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Original Article

Evaluation of forensic toxicological characteristics of cases under the age of eighteen with substance use: a sample from Türkiye

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ABSTRACT

Background. Substance use is rapidly increasing in the pediatric age group worldwide. There is not enough toxicological data on substance use among children and adolescents in Türkiye. This study aims to reveal the forensic toxicological characteristics of cases under the age of eighteen with substance use detected.

Methods. In our study, forensic toxicological reports of biological samples taken from 587 cases brought to our institution by law enforcement officers due to allegations and/or suspicions of substance abuse between January 1, 2022, and June 30, 2024 were retrospectively examined. The cases were reviewed in terms of variables such as gender, age, age group, substance type (if any), and presence of multiple substance use.

Results. Out of the cases, 89.1% (n=523) of the cases were male and 10.9% (n=64) were female. The majority of cases (93.2%) were observed in the 15–17 age group, accounting for 547 individuals. Of the cases, 29.0% (n = 170) were identified as multiple substance users. Amphetamine-type stimulants (ATS) were present in 68.7% (n = 403) and cannabis was found in 48.2% (n = 283) of cases. It was observed that only cannabis use was significantly higher among males and only ATS use was higher among females (Cramer's V = 0.202, $p < 0.001$). The association between gender and substance type was statistically significant; however, the strength of the association was small to moderate.

Conclusion. This study assessed substance use profiles in adolescent populations through substance testing. ATS were the most frequently detected substances. The analysis revealed a significant increase in the proportion of female cases over time. While cannabis use was more prevalent among males, ATS use was more common among females. Collecting objective, valid, and definitive data will facilitate the identification of substance use issues and support the development of effective preventive policies.

Key words: amphetamine-type stimulants, adolescent, cannabis, forensic toxicology, substance use, forensic toxicological analysis.

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Substance use is a serious social issue that threatens the safety and well-being of children and adolescents, who are integral members of families, the smallest fundamental unit of society.[1] Adolescence is a period in which harmful actions and behaviors, such as suicide attempts, smoking, alcohol, and substance use, may emerge.[2] The prevalence of substance use is rapidly increasing among pediatric and adolescent age groups in Türkiye and across the world.[3,4] Epidemiological studies on community samples report that the lifetime prevalence of substance use among adolescents in Türkiye ranges from 3% to 10%. Additionally, evidence indicates that substance use is significantly more prevalent among males.[5] Substance use most commonly begins between the ages of 15 and 17; however, in some cases, it may emerge as early as age 10.[6] Factors such as low socioeconomic status, poor academic performance, thrill-seeking behavior, negative peer influence, dysfunctional family relationships, curiosity, and psychiatric disorders contribute to early substance use.[7]

Early initiation of substance abuse negatively impacts the physical and mental development of children, leading to physical, behavioral, social, and health-related problems.[8] The physical health risks associated with substance use among young individuals include accidental injuries—such as motor vehicle accidents and falls—as well as suicide attempts. Regular substance use, particularly during childhood, can severely disrupt growth and neurological development. Fundamentally, it impairs key cognitive functions, including memory, attention, and executive functioning.[1,9] Substance use in adolescents is often accompanied by psychiatric comorbidities, such as personality disorders, anxiety, and depression. The presence of these conditions is associated with a more severe clinical course and a poorer overall prognosis.[10] The necessity for individuals to engage in criminal acts and illicit behaviors to acquire substances contributes to an escalating societal threat, posing significant implications for public safety and social stability.[11] A significant concern is the heightened risk of addiction among individuals who begin using tobacco, alcohol, or illicit substances before the age of 18. Related studies indicate that a considerable proportion of adults diagnosed with substance use disorders first engaged in substance use during childhood or adolescence.[12]

A nationwide study titled "The Survey on Attitudes and Behaviors Regarding Tobacco, Alcohol, and Substance Use in the General Population in Türkiye", conducted by the Turkish Monitoring Centre for Drugs and Drug Addiction (TUBİM) in 2018 across 26 provinces, examined substance use trends in the general population. The results indicated that 3.1% of participants had used substances at least once in their lifetime. The highest proportion of lifetime substance users was in the 15–24 age group (35.4%), and the mean age of first substance use was reported as 19 years.[13] Findings from another study indicate that individuals diagnosed with substance use disorder in Türkiye accounted for 1.31% of the total population in 2005. This figure has followed a consistent upward trajectory, reaching 1.54% in 2017. Similarly, substance-related deaths have shown an increasing trend over the years.[14]

Substance use in adolescents is a critical public health priority that evolves rapidly and requires frequent monitoring, as it is a preventable contributor to both morbidity and mortality.[15,16] In Türkiye, data regarding the frequency and toxicological findings of substance use among children and adolescents remain insufficient.[4] A study by Doksat et al.[15] examined trends in substance and alcohol use, as well as gender differences, among children and adolescents receiving treatment at an addiction center. The findings revealed a substantial increase in the proportion of adolescents seeking treatment for substance use, rising from 31.4% in 2011 to 68.6% in 2014. Furthermore, the study highlighted a progressive rise in both adolescent admissions and the prevalence of polysubstance use. Notably, the use of alcohol, amphetamine-type stimulants (ATS) , and synthetic cannabinoids showed a significant upward trend.[15] Moreover,

several studies have investigated substance use trends among adolescents who present to emergency departments and other clinical settings for follow-up, treatment, or legal proceedings.[2,4] A biochemistry laboratory-based study examined the prevalence of substance use in the general population by analyzing substance data from forensic and treatment-related admissions.[17] Epidemiological surveys are regularly conducted in Türkiye to assess the prevalence and patterns of substance use among adolescents.[18,19] Although data derived from participant-reported surveys provide valuable insights, they are relatively subjective and inadequate for assessing the prevalence of substance use. Toxicological analysis of biological samples such as urine and blood offers an objective method to obtain substance-related data.[4,20] Forensic toxicological substance testing begins with the supervised collection of biological specimens by trained personnel. The process involves multiple analytical stages, including screening, detection, identification, quantification, and confirmation. It concludes with the comprehensive interpretation and documentation of all findings in an official report. Furthermore, substance analyses serve as legally significant forensic evidence.[21]

This study aims to identify substance use data among the pediatric population referred by the prosecutor's office or courts in Gaziantep, a province located in southeastern Türkiye, and thus to contribute to the development of primary preventive measures in collaboration with relevant institutions, helping children lead healthier lives in the future.

Materials and Methods

City characteristics

Gaziantep, the ninth largest city in Türkiye, holds strategic importance due to its proximity to the Middle East, its well-developed industrial base, and its accessibility to major commercial ports. The city functions as a significant transit route for various substances and is one of the two metropolitan provinces in Türkiye located along the Syrian border. The institution where the current study was conducted is recognized as the leading and most specialized center for forensic toxicological analysis in Gaziantep. Furthermore, Gaziantep was among the provinces impacted by the 2023 earthquake in Türkiye.

Sampling, setting, and procedure of the study

A total of 722 pediatric cases were referred by law enforcement for alleged or suspected substance abuse and were subjected to forensic investigation between January 1, 2022, and June 30, 2024, in Gaziantep and its surrounding regions. During the study period, a total of 36,000 toxicological analyses were performed on different antemortem or postmortem biological samples, of which 2.0% were of antemortem pediatric age group cases.

Initially, forensic toxicological reports indicating substance detection in blood and/or urine samples collected from pediatric cases were evaluated. Among the 722 cases, no substance presence was detected in the samples of 135 cases (18.7%), with their toxicological analysis results being negative; therefore, these cases were excluded from the study. The study sample consisted of 587 pediatric cases with at least one type of substance detected in their biological samples.

Characteristics of the cases

The cases were analyzed in terms of gender, age, age group, year of admission, type of substance used, and the presence of multiple substance use. The Turkish Penal Code (TPC) classifies the age of children and adolescents in terms of criminal responsibility. According to the 31st article of the TPC, children under the age of 12 cannot be held criminally responsible for their actions. For children who are at least 12 years old but less than 15 years old at the time of committing the offence, it is necessary to determine whether they have the capacity to understand the legal meaning and consequences of the offence

and whether they have the capacity to control their behaviour. The TPC recognises that the ability to understand the legal meaning and consequences of the offence and the ability to control behaviour increases in children over the age of 15. Therefore, in this study, we have grouped the age variable as <12, 12-14 and 15-17.[22] The types of substances used were categorized as cannabis, synthetic cannabinoids, opioids (heroin, morphine, codeine), psychiatric medications (benzodiazepines, antipsychotics), gabapentinoids, and ATS (amphetamine, methamphetamine, 3,4-methylenedioxymethamphetamine). The use of two or more types of substances was classified as multiple substance use.

On 6 February 2023, Türkiye and Syria were shaken by two earthquakes with magnitudes of 7.8, centered in Pazarcık, and 7.6, centered in Elbistan, in Kahramanmaraş province, causing significant losses. On 20 February 2023, a third earthquake with a magnitude of 6.4, centered in Samandağ, Hatay province, occurred. These earthquakes affected 11 provinces and caused extensive damage; more than 48,000 people lost their lives, and 14 million people were adversely affected by the disaster.[23] It should be noted that, in the aftermath of the major earthquakes, the number of applications significantly declined, with almost none recorded during the subsequent three-month period.

Analytical procedure

In this study, liquid chromatography-mass spectrometry-mass spectrometry (LC-MS/MS) was used for toxicological validation analysis of each biological sample. Each urine sample underwent an integrity test, which included assessments of urine osmolality, urinary creatinine, pH, and the presence of foreign substances in urine. Solid-phase extraction (SPE), a technique designed for rapid and selective sample preparation and purification, was employed prior to chromatographic analysis. In SPE, one or more analytes are isolated from a liquid sample by partitioning and/or adsorption to a solid stationary phase. The SPE method was used by laboratory personnel for all blood and urine samples at the center. Samples were analyzed qualitatively and quantitatively using LC–MS/MS. ATS, psychiatric drugs, gabapentinoids, cannabis (THC-COOH), synthetic cannabinoids, opiates (morphine, codeine, and 6-monoacetylmorphine [6-MAM]), and their metabolites in blood and/or urine samples were analyzed.

Ethical statement

All procedures used in this research complied with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, and its subsequent updates. The privacy rights of human subjects were respected during the implementation of the study by the authors. The study sample consisted of cases referred by the judicial authorities. Written permission for data use was granted by decision number 2024/1388 of the Forensic Medicine Institute Education and Scientific Research Commission, dated December 3, 2024. Ethical approval was obtained from the local ethics committee on December 17, 2024 (approval number 2024/10-29).

Statistical analyses

The categorical variables in the study were given as a frequency and percentage. Descriptive statistics were given as median (minimum–maximum). The categorical variables were grouped, the percentages calculated and then either Pearson's chi square test or Fisher's test as appropriate was used to compare frequencies. Post hoc analysis methods for chi-square test and Bonferroni correction were applied in the evaluation of significance between groups in multiple groups. We calculated Cramer's V for categorical comparisons as measures of effect size. Strength of association was reported using Cramer's V. Cohen[24] suggested the following guidelines for interpreting Cramer's V; if df=1; Small >0.1, Medium (Moderate) >0.3, and Large >0.5. The Kolmogorov–Smirnov test was used

for normality in continuous variables ($p > 0.05$). Kurtosis–skewness values were also evaluated.

All statistical analyses, tables and graphs were made using the SPSS 22 (IBM Corp., Armonk, NY) program. Cases with a p-value of < 0.05 were considered significant. Because of the low number of cases in some subgroups in the study, some categorical data groups were combined or were not included in the relevant analyses.

Results

A total of 89.1% (n=523) of the cases were male, while 10.9% (n=64) were female (Table I). The mean age of all cases was 16.4 ± 1.0 years. The median age was 17.0 (12–17) years for male cases and 16.0 (12–17) years for female cases. Among the cases, 93.2% (n = 547) were in the 15–17 age group, and 6.8% (n = 40) were in the 12–14 age group. Gender distribution within age groups was similar (Fisher's test, $p = 0.791$).

When examined by year of admission, the highest number of cases was recorded in 2022, with 246 cases. Gender-based analysis of annual admissions showed an increase in the proportion of female cases, from 6.9% to 15.2%, over time (Cramer's V = 0.112, $\chi^2 = 7.363$, df = 2, $p = 0.025$). Although statistically significant, the strength of the association was weak. Post-hoc comparisons using Bonferroni correction ($p = 0.02$) (adjusted significance p value = 0.025) revealed that the proportion of female admissions in 2022 was significantly lower than in other years (Table I).

Of the cases, 71.0% (n = 417) were found to have used a single type of substance, while 29.0% (n = 170) were identified as multiple substance users (Table II). The substances used were analysed, and the results revealed that ATS were present in 68.7% (n = 403) and cannabis was found in 48.2% (n = 283) of cases. Subsequent findings revealed the detection of synthetic cannabinoids in 29 cases, gabapentinoids in 23 cases, and psychiatric medications in another 23 cases (Table II). It was observed that 42.2% (n = 248) used only ATS, while 26.4% (n = 155) used only cannabis. When the chi-square test was performed, the distributions of multiple substance use by gender and age groups were similar (Cramer's V = 0.063, $\chi^2 = 2.331$, df = 1, $p = 0.127$; Cramer's V = 0.055, $\chi^2 = 1.793$, df = 1, $p = 0.181$). Among multiple substance users (n = 170), the most prevalent combination was that of cannabis and ATS, which was detected in 42.9% (n = 73) of cases. Due to the low number of cases using only gabapentinoids, synthetic cannabinoids, opioids, or psychiatric medications (n = 14 in total), these were excluded from substance use-based statistical analyses to ensure the validity of comparisons. When the post hoc Bonferroni test is applied, male cases predominantly used only cannabis ($p < 0.001$) (adjusted significance p value = 0.025), whereas female cases used only ATS ($p = 0.01$) (adjusted significance p value = 0.025) among the remaining cases (Cramer's V = 0.202, $\chi^2 = 23.407$, df = 2, $p < 0.001$; Table III). While the chi-square test indicated a statistically significant relationship between gender and substance type, the effect size pointed to a small to moderate level of association.

Analysis by age groups showed that ATS use was more prevalent in the 12–14 age group, while cannabis use was higher in the 15–17 age group (Cramer's V = 0.108, $\chi^2 = 6.642$, df

Table I. Distribution of the cases according to years and gender.

Years	Male	Female	Total
2022	229 (93.1%)	17 (6.9%)	246 (41.9%)
2023	182 (87.1%)	27 (12.9%)	209 (35.6%)
2024	112 (84.8%)	20 (15.2%)	132 (22.5%)
Total [α]	523 (89.1%)	64 (10.9%)	587 (100.0%)

Percentages were calculated as row percentages, except for the last column.

Table II. Distributions of the type of substance used

Substance	n	%*
ATS	403	68.7
Cannabis	283	48.2
Synthetic cannabinoids	29	4.9
Gabapentinoids	23	3.9
Psychiatric medications	23	3.9
Opioids	12	2.0
Cocaine	3	0.5
Multiple substance use		
Present	170	29.0
Absent	417	71.0
Total	587	100.0

* Some cases have used more than one type of substance; ATS, amphetamine-type stimulants.

= 2, p = 0.036; Table III). Although statistically significant, the strength of the association was weak.

Discussion

A study evaluating the prevalence of substance use in Türkiye based on regional illegal substance analysis results indicates the lack of nationwide studies based on laboratory analysis, and that there is a need for epidemiological studies conducted at the regional level.[17] The important advantage of this study is that it unveils the forensic toxicological data of cases involving individuals under the age of eighteen who use substances in the Gaziantep province, located in the southeastern region of Türkiye.

In studies examining children and adolescents receiving substance use disorder treatment in İstanbul, the most metropolitan city in the west of Türkiye, the proportion of male cases was observed to be 82.4% and 83.3%, respectively.[15,25] In our study, which examined pediatric forensic cases who underwent toxicological analysis due to suspected/alleged substance abuse in Gaziantep, a city in southeastern Türkiye, the male ratio was 89.1%, higher than the aforementioned studies. Becker et al.[26] stated that not only biological and hormonal factors determine substance use behavior, but also sociocultural influences affect the gender distribution in substance use. It is believed that regional sociocultural differences in Türkiye contribute to variations in gender ratios. Unlike studies conducted in Türkiye, a review evaluating adolescent substance use patterns globally, covering 70 studies, found the average male proportion to be 47%.[8] In the Turkish society, women are perceived as guardians of moral values and pillars of the family. The belief that women's substance use would degrade moral values is widespread in Turkish culture.[27] The stigmatisation of women, the paucity of social support, the challenges in accessing treatment, and the subsequent social isolation may explain the lower prevalence of substance use among women in Türkiye.

Our study highlights a notable increase in the proportion of female cases in recent years. Consistent with our results, the literature reports a growing trend in substance use among women over time.[28,29] It is believed that factors

Table III. Distribution of the type of substance used by gender and age groups.

Variables	Only ATS	Only cannabis	Multiple substance abuse	Total
Gender				
Male	210 (41.2%)	154 (30.2%)	146 (28.6%)	510 (89.1%)
Female	38 (60.3%)	1 (1.6%)	24 (38.1%)	63 (10.9%)
Age groups				
12-14 yr	24 (63.2% row, 9.7% col)	6 (15.8% row, 3.9% col)	8 (21.0% row, 4.7% col)	38 (6.6%)
15-17 yr	224 (41.9% row, 90.3% col)	149 (27.9% row, 96.1% col)	162 (30.3% row, 95.3% col)	535 (93.4%)
Total	248 (43.3%)	155 (27.1%)	170 (29.7%)	573 (100.0%)

ATS: amphetamine-type stimulants, col: column.

contributing to the increasing prevalence of substance use among girls in Türkiye include the transformation of traditional family structures, the increased accessibility of substances, the portrayal of substance use as glamorous in social media and popular culture, and the widespread engagement of young people with these platforms. Additionally, the tendency of girls to engage in risky behaviors as a means of achieving equality with and gaining acceptance from their male peers is also considered a contributing factor. Exposure to sexual abuse in childhood has been found to be associated with frequency of substance use, polysubstance use and quantity of substances consumed among girls.[30] Girls who use substances have higher rates of childhood traumatic experiences, post-traumatic stress disorder, and other psychiatric comorbidities.[31] There is a critical need for large-scale studies in Türkiye that comprehensively examine factors associated with substance use among girls, including reasons for use, age of first use, parental education and economic status, criminal history in the child or family, co-occurring psychiatric disorders, and suicide attempts.

The mean age of the cases in this study was 16.4 years, aligning with studies on adolescent substance use data from İzmir and İstanbul.[4,15] In another study investigating substance use characteristics among adolescents presenting to the emergency department in İzmir, the mean age of cases was 15.3 years, younger than in our study.[2] It has been reported that adults' substance use habits and progression to addiction often begin during adolescence. The 10–20 age range plays a decisive role in individuals adopting high-risk and health-threatening behaviors.[32,33] The similarity in age data between both genders may be attributed to the widespread accessibility of substances in society. To reduce and prevent substance use among young individuals, it is recommended to increase awareness and provide education on substance use for youth, teachers, and parents. Additionally, strengthening security measures in school environments and areas with high youth presence, enhancing psychosocial support services, and implementing cybersecurity measures to prevent the dissemination of harmful content on social media are also suggested.

The 2023 World Drug Report by the United Nations Office on Drugs and Crime stated that, in 2021, globally, one in 17 people aged 15–64 used substances at least once in the past year. The estimated number of users reached 296 million (5.8% of the global population aged 15–64), with cannabis remaining the most commonly used substance. Globally, the majority of cannabis users are male (approximately 70%), while the proportion of women is relatively higher for ATS (45% women) and the non-medical use of medications (45%–49% women).[34] In a study by Aslan et al.[4] conducted in İzmir, Türkiye, cannabis was found to be the most commonly used substance among children and adolescents, followed by multiple substance use and ATS. Cannabis was more frequently used among males. Other studies conducted in Izmir and Kayseri, Türkiye, reported ATS as the most frequently used substance.[2,17] In studies based on toxicological screening results among adolescents presenting to emergency departments in the United States and Canada, cannabis and ATS were identified as the most frequently used substances.[35,36] It has been reported that methamphetamine use has become increasingly preferred and used in adolescents due to the fact that the substance is both affordable and easily accessible.[37] In our study, the most frequently observed substance use was ATS alone, followed by multiple substance use and cannabis alone. The commonality across all studies is that ATS and cannabis are the most frequently preferred substances among children and adolescents. According to the 2024 Türkiye Drug Report[38], the sharp increase in methamphetamine seizures, which began in 2019, continued through 2020, 2021, and 2022, culminating in the highest recorded methamphetamine seizure in the country's history in 2023. In addition to the overall rise in the total amount

of methamphetamine seized, the quantity per incident also reached its peak. Similarly, the number of methamphetamine-related incidents and suspects increased. The report further highlights that while methamphetamine was detected in 7.7% of overdose deaths in 2017, this figure surged to 46.3% in 2023. Moreover, deaths caused solely by methamphetamine use rose from 0.3% in 2017 to 42.6% in 2023, underscoring the growing significance of methamphetamine use as a major public health concern.[38] In our study, the higher prevalence of cannabis use among males and ATS use among females aligns with the literature.[34] It is believed that the ease and rapid onset of oral ATS use contribute to its higher preference among females. Women tend to have more negative attitudes toward cannabis use compared to men. A survey conducted in Norway found a gender difference among participants who did not report cannabis use. While 40.9% of men perceived cannabis as risk-free or low-risk, only 16.4% of women shared this perception.[39] It was suggested that male participants in this study were more likely to view cannabis as a safe and low-risk substance.

In a study examining substance use among children and adolescents, polysubstance use was identified in 14.9% of cases, with the most common combination being ATS and cannabis (36.0%).[4] In our study, the rate of polysubstance use was higher at 29.0%, and similarly, the most frequently observed combination was cannabis and ATS (42.4%). The fact that our sample consisted exclusively of criminal cases may be related to the higher polysubstance use rate observed. The prevalence of ATS and cannabis as the most commonly used substances also leads to their frequent co-use in polysubstance combinations.

In a study on the use of cannabis among adolescents in the United States, it was reported that 12–17-year-olds used cannabis at rates of 16%, 13%, and 7% over their lifetime, the past year, and the past month, respectively.[40] Among older adolescents aged 16 and 17, 31% reported lifetime use, 25% reported use in the past year, and 14% reported use in the past month, with the highest rates of use observed in these age groups.[40] Similarly, in our study, cannabis use alone was found to be higher among the older adolescent group aged 15–17. It is thought that as a result of repeated substance use, the likelihood of individuals becoming addicted increases. Moreover, they turn to classic substance types that are easier to access.

Our study has some limitations. First, data on variables such as the age of onset of substance use and the reasons for substance use were not available. Another limitation is the lack of data on alcohol use among the cases. However, we would like to highlight the strengths and unique aspects of our study. This is the first study in Türkiye to analyze forensic toxicological data of individuals under the age of eighteen who were referred for forensic reasons. Another significant advantage is the large sample size of the study.

Conclusion

Substance use is a significant social issue. It is known that substance use among individuals under the age of eighteen is rapidly increasing worldwide and in Türkiye.

In the present study, the majority of cases were male and aged between 15 and 17 years, and ATS was the most commonly used substance. The prevalence of polysubstance use among adolescents, affecting approximately one in three individuals, highlights the ongoing importance of addressing substance use as a major issue in this population. Cannabis use was found to be more prevalent among males, while the use of ATS was more prevalent among females. The increase in substance use rates among girls over time was notable.

In conclusion, obtaining definitive data from biological samples of substance users will aid in identifying substance use-related challenges and serve as a foundation for developing effective preventive measures.

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Ethical approval

The study was approved by Non-Interventional Clinical Research Ethics Committee of Adıyaman University (date: 17.12.2024, number: 2024/10-29).

Author contribution

The authors confirm contribution to the paper as follows: Study conception and design: All authors; data collection: All authors; analysis and interpretation of results: KS, MK, MD; draft manuscript preparation: KS, Statistics: KS; Supervisor: KS, MK, MD. All authors reviewed the results and approved the final version of the article.

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Conflict of interest

The authors declare that there is no conflict of interest.

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