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Original Article

Evaluation of Pediatric Deaths Due to Firearm Injuries: A Single-center Experience

Pediatrik Yaş Grubunda Ateşli Silah Yaralamasına Bağlı Ölümlerin Değerlendirilmesi: Tek Merkez Deneyimi

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ABSTRACT

Objective: Firearm injuries (FIs) hold a significant place among childhood deaths. Our study aims to raise awareness about preventable FIs by discussing deaths due to FIs in children in the light of relevant national and international studies.

Method: The autopsy files of the cases under the age of 18 due to FIs occured between January 2011 and December 2021 were investigated. Sociodemographic data of the cases, location of the incident, injury site, cause of death, number of shots, shooting distance, type of the firearms used, the owner of the weapon, and the identity of the perpetrator were evaluated.

Results: The study population consisted of 12 (80.0%) male, and 3 (20.0%) female pediatric cases with a mean age of 13.1±5.4 years (median age: 15.0 years). The most common cause of the death was homicide (n=6, 40.0%), and the most frequently used type of firearm was a shotgun. FIs most commonly happened at home (n=8, 53.3%), and most frequently victims died of brain hemorrhage and brain tissue damage (n=11, 31.4%). The firearms used in the incidents mostly belonged to the fathers of the deceased children (n=10, 66.6%).

Conclusion: There is a need to develop multidimensional strategies, including financial support, targeting all segments of society to reduce the number of deaths due to firearms. Additionally, we believe that strict measures to control access to firearms and awareness training to prevent violence will reduce the rates of mortality due to FIs.

Keywords: Autopsy, childhood, firearm, firearm fatalities

ÖZ

Amaç: Ateşli silahlar çocukluk çağı ölümleri arasında önemli bir yere sahiptir. Çalışmamızda, pediatrik grupta ateşli silah ölümlerini uluslararası ve ulusal literatürdeki benzer çalışmalar ışığında tartışarak önlenebilir olan ateşli silah ölümleri konusunda farkındalığı artırmak amaçlanmaktadır.

Yöntem: Ocak 2011 ile Aralık 2021 tarihleri arasında 18 yaş altı ateşli silah yaralanması nedeniyle otopsisi yapılan olguların dosyaları incelenmiştir. Olguların sosyodemografik verileri, olayın meydana geldiği yer, yaralanma bölgesi, ölüm nedeni, atış sayısı, atış mesafesi, ateşli silah türü, silahın ait olduğu kişi, failin kimliği gibi bilgiler değerlendirilmiştir.

Bulgular: Çalışma grubunu oluşturanların %80'i (n=12) erkek, geri kalanı (n=3) kız çocuktu. Olguların yaş ortalaması 13,1±5,4, medyanı 15,0 idi. Olay orijini en sık (n=6, %40,0) cinayet, en sık kullanılan ateşli silah türü av tüfeği idi. En sık olay yeri ev (n=8, %53,3) idi. En sık (n=11, %31,4) ölüm nedeni beyin kanaması ve beyin doku harabiyeti idi. Olayda kullanılan ateşli silah çoğunlukla (n=10, %66,6) ölen çocuğun babasına ait idi.

Sonuç: Ateşli silahlara bağlı ölümleri azaltmak adına toplumun her kesimini hedefleyen finansal desteği içeren çok boyutlu stratejilerin geliştirilmesine ihtiyaç vardır. Ayrıca ateşli silahlara erişim noktasında alınacak sıkı tedbirler ve şiddetin önlenmesine yönelik verilecek bilinçlendirme eğitimlerinin, ateşli silahlara bağlı ölümleri azaltacağına inanmaktayız.

Anahtar kelimeler: Otopsi, pediatrik yaş grubu, ateşli silah, ateşli silah ölümleri

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INTRODUCTION

Deaths due to firearm injuries (FIs) are among increasingly significant public health problems. It is noted that in 2019 alone, more than 250,000 people worldwide lost their lives due to FIs, and homicides accounted approximately 71% of these deaths[1,2]. According to Centers for Disease Control and Prevention, firearm-related homicides increased by 35% in 2020 compared to relevant 2019 data, reaching the highest rate in the past 25 years[3].

In the United States (US), 4.2% of children aged 0-17 years have witnessed a firearm incident[4]. Furthermore, in 2020, firearm-related deaths surpassed traffic accidents to become the leading cause of death among children. The incidence of firearm-related deaths continued to increase in 2021 and did not return to pre-coronavirus disease-19 pandemic levels[5]. Hatchimonji et al.[6] based on 2016 National Trauma Data Bank reports stated that 12% of the 45,288 individuals aged 0-19 years who were injured by firearms between 2010 and 2016 died, with the risk of death being higher at younger ages. According to 2022 census data, 26.5% (22.578.378) of the total population of our country is 0-17 years old. Population projections indicate that the proportion of the child population is in a declining trend over the years. In 2021, the most common causes of death among those aged 5-17 years were external injuries and poisoning[7]. Zeybek et al.[8] have shown that in the pediatric age group suicides are committed mostly by hanging followed by use of firearms.

Infant and child mortality rates are fundamental health indicators that reflect the development level and public health status of countries. Although there has been a global decline in infant and child mortality rates, preventable causes of death still rank high[9]. Determining the epidemiological characteristics of child deaths will guide the implementation of preventive measures. Based on this fact, and in the light of data obtained from relevant national and international studies, our study aims to increase awareness about preventable firearm-related deaths by discussing this issue in the pediatric age group.

MATERIALS and METHODS

Study Design

This study was conducted in compliance with the Declaration of Helsinki-Ethical Principles for Medical Research Involving Human Participants and also the Ankara University Human Research Ethics Committee's approval was obtained (approval number: 107-399-22, date: 01.08.2022). This study is a retrospective analysis of deaths due to FIs among individuals under the age of 18 years in Eskişehir (a province in the northwest part of the Central Anatolia region of Turkey) between January 2011 and December 2021. The flow chart of our research study is presented in Figure 1.

Statistical Analysis

The study data were collected using case forms prepared by the researchers. The case forms inquired sociodemographic data, the location of the incident,

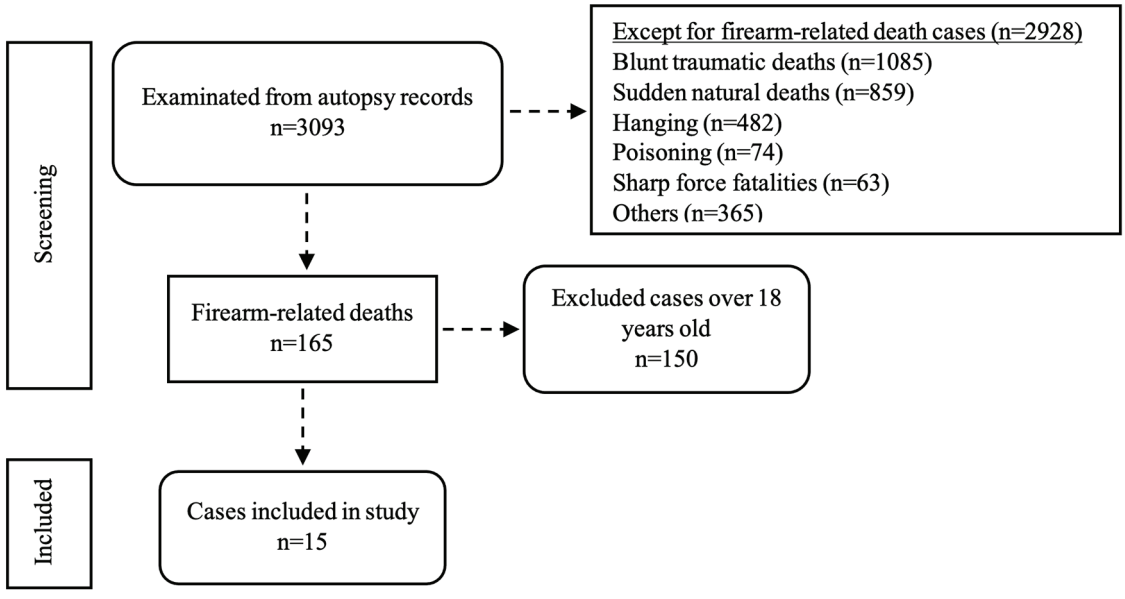

Figure 1. Flow chart

injury site, the cause of death, the number of shots, the shooting distance, the type of firearms used, the owner of the weapon, and the identity of the perpetrator.

Statistical Analysis

The statistical analysis was performed using the IBM SPSS Statistics for Windows [version 20.0 (IBM Inc., Chicago/IL/USA)]. Measured variables are presented as mean ± standard deviation, median, minimum, and maximum values, while categorical data are expressed as numbers (n) and percentages (%).

RESULTS

During the study period, 5.3% (n=165) of the 3,093 forensic deaths were due to FIs. Among those who underwent autopsies due to firearm-related deaths, 9.1% (n=15) were between 0-18 years old. The study population consisted of 12 (80.0%) male and 3 (20.0%) female cases with a mean age of 13.1±5.4 years (age range: 1-18 years; median age: 15.0 years; interquartile range; 13-16 years).

Homicide was the most common cause of the death (n=6, 40.0%), and shotgun was the most frequently used firearm. Victim's home was the most frequently detected crime scene (n=8, 53.3%). The deceased cases who underwent autopsy due to FIs, had (n=10, 66.7%) or had not (n=5, 33.3%) received medical treatment. The most frequent cause of death (n=11, 31.4%) was intracranial bleeding and cerebral parenchymal injury. The firearm used in the incident mostly belonged to the father of the deceased child (n=10, 66.6%). It is noteworthy that the fathers of 2 children who committed suicide were police officers. Demographic and clinical data of the cases are given in Table 1.

The postmortem toxicological examination of the cases could not reveal the suicidal use of sedative, narcotic, or stimulant substances.

DISCUSSION

FIs hold a significant place among childhood deaths both in our country and worldwide. In the US, the incidence rate of firearm-related deaths in children increased by 5.8% from 2018 to 2021[5]. A study conducted in South Africa investigated firearm-related deaths, and found that 1.1% of the deceased cases were

Table 1. Demographic and clinical findings of the cases

Case number	Age (year)/ Sex	Crime scene	Site of injury	Cause of death	Number of GSEW	Origin of death	Range of fire	Types of firearms	Owner of firearm	Killer
1	15/F	Home	Head	ICB and CPI	1	Suicide	Adjacent	Handgun	Father	Own
2	4/M	Home	Chest	IODIB and VDIB	1	Unintentional	Adjacent	Shotgun	Father	Brother
3	9/M	Home	Head	ICB and CPI	1	Unintentional	Close	Shotgun	Father	Brother
4	18/M	Street	Chest, abdomen	IODIB	6	Homicide	Distant	Shotgun	Foe	Foe
5	14/M	Street	Head, chest, abdomen	ICB and CPI and IODIB	3	Homicide	Distant	Shotgun	Foe	Foe
6	15/F	Home	Head	ICB and CPI	1	Suicide	Adjacent	Shotgun	Father	Own
7	16/M	Forest	Neck, chest, extremity	IODIB and VDIB	4	Homicide	Distant	Shotgun	Girlfriend's brother	Girlfriend's brother
8	18/M	Home	Head	ICB and CPI	1	Homicide	Distant	Handgun	Cousin	Cousin
9	16/M	Forest	Head	ICB and CPI	1	Unintentional	Close	Shotgun	Father	Father
10	17/M	Home	Head	ICB and CPI	1	Suicide	Adjacent	Handgun	Father	Own
11	18/M	Forest	Chest, abdomen	IODIB and VDIB	1	Unintentional	Distant	Shotgun	Father	Father
12	1/M	Land	Head	ICB and CPI	1	Homicide	Adjacent	Handgun	Father	Father
13	13/M	Street	Head	ICB and CPI	1	Homicide	Distant	Shotgun	Stranger	Stranger
14	16/F	Home	Head	ICB and CPI	1	Suicide	Adjacent	Handgun	Father	Own
15	7/M	Home	Head	ICB and CPI	1	Unintentional	Close	Handgun	Father	Brother

F: Female, M: Male, GSEW: Gunshot entrance wound, ICB: Intracranial bleeding, CPI: Cerebral parenchymal injury, IODIB: Internal organ damage with internal bleeding, VDIB: Vascular damage with internal bleeding

under the age of 15[10]. Amiri et al.[11], conducted a study in Teheran, and reported the rate of firearm-related deaths as 32.5% among individuals under the age of 20. In a study performed in Diyarbakır province the researchers reported that 34.7% of autopsies conducted between 2014 and 2018 were related to FIs, and 5.8% of these cases autopsies had been performed in children[12]. A study conducted in Muğla province indicated that pediatric cases consisted of 5.9% of firearm-related deaths[13]. Aydın and Yavuz[14] reported a firearm-related mortality rate of 6.07% among individuals under the age of 18. In our study, this mortality rate was 9.1%. As is the case in the rest of the world, firearm-related death rates vary across different regions of our country which are related to the factors such as the approach to violence intervention, access to firearms, socioeconomic inequalities, geographical and cultural differences[5,11].

Based on the data obtained from national and international studies evaluating FIs or deaths in childhood, male children consistuted majority of these cases. In a study by Aydın and Yavuz[14], and a study conducted in Konya[15], and that performed by Çom and Gümüş[12], male children comprised of 69.3%, 68.0%, and 64.2% of the cases injuried or killed by firearms. In the study by Woodruff et al.[16] 76.7% of the cases aged 14 and under who were injuried or killed by firearms between 2005 and 2013 were male victims. In the study by Murhega et al.[17] conducted in the Democratic Republic of Congo, this incidence rate was found to be 63.4%. In as US study, Bayouth et al.[18] revealed that male children consisted of 86.4% of pediatric cases over 20 years of age who were injuried or killed by firearms. Consistent with the literature, the majority of cases (80.0%) in our study were male victims. This phenomenon has been attributed to the curiosity of boys towards dangerous activities[15].

In the US, considering firearm-related homicides in terms of racial and ethnic groups, the highest death rate is among African Americans. From 2012 to 2014, the annual firearm fatality rate among African American children was approximately twice that of American Indian children and four times that of Hispanic children[4]. Ekinci et al.[13] evaluated firearm-related mortality rates in Muğla province, and reported that 1.6% of the cases were of foreign nationality, and half of these cases were part of the resident population. In our study, only 1 (6.6%) resident was a person of foreign nationality while the others (93.3%) were Turkish citizens. The case involving a 16-year-old of Syrian nationality was a homicide victim. According to current data, in Eskişehir, where children constitute 21.0% of the total population, 7.617 foreigners had residence permits[7,19]. Considering that the foreigners with residence permits in Eskişehir constitute 0.84% of the total population, which is below the national average of 1.55%[19,20], the proportion of foreign children in our study is at an expected level.

It has been reported that the firearm-related death rate is higher among children aged 13 and over compared to younger children (0-12 years). This discrepancy in death rates is particularly more pronounced in cases of homicide and suicide[4]. In our study, the rate of homicide in the 13-18 age group was five times higher compared to the 0-12 age group, and suicidal attempts were not observed at all in the 0-12 age group. The lower rate of suicides before adolescence is explained by the rarity of depression and substance abuse in the pre-adolescent age group[21]. In our study, all cases of suicide were aged 15 and above including 1 case with a history of psychiatric illness and substance abuse. While the presence of underlying psychiatric illness in the adolescent age group poses a significant risk for committing suicide, even in the absence of underlying psychiatric illnesses, behavioral components such as age-related impulsivity, environmental factors, and cognitive immaturity or faulty judgment can play an important role in creating a foundation for suicide[21]. In our study, 2 cases committed suicide due to the deterioration of their romantic relationships with their boyfriends, and 1 case who was previously very successful student committed suicide due to a significant decline in academic performance. Family disputes, stress, romantic relationship issues, unrequited love, academic failure, and lack of attention can lead to adolescent crises that may result in suicide. Use of firearms is particularly notable among the methods of suicide in the 15-18 age group[15,22]. Access to firearms is cited as an environmental risk factor in cases of suicide or accidents[15,23]. As is the case in our study, implementation of comprehensive prevention strategies aiming to identify relevant risk factors in health and social services should be considered so as to reduce the risk of suicide among all children, especially those in the late adolescent group.

Wilson et al.[24], indicated that nearly 75% of the perpetrators were the victim's sibling, friend, or acquaintance, and in approximately 30% of the cases, other children witnessed the fatal incident. In our study, 3 cases were unintentionally killed by their siblings, and 2 children were accidentally killed by their fathers. The literature indicates that children who are directly or indirectly exposed to firearm violence experience

a worsening of their mental health problems, with frequently observed symptoms of post-traumatic stress, anxiety, and depression[25]. Therefore, the importance of providing mental health support to children who witness firearm violence is emphasized as a preventive measure in medical practice[24]. However, we believe that it is not solely sufficient to support the emotional well-being of children who are exposed to or witness firearm violence. As indicated in our study, psychological rehabilitation should also be provided to children who unintentionally killed their siblings and to parents who unintentionally killed their children. This is essential for alleviating their suffering and for the recovery of their mental health state.

A study conducted in the US on firearm-related deaths among children aged 5-14 reported a statistically positive association between access to firearm and suicide. It was revealed that in states where firearms are more prevalently available, children are seven times more likely to use firearms and twice as likely to die by suicide[26]. A study evaluating firearm-related deaths in our country between 2013 and 2020, revealed that 93.3% of the firearm-related deaths among child were due to accidents and suicidal attempts[13]. Demirci et al.[15] found that 40% of the these fatalities were due to suicide, and 34% of them were unintentional. In the study by Çom and Gümüş[12], suicide was the leading cause of death (31.3%), followed by homicide (16.4%). In the study by Aydın and Yavuz[14], homicide was the most common cause (32.5%), followed by suicide (29.8%). In our study, the distribution of the firearm-related deaths was relatively close i.e. 6 homicides, 5 unintentional deaths, and 4 suicides. All the unintentionally killed victims were male children. While 3 children were unintentionally killed when their siblings pulled the trigger while playing with a firearm. In the US, from 2003 to 2021, the most common scenario (66.6%) in unintentional pediatric firearm deaths involved children playing with or showing the firearm to someone else when it was discharged[24]. Purchasing realistic toy guns for boys, especially with the advancement of technology, can cause them to perceive all guns, whether real or toy, as playthings. The frequent use of guns in children's games or their enthusiasm for activities involving guns can inevitably lead to unintentional cases of FIs or deaths. Additionally, two children were unintentionally killed by their fathers while hunting wild boars. The practice of parents taking their children along on hunting trips is an important detail that invites unintentional deaths and warrants careful consideration. Both domestic and international studies evaluating firearm-related death cases, reported that male victims constituted the majority of homicide cases[4,14,15]. In our study, the fact that all homicide cases were male is consistent with the relevant literature data.

Keeping firearms at the home is a risk factor for FIs, especially among the pediatric age group[5]. Most unintentional firearm-related deaths in childhood occur at home[24]. Studies investigating firearm-related deaths in the pediatric age group in our country, have revealed that most incidents occur at home[14,15]. In our study, the fact that most incidents involving firearms, including all suicide cases, occurred in the deceased child's home is consistent with the literature data.

According to data from the National Violent Death Reporting System in the US, in 44.6% of unintentional FI deaths among children, the firearms used belonged to the perpetrator's parents[24]. Faulkenberry and Schaechter[27], reported that in 32% of the cases where the firearm owner was identified, the firearm belonged to the father of the victim. Similarly, a study examining child deaths due to FIs in Konya province found that the firearm predominantly belonged to the child's father or his/her relatives (60%)[15]. In our study, consistent with the literature data, the firearm used in the incidents frequently belonged to the father. A study on children presenting to the emergency department due to FIs reported that a family member or a known individual most often shot children[16]. In their study, Faulkenberry and Schaechter[27] found that 84.3% of the cases committed suicide, or killed by a family member, a relative, or a friend. Similarly, in our study, all incidents except for one were committed by the individual themselves, a family member, or someone they knew. As is seen, the inability to prevent access to firearms can result in tragic deaths. This suggestion would also highlight the issue of parental neglect in pediatric cases of firearm-related injuries or deaths.

Relevant national and international literature indicate that in cases when a firearm is fired with suicidal intent, shooting is mostly done from adjacent or nearly close-range, whereas in homicide cases, the firearms are fired from a long distance[11,28,29]. In our study, consistent with the literature data, all suicidal gunshot wounds were caused by adjacent-range shots, whereas the majority of homicide wounds were caused by distant-range shots. The only homicide case involving a adjacent-range shot was a 1-year-old boy who was killed by his father in a fit of rage using a handgun.

In their study on firearm-related deaths, Ekinci et al.[13] found that most cases of firearm-related suicides

and unintentional deaths had a single-entry wound, while most cases of homicide cases had multiple-entry wounds. A study examining firearm-related child deaths in İzmir and its surroundings, indicated that all firearm-related suicide and unintentional cases had a single-entry wound, whereas more than half of the homicide cases had a single-entry wound[14]. The results of our study are consistent with the findings of relevant studies.

Studies on FIs in the US report that the origin of the incident affects the fatality rates at the scene. In firearm-related cases of suicide, medical intervention after the injury is often limited[30]. Mortality rates are higher in cases of gunshot wounds in the head. A study conducted in the US found that 76% of patients with FIs on the head died at the crime scene, and 61% of those who were hospitalized lost their lives[31]. Beaman et al.[32] found that 77.3% of completed suicides had gunshot wounds on the head and these wounds are approximately 2.5 times more fatal than those on the other parts of the body. Another study conducted in the US reported a mortality rate of 39% for FIs in the head and neck[33]. Approximately 75% of all cases in our study, and all suicide-related cases had FIs on the head. Only one of the suicide cases received medical treatment after the FI. The higher fatality rate of head injuries may influence the preference of this region in suicide attempts. It has been reported that hospital admissions for unintentional FIs are at a higher rate compared to suicides[33]. Contrary to the literature, we found that 80% of unintentional cases in our study died at the crime scene without receiving medical intervention. This discrepancy is likely due to our study population consisting solely of fatal cases. Therefore, the exclusion of cases with non-fatal unintentional FIs from the study may explain this discrepancy.

The types of firearms used in pediatric firearm-related deaths vary in national and international studies. In their study on firearm-related deaths among children, Roberts et al.[30] reported that the most commonly used type of firearm in all cases was a handgun, while in the 13-18 age group, the most frequently used firearm was a shotgun. Another study conducted in the US, reported that handguns were the most commonly used type of firearm[16]. In studies examining firearm-related deaths in our country, Demirci et al.[15], and Aydın and Yavuz[14] found that shotguns were used in 66%, and 65.8% of these cases, respectively. While Çom and Gümüş[12] indicated handguns were used in 49.2% of their cases. In our study, the most frequently used type of firearm was a shotgun, while 75% of the suicide cases handguns were used. The most frequent use of shotguns in childhood firearm-related deaths can be explained by the difficulties in concealing shotguns due to their larger size compared to handguns and the common preference for shotguns in rural areas[14,15]. As in our study, the frequent use of handguns in suicide cases may be due to the ease of carrying handguns. Additionally, considering that the fathers of two of our suicide cases were police officers, the failure of law enforcement personnel to adequately secure their firearms at home can lead to fatal consequences.

In our study, use of any sedative, narcotic, or stimulant substances could not be revealed during postmortem toxicological analyses of any cases. However, toxicological examinations should still be performed in cases of mortality due to FIs. This approach helps to determine whether the victim received a sedative or narcotic substance that could have weakened their bodily resistance before the incident or whether they were poisoned by a substance that might have contributed to their death.

Study Limitations

This single-centered study conducted with a limited number of cases makes it difficult to generalize our findings. However, the data obtained from our study can guide new studies conducted with larger sample sizes that include survived cases exposed to FIs. One of the limitations of the study is the lack of data on the socioeconomic status of the cases. Since this a retrospective study, the psychiatric history of the suicide cases prior to the suicide attempts was obtained from the statements of their relatives so detailed psychiatric data of the cases could not be presented.

CONCLUSION

The information obtained from this study may promote the researchers to acquire larger data sets, enabling the identification of relevant epidemiological trends. Establishing a systematic firearm data infrastructure to collect relevant data and identify risk factors could play a crucial role in preventing firearm violence targeting the pediatric population.

Since it is known that low socioeconomic status and high poverty levels increase firearm-related death rates[34], there is a need to develop multidimensional strategies, including financial support targeting all segments of society to reduce firearm-related deaths.

We also believe that strict measures to control access to firearms and awareness training to prevent violence

will reduce firearm-related deaths. The pediatric age group often closely engaged in watching television, the internet, and playing computer games. In this context, since some television shows, movies, social media posts, or computer games may display incidents of firearm violence, we recommend that parents restrict the time passed by their children in front of television, social media, and computers. Furthermore, to prevent easy access to firearms by children, we believe that firearms should be stored securely with safety measures, and should be kept in a gun safe separate from ammunition or in a lockable gun case with a firearm lock.

Ethics

Ethics Committee Approval: This study was conducted in compliance with the Declaration of Helsinki-Ethical Principles for Medical Research Involving Human Participants and also the Ankara University Human Research Ethics Committee's approval was obtained (approval number: 107-399-22, date: 01.08.2022).

Informed Consent: Retrospective study.

Author Contributions

Concept: A.G., E.E., Design: A.G., E.E., Data Collection or Processing: A.G., Analysis or Interpretation: A.G., E.E., G.V., Literature Search: A.G., E.E., G.V., Writing: A.G., E.E., G.V.

Conflict of Interest: The authors have no conflict of interest to declare.

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