



# 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 provide 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 to 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 statistically significant, 55.6%) and Belgium (statistically significant, 56.8%), more males were admitted. The median blood alcohol concentration (BAC) was higher in the Netherlands (2.00 g/L) compared with 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.

## INTRODUCTION

Alcohol use is common among Western European adolescents. According to the WHO, 43.9% of the European 15–19-year-olds are current drinkers.<sup>1</sup> 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

## 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.

study in 2022.<sup>2</sup> 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.<sup>3</sup> Worldwide prevalence rates of HED among drinkers are highest in adolescents and early adulthood (15–24 years old; around 45–55%).<sup>1</sup> In this regard, lifetime self-reported drunkenness occurred in 20% of 15-year-olds.<sup>2</sup> 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%).<sup>1</sup>

This excessive drinking behaviour poses a significant risk to the physical, psychological and social health of adolescents<sup>4–6</sup> and



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contributes to high social and health costs.<sup>6,7</sup> It is also well-documented that engaging in risky drinking behaviour at a young age increases the likelihood of developing alcohol use disorders<sup>8</sup> and other mental health disorders<sup>9–11</sup> later in life. The WHO's European Framework for Action on Alcohol highlights the urgent need for interventions to reduce adolescent alcohol consumption,<sup>7</sup> 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 have led to the development of a successful transmurial healthcare model to support affected young individuals and their parents.<sup>12</sup> Other European countries, specifically Italy and Belgium, are at varying stages of addressing this issue.<sup>2,13,14</sup>

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 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.<sup>15</sup> In Genoa, the San Martino Hospital is not the referral hospital for children; however, adolescents ≥16 years are preferentially treated here, as are children aged 14–16 years with psychomotor agitation. Therefore, it is reasonable to assume that San Martino's catchment area is limited to the nearby four 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 8550 minors resided there.<sup>16,17</sup>

Delft is a city and municipality in the Province of South Holland, the Netherlands. Here, the Reinier de Graaf Hospital is based. The Dutch dataset includes the

adolescents admitted with AAI to the emergency department of this hospital. The Municipality of Delft in the Netherlands contained 109 577 inhabitants in 2024, of which 5150 (4.7%) were 12-to-17-year-olds.<sup>18</sup> 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 3433 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 (3283 and 6165 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 included data from all eight hospitals with an ED in the city of Antwerp, namely six hospitals of the 'Ziekenhuis aan de Stroom' (ZAS) network: 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.<sup>19</sup>

### 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 EDs, 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 the San Martino Hospital between 1 January 2015 and 31 August 2023. The study population included 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 (International Classification of Diseases, 9th Revision (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 also 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 to 2023 were collected using the paediatric alcohol questionnaire.<sup>20</sup> This questionnaire was filled in at the ED for all patients aged younger than 18 years with a positive 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.<sup>13</sup> 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 UZA) and via screening software making use of the search terms 'intoxication', 'alcohol', 'ethanol' and 'drunkenness' (only in 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. In the Netherlands, the Ethics Committee (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 EC of the Antwerp University Hospital. Patient consent was waived in all countries due to the retrospective design of the study.

## Statistical analysis

Descriptive statistics were presented as proportions for categorical variables (sex, age, combined drug use and reason for admittance) and as medians (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  $\chi^2$  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, V.29.0 (Armonk, NY, USA: IBM Corp.), was used.

## Patient and public involvement

Patients were not involved in this research.

## Research reporting guideline

For the reporting of the study, the Strengthening the Reporting of Observational Studies in Epidemiology Statement was followed, which is presented in the separate research checklist.

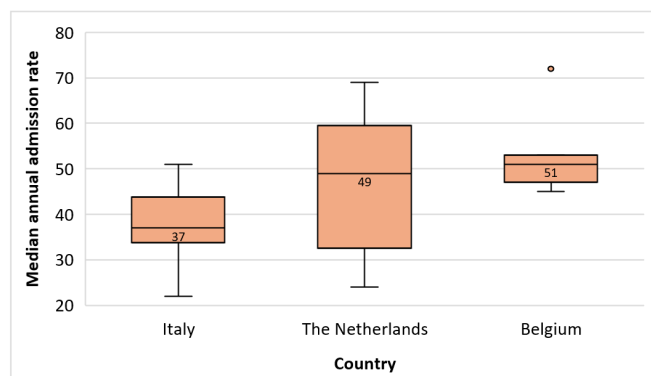
## RESULTS

### 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, 286 (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 available 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 hospitalisation rates were not statistically significant among any of the three countries ( $p=0.285$ ).

Figure 2 shows the absolute number of admissions per year per country. Over time, significant differences in the absolute number of admissions per country per year were observed ( $p<0.001$  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 1** Median annual admission rate of acute alcohol intoxication per 10 000 corresponding inhabitants of 14–17-year-olds per country.

### 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 with Italy and the Netherlands ( $p<0.001$ ), due to a higher percentage of 17-year-old patients in Belgium. On the contrary, 16-year-old patients formed the biggest age group in Italy and the Netherlands. In none of the countries, a significant change in

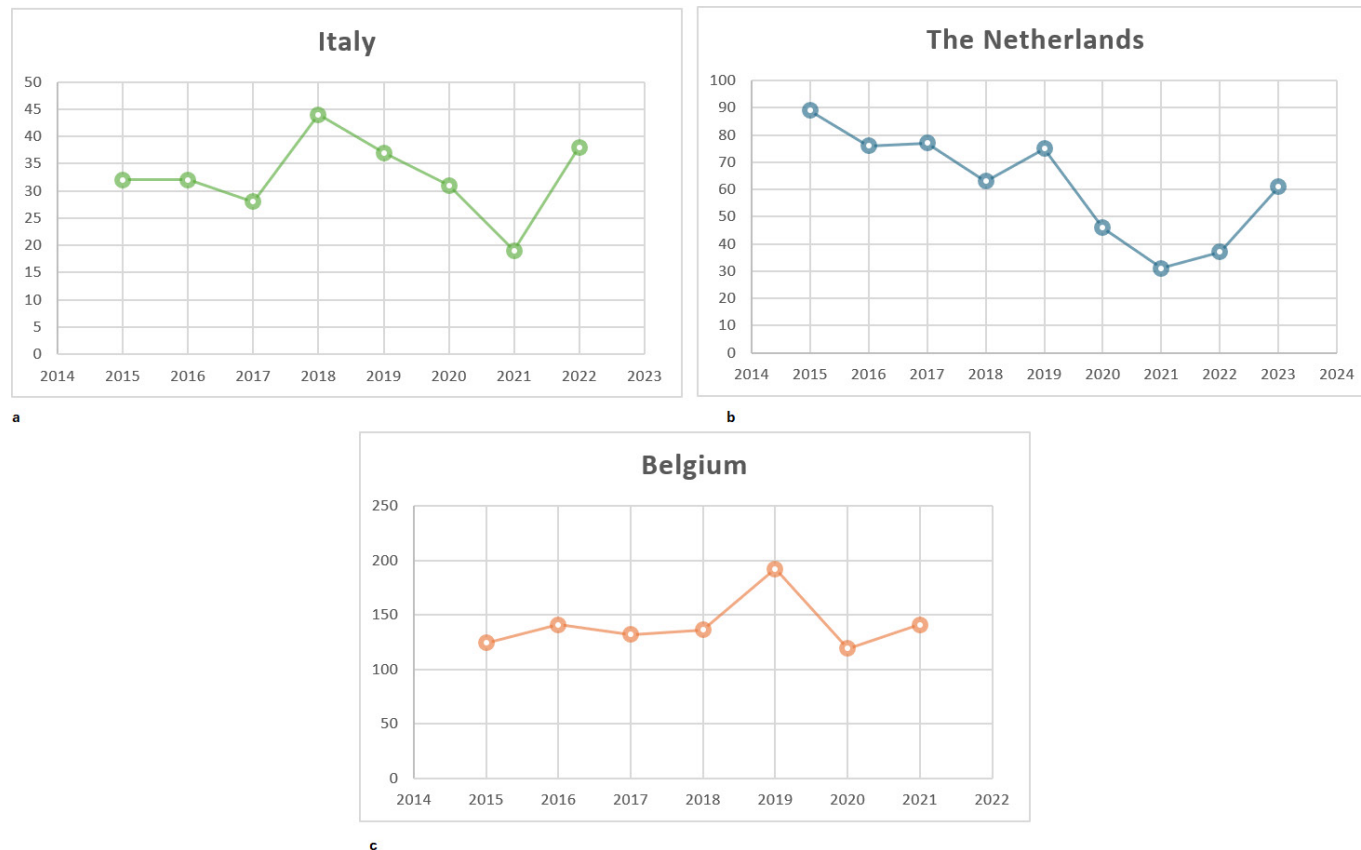
median age was seen over time ( $p=0.636$  in Italy;  $p=0.370$  in the Netherlands;  $p=0.138$  in Belgium).

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%,  $p<0.001$ ). 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 ( $p=0.028$ ).

### Clinical characteristics

In 82.7% of the total admissions, the BAC 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 ( $p<0.001$ ): Dutch patients showed a significantly higher median BAC (2.00 g/L), compared with Italy (1.84 g/L) and Belgium (1.97 g/L), with  $p<0.001$ . 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.



**Figure 2** Absolute number of admissions for acute alcohol intoxication among 14–17-year-olds per year for Italy (a), the Netherlands (b) and Belgium (c).



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

Characteristic	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)	2.00 (1.70–2.40)	1.97 (1.44–2.37)	1.99 (1.50–2.36)
Range	0.06–3.53	0.10–3.60	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 (100.0)	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 (0.0)	2 (3.2)	0 (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)

GHB, Gamma-Hydroxybutyric acid ; XTC, Ecstasy.

The outcome of the multiple regression analysis is presented in [table 3](#). The overall regression model was statistically significant ( $R^2=0.112$ ,  $p<0.001$ ). It was found that apart from age, combined drug use and reason for admission, the country significantly predicted BAC (0.129,  $p<0.001$ ). 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 ecstasy, XTC), Gamma-Hydroxybutyric acid (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 the 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: 100.0% 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 four in Italy). 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 with the other countries ( $p=0.004$ ). In Italy, more admissions were the result of a (traffic) accident compared with 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

**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 <i>p</i> 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 drug use			<0.001*
Drug 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.  
BAC, blood alcohol concentration.

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.

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

Variable	B unstandardised regression coefficient	95% CI	Multiple regression <i>p</i> 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.

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,<sup>21</sup> while in Italy (since 2012) and the Netherlands (since 2014), the legal age for any alcohol consumption is 18 years.<sup>22 23</sup> This discrepancy may partly contribute to the higher admission rates 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.<sup>24</sup> In contrast, a trend towards increasingly stringent parental oversight regarding adolescent alcohol use was seen in the Netherlands<sup>25</sup>. Interestingly, despite cultural similarities in parental attitudes towards alcohol between Belgium and Italy,<sup>24 26</sup> 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,<sup>27 28</sup> 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,<sup>29</sup> 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 with 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.<sup>29</sup> In summary, both the admission rate of AAI and the severity of AAI in minors in Italy are the lowest compared with 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 (ie, better results) on multiple action areas of the European action plan to reduce the harmful use of alcohol 2012–2020, compared with the Netherlands and Belgium, namely: 'leadership, awareness and commitments on drinking and alcohol intoxication', 'alcohol availability' and 'marketing'.<sup>29</sup> 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.<sup>22</sup> Furthermore, Belgium, with the highest admission rate in our study, scored low compared with 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 transmurial healthcare model aimed at supporting young individuals with AAI and their parents. 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 a Northern European-style of heavy drinking is emerging among Italian youth.<sup>26</sup> Conversely, Belgium has a strong cultural association with beer, which is even recognised as immaterial world heritage on the United Nations Educational, Scientific and Cultural Organization (UNESCO) list since 2016.<sup>30</sup> 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.<sup>31</sup> 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.<sup>32–34</sup> 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.<sup>34–35</sup> 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).<sup>29</sup> However, according to the WHO report above, Italy has lower country scores on drink-driving policies than the Netherlands and Belgium.<sup>29</sup>

This study has some limitations. First, the absence of a standardised data collection system across the three countries represented a major barrier to effectively using and comparing the available study data. In Italy, data were retrospectively collected based on the clinical diagnosis (ICD-9 codes) reported in the ED chart and positive BAC screening. Also in Belgium, data were retrospectively collected, although selection took place via positive BAC screening and screening of triage logs. On the contrary, prospective data were 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<sup>13–36</sup> that in the age group of 11–14 years, more females are admitted, a lower BAC is found and less drug use appears, compared with 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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