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The Role of Addictive Substance Use in Adolescent Deaths Between 12-18 Years of Age

12-18 Yaş Arası Ergen Ölümünde Bağımlılık Yapıcı Madde Kullanımının Yeri

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Öz

Amaç: Her geçen gün artmakta olan bağımlılık yapıcı madde kullanımı ergenler arasında ciddi sağlık sorunlarına hatta ölümlere neden olmaktadır. Bir halk sağlığı problemi olan madde kullanımının küçük yaştaki çocuklar arasında sık olarak görülmeye başlaması bu durumun çocuk ölümleri arasında üst sıralara gelmesine neden olmuştur. Bağımlılık yapıcı madde kullanım yaygınlığı hakkında daha kapsamlı bilgiler edinmek, koruyucu çalışmalar için gerekli ve önemli bir adımdır.

Yöntem: Bu çalışma kapsamında Adli Tıp Kurumu Ankara Grup Başkanlığında retrospektif olarak 5 yıllık dosyalar taranmış olup, 12-18 yaş aralığında otopsi yapılan 258 vakanın otopsi raporları, adli tahkikat dosyaları ve toksikolojik analiz sonuçları incelendi. Çocukların yaşları, cinsiyetleri, ölüm nedenleri, ölüm orijini, kan alkol ve bağımlılık yapıcı madde düzeyleri Excel programı üzerine kaydedildi ve Jamovi programı kullanılarak istatistiksel olarak analiz edildi.

Bulgular ve Sonuç: Çalışmamızda 12-18 yaş grubu ölümlerinin kanında en sık saptanan bağımlılık yapıcı madde %10,5 oranla alkol olduğu belirlenmiştir. 12-18 yaş arası ölümlerde kanda uyuşturucu-uyarıcı madde oranı ise %5 olarak tespit edilmiştir. Ergenlik döneminde ölümle sonuçlanan olaylarda en sık rastlanan alkol dışı bağımlılık yapıcı maddenin uçuşu maddeler olduğu tespit edilmiş olup özellikle gelişmekte olan ülkelerde uçuşu maddelerin satışının denetlenmesi ve riskli grupların psikiyatrik açıdan desteklenmesi gerekmektedir.

Anahtar Kelimeler: Uçuşu maddeler, Madde kullanım bozukluğu, Ergen ölümleri

Abstract

Aim: The increasing use of addictive substances day by day is causing serious health problems and even deaths among adolescents. Obtaining more comprehensive information about the prevalence of addictive substance use is a necessary and important step for preventive studies.

Methods: Within the scope of this study, 5 years of files were scanned retrospectively at the Ankara Headquarter, Council of Forensic Medicine, and then the autopsy reports, forensic investigation files, and toxicological analysis results of 258 cases whose autopsies were performed between the ages of 12–18 were examined. The children's ages, genders, causes of death, origin of death, blood alcohol, and addictive substance levels were recorded on the Excel program and statistically analyzed using the Jamovi program.

Results: In our study, it was determined that the most commonly detected addictive substance in the blood of deaths in the 12-18 age group was alcohol, with a rate of 10.5%. In deaths between the ages of 12-18, the rate of narcotic-stimulant substances in the blood was determined to be 5%. It has been determined that the most common non-alcohol addictive substances in fatal incidents during adolescence are volatile substances.

Conclusion: The findings of this study indicate that alcohol consumption and the use of sedative and stimulant substances play a significant role in deaths among the adolescent age group. The development of effective strategies aimed at preventing alcohol and substance use within this demographic—particularly by policymakers, public health professionals, and mental health experts—has the potential to reduce mortality rates

Keywords: Volatile substances, Substance use disorder, Adolescent deaths

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INTRODUCTION

The use of addictive substances is increasing day by day and constitutes one of the greatest dangers on a global world. The rates of addictive substance use in our country are lower compared to Western countries, but they have increased significantly in recent years, and the age of onset of substance use has gradually decreased (1,2). Addictive substances, especially the increasing use among adolescents, cause serious health problems and even deaths.

Due to reasons such as the use of technological developments in the production and purchase of addictive substances, the increase in the international presentation market, and the decrease in production costs, stimulants and narcotics with different active ingredients have been introduced to the market. These substances of different types lead to a wide variety of clinical findings or physical and mental conditions (3). Research shows that addictive substance use in adulthood, which is closely associated with high morbidity/mortality, begins in adolescence (4). The increasing prevalence of addictive substance use among young children, which is a public health issue, has led to it becoming one of the leading causes of child mortality. Obtaining more comprehensive information about the prevalence of addictive substance use is a necessary and important step for preventive studies (5).

This study aims to determine the causes of death, origins of death, types of substances, and the frequency of direct substance-related deaths in cases in which alcohol, stimulants, and narcotics were detected in the blood between the ages of 12 and 18, and to contribute to the determination of precautions to be taken in this age group by examining the contribution of substances to death.

METHODS

Within the scope of this study, autopsy reports, crime

scene investigation reports, and toxicological analysis results of cases aged between 12 and 18, whose autopsies were performed at the Ankara Headquarter, Council of Forensic Medicine, were retrospectively examined over a 5-year period. After excluding cases showing stage 2 and above decomposition findings from a total of 262 cases, 258 cases were included in the study. The children's ages, genders, causes of death, origin of death, and levels of blood, alcohol, and non-alcohol addictive substances were recorded in the Excel program and statistically analyzed using the Jamovi software. In the study, descriptive data were presented as number (n) and percentage (%) values in categorical data, and as mean value $\pm$ standard deviation (Mean $\pm$ SD) values in continuous data. The conformity of continuous variables to normal distribution was evaluated using the Kolmogorov-Smirnov test.

Approval for the study was obtained from the Scientific Research Committee of the Council of Forensic Medicine, with the official letter dated 02/07/2024 and numbered 21589509/2024/689.

RESULTS

Among the cases included in the study, 34.5% (n=89) were female and 65.5% (n=169) were male.

The mean age of the cases was 15.9, with a minimum of 12 and a maximum of 18 years (Table 1).

Table 1. Mean age of cases

	Age
n	258
Median	15.9
Standard deviation	1.76
Minimum	12
Maximum	19

In a total of 258 cases, the origins of death were classified as suicide in 36.4%, accident in 27.1%, homicide in 13.2%,

natural causes in 7.8%, and intoxication in 5.8%. In 9.7% of the cases, the cause of death could not be determined (Table 2).

Table 2. Distribution of Case Manner of Death and Causes of

Death					
Manner of death	n	%	Cause of death	n	%
Suicide	94	36.4	Fall from a height	32	34.0
			Firearm	22	23.4
			Hanging	32	34.0
			Intoxication	5	5.3
			Other	3	3.2
Accident	70	27.1	Fall from a height	6	8.6
			Electrical injury	3	4.3
			Drowning	11	15.7
			Traffic accident	33	47.1
			Other (can be included under asphyxia)	8	11.4
			Burn	6	8.6
			Asphyxia	3	4.3
Homicide	34	13.2	Penetrating Sharp Injury (PSI)	18	52.9
			Firearm	13	38.2
			Strangulation	1	2.9
			Explosion	1	2.9
			Fall from a height	1	2.9
Natural causes	20	7.8	Central Nervous System	9	45.0
			Respiratory System	5	25.0
			Cardiac diseases	5	25.0
			Other	1	5.0
Intoxication	15	5.8			
Undetermined	25	9.7			

26.6 % of cases where the manner of death was recorded as suicide where aged 16. The population distribution by age was as follows: 23.4% were 17 years old, 22.3% were 18 years old, 7.4% were 14 years old, 3.2% were 12 years old, and 1.1% were 13 years old. Among the cases in which the cause of death was determined to be suicide, 51% were male and 43% were female. Alcohol was detected in the blood and intraocular fluid samples of 10.6% (n=10) of

the cases with suicide as the determined cause of death. Ethanol levels detected in the cases varied between 14 mg/dL (minimum) and 241 mg/dL (maximum). Alcohol was detected in blood and intraocular fluid samples of a total of 27 cases, of which 81.5% (n=22) were male and 18.5% (n=5) were female. Among the cases in which alcohol was detected in blood samples, 37% were classified as suicide, 29.8% as accidental death, 18.5% as homicide, and 11.1% as intoxication. In 3.7% of the cases, the cause of death could not be determined (Table 3). It was determined that the youngest individual whose blood samples contained alcohol was 14 years old, while the oldest was 18 years old. The mean blood alcohol concentration was 65.3 mg/dL (Table 4).

When the previous psychiatric diagnoses of the cases in which alcohol was detected in blood and intraocular fluid samples were reviewed, it was found that only one case had a diagnosis of substance use disorder (Table 3).

Table 3. Origin of death, gender, and presence of accompanying psychiatric diagnosis in cases where alcohol was detected in blood and intraocular fluid

	n	% of total
Manner of death	Suicide	10 37.0
	Accident	8 29.8
	Homicide	5 18.5
	Intoxication	3 11.1
	Undetermined	1 3.7
	No	26 96.3
Comorbid Psychiatric Diagnosis	Yes (Substance use disorder)	1 3.7
	Female	5 18.5
Gender	Male	22 81.5

Table 4. Cost distribution according to site of injury

	Age	Blood alcohol levels
n	27	27
Mean	17.0	65.3
Median	18.0	44.0
Standard deviation	1.30	56.2

Minimum	14.0	13.0
Maximum	18.0	241

In 6.9% (n=18) of the total 258 cases, non-alcohol addictive substances were detected in blood and tissue samples (Table 5).

Table 5. Stimulant-Narcotic Substance in Blood Samples

Substance	Counts	% of total
Negative	240	93
Positive	18	6.9

All cases in which non-alcohol addictive substances were detected in blood and tissue samples were found to be male. (Table 5)

The cause of death in 61.1% of these cases was determined as intoxication, 16.7% as traffic accidents, 16.7% as hanging, and 5.6% as (Table 6).

Table 6. Causes of Death in Cases Where Substances Were Detected in Blood Samples

Cause of death	n	%
Traffic accident	3	16.7
Intoxication	11	61.1
Hanging	3	16.7
PSI	1	5.6

In 77.8% of the cases where non-alcohol addictive substances were detected in blood and tissue samples, the location of death was found to be a public area (park, garden, field, etc.).

Based on the analysis of anamnesis information obtained from the relatives of the cases, no pre-mortem disease diagnosis was identified in 72.2% of the cases in which non-alcohol addictive substances were detected in blood and tissue samples (Table 7).

Table 7. Presence of Pre-Mortem Comorbid Diagnoses

Comorbid Disease	% of total	n
Without any comorbid diagnosis	72.2	13
Psychiatric Diagnosis		
Substance addiction	11.1	2
Other	5.6	1
Other (cardiovascular system diseases, neurological system diseases, etc.)	11.2	2

In the examination of blood and tissue samples of the cases, volatile substances were detected in 66.7%, amphetamine and its metabolites in 33.3%, heroin and its metabolite in 5.6%, alcohol in 11.1%, pregabalin in 11.1%, and synthetic cannabinoids in 5.6% (Table 8).

Table 8. Addictive Substances Detected in Blood Samples in Deaths of 12-18 Year-Olds

	Volatile Substances	Amphetamine and metabolites	Heroin	Blood alcohol	Pregabalin	Synthetic cannabinoid
Total n	18	18	18	18	18	18
Positive	%66.7 n=12	%33.3 n=6	%5.6 n=1	%11.1 n=2	%11.1 n=2	%5.6 n=1
Negative	%33.3 n=6	%66.7 n=12	%94.4 n=17	%88.9 n=16	%88.9 n=16	%94.4 n=17

In 26.3% of the cases where non-alcohol addictive substances were detected in blood and tissue samples, multiple addictive substances were identified.

DISCUSSION

According to the data of the Turkish Statistical Institute, 2,648 deaths occurred in the 10–19 age group in Türkiye in 2022. The majority of child deaths occurred due to external injuries and poisonings (6). Tatar et al. reported that 75.4% of adolescent death cases were male (7). There are many studies that link the high prevalence of male gender in adolescent deaths to the increase in risky behaviors among boys in this age group (8). We believe that the male gender predominance (65.5%) in the group included in our study is due to the increase in risky behaviors among men during this period, in line with literature data.

In addition, studies have shown that most deaths in this age group are preventable, with accidents being the leading cause of death, followed by forced deaths (7,9,10). In another study, the origins of adolescent deaths were reported as accident, suicide and murder, respectively (7). A study conducted in Canada reported that the most common cause of death among 15-19 year olds was traffic

accidents; traffic accidents were followed by suicide and homicide, and in 9% of the cases, the cause of death could not be determined (8). In our study, the most common cause of death was suicide (36.4%), followed by deaths from accidents (27.2%), deaths from homicide (13.2%), and deaths from natural causes (7.8%). The cause of death was undetermined in 9.7% of cases.

Suicide is a leading and increasingly prevalent preventable cause of death among adolescents. With increasing impulsivity during adolescence, suicide-related deaths and suicide attempts tend to increase. Clinical studies have shown that 89.7% of adolescent suicide attempt cases are girls, and the most frequent age group is 15-16 years old, accounting for 46.6% (11). Although there are not many autopsy series studies on suicide-related deaths in adolescents, our study demonstrated that males accounted for 51% and females for 43% of suicide cases resulting in death. The age group with the highest frequency of suicide cases is 16 years old at 26.6%, followed by 17 years old at 23.4% and 18 years old at 22.3%.

In a study examining cases of death by suicide, it was reported that the majority of cases involved death by hanging, while cases where the cause of death was determined to be homicide were mostly committed using firearms (7). In our study, it was determined that 34% of suicide cases died by falling from a height, and another 34% died by hanging. On the other hand, among the cases determined as homicide, 52.9% were due to sharp injuries and 29.4% were caused by firearms.

Unlike the literature, it was evaluated that the most common cause of death in cases determined as homicide was sharp injuries, which may be due to the easy access to sharp objects among adolescents in our country. It was also suggested that the methods used in homicide cases may vary due to sociocultural, economic, and regional factors. Since adolescence is considered a period in which intense

physical and emotional changes occur, the tendency towards risky behaviors increases among adolescents. Foremost among these is the use of alcohol and non-alcoholic addictive substances (12). Addictive substance use, one of the leading global health problems, has become increasingly prevalent among adolescents in recent years. Adolescence is the period during which individuals are most likely to begin using drugs. Addictive substance use that starts in childhood and adolescence is a significant risk factor for the development of substance use disorder in the long term (13). Therefore, determining the prevalence of addictive substance use among adolescents, as well as identifying the substances used and their associated mortalities, is extremely important for implementing effective measures against substance addiction. Studies have shown that alcohol is the most commonly abused substance among adolescents, followed by tobacco and illicit drug use (14). Various studies have emphasized that alcohol is the most common addictive substance in this age group, while cannabis is the most commonly used illicit substance (15, 16). In our study, consistent with literature data, alcohol was identified as the most frequently detected addictive substance in the blood of deaths in the 12-18 age group, with a prevalence of 10.5%. In deaths between the ages of 12 and 18, the prevalence of non-alcoholic substances detected in the blood was found to be 5%. This rate was found to be similar to the rates of non-alcoholic addictive substance use among adolescents reported in clinical studies (27).

Alcohol is considered the most common addictive substance among adolescents, and high levels of ethanol can be detected in blood tests in teenage deaths. In a study conducted on deaths among the young age group in Muğla, toxicological analyses revealed that ethanol levels ranging from 7 to 539 mg/dL were detected in the blood of 44 out of 162 samples (9). Additionally, cannabis and its metabolites were found in both blood and urine samples in 6 cases

and in hair samples in 1 case (9). In the study conducted by Okoye and colleagues on the 16-18 age group, it was determined that 14 death cases were due to traffic accidents. Among these cases, alcohol was detected in 3, difluoroethane in 1, morphine in 1, and methamphetamine in 1 (10). In another study conducted in Denizli, MDMA (3,4-Methylenedioxymethamphetamine) and MDA(3,4-Methylenedioxyamphetamine) were detected in 3 cases of traffic accidents; among these, ethanol was also found in 2 cases, while only ethanol was detected in 1 case. In our study, alcohol was identified as the most frequently detected substance in deaths among the 12-18 age group, with a rate of 10.5%. In cases where ethanol was detected in the blood, the most common cause of death was suicide (37%), similar to the literature (17, 18). Suicide-related deaths were followed by accidents (29.8%), homicides (18.5%), and intoxication-related deaths (11.1%). The cause of death for 3.7% of the cases could not be determined.

When examining the causes of death in cases where non-alcoholic addictive substance use was detected, intoxication was identified as the most common cause at a rate of 61.1%, followed by traffic accidents and deaths due to hanging. When variables such as the place of death, sociocultural status, and the type of substance detected in blood samples are considered together, the finding that most cases involving non-alcoholic addictive substance use resulted in death due to intoxication may be attributed to the toxic effects of volatile substances even at low concentrations, challenges in dosage regulation, and their easy availability. Clinical studies have shown that among adolescents hospitalized in psychiatric facilities, the most commonly used non-alcoholic addictive substance is cannabis (29.2%), followed by new psychoactive substances and amphetamines (13%) (2). In a study conducted by Balcı et al. involving the general population, the substances most frequently associated with deaths due to non-alcoholic addictive substance use were identified, in

descending order of frequency, as amphetamines, cannabis, morphine, cocaine, and volatile substances (19). Although death due to cannabis intoxication is rare because of its high lethal dose, it poses a significant public health concern as it often constitutes the first step toward substance dependence. Studies have shown that the majority of individuals who use heroin and cocaine began their drug use with cannabis (17). On the other hand, in our study, volatile substances were detected most frequently in the blood and tissue samples of the cases. In particular, volatile substances are non-alcoholic addictive substances that are easily available, cheap and widely used among adolescents in Türkiye. These substances, which have considerably high morbidity and mortality rates, are most frequently preferred by males and produce rapid effects (20, 21). The discrepancy between the literature and our study is thought to be due to the relatively low cost and easy accessibility of substances such as lighter gas, “bali,” and thinner, as well as their high mortality rates (22). Similarly, in our study, the most frequently used substances were found to be volatile gases, amphetamines, pregabalin, and heroin, respectively. In our study, the finding that 77.8% of cases were found dead in public areas (such as parks, gardens, or open fields)—considering that cases referred for forensic autopsy often have low socioeconomic status—helps explain the high prevalence of volatile substance use (23,24). Our literature review highlights that the use of new synthetic cannabinoids among adolescents has rapidly increased in recent years, and their mortality rates remain unknown. However, in our study, synthetic cannabinoids were detected in the blood sample of only one case among deaths in the 12-18 age group. Despite the rapid rise in synthetic cannabinoid use, their detection remains challenging due to pharmacological factors including the recent emergence of novel psychoactive substances (NPS), the continuous introduction of new compounds, limited understanding of their pharmacodynamics, and

the necessity for developing and validating new analytical techniques (17).

Poly-substance use is defined as the concurrent or sequential consumption of two or more psychoactive substances to attain desired pharmacological effects (25). In a three-year retrospective study, it was determined that 36.2% (n=21) of 58 deaths related to addictive substance use were due to poly-substance use, and 98.3% of deaths associated with addictive substance use occurred in males (17). Clinical studies have reported the frequency of poly-substance use to range between 53% and 77.8% (4, 24), whereas in our study, poly-substance use was detected in 26.3% of cases. Alcohol and amphetamines were identified as the most commonly co-used substances. This discrepancy is likely due to the fact that co-used substances are not consumed at toxic doses in order to enhance the effects of the primary substance.

In our study, only 16.7% (n=3) of patients with non-alcoholic addictive substance use were found to have a comorbid psychiatric diagnosis. This rate was found to be lower compared to clinical studies. Clinical studies have shown that 90% of individuals under the age of 15 with a substance use disorder have at least one comorbid psychiatric diagnosis (26). This discrepancy is thought to stem from insufficient access to the deceased individuals' previous medical records and from protective or concealing attitudes of families due to sociocultural factors.

CONCLUSION

Determining the most commonly used addictive substances and associated risk factors in substance use and related deaths, which pose a serious problem in developing countries, is of utmost importance. There are few studies in the literature linking adolescent age group deaths to substance use, and this study contributes to the existing literature. In incidents resulting in death during adolescence, volatile substances were identified as the most

frequently encountered non-alcoholic addictive substances. Particularly in developing countries, regulation of the sale of volatile substances and providing psychiatric support to at-risk groups are necessary. While the production and market introduction of new generation narcotic and stimulant substances increase daily, our laboratory conducts analyses of the most frequently encountered substances. The development and validation of analytical methods for the detection of new generation stimulant and narcotic substances are of critical importance for their identification and the implementation of necessary measures; further advanced studies are needed in this field.

Declarations

Conflict of Interest

The authors declare that they have no conflict of interest related to this article.

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