of patients with positive drug screening results was 10.4% across the considered population.

Time specific analysis

The number of adolescents presenting with AAI between 2007-2019 increased significantly (n = 78 (2007) vs. 279 (2019)) in the 12 participating hospitals (Poisson regression, $p < .001$). The incidence of adolescents with AAI in the study population was presented for each year (see **Figure 1**). The incidence increased significantly from 2007 to 2009 and from 2010 to 2011. In 2013, there were significantly less (n = 257 vs. 201) adolescents with AAI reported than in 2012 ($p = .009$, CI 0.65 - 0.94). From 2014 – 2019 no annual differences were found.

The mean age of the adolescents with AAI increased significantly over time when performing an overall trend analyses ($p < .001$)[3]. In 2007, 62,8% of the adolescents were < 16 y/o, whereas by 2019 this had dropped to 40.2%. The gender distribution of adolescents with AAI did not change significantly over the years (see **Figure 1**). Although, the

3 Linear regression with age as the dependent variable and year of diagnosis as the independent variable.



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
No. of cases	78	106	160	196	240	257	201	226	267	224	250	276	279
Change in no. of cases	-	+28	+54	+36	+44	+17	-56	+25	+41	-43	+26	+26	+3
Poisson regression (CI) §	-	0.04 (1.01-1.82)	0.001 (1.18-1.93)	0.06 (0.99-1.51)	0.04 (1.01-1.48)	0.45 (0.90-1.28)	0.009 (0.65-0.94)	0.23 (0.93-1.36)	0.07 (0.99-1.65)	0.05 (0.70-1.00)	0.23 (0.93-1.34)	0.26 (0.93-1.31)	0.90 (0.90-1.19)
Sex													
Female, %	53.8	48.6	46.8	44.0	43.8	46.3	46.5	51.1	50.8	46.0	49.1	47.1	46.8
Male, %	46.2	51.4	53.2	56.0	56.2	53.7	53.5	48.9	49.2	54.0	50.9	52.9	53.2
Mean age (SD)	15.0 (1.2)	15.2 (1.2)	15.4 (1.1)	15.6 (1.1)	15.5 (1.2)	15.6 (1.1)	15.6 (1.1)	15.5 (1.2)	15.6 (1.2)	15.5 (1.2)	15.5 (1.1)	15.6 (1.1)	15.7 (1.1)
< 14 y/o, %	12.8	6,6	5.1	3.1	5.0	3.9	4.5	4.0	5.3	4.5	2.0	3.8	2.9
14-15 y/o, %	50.0	48.1	43.0	37.9	37.9	37.9	31.3	40.7	38.3	43.2	40.3	38.3	37.3
16-17 y/o, %	37.2	45.3	51.9	59.0	57.1	58.2	64.2	55.3	56.4	52.3	57.7	58.0	59.9
Mean BAC, g/L (SD)	1.8 (0.6)	1.8 (0.6)	1.9 (0.6)	1.9 (0.6)	1.9 (0.6)	2.0 (0.6)	1.9 (0.6)	2.0 (0.5)	1.9 (0.5)	2.0 (0.6)	2.0 (0.5)	1.8 (0.6)	2.0 (0.6)
Educational level													
Pre-vocational, %	39.4	44.4	37.7	39.2	42.0	43.1	38.1	44.4	35.1	37.8	35.2	40.0	35.5
Higher general secondary, %	24.2	25.3	26.5	26.5	21.5	23.9	20.6	23.1	29.8	25.8	23.5	27.0	21.0
Preparatory scientific, %	14.1	10.1	18.1	10.7	15.5	14.8	18.5	14.4	20.4	18.4	19.1	16.5	22.6
Other or in employment, %	22.3	20.2	17.7	23.6	21.0	18.2	22.8	18.1	14.7	18.0	22.2	16.5	20.9
Positive drug screening result, %	7.7	11.3	10.0	10.2	5.8	7.0	11.4	14.2	7.5	13.4	12.1	11.2	12.9

* Significantly different, when $p \leq .05$. † *n* of 2017 has been corrected with the linear interpolation (from 165 to 250), based on other studies [23]

§ When analysing differences in incidences for each year, a Poisson regression model with 95% CIs was used.

Abbreviations: BAC: blood alcohol concentration, CI: Confidence interval, SD: Standard deviation

Figure 1. Incidence and characteristics of adolescents with AAI for each year

included girls with AAI were significantly younger than the boys with AAI, 15.4 and 15.7 y/o, respectively ($p < .001$). The distribution of the high school education level of adolescents with AAI did not change over the period under examination (see **Figure 1**). This distribution was reasonably in line with the Dutch average education levels [13].

The proportion of adolescents with AAI and positive drug screening results showed a significantly increasing trend between 2007-2019 ($p = .028$)[4]. When positive drug screening results were detected in adolescents with AAI, 59.1% of the patients were 16-17 years old and 37.7% were 14-15 years old.

Before and after the law change

The adolescents prior to the change in the legal drinking age (2007-2013) were significantly younger than those admitted after the law changed (2014-2019) ($p = .048$), see **Table 1.** Furthermore, the proportion with positive drug screening results also increase significantly after the change in legal drinking age to 18 y/o ($p = .012$). The education level, gender and mean BAC did not change before and after January 2014.

Table 1. *Population characteristics of all reported adolescents with AAI before and after the alcohol law changed*

		2007-2013 (7 years)	2014-2019 (6 years)	Total
Total number of adolescents with AAI		1238	1437	2675
				***p* value**
Proportion of boys †		53.7%	51.6%	.268
Age in years (mean, SD) ^		15.5 (1.2)	15.6 (1.1)	.048*
BAC in g/L (mean, SD) ‴		1.9 (0.6)	1.9 (0.5)	.150
Educational level †	Pre-vocational-, %	40.5%	38.1%	0.125
	Higher general education-, %	23.9%	25.4%	
	Preparatory scientific-, %	15.3%	18.4%	
	Other educational level or in employment, %	20.3%	18.1%	
Proportion with positive drug screening results †		8.8%	11.8%	.012*

* Significantly different, when p ≤ .05.

^ Mann Whitney U test, † Chi- square test, ‴ Independent sample T test

Abbreviations: BAC: Blood alcohol concentration, CI: Confidence interval, SD: Standard deviation

4 Binomial regression analyses with drug use as the dependent variable and year of diagnosis as the independent variable.

Discussion

This study showed that the amount of adolescents presenting with AAI between 2007-2019 increased significantly over time. This while the overall number of ED presentations from 2011-2020 in the age group 0-14 and 15-25 y/o shows a decreasing trend [14]. Therefore, the increasing numbers of presentations due to AAI suggests that the proportion of ED presentations that is attributable to alcohol is increasing in this age group.

The Health Behaviour in School-aged Children (HBSC) report show that between 2003-2013 the percentage of young people who have ever drunk alcohol and who used alcohol in the last month roughly halved, with steepest declines in the youngest groups [15]. After 2013, the alcohol consumption of high school students aged 12-16 years has stabilized. From 2015-2017, there are no changes in ever use and last monthly use of alcohol. The HBSC also stated that binge drinking among adolescent drinkers was unabated in 2017. Also, the European school survey Project on Alcohol and other Drugs (ESPAD) did a survey in Dutch 15-16 y/o school-going children [16]. They found that in their population of the current drinkers 45% has ever had an alcohol intoxication in 2007, while in 2019 this percentage had dropped to 36%. The definition given to the surveyed adolescents was intoxicated by alcohol is 'when you for example staggered when walking, not being able to speak properly, throwing up or not remembering what happened'. Therefore, the increasing numbers of presentations due to AAI at the ED in our study, while other HBSC and ESPAD reports state decreasing or stabilizing alcohol use and AAI in this age group, suggests that the group that consumes alcohol still drinks a lot, with hospitalisation as a result.

Moreover, the proportion of AAI admissions involving drug use has significant increased after the alcohol law change (with cannabis as the most frequently used drug). This combination might result in increased admissions as seen in our study even if alcohol consumption in the population remains flat or declines. This also suggests that the study population might have changed to a more high risk group. However, the Netherlands Institute of Mental Health and Addiction stated that, based on their combined quantitative and qualitative Dutch data, they consider it unlikely that the increase in the age limit for alcohol nationwide has led to an increase in drug use among Dutch 16-17 y/o [17]. The prevalence of cannabis use between 2011 and 2015 had decreased amongst Dutch schoolchildren aged 16-17 y/o, while hard drugs use has remained stable. Other research suggested that the use of drugs in adolescents with an AAI might be underestimated [18].

Furthermore, a recent study indicated that amongst adolescents admitted for AAI, the prevalence of co-occurring mental disorders is common, and thus should be factored into treatment and prevention strategies [19]. This study also stated that positive drug screening results were more common in patients with AAI who also had a mental disorder than those without a co-occurring mental disorder. Another recent study was conducted to evaluate the effectiveness of an alcohol targeted prevention programme [20]. This programme appears to have impacted upon the prevalence of binge drinking and alcohol consumption amongst specific groups of young adolescents in the Netherlands, particularly lower educated adolescents and those with a sensation seeking personality trait. Therefore, investing in prevention approaches aimed towards high-risk groups would effectively supplement universal prevention programmes, which, in turn, can improve the health of young people at the population level.

An earlier Dutch study shows that in 2011 69% of the parents gave permission for alcohol consumption by their underage children, compared to a decreased proportion of 19% in 2016 [5]. This is a positive trend because parental approval results in increased drinking [21] and even heavy episodic drinking [22]. The possible effects of this measure might also be seen in our study population where adolescents with AAI were significantly older after the law changed. The decrease in alcohol consumption amongst the general adolescent population, as well as the increased age found in our study population, might be because of the increased legal drinking age and the combined national alcohol prevention campaign.

Strengths and limitations

The strength of this study is that this unique dataset comprising 35% of all Dutch adolescents with AAI reflects trends over time. This large dataset enables us to conduct trend analyses over time related to the characteristics of AAI amongst adolescents. These findings are relevant to monitor ongoing prevention initiatives by the national government and treatment strategies in hospitals. However, the study also had limitations, namely the need for correction in 2017[5] because of the new data collection method since 2018[6].

Conclusions

In sum, the incidence of adolescents presenting with acute alcohol intoxication between 2007 and 2019 increased significantly. Moreover, the mean age of this population increased significantly over time. In 2007, 62,8% of the adolescents were < 16 y/o, whereas by 2019 this had dropped to 40.2%. Furthermore, the proportion with positive drug screening results also increased significantly within patients with acute alcohol intoxication after the alcohol law change in 2014. The most common drug found in the drug screening was cannabis. Therefore, future research should focus on more on polysubstance intoxication in adolescents. These findings are relevant for both the central government's ongoing prevention initiatives and treatment strategies within hospitals.

5 In 2017 the participation rates of the 12 reporting hospitals decreased due to the announcement that the data collection by the NSCK would end after 2017. This announcement resulted in probably less reported patients for the remainder of 2017. Therefore, the incidence of adolescents with AAI in 2017 had to be corrected (from 165 to 250) using the linear interpolation method, which is in line with other studies [23].

6 The questionnaire was standardized and had been filled in by the same paediatricians before and after the new data collection method in 2018, which minimizes the risk of misclassification. Moreover, in 2018, the data was directly collected by the Youth and Alcohol Foundation. This announcement might have resulted in a fresh start with respect to data collection from that moment on.

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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.

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Chapter 3

The influence of the COVID-19 lockdown and re-opening period

Acute alcohol intoxications in Dutch adolescents before, during and after the first COVID-19 lockdown

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Abstract

Purpose

The association between acute alcohol intoxication amongst adolescents and the COVID-19 lockdown has been studied previously in Trieste, Italy. They recommended that emergency services should be prepared for a potential peak of alcohol intoxication-related emergencies amongst adolescents as a result of the COVID-19 lockdown. Therefore, this study investigated the influence of the COVID-19 pandemic on the prevalence of acute alcohol intoxication amongst adolescents in the Netherlands.

Methods

To determine both the prevalence and characteristics of adolescents admitted for acute alcohol intoxication in 2019 - 2020, a retrospective cohort study was conducted. All adolescents < 18 years of age admitted for acute alcohol intoxication in the 12 participating hospitals in the Netherlands in 2019 - 2020 were included. Adolescents were divided in periods prior to, during and subsequent to the first COVID-19 lockdown and the beginning of the second lockdown, in comparison to the same periods in 2019.

Results

The prevalence of acute alcohol intoxication amongst adolescents decreased by 70% during the first lockdown (March 16 – May 31, 2020) compared to the period prior to lockdown (January 1 – March 15, 2020). Between the first lockdown phase and the reopening period (June 1 – October 14, 2020), the prevalence significantly increased.

Conclusions

This study demonstrates that COVID-19 lockdown led to a decrease in acute alcohol intoxication among adolescents. This decrease is multifactorial, including the closure of bars/restaurants, sport clubs, schools and increased parental supervision due to obligatory working from home of parents. Based on the findings, this specific population requires close monitoring, especially in the reopening phases.

Implications and contribution

This study demonstrates the relationship between the COVID-19 lockdown measures and acute alcohol intoxication among adolescents. Further research is needed to identify the predictors and to develop suitable alcohol policies for after the lockdown(s) are lifted.

Introduction

As is the case in the rest of the world, the COVID-19 pandemic is posing an ongoing challenge in the Netherlands. The Dutch government attempted to restrict the spread of the coronavirus by establishing a national 'targeted' or so-called 'intelligent' lockdown, which spanned from March 16 until June 1, 2020. All schools, universities, offices, restaurants and other commercial activities were closed or shut down as part of these measures. The government recommended that people should only leave their homes for justifiable reasons, such as purchasing essential goods, health conditions and employment in the case of those who work in public utility services. These measures were relatively mild in comparison to surrounding countries, where complete restrictions on movement were implemented by their respective governments [1]. On June 1 2020, these initial lockdown measures were lifted and the preventive measures eased, in light of the fact that COVID-19 infection rates in the Netherlands had substantially decreased. However, the second 'partial' lockdown was implemented in October 2020. Although the initial stage of this second lockdown had less invasive lockdown measures than the first, these were subsequently enhanced on December 15 2020.

Research suggests that COVID-19 has negatively impacted the population's mental health [2-4], not to mention that the outbreak would lead to additional health problems across the globe, such as anxiety, stress, insomnia, depressive symptoms, fear and anger [4]. The negative effect of the pandemic on mental health was consistently related to alcohol use indices in Italy [5], Australia [6, 7], Canada [8], USA [9, 10], Germany [11] and the UK [12].

For example, in both Australia and the UK, alcohol sales increased as a result of the COVID-19 restrictions. Indeed, in Australia, the government eased liquor licensing restrictions, resulting in an increase in alcohol sales [6], whereas alcohol sales in the UK disproportionally increased in the first week of lockdown [13]. Conversely, countries like South Africa prohibited the sale of alcohol during the lockdown, which both lifted significant pressure off emergency care units and lowered mortality rates [14]. However, recently an American study about substance abuse among ninth- and tenth-grade students in 8 high schools in Northern California stated that alcohol use did not significantly change before and during the COVID-19 lockdown [15].

Addressing alcohol-related harms and its attendant effects, such as, for example, domestic abuse, should form an integral part of countries' COVID-19 recovery plans [13]. For example, governments should provide public health warnings

concerning excessive alcohol consumption during isolation periods, in order to protect vulnerable individuals [16]. This is important given that alcohol misuse is one of the leading causes of preventable mortality, contributing annually to around 3 million deaths worldwide [17].

In an emergency department in Trieste, Italy, the relative frequency of severe alcohol intoxications after the COVID-19 lockdown increased significantly [5]. In particular, the authors of this study suggested that emergency services must prepare for a possible peak of alcohol intoxication-related emergencies amongst adolescents during this period. This peak constitutes an alarming sign for the mental health of adolescents.

The present study aims to examine hospital admission data of adolescents admitted for acute alcohol intoxication (AAI) to Dutch hospitals, prior to the first lockdown, during the first lockdown, as well as both after the re-opening and during the start of the second lockdown.

Methods

To determine the prevalence of adolescents admitted for AAI in the Netherlands before, during and after the lockdowns, a retrospective cohort study was conducted. Across 12 major district general hospitals around the Netherlands[7], all patients admitted for AAI who were younger than 18 in 2019 – 2020 were registered. Based on the data collected by the Dutch Paediatric Surveillance Unit (NSCK) between 2007 and 2017, we discerned that the data collection in these 12 hospitals reported, on average, 35.1% of the yearly cases of AAI <18 years between 2007 – 2017. All these 12 hospitals have a multidisciplinary outpatient clinic for 'adolescents and alcohol' to reflect on the AAI-incident.

The paediatricians from the participating hospitals provided anonymised data on patients admitted for AAI from January 1, 2019 until December 31, 2020 via a standardized protocol. The inclusion criteria were: adolescents < 18 years of age

7 Reinier de Graaf Gasthuis Delft, Langeland hospital Zoetermeer, Groene Hart hospital Gouda, Medical centre Leeuwarden, Wilhelmina hospital Assen, Van Weel-Bethesda hospital Dirksland, Zuyderland hospital Sittard, Dijklander hospital Hoorn, Admiraal de Ruyter hospital Goes, Maxima Medical Centre Veldhoven, Gelre hospital Zutphen and Catharina hospital Eindhoven.

and being admitted with AAI (positive blood alcohol concentration (BAC) and/or clinical features of alcohol intoxication).

The first lockdown in the Netherlands lasted from March 16 – May 31, 2020. During this period, there were several measures undertaken to restrict movement, including working from home, closing of events and meeting places, in order to prevent the virus spreading [18]. On June 1, 2020, the first lockdown ended due to a substantial decrease in the infection rate in the Netherlands. However, on October 15, 2020 additional preventive measures were again taken by the Dutch government to reduce the virus from spreading, including closing restaurants and limiting contact.

The primary outcome of this study is the prevalence of adolescents admitted for AAI in the Netherlands before, during and after the COVID-19 lockdowns. To estimate the effect of the above mentioned lockdown measures on the admission data of adolescents admitted for AAI, the patients in this study were divided into different time periods; before the first lockdown (January 1 – March 15, 2020), during the first lockdown (March 16 – May 31, 2020), after the first lockdown (June 1 – October 14, 2020) and the beginning of the second lockdown (October 15 – December 31, 2020). The same periods in 2019 were used as a reference group (January 1 – March 15, 2019, March 16 – May 31, 2019, June 1 – October 14, 2019 and October 15 – December 31, 2019). The second lockdown did not end on December 31, 2020 and thus this study only illustrates the effects of the beginning of the second lockdown. In order to compare these different phases with various duration, the prevalence was defined as the number of cases for each thirty-day period.

The secondary outcomes of this study were the BAC (in g/L) and proportion of adolescents with a positive drug screening. As covariates, characteristics such as sociodemographic information (age, sex and educational level) were taken into account. All the patients were classified into the different time periods by the paediatricians in the 12 hospitals, which made the data non-identifiable for the research team.

All the variables for each patient were entered into an SPSS dataset. SPSS for Windows version 25 was used to analyse the data. Descriptive statistics were used to show the baseline characteristics of the study population. Proportions were expressed as percentages, with 95% confidence intervals (CIs). All continuous data were expressed as mean (standard deviation, SD) or median (interquartile range, IQR) based on the Shapiro Wilk test.

To analyse the primary objective of this study; the prevalence of adolescents with AAI per period, a Poisson regression analysis was performed. Prevalence for the thirty-day period was calculated by dividing the total number of cases of adolescents admitted for AAI in each given time period by the number of days in the period, before then multiplying this by 30. When analysing the prevalence/30 days difference for each time period, a Poisson regression[8] was used. A Poisson regression model with 95% CIs was used to estimate change in prevalence during the various time periods. CIs not including one were considered to be statistically significant.

To analyse the secondary outcome of this study and the above mentioned covariates, multiple tests were performed. The BAC and age were not normally distributed continuous variable and therefore a Mann-Whitney U test was used. For the gender differentiation per period a Chi-Square test was used. The fisher exact test was performed to analyse the proportion of positive drug screening. The significance level was set to $p = .05$.

Ethical approval for the study was obtained from the Medical ethical testing committee (METC) Zuid-Holland (research protocol approval ID is G20.175) and the research committee of the Reinier de Graaf Gasthuis.

Results

Between January 1, 2019 and December 31, 2020 482 adolescents < 18 years were admitted for an AAI to one of the 12 participating hospitals. The median age was 16 years. The median BAC was 1.9 g/L. A positive drug screening, most frequently for cannabinoids, was observed in 12.0% of all included patients.

Table 1 displays the primary and secondary outcome measures. The prevalence of adolescents admitted for AAI especially decreased during the first lockdown period compared to the pre-lockdown period (January 1 to March 15, 2020). None of the adolescents admitted during the first lockdown phase had a positive drug screening.

8 This regression model could be used because the prevalence/30 days consisted of count data in a Poisson distribution, the time period was the independent variable, there was an independence of observations and the mean and variance of the model were identical.

Table 1. *Demographic characteristics of adolescents admitted for AAI divided per study phase*

	2019				**2020**			
	Jan 1– Mar 15	Mar 16 May 31	Jun 1– Oct 14	Oct 15– Dec 31	Jan 1– Mar 15 **Pre-lockdown**	Mar 16– May 31 **First Lockdown**	June 1– Oct 14 **Re-opening**	Oct 15– Dec 31 **Second Lockdown**
Prevalence in cases/30 days	24	25	22	19	30	9	20	10
Absolute number of cases	60	63	99	49	74	22	90	27
Duration of period in days	74	77	136	78	75	77	136	78
Prevalence rate ratio (CI)[a]	1.00	1.04 (0.60-1.82)	0.92 (0.51-1.64)	0.79 (0.43-1.45)	1.25 (0.73-2.14)	0.38 (0.17-0.81)*	0.83 (0.46-1.51)	0.42 (0.20-0.87)*
Median age in years (IQR)	16 (2)	15 (1)	16 (2)	16 (2)	16(2))	15 (2)	16 (2)	15 (2)
Proportion of males (CI)	55.2% (42.5-67.3%)	49.2% (37.3-61.2%)	50.5% (40.8-60.2%)	52.1% (38.3-65.5%)	52.7% (41.5-63.7%)	54.5% (34.7-73.1%)	56.7% (46.4-66.4%)	55.6% (37.3-72.4)
Proportion with positive drug screenings (CI)	6.9% (2.7-16.4%)	12.7% (6.6-23.1%)	14.1% (8.6-22.3%)	14.3% (7.1-26.7%)	14.9% (8.5-24.7%)	0.0% (0.0-14.9%)	12.2% (7.0-20.6%)	11.1% (3.9-28.1%)
Median BAC in g/L (IQR)	1.9 (0.7)	1.9 (0.7)	1.9 (0.6)	2.1 (0.7)	1.9 (0.5)	1.8 (1.2)	1.9 (0.8)	2.0 (0.6)

a The prevalence in cases/30 days meets the assumptions of a Poisson distribution.

* Prevalence rate ratio significantly different compared to Jan 1-Mar 15 2019

The results of the Poisson regression model show that the prevalence of adolescents admitted for AAI decreased by 70% (p =.002, CI 0.14 - 0.63) between the pre-lockdown period (January 1 – March 15, 2020) and the first lockdown phase (March 16 – May 31, 2020), see **Figure 1**. However, the patient characteristics (age, sex, BAC and the proportion of positive drug screenings) did not differ with respect to those adolescents admitted for AAI during these periods, see **Table 2**.

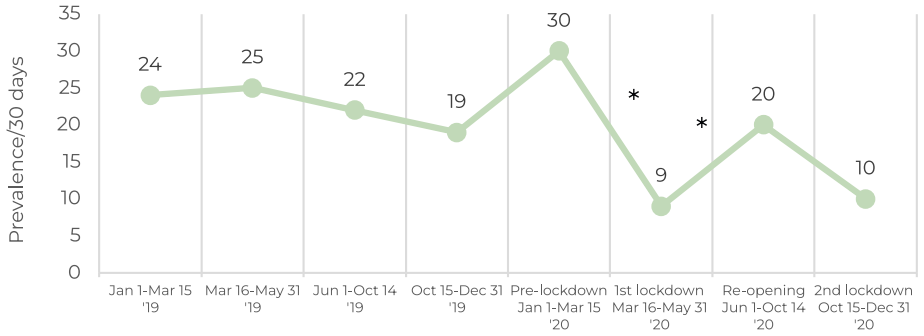

***Figure 1**. Prevalence of adolescents admitted for AAI for per 30 days within the different time periods*

Between the first lockdown phase (March 16 – May 31, 2020) and the reopening phase (June 1 – October 14, 2020), the prevalence of adolescents admitted for AAI significantly increased (p =.047, CI 1.01-4.88), see **Figure 1**. However, the re-opening period did not significantly differ from the second lockdown period (October 15 – December 31, 2020) (p =.074, CI 0.23-1.07).

***Table 2.** Demographic characteristics of adolescents admitted for AAI during both the pre-lockdown and lockdown period*

	2020		**p-value**
	Jan 1–Mar 15 **Pre-lockdown**	Mar 16–May 31 **First lockdown**	
Prevalence in cases/30 days	30	9	0.002[a]
Median age in years (IQR)	16 (2)	15 (2)	0.079[b]
Proportion of males (CI)	52.7% (41.5-63.7%)	54.5% (34.7-73.1%)	0.879[c]
Proportion with positive drug screenings (CI)	14.9% (8.5-24.7%)	0.0% (0.0-14.9%)	0.064[d]
Median BAC in g/l (IQR)	1.9 (0.5)	1.8 (1.2)	0.325[b]

[a] The prevalence in cases/30 days meets the assumptions of a Poisson distribution, [b] Mann-Whitney U test, [c] Chi Square test, [d] Fisher exact test

The Poisson regression model showed that there was no significant difference in the prevalence of cases of AAI between the weeks after the reopening (June 1 – October 14, 2020) and the same period in 2019 (*p* =.758, CI 0.50 – 1.66).

Due to the small sample size, the apparent decrease of concurrent substance use from 14.9% in the pre-lockdown period to 0.0% in the lockdown period was not statistically significant (p = .064, **Figure 2**).

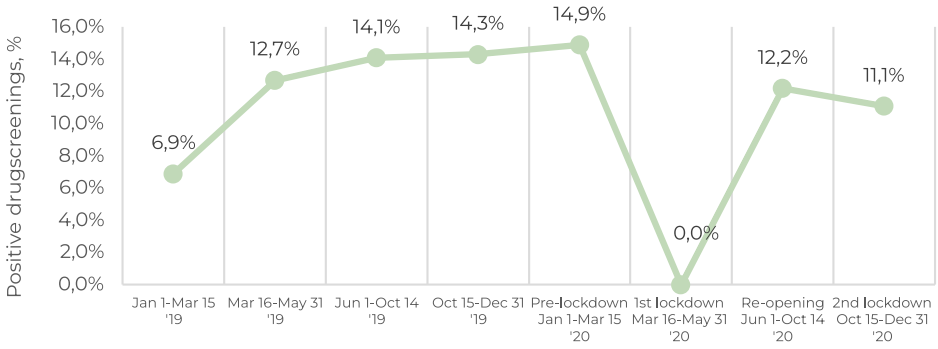

***Figure 2**. Prevalence of adolescents admitted for AAI with positive drug screenings in the different time periods*

Discussion

This study states that the prevalence of adolescents admitted for AAI decreased between the pre-lockdown period and the first lockdown phase. Furthermore, between the first lockdown- and reopening phase, the prevalence of adolescents admitted for AAI significantly increased.

The aforementioned Italian study concluded that there was a decrease in adolescents admitted for AAI during their lockdown period, and then a rebound effect after the lockdown ended [5]. The Italian government introduced stricter measures during their lockdown compared to the Dutch government [1], which may have led to this peak in Italy when the lockdown ended. However, no such peak was noticed after the first lockdown ended in the Netherlands; in fact, the re-opening period after the first lockdown was comparable to the same period in 2019. The aforementioned American study stated that alcohol use did not significantly change before and during the COVID-19 lockdown [15].

Furthermore, there was no significant difference in the prevalence of AAI cases between the reopening period and the second lockdown. This indicates that the influence of lockdown measures in the beginning of the second lockdown had less of an effect on adolescents admitted for AAI than those during the first lockdown. This might be because schools were closed during the first lockdown, whereas in the beginning of the second lockdown they remained open for two months until December 15 , 2020. Therefore, more social contact may have been possible for these adolescents during the start of the second lockdown, thus resulting in AAI. Moreover, depression and anxiety in adolescents steadily increased since the COVID-19 pandemic [19], which might have resulted in excessively drinking alcohol as a form of self-medication.

A retrospective South-African study showed that the amount of unnatural deaths caused by accidents, for example, significantly decreased during the period of total lockdown and national alcohol ban [14]. In the Netherlands, there was no alcohol ban during this period, although it is illegal to buy if one is under the age of 18. During the lockdown in the Netherlands, it was harder for adolescents < 18 years to illegally consume alcohol, because restaurants and sport clubs were closed. This is because checking IDs is done less thoroughly in restaurants and sport clubs than in supermarkets, for example, in the Netherlands [20], thus resulting in less alcohol sales to minors during the lockdown. Moreover, Dutch citizens were instructed to work from home during the lockdown [18], resulting in greater parental supervision of adolescents. Nevertheless, there is a possibility that some adolescents with AAI during first lockdown may have stayed home instead of going to the hospital to receive care because family members or friends may have been worried about the COVID-19 exposure in hospitals.

The strengths of this study are as follows. First, it provides a representative sample of cases of AAI in the Netherlands. Based on data collected by NSCK, we know that the 12 participating major district general hospitals reported 35.1% of the yearly cases of AAI < 18 years between 2007–2017. Secondly, the results of our study can be used for primary prevention purposes during the ongoing, challenging and unknown time period of the COVID-19 pandemic. It must be stressed that the Italian context was not wholly comparable to the Dutch, in light of the aforesaid differences in lockdowns. A limitation of this study is that minor adjustment to lockdown measures by the government, such as changes in the number of citizens allowed to gather together on the streets, were not taken in to account. The time periods were based on prominent preventive COVID-19 lockdown measures, such as the closing and re-opening of restaurants.

Overall, this study indicates that the COVID-19 lockdowns led to a decrease in adolescents admitted for AAI. This might be related to preventive measures, including the closure of bars, sport clubs, restaurants and schools or other lockdown measures. Compared to recent other literature, adolescent alcohol misuse during the COVID-19 lockdown declined among the Dutch, increased among the Italians and remained unchanged among the Americans. These differences were likely multifactorial - parental supervision, access to alcohol, sale of alcohol, contact with peers, etc. - but reveal cross-cultural influences in the response to COVID-19. This patient population needs to be closely monitored in the future, especially during the ongoing COVID-19 pandemic. More research is needed into the predictors and psycho-social factors that incite excessive drinking to explore the development of alcohol policies and primary prevention and therapeutic strategies for after the lockdown(s). It would be interesting to compare the Dutch and Italian data to the European data, which hopefully is rapidly coming.

Acknowledgements

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Chapter 4

Comparison of characteristics from Italy, Belgium and the Netherlands

Acute alcohol intoxication among adolescents in Italy, The Netherlands and Belgium: a cross-national hospital chart comparison study

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Abstract

Background

Excessive drinking among adolescents in Western Europe is prevalent, posing significant health risks and societal costs. Comprehensive data on adolescent drinking patterns is crucial for developing effective prevention strategies. Data on alcohol intoxication among adolescents provides valuable insights in this context.

Methods

To gain insight into the demographic and clinical characteristics of acute alcohol intoxication (AAI) across European countries, we analysed emergency department data on AAI among adolescents (aged 14 - 17) from 2015 - 2023 in three urban regions: Genoa (Italy), Delft (The Netherlands) and Antwerp (Belgium).

Results

Out of 1826 admissions, Belgium had the highest median annual admission rate (51 per 10,000 adolescents), followed by the Netherlands (49 per 10,000) and Italy (37 per 10,000). The median age of patients was 16 years across all countries. Sex was equally distributed among Dutch patients, however, in Italy (not statically significant, 55.6%) and Belgium (statistically significant, 56.8%) more males were admitted. The median blood alcohol concentration (BAC) was higher in the Netherlands (2.0 g/L) compared to Italy and Belgium (1.84 g/L and 1.97 g/L, respectively). This difference remained statistically significant after adjusting for confounders in a multiple linear regression model on BAC. Finally, the proportion of patients with combined drug use (10.4% of the total population) was similar across the three countries.

Conclusions

This is the first international study to consolidate data on AAI in minors from multiple countries, emphasising the need for a unified European database on AAI in adolescents to enhance prevention efforts.

Keywords

Adolescents; Alcohol intoxication; Substance use; Population characteristics; Europe; Cross-National; Hospital chart study; Retrospective study

What is already known on this topic

European adolescents show high rates of excessive alcohol use, which poses a significant risk to their physical, psychological and social health. Effective prevention requires robust, cross-national data to better understand trends and risk factors. Emergency department data on adolescent alcohol intoxication episodes are a valuable resource for this purpose.

What this study adds

This study elaborates on factors associated with alcohol intoxication in minors, similarities and differences in this population among three European countries, and interprets the results in light of country-specific policy and cultural context of alcohol.

How this study might affect research, practice or policy

The results of our study could be of important value for the development of preventive measures for alcohol misuse in adolescents.

Introduction

Alcohol use is common among Western European adolescents. According to the World Health Organization (WHO), 43.9% of the European 15-19-year-olds are current drinkers [1]. Also among younger adolescents, alcohol consumption is common: 57% of all 15-year-old adolescents reported drinking alcohol in their lifetime, and 37% in the last 30 days, according to the Health Behaviour in School-aged Children (HBSC) study in 2022 [2]. Moreover, when adolescents are current drinkers, they often do this in heavy episodic drinking (HED) sessions, defined as consuming six alcoholic beverages or more on at least one occasion in the past 30 days [3]. Worldwide prevalence rates of HED among drinkers are highest in adolescents and early adulthood (15 - 24 years old; around 45 - 55%) [1]. In this regard, lifetime self-reported drunkenness occurred in 20% of 15-year-olds [2]. Especially in Europe, HED among adolescents is a severe problem: here, the prevalence of HED among young people aged 15 - 19 years is the highest in the world (24.1%) [1].

This excessive drinking behaviour poses a significant risk to the physical, psychological and social health of adolescents [4-6] and contributes to high social and health costs [6, 7]. It is also well-documented that engaging in risky drinking behaviour at a young age increases the likelihood of developing alcohol use disorders [8] and other mental health disorders [9-11] later in life. The WHO's European Framework for Action on Alcohol highlights the urgent need for interventions to reduce adolescent alcohol consumption [7], but effective prevention requires robust, cross-national data to better understand trends and risk factors. Emergency department (ED) data on adolescent alcohol intoxication episodes are a valuable resource for this purpose. For instance, in the Netherlands, routine data on adolescent alcohol intoxication has led to the development of a successful transmural healthcare model to support affected young individuals and their parents [12]. Other European countries, specifically Italy and Belgium, are at varying stages of addressing this issue [2, 13, 14].

The goal of the current study is to investigate factors associated with acute alcohol intoxication (AAI) among adolescents accessing ED services in Italy, the Netherlands and Belgium, and to investigate differences and similarities among these countries, considering the policy and cultural context. By analysing data from multiple European countries, this study seeks to provide a comprehensive understanding of AAI in European adolescents. Hence, the findings of this study might contribute to the development of interventions aimed at reducing and preventing alcohol-related issues in adolescents in Europe.

Methods

Study Design

This retrospective observational study compared data from adolescents aged 14 - 17 years with AAI who were admitted to EDs in Italy, the Netherlands and Belgium between 2015 and 2023. The study focused on three urban regions: Genoa in Italy, Delft in the Netherlands and Antwerp in Belgium.

Genoa, the capital of the Liguria Region in Italy, hosts San Martino Hospital, a public Scientific Hospital and Care Institute (IRCCS) of national significance. As the primary tertiary acute-care centre for adults in Liguria and the largest facility in the metropolitan area of Genoa, San Martino Hospital serves a large catchment area [15]. In Genoa, the San Martino Hospital is not the referral hospital for children; however, adolescents ≥ 16 years are preferentially treated here, as are children of 14 - 16 years old with psychomotor agitation. Therefore, it is reasonable to assume that San Martino's catchment area is limited to the nearby 4 eastern municipalities of the Genoa metropolitan area. For the age group of interest (14-17-year-olds), who represented 3.4% of the population in Genoa, approximately 8,550 minors resided there [16, 17].

Delft is a city and municipality in the Provence of South Holland, the Netherlands. Here, the Reinier de Graaf Hospital is based. The Dutch dataset includes the adolescents admitted with acute alcohol intoxication to the emergency department of this hospital. The Municipality of Delft in the Netherlands contained 109,577 inhabitants in 2024, of which 5,150 (4.7%) were 12-to-17-year-olds [18]. As the specific age of the inhabitants was not available, we estimated the number of 14-to-17-year-olds by multiplying the above amount by 2/3. As a result, around 3,433 adolescents aged 14 - 17 years were considered. As adolescents from the municipalities of Gouda and Zoetermeer who experienced an admission due to alcohol intoxication were referred to the Reinier De Graaf Hospital in Delft, they were also taken into account for the catchment area (3,283 and 6,165 adolescents aged 14 - 17 years, respectively). Thus, we estimated that approximately 12,881 minors aged 14 - 17 years resided in the catchment area of the Reinier de Graaf Hospital.

Antwerp is a city and municipality in the Flemish region of Belgium. It is the second largest city in Belgium. The Belgian dataset includes data from all eight hospitals with an ED in the city of Antwerp, namely six hospitals of the Hospital Network Antwerp (ZAS Middelheim, ZAS Cadix, ZAS Palfijn, ZAS Augustinus, ZAS Vincentius and ZAS Sint-Jozef) and two hospitals of the Helix Network, including the Antwerp University Hospital (UZA). Together, these eight hospitals cover the total emergency

care of the city of Antwerp. In 2024, the city of Antwerp had 545,000 inhabitants, of which 26,600 (4.9%) were 14-17 years old [19].

Study variables

To investigate factors associated with AAI among adolescents admitted at EDs in Italy, the Netherlands, and Belgium, as well as demographic and clinical differences in this population among these countries, the following study variables were considered: sex (male/female), age, year of admission, blood alcohol concentration (BAC in g/L), combined drug use (results of urine drug screening) and the primary reason for admittance.

Data Collection

Variables were obtained from hospital chart data of 14-17-year-old adolescents who presented with AAI at one of the included emergency departments, between 2015 and 2023. Each ED visit was recorded separately to ensure comprehensive data collection for cases with multiple admissions.

In Italy, data were collected through a retrospective observational analysis of the Syndromic Surveillance System records from San Martino Hospital, in Genoa, between January 1, 2014 and August 31, 2023. The study population includes all adolescents aged 14 - 17 years who presented to the ED with alcohol-related emergencies during the study period. These were identified based on the clinical diagnosis (ICD-9 codes), assigned by ED physicians for conditions associated with alcohol consumption. In addition, the following Italian search terms were applied to the "diagnosis" field of ED records: '*alcol, alcool, alcolosi, alcolico, alcolica, alcolismo, alcolemia, alcolemico, alcolemica, ebbrezza, ebrezza*'. Selection took place based on a positive BAC (> 0.0 g/L). ED records were reviewed by the researchers and included based on a positive BAC and/or a clinically diagnosed AAI.

In Delft, The Netherlands, data from 2015-2023 were collected using the paediatric alcohol questionnaire [20]. This questionnaire was filled in at the emergency department for all patients aged younger than 18 years old with AAI with a BAC > 0.0 g/L or reported alcohol use. After informed consent, participants were anonymously reported to the Dutch Paediatric Surveillance Unit from the start of the study to 2017, and since 2018, directly to the Youth and Alcohol Foundation. Cases with missing admission years were excluded.

In Belgium, data collected by a recent hospital chart study on AAI among 10-17-year-old adolescents in Antwerp in 2015 - 2021 were used [13]. In that study, the selection

of patients took place via either a positive BAC (> 0.03 or > 0.1 g/L, depending on the laboratory), via screening of triage logs (only in the university hospital) and via screening software making use of the search terms 'intoxication', 'alcohol', 'ethanol' and 'drunkenness' (only in the former GZA hospitals, namely ZAS Augustinus, ZAS Vincentius and ZAS Sint-Jozef). Medical records of selected patients have been reviewed by the researchers and were included based on a positive BAC and/or a clinically diagnosed AAI by the emergency doctor. In the current study, a selection of this dataset has been made: only adolescents aged 14 - 17 years were included.

Ethics

In Italy, the study was carried out under the project "Syndromic surveillance in the Genoa metropolitan area," approved by Liguria Region Council Resolution No. 141 on 17/02/2006. Patient consent was waived in all countries due to the retrospective design of the study. In the Netherlands, the EC of the Faculty of Behavioural, Management and Social Sciences of the University of Twente approved the data collection method until 2017. Since then, the medical EC Leiden-Den Haag-Delft has given a non-WMO statement, which was approved by the data protection officer and research board of the Reinier de Graaf hospital. In Belgium, ethical approval was obtained by all participating hospitals, under the project ID 2021-0412 of the Central Ethics Committee (EC) of the Antwerp University Hospital.

Statistical Analysis

Descriptive statistics were presented as proportions for categorical variables (sex, age, combined drug use and reason for admittance) and as medians [interquartile range (IQR)] for continuous variables (BAC, year of admission), due to non-normal distribution of the variables, determined via histogram assessment and Kolmogorov-Smirnov test performance. To be able to compare the number of admissions among the three countries, we calculated the annual admission rate. This rate was estimated per country by dividing the number of admissions recorded by the corresponding number of 14-17-year-old adolescents living in the catchment area as of 2024, expressed per 10,000 inhabitants. In Italy, the calculation excluded the year 2023, as only admissions up to August of that year were recorded. To investigate differences in outcome variables among countries, Kruskal-Wallis tests for continuous variables and Pearson's chi-squared tests for categorical variables were employed. To assess the univariable association between categorical variables and median BAC, a Mann–Whitney U test was used for variables with two categories (sex and combined drug use), and a Kruskal–Wallis test was used for variables with more than two categories (country, age and reason for admittance). Statistically

significant variables from the univariable analyses were included in a multiple linear regression model to determine if patient characteristics significantly predicted BAC. An alpha level of .05 was used for all statistical tests. IBM SPSS Statistics for Windows, Version 29.0 (Armonk, NY, USA: IBM Corp) was used.

Results

Prevalence

A total of 1826 AAI admissions in patients aged 14 - 17 years occurred over the study period of 2015 - 2023 in the three European regions. Of these admissions, 289 (15.7%) were based in Italy, 555 (30.4%) in the Netherlands, and 985 (53.9%) in Belgium. Of the Italian admissions, 17 (5.9%) were recurrent admissions. However, the recurrence rate data were unavailable in the Netherlands and only partly in Belgium (16 admissions, 1.6%).

The median annual admission rate was highest in Belgium with 51 [IQR 47 - 53] admissions per 10,000 corresponding inhabitants, followed by the Netherlands with 49 [IQR 36 - 59] and Italy with 37 [IQR 33 - 44], as shown in **Figure 1**. However, the differences in median annual admission rates were not statistically significant among any of the three countries (p = 0.285).

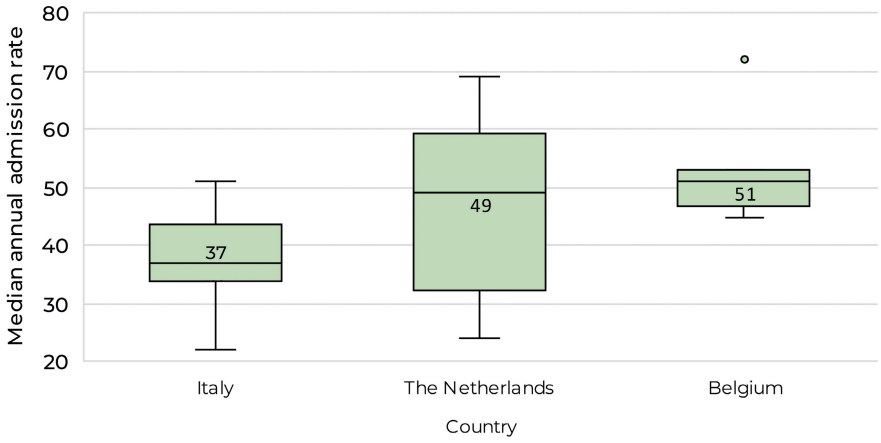

Figure 1. *Median annual admission rate of acute alcohol intoxication per 10,000 corresponding inhabitants of 14 - 17 years old per country*

Figure 2 shows the absolute number of admissions per year per country. Over time, significant differences in absolute number of admissions per country per year were observed ($p < .001$ for all countries). In all countries, a decrease in the number of admissions was seen over the year 2020. In Italy and the Netherlands, this decreasing trend continued over 2021. This decreasing trend seemed to level off in recent years, as an increase was seen in 2022 in Italy and the Netherlands, and in 2021 in Belgium.

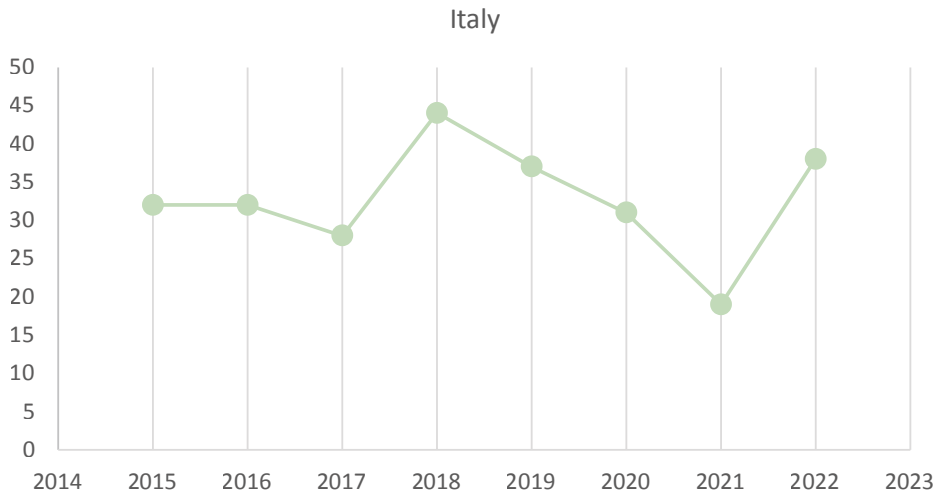

Figure 2a. *Absolute number of admissions for acute alcohol intoxication among 14-17-year-olds per year for Italy*

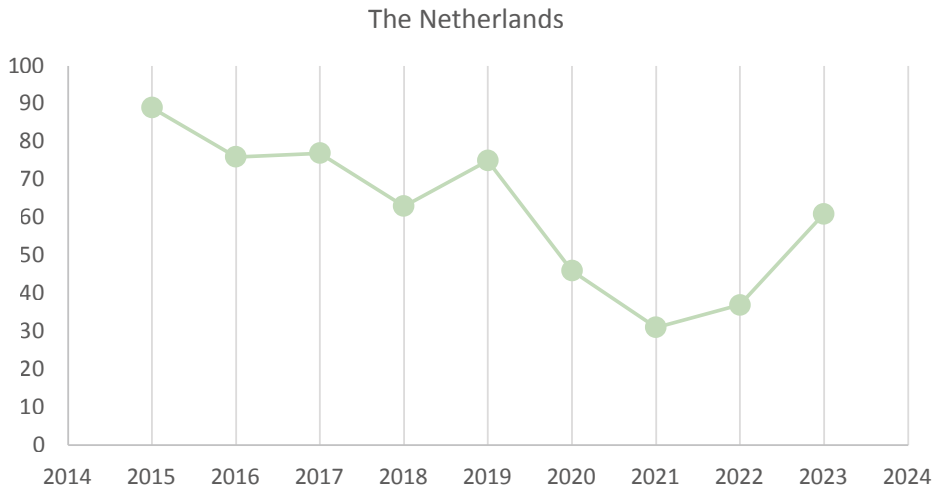

Figure 2b. *Absolute number of admissions for acute alcohol intoxication among 14-17-year-olds per year for The Netherlands*

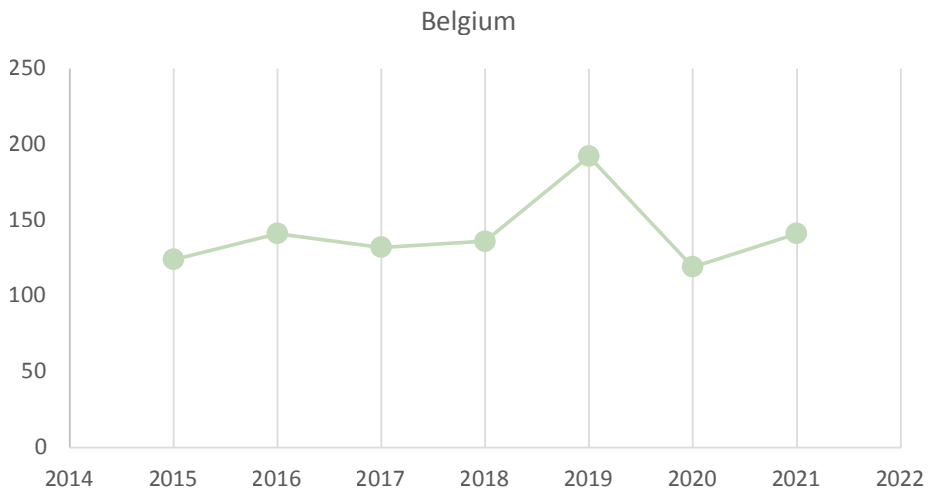

Figure 2c. *Absolute number of admissions for acute alcohol intoxication among 14-17-year-olds per year for Belgium*

Sociodemographics

Characteristics of admitted patients per country and of the total population are shown in **Table 1.** The median age of the admitted patients was 16 years old [IQR 15 - 17]. Although the median age was the same in all countries, a significant difference appeared between the distribution of age in Belgium compared to Italy and The Netherlands ($p < .001$), due to a higher percentage of 17-year-old patients in Belgium. On the contrary, 16-year-old patients form the biggest age group in Italy and The Netherlands. In none of the countries, a significant change in median age was seen over time ($p = 0.636$ in Italy; $p = 0.370$ in the Netherlands; $p = 0.138$ in Belgium).

Overall, more males were admitted with AAI (54.2% of the admissions). However, only in Belgium did the distribution of sex differ significantly favouring males (56.8%, $p < .001$). In both Italy (55.6%, $p = 0.058$) and the Netherlands (48.9%, $p = 0.610$), no significant difference in the distribution of sex was observed. Moreover, when looking at the youngest age group of the data set, the 14-year-olds, a distribution of sex favouring females was seen in all countries (68.6% in Italy, 54.0% in the Netherlands, and 59.8% in Belgium). However, this difference was only significant in Italy ($p = 0.028$).

Table 1. *Characteristics of patients aged 14-17 years with acute alcohol intoxication in Italy, the Netherlands and Belgium between 2015 and 2023*

Characteristics	Italy	The Netherlands	Belgium	Total population
Age (years), n=1826				
Median [IQR]	16 [15-17]	16 [15-17]	16 [15-17]	16 [15-17]
Sex, n (%), n=1823				
Male	159 (55.6)	270 (48.9)	559 (56.8)	988 (54.2)
Blood Alcohol Concentration (g/L), n=1510				
Median [IQR]	1.84 [1.38-2.23]	2.0 [1.7-2.4]	1.97 [1.44-2.37]	1.99 [1.50-2.36]
Range	0.06-3.53	0.1-3.6	0.03-4.09	0.03-4.09
Combined drug use, n(%), n=1826				
Yes	35 (12.2)	63 (11.4)	92 (9.3)	190 (10.4)
Type of combined drug use, n(%)				
Cannabis	35 (100)	50 (79.4)	72 (78.3)	157 (82.6)
Amphetamines/XTC	NA	10 (15.9)	25 (27.2)	35 (18.4)
Cocaine	4 (11.4)	1 (1.6)	5 (5.4)	10 (5.3)
GHB	0 (0)	2 (3.2)	0 (0)	2 (1.1)
Nitrous oxide	NA	NA	3 (3.3)	3 (1.6)
Reason for admittance, n(%), n=1365				
Reduced consciousness	180 (62.9)	182 (88.8)	441 (50.5)	803 (58.8)
(Traffic) accident	49 (17.1)	16 (7.8)	114 (13.0)	179 (13.1)
Vomiting	14 (4.9)	NA	90 (10.3)	104 (7.6)
Other	43 (15.0)	7 (3.4)	229 (26.2)	279 (20.4)

Clinical characteristics

In 82.7% of the total admissions, the blood alcohol concentration was known. The overall median BAC was 1.99 g/L [IQR 1.50 - 2.36], with no specific trends in BAC over time in the three countries. BAC differed significantly among the countries ($p < .001$): Dutch patients showed a significantly higher median BAC (2.00 g/L), compared to Italy (1.84 g/L) and Belgium (1.97 g/L), with $p < .001$. A multiple regression analysis was run to investigate the influence of patient characteristics on BAC. **Table 2** shows the median BACs of subgroups of available patient characteristics, including the test results of the univariable associations.

Table 2. *Median blood alcohol concentration per subgroup, including results of univariate analyses*

Characteristic	n (% with available BAC of total)	Median BAC (g/L) [IQR]	Univariate *p*-value
Total	1510 (82.7)	1.99 [1.50-2.36]	
Country			< 0.001*
Italy	202 (70.6)	1.84 [1.38-2.23]	
Belgium	812 (82.4)	1.97 [1.44-2.37]	
The Netherlands	496 (89.4)	2.00 [1.70-2.40]	
Age (year)			0.002*
14	190 (86.4)	1.90 [1.48-2.30]	
15	331 (83.6)	1.90 [1.47-2.20]	
16	462 (81.6)	1.97 [1.51-2.34]	
17	527 (81.8)	2.03 [1.59-2.43]	
Sex			0.278
Female	693 (83.0)	1.94 [1.50-2.30]	
Male	814 (82.4)	2.00 [1.54–2.37]	
Combined drugs use			< 0.001*
Drugs use	157 (82.6)	1.72 [1.29-2.20]	
No or unknown drug use	1353 (82.7)	2.00 [1.56-2.37]	
Reason for admittance			< 0.001*
(Traffic) accident	147 (82.1)	1.39 [0.13-2.22]	
Vomiting	70 (67.3)	1.83 [1.51-2.17]	
Other/unknown	620 (83.8)	1.90 [1.44-2.30]	
Reduced consciousness	673 (83.8)	2.05 [1.70-2.41]	

*Statistically significant

The outcome of the multiple regression analysis is presented in **Table 3**. The overall regression model was statistically significant ($R^2 = 0.112$, $p < .001$). It was found that apart from age, combined drug use and reason for admission, the country significantly predicted BAC (0.129, $p < .001$). Therefore, we can conclude that while adjusting for other variables that predict BAC, BAC was still significantly different among the three countries.

Combined drug use with cannabis, amphetamines (including XTC), GHB, cocaine or nitrous oxide, was observed in 10.4% of the overall admissions with AAI. When looking at the countries separately, in Italy, combined drug use was only based on drug screening (not on self-reporting), which was performed when required by the emergency doctor. Of the Italian patients with AAI, 35 had a positive drug screening, which corresponds with 12.2% of the admissions. In the Netherlands, a urine drug screening was performed in almost all cases (98.4%). This screening showed that in

11.4% of the cases, there was combined drug use with one or multiple drugs. Finally, in Belgium, drug use was assessed by urine drug screening (in 30.3% of the cases) and by self-reporting of the patient. In total 9.3% of the Belgian patients had used one or more drugs, of which 62% was determined via urine drug screening and 38% by self-reporting. However, differences in number of patients with combined drug use among the countries were insignificant (p = 0.913). Cannabis was the drug most often used in combination with alcohol in all countries: 100% of the cases with combined drug use in Italy, 79.4% in the Netherlands, and 78.3% in Belgium. Most patients with combined drug use used one type of drug (175 patients, 92.1%), and only 15 patients (7.9%) used two or more types of drugs (11 admissions in Belgium and 4 in Italy).

Table 3. *Results of multiple regression analysis of patient characteristics with blood alcohol concentration (g/L) as the outcome*

Variable	B Unstandardized regression coefficient	95% Confidence Interval	Multiple regression *p*-value
Country	0.129	[0.076, 0.182]	< 0.001*
Age	0.077	[0.043,0.111]	< 0.001*
Combined drug use	0.212	[0.099, 0.325]	< 0.001*
Reason for admittance	0.23	[0.192, 0.268]	< 0.001*

*Statistically significant

In 1365 cases (74.8%), the reason for admission could be traced from the medical charts. The most common reason for admission in the total population was reduced consciousness (58.8%), followed by a (traffic) accident (13.1%). In the Netherlands, a higher percentage of admissions was due to reduced consciousness compared to the other countries (p = 0.004). In Italy, more admissions were the result of a (traffic) accident compared to the Netherlands and Belgium, however, these differences were not statistically significant (p = 0.201).

Discussion

This study is the first in Europe to compare factors associated with AAI in adolescents among multiple European countries, namely Italy, the Netherlands and Belgium. Our findings reveal both shared patterns and notable differences in AAI admissions among minors in these countries, with implications for public health policy, cultural attitudes, and clinical practice.

When comparing the median annual admission rate per 10,000 corresponding 14-17-year-old adolescents in the catchment area of the hospitals, Belgium showed

the highest admission rate, closely followed by The Netherlands, whereas Italy had a considerably lower rate. Although this difference was not statistically significant, several contextual factors may explain these discrepancies. In Belgium, the legal drinking age for beer and wine has been 16 years since 2009 [21], while in Italy (since 2012) and the Netherlands (since 2014) the legal age for any alcohol consumption is 18 years [22, 23]. This difference may partly contribute to the higher admission rate observed in Belgium. Furthermore, cultural practices differ by country. Belgian minors often have early exposure to alcohol within the family environment, with parental control over drinking generally lessening as children grow older [24]. In contrast, a trend towards increasingly stringent parental oversight regarding adolescent alcohol use was seen in the Netherlands [25]. Interestingly, despite cultural similarities in parental attitudes toward alcohol between Belgium and Italy [24, 26], Italy's admission rate for AAI in minors remains the lowest. However, this could be an underestimation, as San Martino Hospital is not the sole referral hospital for paediatric cases of AAI in Genoa, potentially leading to missed cases in the Italian dataset.

Our results showed distinctly annual trends in prevalence within each country, likely influenced by the international COVID-19 restrictions from 2020 to 2022. Consistent with prior research, which observed declines in AAI admissions during lockdowns and subsequent rebounds post-lockdown [27, 28], our findings align with these broader patterns, although specific lockdown effects could not be thoroughly examined due to limited admission data from the Dutch dataset.

As highlighted by the multiple linear regression model, the severity of AAI differed among the countries. The most severe cases were seen in the Netherlands (median BAC of 2.00 g/L), followed by Belgium (median BAC 1.97 g/L) and then Italy (median BAC 1.84 g/L). According to the WHO report 'Alcohol Consumption, harm and Policy Response Fact Sheets for 30 European Countries' from 2016 [29], Italian 15-19-year-olds indeed showed the lowest percentages of HED in 2016, namely 8.2% of females and 37.1% of males, compared to their peers in the Netherlands (12.9% of females and 47.1% of males) and Belgium (17% of females and 53.8% of males). According to these estimates, overall, Italian and Dutch adolescents drink less than the European average (15.5% of females and 50.7% of males), while Belgian adolescents exceed it [29]. In summary, both the admission rate of AAI and the severity of AAI in minors in Italy are the lowest compared to the Netherlands and Belgium.

The study's findings raise questions about the role of national alcohol policies in shaping adolescent drinking behaviours. According to the WHO, Italy scores higher

points (i.e., better results) on multiple action areas of the European action plan to reduce the harmful use of alcohol 2012–2020, compared to the Netherlands and Belgium, namely: 'Leadership, awareness and commitments on drinking and alcohol intoxication', 'Alcohol availability' and 'Marketing'. The Netherlands, however, has recently enacted updates to its alcohol policies, particularly concerning pricing and marketing, that may not be fully reflected in these WHO ratings [22]. Furthermore, Belgium, with the highest admission rate in our study, scored low compared to the European average on 'Leadership, awareness and commitments on drinking and alcohol intoxication', 'Alcohol availability', 'Marketing' and 'Reducing public health impact'. In addition, The Netherlands scored high on 'Health services response', which is in line with the national transmural healthcare model aimed at supporting young individuals with AAI and their parents. Also in Belgium, the first outpatient clinic for minors with AAI was set up in Antwerp [13], however, this was not yet the case at the publication date of the WHO report in 2016.

In addition, cultural and sociological factors may also contribute to differences in admission rates and severity of AAI across the countries. Although globalisation is gradually homogenising cultural attitudes towards alcohol, traditional practices still influence drinking patterns in each country. For instance, the Italian 'Centro Nazionale di documentazione e analisi per l'infanzia e l'adolescenza' notes that until recently, Italy adhered to the Mediterranean consumption pattern, involving moderate consumption of low-alcohol drinks with meals; however, a shift towards Northern European-style of heavy drinking is emerging among Italian youth [26]. Conversely, Belgium has a strong cultural association with beer, which is even recognised as immaterial world heritage on the UNESCO list since 2016 [30]. Despite this, breweries and other liquor suppliers are obliged to inform about health risks in advertisements.

The sociodemographic characteristics of adolescents admitted with AAI were similar across the three countries, with a median age of 16 years and no significant age trend over time. The same results were found in a 5-year cohort study in Wales [31]. Notably, only in Belgium, significantly more males were admitted with AAI. Also in Italy, 55.6% of the admissions were males, although this percentage was not statistically significant. It should be considered that the dataset of Italy was rather small (n=286), and a statistically significant difference in the distribution of sex would maybe have been found in a bigger population. Indeed, it is known from previous studies that AAI in older adolescents occurs more often in males [32-34]. Moreover, in around 10% of the admissions in all three countries, adolescents used drugs combined with alcohol. This is in line with other European studies on AAI in

adolescents [34, 35]. However, a potential underestimation in our dataset should be taken into consideration, as amphetamine use was not measured in Italy and the Netherlands. Also, opioids, benzodiazepines and novel psychoactive drugs were not taken into account. Furthermore, urine drug screening was not performed in all cases in both Italy and Belgium and self-reporting of drugs was not recorded in Italy. In addition, when interpreting differences in the primary reason for admission, it stands out that statistically significantly more (traffic) accidents occurred in Italian patients, although the alcohol limit in traffic is the same in all three countries (0.5 g/L) [29]. However, according to the WHO report above, Italy has lower country scores on drink-driving policies than the Netherlands and Belgium [29].

This study has some limitations. First, the absence of a standardized data collection system across the three countries represented a major barrier to effectively using and comparing the available study data. In Italy, data was retrospectively collected based on the clinical diagnosis (ICD-9 codes) reported in the ED chart and positive BAC screening. Also in Belgium, data was retrospectively collected, although selection took place via positive BAC screening and screening of triage logs. On the contrary, prospective data was collected in the Netherlands, where for every admitted minor with AAI a survey was filled in by a doctor at the ED. Therefore, selection bias could have occurred, which could have limited the unbiased comparison of variables across the three countries. Second, only patients aged 14 to 17 years were included in the study, due to the selection procedure in Italy (younger patients were referred to another hospital in Genoa and were therefore not included in the Italian dataset). This potentially influenced our results, as we know from previous Dutch and Belgian studies [13, 36] that in the age group of 11-14 years, more females are admitted, a lower BAC is found and less drug use appears, compared to the total population of AAI under 18 years old. Moreover, as stated above, the calculated admission rate should be interpreted as an estimation, due to potentially missed cases in Italy.

In conclusion, this study provides the first cross-national comparison of AAI characteristics among European minors, emphasising the importance of coordinated, cross-country data to better understand the nuances of adolescent alcohol intoxication in Europe. The findings underscore the need for a standardised European database on AAI among minors, which would facilitate more accurate comparisons, enhance our understanding of AAI in this population, and support the development of tailored, cross-national interventions and preventive strategies.

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Competing interest statement

All authors have completed the ICMJE uniform disclosure form and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

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Chapter 5

Psychological outpatient clinic: drinking patterns and risk factors

Psychological outpatient follow-up after hospitalization for adolescent acute alcohol intoxication

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Abstract

Introduction

Alcohol-related emergency department attendance in adolescents should be considered as a valuable opportunity to address and mitigate future alcohol consumption. Therefore, a paediatric department of a major district hospital in the Netherlands developed an outpatient preventive program targeting adolescents admitted for acute alcohol intoxication. The primary aim of this study is to evaluate how drinking patterns of adolescents participating in the preventive program developed over time.

Methods

This retrospective observational study involved 310 patients from the Reinier de Graaf hospital, Delft, the Netherlands (years 2014 - 2022). The outpatient preventive program consists of three main components: an initial intervention, subsequent an extended counselling session and psychological interventions. The alcohol consumption was compared at three time points: before the admission for acute alcohol intoxication (T=0), 4 - 6 weeks after hospital admission (T=1) and 6 - 12 months after the hospital admission (T=2). Moreover, sociodemographic variables, adolescent risk-taking behaviour and family and pedagogical factors were included in secondary analysis.

Results

Adolescents who experienced an alcohol intoxication exhibited more adolescent risk-taking behaviour (higher rates of lifetime smoking, substance use, and sexual intercourse) compared to the Dutch average. Initially, these adolescents had significantly higher rates of alcohol consumption and drunkenness. Alcohol use decreased significantly in the month following intoxication, even below the Dutch average. Though, 6 - 12 months later, their alcohol consumption increased but remained statistically lower and involved less binge drinking than the Dutch average.

Conclusions

The findings of this study demonstrate that a preventive program following acute alcohol intoxication might contribute to the reduction of adolescent alcohol use and associated risk-taking behaviours.

Keywords

Acute alcohol intoxication, adolescents, alcohol, outpatient clinic, prevention, psychologic follow-up.

What is Known:

- Earlier studies showed that adolescents with problematic alcohol use reported reduced alcohol consumption and fewer alcohol-related problems after participating in a motivational interviewing intervention compared to standard care.
- During the follow-up assessment of adolescents with acute alcohol intoxication it is possible to signalize mental disorders and to determine whether the patient requires referral to specialized mental healthcare.

What is New:

- These findings suggest that the preventive program had a short-term impact in reducing alcohol consumption among adolescents with acute alcohol intoxication, as well as a long-term impact in reducing binge-drinking behaviours.
- The program's success in mitigating binge-drinking behaviours aligns with its goals of promoting safer drinking habits among adolescents.

Introduction

Increasing numbers of youth in need of emergency medical treatment following acute alcohol intoxication (AAI) have been a major public health concern in Europe [1]. This while alcohol consumption between the age of 10 and 24 is the most important risk factor to disability-adjusted life years [2]. Moreover, AAI can result in a variety of immediate medical complications, including decreased consciousness, hypothermia, electrolyte disturbances, and secondary injuries [3]. Also, alcohol in adolescences impacts brain development and leads to impairment of the brain and cognitive and behavioural dysfunctions [4]. Negative effects on social well-being and behaviour can encompass various aspects, such as susceptibility to peer influence, engaging in risky sexual behaviour, participation in criminal activities and decline in academic achievement [5-7].

Common mental health issues in adolescents, including anxiety, depression, impulsive behaviour, feelings of shame or guilt, can serve as a trigger for alcohol consumption or emerge as a consequent of alcohol consumption [8-10]. Disadvantaged and especially vulnerable populations have higher rates of alcohol-related hospitalization and even death [11]. Thus, excessive alcohol use in adolescents continues to be a major public health problem [12] and indicated preventive interventions as early as in adolescence are essential [13, 14].

Alcohol-related emergency department attendance should be considered as a valuable opportunity to address and mitigate future alcohol consumption [1]. Earlier studies showed that adolescents with problematic alcohol use reported reduced alcohol consumption and fewer alcohol-related problems after participating in a motivational interviewing intervention compared to standard care [15-17]. Follow-up assessment of adolescents who were admitted for AAI demonstrate a brief period of reduced alcohol consumption shortly after the incident [18]. Moreover, during the follow-up assessment of adolescents with AAI it is possible to signalize mental disorders and to determine whether the patient requires referral to specialized mental healthcare [19].

In 2007, the paediatric department of a major district hospital in the Netherlands developed an outpatient preventive program targeting adolescents admitted for AAI. The program consists of three main components: an initial intervention, subsequent an extended counselling session and a psychological interventions.

The primary aim of this retrospective cohort study is to evaluate how drinking patterns of adolescents participating in the preventive program developed over

time. Secondary aims were to evaluate risk factors of adolescent alcohol use: substance use patterns, development, positive family history of substance use disorders, parental awareness and alcohol-specific parental rule-setting.

Materials and Methods

Study design and setting

This retrospective observational study was conducted in the Reinier de Graaf hospital, Delft, the Netherlands, whereas prevention-intervention program at the 'Outpatient Department for Adolescents and Alcohol' was implemented in 2007. Adolescents < 18 years of age were invited to the follow-up program after emergency department presentation or hospital admission related to alcohol consumption. Alcohol consumption was defined as reported alcohol use or a blood alcohol concentration > 0.0 gram/litre. Both the psychological follow-up program and the paediatric alcohol questionnaire are standard care for this population, no additional intervention was conducted because of this study.

The program consists of three main components: an initial intervention, subsequent an extended counselling session and a psychological interventions. The initial intervention is conducted on the next day following admission by a trained nurse or pedagogical worker and aims to raise awareness. This includes an introduction to our outpatient clinic, an informative talk and e-learning about alcohol. In total this initial intervention takes about 1-2 hours and parents are only involved in the introduction of the outpatient clinic. The extended counselling session with the paediatrician occurring 3 to 6 weeks after hospital admission focuses on providing a detailed understanding of how alcohol affects adolescents. In this session the paediatrician with alcohol expertise makes use of visual and verbal information and tries to alter the information provided based on the relevance for the specific patient. Parents are also invited to join during this session. The psychological interventions consist of a screening consultation aiming to identify psychological risk factors for the continuation of binge drinking, signalizes mental disorders or psychosocial problems and incorporates motivational interviewing. This consultation is done by the child psychologist and takes place approximately 4 to 6 weeks after hospital admission. Finally, the child psychologist does a final consultation that takes place 6 to 12 months after the emergency department attendance to evaluate how it has been going with the adolescent since their last consultation. Prior research demonstrated follow-up rates of this outpatient clinic were 91% for the consultation at the paediatrician and 67% at the follow-up by a child psychologist [19]. This specific study targets the adolescents that completed the consultation(s)

with the child psychologist. The psychological consultation was split in three different sections: one with the adolescent alone, one with the parents and one with all the family members together.

Data collection

Cases were identified using a search engine in the hospital's electronic health record (Chipsoft HiX, Amsterdam, the Netherlands). The files were extracted by the hospital's data warehouse based on the presence of a diagnosis and treatment combination code 'intake alcohol intoxication', which is used by the child medical psychology department to register all initial consultations related to alcohol intoxication. This registration format at the psychological outpatient clinic was used from 2014 onwards, and therefore data was extracted since 2014. Demographical data were extracted from the health record. All other data were extracted from the medical records of the semi-structured consultation with the child psychologist which took place 4 to 6 weeks after hospital admission and final consultation 6 to 12 months after hospital admission. Pseudonymized data was stored in an online database (Castor Electronic Data Capture, Ciwit BV, Amsterdam, the Netherlands).

Variables primary outcomes

The primary aim was to determine how alcohol consumption patterns developed during the follow-up program. Alcohol consumption before the admission for AAI (T=0) was assessed during the intake consultation with the adolescent alone by the child psychologist. Secondly, alcohol consumption 4 - 6 weeks after hospital admission was assessed during the psychological intake at that time point (T=1). Lastly, alcohol consumption 6 - 12 months after the hospital admission was reassessed during the follow-up session at that time point with the child psychologist (T=2).

At T=0, alcohol consumption before the hospital admission, was assessed by three different outcome measures: lifetime prevalence, lifetime drunkenness, and lifetime binge drinking. At T=1 and T=2 last month alcohol use and binge drinking was assessed. Lifetime prevalence was evaluated by asking whether the adolescent had ever consumed alcohol before the hospital admission. Last month prevalence was assessed by asking if the adolescent consumed alcohol in the last month. Binge drinking was evaluated by asking if the adolescent consumed more than 4 (for girls) or more than 5 drinks (for boys) on a single occasion.

The results of these specific outcome measures were compared to a reference group from a nationally representative sample based on year of admission, sex and age [20-25]. Detailed comparisons are provided in Table A and B in the appendix.

The reference group were sourced from the Health Behaviour in School-aged Children (HBSC) and Peilstations research project, who performed validated questionnaires in the Dutch school-going children in the years 2013, 2015, 2017, 2019 and 2021. The values used for matching study to reference group data includes adolescents' alcohol use parameters (*Lifetime alcohol use, lifetime drunkenness, last month alcohol use, last month binge drinking*) and risk-taking behaviour parameters (*lifetime prevalence smoking, last month smoking, lifetime cannabis use, lifetime sexual intercourse*). These parameters of the reference group were collected via standardised digital questionnaires of the HBSC/Peilstation, while in this study these same parameters were collected verbally. Patients in the study were matched based on their age and year of admission to the same or previous year of the reference group. If exact matching was not possible due to missing information in the reference group, the closest available year was used.

Measures

Sociodemographic variables such as year of hospital admission, age, and sex were extracted from the electronic health records.

Adolescent risk-taking behaviour was assessed by the following measures: age at first alcohol use, lifetime prevalence of smoking, lifetime prevalence of substance use and lifetime prevalence of sexual intercourse. Smoking was defined as a categorical variables with three categories: never smoked, stopped smoking, currently smoking. Furthermore, internalizing and externalizing behaviour were assessed using the validated Child Behaviour Checklist (CBCL), which includes thee questionnaires: CBCL/6-18 by parents, the Teacher's Report Form (TRF) and the Youth Self Report (YSR). The CBCL evaluates two scales: internalizing problems (including anxious/depressed, withdrawn-depressed, and somatic complaints) and externalizing problems (including rule-breaking and aggressive behaviour). This outcome measure is expressed as the percentage of adolescents clinical score on one of the two scales or total score.

Family and pedagogical factors were assessed using the semi-structured intake consultation, conducted separately with the adolescent and with the parents. Family history was assessed by determining the prevalence of alcohol or substance use disorder among first, second or third degree family members. Exposure to parental alcohol use was assessed by asking whether the adolescent had ever seen a parent drunk. Alcohol-specific parental rule-setting was assessed during the session with the adolescent alone and during the session with parents alone. Alcohol-specific parental rule-setting was defined as a categorical variable ranging from 1-3: no rules

or approval (1), rules (2), strict alcohol-specific parental rule-setting/not allowed (3) and was asked to the parents and adolescent separately. Parental awareness was assessed by comparing the adolescent's self-reported lifetime prevalence and last month prevalence of alcohol use with those reported by the parents.

Data analyses

Descriptive statistics were used to present baseline characteristics of the study population. Categorical variables were expressed as proportions. The normality of continuous variables was assessed using the Kolmogorov-Smirnov test. Continuous variables were reported as medians with interquartile range (IQR) for non-normally distributed data or as means with standard deviation (SD) for normally distributed data. Development in drinking patterns were assessed using McNemar test for two-category paired data and the Wilcoxon Signed Ranks test for paired ordinal data. Adolescent risk-taking behaviour and alcohol use parameters from the study population were compared to the reference population using a Chi-square goodness of fit test. The significance level for all statistical tests was set at $\alpha = 0.05$. Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 28.0 (Armonk, NY, USA: IBM Corp).

Ethics

Only patients who gave consent to the Youth and Alcohol department (data ≥ 2018) or to the former the Dutch Paediatric Surveillance System (data < 2017) for data collection for research purposes using the Paediatric alcohol questionnaire were included in this study. The data collection procedure was approved by the Medical Ethics Committee Leiden The Hague Delft, as well as by the research committee and board of directors of the Reinier de Graaf Hospital.

Results

Study population

Between 2014 and 2022, a total of 310 adolescents presented to the emergency department due to AAI and subsequently received outpatient follow-up care from a child psychologist. The characteristics of these patients are summarized in **Table 1**. The median age of the cohort was 16 years (interquartile range [IQR] 1.0 year), with no patients younger than 11 years. There was a slight female predominance, accounting for 57.7% of the cohort.

Table 1. *Population characteristics for total sample*

Sociodemographic characteristics	**Study population** (n = 310)
Year of emergency department presentation	
2014-2016	160 (51.6%)
2017-2019	98 (31.6%)
2020-2022	52 (16.8%)
Sex	
Female	179 (57.7%)
Male	131 (42.3%)
Age	
≤14 years	67 (21.6%)
15 years	83 (26.8%)
16 years	98 (31.6%)
17 years	62 (20.0%)
Adolescent risk-taking behaviour	
Age at first alcohol use	14 (IQR 2)
Lifetime prevalence smoking	47.6%
Current smoking status	
Never smoked	52.3%
Former smoker	24.0%
Current smoker	23.6%
Lifetime prevalence cannabis use	38.1%
Lifetime prevalence sexual intercourse	25.7%
Psychological factors	
Psychological disorders	43.9%
AD(H)D	20.6%
Clinical score CBCL[1,2]	15.1%
Family and pedagogical factors	
Family history of alcohol- and substance use disorders	
Positive in first degree	14.2%
Positive in second or third degree	31.1%
Exposure to parental alcohol use	
Seen parents drunk	41.5%

[1] *CBCL = child behaviour checklist*

[2] *Clinical score as a proportion of adolescents without history of psychological disorders*

Adolescent risk taking behaviour, family and pedagogical factors and psychological disorders

The median age at first alcohol use was 14.0 years (IQR 2.0 years). The lifetime prevalence of smoking was 47.6%, with 23.6% classified as current smokers at baseline. The lifetime prevalence of cannabis use was 38.1%. Additionally, 25.7% had engaged in sexual intercourse. A first-degree relative with a history of alcohol or substance use disorders was reported by 14.2% of the adolescents, while 31.1% reported a second or third-degree relative with such a history. Exposure to parental drunkenness was noted in 41.5% of cases. An earlier diagnosed psychological disorder was present in 43.9% of the adolescents with AAI, with Attention-deficit/hyperactivity disorder (ADHD) being the most common diagnosis. Among those without a prior psychological disorder, 15.1% had clinical scores on the CBCL indicative of undiagnosed psychological disorders.

The chi-square goodness-of-fit test indicated that the lifetime prevalence of smoking was significantly higher in the study population (47.7%) compared to the general Dutch adolescent population (32.1%, $X^2(2)=28.7$, $p < 0.001$). The lifetime prevalence of sexual intercourse in the study population (25.7%) did also differ significantly from that of the general Dutch adolescent population (16.3%, $X^2(2)=15.5$, $p < 0.001$). Furthermore, the lifetime prevalence of cannabis use was significantly higher in the study population (38.1%) than in the general Dutch adolescent population (20.0%, $X^2(2)=54.6$, $p < 0.001$).

Alcohol use parameters at baseline

The alcohol use parameters at baseline are presented in **Table 2**. At the initial assessment (T=0), the majority of adolescents (89.2%) reported alcohol consumption prior to their alcohol-related emergency department visit. In 10.8% of cases, the emergency department visit was due to first-time alcohol use. The lifetime prevalence of alcohol use in the study population (89.2%) was significantly higher compared to the general Dutch adolescent population (65.8%, $X^2(2)=72.0$, $p < 0.001$). Additionally, nearly two-thirds of the adolescents (64.7%) had experienced drunkenness at least once. The prevalence of drunkenness was significantly higher in the study population than in the general Dutch adolescent population (41.8%, $X^2(2)=64.5$, $p < 0.001$). However, among those who had consumed alcohol prior to the emergency department visit, the prevalence of binge drinking was significantly lower in the study population (49.2%) compared to the general Dutch adolescent population (75.5%, $X^2(2)=98.4$, $p < 0.001$).

***Table 2**. Prevalence of alcohol use during the outpatient follow-up program*

	Sex		Age				Total
	Male	Female	≤14	15	16	17	
Lifetime prevalence alcohol use[1]							
T=0	90.4%	88.3%	77.4%	84.1%	96.8%	96.6%	**89.2%***
Lifetime prevalence drunkenness							
T=0	63.3%	65.7%	46.9%	56.1%	74.2%	80.3%	**64.7%***
Last month alcohol use							
T=1	36.0%	28.1%	18.0%	24.4%	36.6%	46.7%	**31.4%***
T=2	49.5%	33.1%	26.7%	41.0%	38.7%	55.1%	**40.4%***
Last month binge drinking[2]							
T=0	52.2%	47.0%	31.3%	40.6%	57.8%	61.4%	**49.2%***
T=2	25.5%	25.0%	36.4%	25.0%	18.5%	28.0%	**25.3%***

[1] Lifetime prevalence of alcohol use before the emergency department presentation for AAI
[2] Last month binge drinking as a proportion of last month alcohol use
** Significantly different than reference population based on chi-square goodness-of-fit test, p<0.05*

Alcohol use parameters over time

At the intake assessment (T=1), two-thirds of the adolescents (68.6%) reported not consuming alcohol between the alcohol-related emergency department visit and the intake with the child psychologist. The last month prevalence of alcohol use at T=1 was significantly lower in the study population (31.4%) than in the general Dutch adolescent population (47.7%, $X^2(2)=31.5$, $p < 0.001$). An exact McNemar test was conducted to determine whether the proportion of alcohol abstinence was sustained over time. During the follow-up period, the prevalence of alcohol use in the last month significantly increased to 40.4% at T=2 (McNemar p = .023). However, the last month prevalence of alcohol use at T=2 (40.4%) remained significantly lower than that in the general Dutch adolescent population (47.7%, $X^2(2)=4.9$, p = 0.027). Conversely, the proportion of binge drinking significantly decreased during the outpatient follow-up program (McNemar p < 0.001).

Development of alcohol-specific parental rule-setting and parental awareness

Prior to the alcohol-related emergency department visit, a substantial proportion of parents either approved of alcohol use or did not have specific rules regarding it (40.1%). One-third of the adolescents (34.6%) reported having strict alcohol-specific parental rules. Following the emergency department visit, 37.6% of parents adopted stricter alcohol-specific rules (Wilcoxon $p < 0.001$). The outpatient follow-up

program led to an increase in the concordance of perceived parental rule-setting, from 71.7% to 82.0%. Parental awareness of lifetime and last month alcohol use (at T=1) indicated that parents underestimated their children's alcohol consumption by 23.3%, as shown in **Table 3**.

***Table 3**. Alcohol-specific parental rule-setting and parental awareness*

	T=0	T=1
Alcohol-specific parental rule-setting		
Strict alcohol-specific parental rule-setting	34.6%	67.6%
Permission with rule-setting	25.3%	15.2%
Approval or absent rule-setting	40.1%	17.2%
Perceived rule-setting		
Rule-setting concordant	71.7%	82.0%
Parental awareness		
Alcohol use concordant	76.7%	
	Child	**Parent**
Lifetime prevalence alcohol use	89.2%	70.7%
Last month prevalence alcohol use (T=1)	31.4%	23.3%

Discussion

The findings of this study provide significant insights into the drinking patterns and associated risk behaviours among adolescents participating in a preventive program following AAI. Our results indicate that these adolescents exhibit higher rates of lifetime smoking, substance use, and sexual intercourse compared to national averages, suggesting a broader spectrum of risk-taking behaviours associated with early and excessive alcohol use. Moreover, nearly half of the patients had a positive family history of alcohol or substance use disorders among first, second, or third-degree relatives. This aligns with existing literature indicating that a family history of substance use disorders significantly increases the risk of similar behaviours and psychiatric morbidity in offspring [26].

Additionally, exposure to parental drunkenness was reported in 41.5% of cases, which literature suggests increases the risk of adolescent binge drinking by approximately twofold [27]. Nearly half of the adolescents with AAI had a confirmed psychological disorder, with ADHD being the most prevalent. Prior studies have shown a strong association between alcohol exposure and the development of mental disorders, highlighting the need for comprehensive mental health

assessments in this population [19, 28]. Among patients without a prior diagnosed psychological disorder, 15.1% had clinical scores on CBCL indicative of undiagnosed psychological disorders. It is crucial to identify these new mental health issues and determine the need for referral to specialized care to prevent recurrent hospital admissions and future regular alcohol consumption [19].

Initial alcohol consumption patterns

At baseline, the data revealed that adolescents with AAI had significantly higher instances of alcohol consumption and episodes of drunkenness before the AAI event compared to their peers. This finding is consistent with previous research indicating that early initiation and frequent alcohol use are predictors of more severe drinking problems and related risk behaviours in adolescence and later life [29]. However, the prevalence of binge drinking before alcohol intoxication was reported lower than the Dutch average, which is unexpected since binge drinking is associated with alcohol intoxication [29]. On the other hand, all these patients did eventually perform in binge drinking resulting in their alcohol intoxication.

Post-intoxication changes in drinking behaviour

Following the acute intoxication event, a notable decline in alcohol use was observed in the subsequent month. This reduction could be attributed to the immediate health scare and the subsequent intervention efforts, reflecting the known short-term efficacy of preventive programs in mitigating risky drinking behaviours [18]. Alcohol consumption rose at 6-12 months post-intoxication, compared to 4-6 weeks after AAI, still remaining to be below the Dutch average. Interestingly, binge drinking did not increased proportionately 6-12 months post-intoxication. This suggests a potential shift in drinking patterns towards less intensive drinking sessions. The prevention programs might therefore also be successful in curbing binge drinking behaviours in the long run, which are often associated with acute health risks and long-term negative outcomes [29].

Alcohol-specific parental rule-setting and parental awareness

Prior to the alcohol-related emergency department presentation, a substantial proportion of parents either approved of alcohol use or did not have specific rules regarding it. Only one-third of the adolescents reported having strict alcohol-specific parental rules. Following the emergency department visit, more than one-third of parents adopted stricter alcohol-specific rules. This is a positive sign since indulgent and negligent parenting styles are associated with a significant increase in prevalence of adolescent binge drinking with 2.51-, and 2.82-fold, respectively

[27]. Additionally, adolescents' perception of high parental disapproval of substance use has been prospectively associated with a non-binge drinking trajectory [30]. Parental awareness of lifetime and last-month alcohol use indicated that parents underestimated the presence of their children's alcohol consumption by 23.3%. This, while research shows that parental monitoring and involvement is a protective factor for alcohol use among adolescents [31, 32].

Strengths and limitations

This study has several strengths starting with the longitudinal design that allows for the observation of changes in drinking patterns over time, providing a dynamic view of adolescent behaviour post-intervention. This design helps understand the long-term effects and sustainability of the preventive program. Additionally, by evaluating not only alcohol consumption but also related risk behaviours such as smoking, substance use, sexual activity, psychological disorders and family and pedagogical factors, the study offers a holistic understanding of the adolescent risk profile. Furthermore, comparing the study population's behaviours with Dutch national averages contextualizes the findings, highlighting the extent of risk behaviours in the studied group relative to broader trends. This comparison underscores the specific needs of our population.

However, a limitation of this study is the lack of a control group of patients with alcohol intoxication who did not receive follow-up care, making it difficult to determine the extent to which the intervention program or the alcohol intoxication itself resulted in the observed decrease in alcohol use. Though, previous studies have shown that adolescents with problematic alcohol use reported reduced alcohol consumption and fewer alcohol-related problems after participating in motivational interviewing interventions compared to standard care [15-17]. Suggestion for further research would therefore be to perform a randomized controlled trial to test effectiveness of the outpatient clinic program with a group of adolescents with AAI with and without this follow-up care.

Furthermore, it is important to underscore that the same adolescent risk taking behaviour measures were used in the reference group and the study population. Although in the reference group they were collected via standardised digital questionnaires of the HBSC/Peilstation, while in this study these same parameters were collected verbally. This might result in an underestimation of the study population adolescent risk taking behaviour because it is less anonymous and might be harder to admit in person.

Moreover, another limitation is the missing information of patients that were lost to follow-up. Prior research demonstrated follow-up rates of this outpatient clinic was 67% at the child psychologist [19]. During the study period, there might have been a shift in the consultation approach with the child psychologist from universal prevention (where every adolescent was referred) to indicated prevention (where referrals were based on initial assessments and concerns). This potential change was because of personnel shortage at the paediatric medical psychology department and the corona pandemic which made live appointments in the hospital more complex. This change introduced heterogeneity into the lost-to-follow-up population and might have led to a selection bias of the study population, potentially resulting in either overestimation or underestimation of the actual problems among participants. The missing outcome parameters of adolescents who did not visit the paediatric psychology department due to for instance continuation of pre-existing mental health care or direct referral to mental health care likely lead to underestimation of the prevalence of major outcomes in the study. Conversely, adolescents who were not referred to the psychology department due to indicated prevention might lead to overestimation of the prevalence of major outcomes among those that visited that paediatric psychology department. Moreover, patients with AAI who came from a different region were referred back to their own region for follow-up because of logistical reasons and to shorten travel time to the hospital. The effect of the adolescents that dropped out before visit to the paediatric psychology department could hypothetically influence the study results in both directions, making it challenging to precisely assess the overall impact (either underestimation or overestimation) of the findings. However, it is hypothesized that the true impact lies somewhere between these extremes.

In conclusion, these findings suggest that the preventive program had a short-term impact in reducing alcohol consumption among adolescents with acute alcohol intoxication (AAI), as well as a long-term impact in reducing binge-drinking behaviours. The program's success in mitigating binge-drinking behaviours aligns with its goals of promoting safer drinking habits among adolescents.

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Statements and Declarations

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Ethics statement: Only patients who gave consent to the Youth and Alcohol department (data ≥ 2018) or to the former the Dutch Paediatric Surveillance System (data < 2017) for data collection for research purposes using the Paediatric alcohol questionnaire were included in this study. The data collection procedure was approved by the Medical Ethics Committee Leiden The Hague Delft, as well as by the research committee and board of directors of the Reinier de Graaf Hospital. Moreover, this study was performed in line with the principles of the Declaration of Helsinki.

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Appendix chapter 5, supplementary tables

Table Appendix A. *reference population HBSC/Peilstations adolescent risk-taking behaviour [20-25]*

Lifetime prevalence smoking						
2013 HBSC	12 years	13 years	14 years	15 Years	16 years	17 years
Total	5.3%	12.9%	23.7%	34.1%	44.8%	
2015 Peilstations						
Male	11.4%	13.8%	23.7%	34.4%	41.2 %	52.5%
Female	4.2%	10.9%	20.2%	35.8%	39.0%	33.9%
2017 HBSC						
Male	6.3%	11.2%	19.3%	27.3%	33.3%	
Female	1.5%	5.6%	15.0%	27.7%	29.0%	
2019 Peilstations						
Male	5.1%	10.6%	18.3%	24.2%	30.7%	43.2%
Female	3.3%	6.3%	17.4%	26.3%	34.4%	37.6%
2021 HBSC						
Total	5.2%	9.0%	14.6%	25.3%	37.9%	
Last month smoking						
2013 HBSC	12 years	13 years	14 years	15 Years	16 years	17 years
Total	1.1%	4.9%	11.9%	18.9%	28.9%	
2015 Peilstations						
Male	3.3%	4.4%	10.7%	17.4%	20.9%	33.8%
Female	0.4%	4.4%	10.1%	17.6%	21.0%	16.3%
2017 HBSC						
Male	0.8%	3.9%	7.7%	14.7%	17.7%	
Female	0.1%	1.7%	8.0%	12.9%	12.9%	
2019 Peilstations						
Male	2.0%	2.0%	8.8%	11.9%	17.5%	23.5%
Female	0.8%	2.1%	8.9%	11.3%	15.9%	18.6%
2021 HBSC						
Total	2.4%	2.5%	8.5%	15.0%	23.0%	
Lifetime cannabis use						
2013 HBSC	12 years	13 years	14 years	15 Years	16 years	17 years
Total	0.3%	3.0%	7.9%	16.0%	26.9%	
2015 Peilstations						
Male	1.1%	2.7%	9.8%	20.3%	26.8%	43.6%
Female	0.1%	1.7%	8.1%	13.4%	17.8%	21.8%

Table Appendix A. *(continued)*

2017 HBSC						
Male	0.4%	2.6%	9.0%	19.3%	29.3%	
Female	0.1%	0.4%	4.8%	13.5%	16.9%	
2019 Peilstations						
Male	1.4%	5.5%	12.0%	19.6%	27.5%	47.9%
Female	0.4%	1.4%	7.7%	11.4%	23.9%	29.4%
2021 HBSC						
Total	1.8%	2.7%	7.6%	16.0%	27.9%	
Lifetime sexual intercourse						
2013 HBSC	12 years	13 years	14 years	15 Years	16 years	17 years
Total	0.5%	3.2%	7.3%	15.1%	31.4%	
2015 Peilstations						
Total	1.2%	2.7%	6.4%	13.0%	23.7%	
2017 HBSC						
Total	1.3%	2.9%	7.0%	16.5%	23.2%	
2019 Peilstations						
Total	1.7%	3.5%	7.9%	16.1%	25.7%	
2021 HBSC						
Total	2.2%	4.2%	7.6%	13.5%	24.0%	

Table Appendix B. *reference population HBSC/Peilstations alcohol use parameters [20-25]*

Lifetime alcohol use						
2013 HBSC	12 years	13 years	14 years	15 Years	16 years	17 years
Total	17.0%	29.0%	48.9%	68.8%	79.3%	
2015 Peilstations						
Male	24.5%	34.4%	46.1%	63.8%	75.8%	88.0%
Female	12.5%	26.3%	39.9%	65.9%	76.5%	74.6%
2017 HBSC						
Total	20.2%	27.1%	47.5%	61.6%	67.2%	
2019 Peilstations						
Male	25.7%	36.0%	49.0%	60.4%	71.8%	83.5%
Female	16.8%	27.1%	53.2%	64.8%	71.5%	79.9%
2021 HBSC						
Total	26.4%	35.8%	46.6%	60.5%	76.0%	
Lifetime drunkenness						
2013 HBSC	12 years	13 years	14 years	15 Years	16 years	17 years
Total	0.6%	5.1%	12.0%	27.6%	44.8%	
2015 Peilstations						
Male	6.7%	9.3%	19.1%	37.2%	56.1%	74.0%
Female	1.3%	7.7%	19.3%	40.4%	53.1%	55.8%
2017 HBSC						
Total	0.6%	3.1%	12.3%	28.8%	38.6%	
2019 Peilstations						
Male	4.1%	7.9%	21.0%	38.1%	52.1%	68.8%
Female	3.4%	8.9%	30.2%	42.3%	54.1%	65.7%
2021 HBSC						
Total	3.0%	6.4%	13.0%	27.8%	46.6%	
Last month alcohol use						
2013 HBSC	12 years	13 years	14 years	15 Years	16 years	17 years
Total	3.7%	10.7%	24.2%	46.7%	66.3%	
2015 Peilstations						
Male	6.4%	9.6%	20.5%	42.3%	59.7%	73.7%
Female	2.4%	8.7%	20.7%	41.3%	58.8%	55.2%
2017 HBSC						
Total	3.7%	8.8%	23.7%	40.0%	49.9%	
2019 Peilstations						
Male	7.3%	9.9%	26.0%	41.1%	52.8%	66.7%
Female	3.3%	9.2%	27.3%	43.8%	53.8%	59.7%
2021 HBSC						
Total	6.9%	13.6%	25.9%	41.8%	59.9%	

Table Appendix B. *(continued)*

Last month binge drinking[1]						
2013 HBSC	12 years	13 years	14 years	15 Years	16 years	17 years
Total	47.2%	62.9%	66.8%	73.8%	79.9%	
2015 Peilstations						
Male	52.9%	52.9%	63.9%	73.2%	80.6%	83.9%
Female	48.8%	61.8%	58.2%	72.7%	68.1%	68.6%
2017 HBSC						
Total	60.3%	62.0%	66.0%	73.0%	84.6%	
2019 Peilstations						
Male	42.1%	36.6%	65.0%	73.2%	77.7%	85.6%
Female	36.6%	59.7%	71.0%	74.1%	79.9%	82.2%
2021 HBSC						
Total	68.5%	72.9%	64.9%	74.3%	82.9%	

[1] Analyses binge-drinking only for those who have been drinking in the past month

Section **2**

Prevention approaches to minimize alcohol consumption in adolescents

Chapter 6

Muscle-related outcomes of acute alcohol intoxication

Elevated creatine kinase levels amongst Dutch adolescents with acute alcohol intoxication

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Abstract

Purpose

This study aims to explore the prevalence of creatine kinase elevation amongst a sample of Dutch adolescents admitted for acute alcohol intoxication.

Methods

The data on all admitted adolescents < 18 years old with acute alcohol intoxication between 2008 and 2021 were collected from a Dutch major district general hospital, Reinier de Graaf Gasthuis, in Delft. Overall, 495 adolescents who were treated for symptoms of acute alcohol intoxication during this period were included in the study.

Results

When evaluating the blood samples of the included patients, elevated creatine kinase levels were found in 60% of the cases, with a mean of 254 U/l (normal value ≤ 145 U/l). A confirmed diagnosis of rhabdomyolysis (increase in CK > 5-fold the upper limit of normal) was present in 4.4% of cases. Moreover, using a linear regression this study found that a higher blood alcohol concentration was associated with higher creatine kinase levels, when adjusted for positive drug screenings amongst the adolescents with acute alcohol intoxication.

Conclusions

This is the first study focusing on how acute alcohol intoxication affects adolescents' muscle tissue. The results could potentially help to prevent alcohol use within the sports world. It could also aid understanding of how acute alcohol intoxication influences the breakdown of adolescents' muscle tissue.

Keywords

Acute alcohol intoxication, alcohol-induced rhabdomyolysis, rhabdomyolysis, adolescents, alcohol.

What is known:

- Alcohol, alongside pharmaceutical agents and illicit drugs, is a significant cause of rhabdomyolysis (increase in creatine kinase > 5-fold the upper limit of normal).
- Patients typically have a history of short-term alcohol intoxication and alcohol-induced coma or immobilisation in many of the cases of alcohol-related non-traumatic rhabdomyolysis reported in extant literature.

What is new:

- Our retrospective cohort study is a pioneer in addressing the effect of acute alcohol intoxication amongst adolescents (< 18 years) upon muscle tissue (creatine kinase level) within a large population.
- When evaluating the blood samples of the included adolescents with acute alcohol intoxication, elevated creatine kinase levels were found in 60% of the cases, with a mean of 254 U/l.
- A higher blood alcohol concentration was associated with higher creatine kinase levels, when adjusted for positive drug screening.
- There is an association between alcohol intoxication and elevated creatine kinase levels amongst adolescents. Future research is needed to further understand the pathophysiology and causality of this interaction.

Introduction

The World Health Organization stated that most adolescents between the age of 15 - 24 drink alcohol in heavy drinking sessions [1]. These sessions, which are also referred to as binge drinking, can lead to acute alcohol intoxication (AAI), which is an ongoing concern amongst adolescents [2]. Alcohol use specifically in adolescence is associated with adverse psychological, social and physical health consequences [3, 4].

In the Netherlands, it is illegal to buy and/or consume alcoholic beverages <18 years old. According to literature, sports canteens/bars are an outlets of major concern because the ID control compliance rates are low [5]. Therefore, it will be interesting to look at muscle related consequences of AAI to potentially help prevent AAI within the sports world. Amongst others, rhabdomyolysis has been identified as a complication of AAI in adults in extant literature [6-9]. However, there is no literature examining the prevalence of rhabdomyolysis amongst adolescents after AAI.

Rhabdomyolysis, acute muscle fibre necrosis, is accompanied by the leakage of muscle constituents into the blood [10]. The diagnosis is confirmed as an increase in Creatine Kinase (CK) to the degree of 5-10 fold the upper limit of normal [11]. Alcohol, alongside pharmaceutical agents and illicit drugs, is a significant cause of rhabdomyolysis. In AAI, CK elevation may be as a result of direct “muscular” toxicity” (myotoxicity) or from prolonged immobilization and ischemic compression induced by coma [8, 9]. The outcomes following rhabdomyolysis vary, ranging from asymptomatic elevations of CK concentration to life-threatening electrolyte abnormalities and acute kidney injury (AKI) [12].

The Reinier de Graaf Gasthuis (RdGG), a major district general hospital in the Netherlands, took a pioneering role in the prevention of AAI amongst Dutch adolescents when it opened a primary outpatient clinic for ‘adolescents and alcohol’ in 2006. When patients <18 years of age were admitted at the emergency department of the RdGG upon suspicion of AAI, blood tests were carried out, including their CK-level. The primary objective of this study is to determine the prevalence of rhabdomyolysis amongst a sample of Dutch adolescents admitted for AAI.

Methods

Participants

In the RdGG, a major district general hospital in Delft, The Netherlands, underage (< 18 years old) patients with AAI (positive BAC and/or clinical features of alcohol intoxication) during the period 2008 to 2021 were included in the study. This included patients who gave consent for data collection using the Paediatric alcohol questionnaire [13], while additional relevant non-identifiable information about the AAI event was retrospectively collected via the diagnostic treatment code 'alcohol intoxication'.

Materials

The primary objective of this study was to determine the prevalence of rhabdomyolysis amongst adolescents with AAI in the RdGG. Therefore, the CK level was evaluated for each patient with AAI. The secondary objectives were to determine whether characteristics such as gender, mean age, mean BAC, mean Glasgow coma score (EMV) score and/or proportion of positive drug screenings differed across those patients with elevated and normal CK levels. Sociodemographic characteristics such as age and gender were the continuous variables and therefore a mean with standard deviation (SD) was given. The intoxication characteristics such as BAC and positive drug screenings were expressed in gram/litre (g/L) and in % of the total population, respectively.

Moreover, the standard blood tests carried out on patients admitted with AAI includes: Sodium (in mmol/l), Potassium (in mmol/l), Calcium (in mmol/l), glucose (in mmol/l), Chloride (in mmol/l), CK (in U/l), Urea (in mmol/l), Creatinine (in µmol/l), Aspartate Aminotransferase (ASAT, in U/l), Alanine Aminotransferase (ALAT, in U/l), Gamma-glutamyl transferase (GGT, in U/l), Bilirubin (in µmol/l), Alpha-fetoprotein (in U/l), Lactate dehydrogenase (LDH, in U/l), Blood pH, Bicarbonate ($HCO3^-$, in mmol/l) and pCO2 (in kPa). The central laboratory for analysis of these samples is the Reinier Medical Diagnostic Centre. During the study period, the Cobas analyser (Roshe firm) was used for laboratory tests during the entire study period.

These blood values are shown in **Table 1**, along with the normal value range, the mean and the proportion (in %) of reduced or elevated values within the population. To assess the effects of BAC on CK levels, we used logistic regression models. First, we ran the analyses crude. Next, we ran the analyses adjusted for relevant covariates. Here, we selected covariates that had a 10% effect on the beta coefficients of the original analyses. We report *p*-values, beta coefficients and 95% confidence intervals (CI).

Procedures

All anonymous data were transformed in an SPSS dataset (version 25) for the purposes of the analyses. Descriptive statistics were used to show the baseline characteristics of the study population. Proportions were expressed as percentages, with 95% CIs. All continuous data were expressed as the average with SD. Those CIs that did not include one were considered to be statistically significant. The significance level was set to p = .05.

Both the medical ethical commission Leiden-Den Haag-Delft (*METC code G1.192*) and the research committee of the RdGG approved the manner of data collection adopted in this study.

Results

Overall, 506 adolescents < 18 years were admitted to the emergency department of the RdGG during the period 2008 - 2021 with the diagnostic treatment code 'alcohol intoxication'. In seven cases, there was a misclassification of the diagnostic treatment code, and no alcohol intoxication was reported in the electronic patient file, and therefore these patients were excluded from the study. Moreover, blood tests had not been performed on four patients, due to, amongst other things, resistance from the patient, and thus these patients were also excluded. Thus, 495 patients were included in this study. Five patients were admitted on two separate occasions to the emergency department with AAI, and so both events were included, because a new AAI event had taken place.

Of the 495 patients, 277 (56%) were girls (see **Table 1**). The median age of the entire study population was 16 years old, with girls being significantly younger than boys at the time of admission, aged 15 and 16, respectively (p = 0.003). The youngest children in the study were 12 years old (n = 4). The mean BAC was 0.19 g/L.

When evaluating the blood samples of the included patients, elevated CK levels were found in 60% (n = 275) of cases, with a mean of 254 U/l (see **Table 1**). The confirmed diagnosis rhabdomyolysis (increase in CK > 5-fold the upper limit of normal) was present in 4.4% of cases (n = 21), with the highest value being 3458 U/l. The creatinine was elevated in 36% (n = 171) of the included adolescents with AAI. Moreover, the blood pH was lower than 7.35 in 41% of cases. Within the acidotic patients, 28% had a bicarbonate < 21 mmol/l in and 31% had a pCO2 > 6.0 kPa. The chloride levels were elevated in 38% of the patients. The liver panel was in the normal range within this population (ASAT mean 26 U/l, ALAT mean 23 U/l, LDH 198 U/L).

Table 1. *Population characteristics with blood sample*

		Girls	Boys	Total population
Amount of adolescents		277 (56%)	218 (44%)	495
Median age, IQR (years, *n* = 495)		15 (1)	16 (1)	16 (1)
Mean BAC, sd (g/L, *n* = 493)		0.19 (0.06)	0.20 (0.05)	0.19 (0.06)
Median EMV-score, IQR (*n* = 181)		14 (3)	15 (3)	15 (3)
Proportion of substance abuse, CI (*n*, %)		11 (4.6%)	29 (15.4%)	40 (9%)
Blood sample with normal value in SI-unit	**N**	**Mean (SD)**	**Below lower limit of normal (n, %)**	**Above higher limit of normal (n, %)**
Sodium (135-145 mmol/l)	486	142 (3)	2 (0.4%)	39 (8%)
Potassium (3.2-4.7mmol/l)	478	3.8 (0.4)	24 (5%)	16 (3.2%)
Calcium (2.20-2.65 mmol/l)	464	2.3 (0.1)	90 (19%)	0 (0%)
Chloride (97-107 mmol/l)	469	106 (3)	2 (0.4%)	178 (38%)
CK (≤ 145 U/l)	458	254 (321)	--	275 (60%)
Urea (1.8-6.4 mmol/l)	478	3.9 (1.1)	5 (1.0%)	4 (0.8%)
Creatinine (40-68 µmol/l)	477	65 (11)	5 (1.0%)	171 (36%)
ASAT (0-31 U/L)	450	26 (9)	--	71 (16%)
ALAT (< 34 U/L)	470	23 (9)	--	43 (9.1%)
GGT (< 38 U/L)	477	15 (7)	--	7 (1.5%)
Bilirubin (< 21 µmol/l)	465	7 (5)	--	12 (2.6%)
Alkaline Phosphatase (0-500 U/L)	464	123 (73)	--	0 (0%)
LDH (< 247 U/l)	419	199 (36)	--	34 (8.1%)
pH (7.35-7.45)	364	7.36 (0.58)	149 (41%)	27 (7.4%)
Bicarbonate (HCO_3-, 21-28 mmol/l)	466	22 (3)	134 (29%)	4 (0.9%)
pCO_2 (4.3-6.0 kPa)	325	5.3 (1.0)	38 (12%)	48 (15%)

When using a linear regression model to analyse the effects of a higher BAC on CK levels, we did not find a statistically significant association (p = 0.089; β = 49.42; 95% CI -7,483–104.31). However, when adjusted for positive drug screening, we found that a higher BAC was associated with higher CK levels (p = 0.027; β = 66.88; 95% CI 7.68-126.08).

Discussion

Of the 495 adolescents with AAI included in our study, 60% (n = 275/458) showed elevated CK levels in their blood samples. Rhabdomyolysis (increase in CK > 5-fold the upper limit of normal) was present in 4.4% of cases (n = 21/458). Consequently,

most of the adolescents with AAI were in the preliminary stage of rhabdomyolyses with elevated CK levels (< 5-fold the upper limit of normal). It is important to know that CK elevation is present within patients in order to prevent extensive rhabdomyolysis from occurring [8]. Therefore, when patients are admitted to an emergency department with AAI, they should always undergo blood and urine tests for early recognition and treatment of rhabdomyolysis [14]. The treatment aims at the discontinuation of further skeletal muscle damage, the prevention of acute renal failure, and rapid identification of potentially life-threatening complications, such as hyperkalaemia and compartment syndrome [11]. Intravenous fluids should be initiated as soon as possible, preferably within the first six hours after experiencing muscle injury. Furthermore, using a linear regression this study found that a higher BAC was associated with higher CK levels, when adjusted for positive drug screenings amongst adolescents with AAI. The combination of elevated CK levels and the fact that the liver panel is mostly in the normal range within this population, could be a sign of muscle breakdown.

There can be multiple contributing factors leading to CK elevation amongst patients with AAI than merely alcohol intoxication itself, including, amongst other things, trauma [11], heavy sports training prior to drinking [15], or immobilisation (coma) during hospital admission for AAI. The risk of accidents that lead to trauma increases when alcohol has been consumed, primarily due to reduced coordination, reaction times and concentration. A recent study based on the entire Dutch population of AAI < 18 years old from 2007-2017 addressed the reason for admittance to emergency departments [16]. The category 'accident, fracture or suicide attempt' was given as the reason for admission in 11% of cases. Consequently, we presume that the CK elevation observed amongst 60% of our population cannot only be explained by trauma (which was present in 11% of a comparable population [16]). Therefore, we presume that the alcohol intoxication itself must have contributed to elevated CK levels amongst this population. Conversely, heavy sports training prior to the emergency department visit can also result in elevated CK levels. Indeed, extant literature shows that CK elevation can still be visible 72 hours post-workout [17]. However, the cut-off point for the serum creatine kinase upper limit in this literature often differs from our study. For instance, rather than > 5-fold, as used in our study, one study used two-times the upper limit of normal for CK [18], which might have resulted in more extensive outcomes. Although we do not have data regarding the patients' sporting activities prior to their admission to the emergency department, we do know that 75% of adolescents aged between 12 to 17 engage in sport more than one time per week [19]. The immobilisation factor amongst

adolescents with AAI can also influence CK elevation. However, the median EMV score amongst our population (reported in *n* = 181) was 15. This indicates that at the time the blood tests were carried out, it was unlikely that there were any signs of a coma that may result in immobilisation.

There were other interesting blood results. As expected, creatinine, which point out the degree of kidney damage (either pigment induced or secondary to fluid volume depletion), was elevated in 36% (*n* = 171) of the included adolescents with AAI. Moreover, the blood pH < 7.35 was present in 41% of cases. Acidosis may result either from hypoventilation (respirator) or from metabolic causes in the adolescents with AAI. In our population of 149 patients with an acidosis, the cause was respirator in 31% (*n* = 46 with pCO2 > 6.0 kPa) and metabolic in 28% (*n* = 41 with bicarbonate < 21 mmol/l). The chloride levels were elevated in 38% of our population. The aforementioned article focusing on AAI amongst Dutch adolescents in 2000 - 2010 also found hyperchloremia in 31% of their patients [20]. However, they also found low bicarbonate (22%), hypokalemia (12%) and hypernatremia (8%). The hypokalemia and hypernatremia were not as prominent in our study, while bicarbonate was < 21 mmol/l in 29% of our patients (*n* = 134).

Our retrospective cohort study is a pioneer in addressing the effect of AAI amongst adolescents upon muscle tissue (CK level) within a large population. Prior to this study, there have been only a couple of case reports published on this topic. Based on our study, we can presume that there is an association between alcohol intoxication and elevated CK levels amongst adolescents < 18 years old. Future research is needed to further understand the pathophysiology and causality of this interaction. Due to the lack of ID control in Dutch sports canteens, there are less barriers to underage alcohol consumption [5]. Therefore, we hope that our results can potentially help prevent alcohol intoxication within the sports world.

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Statement and declaration

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Competing interests
The authors have no relevant financial or non-financial interests to disclose.

Authors contribution
All authors contributed to the study conception and design. Material preparation, data collection and analysis was performed by Louise Pigeaud. The first draft of the manuscript was written by Louise Pigeaud and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Ethical approval
This study was performed in line with the principles of the Declaration of Helsinki. Both the medical ethical commission Leiden-Den Haag-Delft (*METC code G1.192*) and the research committee of the Reinier de Graaf Gasthuis approved the manner of data collection adopted in this study.

Consent to participate
The included patients gave consent for data collection using the Paediatric alcohol questionnaire. When adolescents were < 16 years old, parents gave additional permission for data collection.

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Chapter 7

Understanding why European adolescents drink alcohol

Drinking motives among 15–16-year-old school-going students in 16 European countries

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Abstract

Purpose

Investigating drinking motives among minors across various countries is crucial for understanding the broader social context of alcohol consumption. Thus, this study aimed to examine the differences and similarities in drinking motives among 15–16-year-old adolescents who consume alcohol across 16 European countries.

Methods

The data were obtained from the European School Survey Project on Alcohol and Other Drugs database. The analysis focused on 15–16-year-old school going students across 16 European countries (Denmark, Estonia, Finland, Germany, Greece, Iceland, Italy, Latvia, Lithuania, The Netherlands, Norway, Poland, Portugal, Romania, Sweden and Spain). The students were presented with a series of questions pertaining to drinking motives, aimed at elucidating the reasons behind their alcohol consumption within the past 12 months.

Results

A total of 52,141 students participated, with 75.2% reporting lifetime alcohol consumption and 65.8% reporting alcohol consumption in the past year. Among those who drank in the past year (n = 34,295), three distinct drinking motive factor groups were identified: enhancement and social motives, coping motives, and conformity motives. Enhancement and social motives were most prevalent across all countries, followed by coping motives, with conformity motives less common.

Discussion

This largest drinking motive study conducted to date, examined drinking motives among 15–16-year-old students across 16 European countries. There is a significant positive correlation between alcohol intoxication prevalence and mean score on enhancement and social motives at an aggregate level, which suggests a stronger presence of enhancement and social motives in cultures with a more intoxication-oriented drinking pattern.

Keywords

Adolescents, alcohol, alcohol intoxication, binge drinking, cross-national study, drinking motives, ESPAD, European School Survey Project on Alcohol and Other Drugs, Europe, minors.

Implication and contribution

This study of 15–16-year-old students across 16 European nations revealed consistent patterns in drinking motives, notably emphasizing enhancement and social motives. Findings suggest broad applicability for health promotion efforts targeting drinking motives across Europe, contributing to effective interventions for adolescent alcohol consumption.

Introduction

According to data from the World Health Organization (WHO), European nations demonstrate the highest prevalence of current alcohol consumption among adolescents aged 15 to 19 globally (43.8%), followed by the American nations (38.2%) and Western Pacific nations (37.9%) [1]. Significant disparities in alcohol consumption among adolescents exist across European countries [2, 3]. Notably, adolescents from southern and central European countries report more frequent alcohol consumption, whereas those from northern Europe report more frequent episodes of intoxication [4-8]. Apart from alcohol policy and drinking culture and patterns [2, 3], variations in drinking behaviours among adolescents between countries may also be influenced by drinking motives [9, 10]. These motives can be categorized based on the type of reinforcement individuals seek, whether positive or negative, in relation to either the psychoactive effects of alcohol (internal) or social effects (external) [4]. Thirty years ago, a four-factor model for understanding drinking motives among adolescents was developed and validated [11]. These factors encompass: enhancement (internal positive, e.g., drinking to have fun); social (external positive, e.g., drinking to be sociable); coping (internal negative, e.g., drinking to forget problems); and conformity (external negative, e.g., drinking to fit in with a group).

In the last two decades there has been a significant decrease in adolescent alcohol use and heavy episodic drinking (HED) in some European countries, including several Nordic countries, while other secular trends were observed in others, including a curvilinear trend in some Mediterranean countries [12]. This is interesting because traditionally, adolescent drinking cultures have diverged between Nordic and Mediterranean countries. The former is characterized by low overall alcohol consumption but a relatively high frequency of HED. In contrast, the latter is distinguished by higher overall alcohol consumption, albeit with a smaller proportion of HED occurrences. Previous research showed that for instance social drinking motives are correlated with frequent drinking, while enhancement and coping motives are associated with frequent drunkenness [10, 13]. Thus, now that drinking behaviour trends changed, it is possible that drinking motives may have evolved along in various European countries and hence it is of interest to reassess current drinking motives among adolescents across European countries.

A noteworthy study, with data from 2008 to 2010, delved into the drinking motives and correlating this with alcohol use differences in gender and culture among adolescents aged 11 to 19 across 13 European countries, primarily utilizing data from

the Health Behaviour in School-aged Children (HBSC) research project [4]. This study found that adolescents from Southern and Central European countries drank alcohol more frequently, while those from Northern Europe reported experiencing intoxication more often. They stated that this significant indirect effects indicated that certain cultural differences in drinking behaviours are attributed to higher levels of social, enhancement, and coping motivations in Northern Europe compared to Southern and Central Europe [4].

Previous studies [10], utilizing individual level data, have revealed that drinking motive items tend to cluster into distinct patterns based on the desired reinforcement individuals seek (enhanced positive effects or reduced negative effects) and the source of the anticipated effect (internal versus external). Considering the substantial and different secular trends in adolescent drinking behaviour across European countries over the past two decades, the present study aimed to assess whether such patterning and the relative significance of various drinking motives exhibited variability across a large number of European countries, employing recent data. Additionally, as a secondary objective, this study assessed whether drinking motives were correlated with levels of alcohol consumption- and intoxication at the population level.

Methods

The data utilized in this study were sourced from the European School Survey Project on Alcohol and Other Drugs (ESPAD), recognized as the most extensive cross-national database on adolescent substance use globally. Over the period from 1995 to 2019, the ESPAD Group systematically gathered comparable data on substance use among samples of 15-16-year-old students in as many European countries as feasible [14]. The target population for the ESPAD consists of students who turn 16 years old within the calendar year of the survey and are present in the classroom on the survey day. The study was carried out on a representative sample of the target population in all participating countries. This population includes students enrolled in regular, vocational, general, or academic programs. Data collection was conducted through self-administered questionnaires, which students completed anonymously in the classroom setting. The school participation rate (share of selected schools taking part in the survey) and the class participation rate (share of selected classes participating) were both generally high per country, with an average of 81% and 85 % respectively. The proportion of students in the selected classes who were present on the day of the survey and who answered

the questionnaire was high (86 % on average). Overall, participation coverage for the target population exceeded 90% within each country, and parental consent was required for student participation in the survey. For additional information about data collection method the ESPAD 2019 methodology report can be found online [15]. The study protocol was submitted to the ESPAD Group by the authors, and approval with data access was granted for this study. Data from the most recent survey year, 2019, and European countries that included the drinking motive questions were incorporated into the analysis. Consequently, data from 16 countries (Denmark, Estonia, Finland, Germany, Greece, Iceland, Italy, Latvia, Lithuania, The Netherlands, Norway, Poland, Portugal, Romania, Sweden, and Spain) were included in the study, see **Figure 1**. Identical questions on alcohol use and drinking motives were administered across all included countries. The total sample size across all surveys and countries amounted to *n* = 52,141 school-going students aged 15–16 years.

Figure 1. *Included 16 European countries coloured in green*

Baseline characteristics

First, an overview of key demographic variables and alcohol-related behaviours for both the total study population and individual countries was explored, as detailed in **Table 1**. Sex was categorized as male or female, while birth year was recorded to assess the age distribution of surveyed students. Alcohol consumption frequency was measured by the question: 'On how many occasions (if any) have you had any alcoholic beverage to drink in the last 12 months?' Response options ranged from: 0 to 40 + occasions. Additionally, alcohol intoxication frequency was assessed in students who consumed alcohol in the last 12 months with the question: 'On how many occasions (if any) have you been intoxicated from drinking alcoholic beverages, for example staggered when walking, not being able to speak properly, throwing up or not remembering what happened?' Responses were categorized similarly, ranging from 0 to 40+ occasions within the last 12 months. In the analysis, we employed two dichotomous measures; separating those who had not consumed alcohol from those who had, and separating those who had not been intoxicated from those who had.

Drinking motives

The students were presented with a series of questions pertaining to drinking motives, aimed at elucidating the reasons behind their alcohol consumption within the past 12 months. The items assessing drinking motives included the following: In last 12 months how often did you drink... (1) because it helps you enjoy a party, (2) because it helps you when you feel depressed or nervous, (3) to cheer up when you're in a bad mood, (4) because you like the feeling, (5) to get high, (6) because it makes social gatherings more fun, (7) to fit in with a group you like, (8) because it improves parties and celebrations, (9) to forget about your problems, (10) because it's fun, (11) to be liked, (12) so you won't feel left out. Responses to these 12 items were recorded using a validated five-point scale from the Drinking Motives Questionnaire Revised Short Form (DMQ-R-SF) [13], with options: 1 = never, 2 = seldom, 3 = sometimes, 4 = mostly, 5 = always. **Table A1** presents the mean score of both the total study population and country-specific data on drinking motives for participants who had consumed alcohol within the past 12 months and completed the drinking motive questions.

Analysis

The SPSS database was meticulously prepared for this research project by the ESPAD Group subsequent to the approval of our study protocol. Analysis for this study was conducted employing IBM SPSS Statistics version 25.0.0.2 [16]. First, descriptive analysis was employed to reveal the demographic characteristics, as presented in **Tables 1**

and A1. To examine the differences in drinking motives across European countries, an exploratory factor analysis (principal component analysis) was conducted to explore underlying correlations within the entire population of individuals who had consumed alcohol within the past 12 months. All 12 aforementioned drinking motive items, along with their respective response alternatives, were included in the analysis. The principal component method with Varimax rotation and Kaiser Normalization, was utilized for factor extraction. The determination of the number of factors was based on criteria including Eigenvalue > 1, the visual assessment of scree plots, and the interpretability of the extracted factors [17]. The resulting factors and their corresponding factor loadings are illustrated in **Figure 2**.

In the existing literature [17, 18], two distinct methods have been outlined for deriving scores from factor analysis when handling this type of data. Firstly, factor scores were computed by multiplying the factor loadings with the response scores from the DMQ-R-SF for each individual on all 12 items, followed by summing up all these subscores. Factor loadings below 0.30 were also included in this calculation. Subsequently, for each individual, factor scores were computed for each identified factor. In **Table 2** the mean with standard deviation (SD) per country, as well as the total for all 16 countries, were presented.

Secondly, the sum score method, as described in the literature [17, 18], was employed. This method involved forming a sum score for each factor, where items were allocated based on the factor with the highest factor loading. Subsequently, for each factor, a sum score was calculated by summing the mean scores of the DMQ-R-SF items within that factor and dividing by the number of items in the factor group, as outlined in **Table A2**. In this approach, all items within a factor were accorded equal weight, irrespective of their loading values, and each item was exclusively assigned to one factor.

Both methods were used, and it was examined whether the scores from the two methods correlated (i.e. for each of the identified factors) using the Pearson correlation test at the aggregate level. When the scores correlated, the findings based on the factor score method were presented as the main finding and that findings from the sum-score method are presented as supplemental material. This choice was made because the factor score method accounted for factor loadings, which makes it more precise.

Differences in drinking motive factor scores between each country and the total population were computed and illustrated in **Figure 3**. Subsequently, aggregate-level analyses were conducted utilizing one-way ANOVA tests, followed by post hoc

Tukey tests, to explore variations and similarities in mean factor scores of drinking motives across countries.

Additionally, further aggregate-level analyses were employed to investigate correlations between drinking motives and prevalence rates of alcohol consumption and intoxication within the last 12 months.

Results

Demographic characteristics

Data from 52,141 school going children aged 15–16-year-old in 16 countries were analysed. Among them, 51.1% were of the female gender, and the majority were born in the year 2003 (98.2%), as delineated in **Table 1**. Within the total population, 75.2% reported lifetime alcohol consumption and 65.8% (*n* = 34,295) indicating alcohol consumption within the last 12 months. Notably, in Denmark, Germany, and Greece the alcohol consumption percentage in the last 12 months was highest, 87.6%, 87.6% and 82.6% respectively. Conversely, Iceland, Norway, and Sweden demonstrated the lowest rates of alcohol consumption in the last 12 months, at 25.8%, 43.3%, and 45.8%, respectively. Alcohol intoxication in the last 12 months was reported by 27.4% of the current alcohol comsuming student in all 16 countries with respondents from Denmark surpassing this mean considerably at 63.0%, while respondents from Iceland fell notably below it at 9.3%.

Drinking motives differences per country

Table A1 presents an overview of the mean scores for responses to the 12 items assessing drinking motives, categorized by country and encompassing the total population who drank alcohol in the last 12 months and completed the drinking motive questions (*n* = 34,295). Across all 16 countries, the highest score of drinking motive was observed for ‘To enjoy parties’, with a mean score of 2.5 (SD = 1.4), whereas ‘To be liked’ received the lowest mean score 1.3 (SD = 0.7). Additionally, motives such as ‘Enhancing social gatherings’, ‘Improve parties’, ‘It’s fun’ and ‘Like the feeling’ also garnered a notable mean score, respectively of 2.4 (SD = 1.4), 2.4 (SD = 1.4), 2.3 (SD = 1.4) and 2.2 (SD = 1.3). Substantial variation in mean scores for the motive ‘To enjoy parties’ existed among countries, ranging from Iceland’s mean score of 2.2 (SD = 1.4) to Denmark’s mean score of 3.3 (SD = 1.4). Furthermore, all mean scores for drinking motives in Iceland were either lower or equal to the overall average across the 16 countries. Conversely, all mean scores for drinking motives in Denmark were either higher or equal to the overall average across the 16 countries.

***Table 1**. Population characteristics for the total sample and per country*

Country	*n*	Sex, proportion females	Birth Year	Any alcohol consumption last 12 months	Any alcohol intoxication in the last 12 months #
All 16 countries	52,141	51.1%	2003 98.2% 2004 1.8%	65.8%	27.4%
Iceland	2,534	51.3%	2003	25.8%	9.3%
Norway	4,313	49.9%	2003	43.3%	18.9%
Sweden	2,546	49.8%	2003	45.8%	21.5%
Finland	4,594	50.4%	2003	59.3%	29.5%
Portugal	4,365	54.3%	2003	68.2%	23.5%
Italy	2,542	47.6%	2003	76.1%	27.2%
Spain	3,557	52.0%	2003	69.9%	36.4%
Greece	5,988	51.2%	2003	82.6%	25.1%
Lithuania	2,393	50.4%	2003	60.8%	22.5%
Estonia	2,520	52.1%	2003	64.2%	25.1%
Romania	3,764	49.8%	2003	71.9%	23.1%
Poland	5,047	52.7%	2003	69.2%	25.9%
Latvia	2,743	49.4%	2003	72.9%	31.6%
Denmark	2,488	52.4%	2003	87.6%	63.0%
The Netherlands	1,288	52.7%	2003 28.6% 2004 71.4%[1]	65.8%	32.5%
Germany (Bavaria)	1,459	51.3%	2003	87.6%	42.7%

#: As part of the students that consumed alcohol in the last 12 months. Alcohol intoxication was surveyed with the following question: 'On how many occasions (if any) have you been intoxicated from drinking alcoholic beverages, for example staggered when walking, not being able to speak properly, throwing up or not remembering what happened?

[1]The data collection in the Netherlands was 7 months later than in the other participating countries. In order to have the same age group as the other ESPAD countries, the Dutch birth-cohort included also students born in 2004.

Drinking motives factor analysis

Upon conducting factor analysis to discern interrelated components within the drinking motives among all participants who consumed alcohol within the last 12 months, three distinct factors emerged, as illustrated in **Figure 2**. These factors collectively explained 72.5% of the variance. The first factor was characterised by items from the DMQ-R-SF pertaining to enhancement and social (internal and external positive) drinking motive. The second factor encompassed DMQ-R-SF items predominantly associated with coping (internal negative) drinking motive,

while the third factor was distinguished by items reflecting a conformity (external negative) drinking motive focus.

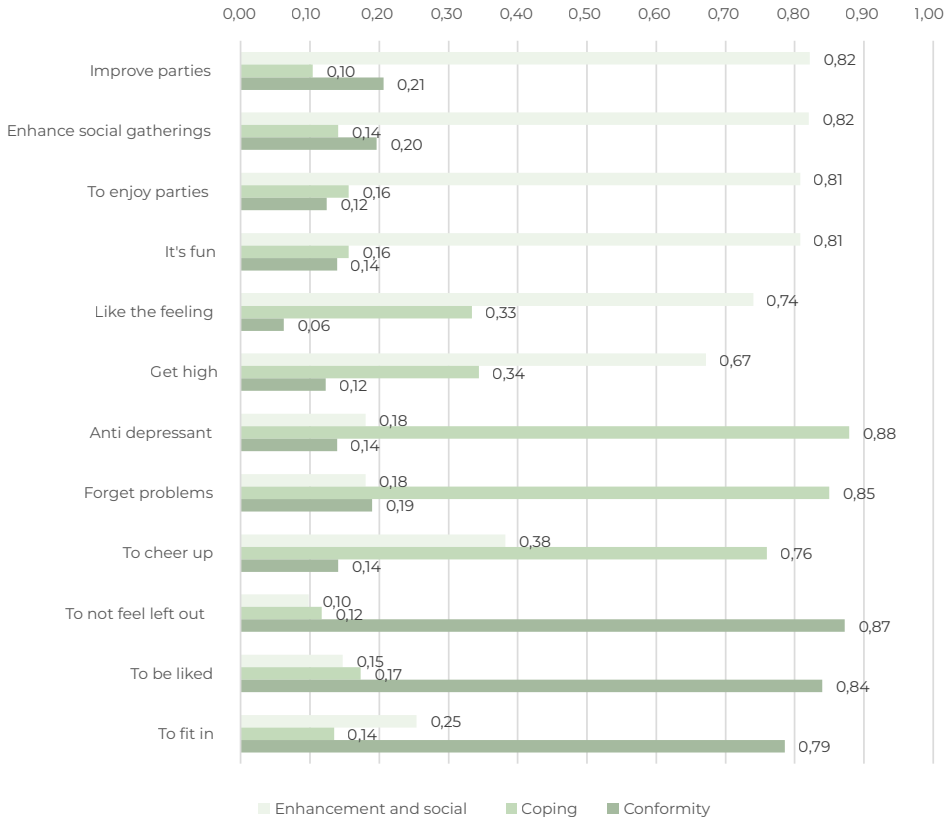

Figure 2. *Three drinking motives factors with their factor loading*

Drinking motive factor scores

The total factor score was computed based on factor loadings for three drinking motive factors[9]. As depicted in **Table 2**, enhancement and social motive predominated across all countries, with Denmark exhibiting the highest score (16.5, SD 6.0) and Norway ranked second (15.5, SD 7.2). Portugal, Iceland, and Poland displayed the lowest scores in the enhancement and social drinking motive. Coping motive scored lower overall mean scores (7.4, SD 3.4), than the enhancement and social drinking motive, with Norway recording the highest mean (9.1, SD 4.4), followed by Estonia and Denmark, see **Table 2**. The lowest coping drinking motive score was seen in The Netherlands (6.5, SD 2.5). Conformity motive had the lowest mean score of all factors (6.1, SD 2.5), with Norway and Denmark scoring highest, and Portugal and The Netherlands scoring lowest.

***Table 2**. Drinking motives factor scores per country*

Country	Percentage of population with alcohol consumption last 12 months	Drinking motives factor score, mean (SD)+		
		Enhancement and social (Internal and external positive)	Coping (Internal negative)	Conformity (External negative)
All 16 countries	65.8%	12.6 (5.7)	7.4 (3.4)	6.1 (2.5)
Iceland	25.8%	11.2 (5.8)	6.8 (3.6)	5.6 (2.5)
Norway	43.3%	15.5 (7.2)	9.1 (4.4)	7.6 (3.6)
Sweden	45.8%	12.6 (5.8)	7.2 (3.4)	5.9 (2.3)
Finland	59.3%	13.4 (6.3)	7.7 (3.7)	6.2 (2.5)
Portugal	68.2%	11.2 (5.2)	6.8 (3.1)	5.4 (1.9)
Italy	76.1%	12.1 (5.4)	7.0 (3.1)	5.7 (2.2)
Spain	69.9%	12.5 (5.2)	7.1 (3.0)	5.8 (2.0)
Greece	82.6%	11.6 (5.0)	7.0 (3.2)	5.9 (2.3)
Lithuania	60.8%	12.5 (5.8)	7.6 (3.5)	6.4 (2.9)

9 The drinking motive sum scores was also calculated to investigate similarities and differences with the drinking motive factor scores, see Table 2 and A2. Additional analysis based on the mean factor score and mean sum score for each country per factor showed that they were high and statistically significant correlations (all three factors $p < 0.001$, Pearson correlation for enhancement and social drinking motive = 0.99, coping drinking motive = 0.89, conformity drinking motive = 0.90). Because results showed resemblance, the factor score method was used as the primary method for illustrating the drinking motives because it took factor loading into account and therefore was more precise.

***Table 2**. (continued)*

Country	Percentage of population with alcohol consumption last 12 months	Drinking motives factor score, mean (SD)[+]		
		Enhancement and social (Internal and external positive)	Coping (Internal negative)	Conformity (External negative)
Estonia	64.2%	13.3 (6.3)	8.6 (4.1)	6.7 (3.0)
Romania	71.9%	11.6 (5.1)	6.8 (3.0)	5.9 (2.4)
Poland	69.2%	11.3 (5.1)	7.1 (3.3)	5.7 (2.3)
Latvia	72.9%	12.1 (5.2)	7.5 (3.3)	6.0 (2.2)
Denmark	87.6%	16.5 (6.0)	8.4 (3.4)	7.5 (2.8)
The Netherlands	65.8%	12.6 (5.2)	6.5 (2.5)	5.6 (1.8)
Germany (Bavaria)	85.3%	13.9 (5.5)	7.3 (2.9)	6.3 (2.2)

[+] *Factor scores were calculated by multiplying factor loadings from **figure 2** with the DMQ-R-SF response scores for each person and adding all these subscores of the 12 DMQ-R-SF items together. For each individual person a factor score for each factor is then calculated. The mean factor score with SD will be shown per country and as a total.*

Figure 3 demonstrates minimal deviation per country from the total population mean factor score, except for Denmark and Norway, where scores are notably higher across all three drinking motive factors. A one-way ANOVA revealed a significant difference between countries' scores in the enhancement and social group ($F(16, 32924) = 146.02$, $p < .001$). Tukey post hoc analysis confirmed Denmark's significantly highest mean score ($p < .001$) compared to all other countries and Iceland's significantly lowest score, differing significantly from most countries except Greece, Poland, Portugal, and Romania. Similarity in enhancement and social motive scores compared to the total population were observed for Sweden, Italy, Spain, Lithuania, Latvia, The Netherlands, and Estonia.

A significant difference in coping drinking motive scores among countries was found via one-way ANOVA ($F(16, 32924) = 77.79$, $p < .001$). Tukey post hoc analysis identified Norway with significantly higher score than all other countries ($p < .001$, except Estonia, $p = .026$). The Netherlands exhibited the lowest coping motive score, significantly lower than most countries, except Iceland, Italy, Portugal, and Romania. Similarity in coping motive mean scores compared to the total population were objectified in Latvia, Lithuania, Germany (Bavaria), Sweden, and Finland.

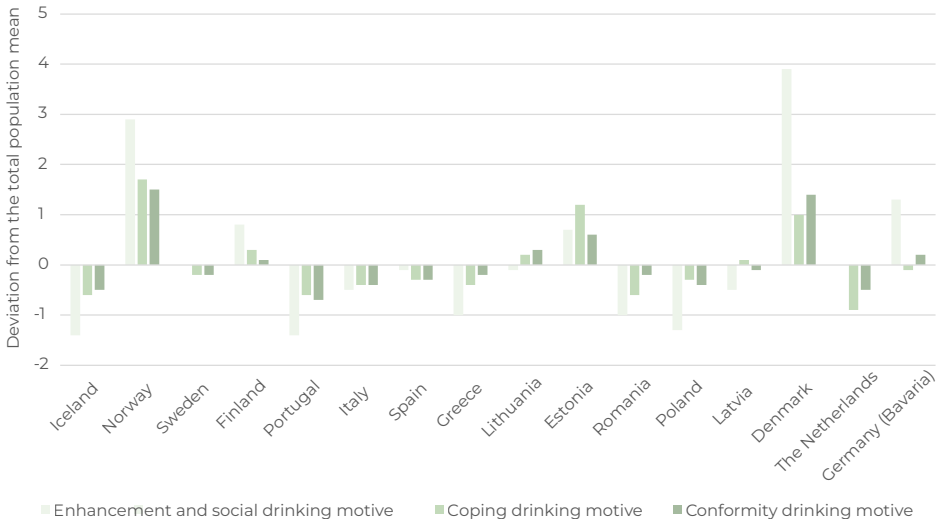

***Figure 3**. Countries drinking motive factor score mean compared to the total population*

For conformity drinking motive, a significant difference among countries was observed by the one-way ANOVA ($F(16, 32924) = 118.53$, $p < .001$). Tukey post hoc analysis indicated Norway with the highest mean score, significantly higher than all other countries ($p < .001$, except Denmark, $p = .996$). Similarity in conformity motive mean scores compared to the total population were observed for Finland, Germany (Bavaria), Lithuania, Latvia, and Sweden.

Drinking motives and alcohol consumption- and intoxication in the last 12 months

At the aggregate level with countries as the unit of analysis, no correlation was found between alcohol consumption prevalence in the last 12 months and drinking motives ($p = .405$ for enhancement and social drinking motive, $p = .974$ for coping drinking motive, $p = .656$ for conformity drinking motive). However, a significant positive correlation was observed between prevalence of alcohol intoxication in the last 12 months and the mean score on enhancement and social drinking motive (Pearson correlation coefficient = .732, $p < .001$). Neither coping nor conformity drinking motives mean scores showed statistically significant correlations with alcohol intoxication in the last 12 months ($p = .197$ and $p = .055$, respectively).

Discussion

This study found that across 16 European countries, drinking motives among 15–16-year-old students who reported alcohol consumption in the past 12 months (*n* = 34,295) can be grouped into three drinking motive factor groups: (1) enhancement and social, (2) coping, and (3) conformity motives. This three-factor model differs slightly from the earlier mentioned four-factor model from existing literature [11, 19]. In the four-factor model, positive drinking motives were separated into internal (enhancement) and external (social) components, whereas our study with ESPAD data, all positive drinking motives loaded on one factor in the factor analysis.

The prominence of enhancement and social drinking motives was consistent across all countries, with Denmark showing the highest mean score, statistically significant compared to all other countries. Notably, Denmark, alongside Germany (Bavaria), exhibited the highest rates of alcohol consumption and intoxication among school-going students. Denmark's known culture of heavy intoxication-oriented, playful drinking [20] aligns with these findings. This suggests that in countries where intoxication is prevalent, and possibly more socially accepted [5, 6], motives like 'to get high' and 'likes the feeling' may be more pronounced. This differs considerably from southern European, mostly wine-producing countries, where the predominant drinking pattern is frequent consumption of moderate amounts of alcohol, often accompanying meals [5, 6]. Indeed in this study, most of the southern European countries like Greece, Spain, and Portugal scored significantly lower on this motive compared to the total population, which might reflect cultural differences in drinking behaviours.

The order of importance in drinking motives — enhancement and social, followed by coping and then conformity — echoes findings in existing literature [10]. Here, coping motives emerged as the second most prominent motive, with Norway exhibiting the highest mean score, significantly surpassing other countries. Coping motives are typically associated with frequent drunkenness and alcohol-related problems [10, 13]. While alcohol consumption and HED frequency have declined markedly among Norwegian adolescents since the turn of the millennium, the drinking culture is still oriented towards HED and a substantial fraction of drinking occasions result in intoxication [21].

Conformity motives scored the lowest mean factor score across all countries, with Norway showing the highest score, statistically significant compared to most countries except Denmark. In environments where alcohol use is prevalent, conformity motives such as 'to fit in' and 'not feel left out' may be more pronounced.

However, it's noteworthy that Norway's alcohol consumption rate in the last 12 months (43.3%) is lower than Denmark's (87.6%).

Overall, Denmark and Norway stood out with higher drinking motive scores across all three factors compared to other countries. At the aggregate level, we found no significant correlation between prevalence of alcohol consumption in the last 12 months and mean scores on drinking motives, but we found a significant positive correlation between alcohol intoxication prevalence and mean score on enhancement and social motives. This suggests a stronger presence of enhancement and social motives in cultures with a more intoxication-oriented drinking pattern, which aligns with previous research [10, 13]. The previously mentioned study, which utilized HBSC data from 2008 to 2010, concentrated on drinking motives and examined how these motives correlate with differences in alcohol use across gender and culture among adolescents from 13 European countries differing from countries used in our study. This research identified a stronger relationship between enhancement motives and drinking frequency among 14- to 16-year-old boys than girls, whereas the link between coping motives and drunkenness frequency was significantly stronger among 14- to 16-year-old girls. Other previous research also showed that coping motives are related to frequent drunkenness [10, 13], while we did not find an association between prevalence of drunkenness and coping motives scores in our study, it is possible that an aggregate level association between frequent drunkenness and coping motives scores exists.

This previous study did found that despite cultural variations, internal and external positive drinking motives prevail followed by internal negative and external negative motives [19]. This is in line with our study, using 16 mainly different European countries. This consistency suggests the applicability of health promotion efforts based on drinking motives throughout Europe. For instance, preventive mass media campaigns or informative talks in school classes to give more information to minors about the risks of alcohol and suggest alcohol-free options to fulfil their demands, focused on most prevalent drinking motives in this specific age group.

This study's strengths lie in its large sample size (n = 52,141) of 15–16-year-old school-going students across 16 European countries, making it the most extensive drinking motive study to date. It offers a comprehensive overview of drinking motives' similarities and differences at the population level, utilizing standardized data collection methods by the ESPAD committee and validated screening tools (DMQ-R-SF). However, a limitation arises from conducting factor analysis based

on the entire population (that consumed alcohol in the last 12 months) rather than individually by country. This decision was made because otherwise different factor loadings and subscores would be formed in each country, which makes countries incomparable with each other and total population analyses would not be possible. Nevertheless, this approach provides insights into a generalized structure of drinking motives within broader societal contexts. In future research it would be of additional value to study the association between drinking motives and alcohol-related outcomes in a multi-level model, while controlling for background factors and accounting for clustering effects on the country level. Furthermore, the proportion of students in the selected classes who were present on the day of the survey and who answered the questionnaire was 86 % on average, which could potentially create bias because students who were absent on the day of the survey might be more risk seeking. Lastly, data from the most recent available ESPAD study year 2019 was used and this data were collected before the COVID pandemic. Therefore the influence of the COVID pandemic on adolescent drinking motives could not be evaluated, while research shows that the COVID pandemic has influenced alcohol use in adolescents [22]. Future research on drinking motives in adolescents, utilizing standardized data collection methods and validated screening tools (such as DMQ-R-SF), could extend this cross-cultural comparison beyond Europe to include countries from other continents. In this way it will be possible to explore if these patterns are also visible in other continents, and additional recommendations for prevention strategies could be made globally. Moreover, recent data should be used also taking in to account the period before and after the COVID pandemic, to understand the effects of this potential different period.

Conclusion

In conclusion, this comprehensive study delves into drinking motives among 15–16-year-old students across 16 European countries, revealing consistent patterns across cultures. Internal and external positive drinking motives emerged as predominant, followed by internal negative and external negative motives. Moreover, there is a significant positive correlation between alcohol intoxication prevalence and mean score on enhancement and social motives at an aggregate level, which suggests a stronger presence of enhancement and social motives in cultures with a more intoxication-oriented drinking pattern. These findings underscore the potential applicability of health promotion strategies integrating drinking motives throughout Europe, offering valuable insights for prevention effort.

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Conflict of interest statement

The authors have no conflicts of interest to declare.

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Appendix

***Table A1**. Overview of answers of the 12 drinking motives items per country*

Country	Drinking motives (mean score with SD)*											
	To enjoy parties	*Anti-depressant*	*To cheer up*	*Like the feeling*	*Get high*	*Enhance social gatherings*	*To fit in*	*Improve parties*	*Forget problems*	*It's fun*	*To be liked*	*To not feel left out*
All 16 countries (n = 34,295)	2.5 (1.4)	1.6 (1.0)	1.8 (1.1)	2.2 (1.3)	1.9 (1.2)	2.4 (1.4)	1.5 (0.9)	2.4 (1.4)	1.6 (1.1)	2.3 (1.4)	1.3 (0.7)	1.4 (0.8)
Iceland (n = 655)	2.2 (1.4)	1.5 (1.0)	1.6 (1.0)	2.0 (1.4)	1.6 (1.2)	1.8 (1.2)	1.4 (0.8)	2.0 (1.3)	1.6 (1.1)	2.5 (1.5)	1.3 (0.7)	1.3 (0.8)
Norway (n = 1867)	2.9 (1.5)	1.8 (1.2)	2.5 (1.5)	2.7 (1.5)	2.4 (1.4)	2.9 (1.5)	1.8 (1.1)	2.9 (1.5)	1.8 (1.3)	3.0 (1.5)	1.6 (1.1)	1.7 (1.2)
Sweden (n = 1165)	2.5 (1.5)	1.6 (1.0)	1.6 (1.0)	2.3 (1.4)	2.1 (1.4)	2.4 (1.4)	1.4 (0.8)	1.9 (1.2)	1.6 (1.1)	2.8 (1.5)	1.2 (0.6)	1.3 (0.7)
Finland (n = 2723)	2.5 (1.3)	1.5 (1.0)	1.8 (1.2)	2.4 (1.4)	2.2 (1.4)	2.6 (1.4)	1.4 (0.8)	2.4 (1.3)	1.7 (1.1)	2.7 (1.5)	1.3 (0.6)	1.3 (0.7)
Portugal (n = 2976)	2.2 (1.2)	1.5 (0.9)	1.5 (0.9)	2.2 (1.3)	1.8 (1.1)	2.1 (1.2)	1.3 (0.7)	2.0 (1.2)	1.6 (1.1)	2.0 (1.2)	1.1 (0.4)	1.2 (0.6)
Italy (n = 1935)	2.5 (1.3)	1.5 (1.0)	1.6 (1.0)	2.2 (1.3)	1.8 (1.2)	2.0 (1.3)	1.4 (0.9)	2.5 (1.4)	1.5 (1.0)	2.2 (1.3)	1.2 (0.6)	1.2 (0.7)
Spain (n = 2487)	2.7 (1.4)	1.5 (0.9)	1.6 (1.0)	2.2 (1.3)	1.5 (1.0)	2.2 (1.3)	1.3 (0.7)	2.6 (1.4)	1.6 (1.1)	2.5 (1.4)	1.2 (0.6)	1.2 (0.7)
Greece (n = 4944)	2.5 (1.3)	1.6 (1.0)	1.8 (1.1)	1.9 (1.2)	1.9 (1.2)	2.1 (1.2)	1.5 (0.9)	2.3 (1.3)	1.5 (1.0)	1.8 (1.1)	1.2 (0.6)	1.4 (0.8)
Lithuania (n = 1456)	2.4 (1.3)	1.7 (1.1)	1.8 (1.1)	2.1 (1.2)	2.0 (1.2)	2.2 (1.3)	1.6 (1.0)	2.4 (1.3)	1.7 (1.2)	2.4 (1.3)	1.5 (0.9)	1.4 (0.9)
Estonia (n = 1617)	2.3 (1.4)	1.9 (1.2)	2.5 (1.4)	2.3 (1.3)	1.9 (1.2)	2.6 (1.4)	1.7 (1.1)	2.4 (1.4)	2.0 (1.3)	2.5 (1.4)	1.4 (0.8)	1.5 (0.9)
Romania (n = 2705)	2.5 (1.3)	1.4 (0.9)	1.6 (1.0)	1.9 (1.1)	1.9 (1.2)	2.2 (1.3)	1.5 (0.9)	2.2 (1.3)	1.5 (1.0)	1.9 (1.2)	1.3 (0.8)	1.4 (0.8)
Poland (n = 3494)	2.3 (1.3)	1.7 (1.1)	1.8 (1.1)	1.8 (1.1)	1.5 (1.0)	2.3 (1.3)	1.4 (0.8)	2.2 (1.2)	1.6 (1.1)	1.8 (1.1)	1.2 (0.6)	1.3 (0.7)
Latvia (n = 1999)	2.4 (1.3)	1.7 (1.1)	1.8 (1.1)	2.0 (1.1)	1.8 (1.1)	2.4 (1.3)	1.6 (0.9)	2.2 (1.2)	1.7 (1.1)	2.3 (1.3)	1.2 (0.6)	1.2 (0.6)

***Table A1**. (continued)*

Country	Drinking motives (mean score with SD)*											
	To enjoy parties	*Anti-depressant*	*To cheer up*	*Like the feeling*	*Get high*	*Enhance social gatherings*	*To fit in*	*Improve parties*	*Forget problems*	*It's fun*	*To be liked*	*To not feel left out*
Denmark (n = 2180)	3.3 (1.4)	1.6 (1.0)	1.8 (1.1)	2.7 (1.4)	2.4 (1.4)	3.3 (1.3)	1.8 (1.0)	3.1 (1.4)	1.6 (1.0)	3.5 (1.3)	1.4 (0.8)	1.6 (1.0)
The Netherlands (n = 847)	2.5 (1.4)	1.2 (0.7)	1.4 (0.8)	2.4 (1.5)	1.4 (0.9)	2.3 (1.4)	1.2 (0.7)	2.4 (1.4)	1.4 (0.9)	3.0 (1.5)	1.1 (0.5)	1.2 (0.6)
Germany, Bavaria (n = 1245)	2.7 (1.4)	1.4 (0.9)	1.8 (1.1)	2.3 (1.3)	1.4 (1.0)	3.1 (1.4)	1.5 (0.9)	2.8 (1.4)	1.5 (1.0)	3.0 (1.5)	1.2 (0.6)	1.3 (0.7)

Abbreviations: SD = Standard deviation

**Question: 'In the last 12 months, how often did you drink because of the above mentioned drinking motive'. Answer options: 1 = never, 2 = seldom, 3 = sometimes, 4 = mostly, 5 = always*

***Table A2**. Drinking motives mean sum score*

Country		Drinking motives sum score (mean)[+]		
	Percentage of population with alcohol consumption last 12 months	**Enhancement and social (Internal and external positive)**	**Coping (Internal negative)**	**Conformity (External negative)**
All 16 countries	65.8%	2.3	1.7	1.4
Iceland	25.8%	2.0	1.6	1.3
Norway	43.3%	2.8	2.0	1.7
Sweden	45.8%	2.3	1.6	1.3
Finland	59.3%	2.5	1.7	1.3
Portugal	68.2%	2.1	1.5	1.2
Italy	76.1%	2.2	1.5	1.3
Spain	69.9%	2.3	1.6	1.2
Greece	82.6%	2.1	1.6	1.4
Lithuania	60.8%	2.3	1.7	1.5
Estonia	64.2%	2.3	2.1	1.5
Romania	71.9%	2.1	1.5	1.4
Poland	69.2%	2.0	1.7	1.3
Latvia	72.9%	2.2	1.7	1.3
Denmark	87.6%	3.1	1.7	1.6
The Netherlands	65.8%	2.3	1.3	1.2
Germany (Bavaria)	87.6%	2.6	1.6	1.3

[+]Question: 'In the last 12 months, how often did you drink because of the above mentioned options'. Answer options: 1 = never, 2 = seldom, 3 = sometimes, 4 = mostly, 5 = always

Chapter 8

Qualitative approach for prevention insights from Dutch minors

And then I blacked out - A qualitative interview study on alcohol intoxication events in adolescents under 18 years old

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Abstract

Background

Understanding the mechanisms influencing alcohol consumption in adolescents is crucial for developing effective strategies to minimize alcohol intoxication in this age group. This study seeks to explore the experiences of adolescents who have had an alcohol intoxication, aiming to better understand their motivations and inform the development of improved prevention strategies.

Methods

The study involved adolescents under 18 years old admitted for an alcohol intoxication at Reinier de Graaf Gasthuis in Delft, The Netherlands. Data from 24 semi-structured interviews, part of the "Youth and Alcohol" outpatient clinic's standardized follow-up program, were analysed. In-depth interviews were conducted 1-2 months after the intoxication event.

Results

Four key themes emerged from the interviews: (1) Context of alcohol consumption, (2) alcohol consumption patterns, (3) consequences of the alcohol intoxication event, and (4) reflections on the alcohol intoxication event and recommendations for preventive measures. A common observation was that many adolescents reported not recognizing when they became intoxicated, often describing a "black-out" experience. During the alcohol intoxication event, they often consume spirits in the evening/night, typically in social settings with friends, motivated by social and enhancement drinking motives. The adolescents who participated emphasised the importance of alcohol education, stricter advertising regulations, and stronger enforcement of alcohol laws as key measures to reduce alcohol intoxication and mitigating alcohol's harmful consequences in their population.

Conclusion

This study provides valuable insights into alcohol consumption patterns and consequences in adolescents who had an alcohol intoxication. It underscores the need for adaption of prevention strategies, suggested by the adolescents themselves, to effectively reduce alcohol intoxication in adolescents

Keywords

Alcohol intoxication, adolescents, critical incident technique, interview, qualitative research.

Highlights

- Many adolescents did not recognize when they became intoxicated by alcohol.
- Adolescents stressed the need for better education on the effects of alcohol.
- They stated that minimizing alcohol advertisements, especially on social media, is needed.
- Adolescents had easy access to alcohol despite being underage.
- Lack of awareness about standard drink servings led to over-pouring and intoxication.

Introduction

In the last decades the incidence of adolescent alcohol intoxication (AAI) in Dutch hospitals initially increased and later stabilized [1, 2]. Meanwhile, there has been a declining trend in lifetime alcohol use (84% in 2003 to 45% in 2021) and lifetime drunkenness (45% in 2003 to 18% in 2021) among Dutch 12-to-16-year-olds [3]. A focus on minimizing alcohol intoxication among adolescents is also important because of the short and long-term negative consequences. Acute medical complications from alcohol intoxication are reduced consciousness, hypothermia, metabolic acidosis, electrolyte disturbances [4], traumatic brain injuries [5] and other alcohol-related problems [6]. Furthermore, research has shown that alcohol consumption during adolescence is associated with various risk factors, including smoking, substance abuse, violence and aggression, and truancy from school [7-9]. Most importantly, alcohol consumption (especially binge drinking) during adolescence has negative effects on brain development as a whole [10], and increases the risk of developing cancer later in life [6].

To develop effective strategies for minimizing alcohol intoxication in adolescents, it is crucial to gain a deeper understanding of the underlying mechanisms driving alcohol consumption in this age group. Previous research in the Netherlands has demonstrated that alcohol consumption is deeply ingrained in the lives of adolescents, with the role of parents often posing challenges. For example, some parents exhibit a relatively lenient response to their child's alcohol use, which may contribute to the problem [11]. This is consistent with the fact that indulgent or negligent parenting styles are associated with a higher risk of adolescent binge drinking [12]. In adults it has been shown that health-related experiences, such as hospitalization and medical issues, can result in short-term decrease of alcohol use [13]. There have been conflicting findings for young people, as on the one hand previous research found that a negative drinking experience does not lead to lower drinking intentions in adolescents [11]. On the other hand, a recent study examined the effects of the Youth and Alcohol preventive program following an AAI in adolescents. The findings suggested that the program had a short-term effect in reducing alcohol consumption and a long-term effect in decreasing binge-drinking behaviours in this population [14]. Furthermore, research indicates that adolescents often fail to recognize when they are becoming intoxicated, leading to "black-outs" in which they lose memory of events and sometimes even consciousness [15]. Although all insights above are valuable for guiding alcohol prevention programs for adolescents, it is essential to also consider the experiences and insights of the participants themselves in order to further develop these intervention.

This study aims to address this gap by gaining insights from adolescents who have personally experienced an AAI. The goal is to better understand the rationale behind their alcohol consumption that led to the intoxication event, and ultimately, to contribute to the development of new prevention strategies for AAI. We conducted in-depth interviews with each adolescent, approximately one to two months after their hospital emergency department admission, first, to investigate the details of the alcohol intoxication event. These interviews are part of the standardized follow-up program at the 'Youth and Alcohol' outpatient clinic. Second, during these individual interviews, we aim to explore the factors that contributed to the event, with a particular focus on identifying the critical turning point for each adolescent. This refers to the specific moment when they recognized things started to go wrong and when they reflect on what could have been done differently to prevent excessive intoxication, as this insight could be crucial for developing effective prevention strategies. Finally, we seek to understand what interventions could help prevent a recurrence of such an event for themselves and their peers, and include them in advising us on this matter. All interviews will be analysed as part of a prospective qualitative study, which we hope will provide valuable insights for the development of improved prevention strategies.

Methods

Participants

The study population consists of adolescents under the age of 18 who were admitted with an AAI in the region of the Reinier de Graaf Gasthuis, Delft, The Netherlands. Data for this study were collected from May 2022 to July 2023 during their participation in the standardized Youth and Alcohol follow-up program. The interviews were conducted as part of their routine clinical appointment. The inclusion criteria were as follows: adolescents who experienced an alcohol intoxication within two months prior to the follow-up interview at the 'Youth and Alcohol' outpatient clinic, and who provided prior informed consent for the additional use of their data for research purposes. The exclusion criterion was participants over the age of 18. To ensure confidentiality, all interviews were conducted anonymously and individually, allowing participants to share their experiences freely without discomfort.

Data collection

Data were collected through semi-structured interviews with adolescents who had experienced an AAI within the last two months. A critical case sampling

strategy was employed to select participants from the 'Youth and Alcohol' outpatient clinic follow-up program. The program aimed to facilitate reflection on the alcohol intoxication event and provide education on the dangers of alcohol use. Adolescents could choose whether or not their parents or caretakers were present during the interview. On average, the interviews lasted between 30 and 45 minutes. The interviews were conducted by authors LP and NL, both of whom are clinical physicians.

The critical incident interview technique [16] was used, where "critical incidents" served as triggers or entry points for participants to retrospectively describe and evaluate their AAI incident. This method gathers detailed descriptions and these incidents are typically key moments that reveal important information about behaviours, actions, or decisions. This approach allowed participants to freely express their experiences in their own words and allows them to focus on concrete events, making the interview process more accessible and less intimidating for the adolescents. The interviewers followed an interview guide that included at least the following topics: the location of alcohol intake, methods of alcohol procurement, who was present during drinking, the quantity and type of alcohol consumed, any concurrent drug use, the critical turning point of the event, the participant's reaction at that moment, their reflections on the event, the reaction of social environment, and suggested prevention strategies from the adolescents' perspective. The semi-structured format provided flexibility for follow-up questions, primarily open-ended, to allow for in-depth exploration. Each interview was audio-recorded and transcribed verbatim. Data collection continued until no new themes emerged from the interviews, indicating data saturation.

Ethics

All participants who were asked to record their interview at the Youth and Alcohol outpatient clinic, gave consent for data collection for research purposes (Medical ethical testing committee number N.21.021). Informed consent for data collection was given by all included participants. No (financial) compensation was offered for participation. Participants were able to withdraw from this study at any time and received contact information and all the, already verbally explained, study information on a printed stencil before the interview. Additional consent for the recording of the interviews was approved by the ethical commission of the Faculty of Behavioural Sciences of the University of Twente (nr. 220577).

Data analysis

All interviews were audio recorded with a voice-recorder. Recordings were stored on a secure computer folder until they were transcribed anonymously. Later on, the Braun and Clarke thematic analysis method [17] was used for all the data. The following steps in analysis were followed: 1. Familiarizing with the data and reading through the transcribed interviews. 2. Identifying themes. 3. Making a reliable coding schema. 4. Organizing codes and themes. For this coding the application NVivo (version 14) for Windows was used. LP coded all the transcripts and JH joined when negotiating the final codes and themes and their content.

Results

Study population

A total of 25 adolescents were initially included in the study at the 'Youth and Alcohol' outpatient clinic from May 2022 to July 2023. However, one patient did not consent to the recording during this period and was therefore excluded, leaving 24 participants in the final cohort. The age of the interviewed adolescents ranged from 13 - 17 years old (y.o.), with a mean age of 15 y.o.. The sex distribution was equal between females and males.

Thematic analysis results

In the analysis of the data, four prominent themes emerged, see **Figure 1**. The first theme pertains to the context of the alcohol consumption incident, encompassing factors such as location, time of day, social company, and the rationale behind alcohol ingestion (drinking motive). The second theme centres on alcohol consumption patterns, incorporating aspects such as frequency of use prior to intoxication, types of alcohol consumed, instances of combined drug use, methods of alcohol procurement, and the quantity of alcohol ingested. The third theme addresses the consequences of AAI event, examining effects experienced during and after the event, as well as implications for the immediate social environment, including friends and family. Finally, the fourth theme involves reflection on the experience of alcohol intoxication and recommendations for preventive measures. This theme focuses on participants' retrospective evaluations of the alcohol-related incident, changes they intend to implement in the future, the existence of a critical turning point during AAI and advice they might offer for prevention efforts.

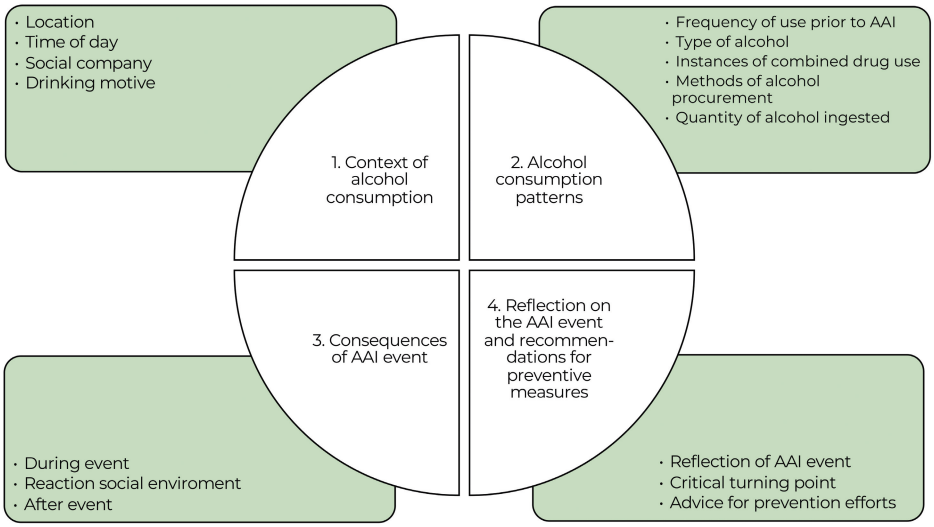

Figure 1. *Four themes with subthemes that emerged from interviews*

Theme 1: Context of alcohol consumption

In the majority of cases, alcohol consumption occurred in the evening/night, although there were instances where midday was also reported as the time of consumption. The rationale behind the alcohol ingestion, so called drinking motive, varied, with social and enhancement-related motives being most prevalent, followed by coping motives. For example, most participants described their alcohol use in terms of social situations, such as respondent X (male, 17 y.o.) who stated, "I drank that night at the party because it was fun, and everyone in my friend group was drinking." However, some participants reported drinking for more personal coping reasons, for example respondent I (female, 13 y.o.) remarked, "I used alcohol because I feel depressed, especially when I'm at school, and alcohol helps me forget about my problems." Similarly, respondent V (male, 15 y.o.) explained, "I had a conflict with a girl at school that day, and when I went to the party, alcohol was available, so I just decided to drink."

Alcohol consumption typically took place at parties at people's homes or at social events in bars or sport clubs, although other locations such as shopping malls, parks, and schoolyards were also mentioned. See **Figure 2** for the most common stated answers and subthemes of Theme 1. Social context was a key aspect of the drinking events, with most participants consuming alcohol in the company of one or more friends, the majority of whom were also drinking. In some instances, there was indirect parental supervision, as noted by respondent VIII (male, 15 y.o.), who explained, "The party was in my friend's garden house, and their parents were inside

the main house, aware that there was alcohol at our party." This type of situation occasionally led to reactions from the adolescents' parents during outpatient clinic visits. These parents frequently expressed frustration over their child's access to alcohol at a friend's house, especially when the friend's parents were aware of the situation but did not intervene and did not monitor alcohol consumption. They often mentioned the difficulty of not knowing all the parents and friends of their child during the adolescent years, noting that alcohol-related rules could vary significantly between different households.

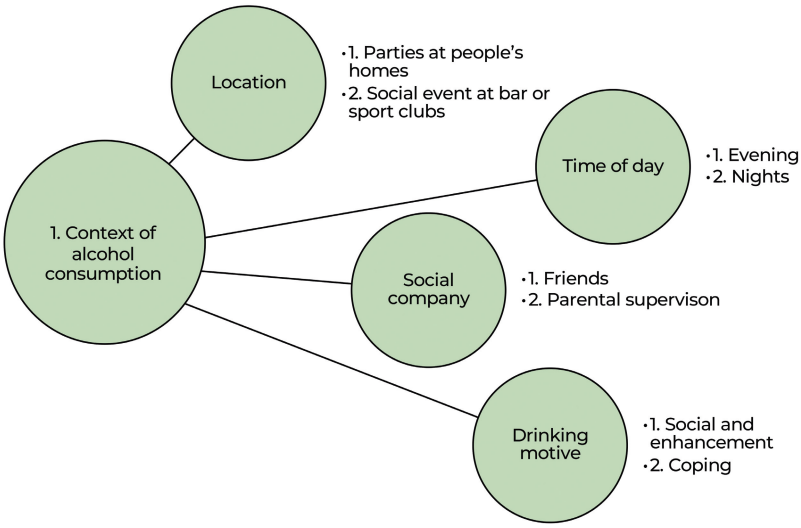

***Figure 2**. Theme 1 Context of alcohol consumption with subthemes and most common stated answers*

Theme 2: Alcohol consumption patterns

More than half of the adolescents reported having consumed alcohol prior to the AAI event. For example, respondent XXIV (female, 15 y.o.) stated, "I drank alcohol since I was 14 y.o., in smaller amounts, this was the first time I drank so much that I had to be admitted to the hospital." In contrast, for respondent XVI (female, 14 y.o.), this was the second AAI event. The most commonly consumed alcoholic beverages were spirits mixed with sodas. Respondent XI (female, 17 y.o.) described, "We were drinking vodka mixed with energy drinks because it was sweet and gave us energy." Similarly, respondent XIV (male, 13 y.o.) mentioned drinking vodka with orange soda, which was chosen simply because it was available at the party. Fast drinking from shot glasses was frequently reported, while other types of alcoholic beverages such as wine and beer were less common in this group. No other substances other than alcohol were reported during their alcohol intoxication event. Several respondents

suggested that their intoxication might have been due to an adulterant in their drink, given the severity of their symptoms. However, routine urine screening conducted upon admission for all participants revealed negative results in these cases, indicating that alcohol was the sole substance responsible for the observed intoxication. **Figure 3** illustrates the most common stated answers and subthemes of Theme 2.

The minimum legal drinking age in the Netherlands is 18 y.o. and in this study the methods of alcohol procurement in these participants were unclear in several cases. For instance, respondent III (female, 15 y.o.) explained, "I went to the party not knowing there would be alcohol, but someone over 18 y.o. brought it; I don't know who exactly." Many respondents reported being able to purchase alcohol despite being underage. Respondent XVII (male, 17 y.o.) described, "I got a rum and coke at a public bar where my friend's birthday party was, and I didn't have to show my ID." Likewise, respondent XXIV (female, 15 y.o.) shared, "You can easily buy alcohol at evening shops as a minor." Some respondents also mentioned taking alcohol from the liquor cabinet of their own or their friends' parents.

The quantity of alcohol consumed was often unknown to the adolescents in this study. Respondent XVIII (female, 15 y.o.) stated, "I drank only three or four red cups full of vodka or rum, so I don't know why I was that intoxicated." When the differences in alcohol units per beverage were explained to these adolescents, many were unfamiliar with this concept.

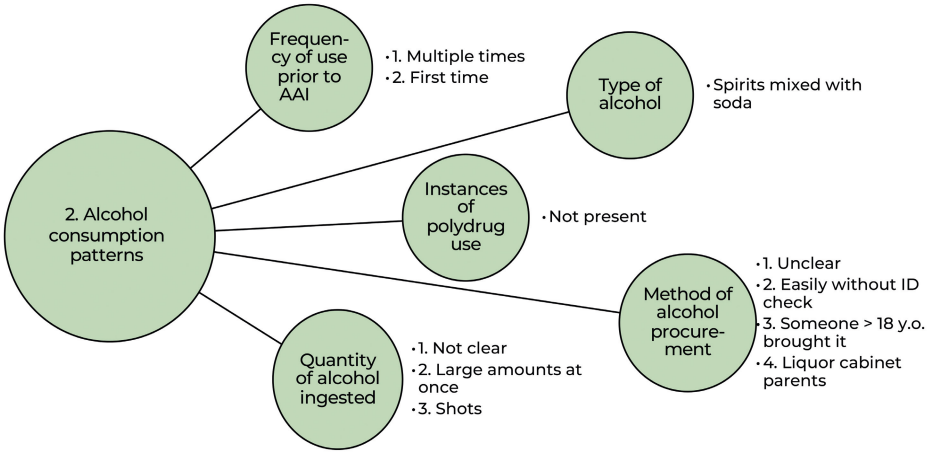

***Figure 3**. Theme 2 Alcohol consumption patterns with subthemes and most common stated answers*

Theme 3: Consequences of the AAI event

In nearly all cases, participants reported having no active memories of the later stages of their intoxication incident. Vomiting was commonly mentioned, and in some instances, secondary injuries and loss of consciousness resulting from alcohol consumption were reported. For example, respondent VIII (male, 15 y.o.) mentioned falling off his bike, hitting his head on the ground, and sustaining a hematoma, with a friend filming the incident. The ambulance was called in almost all cases, although on a few occasions, parents or other family members transported the adolescent to the emergency department by car. **Figure 4** illustrates the most common stated answers and subthemes of Theme 3.

The immediate social environment of the patient, particularly those not involved in the alcohol consumption, was typically very shocked and concerned, and sometimes even felt embarrassed by the situation. For instance, the parent of respondent III (female 15 y.o) stated, “It was really frightening but also humiliating to pick her up like that, what if she suffocates in her puke?” Often, adolescents reported that friends who had been involved in the drinking called their parents to inform them of the situation. The parents of respondent X (male, 17 y.o.) expressed, “We were furious with the parents of his friend, where the alcohol was consumed. How could it be possible for children to drink strong spirits under their roof and supervision?” Additionally, respondent XI (female, 17 y.o.) stated, “My friends told me later that they were really worried and panicked because I wasn’t reacting properly. They called my parents, who came to check on me, and then they eventually called the ambulance.”

In one case, in the middle of the night the parents of a respondent received a visit from the police, who came to inform them of their child’s intoxication and hospital admission, as they had been unable to reach the parents, who thought their child was sleeping over at a friend’s house. The parents of respondent XVIII (female, 15 y.o.) shared, “When we arrived at the paediatric intensive care unit and they told us that our daughter had an alcohol intoxication, we were really shocked. We never thought she would already be interested in alcohol.”

Following the AAI event, some participants faced consequences such as being grounded, while others, like respondent I (female, 13 y.o.), were no longer allowed to see the friend who had provided the alcohol. In many households, the event served as a facilitator for discussions about alcohol consumption, often leading to the establishment of stricter alcohol specific parental rule-setting.

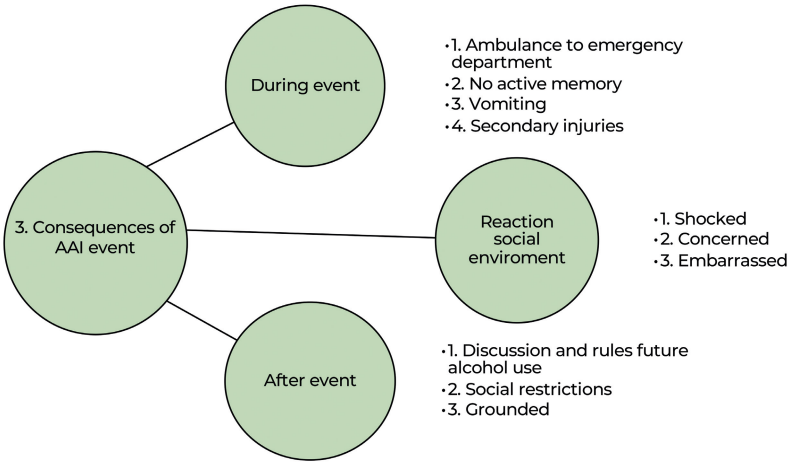

Figure 4. *Theme 3 Consequences of AAI event with subthemes and most common stated answers*

Theme 4: Reflection on the AAI incident and considerations for preventive measures

Many respondents stated they preferred not to think back to this event, such as respondent XI (male, 13 y.o.) stated: ''I prefer not to look back to it because it was not a nice experience. I have definitely learned from it and will no longer drink alcohol to prevent it from happening again''. Similarly, respondent II (female, 16 y.o.) mentioned that she was relieved she did not remember the event, as she felt ashamed and did not want to see herself in the state of vomiting. When asked about a critical turning point, specifically, if they recalled when things started to go wrong or what could have been done differently to avoid excessive intoxication, almost all respondents shared similar narratives. For instance, respondent VI (female, 17 y.o.) explained: "I did not really have a moment where I thought that it went the wrong way. I did not notice getting drunk at all, until it really hit me and I was too far gone." Respondent XV (female, 16 y.o.) recalled: "I remember being at the party with friends doing shots, but after that I do not remember anything. It is really weird and scary to hear people telling you stories about what you did that night. Apparently, I was really aggressive, which is something I normally am not at all." These responses indicate that, for most adolescents, there was no identifiable turning point signalling when intoxication became excessive, as they did not see it coming and many experienced a blackout. Furthermore, numerous respondents mentioned quitting alcohol consumption after the AAI event. **Figure 5** illustrates the most common stated answers and subthemes of Theme 4.

When soliciting advice from adolescents on how to prevent alcohol consumption among them and their peers, their responses were notably consistent. Almost all respondents emphasized the need for increased education, particularly through channels such as social media or schools, to raise awareness about alcohol and its harmful effects. Such as respondent XII (male, 16 y.o.) stated: "I believe schools should provide better information about the dangers of alcohol use." Also respondent XXI (male, 14 y.o.) said: "I am really shocked by what happened to me. Just put me in front of a classroom, and I will share my story with others."

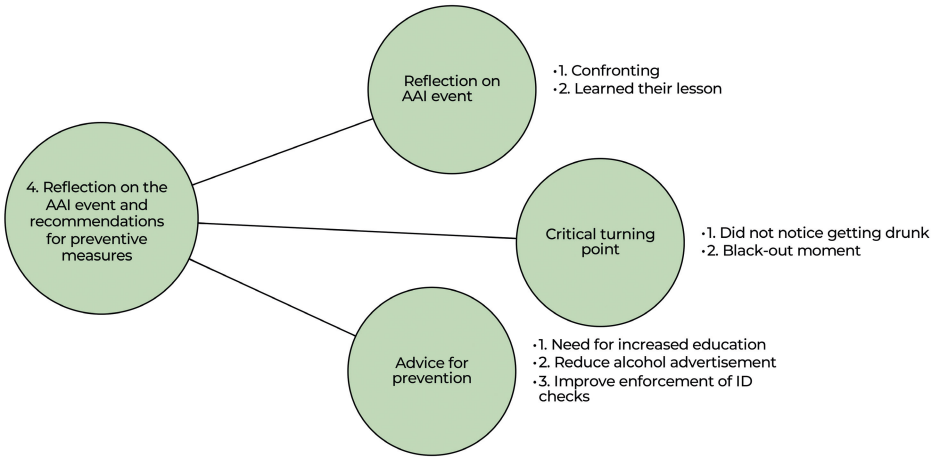

Figure 5. *Theme 4 Reflection on the AAI event and recommendations for preventive measures with subthemes and most common stated answers*

Many stated that they were unaware of the physiological impact of alcohol or the existence and use of alcohol units. For instance, respondent IX (male, 13 y.o.) suggested to create a film containing essential information about alcohol that should be made mandatory for all schools to show to their students. Additionally, several participants suggested reducing alcohol-related advertisements, especially on social media, and improving the enforcement of identification checks when purchasing or consuming alcohol. Respondent XV (female, 16 y.o.) proposed, "Deterrent images should be placed on alcohol packaging, similar to cigarette packaging, to highlight its harmful health effects." However, multiple respondents also acknowledged the difficulty of effectively preventing alcohol consumption among adolescents due to its widespread normalization. This segment of the interview was particularly insightful for parents. For example, the parent of respondent XXIII (female, 16 y.o.) commented, "What should we do as parents? You can't ban alcohol for our children because they'll drink anyway." During the session at the Youth and Alcohol outpatient clinic it was addressed and explained

to parents that precisely the strict alcohol specific rule setting can decrease their children's alcohol use.

Discussion

In this qualitative study, 24 semi-structured interviews with adolescents who experienced an alcohol intoxication and presented at the "Youth and Alcohol" outpatient clinic at Reinier de Graaf Gasthuis in Delft were analysed. Four prominent themes emerged from the data: 1. Context of alcohol consumption, 2. Alcohol consumption patterns, 3. Consequences of the AAI event, and 4. Reflection on the AAI event and recommendations for preventive strategies.

The first theme, context of the alcohol consumption, revealed that adolescents in this population primarily consume alcohol in the evening and night, typically in social settings with friends, motivated by social and enhancement drinking motives. This finding aligns with previous research, including a study of 5,511 patients with AAI, of which 64.6% presented to the hospital during the night and 28.0% during the evening [18]. Additionally, a recent study highlighted similar findings that European adolescents most commonly drink for social and enhancement motives, such as enjoyment and to enhance social gatherings [19].

The second theme, alcohol consumption patterns, indicated that adolescents who experienced an alcohol intoxication often already consumed alcohol prior to the incident and when they were drinking it includes typically spirits, sometimes also mixed with soda. They had relatively easy access to alcohol despite being underage, and consumed large quantities in a single session, without the combined use of other substances.

Based on data from Dutch students aged 15-16, the most recent alcoholic beverage they consumed was reported as approximately 32% beer, 30% spirits, and 20% pre-mixed drinks, with the remaining percentage consisting of ciders and wines [20]. Consequently, it appears that these adolescents who experienced AAI tends to consume spirits more than their peers. Alcohol consumption in larger quantities per occasion is known to be more prevalent in adolescents compared to adults, with binge drinking typically defined as the consumption of 4-5 units per occasion [21]. A study conducted in the United States among adolescents found that binge drinking frequently involves distilled spirits [22], a pattern also observed in the adolescents in the current study. Furthermore, a lack of awareness regarding standard drink servings, particularly for spirits, leading to over-pouring

and increased risks of intoxication, has been documented in literature [23-25]. This phenomenon and risk of intoxication is also seen in the adolescents in our study. Thus, drinking alcohol in adolescents has significant risks of AAI incidents, therefore alcohol prevention should include education on both minimizing harm related to alcohol use and specifically addressing the risk of AAI. Moreover, previous research conducted within a comparable Dutch AAI-population from 2007 - 2019 (n = 2675) indicated that combined drug use was observed in 10.4% of participants [1]. Therefore, the absence of combined drug use in AAI in this study, which places greater emphasis on narrative rather than quantitative analysis and has a smaller sample size, may result in an underestimation of combined substance use in this population. Last, several respondents suspected an adulterant in their drink due to the severity of their symptoms, but routine urine screenings upon admission were negative, confirming that alcohol was the sole cause of intoxication. This highlights the importance of individual differences in alcohol tolerance and metabolism in the severity of intoxication symptoms. Besides the amount of alcohol consumed, factors such as sex, medication use, body weight and the duration of alcohol consumption, also influence the clinical presentation of AAI [26].

The third theme, consequences of the AAI event, illustrated common outcomes of severe intoxication, such as vomiting and being transported by ambulance to the emergency department, sometimes accompanied by secondary injuries and loss of consciousness. Many parents asked questions about strategies for setting alcohol-related boundaries, underscoring the need for easily accessible information to inform parents about the effects and regulations of alcohol and to support them regarding parenting strategies related to alcohol.

Following the AAI event, alcohol consumption was frequently discussed in households, and, with guidance and education for also the parents from the Youth and Alcohol outpatient clinic, new alcohol-related rules were implemented. This is a critical component of the process, as evidence suggests that combining strict parental rule-setting with a warm and supportive family environment confers protective effects for adolescent [27, 28].

The fourth theme, reflection on the AAI event and recommendations for preventive strategies, revealed that most adolescents did not recognize when they were becoming intoxicated, often describing a “black-out” experience. Adolescents that drink alcohol are less likely to experience staggering or loss of speech compared to adults. While they are less sensitive to alcohol’s sedative effects, they are more vulnerable to memory issues and neurotoxic effects, such as blackouts [29].

These differences can make it harder to recognize earlier signs of intoxication in adolescents [15]. This phenomenon should be emphasized in prevention and education efforts.

One of the current study's main goals was to understand from the adolescent participants possible solutions and prevention strategies gained from their lived experiences of AAI, to reduce alcohol-related harm for young people in the future. Adolescents stressed the need for better education on alcohol effects and standard drink units. This is also well supported by evidence, which highlights that effective school-based interventions are theory-based, challenge social norms, build resistance skills and are culturally appropriate and sustained over time [30].

Adolescents also called for reduced alcohol advertising, especially on social media, which plays a pervasive role in their daily lives. This aligns with the World Health Organization's Global Alcohol Action Plan [31], which recommends restricting alcohol marketing to mitigate youth exposure. Moreover, a recent study also stated that most youths are in favor of automated warning messages to raise awareness at alcohol related social media posts [32]. By incorporating such measures, it is possible that adolescents may develop a heightened awareness of the risks associated with alcohol use, which could lead to more informed decision-making.

Additionally, the adolescents recommended stricter enforcement of ID checks for alcohol purchase and consumption, which are often inadequately implemented at present [33, 34]. This is in line with data from European School Survey Project on Alcohol and Other Drugs, which stated that 79% of Dutch 15-16 y.o. students state that it is easy to obtain alcohol [20]. Strengthening these enforcement measures could contribute to limiting adolescents' access to alcohol, which in turn may reduce alcohol intoxication and subsequent behavioral risks.

Overall, the alignment between adolescent insights and previous evidence highlights the potential of youth-informed strategies to enhance the relevance, acceptability, and impact of alcohol prevention efforts. By implementing these recommendations, it is possible to not only address the immediate risks but also encourage long-term behavioral changes that could have a lasting impact on reducing alcohol use among youth. Policymakers cannot afford to overlook these helpful prevention solutions suggested by the adolescents themselves.

One of the strengths of this study is its qualitative design, which allows for in-depth exploration of adolescents' experiences with alcohol intoxication and alcohol consumption patterns. By utilizing semi-structured interviews, the research

captures rich, detailed insights from a group of adolescents who experienced an alcohol intoxication events. Furthermore, the findings align with previous research, strengthening the validity and relevance of the results. While many of the recommendations, such as enhanced education, stricter regulation of alcohol advertising, and better enforcement of alcohol-related laws, have been proposed in earlier studies, this study contributes by highlighting these specific preventive measures suggested by adolescents themselves.

A limitation of this study is the reliance on self-reported data, which poses the risk of recall bias, as participants may not accurately remember or may minimize the severity of their alcohol consumption and AAI experiences. The setting of patient and doctor could also potentially also influence responses. Additionally, there is a risk of interview subjectivity, both from the researcher and the interviewed adolescents. To reduce this, we used a structured checklist with open-ended questions during the Critical Incident Technique to encouraged participants to share their experiences in detail. Future research could explore how adolescents perceive sharing their stories in the outpatient setting and consider focus groups or perspectives from healthcare providers to develop prevention strategies and gain a more holistic understanding of adolescent alcohol use.

Conclusion

This study offers valuable insights into the influences and consequences of adolescent alcohol consumption, in the context of AAI events, highlighting critical directions for preventive intervention. This is crucial to gain this deeper understanding of the underlying factors driving alcohol consumption in this age group to develop effective strategies for minimizing alcohol intoxication in adolescents. A common observation was that many adolescents reported not recognizing when they became intoxicated, often describing a “black-out” experience. This phenomenon highlights a critical factor for prevention combined with their lack of knowledge about the effects of alcohol. Adolescents emphasised the importance of alcohol education, stricter advertising regulations, and stronger enforcement of alcohol laws as key measures to reduce AAI and mitigating its harmful consequences in the adolescent population. Suggested measures include integrating alcohol education into school curricula (for both students and parents), banning alcohol ads, enforcing age verification, launching public awareness campaigns, and offering support for adolescents with problematic alcohol use.

Authors contribution

Conceptualization, data curation: LP, JH, NL, Formal analysis: LP, JH, Writing: LP, Supervision: JH, NL

Statements

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Interest

All authors have no conflicting interests.

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Chapter 9

Qualitative approach for prevention insights from European healthcare professionals

Differences in pre-hospital, hospital, and post-hospital care of adolescents with an alcohol intoxication in Norway, Belgium and the Netherlands: elite interview study

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Under consideration at Journal of Child and Adolescent Substance Use (Submitted February 2025)

Abstract

This study aims to investigate differences and similarities in pre-hospital, hospital and post-hospital care of adolescents with an acute alcohol intoxication in European countries.

Qualitative data were collected using semi-structured interviews with paediatricians from all participating countries. These paediatricians were selected based on their experience with the treatment of adolescents with an alcohol intoxication in their country. A total of three paediatricians from the Netherlands, Norway and Belgium were interviewed. Four main themes were debated; pre-hospital care-, hospital care-, post-hospital care- and context of adolescents with acute alcohol intoxication.

The major differences in the (pre-)hospital section lay within the fact that paediatricians are often not involved in patients with alcohol intoxication at emergency department/primary care settings in Belgium and Norway, whereas in the Netherlands they are almost always involved. Furthermore, differences in hospital care between the countries exist, although the core treatment is the same. Moreover, primary and secondary prevention with healthcare professional involvement has only been reported in the Netherlands. Tertiary prevention, like a follow-up program, has been present in all countries. All paediatricians acknowledge that the adolescents often lack awareness of the potential risks associated with alcohol consumption. Consequently, they agree that preventive events or public service announcements aimed at increasing the knowledge on this topic are essential, including involvement of healthcare professionals.

Improving primary, secondary and tertiary prevention of alcohol consumption in minors is extremely important to minimize alcohol-related hazardous behaviour, injuries and intoxications. Thus, there should be aimed for European unification of alcohol intoxication health care pathway.

Keywords

Adolescents, Alcohol intoxication, Europe, Health care pathway, Paediatrician.

Introduction

In Europe, the alcohol consumption rate among 15-19-year-olds is the highest worldwide [1]. Early alcohol initiation in adolescence has numerous negative consequences, such as including risk of excessive alcohol use and dependence later in life and premature mortality in adulthood [1-3]. Thus, preventing early alcohol initiation in adolescence is a public health priority, particularly in Europe.

The World Health Organisation has promoted several measures to reduce alcohol-related harm and improve population health [4]. One of their focus areas is the implementation of early identification and brief intervention programmes for individuals with hazardous or harmful alcohol consumption [4].

In some European countries, prevention and follow-up programs have been set up for adolescents with hazardous and harmful alcohol consumption such as admission to the emergency department with an acute alcohol intoxication (AAI). For instance, in The Netherlands, a multidisciplinary follow-up outpatient clinic for patients admitted with an AAI was established in 2007. This outpatient clinic aims to prevent recurrent AAI, screen these adolescents for signs of mental disorders and provide individual education on the effects of alcohol [5]. The 'Youth and Alcohol' outpatient clinics were set up in various Dutch hospitals throughout the country, which also collected data on this patient population. Adequate registration and monitoring were essential in effecting changes in the Dutch alcohol policy law and raising awareness for this harmful issue in society.

In Belgium, emergency physicians have recently raised concerns about the increasing number of adolescents admitted to hospitals due to AAI [6]. A recent retrospective hospital chart study in Antwerp showed a high yearly hospitalisation rate of 31 per 10,000 10-to-17-year-olds [7]. Following the Dutch example, a pilot project was initiated to provide outpatient follow-up for adolescents with AAI. In Southern Norway, adolescents with AAI at the emergency department with self-harm intentions are usually offered further follow-up, whereas adolescents with substance misuse-related poisoning were rarely offered follow-up [8]. In other European countries, there was no information present on current health care follow-up programs.

This study focusses on the 3 European countries, Norway, Belgium and the Netherlands, with prior published studies on intervention programs for adolescents with acute alcohol intoxication. The study involves elite interviews with paediatricians experienced in treating this study population. By examining

the differences in prevention and clinical care provided to adolescents with AAI across these countries, we can evaluate and potentially give recommendations for improvements.

Materials and methods

Participating paediatricians from the Netherlands, Belgium and Norway were purposefully selected based on their experience with the treatment of adolescents with an alcohol intoxication in their country. Data were collected using interviews with paediatricians from these three participating countries. The interviews focussed on the pre-hospital, hospital and post-hospital care of adolescents with AAI. A semi-structured interview technique was used, to be able to compare the different countries, while giving the participants the freedom to elaborate on country-specific details (**see appendix** for interview question checklist). The interviewed paediatricians received the questions at least one week beforehand to prepare for the interview if they desired. All paediatricians gave consent for the interview and the non-anonymised character of it. No financial compensation was offered for participation. The interviewed participants also approved the final version of the article. This study was performed in line with the principles of the Declaration of Helsinki. No ethical approval was required in this expert interview study.

Data collection and analysis

All interviews were performed via Zoom video call (because the interviewer and interviewees were often geographically dispersed) by the primary research team member (LP). On average, the interviews lasted 30 - 45 minutes. Positivism was used as the theoretical perspective of this interview study. The interviews were audio recorded and transcribed verbatim. Each stage of care was summarized per participating country to illustrate potential differences.

A framework analysis developed by the National Centre for Social Research [9] was used because of the practice-orientated findings and the focus on maintaining individual respondent accounts' integrity. In this framework, the first four steps are primarily focused on ordering and managing the data: (1) familiarisation, (2) identifying a thematic framework, (3) indexing and (4) charting. ATLAS.ti version 23.3.4 for Windows was used by two individual research team members (LP and HvR) to become familiar with the data and the creation of the codebook. A thematic framework was drawn up based on themes already elaborated on in advance by the research team (and questioned in the interviews, **see appendix** for checklist)

and complemented with themes emerging from the interviews. Subsequently, the data was coded systematically (indexing) by the same researchers (LP and HvR), after which charting occurred in Excel: rearranging the data according to thematic content for within and between case analyses. The final step, mapping and interpretation, is where the researchers looked at relationships and associations between concepts. The themes that emerged the most in the interviews, and the concepts that emerged from the final step of the analysis, will be highlighted in the text and illustrated using Venn-diagrams.

Results

Interviewed population

Three paediatricians, from the Netherlands, Norway and Belgium, were interviewed (between May and August 2023). The participants were aged between 44 and 60 years old. All were hospital-based and had experience with the care for adolescents with an AAI in their respective country. Prof.dr. N. van der Lely is a Dutch paediatrician who founded the Youth and alcohol foundation and established a multidisciplinary follow-up outpatient clinic for patients who were admitted with an AAI in 12 Dutch Hospitals. Additionally, he is a professor at Antwerp University in Belgium where he is involved in organizing alcohol prevention in minors. Dr. J. Rueness is a paediatrician from Norway working in a paediatric emergency department in Oslo, where also adolescents with alcohol intoxication are referred to. Moreover, she has a relevant social paediatric focus with a PhD in Child abuse. Dr. A. Vander Auwera is a paediatrician from Belgium, involved in setting up the multidisciplinary follow-up outpatient clinic for patients admitted with an acute alcohol intoxication in Antwerp.

Thematic analysis results

To answer our research question, we identified four main themes; pre-hospital care-, hospital care-, post-hospital care- and the context of adolescents with AAI. Each of the main themes was divided in two or three subthemes, based on the interview data. These themes are described below and illustrated in **Figure 1**.

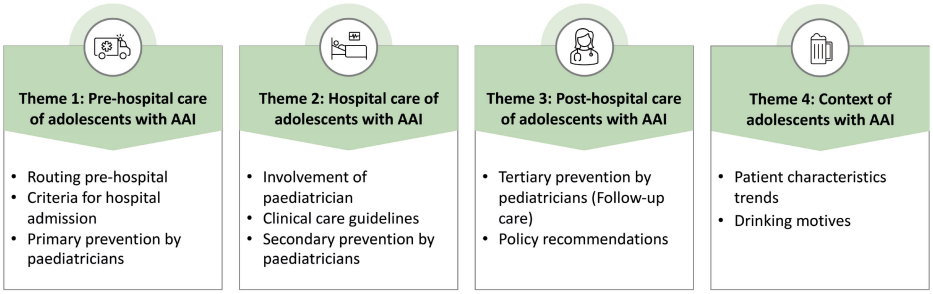

Figure 1. *Four themes with subthemes extracted from the interviews*

Theme 1: Pre-hospital care of adolescents with AAI

Routing pre-hospital

In both the Netherlands and Belgium, an isolated event of AAI warrants admission to the emergency department (ED) of a hospital. In the Netherlands, the paediatrician is directly involved at the ED, whereas this is not the case in Belgium. In Oslo, Norway, isolated alcohol intoxication in adolescents is most often treated in a primary care setting if the total treatment time is less than 7 hours total, without the involvement of a paediatrician.

Criteria for hospital admission

Criteria for admission to the paediatric ward in the Netherlands include one of the following criteria: a blood alcohol concentration (BAC) > 1.5 g/L, secondary injuries, sexual harassment, age < 15 years old, or combined drug use. In Norway, patients are frequently discharged without admission to the paediatric ward, except in the case of impaired consciousness, combined drug use, being clinically unstable or secondary injuries that require treatment in the hospital, such as head trauma. In Belgium, minors with AAI are treated at the emergency department, without the involvement of a paediatrician. Here, no specific protocol for alcohol intoxication in minors is used at the emergency room. *'But when there are any injuries, unconsciousness, hypothermia, hypoglycaemia or when the patient is in need of an intravenous therapy, they will stay overnight in the 'night-hospital' and will be sent home the next morning'*. These observations highlight the differences in pre-hospital routing and hospital admission criteria for adolescents with AAI across the Netherlands, Norway, and Belgium.

Primary prevention by paediatricians

In the Netherlands, paediatricians are involved in the primary prevention of alcohol consumption; '*We are giving informative events on sport clubs and schools on*

alcohol prevention. This helps parents and children in understanding the problem and risks'. '*We see the tip of the iceberg of the problem in the hospitals, so primary prevention is extremely important.*' In Belgium and Norway, there are no alcohol prevention projects in which paediatricians participate. The emerged differences and similarities between countries in pre-hospital care of adolescents with AAI are illustrated in **Figure 2**.

Figure 2. *Emerged differences and similarities between countries in pre-hospital care of adolescents with AAI*

Theme 2: Hospital care of adolescents with AAI

Involvement of paediatrician

In the Netherlands, the paediatrician is almost always involved in patients with AAI at the ED, and approximately 95% of patients presenting themselves at the ED with AAI are admitted to the paediatric department. In Norway and Belgium, these patients are very often discharged from the ED, night hospital or primary care setting without admission to the paediatric department or involvement of a paediatrician.

Clinical care guidelines

There is a treatment guideline for alcohol intoxication in Norway, acknowledged by the Norwegian Paediatric Association. *'Intravenous fluid administration and blood test to measure ethanol level are standard care. Urine drug screening test is not standard care and additional permission is needed and hard to obtain in that acute moment. However, urine drug screening will give you a lot of information about potential illegal drugs that require follow-up. I do think this is important information and relevant'.* In Belgium, there is no treatment protocol present for this patient population; *'Emergency doctors decide how severe the alcohol intoxication is and how much extra observation and treatment is necessary. Blood screening is almost always done, drug screening not, because it costs money and this has to be paid directly by the patients/caregivers.'* In the Netherlands, there is a standardized medical protocol with flow charts to decide the personalised treatment for patients with alcohol intoxication. In the case of hospital admission, all patients will be monitored, will get glucose controls 1, 2 and 4 hours after admission and will receive intravenously rehydration. Blood workup (with BAC, blood gas, glucose level, electrolytes, and liver panel) and urine drug screening will be performed as standard care. '*However, when adolescents primarily present themselves with injuries at the ED, their blood alcohol concentration should be tested to determine if alcohol has influenced their condition. Currently, this testing is not conducted frequently enough, and improvements are needed in this regard*'

Secondary prevention by paediatricians

In Belgium and Norway, there was no standard secondary preventive intervention. In the Netherlands, however, secondary prevention by the paediatrician is integrated into their alcohol intoxication health care pathway*: 'Upon awakening in the hospital, adolescents are provided with preventive information about alcohol and its associated risks. They fill in a questionnaire and explore interactive websites and evaluate the event with a health care professional. The emphasis is on encouraging their participation in a follow-up care program aimed at preventing recurrence and identifying any underlying issues or pathology.'* The emerged differences and similarities between countries in hospital care of adolescents with AAI are illustrated in **Figure 3**.

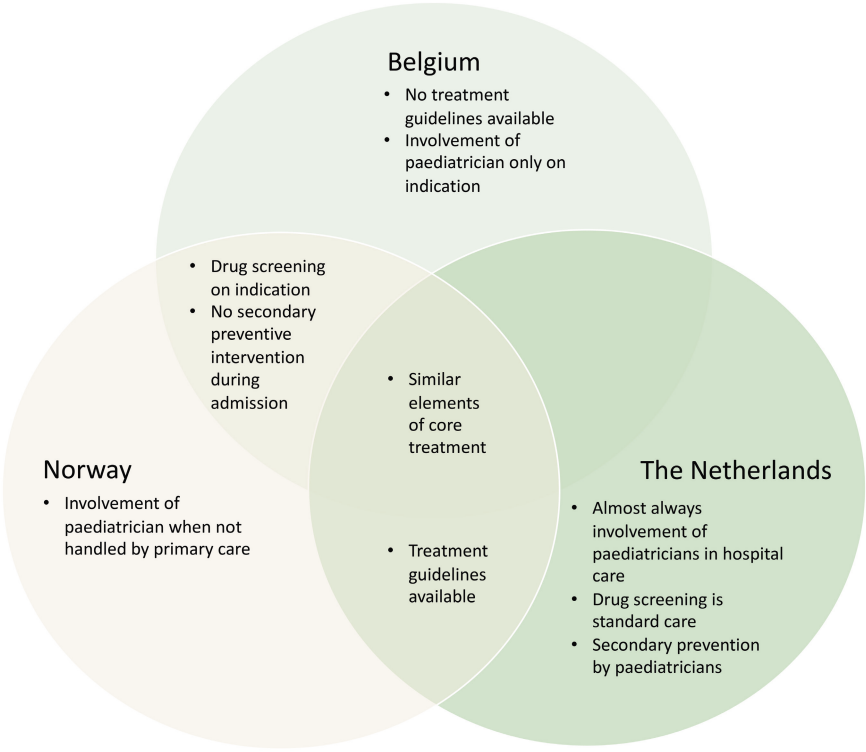

Figure 3. *Emerged differences and similarities between countries in hospital care of adolescents with AAI*

Theme 3: Post-hospital care of adolescents with AAI

Tertiary prevention by paediatricians (Follow-up care)

In the University Hospital in Oslo, Norway, there used to be a follow-up outpatient clinic with paediatricians scheduled a month after the alcohol intoxication event. Unfortunately, due to financial cuts, this was eliminated. However, tertiary prevention programs without the involvement of paediatricians, do exist: '*The child protection services do have programs dedicated to minors using drugs and alcohol. It is designated for minor with alcohol intoxication to participate in these programs. However, health care personals often fail to refer patients to child protection services following an acute alcohol intoxication. Thus, not all adolescents who have undergone hospitalization due to alcohol intoxication are offered participation in this programme. In theory, parents may also refuse participation in this programme on behalf of the child, but this is uncommon.* In the Netherlands, both the paediatrician and child psychologist are involved in the alcohol outpatient clinic, with a total follow-up period of 6-12 months. '*There are*

12 youth and alcohol outpatient clinics across the country, all following the same intervention program. Formerly in Belgium, there was no planned follow-up for this population. However, since 2023, a pilot study in Antwerp is started to offer a follow-up to adolescents aged 10-17 years old admitted with acute alcohol intoxication, modelled after the structured approach used in the Netherlands.

Policy recommendations

All paediatricians acknowledge that the adolescents often lack awareness of the potential risks associated with alcohol consumption. Consequently, they agree that preventive events or public service announcements aimed at increasing the knowledge on this topic are essential. They emphasise that healthcare professionals should be involved in this. The emerged differences and similarities between countries in post-hospital care of adolescents with AAI are illustrated in **Figure 4**.

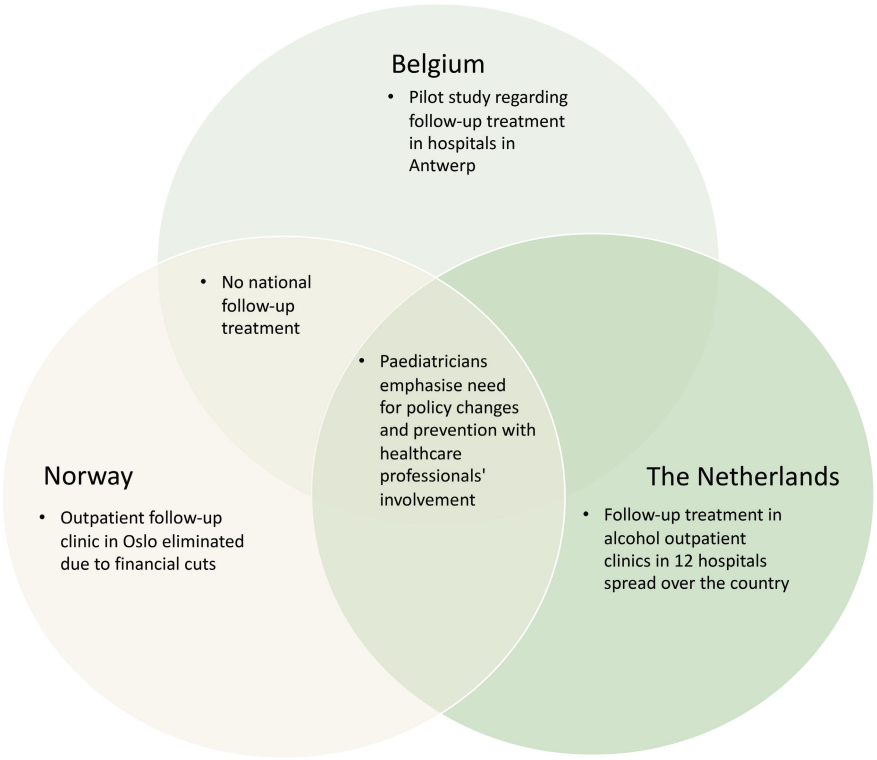

***Figure 4**. Emerged differences and similarities between countries in post-hospital care of adolescents with AAI*

Theme 4: Context of adolescents with AAI

Patient characteristics trends

In all countries, patients are presented predominantly during weekends (evening and night) and with reduced consciousness. Furthermore, the average age of patients in Belgium and the Netherlands is around 16 years old. In the Netherlands: '*The mean age has significantly increased since the alcohol law changed in 2014 (setting the minimum age to consume low alcohol beverages at the age of 18 years old instead of 16 years old)'*[10]. Conversely, in Norway it appears to be a trend of decreasing age among patients: *'I have noticed that children that are referred here are typically younger than when I started working here. Now they may be 11 or 12 years old, while 10 years ago they were 16 or 15 years old'.* Moreover, the distribution of sex is equal in the Netherlands, whereas slightly more boys than girls are admitted with AAI in Belgium.

Furthermore, combined drug use seems to be increasing in both Norway and the Netherlands. In Belgium and the Netherlands, the most common combined drug is cannabis [7, 10]. In Norway, the most used type of drug is changing over time: *'Now cocaine is the most frequent combined drug, because cocaine is now quite cheap and therefore more easy to access by minors. Ecstasy and cannabis are now more expensive, therefore you see it less often. It depends on what is available'. In the Netherlands and Belgium, the average blood alcohol concentration seems to be around 1.8-2.0g/L*.

In addition, in the Netherlands, there has been an increase in patients with psychological problems since data collection began in 2007. Similarly, in Norway, there is an observed increase in the combination of alcohol intoxication and self-harm. '*In the last 3-4 years, we have seen that alcohol intoxication is quite common among patients who also engage in self-harm (auto mutilation), which may be linked to personality disorders like borderline, although these are not typically diagnoses in children in Norway*'

Last, regarding the prevalence of AAI, there has been stabilization in the Netherlands: *'The problem has stabilised;* fewer adolescents are drinking, but those who do, engage in binge drinking more often. *However, during the COVID-19 pandemic lockdown period, there was a significant decrease in* acute alcohol intoxication *events in both the Netherlands* [11] *and Belgium [7].* In Norway, the alcohol intoxications are becoming more severe due to younger patients with increased combined drug use. '*But of course, I only see a subset of the population referred to me in the hospital.*'

Drinking motives

In Norway and Belgium, patients often mention that alcohol consumption and drug use are common within their social circles. In contrast, patients admitted with AAI in the Netherlands and Belgium frequently cite social and enhancement drinking motives or even sometimes the "urge to fit in" and "peer pressure" as significant factors. Prof dr. van der Lely underscores: *'Adolescents fail to acknowledge the influence of social media and influencers on their alcohol intake. I believe this influence is considerable, growing, and is a specific problem of their age group, which may contribute to their lack of awareness'*. Dr Rueness highlights that '*Drinking might also serve as a coping mechanism. I notice that this population is often traumatised and more vulnerable'*. Dr Vander Auwera adds*: 'Given the prevalence of alcohol and its normalization, it is challenging for young people to resist societal pressure to consume alcohol'*. The emerged differences and similarities between countries in the context of adolescents with AAI are illustrated in **Figure 5**.

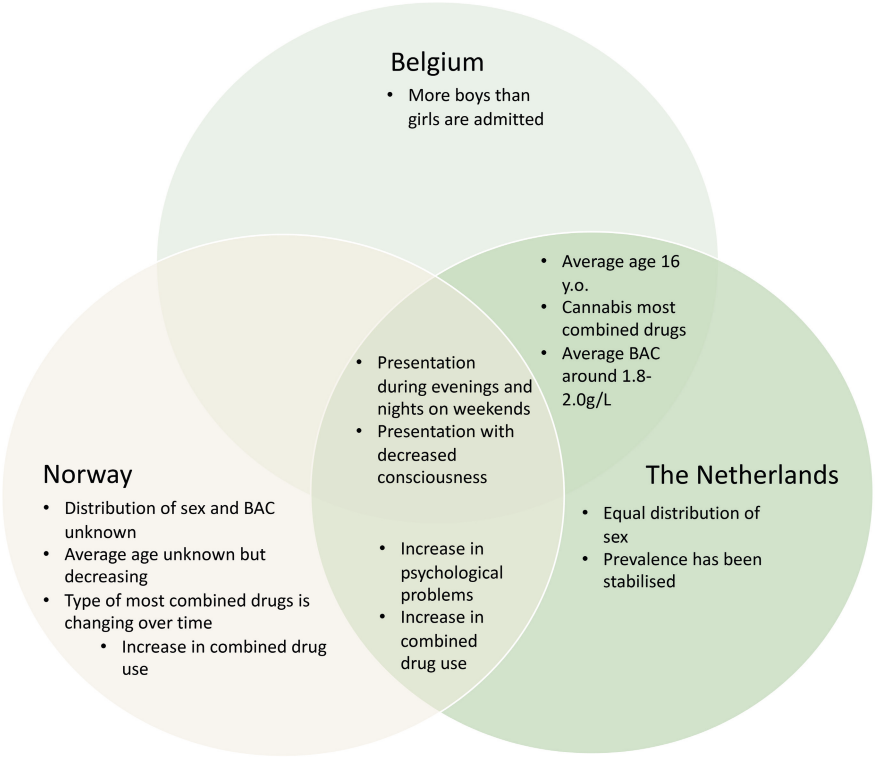

Figure 5. *Emerged differences and similarities between countries in the context of adolescents with AAI*

Discussion

This study explores the similarities and differences in pre-hospital, hospital and post-hospital care of adolescents with AAI across three European countries. Three paediatricians from Norway, the Netherlands and Belgium participated in semi-structured interviews. A framework analysis revealed notable variations among the countries.

In the pre-hospital phase, a significant difference highlighted was the involvement of paediatricians in managing alcohol intoxication cases at emergency departments (ED) or primary care settings. In the Netherlands, paediatricians are always involved, whereas in Belgium and Norway, their involvement varies and is often absent. Additionally, the Netherlands admits almost all AAI patients to paediatric departments, whereas in Belgium and Norway, most are not admitted.

Although the core treatment for adolescents with AAI (observation, blood workup, and intravenous treatment) is generally similar across the countries, differences exist in hospital care protocols. For instance, drug screening is routine in the Netherlands but selective in Belgium and Norway. Moreover, treatment protocols are established in Norway and the Netherlands but not in Belgium.

Primary and secondary prevention efforts involving healthcare professionals are reported only in the Netherlands. Paediatricians engage in primary prevention through educational talks at sports clubs and schools on alcohol prevention. Secondary prevention in the Netherlands includes providing additional information on alcohol effects, risk reflection, and motivational interviewing during hospital stays [5]. Tertiary prevention is essential and only possible when the pediatrician is aware of the AAI event in the adolescent to arrange the follow-up. These types of follow-up programs, as recommended by the World Health Organization [4, 12], are established in all three countries, albeit 12 years ago terminated in Norway due to financial constraints. However, in Norway, the child protection services have a mandatory follow-up program without the involvement of the healthcare system. In Belgium, a pilot project for a multidisciplinary outpatient clinic commenced in 2023 in Antwerp with a 6-month follow-up, while the Netherlands operates similar clinics in 12 hospitals nationwide.

Paediatricians express concerns about adolescents' limited knowledge regarding alcohol effects and risks, emphasizing the importance of enhanced primary and secondary prevention efforts. In Norway, alcohol intoxications appear to be worsening due to an increase in younger admissions, combined drug use, and

incidents of self-harm. Moreover, hospital admissions represent only a fraction of the broader issue, underscoring the critical role of primary prevention in reaching all adolescents.

Comparing with other European countries is challenging due to limited data on tertiary prevention. Brief motivational interventions in Germany [13] and alcohol screening programs in the United Kingdom [14] are notable exceptions.

Strengths and limitations

This study provides the first comprehensive overview of care differences for adolescents with AAI in European countries, identifying strengths and weaknesses in healthcare pathways. The qualitative nature introduces potential researcher bias, mitigated by using multiple researchers for data coding and interpretation, and participant feedback on findings. We acknowledge that only one expert per country was interviewed, which may have limited the capture of region-specific information within each country. This study serves as an initial step in evaluating the current state and identifying potential differences between countries from which we could learn. The use of the elite-interview technique, which involves preselected experts with a comprehensive understanding of the country's situation, ensures that the results are reasonably reflective of the reality. However, for greater confidence and precision, future studies could expand to include interviews from additional regions within each country and potentially involve more European countries.

Conclusion

This elite interview study underscores difference in the pre-hospital phase, at the emergency department, is that paediatricians are rarely involved in Belgium and Norway, while they are typically involved in the Netherlands. Although clinical care for AAI is similar across countries, differences exist in primary and secondary prevention efforts, with the Netherlands being the only country reporting healthcare professional involvement in these areas. Tertiary prevention, as recommended by the WHO, is implemented in all three countries, but in Norway without involvement of paediatrician in it. All paediatricians acknowledge that the adolescents often lack awareness of the potential risks associated with alcohol consumption. Consequently, they agree that preventive events or public service announcements aimed at increasing the knowledge on this topic are essential. They emphasise that healthcare professionals should be involved in this. Improving primary, secondary, and tertiary prevention of alcohol consumption in minors is

crucial to reducing alcohol-related hazardous behaviour, injuries, and intoxication. A unified European evidence based approach to alcohol intoxication healthcare pathways is recommended.

Declarations

Disclosure statement

The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

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Appendix chapter 9

Questionnaire for interviewed European paediatricians

General

- Name, profession, city and country of profession
- Ever had experience with treatment of adolescents with alcohol intoxication? If yes, what?

Pre-hospital section

- Are you familiar with interventions in your hospital district to prevent alcohol consumptions within minors? If yes, what type of interventions are there ? Does your hospital plays a part in this prevention?
- How big is the problem of alcohol consumption by minors in your opinion? And why?
    - Do you see a trend?
- What is the story you often hear from the minors about why they became intoxicated?
- If a child (<18 y.o.) is intoxicated because of alcohol, what happens pre-hospital?
    - Who are primarily involved when an alcohol intoxicated adolescents is spotted? (The police, general practitioner, ambulances etc.?)
        - And what is their policy for these type of patients?
        - Is an ambulance often called?
        - Is there a policy among the ambulances in case of an alcohol intoxicated adolescent?
        - Does the ambulance use criteria for bringing people in?
        - How often do they end up in the hospital, are they often send home initially?
        - Do the parents bring their adolescents to the hospitals?

Hospital section

- Do minors with an alcohol intoxication go to primary care or hospitals for treatment?
    - What are the treatment criteria for each?
    - Do you identify the alcohol intoxication often when secondary injury has been found or as a primary cause of hospital admission?
        - Does secondary injury due to alcohol influence the admission to the hospital?

- How often are they discharged without a paediatrician seeing the child?
- How often are they discharged without admission on the paediatric ward? Are there criteria for admission?
- What is the standard care for these alcohol intoxicated children in the hospital?
    - Standard care per hospital or ED-department or labour association or country?
    - Blood workup with BAC?
    - Urine drug screening ?
- Do you have preventive interventions during their hospital stay (like giving them more information about alcohol, letting them fill in a questionnaire and evaluating the answers together)
- From you expertise in this population, do you think this problem is:
    - Increasing or decreasing?
    - More boys or girls?
    - Age group?
    - Trend of other characteristics? For instance drugs?
- Other interesting findings about this population in your country? What kind of minors are they usually?

Post-hospital section

- Is there a follow-up program for these patients after the alcohol intoxication event has taken place ?
    - If not, why?
    - If yes, how does the follow-up program look?
        - Who sees them (primary care, paediatrician, child psychologist etc.)?
        - How long is the follow-up period?
    - Is this the same for all the hospitals in your country or are there regional differences? If yes, what kind of differences?
    - Is the central government involved with this type of problem? (for instance prevention subsidies)
    - How should we prevent AAI in minors in your opinion?

Discussion

Part 1

General discussion and main findings

Part 2

General conclusion

Part 1 General discussion and main findings

1. European vs. Dutch alcohol consumption in minors

Despite numerous prevention efforts, adolescent alcohol consumption remains a significant public health concern across Europe [1], with notable variations in drinking patterns among young people in different countries [2, 3]. Compared to adults, adolescents tend to drink less frequently, but when they do, they consume larger amounts in a single session, a pattern known as binge drinking [4]. Over the past two decades, some European countries, particularly in the Nordic region, have experienced a substantial decline in adolescent alcohol use and binge drinking. In contrast, other regions, including certain Mediterranean countries, have exhibited curvilinear trends [5].

Chapters 2, 3, 5, 6, and 8 present data on adolescents admitted with acute alcohol intoxication (AAI) in the Netherlands. It is important to note that these findings specifically reflect the drinking and demographic patterns of AAI patients and do not represent broader trends in alcohol use among Dutch minors. To examine national and European trends, the most recent ESPAD report can be consulted, as it focusses on alcohol consumption among 15- to 16-year-old school-going students across Europe [6]. According to the ESPAD report, while adolescent alcohol consumption remains prevalent, temporal trends from 1995 to 2019 show a gradual decline in both lifetime and last 30 days alcohol use, as depicted in **Figure 1a**. Notably, binge drinking in the past month has decreased across Europe between 2007 and 2019. A similar trend is observed among Dutch 15-16-year-olds, with reductions in both lifetime and last 30 days alcohol use, as shown in **Figure 1a**. However, despite these trends, binge drinking rates among current drinkers in the Netherlands remain above the European average, with 41% of boys and 44% of girls reporting binge drinking in the past 30 days in 2019 [6], as illustrated in **Figure 1b**. Additionally, Dutch adolescents in this age group reported an average of 6.5 drinking occasions in the past month, with boys averaging 7.6 and girls 5.5 occasions [6]. When they did drink, their alcohol consumption ranked third highest in Europe, with an average intake of 6.6 centilitres (cl) pure alcohol, with 7.1cl for girls and 6.2cl for boys.

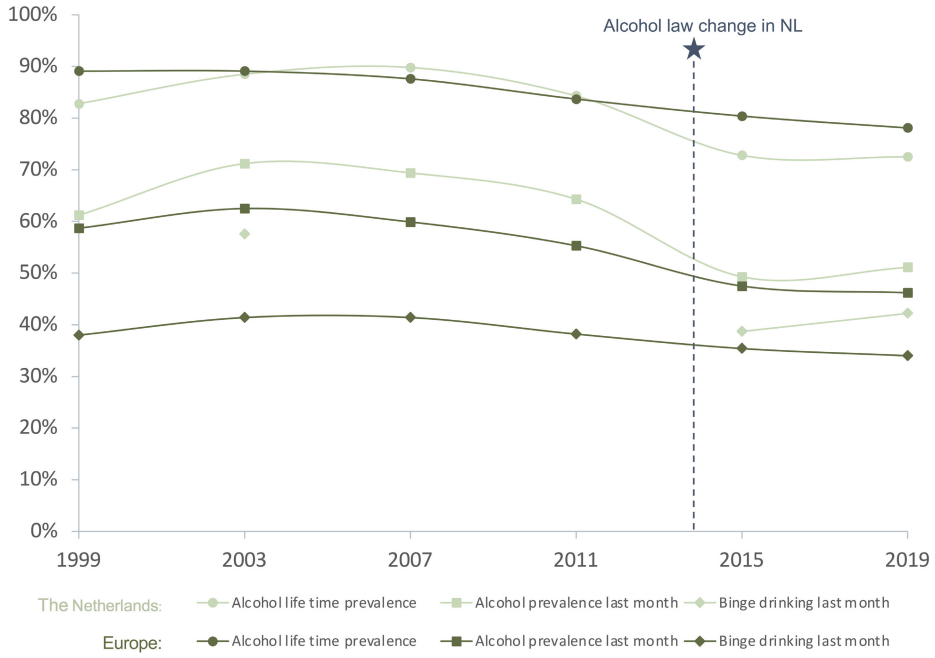

Figure 1a *Dutch and European data on alcohol consumption in 15-16 y.o. students in 1999-2019 based on ESPAD 2019 report [6]*

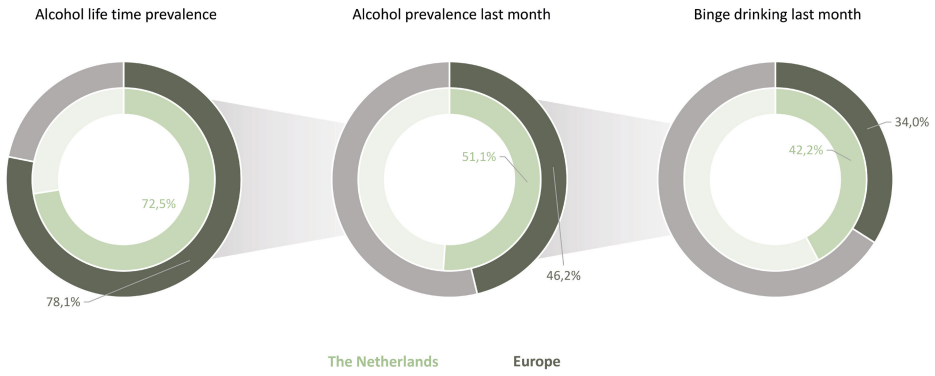

Figure 1b *Dutch and European data on alcohol consumption in 15-16 y.o. students in 2019 based on ESPAD 2019 report [6]*

Similarly, the Health Behaviour in School-aged Children (HBSC) study indicates a long-term decline in alcohol consumption among Dutch high school students [7]. Specifically, the lifetime prevalence of alcohol use decreased from 84% in 2003 to 45% in 2021. Additionally, the percentage of students who reported consuming alcohol in the past month dropped from 55% in 2003 to 25% in 2021. However,

among those who did consume alcohol, the proportion engaging in binge drinking increased from 64% to 74% over the same period, and has remained stable since 2013. As the overall proportion of students who drink alcohol has more than halved from 2003 to 2021, the relative prevalence of binge drinking among the total youth population has declined [7]. These trends highlight both progress and opportunities for further improvement, not only in the Netherlands, but across Europe. Strengthening primary prevention efforts, particularly those involving healthcare professionals, can help adolescents and their parents better understand the risks and effects of alcohol consumption. Additionally, law enforcement plays a crucial role in addressing alcohol-related issues.

2. Acute alcohol intoxication data

2.1. Alcohol law change

An increase in the minimum legal drinking age (MLDA) has generally been associated with a reduction in alcohol consumption among minors [8, 9]. In the Netherlands, the MLDA was raised to 18 years for all alcoholic beverages on January 1, 2014. When examining hospital admission data for Dutch adolescents admitted for AAI between 2007 and 2019, with specifically focussing on time points before and after this legal change (**Chapter 2**), we observed that the effects of this policy might be reflected in our study population. After the law was enacted, adolescents presenting with AAI were significantly older, see **Figure 2**. The observed decline in alcohol consumption among the general adolescent population (see **Figure 1a**) and the older age of individuals in our study may be linked to both the increased MLDA and the national alcohol prevention campaign that accompanied it.

Despite the overall reduction in alcohol consumption, the number of adolescents presenting with AAI at emergency departments (ED) increased significantly over time, although it appears to have stabilized in the most recent years. This trend is concerning, as the ED visits among the 0-14 and 15-25 age groups declined between 2011 - 2020 [10]. The rising number of AAI-related ED visits suggests that alcohol-related cases are making up a growing proportion of adolescent ED presentations. Additionally, while alcohol use has generally declined in the population (see **Figure 1a**), the group that continues to consume alcohol is likely to be drinking at higher levels, resulting in the risk of hospitalization. In the adolescent AAI population, characteristics as sex, BAC and educational level remained stable over time, see **Figure 2**.

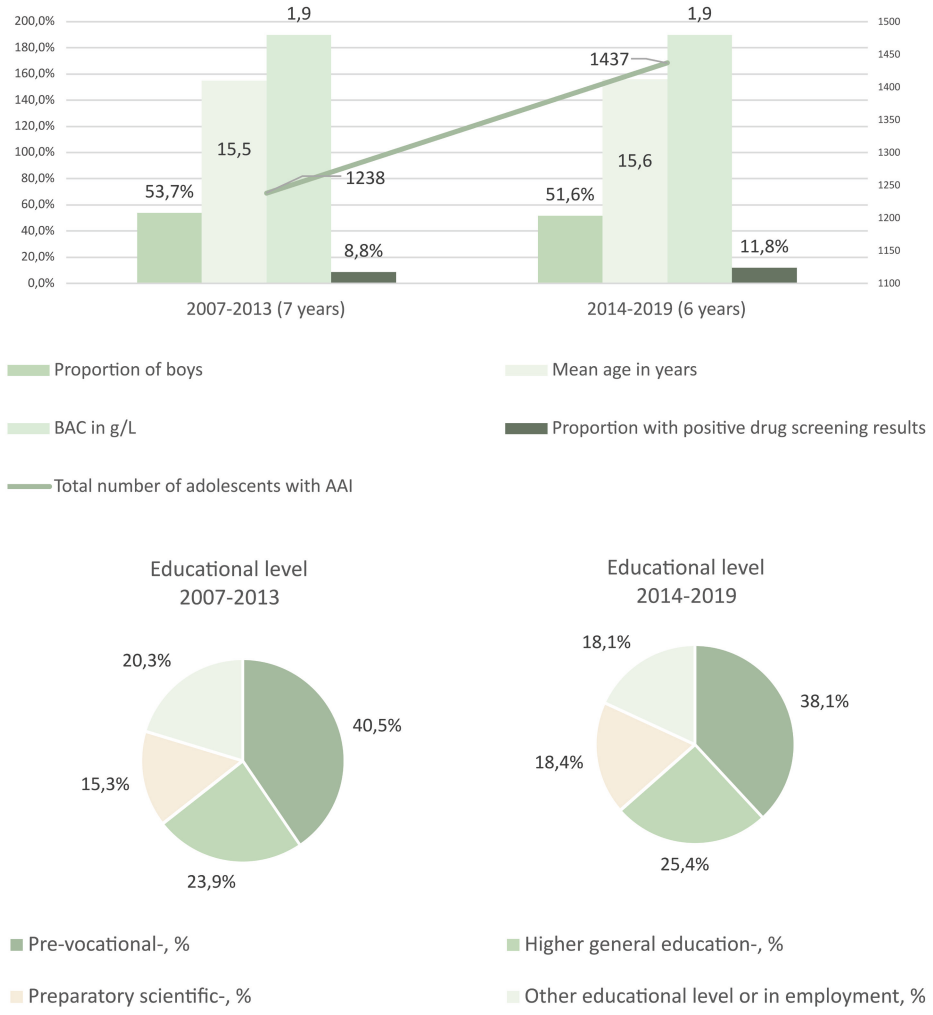

Figure 2. *Differences in population before and after the Dutch alcohol law change*

Moreover, the proportion of AAI cases involving co-occurring drug use has increased significantly since the alcohol law change, with cannabis being the most commonly used drug. This combination of alcohol and drugs could partly explain the higher number of hospital admissions, even as overall alcohol consumption remains stable or declines. However, the Netherlands Institute of Mental Health and Addiction has stated that, based on both quantitative and qualitative data, it is unlikely that the nationwide MLDA increase contributed to a rise in drug use among Dutch 16-17-year-olds [11]. In fact, cannabis use among Dutch schoolchildren aged 16-17 declined between 2011 and 2015, while hard drug use remained stable. This further suggests that the study population may have shifted toward a higher-

risk subgroup. Additionally, research indicates that co-occurring mental disorders are common among Dutch adolescents admitted for AAI, and these conditions are often associated with positive drug screening results [12]. Therefore, gaining a deeper understanding of the psychological and mental health status of this population is crucial for identifying the factors driving these trends.

2.2. Influence of the COVID Pandemic

Given that adolescents with AAI represent a high-risk group, they should be closely monitored during periods of isolation due to concerns about excessive alcohol consumption. Research indicates that the COVID-19 pandemic has negatively impacted mental health globally, leading to issues like anxiety, stress, insomnia, depression, fear, and anger [13-15]. The pandemic's adverse effect on mental health has been linked to increased alcohol use in several countries, including Italy [16], Australia [17, 18], Canada [19], USA [20, 21], Germany [22] and the UK [23].

When we investigated the impact of COVID-19 lockdowns and the subsequent reopening on AAI in adolescents in this thesis (**Chapter 3**), we found that during the first lockdown in 2020, AAI prevalence among adolescents decreased by 70% compared to the pre-lockdown period, see **Figure 3**. Yet, between the first lockdown and reopening period, AAI prevalence significantly increased. A previous study in Italy found a similar decrease in AAI during their lockdown, followed by an exceptional increase (rebound effect) after restrictions eased [16]. In contrast, no such peak was observed in the Netherlands; the reopening period was comparable to the same period in 2019. Italy implemented stricter lockdown measures than the Netherlands [24], which may have contributed to this rebound. The dutch patient characteristics (age, sex, BAC and the proportion of positive drug screenings) did not differ with respect to those adolescents admitted for AAI during these different periods.

The decline in AAI during the lockdown can be attributed to several factors, such as the closure of bars, restaurants, sports clubs, and schools, as well as increased parental supervision due to remote working arrangements. This study underscores the relationship between COVID-19 lockdown measures and instances of AAI among adolescents. It was probably beneficial that the Dutch lockdown measures were less strict compared to other countries because more restrictions may result in a rebound effect of alcohol use after the lockdown. To protect the mental health of adolescents, the government should prioritise minimizing social restrictions for this age group as much as possible during pandemics, because these measures can lead to mental problems and increased alcohol use.

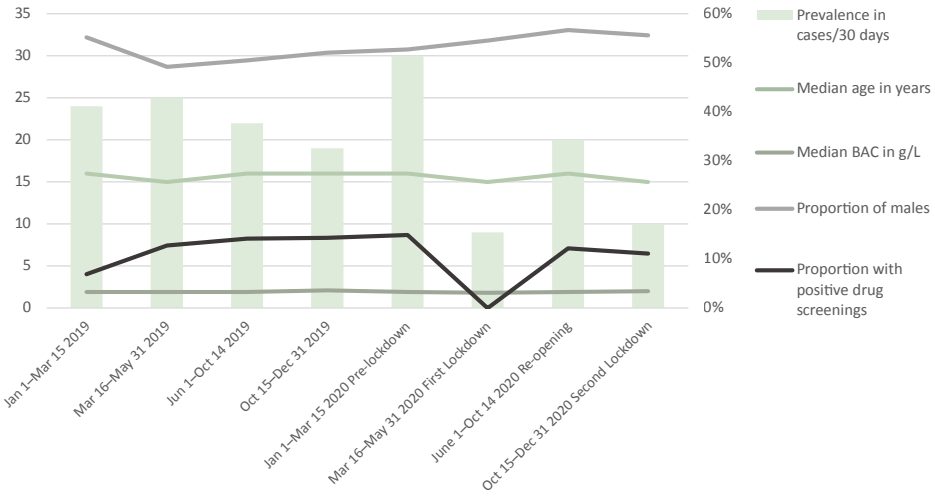

Figure 3. *Time trend analysis before, during and after first COVID-19 lockdown*

A report with more recent data on AAI in Dutch emergency departments (ED) reveals that in 2023, nearly a quarter of all alcohol-related ED visits in the Netherlands involved adolescents under 18 y.o. [25]. When adjusted for Dutch population composition, the risk of ending up in the ED with an AAI is highest among 12- to 17-year-olds. Within this age group, girls face a significantly higher risk (107 cases per 100,000) compared to boys (68 cases per 100,000). While the number of AAI-related ED visits among boys has decreased, the number for girls has risen to levels similar to those seen before the COVID-19 pandemic. This increase among girls warrants further attention, and follow-up research is needed to understand the underlying causes. The significant rise in emotional issues and declining mental health among Dutch high school students between 2017 and 2021, particularly among girls, might for instance play a role to this problem [7].

2.3. Italy, Belgium and the Netherlands compared

Effective prevention of AAI requires comprehensive, cross-national data to understand trends and risk factors. ED data on AAI provides valuable insights for this purpose. In this thesis (**Chapter 4**) the first international study with AAI data across three European countries revealed that Belgium had the highest median annual admission rate (51 per 10,000 adolescents), followed by the Netherlands (49 per 10,000) and Italy (37 per 10,000), see **Figure 4**. While sex distribution was similar in the Netherlands and Italy, Belgium had significantly more male patients. The median blood alcohol concentration (BAC) was highest in the Netherlands (2.00

g/L), followed by Belgium (1.97 g/L) and Italy (1.84 g/L), with other factors like age and co-occurring drug use being comparable across countries.

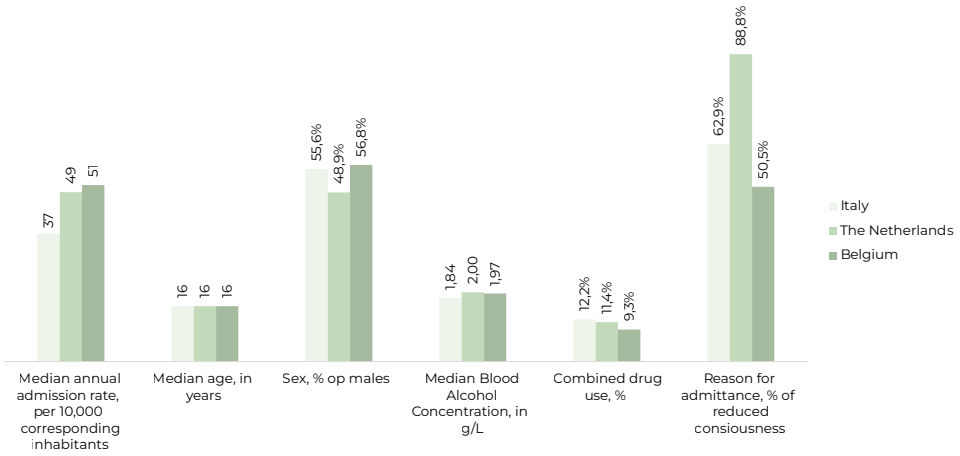

Figure 4. *Comparison of Italian, Belgium and Dutch adolescent AAI characteristics*

Although this difference in admission rate was not statistically significant between countries, several contextual factors may explain discrepancies. For instance, variations in the MLDA; Belgium's MLDA for beer and wine has been 16 since 2009 [26], while the Netherlands and Italy set the MLDA at 18 for all alcoholic beverages (in 2014 and 2012, respectively) [27, 28]. Moreover, lifetime alcohol prevalence among Italian and Dutch adolescents is lower than the European average, while Belgian adolescents exceed it [29]. The study's findings raise questions about the role of national alcohol policies in shaping adolescent drinking behaviours. Among the three countries, Italy performs best in several areas of the European action plan to reduce harmful alcohol use, including "Leadership, awareness and commitments on drinking and alcohol intoxication" ''Alcohol availability'' and "Marketing" [27].

This first cross-national comparison of AAI characteristics among European minors emphasizing the need for standardized coordinated, cross-country database. This database would enable more accurate comparisons, improve our understanding of AAI in this population, and support the development of targeted, cross-national preventive strategies.

2.4. Evaluation of drinking patterns and risk factors at the psychological outpatient clinic

The previously mentioned HBSC study highlights a significant increase in emotional problems and declining mental health among Dutch high school students between

2017 and 2021, particularly among girls [7]. In this thesis, when assessing the mental health of adolescents with acute alcohol intoxication (AAI) at the psychological outpatient clinic (**Chapter 5**), we found that 43.9% had a previously diagnosed psychological disorder, most commonly ADHD. Among those without a prior diagnosis, 15.1% exhibited clinical signs of undiagnosed psychological issues. This underscores the importance of the outpatient clinic in identifying mental health concerns early and determining the need for referral to specialized care to prevent recurrent hospital admissions and future excessive alcohol consumption [12].

Beyond psychological disorders, we also considered alcohol consumption patterns, related risk behaviours and family and pedagogical factors, to provide a holistic understanding of adolescent risk profiles. Adolescents with AAI exhibited higher levels of risk-taking behaviours, such as smoking, substance use, and sexual activity, compared to the Dutch average (see **Figure 5**). This suggests that early and excessive alcohol use is associated with a broader spectrum of risk-taking behaviours. Initially, these adolescents had significantly higher rates of alcohol consumption and drunkenness. However, during the outpatient clinic preventive program, their alcohol use decreased substantially in the month following intoxication, even dropping below the Dutch average. Six to twelve months later, their alcohol consumption increased again, though it remained lower and involved less binge drinking than the Dutch average.

Nearly half of these adolescents had a family history of alcohol or substance use disorders, aligning with research indicating that a positive family history increases the risk of similar behaviours and psychiatric issues [30]. Additionally, 41.5% reported exposure to parental drunkenness, which has been linked to a twofold increase in the risk of binge drinking [31]. Before their emergency department (ED) visit, many adolescents had parents who either approved alcohol use or lacked specific rules about it, with only one-third reporting strict alcohol-related rules. Encouragingly, following the ED visit, over one-third of parents implemented stricter alcohol rules. This shift is important, as indulgent or negligent parenting styles are associated with a higher risk of adolescent binge drinking [31].

Overall, this study demonstrates that adolescents admitted with AAI who participated in the follow-up program showed a reduction in alcohol use, particularly binge drinking. However, this group also exhibited high levels of risk-taking behaviour, psychological disorders, and a strong family history of substance use or drunkenness. Given these factors, it is crucial to implement follow-up programs for this population to reduce future alcohol consumption and if necessary provide

referrals for additional care, such as mental health support. Future research should compare outcomes of adolescents with AAI with outpatient care to those without follow-up to assess which results stem from the intervention or the intoxication itself. Though, previous studies have shown that adolescents with problematic alcohol use reported reduced alcohol consumption and fewer alcohol-related problems after participating in motivational interviewing interventions compared to standard care [32-34]

Figure 5. *Psychological outpatient clinic results*

3. Prevention approaches

Alcohol misuse is a leading cause of preventable mortality, contributing approximately 3 million deaths globally each year [35]. In response, the World Health Organization (WHO) has outlined a cost-effective strategy known as the “Best Buys” to prevent noncommunicable diseases, which includes measures to reduce harmful alcohol consumption. These key strategies involve increasing excise taxes on alcohol, banning or restricting alcohol advertising, limiting alcohol availability, enforcing drink-driving laws, and providing psychosocial interventions for individuals with hazardous or harmful alcohol use.

As part of this thesis, I spent four months in Oslo in collaboration with the Norwegian Institute of Public Health (Alcohol Research Group), to gain a deeper understanding of Norway’s preventive system. Norway serves as a strong example of implementing the WHO Best Buys strategy, with measures such as high alcohol taxes, a ban on alcohol advertising, restricted alcohol availability through state-run stores and designated time slots for alcohol sales. These policies have significantly reduced alcohol consumption among minors and minimized its presence in daily

life. For instance, in Norway, it is uncommon for alcohol to be offered to other parents at a child's birthday party, something considered quite normal in many other European countries. According to ESPAD data, the proportion of 15-to-16-year-old students who consume alcohol in Norway is far below the European average [6]. However, in social settings, an intoxication-oriented drinking culture among adults was noticeable, although literature [5] suggests this trend is declining.

This section (**Section 2**) of the thesis will focus on prevention approaches targeting adolescent alcohol consumption. It will explore strategies within the sports domain, approaches based on drinking motives, and a qualitative analysis to gain new prevention insights from minors and healthcare professionals.

3.1. Alcohol combined within sports sector

Despite various activities around alcohol prevention efforts within sports clubs, significant progress still needs to be made. For instance, the alcohol industry continues to sponsor major sporting events, such as Formula 1 races and the UEFA Champions League. Exposure to alcohol advertising during sports broadcasts has been linked to increased alcohol consumption among adolescents [36]. Additionally, due to reduced Dutch sports subsidies, local sports clubs have become somewhat reliant on bar revenues, creating a conflict of interest between alcohol prevention and alcohol sales. Furthermore, recent government data indicate a decline in alcohol ID verification compliance rates for minors in sports canteens, dropping from 28.8% in 2022 to 22.4% in 2024 [37].

Sporting adolescents may be particularly receptive to research highlighting the negative impact of alcohol on athletic performance. Therefore, studies on the potential muscle-related consequences of alcohol use and alcohol-associated injuries could play a valuable role in shaping preventive strategies within the sports context. One such complication is rhabdomyolysis, an acute condition characterised by muscle fibre necrosis, defined by creatine kinase (CK) levels exceeding 5 times the upper limit of normal. In Dutch adolescents with AAI, the incidence of elevated CK levels was found to be 60%, with 4.4% exhibiting rhabdomyolysis (**Chapter 6**). Most patients were in the early stages of rhabdomyolysis, with CK levels below this critical threshold. Early detection of CK elevation is crucial in preventing severe muscle damage [38]. Therefore, adolescents admitted for AAI should undergo blood and urine tests for early diagnosis and treatment of rhabdomyolysis [39]. The primary treatment goal is to prevent further muscle damage, acute renal failure, and life-threatening complications such as hyperkalaemia and compartment syndrome [40].

Our findings also revealed a positive association between higher blood alcohol concentration (BAC) and elevated CK levels, after adjusting for positive drug screenings. Several factors could contribute to CK elevation in adolescents with AAI, including trauma [40], intense physical activity before drinking [41], or immobilization during hospitalization. However, trauma was present in only 11% of a comparable Dutch AAI population [42]. CK elevation following intense exercise can persist for up to 72 hours [43]. While we lack specific data on patients' sporting activities before their ED admission, it is known that 75% of Dutch adolescents aged 12–17 engage in sports more than once per week [44]. Immobilization as a cause of CK elevation is unlikely, given the median Glasgow Coma Scale score of 15 (the maximum) at the time of blood testing. Therefore, we hypothesize that alcohol intoxication itself likely contributes to the elevated CK levels in this population.

This study is the first large-scale investigation into the impact of AAI on muscle tissue in adolescents under 18, highlighting alcohol-related muscle injuries within the sports context. Previously, only a few case reports had been published on this topic. Our findings, along with existing literature on rhabdomyolysis in adults [38, 45-47], suggest that rhabdomyolysis could also be a concern for adolescents with AAI. Further research is necessary to better understand the pathophysiology and causal mechanism underlying this interaction. We hope that our results will contribute to raising awareness about the negative effects of alcohol use on athletic performance in adolescent athletes. Additionally, we recommend banning alcohol advertising within the sports sector, including alcohol-free branding promotions. Furthermore, enforcement of alcohol restrictions for minors should be strengthened within this sector, as declining compliance rates indicate that alcohol remains more accessible than it should be.

3.2. Understanding why European adolescents drink

Among the 52,141 students (aged 15-16 y.o.) from 16 European countries (Denmark, Estonia, Finland, Germany, Greece, Iceland, Italy, Latvia, Lithuania, The Netherlands, Norway, Poland, Portugal, Romania, Sweden and Spain), 75.2% reported lifetime alcohol consumption, and 65.8% drank alcohol in the past year (**Chapter 7**). In **Figure 6** percentage of students per country who consumed alcohol in the last 12 months are illustrated. Among those who drank alcohol in the past year (n = 34,295), three main drinking motives were identified: 1. enhancement and social, 2. coping, and 3. conformity. The most common was the enhancement and social drinking motive across all countries, followed by coping, with conformity being less frequent.

Within the enhancement and social drinking motive, Denmark had the statistically significant highest mean score compared to all other countries, see **Figure 7** which displays the distribution of drinking motives per country. Notably, Denmark, along with Germany (Bavaria), exhibited the highest rates of alcohol consumption (see **Figure 6**) and intoxication among school-going students. Denmark's culture of heavy, intoxication-oriented, playful drinking [48] aligns with these findings. This suggests that in countries where intoxication is more prevalent, and possibly more socially accepted [49, 50], motives like 'to get high' and 'like the feeling' may be more pronounced. This pattern contrasts with southern European countries, which are typically wine-producing, where the predominant drinking pattern involves the frequent consumption of moderate amounts of alcohol, often accompanying meals [49, 50]. In this study, most of the southern European countries like Greece, Spain, and Portugal reported significantly lower scores for these motives compared to the overall population, reflecting cultural differences in drinking behaviours.

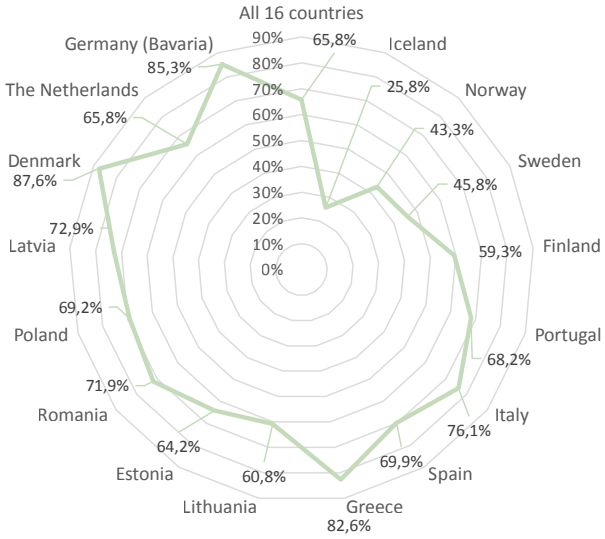

Figure 6. *Percentage of the population per country that consumed alcohol in the last 12 months*

Additionally, a significant positive correlation was found between alcohol intoxication and the enhancement and social drinking motive. This suggests a stronger presence of the enhancement and social motive in cultures with an intoxication-oriented drinking pattern, which is consistent with previous research [51, 52]. Denmark and Norway scored the highest on the enhancement and social drinking motive. On average, European students consumed 4.6 cl of alcohol on their last drinking day,

with Denmark (8.8 cl), Norway (6.7 cl), and the Netherlands (6.6 cl) exceeding this average significantly [6], indicating an intoxication-oriented drinking pattern.

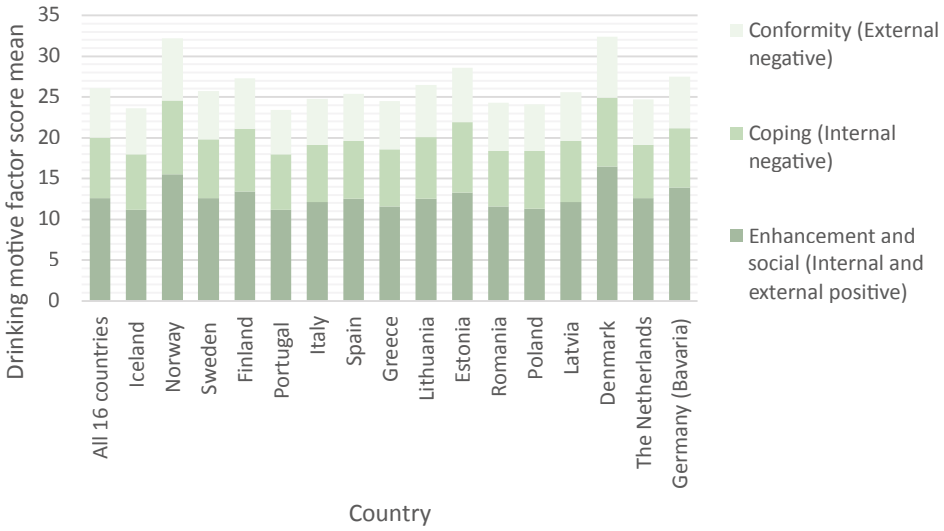

Figure 7. *Distribution of drinking motives per country*

The order of importance of drinking motives in European schoolchildren: enhancement and social-, coping-, and then conformity, aligns with prior research on high school students from 2010-2013 which also included other European countries [53]. This suggests that health promotion strategies targeting these enhancement and social drinking motives could be effective across Europe. For example, media campaigns or school programs could address alcohol risks and promote alcohol-free alternatives in social and enhancement settings. Additionally, restrictions on alcohol advertising play a crucial role, as the alcohol industry seeks to maintain the association between alcohol and fun, celebratory moments. The tactics used in alcohol marketing to shape our perceptions of alcohol need to be curtailed. It is essential to stop normalising alcohol within the community.

The prevention model used in Iceland is an excellent example of a community-based approach. Municipalities collaborate with local partners, parents, sports clubs, and prevention professionals to create an environment where young people can grow up healthy and happy, without engaging in alcohol use, drug use or smoking, and preventing them from doing so in the future. Given the effectiveness of this model, also evidenced by the lowest rates of alcohol consumption among participating teens from Iceland (see **Figure 6**), it should serve as an example for other countries.

3.3. Qualitative approach for prevention insights by minors

Gathering insights from adolescents who experienced acute alcohol intoxication (AAI) helps us better understand their motivations and improve prevention programs targeting alcohol misuse in this age group (**Chapter 8**). Adolescents primarily drink in the evening and night in social settings with friends, driven by social and enhancement drinking motives, as shown in **Figure 8**. They often consume spirits, sometimes mixed with soda, in large quantities per session. As mentioned above, spirits were the most commonly consumed type of alcohol in our population, far more than among alcohol-drinking peers in the general Dutch population [6]. Adolescents are more prone to binge drinking (consuming 4-5 units per occasion) compared to adults [4]. Literature indicates that binge drinking among minors frequently involves distilled spirits [54], which is also evident in our population. Additionally, a lack of awareness about standard drink sizes, particularly for spirits, contributes to over-pouring and increased intoxication risks [55], a pattern also observed in our population.

The adolescents reported easy access to alcohol despite being underage, with their AAI often resulting in vomiting, emergency transport, and sometimes secondary injuries or unconsciousness. At the outpatient clinic, many parents asked questions about strategies for setting alcohol-related boundaries. This underscores the need for easily accessible information to inform parents about the effects and regulations of alcohol and to support them regarding parenting strategies related to alcohol. This is a critical component of the process, as evidence suggests that combining strict parental rule-setting with a warm and supportive family environment confers protective effects for adolescents [56, 57].

A common theme among adolescents was the inability to recognize when they became intoxicated, often describing “black-out” experiences. This made it difficult for them to anticipate intoxication in a timely manner, which is a critical factor for prevention. They also lacked knowledge about alcohol’s effects, underscoring the need for better education. This is also well supported by evidence, which highlights that effective school-based interventions are theory-based, challenge social norms, build resistance skills and are culturally appropriate and sustained over time [58]. Many adolescents expressed the desire for reduced alcohol advertising, particularly on social media, which strongly influences their daily lives. This aligns with the WHO’s Global Alcohol Action Plan [59], which advocates for banning alcohol ads to reduce alcohol-related harm. In summary, adolescents recommended improved education, stricter advertising regulations, and better enforcement of alcohol laws to help reduce alcohol consumption, AAI and its negative impacts on minors.

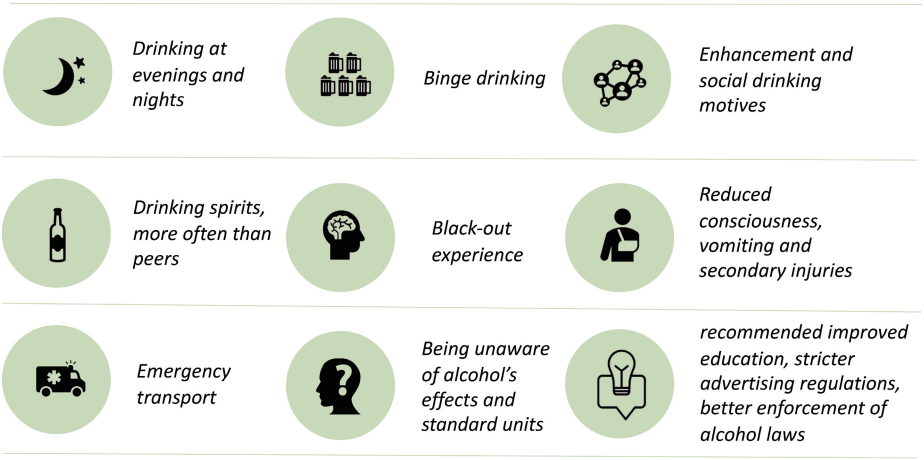

Figure 8. *Findings of AAI incident of the adolescents*

3.4. Qualitative approach for prevention insights by health care professionals

Improving the clinical care for adolescents with AAI and the primary, secondary, and tertiary prevention of alcohol consumption in minors is crucial to reducing alcohol-related hazardous behaviour and injuries. Paediatricians from Norway, the Netherlands, and Belgium were asked to assess the prevention and clinical care provided to adolescents with AAI (**Chapter 9**). When an adolescent with AAI is admitted at the emergency department, paediatricians are rarely involved in Belgium and Norway, whereas they are typically involved in the Netherlands, as shown in **Table 1**. Although clinical care for AAI is largely similar across these countries, differences exist in primary and secondary prevention efforts, with the Netherlands being the only country reporting involvement of healthcare professional in these areas. Tertiary prevention, including follow-up programs recommended by the WHO [12, 60], is implemented in all three countries; however, in Norway, it is carried out without the involvement of a paediatrician.

All interviewed paediatricians acknowledge that the adolescents often lack awareness of the potential risks associated with alcohol consumption. Consequently, they agree that preventive events or public service announcements aimed at increasing the knowledge on this topic are essential. They emphasise that healthcare professionals should be involved in this. Improving primary, secondary, and tertiary prevention of alcohol consumption among minors is crucial to reducing alcohol-related hazardous behaviour, injuries, and intoxication. Comparison across European countries is challenging due to limited data especially on tertiary prevention,

although notable exceptions include brief motivational interventions in Germany [61] and alcohol screening in the UK [62].

A unified, European evidence-based approach for prevention and an alcohol intoxication care pathway is recommended. To acquire the knowledge necessary to improve prevention and optimize healthcare pathways, a pilot study involving more paediatricians across multiple European countries should be initiated. Moreover, it is recommended that European countries follow the WHO's recommendations to provide psychosocial interventions for individuals with hazardous or harmful alcohol use, as this is not yet standard care in many countries.

Table 1. *Overview primary, secondary and tertiary prevention and health care pathway in the three included European countries*

	Norway	**Belgium**	**The Netherlands**
Primary prevention by paediatrician	No	No	Yes
Location presentation adolescent with AAI	Primary care	Emergency department	Emergency department
Admission adolescent with AAI	Primary care	Night hospital	Paediatric department
Involvement paediatrician during admission	No	No	Yes
Standardised treatment guideline	Yes	No	Yes
Secondary prevention by paediatrician	No	No	Yes
Tertiary prevention by paediatrician	No	Yes	Yes

Finally, all the knowledge gained during from thesis, as well as other sources, should be shared with other European countries to raise awareness. This information should be used to inform national policymakers, encouraging them to apply this knowledge in prevention efforts and to initiate new research specifically tailored to their respective countries. This approach allows European policies to be shaped by reliable information, helping raise awareness of alcohol-related harm. Only then can meaningful societal changes be achieved.

Part 2 General conclusion

This thesis demonstrates the current characteristics of acute alcohol intoxication (AAI) in Dutch adolescents. Adolescents presenting with AAI have become significantly older since the Dutch alcohol law change and the implementation of a combined prevention campaign (enacted in 2014). Despite the decrease in overall alcohol consumption in the general adolescent population, the number of adolescents presenting with AAI at the emergency department (ED) has increased significantly over time, although it appears to have stabilized in recent years. Moreover, the proportion of AAI cases involving co-occurring drug use has increased significantly over time. This suggests that the study population may have shifted toward a higher-risk subgroup. Therefore, gaining a deeper understanding of this population is crucial for identifying the factors driving these trends.

Given that adolescents with AAI represent a high-risk group, they should be closely monitored during periods of isolation due to concerns about potential mental health issues which might be linked to excessive alcohol consumption. Yet, during the COVID-19 pandemic, there was a 70% decrease in AAI admissions during the first lockdown in 2020 compared to the pre-lockdown period. Between the first lockdown and the reopening period, AAI prevalence significantly increased back to pre-COVID levels. Patient characteristics (age, sex, BAC and the proportion of positive drug screenings) did not differ across these periods. It was probably beneficial that the Dutch lockdown measures were less strict compared to other countries because more restrictions may result in excessive alcohol use or a rebound effect of alcohol use after the lockdown. To protect the mental health of adolescents, the government should prioritise minimizing social restrictions for this age group as much as possible during pandemics, because these measures can lead to mental problems and increased alcohol use.

Effective prevention of AAI requires comprehensive, cross-national data to understand trends and risk factors. ED data on AAI provides valuable insights for this purpose. Dutch AAI data was compared with data from Belgium and Italy, where ED AAI data was available. It was found that Belgium had the highest median annual admission rate (51 per 10,000 adolescents), followed by the Netherlands (49 per 10,000) and Italy (37 per 10,000), although these differences were not statistically significant. While sex distribution was similar in the Netherlands and Italy, Belgium had significantly more male patients. The median blood alcohol concentration (BAC) was highest in the Netherlands (2.00 g/L), followed by Belgium (1.97 g/L) and Italy (1.84 g/L). Other factors, such as age and

co-occurring drug use were comparable across countries. This first cross-national comparison of AAI characteristics among European minors emphasizing the need for standardized coordinated, cross-country database. This would enable more accurate comparisons, improve our understanding of AAI in this population, and support the development of targeted, cross-national preventive strategies.

At a psychological outpatient clinic 43.9% of adolescents with AAI had a prior diagnosed psychological disorder, most commonly ADHD. Among those without a prior diagnosis, 15.1% showed clinical signs of undiagnosed psychological issues. This highlights the importance of the outpatient clinics in identifying mental health concerns early and determining the need for referral to specialized care to prevent recurrent hospital admissions and future excessive alcohol consumption . Adolescents with AAI exhibited higher levels of risk-taking behaviours, including smoking, substance use, and sexual activity, compared to the Dutch general population. During their outpatient clinic program, their alcohol consumption significantly decreased in the month following intoxication, even falling below the Dutch average. However, 6-12 months later, their alcohol use increased, though it remained lower and involved less binge drinking than the Dutch average. Overall, we can state that this population is an at risk population for alcohol related problems. These findings suggest that the preventive program had a short-term impact in reducing alcohol consumption among adolescents with AAI, as well as a long-term impact in reducing binge-drinking behaviours. The program's success in mitigating binge-drinking behaviours aligns with its goals of promoting safer drinking habits among adolescents.

Furthermore, this thesis focused on prevention approaches specifically targeting adolescent alcohol consumption. At first, in the sports domain, which has been identified as a key area of concern due to low compliance with ID control measures and significant involvement of the alcohol industry. Sporting adolescents may be particularly sensitive to findings that highlight the negative impact of alcohol use on athletic performance. Therefore, research into the potential muscle-related consequences and alcohol-associated injuries could play a valuable role in shaping preventive strategies within the sports context. One such complication is rhabdomyolysis, acute muscle fibre necrosis, defined by creatine kinase (CK) levels > 5 times the upper limit of normal. The incidence of elevated CK levels in Dutch adolescents with AAI was found to be 60%, with 4.4% exhibiting rhabdomyolysis. The results could aid in understanding how AAI influences the breakdown of muscle tissue in adolescents and help prevent alcohol use within the sports world. Additionally, we recommend banning alcohol advertising within the sports sector,

including alcohol-free branding promotions. Furthermore, enforcement of alcohol restrictions for minors should be strengthened within this sector, as declining compliance rates indicate that alcohol remains more accessible than it should be.

Investigating drinking motives among minors across various countries is crucial for understanding the broader social context of alcohol consumption and identifying possibilities for prevention. Among the 52,141 students (aged 15-16 years old) from 16 European countries (Denmark, Estonia, Finland, Germany, Greece, Iceland, Italy, Latvia, Lithuania, The Netherlands, Norway, Poland, Portugal, Romania, Sweden and Spain), three main drinking motives were identified: enhancement and social, coping, and conformity motives. The most common were enhancement and social motives across all countries, followed by coping motives, with conformity being less frequent. This pattern aligns with prior research suggesting that health promotion strategies based on enhancement and social drinking motives could be effective across Europe. Therefore, restrictions on alcohol advertising play a significant role, as the alcohol industry aims to maintain the connection between alcohol and fun, celebratory moments. The tactics used in alcohol marketing to shape adolescents' perceptions of alcohol need to be curtailed.

Gathering insights from adolescents who had an AAI helps us understand their motivations and improve prevention programs targeting alcohol misuse in this age group. Adolescents reported that they primarily drink in the evening and night in social settings with friends, driven by social and enhancement motives. They often consume spirits, sometimes mixed with soda, in large quantities per session. A common theme among adolescents was the inability to recognize when they became intoxicated, often describing "black-out" experiences. This made it difficult for them to anticipate intoxication in a timely manner, highlighting a critical factor for prevention. The adolescents also reported easy access to alcohol despite being underage. Therefore they recommended better enforcement of alcohol laws to help reduce AAI and its negative impacts. They also lacked knowledge about alcohol's effects, emphasizing the need for better education. Lastly, many called for reduced alcohol advertising, particularly on social media, which strongly influences their daily lives.

Improving the clinical care for adolescents with AAI and the primary, secondary, and tertiary prevention of alcohol consumption in minors is crucial to reducing alcohol-related hazardous behaviour and injuries. Based on interviews with paediatricians who are experts at the AAI care for adolescents, it seems that in the Netherlands, Norway and Belgium clinical care for AAI seems relatively similar. However, differences exist in primary and secondary prevention efforts across

the included countries, with the Netherlands being the only country involving a paediatrician in these efforts. Tertiary prevention, such as follow-up interventions for individuals with hazardous or harmful alcohol use as recommended by the World Health Organization (WHO), is implemented in all three countries, tough in Norway without involvement of a paediatrician. All interviewed paediatricians acknowledge that the adolescents often lack awareness of the potential risks associated with alcohol consumption. Consequently, they agree that preventive events or public service announcements aimed at increasing the knowledge on this topic are essential. They emphasise that healthcare professionals should be involved in this. Comparing health care pathways and prevention efforts across European countries is difficult due to limited data, particularly on tertiary prevention. Therefore, European countries should collaborate to develop a unified European evidence-based approach to alcohol intoxication care and prevention, in line with WHO recommendations.

Finally, all the knowledge gained should be shared with other European countries to raise awareness. This information should be used to inform national policymakers, encouraging them to apply this knowledge in prevention efforts and to initiate new research specifically tailored to their respective countries. This approach allows European policies to be shaped by reliable information, helping raise awareness of alcohol-related harm. Only then can meaningful societal changes be achieved.

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Appendices

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Appendix 1 English summary

Improvement of the prevention of alcohol consumption and intoxication in adolescents first requires comprehensive, cross-national data to understand trends and risk factors. Data on adolescents with acute alcohol intoxication (AAI) as well as alcohol consumption data from the general adolescent populations both provide valuable insights for this purpose. That is why in **Section 1** there were four studies performed to evaluate the characteristics, risk factors and determinants of adolescent alcohol intoxication over time. In **Figure 1**, an illustrative summary of the Dutch population with AAI is presented.

In **Chapter 2** hospital admission data pertaining to Dutch adolescents admitted for AAI between 2007 – 2019 is analysed with specific focus on the increase in the minimal legal drinking age (MLDA) nationwide (from 16 to 18 years old for low alcoholic beverages on January 1st, 2014). We observed that the effects of this policy might be reflected in our study population, as adolescents presenting with AAI were significantly older after the law was enacted. Despite the decrease in overall alcohol consumption in the Dutch population of adolescents, the number of adolescents presenting with AAI at the emergency department increased significantly over time, although it appears to have stabilized in the most recent years of data collection. Moreover, the proportion of AAI admissions involving co-occurring drug use has significantly increased over time, with cannabis being the most commonly used drug. This combination of alcohol and drugs could explain the higher number of hospital admissions, even if alcohol consumption overall remains stable or declines. This further suggests that the study population may have shifted toward a higher-risk subgroup.

In **Chapter 3** the impact of COVID-19 lockdowns and the subsequent reopening periods on AAI in adolescents was examined due to concerns about mental health issues during periods of isolation which might include excessive alcohol consumption. We found that during the first lockdown in 2020, AAI prevalence among adolescents decreased by 70% compared to the pre-lockdown period. Yet, between the first lockdown and reopening period, AAI prevalence significantly increased again, back to pre-COVID levels. The decrease in AAI during the lockdown can be attributed to multiple factors, including the closure of bars, restaurants, sports clubs, and schools, as well as increased parental supervision due to remote work. It was probably beneficial that the Dutch lockdown measures were less strict compared to other countries because more restrictions may result in a rebound effect of alcohol use after the lockdown. To protect the mental health of

adolescents, the government should prioritise minimizing social restrictions for this age group as much as possible during pandemics, because these measures can lead to mental problems and increased alcohol use.

In **Chapter 4** an international study with AAI data across three European countries revealed that Belgium had the highest median annual admission rate (51 per 10,000 adolescents), followed by the Netherlands (49 per 10,000) and Italy (37 per 10,000). While sex distribution was similar in the Netherlands and Italy, Belgium had significantly more male patients. The median blood alcohol concentration (BAC) was highest in the Netherlands (2.00 g/L), followed by Belgium (1.97 g/L) and Italy (1.84 g/L), with other factors like age and co-occurring drug use being comparable across countries. Although this difference in admission rate was not statistically significant between countries, several contextual factors may explain discrepancies. For instance, the variations in the MLDA between the three countries. Belgium's MLDA for beer and wine has been 16 since 2009, while the Netherlands and Italy set the MLDA at 18 for all alcoholic beverages (in 2014 and 2012, respectively). Moreover, the European action plan to reduce harmful alcohol use included differences in alcohol prevention per country and possible improvement suggestions for especially Belgium and The Netherlands. This first cross-national comparison of AAI characteristics among European minors emphasizing the need for standardized coordinated, cross-country database. This database which would enable more accurate comparisons, improve our understanding of AAI in this population, and support the development of targeted, cross-national preventive strategies.

In **Chapter 5** the drinking patterns and psychological risk factors for alcohol consumption of adolescents who previously had an AAI event were evaluated at the psychological part of the outpatient clinic. We found that 43.9% had a prior diagnosed psychological disorder, most commonly ADHD. Among those without a prior diagnosis, 15.1% showed clinical signs of undiagnosed psychological issues. Moreover, the adolescents with AAI exhibited higher levels of risk-taking behaviours, including smoking, substance use, and sexual activity, compared to the Dutch average. Initially, these adolescents had significantly higher rates of alcohol consumption and drunkenness. However, during the outpatient clinic preventive program, their alcohol use decreased substantially in the month following intoxication, even dropping below the Dutch average. Yet, 6-12 months later, their alcohol use increased, though still lower and involving less binge drinking than the Dutch average. Nearly half of these adolescents had a family history of alcohol or substance use disorders. Overall, we can state that this population is an at risk population for alcohol related problems. This study demonstrates that this preventive program following AAI might

contribute to the reduction of adolescent alcohol use, especially binge drinking. The program's success in mitigating binge-drinking behaviours aligns with its goals of promoting safer drinking habits among adolescents.

In **Section 2** there were four studies performed to examine possibilities for prevention purposes in adolescent alcohol consumption. Especially focussing on strategies within the sports domain, approaches based on drinking motives, and a qualitative approach to gain new prevention insights from minors and healthcare professionals.

In **Chapter 6** potential muscle-related consequences of alcohol were investigated in adolescents, as the sport sector has been identified as one of the key areas of concern with low compliance to ID control measures and much involvement of the alcohol industry. Sporting adolescents may be particularly sensitive to study findings that highlight the negative impact of alcohol use on athletic performance. For instance the complication rhabdomyolysis, also known as acute muscle fibre necrosis, defined by creatine kinase (CK) levels of more than 5 times the upper limit of normal. When examining the incidence of elevated creatine kinase (CK) levels in Dutch adolescents with AAI, we found that 60% of AAI patients had elevated CK levels, and in 4.4% rhabdomyolysis. Most patients were in the preliminary stages of rhabdomyolysis. Identifying CK elevation early is crucial to prevent severe muscle damage and other related problems. Therefore, adolescents admitted for AAI should undergo blood and urine tests for early detection and treatment of rhabdomyolysis. We also found a higher BAC to be associated with higher CK levels, after adjusting for positive drug screenings. This study is a pioneer in exploring the impact of AAI on muscle tissue in adolescents < 18 years on a larger scale. Our findings, combined with existing literature of rhabdomyolysis in adults after excessive alcohol consumption, suggests that rhabdomyolysis could also affect adolescents with AAI. Further research is needed to better understand the pathophysiology and causality of this interaction. We hope that our results may play a valuable role in shaping preventive strategies within the sports context. We recommend banning alcohol advertising within the sports sector, including alcohol-free branding promotions. Furthermore, enforcement of alcohol restrictions for minors should be strengthened within this sector, as declining ID compliance rates indicate that alcohol remains more accessible than it should be.

In **Chapter 7** a large drinking motives study among the 52,141 students (aged 15-16 years old) from the 16 European countries (Denmark, Estonia, Finland, Germany, Greece, Iceland, Italy, Latvia, Lithuania, The Netherlands, Norway, Poland, Portugal, Romania, Sweden and Spain) was described. Of those who drank in the past year

(n = 34,295), three main drinking motives were identified: enhancement and social, coping, and conformity motives. The most common were enhancement and social motives across all countries, followed by coping motives, with conformity motives being less frequent. This pattern aligns with prior research, suggesting that health promotion strategies based on enhancement and social drinking motives could be effective across Europe. Additionally, a significant positive correlation was found between alcohol intoxication and enhancement and social motives. This suggests a stronger presence of enhancement and social motives in cultures with a more intoxication-oriented drinking pattern. Therefore, restrictions on alcohol advertising plays a significant role, as the alcohol industry aims to maintain the connection between alcohol and fun and celebratory moments. The tactics used in alcohol marketing to shape adolescent's perceptions of alcohol need to be curtailed.

In **Chapter 8** a qualitative study at the Youth an Alcohol outpatient clinic was performed to gather insights from adolescents who experienced AAI to help us better understand their motivations and improve prevention programs targeting alcohol misuse in this age group. It was found that adolescents primarily drink in the evening and night in social settings with friends, driven by social and enhancement motives. They often consume spirits, sometimes mixed with soda, in large quantities per session. The adolescents also reported easy access to alcohol despite being underage, with their AAI often resulting in vomiting, emergency transport, and sometimes secondary injuries and unconsciousness. At the outpatient clinic, many parents asked questions about strategies for setting alcohol-related boundaries. This underscores the need for easily accessible information to inform parents about the effects and regulations of alcohol and to support them regarding parenting strategies related to alcohol. A common theme among adolescents was their inability to recognize when they became intoxicated, often describing "black-out" experiences. This made it difficult for them to anticipate intoxication in a timely manner, highlighting a critical factor for prevention. They also lacked knowledge about alcohol's effects, emphasizing the need for better education. Many called for reduced alcohol advertising, particularly on social media, which strongly influences their daily lives. In summary, the adolescents who participated emphasised the importance of alcohol education, stricter advertising regulations, and stronger enforcement of alcohol laws as key measures to reduce AAI and mitigating alcohol's harmful consequences in their population.

In **Chapter 9** a qualitative study based on interviews with paediatricians from Norway, the Netherlands, and Belgium was performed. They were asked to evaluate the prevention and clinical care provided to adolescents with AAI in their

respective countries. This is important since the World Health Organisation (WHO) has promoted the implementation of early identification and brief intervention programmes for individuals with hazardous or harmful alcohol consumption as one of the key pillars to reduce alcohol-related harm and improve population health. Based on interviews with paediatricians who are experts at the AAI care for adolescents, it seems that in the Netherlands, Norway and Belgium clinical care for AAI seems relatively similar. However, differences exist in primary and secondary prevention efforts, with the Netherlands being the only country reporting healthcare professional involvement in these areas. Tertiary prevention, as recommended by the WHO, is implemented in all three countries, but in Norway without involvement of paediatrician in it. All paediatricians acknowledge that the adolescents often lack awareness of the potential risks associated with alcohol consumption. Consequently, they agree that preventive events or public service announcements aimed at increasing the knowledge on this topic are essential. They emphasise that healthcare professionals should be involved in this. Improving primary, secondary, and tertiary prevention of alcohol consumption in minors is crucial to reducing alcohol-related hazardous behaviour, injuries, and intoxication. Therefore, European countries should collaborate to develop a unified European evidence-based approach to alcohol intoxication care and prevention, in line with WHO recommendations.

Finally, all the knowledge gained should be shared with other European countries to raise awareness. This information should be used to inform national policymakers, encouraging them to apply this knowledge in prevention efforts and to initiate new research specifically tailored to their respective countries. This approach allows European policies to be shaped by reliable information, helping raise awareness of alcohol-related harm. Only then can meaningful societal changes be achieved.

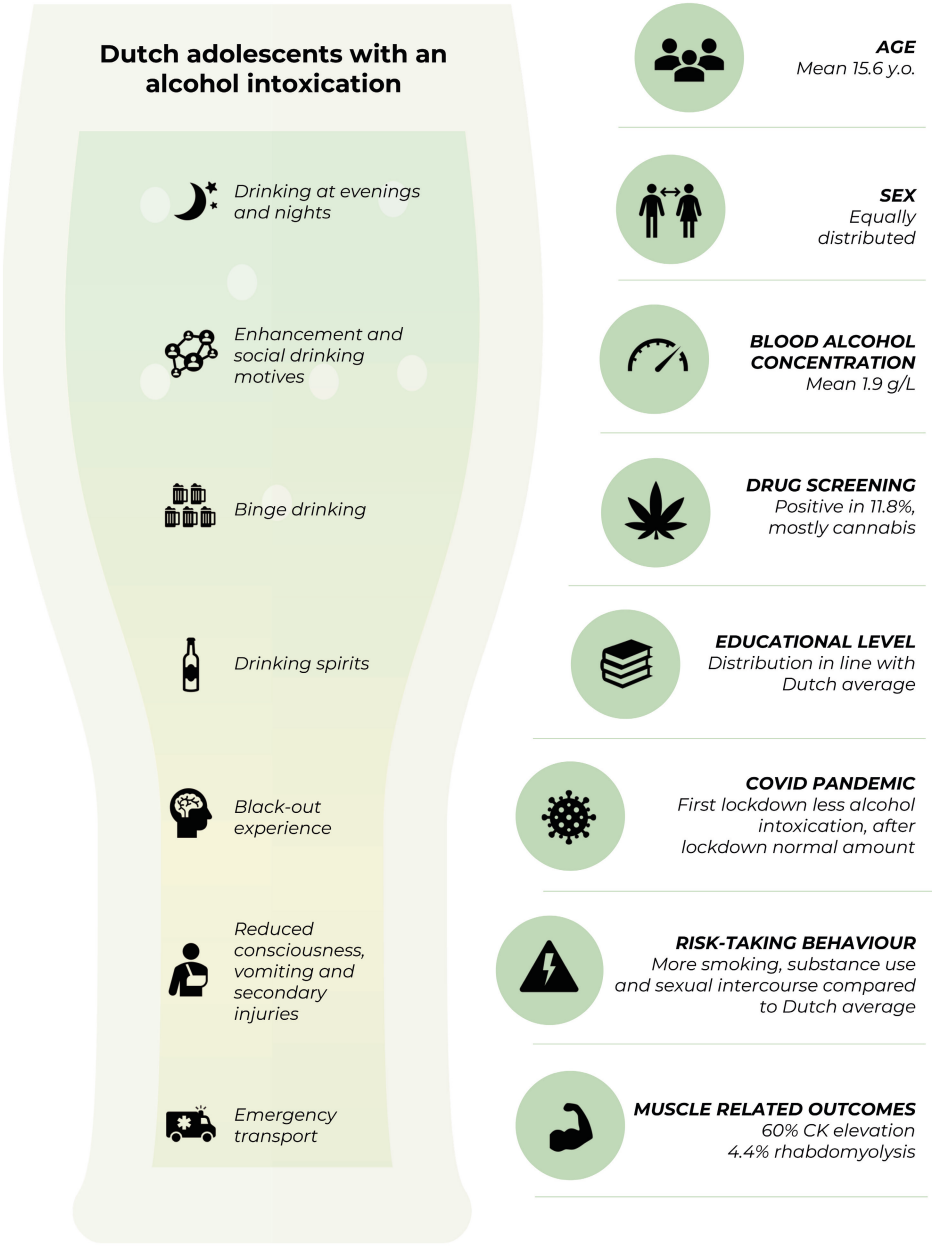

Figure 1. *Summary figure of Dutch adolescents with acute alcohol intoxication*

Appendix 2 Nederlandse samenvatting

Om de preventie van alcoholgebruik bij minderjarigen te verbeteren is het essentieel om inzicht te krijgen in trends, determinanten en risicofactoren van alcoholgebruik. Zowel gegevens over adolescenten met een alcoholintoxicatie als gegevens van alcoholgebruik in de algemene populatie vormen waardevolle bronnen. In **Sectie 1** van dit proefschrift worden daarom vier uitgevoerde studies beschreven die huidige trends, risicofactoren en determinanten van alcoholintoxicatie bij adolescenten onderzoeken.

In **Hoofdstuk 2** worden ziekenhuisopnamegegevens van Nederlandse adolescenten met een alcoholintoxicatie geanalyseerd over de periode 2007 tot en met 2019. Hierbij werd specifiek gekeken naar de invloed van de verhoging van de wettelijke leeftijdsgrens voor laag alcoholische dranken (van 16 naar 18 jaar op 1 januari 2014) en de bijbehorende preventieve NIX18-campagne. Het effect van de landelijke wetswijziging lijkt zichtbaar te zijn in onze data, aangezien adolescenten met alcoholintoxicaties significant ouder waren vanaf 2014. Ondanks de afname van de alcoholconsumptie in de algemene Nederlandse populatie van adolescenten, nam het aantal adolescenten dat zich met een alcoholintoxicatie op de spoedeisende hulp (SEH) meldde significant toe over de jaren, met een stabilisatie in de meest recente jaren van dataverzameling. Bovendien is het aandeel gelijktijdig drugsgebruik bij de opgenomen patiënten met een alcoholintoxicatie significant gestegen over de tijd, waarbij cannabis de meest gebruikte drug is. Deze combinatie van alcohol en drugs zou een verklaring kunnen zijn voor het hogere aantal ziekenhuisopnames, zelfs als het totale alcoholgebruik stabiel blijft of afneemt bij deze leeftijd in de algemene Nederlandse bevolking. Dit suggereert dat de populatie mogelijk een risicovollere populatie wordt.

In **Hoofdstuk 3** wordt het onderzoek beschreven over het effect van COVID-19 lockdowns en de daaropvolgende heropeningsperioden op alcoholintoxicaties bij adolescenten. Dit is relevant vanwege het risico op psychische problemen tijdens perioden van isolatie, wat weer kan leiden tot overmatig alcoholgebruik. Tijdens de eerste lockdown in 2020 is het aantal alcoholintoxicaties onder adolescenten met 70% gedaald ten opzichte van de periode vóór de lockdown. In de heropeningsfase na de eerste lockdown nam het aantal alcoholintoxicaties weer significant toe tot een vergelijkbare hoeveelheid ten opzichte van voor COVID. De afname van alcoholintoxicaties tijdens de eerste lockdown kan worden toegeschreven aan meerdere factoren, waaronder de sluiting van bars, restaurants, sportclubs en scholen, evenals toegenomen ouderlijk toezicht als gevolg van thuiswerken. Het

is waarschijnlijk gunstig geweest dat de Nederlandse lockdown maatregelen minder streng waren vergeleken met andere landen, omdat strengere maatregelen in excessief alcoholgebruik dan wel een rebound-effect van alcoholgebruik na de lockdown kunnen resulteren. Om de mentale gezondheid van adolescenten te beschermen, zou de overheid tijdens pandemieën sociale beperkingen voor deze leeftijdsgroep zoveel mogelijk moeten beperken, omdat deze restricties tot mentale problemen en meer alcoholgebruik kunnen leiden.

In **Hoofdstuk 4** wordt een internationaal onderzoek beschreven waarin Europese data van alcoholintoxicaties onder adolescenten op de SEH wordt vergeleken. Deze data waren beschikbaar in verschillende steden in Nederland, België en Italië. De mediane jaarlijkse ziekenhuisopnames waren het hoogste in België (51 per 10.000 adolescenten), gevolgd door Nederland (49 per 10.000) en Italië (37 per 10.000). Terwijl de geslachtsverdeling vergelijkbaar was in Nederland en Italië, had België significant meer mannelijke patiënten. Het mediane alcohol promillage was het hoogst in Nederland (2,00 g/L), gevolgd door België (1,97 g/L) en Italië (1,84 g/L), waarbij andere factoren zoals leeftijd en gelijktijdig drugsgebruik vergelijkbaar waren tussen de landen. Hoewel het verschil in mediane jaarlijkse ziekenhuisopnames niet statistisch significant was tussen landen, kunnen verschillende contextuele factoren wel mogelijke verschillen verklaren. Een voorbeeld hiervan is de variaties in de alcoholwetgeving. De minimale leeftijd voor alcoholconsumptie van België voor bier en wijn is 16 jaar sinds 2009, terwijl Nederland en Italië de leeftijd hebben vastgesteld op 18 jaar voor alle alcoholische dranken (respectievelijk sinds 2014 en 2012). Bovendien bevatte het Europese actieplan om schadelijk alcoholgebruik terug te dringen een overzicht van de verschillen in alcoholpreventie per land, waarbij met name verbeteringsvoorstellen voor België en Nederland werden geopperd. Om nauwkeurigere vergelijkingen mogelijk maken zou een gestandaardiseerde, gecoördineerde, cross-nationale database gewenst zijn. Hiermee kunnen we ons begrip van alcoholintoxicaties in deze populatie verbeteren en de ontwikkeling van gerichte, cross-nationale preventiestrategieën ondersteunen.

In **Hoofdstuk 5** wordt een onderzoek beschreven dat drinkpatronen en psychologische risicofactoren voor alcoholgebruik van adolescenten met alcoholintoxicatie onderzocht. Op de psychologische follow-up van de alcoholpolikliniek was er in 43,9% van de adolescenten sprake van een eerder gediagnosticeerde psychische stoornis, meestal ADHD. Van degenen zonder eerdere diagnose vertoonden 15,1% klinische tekenen van psychische problematiek. Bovendien vertoonden adolescenten met alcoholintoxicatie ook hogere niveaus van risicogedrag op

andere vlakken (zoals roken, middelengebruik en seksuele activiteit) vergeleken met de Nederlandse referentiepopulatie. Aanvankelijk hadden deze adolescenten significant hogere percentages alcoholgebruik en dronkenschap. Hun alcoholgebruik nam significant af in de maand na alcoholintoxicatie en daalde zelfs tot onder het Nederlandse gemiddelde. Zes tot twaalf maanden later steeg hun alcoholgebruik echter, hoewel nog steeds lager en met minder binge-drinken dan de Nederlandse referentiepopulatie. Bijna de helft van deze adolescenten had een familiegeschiedenis van alcohol- of middelenmisbruik. Gebaseerd op deze cijfers kunnen we stellen dat deze populatie risico loopt op alcohol gerelateerde problematiek. Daarnaast wordt aangetoond dat het preventieve programma na alcoholintoxicatie lijkt bij te dragen aan de vermindering van alcoholgebruik door adolescenten, met name binge-drinken.

In **Sectie 2** worden vier studies toegelicht over mogelijkheden voor preventie van alcoholgebruik door adolescenten. Er werd gefocust op strategieën binnen het sportdomein, drinkmotieven en op een kwalitatieve benadering om nieuwe preventieve inzichten te krijgen van minderjarigen en gezondheidsprofessionals.

In **Hoofdstuk 6** wordt een studie over mogelijke spiergerelateerde gevolgen van alcohol bij adolescenten beschreven. Dit is een belangrijk aandachtsgebied omdat de sportsector bekend staat om lage naleving van ID-controlemaatregelen en veel betrokkenheid van de alcoholindustrie. We hopen dat sportende adolescenten gevoelig zijn voor onderzoeksresultaten die de negatieve impact van alcoholgebruik op atletische prestaties benadrukken. Daarom werd de incidentie van verhoogde creatinine kinase (CK)-waarden bij Nederlandse adolescenten met een alcoholintoxicatie onderzocht. Als CK meer dan 5 keer hoger dan de normaalwaarde was, werd de diagnose rhabdomyolyse, ook bekend als acute spiervezelnecrose, bevestigd. We vonden dat 60% van deze patiënten verhoogde CK-spiegels had, en 4,4% tekenen van rhabdomyolyse vertoonden. De meeste patiënten bevonden zich dus in het voorstadium van rhabdomyolyse. Vroegtijdige identificatie van CK-verhoging is cruciaal om ernstige spierschade en andere gerelateerde problemen te voorkomen. Daarom moeten adolescenten die worden opgenomen met alcoholintoxicatie standaard bloed- en urineonderzoek ondergaan voor vroegtijdige detectie en behandeling van rhabdomyolyse. Een hoger alcohol promillage was ook geassocieerd met hogere CK-spiegels gecorrigeerd voor positieve drugsuitslagen. Onze bevindingen, gecombineerd met bestaande literatuur over rhabdomyolyse na overmatig alcoholgebruik bij volwassenen, suggereren dat rhabdomyolyse ook bij adolescenten na alcoholintoxicatie aanwezig kan zijn. Verder onderzoek is nodig om de pathofysiologie en causaliteit van deze interactie beter te begrijpen. We hopen dat onze resultaten kunnen bijdragen aan preventiestrategieën

om alcoholconsumptie in de sportwereld te verminderen. Ons advies is om alcoholreclame in de sportsector te verbieden. Bovendien moet de handhaving van alcoholbeperkingen voor minderjarigen binnen deze sector worden versterkt, aangezien de dalende nalevingspercentages van leeftijdscontroles erop wijzen dat alcohol toegankelijker blijft voor jongeren dan zou moeten.

In **Hoofdstuk 7** wordt een groot onderzoek naar drinkmotieven beschreven onder 52.141 studenten (15-16 jaar) uit 16 Europese landen (Denemarken, Estland, Finland, Duitsland, Griekenland, IJsland, Italië, Letland, Litouwen, Nederland, Noorwegen, Polen, Portugal, Roemenië, Zweden en Spanje). Van degenen die alcohol dronken in het afgelopen jaar (n = 34.295), werden drie belangrijke drinkmotieven geïdentificeerd: (1) stemming verbeterende en sociale-, (2) coping- en (3) conformiteit drinkmotieven. In alle landen was het meest voorkomende drinkmotief: stemming verbeterende en sociale motieven, gevolgd door coping motieven, terwijl conformiteit als motief minder vaak voorkwam. Dit patroon komt overeen met eerder Europees onderzoek en suggereert dus dat alcohol preventiestrategieën gebaseerd op stemming verbeterende en sociale drinkmotieven in heel Europa effectief zouden kunnen zijn. Daarnaast werd er een significante positieve correlatie gevonden tussen alcoholintoxicatie en stemming verbeterende- en sociale motieven. Het beperken van alcoholreclame speelt dus een belangrijke rol omdat de alcoholindustrie de band tussen alcohol en gezellige, feestelijke momenten in stand wil houden. Deze tactieken die in alcoholmarketing worden gebruikt om het beeld dat adolescenten van alcohol hebben te vormen, zouden moeten worden verboden.

In **Hoofdstuk 8** worden door middel van kwalitatief onderzoek op de alcohol-polikliniek inzichten verzameld van adolescenten die een alcoholintoxicatie gehad hadden. Het doel was om hun motivaties te begrijpen en vanuit hun perspectief te horen hoe alcoholpreventie ingezet zou moeten worden in deze leeftijdsgroep. We ontdekten dat adolescenten vooral ‘s avonds en ‘s nachts drinken in een sociale omgeving met vrienden, gedreven door sociale en stemming verbeterende drinkmotieven. Ze gebruiken vaak sterke drank, soms gemengd met frisdrank, in grote hoeveelheden tegelijk. De adolescenten meldden ook dat ze gemakkelijk toegang hadden tot alcohol ondanks het feit dat ze minderjarig waren. Hun alcoholintoxicatie resulteerde vaak in braken, bewusteloosheid en ambulance transport naar SEH met soms ook secundaire verwondingen. Op de nazorgpolikliniek stelden veel ouders vragen over strategieën om alcohol gerelateerde grenzen te stellen, wat de behoefte onderstreept aan toegankelijke informatie om ouders te informeren en ondersteunen met alcoholgerelateerde

opvoedingsstrategieën. Een veelvoorkomend thema onder adolescenten was het onvermogen om te herkennen wanneer ze dronken raakten, waarbij ze vaak “black-out”-ervaringen beschreven. Dit maakte het moeilijk voor hen om tijdig te anticiperen op hun intoxicatie, wat een kritieke factor voor preventie benadrukt. De participerende adolescenten adviseerden beter onderwijs over alcohol, strengere reclameregels en betere handhaving van alcoholwetten om alcoholintoxicaties en de negatieve effecten van alcohol te helpen verminderen binnen hun generatie.

In **Hoofdstuk 9** wordt een kwalitatieve studie beschreven op basis van interviews met kinderartsen uit Noorwegen, Nederland en België. Aan hen werd gevraagd om de zorg te evalueren die wordt verleend aan adolescenten met alcoholintoxicatie, met name het specifiek gevolgde zorgpad en de preventie. Dit is belangrijk omdat de Wereldgezondheidsorganisatie (WHO) de implementatie promoot van preventieve programma’s voor vroegtijdige opsporing en korte interventie voor personen met gevaarlijk alcoholgebruik. Dit is namelijk een belangrijke pijler om alcohol gerelateerde schade te beperken en de volksgezondheid te verbeteren. Op basis van de interviews blijkt dat de klinische zorg voor adolescenten met alcoholintoxicatie in Nederland, Noorwegen en België relatief vergelijkbaar is. Er bestaan echter verschillen in de inspanningen op het gebied van primaire en secundaire preventie, waarbij Nederland het enige land lijkt dat hierbij betrokkenheid van zorgprofessionals heeft. Tertiaire preventie, zoals aanbevolen door de WHO, worden in alle drie de landen geïmplementeerd, alleen in Noorwegen zonder betrokkenheid van een kinderarts. Alle geïnterviewde kinderartsen erkennen dat adolescenten zich vaak niet bewust zijn van de potentiële risico’s van alcoholgebruik. Daarom zijn ze het erover eens dat preventieve evenementen of publieke voorlichtingscampagnes, gericht op het vergroten van kennis over dit onderwerp, essentieel zijn. Zij benadrukken dat zorgprofessionals hierbij betrokken moeten worden. Het verbeteren van de primaire, secundaire en tertiaire preventie van alcoholgebruik bij minderjarigen is cruciaal om alcohol gerelateerd risicogedrag, schade en intoxicatie terug te dringen. Daarom zouden Europese landen moeten samenwerken om een gezamenlijke, op bewijs gebaseerde Europese aanpak te ontwikkelen voor zorg en preventie van alcoholintoxicatie, in lijn met de aanbevelingen van de WHO.

Tot slot wordt aanbevolen om alle opgedane kennis te delen met andere (Europese) landen om hun bewustzijn te vergroten. Deze informatie kan gebruikt worden om nationale beleidsmakers te informeren en hen aan te moedigen om deze kennis toe te passen bij preventie-inspanningen en om nieuw onderzoek te initiëren dat specifiek is afgestemd op hun respectievelijke landen. Op die manier kan

Europees beleid geïmplementeerd worden dat gebruik maakt van betrouwbare informatiebronnen om het bewustzijn van alcohol gerelateerde schade te vergroten. Alleen dan kunnen zinvolle maatschappelijke veranderingen worden bereikt.

Appendix 3 List of abbreviations

AAI – Acute Alcohol Intoxication
ADHD – Attention-deficit/hyperactivity disorder
AKI – Acute kidney injury
BAC – Blood Alcohol Concentration
CBCL – Child Behaviour Checklist
CI – Confidence interval
CK – Creatine Kinase
DMQ-R-SF – Drinking motives questionnaire revised short form
ED – Emergency department
EMV – Glasgow coma score
ESPAD – European School Survey Project on Alcohol and Other Drugs
HBSC – Health Behaviour in School-aged Children
HED – Heavy Episodic Drinking
Y.o. – Years old
MLDA – Minimum legal drinking age
NSCK – Dutch Paediatric Surveillance Unit
RdGG – Reinier de Graaf Gasthuis
SD – Standard deviation
TRF – Teacher's Report Form of Child behaviour checklist
WHO – World Health Organisation
YSR – Youth Self Report of Child behaviour checklist

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Appendix 5 About the author

Louise Pigeaud was born in Blaricum on the 7th of March 1998. In 2016, she graduated from secondary school at Willem de Zwijger College in Bussum. That same year, she moved to Leiden and began her medical training at Leiden University Medical Centre (LUMC). Her interest in scientific research within paediatrics was raised during her three year involvement in the prevent-CD project at the paediatrics gastroenterology department at Willem-Alexander Children's Hospital, LUMC, while completing her bachelor's degree. For her master's thesis, she worked at the Dutch Forensic Institute, studying the prevalence of spinal injuries caused by abusive head trauma, which is a leading cause of death among abused young children. This experience further raised her attention of social paediatric topics. During the COVID-19 pandemic, while waiting for her clinical rotations to begin, she worked as a research assistant at the Youth and Alcohol Foundation.

This eventually led to her PhD project on preventing adolescent alcohol intoxication. Since she started her PhD before completing her master's degree, she required approval of exception from the dean of Erasmus University in Rotterdam. The PhD program was combined with full-time clinical rotations, and after becoming a physician, combined while working as a resident at the Paediatric department of Alrijne Hospital in Leiderdorp. Additionally, as part of her thesis, she spent four months in Oslo collaborating with the Alcohol Research Group of the Norwegian Institute of Public Health to gain a deeper understanding of Norway's preventive system. Furthermore, during her time in Oslo she took extracurricular master courses at the Health Management and Health Economics faculty of the University of Oslo.

Currently, Louise lives in Amsterdam with her boyfriend Max and works as a resident at Emma Children's Hospital (Amsterdam University Medical Centre). In the years ahead, she aims to further develop herself as an empathetic and competent doctor at the paediatric department. Finally, she also hopes to maintain her connection with research and preventive education at the Youth and Alcohol Foundation.

Curriculum Vitae

Professional experience

2025-present Paediatrics resident, Emma Children's hospital, Amsterdam University Medical Centre

2021-2025 PhD Candidate 'Youth and alcohol foundation', Erasmus University, Rotterdam & Reinier de Graaf Gasthuis, Delft, Title: 'Uncorking a healthier generation - prevention of adolescents alcohol use and intoxication

2024-2025 Paediatrics resident, Alrijne hospital Leiderdorp

2018-2021 Medical research assistant paediatric gastroenterology department, Willem-Alexander Children's Hospital, Leiden University Medical Centre (LUMC)

Education

2016-2023 Bachelor and Master of Medicine, LUMC

2021-2023 Medical residencies, with elective residencies: Paediatrics at Juliana children's hospital, The Hague and Child Psychiatry at Youz (Parnassia), The Hague.

2023 Exchange in Oslo for research collaboration with the Norwegian Institute of Public Health and following extracurricular master courses at the University of Oslo (duration 4 months).

2020 Master scientific internship at Dutch Forensic Institute. Research on the prevalence of spinal injuries resulting from abusive head trauma (duration 28 weeks).

2018 International minor 'Infections in Health and Disease', Universitas Indonesia, Jakarta

2010-2016 VWO (pre-university education), Willem de Zwijger College, Bussum, Exam courses: Biology, Physics, Chemistry, Mathematics, English, French, Dutch, Management & Organisation. Extra: Bookkeeping certificate and member of the Bussumse Lyceum Bond.

Extra-curricular

2019-2020 Chairman of the Faculty of (Bio)Medical sciences at Leiden Student association ‘Minerva’

2019-2020 Minerva Scholarship Fund committee member

2019-2020 VVSL dies Committee, responsible for the logistics of the 120th anniversary

2019 Extra-curricular minor ‘Family pedagogics’, Erasmus University Rotterdam

2016-2020 Teddy bear doctor committee LUMC, Chairmen 2019 & 2020, Treasurer 2018

Appendix 6 PhD portfolio

Erasmus University Rotterdam, The Netherlands: Erasmus School of Health Policy and Management, Health Services and Management.
PhD period: February 2021 – April 2025
Promotors: prof.dr. C.G.J.M. Hilders & prof.dr. N. van der Lely
Co-promotors: dr. J.J. van Hoof (until 2023) & dr. Loes de Veld (from 2023 onwards)

Table 1 PhD portfolio

	Year	Workload (ECTS)
Courses/Training		
''Professionalism and Integrity in research'' course of the Erasmus University Graduate school, Rotterdam, The Netherlands	2025	1,5
Master course ''Fundamentals of economic evaluation in health care'' at Health management and Health economics faculty of the University of Oslo, Norway	2023	5,0
Master course ''Qualitative methods'' at Health management and Health economics faculty of the University of Oslo, Norway	2023	5,0
Wet medisch-wetenschappelijk onderzoek met mensen - good clinical practice (WMO-GCP) + Medical device regulation (MDR) training, exam passed	2022	2,0
Clinical epidemiology course Reinier de Graaf Gasthuis, Delft, The Netherlands	2022	3,0
''Searching and finding and managing your literature'' course of the Erasmus University Graduate school, Rotterdam, The Netherlands	2021	1,0
Oral presentations		
''Drinking motives among 15–16-year-old school-going students in 16 European countries'' *- Amsterdam Kindersymposium, The Netherlands*	2025	1,0
''Psychological outpatient follow-up after hospitalization for adolescent acute alcohol intoxication'' *- Reinier de Graaf Gasthuis Research event, Delft, The Netherlands*	2025	1,0
''Acute alcohol intoxication in adolescents before and after the Dutch alcohol law change'' *- European academy of Paediatric societies congress in Vienna, Austria*	2024	1,0
''Elevated creatine kinase levels amongst Dutch adolescents with acute alcohol intoxication'' *- Amsterdam Kindersymposium, The Netherlands*	2024	1,0
''Acute alcohol intoxication among adolescents in Italy, Belgium and The Netherlands: a hospital chart comparison study'' *- Workshop at European Public Health conference in Lisbon, Portugal*	2024	1,0
''Acute Alcohol Intoxication in Dutch Adolescents Before, During, and After the First COVID-19 Lockdown'' *- Reinier de Graaf Gasthuis Research event, Delft, The Netherlands* *- Symposium Youth and Alcohol Chair, University of Antwerp, Belgium*	2022	2,0

Table 1 PhD portfolio	**Year**	**Workload (ECTS)**
Poster presentations		
''Elevated creatine kinase levels amongst Dutch adolescents with acute alcohol intoxication'' *- European academy of Paediatric societies congress in Vienna, Austria*	2024	0,5
''Acute alcohol intoxication among adolescents in Italy, Belgium and The Netherlands: a hospital chart comparison study'' *- European academy of Paediatric societies congress in Vienna, Austria*	2024	0,5
''Acute Alcohol Intoxication in Dutch Adolescents Before, During, and After the First COVID-19 Lockdown'' *- European academy of Paediatric societies congress in Barcelona, Spain* *- Klingenstein Third Generation Foundation conference of American academy of child and adolescent psychiatry (virtual presentation)*	2022	2,0
Attendance to conferences without presenting research		
Nationaal alcoholcongres	2025	1,0
Werkconferentie Lokale aanpak risicovol alcoholgebruik studenten	2024	1,0
Nederlandse Vereniging voor Kindergeneeskunde Young researcher congres	2021	1,0
Amsterdam Kindersymposium	2021	1,0
Teaching		
Supervisor of research project by secondary school students	2021	3,0
Alcohol prevention presentation on secondary schools, local governmental organisations and student associations	2021-2025	2,0
Additional publications		
Writing a chapter in the book ''Stop met alcohol voor jongeren, waarom dat moet en hoe het kan'', Nico van der Lely	2025	0,0
Nascholingsartikel ''Alcoholintoxicaties bij adolescenten < 18 jaar in Nederland '' geschreven voor: *- iAM, nascholingsvaktijdschrift voor anesthesiemedewerkers* *- Tijdschrift Nurse Academy Ziekenhuiszorg*	2022	0,0
Column written about PhD in Reinier research magazine	2021, 2025	0,0
Director of preventive alcohol intoxication movie for Youth and Alcohol foundation	2021	5,0
''Alcohol in minors'' factsheet development, suitable for parents and patients	2021	4,0
Awards and prices		
Publieksprijs beste onderzoekspresentatie wetenschapsavond Reinier de Graaf Ziekenhuis	2025	0,0
Total workload (ECTS)		**45,5 ECTS**

List of publications

This thesis

L.Pigeaud, L. de Veld, J. van Hoof, N. van der Lely, Acute alcohol intoxication in adolescents before and after the Dutch alcohol law change, Preventive Medicine Reports 2023, doi: 10.1016/j.pmedr.2023.102310

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Other publications

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Appendix 7 Dankwoord

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Prof.dr. C.J.G.M. Hilders, beste Carina, dankjewel dat jij ondanks je drukke agenda en vele functies bereid was om mij te begeleiden tijdens mijn promotietraject. Onze overleggen waren efficiënt maar jouw oprechte interesse en empathie waren altijd erg merkbaar.

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het analyseproces een stuk prettiger en konden we met de mooie resultaten laten zien dat er op de alcoholpoli belangrijk werk wordt verricht.

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