Received: 23 December 2024 | Accepted: 10 September 2025

DOI: 10.1111/add.70233

RESEARCH REPORT

ADDICTION SSA

Changes in clinical features and severity in patients presenting to European emergency departments with acute cannabis toxicity over the 10-year period from 2013 to 2022

Òscar Miró[1,2] | Miguel Galicia[1] | Paul I. Dargan[3,4] | David M. Wood[3,4] | Alison M. Dines[3] | Fridtjof Heyerdahl[5,6] | Knut Erik Hovda[6,7] | Isabelle Giraudon[8] | Christopher Yates[9] | Matthias Liechti[10] | Odd Martin Vallersnes[11,12] | Florian Eyer[13] | Guillermo Burillo-Putze[14] on behalf of *the Euro-DEN Plus Research Group

[1]Emergency Department, Hospital Clínic, Barcelona; IDIBAPS, Barcelona, Catalonia, Spain

[2]Medical School, University of Barcelona, Catalonia, Spain

[3]Clinical Toxicology, Guy's and St Thomas' NHS Foundation Trust and King's Health Partners, London, UK

[4]Clinical Toxicology, Faculty of Life Sciences and Medicine, King's College London, UK

[5]Air Ambulance Department, Division of Prehospital Services, Oslo University Hospital, Oslo, Norway

[6]Institute of Clinical Medicine, University of Oslo, Oslo, Norway

[7]Department of Acute Medicine, Medical Division, Oslo University Hospital, Oslo, Norway

[8]European Union Drugs Agency (EUDA), Lisbon, Portugal

[9]SAMU 061 Balears Clinical Toxicology Workgroup, Health Research Institute of the Balearic Islands (IdISBa), Spain

[10]Division of Clinical Pharmacology and Toxicology, University Hospital and University of Basel, Switzerland

[11]Department of General Practice, University of Oslo, Oslo, Norway

[12]Oslo Accident and Emergency Outpatient Clinic, City of Oslo Health Agency, Oslo, Norway

[13]Department of Clinical Toxicology, TUM University Hospital, Technical University of Munich, Germany

[14]Emergency Department, Hospital Universitario de Canarias, Universidad de La Laguna, Tenerife, Spain

Abstract

Background and aims: In recent years, the potency of natural cannabis products (herb and resin) has increased with a higher delta- 9-tetrahydrocannabinol (Δ9-THC) content, but there are limited data on trends on clinical presentation and severity of toxicity in cannabis users consulting the emergency department (ED) for acute intoxication. This study aimed to analyse the evolution over time of clinical findings and severity of presentations in a large series of patients presenting to European EDs with acute toxicity after lone cannabis use.

Design: Secondary analysis of data included in the Euro-DEN Registry from 1 October 2013 to 31 December 2022.

Setting: 40 EDs in 25 European countries.

Participants/cases: ED presentations reporting lone cannabis use. Presentations reporting concomitant use of, or having positive toxicological tests for, ethanol or other drugs were excluded. 3839 ED presentations reporting lone cannabis use were analysed (median age 25 years, interquartile range= 20–33; 71% male).

Measurements: Temporal trends of 14 pre-defined clinical signs/symptoms and 4 markers of severity, which included the need for ambulance transfer to the ED, hospitalisation, intensive care unit admission (ICU) and death.

Findings: The most frequent clinical features were anxiety (35%), agitation (22%), decreased alertness (drowsiness or coma, 21%) and vomiting (20%), while seizures, arrythmias and hyperthermia were observed in <3% of cases. Statistically significant changes over time were only found in the frequency of hypotension [adjusted odds ratio (OR) = 1.239 per every subsequent year, 95% confidence interval (CI) = 1.107–1.386], hypertensive crisis (OR = 1.168, 95% CI = 1.070–1.274) and palpitations (OR = 0.922, 95% CI = 0.883–0.962). Nonlinear analyses detected statistically significant mid-period increases for anxiety, agitation and arrhythmias that subsided by the end of the study, and showed increases in chest pain and decreases in seizures that became statistically significant in the latter half of the period. Regarding episode severity, 76% of cases were

*The members of the Euro-DEN Plus Research Group are listed at the end of this article.

Correspondence

Òscar Miró, Emergency Department, Hospital Clínic, Villarroel 170, 08036 Barcelona, Spain.
Email: omiro@clinic.cat

Miguel Galicia, Emergency Department, Hospital Clínic, Villarroel 170, 08036 Barcelona, Spain.
Email: miguelgalicia@hotmail.es

Funding information

The present study was possible, in part, through a grant from the Drug Prevention and Information Programme (DPIP)/Prevention of and Fight Against Crime Programme (ISEC) programme of the European Union (JUST/2012/DPIP/AG/3591). The project in Bern (Switzerland) has received financial support from the Burgergemeinde Bern.

brought to the ED by ambulance, 13% required hospitalisation, 1% were admitted to the ICU and 0.1% died. No statistically significant changes were observed over time in either the linear or the nonlinear models.

Conclusion: Very few changes in the clinical features of patients presenting to European emergency departments with lone acute cannabis toxicity were identified over 2013 to 2022, suggesting that despite the increase in potency of cannabis in Europe over this period, the severity of acute intoxication has remained unchanged.

KEYWORDS

cannabis, emergency department, hashish, marihuana, severity, temporal trends

INTRODUCTION

The potency of natural cannabis products (herbal and resin) has increased in recent years in the USA and Europe [1, 2]. The Δ9-tetrahydrocannabinol (Δ9-THC)/cannabidiol (CBD) ratios found in both herbal and resin samples has confirmed a change in the chemotypes present, in favour of higher potency categories [3]. With this increasing potency of natural cannabis products, there has been concern about the public health impact of cannabis use and the potential increased risk of acute adverse events in cannabis users [4, 5].

Regarding the long-term consequences of cannabis use, a recent systematic review showed that use of higher potency cannabis was associated with an increased risk of psychosis and cannabis use disorder, whilst evidence varied for depression and anxiety [6]. On the other hand, a number of adverse events can develop following acute cannabis consumption, which mainly include neuropsychological symptoms, such as anxiety, ataxia, distrust, fear, hallucinations, psychotic symptoms, stupor, suicidal ideation/tendency or unease, and seizures associated with cannabinoid hyperemesis syndrome (CHS) [7, 8]. Moreover, adverse cardiovascular effects such as palpitations, chest pain, syncope and symptomatic changes in blood pressure have also been described [9, 10]. Currently, there is limited published data, with no large series from either the USA or Europe, on whether changes in adverse events or case severity have been observed in recent years following acute cannabis use. Users experiencing the most severe acute adverse events require urgent care and they will typically present to emergency departments (EDs) [10–13]. Therefore, analysis of these patients may provide data relevant to this issue. The aim of this study was to use the European Drugs Emergencies Network (Euro-DEN) Plus data set to describe the changes in clinical features in a large series of patients presenting to European EDs with acute recreational drug toxicity associated with the lone use of cannabis, and investigate the severity of these presentations over the 10-year period from 2013 to 2022. Although this design does not allow changes in clinical presentation and severity of acute cannabis-related ED visits to be directly attributed to the increase in the potency of cannabis products, it could highlight the real emerging hazards of cannabis consumption to drug users.

METHODS

Euro-DEN plus registry

The Euro-DEN Network was created in 2013 and was funded by a grant from the European Commission (JUST/2012/DPIP/AG/3591) during the period of 2013–2015. It initially comprised 16 sentinel centres in 10 European countries. Since 2014 the network has expanded to form the Euro-DEN Plus project, and by the end of 2024 it comprised 40 centres in 25 European countries. Data are collected on all presentations with acute recreational/illicit drug toxicity to each sentinel ED using a purposively designed minimum data set. Case adjudication is made by the principal investigator of each centre, with no external or central review of the diagnosis. Detailed information on the inclusion/exclusion criteria, data collection methodology, definition of collected signs and symptoms and ethical/Institutional Review Board approval processes have been described elsewhere [14–16].

Study design

This is an exploratory analysis of data contained in the Euro-DEN Plus registry and the statistical plan was not registered in advance. We retrospectively identified Euro-DEN presentations that involved the use of cannabis (herb, resin or both) from 1 October 2013 to 31 December 2022. The use of cannabis was based on at least one the following criteria: (i) the patient and/or accompanying person reporting any form of cannabis use associated with the presentation; and/or (ii) the attending physician recording that the presentation was consistent with cannabis use; and/or (iii) cannabis metabolites were confirmed in toxicology analyses (routine toxicological analysis is not undertaken in

all Euro-DEN centres). As the registry is non-interventional and records clinical practice, not all patients included in the study underwent analytical tests to confirm the statement from the patient/accompanying person or the physician suspicion about the kind of drug(s) consumed. Double case detection was used, with the checking of medical charts and a review of the list of positive toxicological tests in each centre. After identifying a patient by medical report, we looked for any laboratory determination, and vice versa; when a positive test in the laboratory analysis was detected, the medical report was consulted to identify the substances used. As changes in clinical presentation and severity over time associated with cannabis use were of interest, patients in whom cannabis was the only drug used (self-reported or analytically confirmed) were specifically identified. For this reason, patients reporting the concomitant use of, or having positive toxicological tests for, ethanol and/or other drugs were excluded, as were presentations related to the use of synthetic cannabinoid receptor agonists. The exclusion of synthetic cannabinoids was made on the basis of clinical history, and no confirmation by analytical tests was required. Similarly, the classification of edible natural or synthetic cannabis products was also based on data extracted from the medical reports, without laboratory investigation.

Variables analysed

The following data were extracted from the Euro-DEN Plus database: (i) demographic data (age, sex and country); (ii) the presence of 14 pre-defined clinical features, including neuropsychiatric (hallucinations, agitation or aggressive behaviour, psychosis, anxiety, drowsiness/coma and seizures), cardiovascular (chest pain, palpitations, arrhythmia, hypotension and hypertensive crisis if systolic blood pressure was <90 mmHg or >180 mmHg, respectively, with potentially related symptoms being present) and other (vomiting, headache) symptoms; and (iii) four markers of case severity, which included the need for an ambulance to arrive at the ED, hospitalisation, intensive care unit (ICU) admission and death.

Statistical analysis

The overall data are presented for all presentations related to lone cannabis use, with qualitative variables expressed as absolute numbers and percentages, and with quantitative variables expressed as median and interquartile range (IQR). Temporal trends in clinical features and severity were depicted using point estimates and fitted curves—linear and restricted cubic spline (RCS)—derived from logistic regression models to describe changes over time in symptom frequencies and severity markers.

First, we assessed the association between calendar year and each clinical symptom and severity marker under a simple linear time effect to test for overall increasing or decreasing trends across the study period. For each outcome, we fitted unadjusted and adjusted logistic regression models to estimate the odds ratio (OR) per 1-year increment

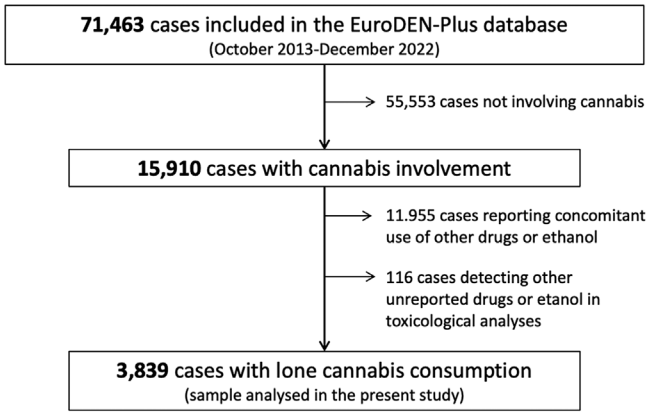

FIGURE 1 Patient inclusion flow chart.

with 95% confidence intervals (95% CIs). Adjusted estimates were obtained from multi-level (mixed-effects) binary logistic regression with age, sex and year as fixed effects, and with centre as a random effect.

Second, to explore potential non-linear relationships over the 10-year period, we fitted RCS logistic regression models. RCS flexibly models associations using piecewise cubic polynomials joined at pre-specified knots and constrained to be linear in the tails. For each outcome, we modelled and drew probability curves for the symptom or severity marker as a function of calendar year, placing three knots at the 10th, 50th and 90th percentiles of the year distribution, as recommended by Harrell [17]. The magnitude of the effects of calendar year on outcomes were then displayed as dose–response curves showing ORs with 95% CIs, using 2013 as the reference year [18]. Adjusted analyses used the same covariates as the linear-effect models (age, sex, centre).

Finally, to assess the potential influence of Δ9-THC concentration on our findings, we estimated the OR (95% CI) per single percentage point increase in the mean Δ9-THC content of seized cannabis herb for each country–year for every symptom and severity marker. Estimates were derived from multi-level (mixed-effects) binary logistic regression with age, sex, calendar year and Δ9-THC concentration as fixed effects, and with a random intercept for centre. Concentration data were obtained from the European Union Drugs Agency (EUDA) [19].

All analyses were performed using SPSS 29 (IBM, Armonk, NY, USA) and STATA 13 (StataCorp LLC, College Station, TX, USA). To establish statistical significance, Bonferroni's correction for multiple comparisons was applied. To test changes in 14 clinical complaints and four severities over time, the widely used P cut-off for statistical significance (0.05) was divided by 18. Accordingly, $P < 0.0028$ was considered statistically significant.

Ethics

The study was undertaken in accordance with the Declaration of Helsinki. Each centre had appropriate approval to collect the data. Written consent was not required as no data other than those collected as part of routine clinical care were included.

TABLE 1 Demographic data and clinical characteristics and severity of presentations in patients presenting in the emergency department after lone cannabis consumption.

	All patients (*n* = 3839) *n* (%)	Missing values *n* (%)
Demographical data		
Age (in years), median (IQR)	25 (20–33)	4 (0.1)
Sex (male)	2703 (70.4)	0 (0)
Countries (total number of cases included in the EuroDEN Plus registry from 2013 to 2022)		
Netherlands (4389)	971 (25.3)	0 (0)
Malta (3921)	579 (15.1)	0 (0)
Spain (5117)	417 (10.9)	0 (0)
Switzerland (5580)	357 (9.3)	0 (0)
Belgium (4020)	306 (8.0)	0 (0)
UK (15859)	288 (7.5)	0 (0)
Norway (17145)	254 (6.6)	0 (0)
Bulgaria (398)	108 (2.8)	0 (0)
Ireland (5392)	79 (2.1)	0 (0)
Lithuania (968)	76 (2.0)	0 (0)
France (2753)	69 (1.8)	0 (0)
Romania (194)	61 (1.6)	0 (0)
Slovakia (490)	57 (1.5)	0 (0)
Estonia (824)	50 (1.3)	0 (0)
Italy (252)	43 (1.1)	0 (0)
Germany (1147)	27 (0.7)	0 (0)
Slovenia (857)	26 (0.7)	0 (0)
Poland (1033)	26 (0.7)	0 (0)
Denmark (357)	17 (0.4)	0 (0)
Latvia (307)	15 (0.4)	0 (0)
Georgia (68)	9 (0.2)	0 (0)
Cyprus (15)	2 (0.1)	0 (0)
Finland (253)	1 (0.0)	0 (0)
Turkey (54)	1 (0.0)	0 (0)
Year		
2013 (3 months, 7 centres)	19 (0.5)	
2014 (12 months, 14 centres)	102 (2.7)	
2015 (12 months, 14 centres)	89 (2.3)	
2016 (12 months, 16 centres)	149 (3.9)	
2017 (12 months, 26 centres)	286 (7.4)	
2018 (12 months, 27 centres)	727 (18.9)	
2019 (12 months, 29 centres)	679 (17.7)	
2020 (12 months, 27 centres)	554 (14.4)	
2021 (12 months, 25 centres)	497 (12.9)	
2022 (12 months, 24 centres)	737 (19.2)	
Clinical data		
Neuropsychiatric symptoms		
Anxiety	1351 (35.4)	20 (0.5)
Agitation or aggressive behaviour	820 (21.5)	18 (0.5)
Decreased alertness (drowsy or coma)	746 (20.6)	218 (5.7)

(Continues)

TABLE 1 (Continued)

	All patients (*n* = 3839) *n* (%)	Missing values *n* (%)
Psychotic signs and symptoms	511 (13.4)	20 (0.5)
Hallucinations	416 (10.9)	19 (0.5)
Seizures	97 (2.5)	22 (0.6)
Cardiovascular symptoms		
Palpitations	715 (18.7)	21 (0.5)
Chest pain	463 (12.1)	22 (0.6)
Hypertensive crisis (>180 mmHg)	189 (5.0)	59 (1.5)
Hypotension (<90 mmHg)	109 (2.9)	58 (1.5)
Arrhythmia	57 (1.6)	58 (1.5)
Other symptoms		
Vomiting	764 (20.0)	23 (0.6)
Headache	263 (6.9)	21 (0.5)
Hyperthermia	17 (0.5)	123 (3.2)
Severity markers		
Brought to the ED by ambulance	2102 (56.3)	105 (2.7)
Hospitalisation	683 (18.5)	139 (3.6)
ICU admission	40 (1.0)	140 (3.6)
Death during the episode	3 (0.1)	4 (0.1)

Abbrevaitions: ED, emergency department; IQR, interquartile range; ICU, intensive care unit.

RESULTS

There were 71 463 presentations recorded in the Euro-DEN Plus registry between 1 October 2013 and 31 December 2022; of these, there were 3839 (5.4%) presentations with lone cannabis use (Figure 1). The median age of these lone cannabis presentations was 25 years (IQR = 20–33) and 71% were male. Over 25% of cases were from the Netherlands, with more than 10% from both Malta and Spain; overall, these three countries contributed 51% of the whole study sample. There was a wide range of proportions of lone cannabis-related ED visits among countries with respect to all patients included in the Euro-DEN Plus registry, with the highest proportions (>20%) registered in the Netherlands and Bulgaria, and the lowest proportions (<2%) registered in the UK, Ireland, Finland and Turkey (Table 1).

The most frequent clinical features were anxiety (35%), agitation (22%), decreased alertness (drowsiness or coma, 21%) and vomiting (20%), while seizures, arrythmias and hyperthermia were the least frequently observed (<3% of presentations) (Table 1). The frequency of presentations over time is presented in Figure 2, and unadjusted estimations based on linear and RCS models are shown in Figure 3. A curvilinear relationship was observed in some cases, especially for anxiety and palpitations (with an increase in the middle years) and the need for hospitalisation (with a decrease in the middle years). When assessed by linear models, we found significant linear trends over time for four clinical complaints, with an increase in the proportion of presentations with chest pain and hypertensive crisis and a decrease in the proportion of presentations with anxiety and palpitations (despite these two presentations having increased during the middle years). The other clinical features showed no significant pattern, while trends for hyperthermia could not be calculated as there were only 15 presentations with hyperthermia over the 10-year period. After adjustment, significant linear changes over time only persisted for yearly increases in hypertensive crises (OR = 1.168, 95% CI = 1.070–1.274) and hypotension (not statistically significant in the unadjusted analysis; OR = 1.239, 95% CI = 1.107–1.386), and for yearly decreases in palpitations (OR = 0.922, 95% CI = 0.883–0.962) (Table 2). Moreover, when non-linear models were used, significant mid-period increases for anxiety, agitation and arrhythmias that subsided by the end of the study were detected, while increases in chest pain and decreases in seizures that became significant in the latter half of the period were observed (Figure 4).

Regarding the severity of the episode, 76% of cases were brought to the ED by ambulance, 13% needed hospitalisation, 1% were admitted to ICU and 0.1% died (Table 1). We found a significant linear trend for increased hospitalisation, which disappeared in all the adjusted models (Figure 3; Table 2). Non-linear adjusted models do not show any significant association over time (Figure 4). Trends in mortality could not be calculated, as only three patients died during the index episode.

The mean Δ9-THC content of seized cannabis herb for country and year was available in 2784 out of the 3839 patients included in the study (73%). Analysis of the impact of Δ9-THC concentrations in cannabis herb did not render any significant relationship with clinical complaint frequency or severity of the index episodes (Figure 5).

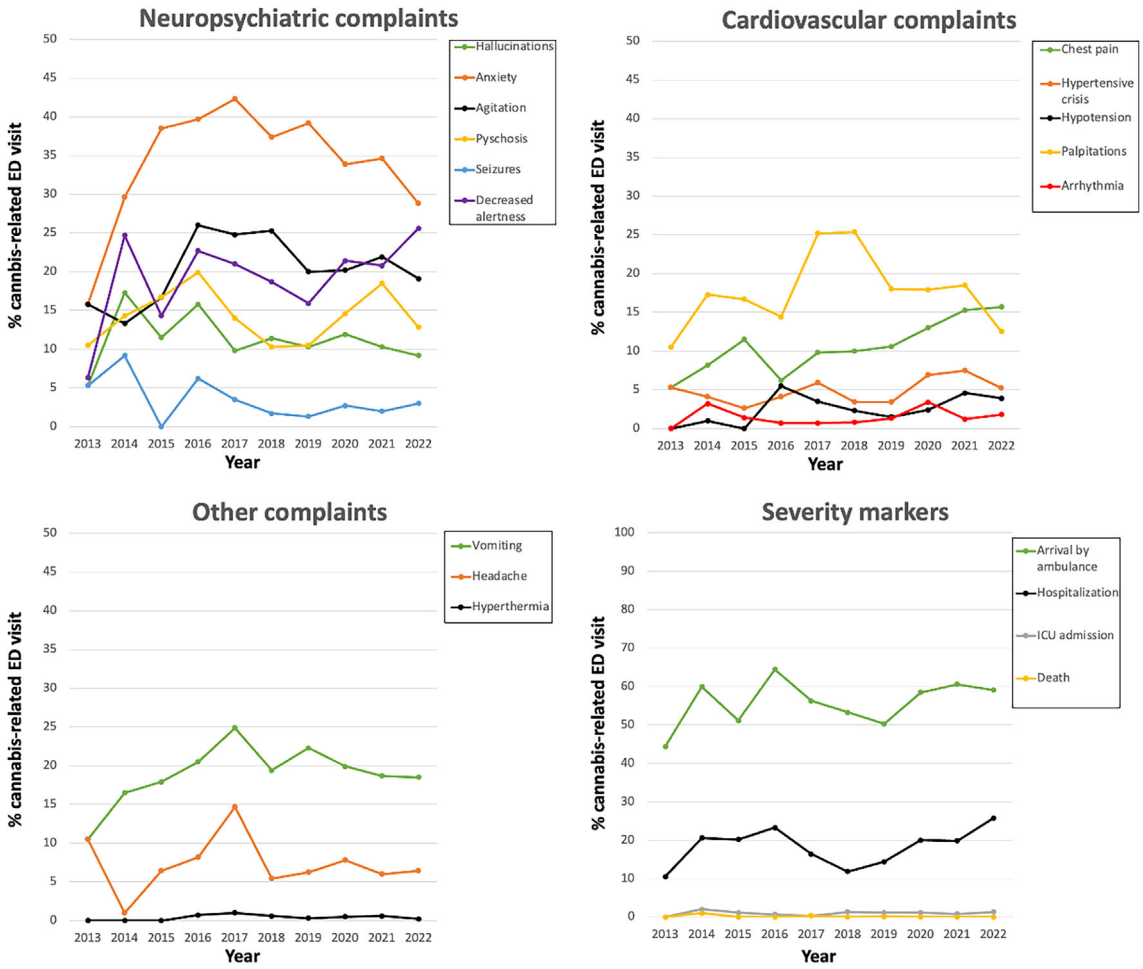

FIGURE 2 Annual point estimations for the percentage of cases presenting to emergency departments (EDs) with each clinical complaint and with each severity marker.

DISCUSSION

In the present multi-national study including a large series of patients attending a sample of European EDs, few changes were observed over time in drug-related complaints involving exclusively cannabis use. With regard to clinical features, only some linear changes in cardiovascular presentations were observed over the whole period (cases with hypotension and hypertensive crisis increased, whilst palpitations decreased). By contrast, non-linear significant changes could also be seen: mid-period increases for anxiety, agitation and arrhythmias that subsided by the end of the study were found, as well as increases in chest pain and decreases in seizures that became significant in the latter half of the period. These temporal changes may be driven by what was observed in the Netherlands, Malta and Spain, the countries that contributed around half of the cases in this series. Nonetheless, the results do not suggest an increase in severe clinical presentations or in the number of severe cases that attended the EDs over a 10-year period, as the need for ambulance, hospitalisation or admission to an ICU remained stable.

Some specific aspects of this study should be highlighted for the correct interpretation of the results. First, it was not designed to test a direct relationship between changes in the clinical presentation and severity of acute cannabis-related ED visits and the potency of the cannabis products consumed by users. Although we tested the possible relationship of such Δ9-THC concentrations with patient symptomatology and severity, cannabis potency is not constant across European countries and for all cannabis products. Moreover, none of the national trends could be applied to the centres participating in the Euro-DEN Plus registry, as in large countries the Δ9-THC concentrations in cannabis herbs and resin can vary depending on different drug supply or distribution channels. Second, users can adapt their consumption doses to the potency of the product; therefore, changes in presentation and severity are not only related to cannabis potency but also to other unknown factors. As the general increasing trend in the potency of cannabis products over the last decades is undisputed [1–3, 20–22], the absence of gross changes in clinical presentation and severity between 2013 and 2022 would be consistent with consumer self-regulation. Finally, the present study analysed only cases of 'lone' cannabis intoxication, which refers to 5.4% of the cases included in the Euro-DEN Plus registry. Hypothetically, it is possible that the number of adverse events over time could be higher when cannabis is used in combination with alcohol or other drugs (which is

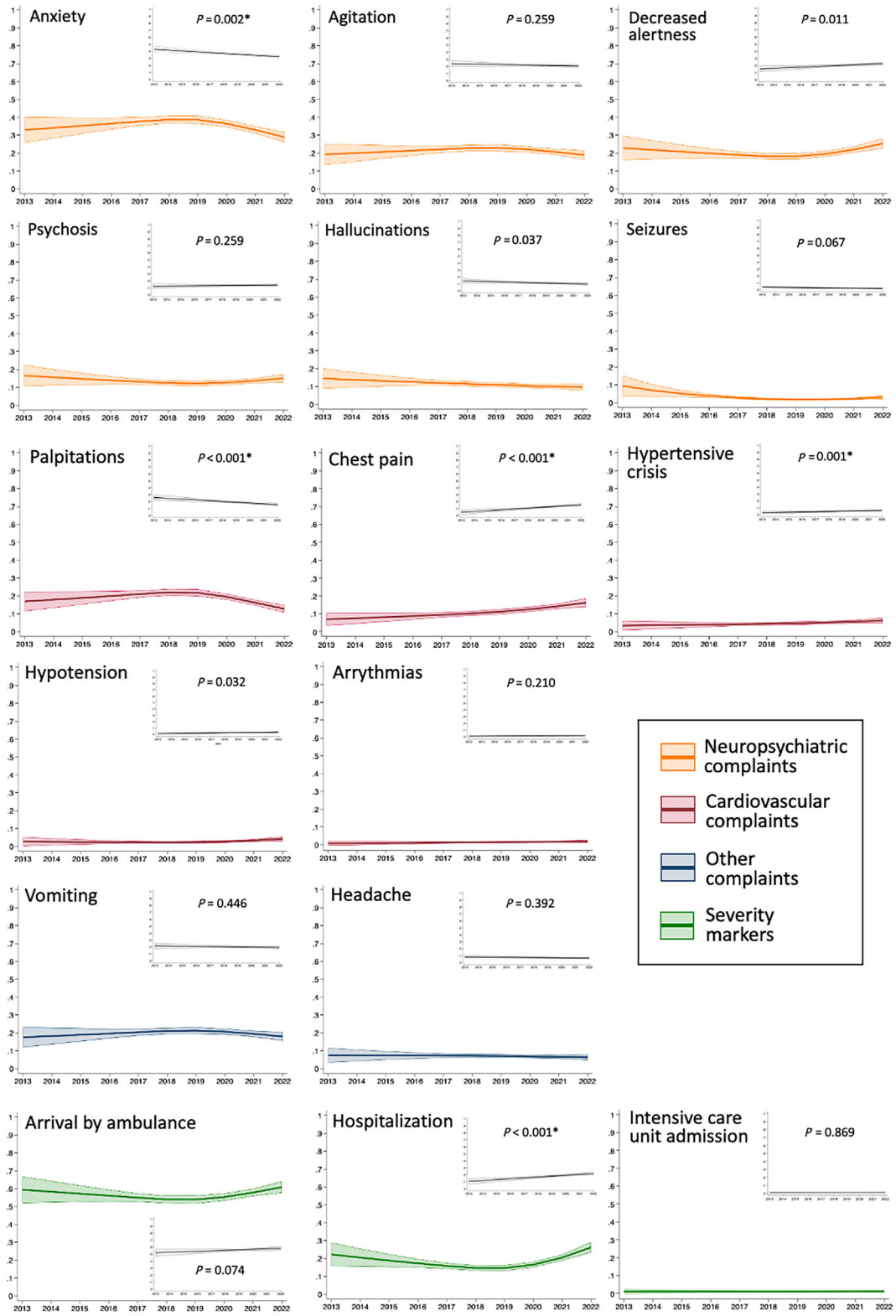

FIGURE 3 Trends in the percentage of cases presenting to emergency departments (EDs) with each clinical complaint and with each severity marker. Trends were obtained using unadjusted restricted cubic spline models (large graphs) and linear models (small graphs inside the big graphs). *Statistical significance after application of Bonferroni's correction for multiple comparisons ($P < 0.0028$, obtained by dividing 0.05 by 18 main clinical data and severity markers).

TABLE 2 Analysis of unadjusted and adjusted temporal trends in the clinical findings and severity of cases.

Main clinical data	Unadjusted OR (95% CI) per every subsequent year	Adjusted OR (95% CI) per every subsequent year[a]
Neuropsychiatric symptoms		
Anxiety	0.950 (0.921–0.981)[b]	0.959 (0.924–0.995)
Agitation or aggressive behaviour	0.979 (0.943–1.016)	0.974 (0.934–1.016)
Decreased alertness (drowsy or coma)	1.052 (1.012–1.094)	1.048 (1.001–1.096)
Psychotic signs and symptoms	1.013 (0.968–1.059)	0.963 (0.916–1.012)
Hallucinations	0.950 (0.906–0.997)	0.951 (0.901–1.003)
Seizures	0.917 (0.835–1.006)	0.983 (0.888–1.088)
Cardiovascular symptoms		
Palpitations	0.929 (0.894–0.965)[b]	0.922 (0.883–0.962)[b]
Chest pain	1.127 (1.073–1.185)[b]	1.055 (0.999–1.114)
Hypertensive crisis (>180 mmHg)	1.083 (1.006–1.166)[b]	1.168 (1.070–1.274)[b]
Hypotension (<90 mmHg)	1.112 (1.009–1.226)	1.239 (1.107–1.386)[b]
Arrhythmia	1.087 (0.954–1.238)	1.018 (0.937–1.106)
Other symptoms		
Vomiting	0.985 (0.948–1.025)	1.041 (0.996–1.088)
Headache	0.974 (0.918–1.034)	1.035 (0.965–1.109)
Hyperthermia	NC (too few cases)	NC (too few cases)
Severity markers		
Brought to the ED by ambulance	1.029 (0.997–1.061)	1.054 (1.016–1.094)
Hospitalisation	1.090 (1.047–1.136)[b]	0.980 (0.935–1.027)
ICU admission	1.013 (0.873–1.175)	1.000 (0.919–1.087)
Death	NC (too few cases)	NC (too few cases)

Abbreviations: ED, emergency department; ICU, intensive care unit; NC, not calculable.

[a]Adjusted odds ratios were obtained by mixed multi-level binary logistic regression that included year, patient age and sex as fixed effects and centre as a random effect.

[b]Denotes statistical significance after application of Bonferroni's correction for multiple comparisons ($P < 0.0028$, obtained by dividing 0.05 by 18 main clinical data and severity markers).

usually the case, as this was observed in an additional 17% of Euro-DEN Plus cases).

The predominant clinical features in our study are the same as and have similar percentages to those observed in previous studies analysing acute adverse events associated with cannabis use in different populations [10, 23], which, in our opinion, reinforces the consistency of the clinical findings in our sample. Cardiovascular symptoms were the only ones to show consistent temporal change, whereas neuropsychiatric symptoms remained relatively stable across the study period. We observed a transient mid-period increase in anxiety and agitation that resolved by the end of the study, and a significant decline in seizures, particularly in the final years. A recent study of 1697 symptomatic cannabis mono-intoxicated patients presenting to a single ED in Amsterdam (the Netherlands) reported a high frequency of cardiovascular symptoms (47.2% of cases). Palpitations were the most common, followed by syncope and chest pain, and remarkably, eight patients (0.5%) presented severe cardiovascular complications (three myocardial infarctions and five severe arrhythmias) [9]. Δ9-THC activates the type-1 cannabinoid receptor. At low doses it causes endothelial dysfunction, atherosclerosis and sympathetic activation, while at high doses it can cause bradycardia and orthostatic hypotension. THC also activates inflammatory cytokines associated with cardiovascular disease. Finally, anxiety, psychosis or other neuropsychological manifestations (common in patients with acute cannabis use) cause tachycardia, which would explain some cases of hypertensive crisis (rather than hypotension) [24–26]. Although the full pathophysiology and clinical relevance of cardiovascular symptoms is largely unknown, serious cardiovascular complications may increase in the following years [9]. In addition, the present study also highlights the 'crude' increase in cases of chest pain ($P < 0.001$), which becomes statistically significant in the second half of the period when this symptom is analysed using non-linear models, as well a mid-period increase in arrythmias that subsided by the end of the study period. Recent work conducted in Denmark in 5400 patients using medical cannabis between 2018 and 2021 found an increased risk of arrhythmias, mainly atrial fibrillation, but found no differences in the development of acute coronary syndromes [27]. Therefore, although our data are not definitive, they warrant vigilance: health authorities should maintain enhanced surveillance over the coming years and consider the targeted monitoring of arrhythmias and acute coronary syndromes potentially associated with cannabis use.

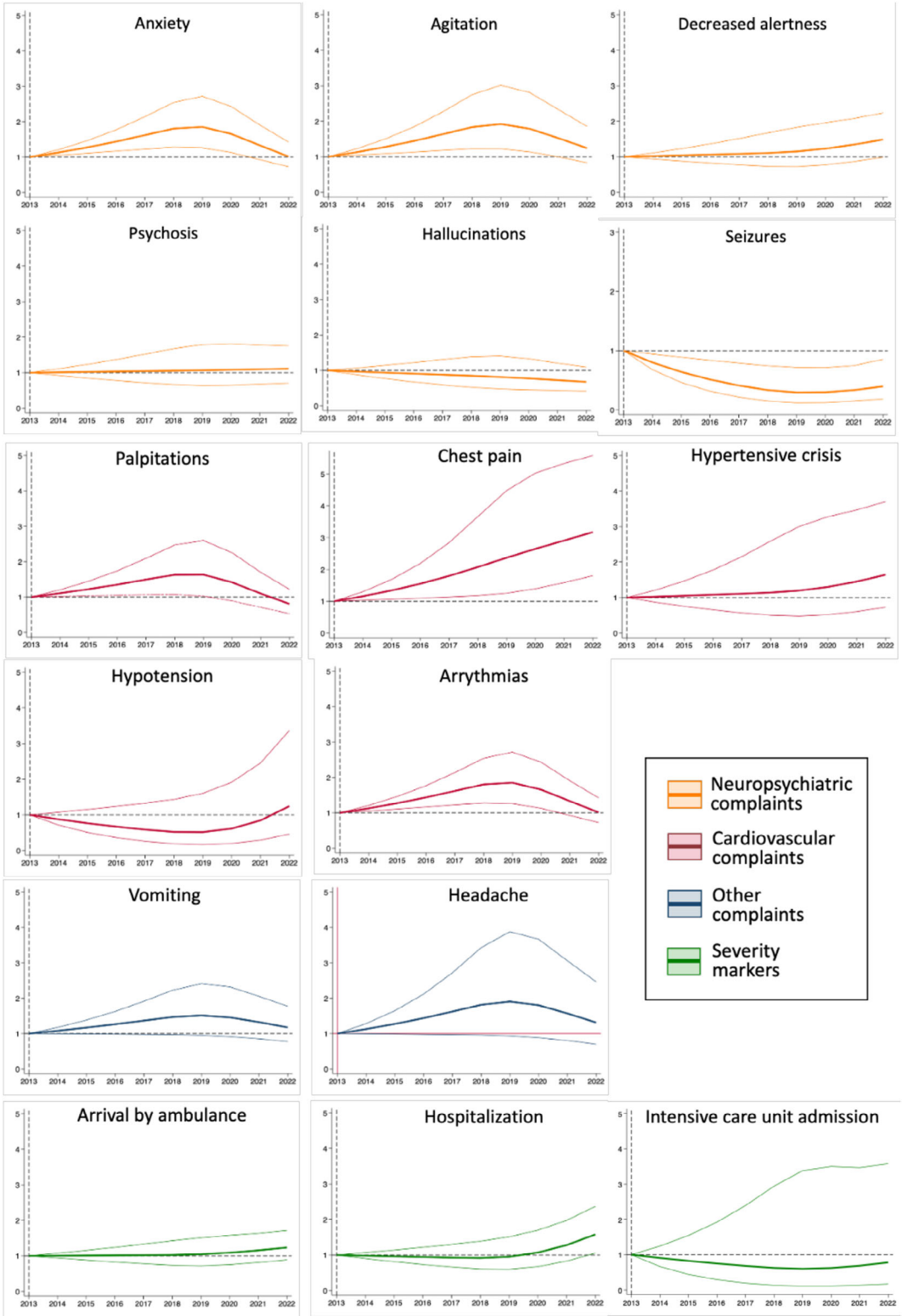

FIGURE 4 Adjusted odds ratios for each clinical complaint and severity marker over time, modelling these relationships with restricted cubic spline models. Dashed vertical lines correspond to the year taken as the reference (2013), horizontal dashed lines correspond to the reference odds ratio of 1, and coloured lines correspond to the adjusted odds ratios (thick lines) and 95% confidence interval limits (thin lines).

With regards to the severity of the cases presenting in the EDs, the need for an ambulance, hospitalisation and ICU admission seem to have remained unaltered over the years. We used these parameters as indirect indicators of the overall clinical severity as the clinical data collected in the Euro-DEN Plus registry do not grade the intensity/severity of the most common features (such as anxiety and agitation

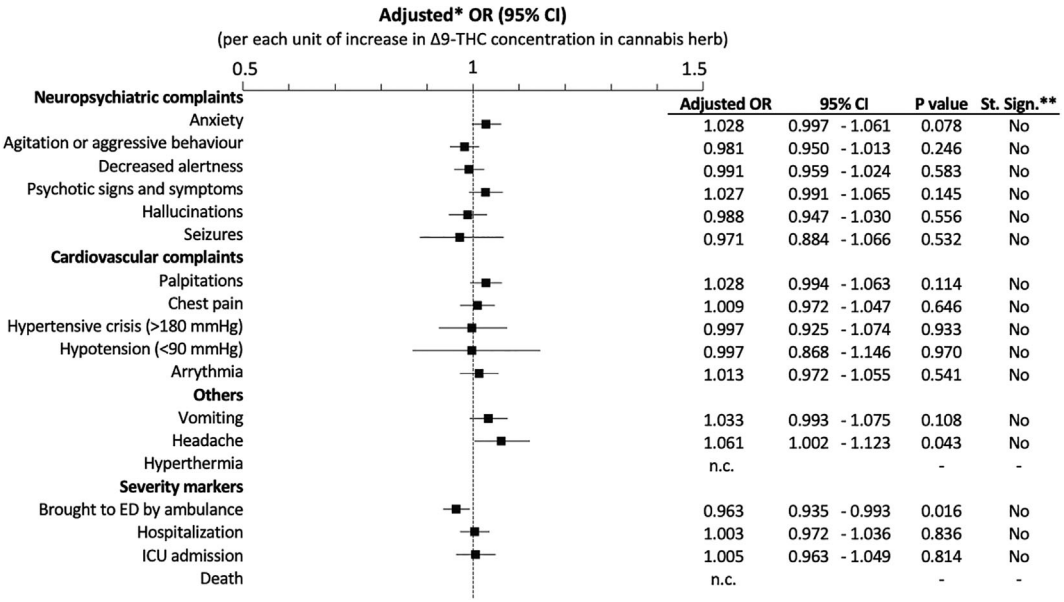

FIGURE 5 Analysis of the association between Δ9-tetrahydrocannabinol concentrations in seized cannabis herb and clinical complaints and severity markers. *An adjusted odds ratio for each clinical complaint and severity marker was obtained with adjusted model 3, which was produced by mixed multi-level binary logistic regression including year, patient age, sex, percentage of Δ9-tetrahydrocannabinol found in cannabis herb seizures during that year, and country of the centre as fixed effects, and including centre as a random effect. **Statistical significance after application of Bonferroni's correction for multiple comparisons ($P < 0.0028$, obtained by dividing 0.05 by 18 main clinical data and severity markers). ED, emergency department; St. Sign., statistical significance; ICU, intensive care unit.

or other behavioural disturbances) in patients with cannabis intoxication. Therefore, a definitive conclusion about temporal trends in the severity of acute cannabis intoxication presenting in EDs cannot be firmly made. Moreover, very few deaths were recorded (three patients). All these findings must be interpreted in light of the fact that cannabis is the drug most commonly used in Europe (apart from alcohol) and is one of the drugs most frequently associated with drug-related events in EDs [28, 29]. Given the evolution of policies related to the liberalisation of cannabis use and availability, it is foreseeable that the number of users and, consequently, the related morbidity could increase in future years [30]. Concerns about cannabis legalisation includes the increase in use among young people, the higher prevalence of impaired driving, the risk of polysubstance use, societal normalisation of a once-illicit drug and the potential negative health effects of chronic cannabis use, particularly on the cognitive development of adolescents, among others [27]. Some recent studies have shown that marijuana legalisation is associated with increased rates of ED visits for marijuana-related complaints and an increased use of antipsychotic medications to control symptoms [31–33]. In addition to symptoms of acute marijuana intoxication, other presentations associated with chronic marijuana use, such as CHS and psychiatric presentations that may require urgent assessment and treatment in the ED, are also increasing in association with cannabis legalisation [34, 35].

Limitations

First, this study retains the limitations inherent in the design of the Euro-DEN Plus data source, such as the fact that countries are represented by centres usually located in large cities (which implies that the characteristics of populations living in small towns are underrepresented), the lack of information on the context of drug use, and the interval between drug use and emergency treatment. Second, the selection of cases (consumption of cannabis alone) was based on the patient's declaration or the results of the toxicological analysis in the ED. Therefore, the presence of substances unknown to the user and not detected in the toxicology laboratory cannot be excluded [36]. The best example of this is the inability to analyse the role that undeclared synthetic and semi-synthetic cannabinoids contained in cannabis herbs or resins may play in the clinical picture of patients included in the present study [28, 37]. During the last few years, there has been an increase in reports of the detection of natural cannabinoids together with synthetic cannabinoids in at least 13 European countries, and most of the centres participating in the Euro-DEN Plus registry are still not able to detect these products [21]. On the other hand, it is possible that some cases with a positive laboratory test for cannabis could correspond to chronic consumption rather than to acute intoxication. This may lead to some misclassification and confounding, as some patient complaints recorded during the ED visit that were attributed to acute use may in fact correspond to chronic use, or may even be unrelated to cannabis. In addition, some patients could have been included on the basis of a positive laboratory test that indicates prior use but not acute intoxication. Third, more than half of the cases were from only three countries, which may distort the overall European picture of the problem. Fourth, the type of cannabis consumed (resin, herb, oil, edible product) and the route of administration (smoked, vaped, ingested) were also not considered and may have contributed to the intensity of symptoms or the

severity of the cases [30]. Fifth, the variables selected as a proxy for the severity of intoxication are subjective, and the need for hospitalisation or ICU admission are not homogeneous throughout Europe and may even differ from centre to centre in the same country. Sixth, although the present results were obtained using a large registry of more than 70 000 cases seen in the ED, the number of annual events for certain symptoms or severity markers was small, rendering the statistical power too low to rule out a beta error in some of the estimates (i.e. the existence of significant temporal trends for some of the variables evaluated cannot be ruled out with certainty). Finally, discrepancies between results from linear models (treating the entire period as a single trend) and non-linear models (allowing for flexible time effects) suggest that a longer follow-up period is needed to draw more definitive conclusions.

CONCLUSION

Despite the increase in potency of cannabis-derived products in Europe in recent years, very few changes in the clinical complaints and the severity of acute events related to isolated cannabis use over the 10-year period analysed in this large European cohort were identified.

AUTHOR CONTRIBUTIONS

Òscar Miró: Conceptualization (lead); data curation (lead); formal analysis (lead); funding acquisition (equal); investigation (lead); methodology (lead); project administration (lead); resources (equal); software (lead); supervision (lead); validation (lead); visualization (lead); writing—original draft (lead); writing—review and editing (lead). **Miguel Galicia:** Conceptualization (equal); formal analysis (equal); investigation (equal); visualization (equal); writing - original draft (equal); writing—review and editing (equal). **Paul I. Dargan:** Conceptualization (equal); data curation (equal); funding acquisition (equal); resources (equal); supervision (equal); visualization (equal); writing—review and editing (equal). **David M. Wood:** Conceptualization (equal); data curation (equal); formal analysis (equal); funding acquisition (equal); visualization (equal); writing—review and editing (equal). **Alison M. Dines:** Funding acquisition (equal); investigation (equal); methodology (equal); project administration (equal); supervision (equal); visualization (equal); writing—original draft (equal); writing—review and editing (equal). **Fridtjof Heyerdahl:** Conceptualization (equal); investigation (equal); methodology (equal); writing—review and editing (equal). **Knut Erik Hovda:** Investigation (equal); methodology (equal); supervision (equal); visualization (equal); writing—review and editing (equal). **Isabelle Giraudon:** Formal analysis (equal); methodology (equal); resources (equal); supervision (equal); writing—review and editing (equal). **Christopher Yates:** Formal analysis (equal); funding acquisition (equal); investigation (equal); methodology (equal); project administration (equal); resources (equal); supervision (equal); validation (equal); writing—original draft (equal); writing—review and editing (equal). **Matthias Liechti:** Data curation (equal); formal analysis (equal); funding acquisition (equal); investigation (equal); methodology (equal); project administration (equal); supervision (equal); validation (equal); visualization (equal); writing—original draft (equal); writing—review and editing (equal). **Odd Martin Vallersnes:** Conceptualization (equal); data curation (equal); formal analysis (equal); funding acquisition (equal); investigation (equal); methodology (equal); project administration (equal); resources (equal); software (equal); supervision (equal); validation (equal); visualization (equal); writing—original draft (equal); writing—review and editing (equal). **Florian Eyer:** Investigation; supervision; visualization; writing—review and editing. **Guillermo Burillo-Putze:** Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; project administration; resources; software; supervision; validation; visualization; writing—original draft; writing—review and editing.

ACKNOWLEDGEMENTS

The present study was possible, in part, through a grant from the Drug Prevention and Information Programme (DPIP)/Prevention of and Fight Against Crime Programme (ISEC) programme of the European Union (JUST/2012/DPIP/AG/3591). The project in Bern (Switzerland) has received financial support from the Burgergemeinde Bern. All the authors thank their colleagues in the emergency department for their assistance with data management and extraction.

DECLARATION OF INTERESTS

The authors have none to declare.

DATA AVAILABILITY STATEMENT

Data are not publicly available but can be shared upon reasonable request.

ORCID

Miguel Galicia https://orcid.org/0000-0002-5333-3090

REFERENCES

1. ElSohly MA, Mehmedic Z, Foster S, Gon C, Chandra S, Church JC. Changes in cannabis potency over last two decades (1995-2014). Analysis of current data in the United States. Biol Psychiatry. 2016; 79:613–9.
2. Freeman TP, Groshkova T, Cunningham A, Sedefov R, Griffiths P, Lynksey MT. Increasing potency and price of cannabis in Europe, 2006-2016. Addiction. 2019;114:1015–23.
3. Dujourdy L, Besacier F. A study of cannabis potency in France over a 25 years period (1992-2016). Forensic Sci Int. 2017;272:72–80. https://doi.org/10.1016/j.forsciint.2017.01.007
4. Petrilli K, Hines L, Adams S, Morgan CJ, Curran HV, Freeman TP. High potency cannabis use, mental health symptoms and cannabis dependence: triangulating the evidence. Addict Behav. 2023;144: 107740. https://doi.org/10.1016/j.addbeh.2023.107740
5. Manthey J, Freeman TP, Kilian C, López-Pelayo H, Rehm J. Public health monitoring of cannabis use in Europe: Prevalence of use, cannabis potency, and treatment rates. Lancet Reg Health Eur. 2021;10: 100227.
6. Petrilli K, Ofori S, Hines L, Taylor G, Adams S, Freeman TP. Association of cannabis potency with mental ill health and addiction: a systematic review. Lancet Psychiatry. 2022;9(9):736–50. https://doi.org/10.1016/S2215-0366(22)00161-4

7. Karila L, Roux P, Rolland B, Benyamina A, Reynaud M, Aubin HJ, et al. Acute and long-term effects of cannabis use: a review. Curr Pharm Des. 2014;20(25):4112–8. https://doi.org/10.2174/1381612813199990620
8. Schep LJ, Slaughter RJ, Glue P, Gee P. The clinical toxicology of cannabis. N Z Med J. 2020;133(1523):96–103.
9. Gresnigt F, van den Brink LC, Hunault C, Franssen E, de Lange D, Riezebos R. Incidence of cardiovascular symptoms and adverse events following self-reported acute cannabis intoxication at the emergency department: a retrospective study. Emerg Med J. 2023;40(5):357–8. https://doi.org/10.1136/emermed-2022-212784
10. Burillo-Putze G, Ibrahim-Achi D, Galicia M, Supervía A, Martínez-Sánchez L, Ortega Pérez J, et al. Clinical manifestations and serious adverse effects after cannabis use: Role of age according to sex and coingestion of alcohol. Emergencias. 2022;34:275–81.
11. Burillo-Putze G, Miró Ò. Drug users coming to European emergency departments: general basic approach and recommendations for safe discharge. Eur J Emerg Med. 2024;31(4):236–9. https://doi.org/10.1097/MEJ.0000000000001145
12. Vallecillo Sánchez G, Chen Quin J, Losada Parente A, Ochoa S, Smithson Amat A, Anaya S, et al. Street drugs associated with acute poisoning: description and analysis of differences in women attended in a hospital emergency department. Emergencias. 2024;36(2):104–8. https://doi.org/10.55633/s3me/025.2023
13. Losada A, Supervía A, Vallecillo G, Petrus C, Aranda D, Chen J, et al. Patients with drug-abuse poisoning with and without HIV infection: differential characteristics. Emergencias. 2023;35(2):103–8. https://doi.org/10.55633/s3me/E077.2023
14. Wood DM, Heyerdahl F, Yates CB, Dines AM, Giraudon I, Hovda KE, et al. The European drug emergencies network (euro-DEN). Clin Toxicol (Phila). 2014;52(4):239–41. https://doi.org/10.3109/15563650.2014.898771
15. Dines AM, Wood DM, Yates C, Heyerdahl F, Hovda KE, Giraudon I, et al. Acute recreational drug and new psychoactive substance toxicity in Europe: 12 months data collection from the European drug emergencies network (euro-DEN). Clin Toxicol (Phila). 2015;53(9):893–900. https://doi.org/10.3109/15563650.2015.1088157
16. Miró Ò, Waring WS, Dargan PI, Wood DM, Dines AM, Yates C, et al. Variation of drugs involved in acute drug toxicity presentations based on age and sex: an epidemiological approach based on European emergency departments. Clin Toxicol (Phila). 2021;59(10):896–904. https://doi.org/10.1080/15563650.2021.1884693
17. Harrell F. Regression Modeling Strategies 2nd ed. New York: Springer-Verlag; 2015.
18. Lopez-Ayala P, Riley RD, Collins GS, Zimmermann T. Dealing with continuous variables and modelling non-linear associations in healthcare data: practical guide. BMJ. 2025;390:e082440. https://doi.org/10.1136/bmj-2024-082440
19. European Union Drug Agency. Statistical Bulletin 2024: price, purity and potency [Internet]. [cited 2024 Apr 27]. Available from: https://www.euda.europa.eu/data/stats2024/ppp_en
20. Santos-Álvarez I, Pérez-Lloret P, González-Soriano J, Pérez-Moreno M. An approach to the evaluation of the potency of cannabis resin in Madrid: A health hazard? Adicciones. 2021;35:279–88.
21. Zamengo L, Frison G, Bettin C, Sciarrone R. Cannabis potency in the Venice area (Italy): update 2013. Drug Test Anal. 2015;7(3):255–8. https://doi.org/10.1002/dta.1690
22. Freeman TP, van der Pol P, Kuijpers W, Wisselink J, Das RK, Rigter S, et al. Changes in cannabis potency and first-time admissions to drug treatment: A 16-year study in the Netherlands. Psychol Med. 2018;48(14):2346–52. https://doi.org/10.1017/S0033291717003877
23. Schmid Y, Scholz I, Mueller L, Exadaktylos AK, Ceschi A, Liechti ME, et al. Emergency department presentations related to acute toxicity following recreational use of cannabis products in Switzerland. Drug Alcohol Depend. 2020;206:107726. https://doi.org/10.1016/j.drugalcdep.2019.107726
24. Wei T-T, Chandy M, Nishiga M, Zhang A, Kumar KK, Thomas D, et al. Cannabinoid receptor 1 antagonist genistein attenuates marijuana-induced vascular inflammation. Cell. 2022;185(10):1676–1693.e23. https://doi.org/10.1016/j.cell.2022.04.005
25. Richards JR, Blohm E, Toles KA, Jarman AF, Ely DF, Elder JW. The association of cannabis use and cardiac dysrhythmias: a systematic review. Clin Toxicol (Phila). 2020;58(9):861–9. https://doi.org/10.1080/15563650.2020.1743847
26. Lukas SE, Orozco S. Ethanol increases plasma delta(9)-tetrahydrocannabinol (THC) levels and subjective effects after marihuana smoking in human volunteers. Drug Alcohol Depend. 2001;64(2):143–9. https://doi.org/10.1016/S0376-8716(01)00118-1
27. Holt A, Nouhravesh N, Strange JE, Kinnberg Nielsen S, Schjerning AM, Vibe Rasmussen P, et al. Cannabis for chronic pain: cardiovascular safety in a nationwide Danish study. Eur Heart J. 2024;45(6):475–84. https://doi.org/10.1093/eurheartj/ehad834
28. European Monitoring Centre for Drugs and Drug Addiction. European drug report 2023: NPS; the current situation in Europe [Internet]. Available from: https://www.emcdda.europa.eu/publications/european-drug-report/2023/new-psychoactive-substances
29. European Monitoring Centre for Drugs and Drug Addiction. European Drug Emergencies Network (Euro-DEN Plus): data and analysis [Internet]. January 2024. Available from: https://www.emcdda.europa.eu/publications/data-factsheet/european-drug
30. Crowley R, Cline K, Hilden D, Beachy M, Health and public policy Committee of the American College of physicians. Regulatory framework for cannabis: A position paper from the American College of Physicians. Ann Intern Med. 2024;177(8):1104–5. https://doi.org/10.7326/M24-0638
31. Nguyen A, Lee R, Zhao L, Qu L, Todd B. The impact of recreational cannabis legalization on ED visit rates for acute cannabis intoxication. Am J Emerg Med. 2024;84:124–9. https://doi.org/10.1016/j.ajem.2024.07.041
32. Myran DT, Pugliese M, Tanuseputro P, Cantor N, Rhodes E, Taljaard M. The association between recreational cannabis legalization, commercialization and cannabis-attributable emergency department visits in Ontario, Canada: an interrupted time–series analysis. Addiction. 2022;117(7):1952–60. https://doi.org/10.1111/add.15834
33. Roehler DR, Hoots BE, Holland KM, Baldwin GT, Vivolo-Kantor AM. Trends and characteristics of cannabis-associated emergency department visits in the United States, 2006–2018. Drug Alcohol Depend. 2022;232:109288. https://doi.org/10.1016/j.drugalcdep.2022.109288
34. Bollom A, Austrie J, Hirsch W, Nee J, Friedlander D, Iturrino J, et al. Emergency department burden of nausea and vomiting associated with cannabis use disorder: US trends from 2006 to 2013. J Clin Gastroenterol. 2018;52(9):778–83. https://doi.org/10.1097/MCG.0000000000000944
35. Burillo-Putze G, Trujillo-Burillo D, García-Hernandez JC, López-Hernández MA, Hernández-Ramos I, Ramos-Suárez I, et al. Cannabis hyperemesis syndrome: incidence and treatment with topical capsaicin. Med Clin (Barc). 2022;159(4):183–6. https://doi.org/10.1016/j.medcli.2021.07.028
36. Fernández Alonso C, Vargas Lobé S, Fernández García L, Fuentes Ferrer M, Quintela Jorge O, Bravo Serrano B, et al. Differences in toxicology reports and hospital emergency care for patients suspected of experiencing drug-facilitated crimes: An analysis according to gender. Emergencias. 2024;36:249–56.
37. Malaca S, Busardò FP, Nittari G, Sirignano A, Ricci G. Fourth generation of synthetic cannabinoid receptor agonists: A review on the latest insights. Curr Pharm Des. 2022;28(32):2603–17. https://doi.org/10.2174/1381612827666211115170521

REST OF EURO-DEN PLUS RESEARCH GROUP AUTHORS (CORPORATE AUTHORS)

First name	Middle name	Last/family name	Affiliation	Email
Monia		Aloise	Humanitas Research Hospital, via Manzoni 56, 20 089 Rozzano, Italy	monia.aloise@humanitas.it
Jacek	Sein	Anand	1. Pomeranian Centre of Toxicology, Gdansk, Poland 2. Medical University Gdansk, Department of Clinical Toxicology, Gdansk, Poland	jacek.anand@gumed.edu.pl
Kurt		Anseeuw	Department of Emergency Medicine, ZAS Cadix, Antwerp, Belgium	kurt.anseeuw@zas.be
Erato		Antoniou	Emergency Department, Nicosia General Hospital, Nicosia, Cyprus	
Robertas		Badaras	Republic Vilnius University Hospital, Vilnius, Lithuania	badaras@gmail.com
George		Bailey	Emergency Department, St Mary's Hospital, Imperial College Healthcare NHS Trust, London, UK	george.bailey1@nhs.net
Marcin		Bitel	Pomeranian Centre of Toxicology, Gdansk, Poland	marcinbitel@gmail.com
Jeffrey		Bonnici	Mater Dei Hospital, Msida, MSD 2090, Malta	jeffreybonnici@gmail.com
Miran		Brvar	Centre for Clinical Toxicology and Pharmacology, University Medical Centre Ljubljana, Ljubljana, Slovenia	miran.brvar@kclj.si
Blazena		Caganova	National Toxicological Information Centre, University Hospital, Bratislava, Slovakia	caganova@ntic.sk
Feriyde		Calýskan	Izmir Medical Sciences University, Tepecik Training and Research Hospital, Izmir, Turkey	feriyde18@gmail.com
Alessandro		Ceschi	Institute of Pharmacological Sciences of Southern Switzerland, Division of Clinical Pharmacology and Toxicology, Ente Ospedaliero Cantonale, Lugano, Switzerland	alessandro.ceschi@eoc.ch
Karam		Chamoun	Department of Medical and Toxicological Critical Care, Lariboisière Hospital, INSERM UMRS-1144, Paris University, Paris, France	karam.chamoun@hotmail.com
David		Curtelin	Emergency Department, Hospital Clinic Barcelona Spain	curtelin@clinic.cat
Laurence		Daveloose	Emergency Department, Ghent University Hospital, Belgium	laurence.daveloose@ugent.be
Birgit	Andrea	Gartner	Division of Emergency Medicine, Department of Anesthesiology, Clinical Pharmacology, Intensive Care and Emergency Medicine, Geneva University Hospitals, Rue Gabrielle-Perret-Gentil 4, Geneva, Switzerland	birgit.gartner@hug.ch
Ketevan		Gorozia	Archangel St. Michael Multiprofile Clinical Hospital, Tbilisi, Georgia	goroziaketi@yahoo.com
Damjan		Grenc	Centre for Clinical Toxicology and Pharmacology, University Medical Centre Ljubljana, Ljubljana, Slovenia	damjan.grenc@kclj.si
Femke	MJ	Gresnigt	Emergency department, OLVG Hospital, Amsterdam, The Netherlands	f.m.j.gresnigt@olvg.nl
Laura		Hondebrink	Dutch Poisons Information Center, University Medical Center, Utrecht University, Utrecht, The Netherlands	l.hondebrink@umcutrecht.nl
Gesche		Jürgens	Zealand University Hospital Roskilde, Clinical Pharmacology Unit Roskilde, Denmark	gju@regionsjaelland.dk
Jutta		Konstari	Malmi Hospital, Helsinki, Finland	jutta.konstari@hel.fi
Soso		Kutubidze	Archangel St. Michael Multiprofile Clinical Hospital, Tbilisi, Georgia	s.kutubidze@gmail.com

First name	Middle name	Last/family name	Affiliation	Email
Gabija		Laubner	Republic Vilnius University Hospital, Vilnius, Lithuania	gabija.laubner@gmail.com
Evangelia		Liakoni	Clinical Pharmacology and Toxicology, Department of General Internal Medicine, Inselspital, Bern University Hospital, University of Bern, Bern, Switzerland	evangelia.liakoni@insel.ch
Viesturs		Liguts	Riga East Clinical University Hospital, Riga, Latvia	viesturs.liguts@aslimnica.lv
Cathelijne		Lyphout	Emergency Department, Ghent University Hospital, Belgium	cathelijne.lyphout@uzgent.be
Roy		McKenna	Department of Emergency Medicine, Our Lady of Lourdes Hospital, Drogheda, County Louth, Republic of Ireland	roymckenna89@gmail.com
Bruno		Mégarbane	Department of Medical and Toxicological Critical Care, Lariboisière Hospital, INSERM UMRS-1144, Université Paris Cité, Paris, France	bruno.megarbane@lrb.aphp.fr
Adrian		Moughty	Emergency Department, Mater Misericordiae University Hospital, Dublin 7, Republic of Ireland	amoughty@mater.ie
Gabriela	Viorela	Nitescu	Childrens Hospital Grigore Alexandrescu, Bucharest, Romania	viorela.nitescu@yahoo.com
Roberta		Noseda	Institute of Pharmacological Sciences of Southern Switzerland, Division of Clinical Pharmacology and Toxicology, Ente Ospedaliero Cantonale, Lugano, Switzerland	roberta.noseda@eoc.ch
Niall		O'Connor	Department of Emergency Medicine, Our Lady of Lourdes Hospital, Drogheda, County Louth, Republic of Ireland	niall.oconnor@hse.ie
Juan		Ortega Perez	Clinical Toxicology Unit, Emergency Department, Hospital Son Espases, Palma de Mallorca, Balearic Island, Spain	juanop24@gmail.com
Raido		Paasma	Foundation Pärnu Hospital, Pärnu Estonia	raido.paasma@gmail.com
Marius		Perminas	Lithuanian University of Health Sciences, Kaunas, Lithuania	m.perminas@gmail.com
Per Sverre		Persett	Department of Acute Medicine, Medical Division, Oslo University Hospital, Norway	pspersett@gmail.com
Kristiina		Põld	Emergeny Medicine Department, North-Estonia Medical Centre, Tallinn, Estonia	kristiina.pold@regionaalhaigla.ee
Erik		Puchon	National Toxicological Information Centre, University Hospital, Bratislava, Slovakia	erik.puchon@ntic.sk
Jordi		Puiguriguer	Clinical Toxicology Unit, Emergency Department, Hospital Son Espases, Palma de Mallorca, Balearic Island, Spain	jordi.puiguriguer@ssib.es
Julia		Radenkova-Saeva	University Hospital for Emergency Medicine "N.I.Pirogov", Sofia, Bulgaria	jrsaeva2@yahoo.co.uk
Jan		Rulisek	Department of Anesthesia and Intensive Care, 1st Faculty of Medicine, Charles University and General University Hospital, U Nemocnice 2, 120 00 Prague 2, Czech Republic	jan.rulisek@vfn.cz
Perla		Sader	Department of Medical and Toxicological Critical Care, Lariboisière Hospital, INSERM UMRS-1144, Université Paris Cité, Paris, France	perlasader@gmail.com
Caroline		Samer	Division of Clinical Pharmacology and Toxicology, Department of Anesthesiology, Clinical Pharmacology, Intensive Care and Emergency Medicine, Geneva University Hospitals, Rue Gabrielle-Perret-Gentil 4, Switzerland	caroline.samer@hug.ch
Yasmin		Schmid	Clinical Pharmacology and Toxicology, University Hospital and University of Basel, Basel, Switzerland	yasmin.schmid@usb.ch
Irene		Scholz	Clinical Pharmacology and Toxicology, Department of General Internal Medicine, Inselspital, Bern University Hospital, University of Bern, Bern, Switzerland	irene.scholz@swissmedic.ch

(Continues)

First name	Middle name	Last/family name	Affiliation	Email
Roberts		Stašinskis	Riga East Clinical University Hospital, Riga	roberts.stasinskis@inbox.lv
Jonas		Surkus	Lithuanian University of Health Sciences, Kaunas, Lithuania	jonas.surkus@kaunoklinikos.lt
Irma		van den Hengel-Koot	Dutch Poisons Information Center, University Medical Center, Utrecht University, Utrecht, The Netherlands	i.s.koot@umcutrecht.nl
Federico		Vigorita	Fondazione IRCCS San Gerardo dei Tintori, Monza, Italy	federico.vigorita@gmail.com
Severin		Vogt	Clinical Pharmacology and Toxicology, University Hospital and University of Basel, Basel, Switzerland	severinbenjamin.vogt@usb.ch
Wojciech		Waldman	1. Pomeranian Centre of Toxicology, Gdansk, Poland 2. Medical University Gdansk, Department of Clinical Toxicology, Gdansk, Poland	w.waldman@pctox.pl
William	Stephen	Waring	Acute Medical Unit, York Teaching Hospitals NHS Foundation Trust York, UK	stephen.waring2@nhs.net
Ioanna		Yiasemi	Monitoring Department, Cyprus National Addictions Authority, Nicosia, Cyprus	ioanna.yiasemi@naac.org.cy
Sergej		Zacharov	Toxicological Information Centre, Department of Occupational Medicine, 1st Faculty of Medicine, Charles University and General University Hospital, Na Bojisti 1, 120 00 Prague 2, Czech Republic	sergej.zacharov@vfn.cz
Tobias		Zellner	Department of Clinical Toxicology, TUM School of Medicine and Health, Technical University of Munich, Germany	tobias.zellner@tum.de

How to cite this article: Miró Ò, Galicia M, Dargan PI, Wood DM, Dines AM, Heyerdahl F, et al. Changes in clinical features and severity in patients presenting to European emergency departments with acute cannabis toxicity over the 10-year period from 2013 to 2022. Addiction. 2026;121(2): 316–30. https://doi.org/10.1111/add.70233