Infant and adolescent deaths in Istanbul due to home accidents

Mahmut Aşırdizer[1], Mehmet Sunay Yavuz[2], Emre Albek[3], Gürol Cantürk[4]

[1]Department of Forensic Medicine, Celal Bayar University Faculty of Medicine, Manisa, [2]Department of Forensic Medicine, Süleyman Demirel University Faculty of Medicine, Isparta, [3]Department of Forensic Medicine, İstanbul University Cerrahpaşa Faculty of Medicine, İstanbul, [4]Department of Forensic Medicine, Ankara University School of Medicine, Ankara, Turkey

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Adolescent and infant deaths due to home accidents pose an important social problem and can be prevented significantly by appropriate measures. The aims of this study about adolescent deaths under the age of 18 and infant deaths due to home accidents were assessment of risk factors and proposals for protective measures.

Toward these aims, 414 autopsy reports (Provided by Mortuary Section, Council of Forensic Medicine, Istanbul Turkey, 1996-2000) were reviewed, as well as scene investigation data and information from eyewitnesses.

Determination of risk factors, appropriate education, as well as legal regulations for manufacturers of household articles may significantly reduce the number of infant and adolescent deaths due to home accidents.

Key words: home accidents, infant deaths, adolescent deaths, forensic medicine.

Home accidents occur inside or around a house[1,2]. The importance of home accidents is increasing[3]. According to Kazar et al.[4], home accidents constitute approximately half of all accidents and show an increasing trend. Home accidents account for up 23.5% of all accidents in Sweden, and therapeutic measures for a home accident victim cost approximately 1,300 USD annually in Norway[5,6]. In France, 10% of all public health costs are the result of home accidents[2].

Home accidents among children pose a serious problem for public health in developed and developing countries. According to the studies, children and individuals beyond the age of 65 years are mostly affected[1,2]. In several studies, it has been reported that 55% of the victims are pre-school children. The incidence of home accidents among children under 6 years is 51/1,000 and among children under 15 years of age 279/10,000; respectively, 26% of all accidents in the 0-19 age group occur inside the domicile, with the rate of victimization during household activities being 1.5-4.88 per 100,000 infant hours[2,6,8-12].

In 10% of the cases home accidents are serious enough to require hospitalization and are a major cause of infant death. Five percent of the victims succumb before hospitalization. In the United States alone, home accidents among children and adolescents are the second leading cause of death after traffic accidents[2,9,13,14].

According to Thomsen et al.[15], the role of forensic medicine in society is not only limited to the investigation of criminal cases; forensic scientists must also conceive appropriate measures for preventable deaths.

The aim of this study was to investigate domestic accident-related cases of death in Istanbul (Turkey) for infants and adolescents in the age group 0-18 years, to assess risk factors and to develop appropriate preventive measures.

Material and Methods

Autopsy reports of 414 home accident victims (0-18 years old) between 1996-2000 were reviewed as well as scene investigation data and information obtained from eyewitnesses.

Home accidents under the age of 18 were classified based upon the "Home Accident Prevention Inventory" proposed by Tertinger et al.[16], and modified by the authors.

1. Deaths due to poisoning by solid/liquid and gaseous compounds.
2. Deaths due to falls and blunt trauma.
3. Deaths due to burning, scalding, or electrocution.

4. Deaths due to drowning and other asphyxiants.
5. Deaths due to firearm wounds.
6. Deaths due to stabbing.

We investigated, in a further step, the cause of accidents, types of fatalities according to age groups and gender, and high-risk areas at home, as well as household articles and activities leading to accidents.

Deaths at home due to homicidal or suicidal origin as well as fatalities not identified as accidental were investigated in the group; other deaths under the age of 18 were not included in the study. Deaths by drug overdose identified as non-homicidal, however, were included in the home accident group.

In statistical evaluation, the arithmetical mean of the data was assessed and χ^2-test was applied. (Fisher's probability test was carried out when necessary).

Deaths due to home accidents of infants and adolescents make up 3% of all deaths, and 26% of all fatalities in this age group.

Additionally, infant and adolescent victims account for 34% of all deaths due to home accidents.

The female/male ratio was 1:2.02 for all deaths, and 1:1.26 for the 414 home accident victims.

Deaths by home accidents reached a peak in the age group of 0-3 years in both sexes, declining in older ages. Beyond the age of 12, there was again an increase in the rate of deaths by home accidents (Table I).

In 154 cases, there was no information available regarding where the accident occurred. Among the remaining 260 cases with sufficient scene information, most of the fatalities (n=103, 39%) occurred in bedrooms (Table I).

Table I. Deaths Caused by Home Accidents Among Infants and Adolescents Age Groups, Sex and Location in Home

Distribution of victims	Number			%	
A) Distribution by age groups and sex	Male	Female	Total	Male	Female
0-3 years	83	74	157	52.9	47.1
4-6 years	30	31	61	49.2	50.8
7-9 years	17	8	25	68	32
10-12 years	14	5	19	73.7	26.3
13-15 years	36	25	61	59	41
16-18 years	51	40	91	56	44
Total	231	183	414	55.8	44.2

B) Distribution by location in homes (n=260)	Number	%
Bedroom	103	39.6
Bathroom	65	25
Living room	37	14.2
Balcony	26	10
Kitchen	14	5.5
Roof	7	2.7
Stairs	4	1.5
Elevators and shafts	4	1.5

Results

A total of 13,801 autopsies were carried out in the Mortuary Section of the Council of Forensic Medicine between 1996-2000. Of these, 1591 were infants and adolescents under the age of 18; 414 of those were caused by home accidents.

The relationship between the type of home accident and age/sex of the victim is shown in Table II. In all age groups except 10-12 years, intoxications were first, followed by falling and blunt trauma, burning-scalding or electrocution, and other causes of death. In the age group of

Table II. Cause of Deaths in Individuals Under the Age of 18

Cause of death	Number	%
Poisoning with solid, liquid or gaseous compounds (n=178)		
0-3 years	51	28.7
4-6 years	23	12.9
7-9 years	11	6.2
10-12 years	8	4.5
13-15 years	36	20.2
16-18 years	49	27.5
Male	95	53.4
Female	83	46.6
Full or blunt trauma (n=101)		
0-3 years	37	36.6
4-6 years	18	17.8
7-9 years	9	8.9
10-12 years	1	1
13-15 years	14	13.9
16-18 years	22	21.8
Male	59	58.4
Female	42	41.6
Burn, scalding or electrocutions (n=18)		
0-3 years	26	32.1
4-6 years	16	19.8
7-9 years	5	6.2
10-12 years	9	11
13-15 years	8	9.9
16-18 years	17	21
Male	48	59.3
Female	33	40.7
Drowning and other asphyxiants (n=19)		
0-3 years	36	92.3
4-6 years	1	2.6
7-9 years	0	0
10-12 years	0	0
13-15 years	0	0
16-18 years	2	5.1
Male	21	53.8
Female	18	46.2
Firearm wounds (n=15)		
0-3 years	7	46.6
4-6 years	3	20
7-9 years	0	0
10-12 years	1	6.7
13-15 years	3	20
16-18 years	1	6.7
Male	8	53.4
Female	7	46.6

10-12 years, burning-scalding or electrocution was the leading cause of death, followed by intoxications and other causes. In all groups, there was a clear male preponderance.

Fatalities due to perforating and/or stab wounds were not included in our series.

1. Deaths due to Intoxication by Solid-Liquid and Gaseous Compounds

Among 178 cases of intoxication, carbon monoxide was involved in 139 (78%). It is the leading cause of all home accidents, accounting for 34% of the cases.

There were 71 cases of carbon monoxide poisoning due to the inhalation of fumes from coal ovens. The source of carbon monoxide was gas heaters in bathrooms in 50 cases (36%). Other sources were catalytic gas ovens (n=7) and gas stoves (n=3), all due to improper usage of the devices or inattention. In eight cases (6%) hospitalized due to carbon monoxide poisoning at home who died later, no information was available about the carbon monoxide source.

Carbon monoxide poisoning by inhalation of fumes from coal ovens led to the deaths of seven children and adolescents in one residence. Furthermore, there was more than one infant and/or adolescent victim in 15 houses. In other houses, parents or brothers and sisters over the age of 18 had also died or had been treated for carbon monoxide poisoning.

Eighteen of the deaths caused by drug intoxication occurred in the age groups of 0-3 years (n=12) and 4-6 years (n=6). In these cases, the victims ingested drugs improperly stored within the reach of children.

All cases of mushroom poisoning (15 cases) were caused by wild mushrooms collected for cooking, and in each case, all family members were affected. All victims died in the hospital, and no scene information was available.

Narcotic drug (heroin) overdosage was the cause of death in four cases (all 15-18 years).

A four-year-old boy died due to potassium chlorate poisoning after swallowing firework contents left on the table.

2. Deaths due to Falls and Blunt Trauma

Sixty-eight children under the age of 18 years died due to falls from balconies, terraces, or elevator shafts. The accidents occurred while looking from windows (n=25) or from balconies (n=17), cleaning the windows (n=9, all girls aged 13-18 years), placing laundry on balconies for drying (n=7, all girls aged 13-18 years), adjusting position of TV antennas (n=4, all male adolescents older than 12 years) and while playing on the terrace (n=3).

Two children had accidentally fallen into the elevator shaft.

A 16-year-old boy who lost the key to his house died after falling from the neighbor's balcony while attempting to reach his own balcony.

Eleven children died as a result of falls from beds and cribs (all aged 0-6 years) and five children (between 1 and 14 months of age) had fallen from someone's lap.

All four children who fell down stairs were boys under the age of 12 years.

A 14-year-old girl lost her footing on a wet floor in the bathroom and hit her head against the toilet.

Seven children who died of blunt trauma after being entrapped between or under furniture pieces were under the age of three years.

One child's neck was entrapped between window shutters, one child was entrapped under the television, and three children were entrapped between the elevator and the wall, the bed and the wall, and between a crib and a trunk, respectively.

3. Deaths due to Burning, Scalding, or Electrocution

In two cases, death occurred from an oven explosion when gas and cologne were combined, and in one case, a short circuit in an electric bed sheet was the cause of death.

The scene investigation reports contained no information about the locations and causes of the fire.

Three cases of death due to scalding burns occurred in children aged 0-3 years. In all cases, the scalding was caused by hot fluids from the cooking stove. In addition, two boys (2 and 3 years old, respectively) died in the kitchen after explosion of a liquid gas bottle.

Twenty children had died due to electrocution. Four victims aged 0-6 years had introduced an object into unprotected wall sockets. Four children aged seven years or more died while handling washing machines, hair dryers, and electrical water boilers; four by a surge of current from the refrigerator. Two children had touched exposed live electrical wires in the living room. A 16-year-old boy died while repairing a defective electrical oven. The details of the accident for the five cases of accidental electrocution were unavailable although there were positive autopsy findings.

4. Deaths due to Drowning and Other Asphyxiants

In this group, 11 cases of death due to drowning occurred (10 cases in buckets of water in the bathroom, 1 case in a bucket on the balcony); the eldest victims were aged four years.

Seven infants died during nursing by choking on the nipple (the eldest victim being 14 months of age), one was asphyxiated by a plastic bag on the head, one was smothered by the bed sheet, one by strangulation with crib cording and one by strangulation with a long TV cable while playing.

Fifteen of 17 children who died by foreign body (food) aspiration were aged 0-3 years. Fourteen had died due to aspiration of food, like beans, mandarins, or pieces of apple (found on the floor or while eating). In one case, a piece of a toy was aspirated. A 16-year-old girl died by aspiration after having fallen asleep with chewing gum in her mouth.

A 17-year-old boy, while drinking alcohol with his friends at home, died from aspiration of a piece of meat.

5. Deaths due to Firearm Wounds

This group included 15 fatalities (13 by pistols, 2 by rifles). Death occurred during cleaning of the weapons by parents or relatives (n=9), while playing with firearms placed in the home within easy access of children (n=5), or after being wounded by a weapon outside the home (n=1). Ten of the victims were younger than six years, the remainder older than 10.

The relationship between the cause of home accidents and age/sex percentage of victims is given in Table III.

Discussion

In our study, fatalities of infants and adolescents who died due to home accidents constituted 3% of all deaths, and 26% of those were under the

Table III. Cause of Death

Cause of death	n	%	Male/Female	Range of age
Deaths due to poisoning with solid, liquid or gaseous compounds (n=178)				
Carbon monoxide poisoning	139		75/64 (1.2/1)	9.6±0.2 years
Drug intoxication	19		9/10 (1/1.1)	3.4±0.6 years
Mushroom poisoning	15		8/7 (1.1/1)	9.6±0.1 years
Narcotic drug overdose	4		2/2 (1/1)	17.3±0.1 years
Potassium chlorate poisoning	1		1/0 (1/0)	4 years
Deaths due to fall or blunt trauma (n=101)				
Falling from windows, balconies or roofs	68		42/26 (1.6/1)	9.4±0.3 years
Falling down staircases	4		4/0 (4/0)	6.5±0.1 years
Falling from beds or cribs	11		3/8 (1/2.7)	1.5±0.6 years
Falling from parent's lap	5		4/1 (4/1)	5±0.1 months
Falling underground by slipping	1		1/0 (1/0)	14 years
Trapping between or under piece of furniture	12		6/6 (1/1)	4.71±0.8 years
Deaths due to burning, scalding or electrocution (n=81)				
Burning	56		27/29 (1/1.1)	7±0.1 years
Scalding	3		2/1 (2/1)	2±0.3 years
Liquid gas bottle explosion	2		2/0 (2/0)	2.5 years
Electrocution	20		17/3 (5.7/1)	12.9±0.3 years
Deaths due to drowning or other asphyxiants (n=39)				
Drowning	11		7/4 (1.8/1)	1.9±0.3 years
Obstruction by mother's nipple	7		3/4 (1/1.3)	1.2±0.1 years
Obstruction by a plastic bag on lead	1		0/1 (0/1)	2 years
Obstruction by covering with the bed-sheet	1		0/1 (0/1)	9 months
Strangulation with crib cording	1		0/1 (0/1)	3 years
Strangulation with long TV cable	1		1/0 (1/0)	2 years
Foreign body aspiration	17		10/7 (1.4/1)	3±0.7 years
Deaths due to firearm wounds (n=15)				
Wounding by pistol or rifle	15		8/7 (1.1/1)	6.2±0.4 years

age of 18. Among a total of 1211 deaths due to home accidents, 34% occurred in individuals under the age of 18. Those rates are severe for infant and adolescent health and should be evaluated carefully.

According to Laffoy [13], 59.2% of 74 children injured in home accidents were males. Lindblad et al.[17] reported a female/male ratio of 1/1.6 for home accident victims aged 0-15 years. According to a study of Hijar-Medina et al.[14] on home accidents in children under 10 years of age, there is a male preponderance of 62%. In contrast, Zannetti et al.[18], in a study on home accidents involving all age groups, reported that 64.7% of all affected victims are females. In our study the male/female ratio was 2.02/1 for all deaths and 1.26/1 (male: 55.8 per 100) for deaths due to home accidents under the age of 18. These results approximate the data reported in literature except for Zannetti's findings.

Compared with all deaths and all fatalities under the age of 18, there has been a statistically nonsignificant increase in the number of female victims of home accidents and of those occurring under the age of 18 ($p>0.05$) ($x^2=3.474 < x^2$ (3-0.05)=7.82). Sex distribution based on age groups was not significant ($p>0.05$) ($x^2=5.39 < x^2$ (5-0.05)=11.07).

As for the age distribution in home accidents, Laffoy[13] reported that 66% of the victims in his study group were under the age of five. According to Lindblad et al.[17], home accidents most frequently occurred in infants younger than one year. Gaillard et al.[2] reported that infants younger than five years were most frequently involved in home accidents. According to Hijar-Medina et al.[14], 37% of home accident victims under 15 years were in the age group of 1-2 years. Laflamme et al.[19] reported that the incidence of injuries due to home accidents was higher in the age group of 1-2 years. In our study, fatalities due to home accidents showed a parallel course in both sexes, culminating in the age group of 0-3 years and decreasing in elder age groups. The fatality rate, however, increases again beyond the age of 12 and approximates the rates of the 0-3 age group in the age group of 16-18 years. There was an accumulation of the cases (38%) in the age group of 0-3 years, followed by the age group of 16-18 years (22%). These results contrasted the data in the literature. Children under six years accounted for 53% of the cases. This age distribution was found to be statistically minimally significant ($p<0.001$) ($x^2=185.39 > x^2$ (5-0.001)=20.52). The increase beyond the age of 12 can be explained by the high number of cases of electrocution, carbon monoxide and mushroom poisoning, falls and firearm wounds, with their high mortalities and high age average. Furthermore, series in other studies covered victims younger than 15 years, cases with non-fatal outcome, or both fatalities and cases with minor injuries.

The kitchen has been reported in the literature as the most dangerous area of the home but in our study, only 5% of 260 cases for which information was obtained on the scene of the home accident occurred in kitchens; most occurred in bedrooms (39%) and bathrooms (25%), respectively ($p<0.001$) ($x^2=98.72 > x^2$(7-0.001)=24.32). This can be explained by the high rate of carbon monoxide poisoning among our cases[1,2].

According to Schelp et al.[5], the most frequent type of home accident was falling for females and blunt-incisive trauma and collisions for males. Laffoy et al.[13] reported that 50.8% of home accidents were caused by falling, 22.6% by blunt and incisive trauma, 13% by burns, 7.9% by poisonings and 5.7% by foreign body aspiration. According to Zannetti et al.[18], home accidents with fatal and non-fatal outcome were most frequently caused by falls, followed by burn. Hijar-Medina et al.[14] reported that home accidents were caused mainly by falls (either on the same or from different levels) and intoxications. According to Hu et al.[20], falls were the leading cause of home accidents among children and adolescents (51%), followed by traumatization with different objects in 18% and by incisive wounds in 9%. In our study, among the total of 414 fatalities, intoxications accounted for the most fatalities (43%), followed by falling and blunt trauma (24%), burns, scalding or electrocution (20%), drowning or other asphyxiants (9%), and by firearm wounds (4%).

As for the relationship between type of the accident and age of the victim, drowning and asphyxia were not represented significantly beyond the age of six years. These were most frequent between 0-3 years, diminishing in elder victims and reappearing in the age group

of 16-18 years. No fatalities due to firearm wounds were present in 7-9 year olds. In all age groups except for 10-12 years, intoxication occupied the first rank, followed by falls, entrapment, and burns and electrocution. In the age group of 10-12 years, fatalities were most frequently caused by burns, scalding or electrocution, followed by intoxication. The relationship between type of home accident and age distribution was statistically the most significant (Fisher probability test; $p<0.05$). The relationship between type of home accident and sex was not statistically significant ($p>0.05$) ($x^2=1.4984 < x^2$ (5-0.05)=11.07).

Deaths due to perforating and/or stab wounds, which accounted for a high number in the general groups of fatalities, were not included in our series regarding fatal home accidents under the age of 18.

Seventy-eight percent of 178 cases of intoxication involved carbon monoxide poisoning. Carbon monoxide poisoning shows a decreasing tendency in developed countries owing to appropriate measures and technological facilities. However, it is still a major cause of home accidents in developing or underdeveloped countries. According to a study in Spain, among 10 cases of carbon monoxide poisoning with 17 victims, fumes from water-heaters and gas-ovens caused nine and fumes from a conventional coal oven caused one. All family members were involved in the accident except in one case[21]. A Danish study emphasized the role of gas boilers in carbon monoxide poisoning, if not properly installed by authorized personnel[15]. In contrast to this, our study showed that poisoning originating from conventional coal ovens was more frequent (n=71). Poisoning from gas boilers also accounted for a considerable number of home accidents (n=50). All gas boilers were installed in a nonprofessional manner in bathrooms without sufficient airflow. In seven cases, carbon monoxide poisoning resulted from gas ovens in rooms without airflow, and in three cases from ovens not properly serviced.

A paper presented by Lindblad et al.[22] showed that home accidents by poisoning were mostly caused by drugs (34%) and organic solvents (25%). According to Casey et a1.[23] and Thompson et a1.[24], pesticide poisoning accounted for 3.4% and 3.9% of cases respectively, in children younger than 10 years, and constituted 0.2% of home accidents. Hijar-Medina et al.[14] emphasized that cleaners and make-up utensils were easily accessible to children, and they caused home accidents in children at a ratio of 38% and 34%, respectively. Nielsen et al.[25] reported that cleaners were kept properly locked in only 2.5% of households; poison and drugs were properly locked in only 8% of households. No poisoning by organic solvents, pesticides, cleaners or make-up articles was observed in our study. The only chemical poisoning was that by potassium chlorate. Drug poisoning was present in 19 cases and constituted a major cause of death in children younger than six years (n=18). The drugs in these cases were again easily accessible to the children. Poisoning by wild mushroom occupied the third rank (n=15) among intoxications, especially in suburban districts, and involved all family members who consumed the meal prepared with mushrooms. Although not regarded as a home accident in the literature on this subject, our paper includes four fatalities due to overdose intake of narcotic drugs (heroin).

Various studies reported that falling accounts for a major cause of home accidents[5,13,14,18,20,25,26]. This study emphasizes that there were dangerous windows in 30% of houses, cradles without guard rails in 30%, staircases without banister in 44%-59%, and open entrances to the roof in 44% of the houses. Our study also showed that after carbon monoxide poisoning, falls were the leading cause of home accidents (n=89, 21 %), emphasizing the importance of this type of trauma.

Blunt trauma by entrapment between or under furniture was also frequent (n=12). The main cause of entrapment was open space between furniture and the wall, where small children can easily become trapped.

Fifty-six infants and adolescents died due to burns. In Turkey, the majority of households lack smoke detectors and fire extinguishers. In contrast, only 27% of families in the United States do not have smoke detectors in their homes[26]. In all three fatalities due to scalding, hot water from containers on the stove had spilled onto the victims; the accidents were exclusively caused by negligence. The explosion of the LPG bottle causing the death of two children in the kitchen was due to defective production and lack of control measures.

Regarding electrocutions, four among 20 victims died after introduction of diverse objects into wall sockets, and eight because of short circuits in washing machines, hair dryers, refrigerators and water boilers. Two died from contact with uninsulated cables and one while repairing an electrical heater. In various papers, unprotected wall sockets were reported in 40-42% and exposed live wires in 30% of the cases as risk factors[14,25].

Eleven children drowned in water containers used for storage. Similar cases were reported only in a paper from Mexico[27].

There were seven fatalities (the oldest being 14 months) during nursing; one was asphyxiated by a plastic bag over the head; one was smothered under a bed sheet; one died from strangulation with a rope in the crib and one with a TV cable. In addition, 17 victims (most cases were between 0-3 years) died of foreign body aspiration like beans, fruits, toys, gum, and meat. According to Hijar-Medina et al.[11], 30% of young children were at increased risk from easily accessible plastic bags and small toys. Thirteen adolescents and infants died of pistol wounds and two adolescents by rifle wounds. Ten of the victims were under six, and the remaining beyond the age of six. Nine died accidentally from gunshot wounds from firearms which were being cleaned or handled by parents or relatives, and five while playing with firearms not stored safely. One victim was killed accidentally by a bullet while looking out of the window. Farah et al.[28] and Patterson et al.[29] emphasized the risk of being injured by weapons if they were not stored properly and out of the reach of children; families possessing firearms frequently reported that they were not aware of this risk.

The sources of risk mentioned in previous studies include: structural design of the house like unprotected windows and staircases, and roofs with easy access; unprofessionally installed or improperly serviced gas water boilers and heaters; water containers; furniture; play equipment (swings etc.); small playthings that may be easily ingested; plastic bags accessible to children; sport articles; strollers/carriages for babies and young children; unguarded cradles; hot objects (steam radiators etc.); chemical agents like medicines, cleaning materials and poisons easily accessible to children; kitchen equipment; easily accessible firearms; exposed live wires and unprotected wall sockets; and deficiency in fire detectors[5,13-32].

In our opinion, there are further risk factors, primarily the following: coal ovens without properly cleaned channels and ovens kept burning overnight in windy weather; eating of wild mushrooms; leaving narrow spaces between pieces of furniture; failing to immobilize furniture; failure to maintain service for elevators and protection doors; lack of fire extinguishers at home; electrical devices without maintenance; heavy bed sheets and pillows in cribs; unattended TV cables; cording attached to cribs; and food, especially beans and the like, left unattended in households with children under the age of three.

The literature on the prevention of home accidents mentions various measures, mainly defining sources of potential danger according to the psychological and motor development of children; appreciating that all children, regardless of the age, are at enhanced risk for home accidents; educating parents and attending personnel; home-safety measures on the basis of legal regulations; safe home design and production of safe household articles; special safety regulations for household equipment and environmental conditions; labeling of chemical agent containers; supervision of home-safety measures by inspectors; and financial support for families to implement measures to improve safety[7,13,14,18-20,25,26,33-39].

Infant and adolescent deaths due to home accidents are a major public health problem throughout the world. We can conclude that, especially in developing countries like Turkey, as well as in underdeveloped countries, protection of children from home accidents is insufficient, resulting in fatalities at home. Defining risk factors and risk groups, providing appropriate education, and enforcing building regulations and regulations for manufacturers of household articles would help to reduce significantly the number of fatalities among infants and adolescents due to home accidents.

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