



# Epidemiological Study on the Causes of Mortality Among Children Aged 5-14 Years in the Northeast of Iran in 2013-2019: A Descriptive Study

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## Abstract

**Background and aims:** To identify the pattern and causes of death and to deal with them are among the most appropriate strategies to increase human life expectancy. The pattern of death in society must be identified to cope with the causes of premature deaths. The aim of this study was to epidemiologically investigate the causes of death in people aged 5-14 years in northeastern Iran.

**Methods:** Data on the deaths of people aged 5-14 years from Khorasan Razavi province during 2013-2019, drawn from the Causes of Mortality Classification System of the Ministry of Health and Medical Education, were used to conduct the study.

**Results:** Data on 2084 deaths were examined, of which 824 (40.04%) occurred in girls. The number of deaths was 976 (53.83%) and 1108 (46.17%) in the age group of 5-9 and 10-14, respectively. Traffic accidents, cancers, external causes (unexpected events), and circulatory system diseases were found as the main causes of death. Among the cancers, lymphoid leukemia, malignant brain tumors, and myeloid leukemia (18%, 12%, and 7%, respectively) were the most common cancers, leading to death. In rural areas, unexpected events (20%) were the leading cause of death, followed by traffic accidents and cancers (19% and 13%, respectively).

**Conclusion:** Overall, the mortality rate in children aged 5-14 years due to traffic accidents and unexpected events (suffocation, burns, and the like) seems to be substantially higher in Iran compared to some developing countries and some neighboring countries such as Turkey. Given the possibility of taking preventive measures in this regard, it is necessary to develop policies to reduce the mortality rate in the age group.

**Keywords:** Adolescent mortality, Neoplasm, Traffic accident

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## Introduction

One of the most appropriate strategies to increase human life expectancy is to identify the pattern and causes of death and cope with the causes. The patterns of death in society must be identified to deal with the causes of premature deaths. Reliable information on the causes of death and a description of the mortality process changes greatly assist in planning, managing, and evaluating health systems across the world.<sup>1</sup> According to the World Health Organization (WHO) report, adolescents account for around one-sixth of the world's population. Considering that 90% of adolescents aged 10-19 live in low- and middle-income countries,<sup>2</sup> their health is of critical importance. Information on the causes of death has long been used to monitor the promotion of public health and set the priorities of health policies.<sup>1</sup> The systems for registering and collecting mortality data have already been created in developed countries. In Iran, the Ministry of Health and Medical Education, with the

collaboration of the Civil Registration Organization and the implementation of a program to register mortality data, including the death causes and characteristics of the deceased, has taken an important step toward determining the mortality pattern and monitoring its process, which assists in the formulation, designing, and implementation of interventional programs and the evaluation of public health programs.<sup>3</sup> The study of epidemiological changes in Iran reveals new priorities in health-related and socioeconomic development programs that are essential for the continuation and improvement of past activities, as well as the creation of demographic and cultural strategies, social development, and resolution of health-related issues. Undoubtedly, identifying the causes and risk factors of mortality is the first measure to reduce mortality.<sup>4-6</sup> Belfer reported that 20% of children and adolescents have mental disorders, and suicide is the third leading cause of death among adolescents.<sup>7</sup> In the study of Hashemi and Okazi on the causes of death

in children and adolescents referred to the Forensic Medicine Research Center of Tehran Province, trauma and accidents were reported as the most common causes of death among the age groups.<sup>8</sup> The findings of a study by Roudsari et al on the causes of death in children and adolescents aged under 15 demonstrated that 50%, 18%, 6%, and 6% of deaths were due to accidents, burns, falls, and poisoning, respectively.<sup>9</sup> In the study of Abdul-Razak et al on the causes of death in people aged 1-24 years in Malaysia during 1990-2013, the main cause of death in both girls and boys aged 1-9 in 1990 was vaccine-preventable diseases. Neoplasms were reported as the leading cause of death in this age group in 2013. Moreover, neoplasms and road accidents were the most common causes of death in girls and boys, respectively, in the age group of 10-24.<sup>10</sup> Based on the result of a study in Poland on the external causes of children and adolescent mortality from 1999 to 2012, unintentional accidents remained the leading cause of death in the age groups.<sup>11</sup> Considering that the epidemiological investigation of mortality in this age group in Iran, including the east of the country, has not so far been conducted, this study aimed to investigate the epidemiology of death causes among children aged 5-14 years in the population covered by Mashhad University of Medical Sciences (MUMS) during 2013-2019.

## Materials and Methods

### Study Design

This cross-sectional study was conducted using the data registered in the Registry and Classification System of Death Causes after making necessary coordination with the Health Deputy of MUMS.

### Study Population

Non-identifying information on all deaths in people aged 5-14 years during 2013-2019 was collected from the system.

### Data Collection Tool

The data were gathered from death certificates issued in hospitals, medical centers, offices, health houses, forensic medicine organizations, and sanctuaries of Mashhad and all studied counties. The reviews for the accuracy of demographic characteristics and mortality data, as well as recounting were conducted in several stages.

Khorasan Razavi province is located in the northeast of Iran and its capital, Mashhad, is the second most populous collected of the country. MUMS is one of the largest universities in Iran, affiliating 20 health networks (in 16 cities) and providing a wide range of health services to a population of over 5 million.<sup>12</sup> The population covered by the university accounts for 75% of the total provincial province (6 400 000, the 2016 Population and Housing Census), and the rest of the population is covered by the medical universities of Sabzevar, Gonabad, Torbat-e-Jam, Torbat-e Heydarieh, and Neyshabur. Further, more than 72% of the population aged 5-14 years in Khorasan Razavi

province is covered by MUMS.<sup>13</sup>

The causes of death, defined at entering data in the early stages of registration, were reviewed as per the International Classification of Diseases, 10th Revision (ICD-10) codes to be analyzed using the program. To standardize qualitative control and methods of data analysis, WHO has provided a package called Analyzing mortality levels and causes-of-death (ANACoD). This tool provides relatively simple methods to investigate the internal validity and consistency of mortality data, and helps examine the consistency and reasonableness of data through comparison with the other sources of mortality data approved by the WHO. This comparison can be accomplished thanks to the verified information from countries with different income levels collected using the package. By performing these simple control methods, experts and physicians will be able to identify data weaknesses.<sup>14</sup> In this study, such errors were identified and corrected using ANACoD.

### Data Analysis

After data sorting, they were analyzed by Excel software using descriptive statistics. All the probabilities under study were expressed in 1 per 1000 populations and calculated as the number of events (deaths) through one year in the area covered by MUMS divided by the number of people exposed to the event, multiplied by 1000.

## Results

In this study, data on 2084 deaths in children aged 5-14 years during 2013-2019 were examined, of which 10245 (59.06%) occurred in boys. Based on the results, the number of deaths was 976 (53.83%) and 1108 (46.17%) in the age group of 5-9 and 10-14, respectively. Of the total deaths, 565 (27.11%) and 1483 (72.89%) cases were reported from rural and urban areas, respectively. Figure 1 illustrates the changes in the mortality rate in urban and rural areas from 2013 to 2019. Interestingly, the mortality rate in children aged 5-14 in rural areas increased again in 2019 and reached its highest value (33%) at the completion of the studied period. The mean age of the deceased girls and boys was  $9.24 \pm 3.00$  and  $9.39 \pm 2.98$ , respectively, representing no statistically significant difference in terms of gender ( $P=0.25$ ). The mortality rate was higher in boys than in girls throughout all studied years and in both age groups. The mortality rate in both genders was higher in children aged 5-9 than in those aged 10-14

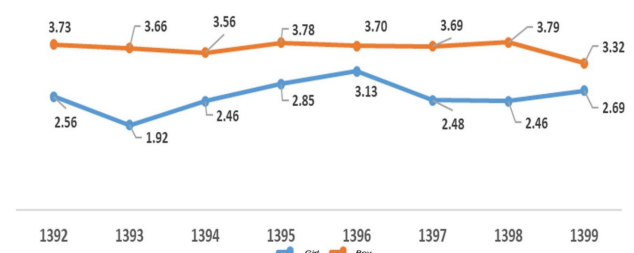


Figure 1. Mortality Rate of Children Aged 5-14 Years (Per 10000 Population) in the Population Covered by Mashhad University of Medical Sciences by Gender in 2013-2019.

(Table 1, Figure 1).

Based on the obtained data (Table 2), the most common causes of death during the studied period were traffic accidents (n=413, 20%), cancers and unexpected events (n=333, 16%, separately), and circulatory system diseases (n=290, 14%). In general, mortality due to traffic accidents during the studied period decreased substantially and reached its lowest value in 2019, especially compared to 2013 and 2014 so that traffic accidents were responsible for 27% of deaths in 2013, decreasing to 17% in 2018 and dropping to its lowest value with a 6% decrease in 2019. A clear difference in the order of the causes of death was noticed between urban and rural areas in a more detailed investigation. In urban areas, traffic accidents remained the leading cause of death (n=294, 20%), followed by neoplasms (n=254, 17%), unexpected events (n=218, 15%) and circulatory system diseases (n=210, 14%). However, in rural areas, unexpected events (n=111, 20%), followed by traffic accidents (n=110, 19%) and circulatory system diseases and neoplasms (n=76 and 71, 13%, respectively) were drawn as the four leading causes of death (Figure 2). On the other hand, deaths due to unexpected events increased and reached their highest value (26%) in 2019. Poisoning accounted for 11% of deaths due to unexpected events in 2019. Neoplasms slowly decreased from 17% to 13%. Overall, lymphoid leukemia (18%), malignant brain neoplasm (12%), and myeloid leukemia

(7%) were the most common causes of cancer deaths (Table 3).

## Discussion

In the present study, which was performed to epidemiologically evaluate the causes of death in children aged 5-14 years in the population covered by MUMS during 2013-2019, the mortality rate was generally higher in boys compared to girls. In some studies conducted in Iran, the mortality rate of boys was reported to be 59.7% and 62%<sup>15,16</sup>. In Pakistan and Turkey, the mortality rate due to non-natural causes and accidents was higher in boys than in girls.<sup>17,18</sup> Traffic accidents, cancers, tumors, and other external factors (unexpected events) were identified as the main causes of death in our study.

### Traffic Accidents

The extent of injuries caused by traffic accidents in Iran and the world is so high that these accidents are consistently considered one of the main public health issues.<sup>19</sup> According to the World Health Statistics 2014, accidents were the second leading cause of death in Iran and the leading cause of death among Iranian youth.<sup>20</sup> In the present study, traffic accidents were found as the first leading cause of death in the population aged 5-14 covered by MUMS during 2013-2018. However, following the outbreak of COVID-19 and the execution of traffic

**Table 1.** Frequency Distribution and Mortality Rate of Children Aged 5-14 Years (per 10000 Population) by Age Group and Gender in 2013-2019

Age Group (y)	Gender	Year							
		2013	2014	2015	2016	2017	2018	2019	2020
		Number (Rate)							
5-9	Total	133 (09.3)	136 (3.01)	145 (3.34)	165 (3.74)	139 (3.43)	121 (2.77)	138 (2.94)	131 (2.62)
	Female	55 (2.62)	43 (1.95)	60 (2.82)	64 (2.98)	65 (3.29)	52 (2.44)	57 (2.49)	58 (2.38)
	Male	78 (3.53)	93 (4.03)	85 (3.83)	101 (4.46)	74 (3.56)	69 (3.08)	81 (3.37)	73 (2.85)
10-14	Total	134 (3.24)	111 (2.59)	108 (2.68)	114 (2.86)	118 (3.42)	126 (3.50)	127 (3.39)	138 (3.51)
	Female	51 (2.51)	40 (1.90)	41 (2.07)	53 (2.71)	50 (2.95)	45 (2.54)	45 (2.43)	60 (3.09)
	Male	83 (3.95)	71 (3.26)	67 (3.27)	61 (3.01)	68 (3.87)	81 (4.44)	82 (4.33)	78 (3.93)
5-14	Total	267 (3.16)	247 (2.81)	253 (3.02)	279 (3.32)	257 (3.42)	247 (3.10)	265 (3.14)	269 (3.01)

**Table 2.** Leading Causes of Death in Children Aged 5-14 Years in the Population Covered by Mashhad University of Medical Sciences in 2013-2019

Cause of Death, No. (%)	Year								Total
	2013	2014	2015	2016	2017	2018	2019	2020	
Traffic accidents	72 (27)	64 (26)	47 (19)	51 (18)	52 (20)	53 (21)	44 (17)	30 (11)	413 (20)
Unexpected events	22 (8)	31 (13)	37 (15)	55 (20)	28 (11)	52 (21)	37 (14)	71 (26)	333 (16)
Neoplasms	45 (17)	39 (16)	45 (18)	49 (18)	46 (18)	34 (14)	41 (15)	71 (13)	333 (16)
Circulatory system diseases	37 (14)	40 (16)	46 (18)	32 (11)	39 (15)	32 (13)	37 (14)	27 (10)	290 (14)
Nervous system diseases	16 (6)	22 (9)	19 (8)	24 (9)	35 (14)	26 (11)	49 (18)	17 (6)	208 (10)
Congenital anomalies	26 (10)	11 (4)	13 (5)	17 (6)	7 (3)	10 (4)	17 (7)	16 (6)	118 (6)
Uncoded causes	5 (1)	9 (4)	9 (4)	10 (4)	10 (4)	7 (3)	9 (3)	17 (3)	64 (3)
Behavioral disorders	17 (6)	11 (4)	7 (3)	3 (1)	6 (2)	7 (3)	5 (2)	7 (1)	59 (3)
Infectious and parasitic diseases	8 (3)	8 (3)	6 (2)	7 (2)	8 (20)	4 (21)	5 (17)	3 (11)	46 (2)
Endocrine diseases	6 (2)	3 (1)	3 (1)	11 (3)	7 (3)	7 (3)	4 (2)	1 (3)	45 (2)

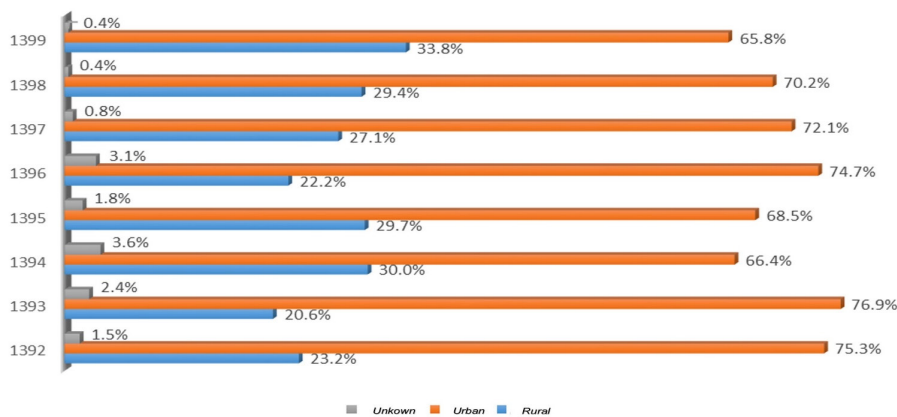


Figure 2. Mortality Rates of Children Aged 5-14 Years by the Residence Place (Urban vs. Rural) in 1392-1399.

restrictions in order to create social distance, the first leading cause of death in this age group was expected events (26%), followed by COVID-19 and its complications (14%) and neoplasms (11%), and traffic accidents dropped to the 10th rank (10%). The total mortality rate in this age group did not increase after the COVID-19 pandemic compared to previous years. In the study by Christey et al on the types of trauma leading to hospital admission during the national level 4 lockdown for COVID-19 in New Zealand, the total number of injuries decreased by 43%, including a 48% decrease in children aged 0-14 years.<sup>21</sup>

Similarly, Keays et al reported that injuries from vehicle crashes in 2020 unprecedentedly decreased compared to the 1993-2019 period. The lowest decrease (35%) was observed in the age group of 2-5 years, while the highest decrease (83%) belonged to the age group of 12-17.<sup>22</sup> However, studies conducted before 2020, except for 1999, demonstrated the high frequency of this death cause among children. In the study by Roudsari et al on the causes of death in children under 15, 50% of deaths were due to vehicle crashes.<sup>16</sup> In their study on the same age group in the UAE, Bener et al concluded that 29.8% of deaths were reportedly due to accidents.<sup>23</sup> Increasing population, manufacture and use of vehicles, changing lifestyle, increased demand for travel and use of personal, including unsafe, cars, as well as non-standard urban and suburban roads were the main causes of traffic injuries.<sup>24,25</sup> Additionally, insufficient development of roads and highways and non-compliance with traffic regulations could increase the risk of traffic accidents and resulting casualties.<sup>26,27</sup>

**Cancers and Tumors**

Cancer was drawn as the second leading cause of death worldwide in 2018. In Iran, cancer is the third leading cause of death after cardiovascular disease and unintentional accidents.<sup>28</sup> In the present study, cancer was found as one of the main causes of death, following traffic accidents. According to the American Cancer Society, the incidence of cancer in the population under 15 years has increased in recent decades so that 10 270 new cases and 1190 resulting deaths were reported in 2017.<sup>29</sup> According to the official statistics, cancers accounted for 13% of deaths in people

aged 5-15 years in 1999 in Iran.<sup>30</sup> The most common type of cancer in children under 15 years is leukemia so that it accounts for 23% of all cancers and 76% of all leukemia in this age group. The incidence of acute lymphoid leukemia is higher in boys than in girls and varies in different geographical areas.<sup>31</sup> In the current study, 65% of deaths due to lymphoid leukemia were detected in boys. Lymphoid leukemia is five times more common than myeloid leukemia.<sup>32</sup> In one study, brain tumors accounted for 20% of childhood cancers.<sup>33</sup> In the present study, the mortality rate of lymphoid leukemia was approximately 2.7 times higher than that of myeloid leukemia.

**Other External Causes (Unexpected Events)**

Unexpected events refer to all accidents that lead to death unintentionally and accidentally, including falling from height, drowning, suffocation, electric shock, burns, and poisoning. Reports from developed countries state that unintentional injuries leading to death are the major causes of death in the population aged under 15 years, while over 90% of these injuries are preventable and controllable.<sup>34</sup> In a study on 1320 children under 15 in Pakistan, 18% of deaths were due to drowning.<sup>17</sup> In the study by Bener et al, drowning and burns were the main causes of death after traffic accidents.<sup>23</sup> In another study, Roudsari et al reported that vehicle crashes were the most common causes of death in children under 15, followed by burns (18%), falls (6%), and poisoning (6%).<sup>16</sup> In the present study, the mortality rates in spring and summer were higher than those in fall and winter so that 30% and 26% of deaths occurred in summer and spring, respectively (Figure 3). However, in 2019, most deaths occurred in fall, which could be attributed to the COVID-19 pandemic restrictions. In a study on the frequency of accidents in children under 15

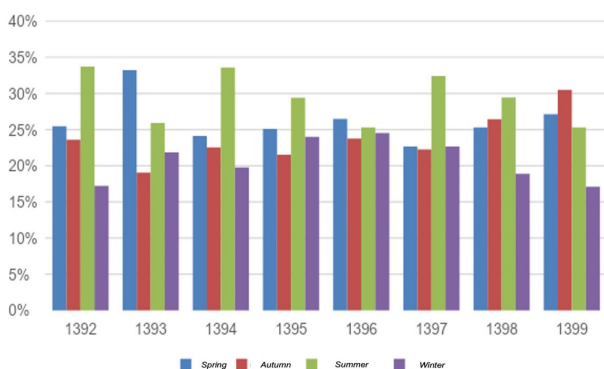
Table 3. The Most Common Cancers Leading to Death in Children Aged 5-14 Years Covered by Mashhad University of Medical Sciences by Gender in 2013-2019

Type of Cancer, No. (%)	Gender		
	Female	Male	Total
Lymphoid leukemia	29 (39)	45 (61)	74 (100)
Malignant brain neoplasms	21 (43)	28 (57)	49 (100)
Myeloid leukemia	10 (33)	20 (67)	30 (100)

in Rafsanjan, southeast Iran, Khodadadi et al found that most accidents reportedly occurred in summer.<sup>35</sup> Likewise, Mohammadian et al evaluated the seasonal pattern of the fatality rate from traffic accidents in Isfahan, central Iran and concluded that seasonal changes were effective on the incidence of mortality due to traffic accidents. In the mentioned study, the highest rate of traffic accidents was reported in spring and summer, while the lowest rate belonged to fall and winter,<sup>36</sup> probably because the incidence of traffic accidents is more likely in spring and summer due to the closure of schools and travels.

The mortality rate in the age group of 5-14 years is lower in Iran compared to the neighboring countries (Table 4).<sup>37</sup> Further, the probability of mortality in this age group in the present study, which was conducted in the northeast of Iran, was less than the corresponding national rate. One possible reason for this finding is the substantial reduction in the mortality rate due to accidents in this subpopulation. One of the strengths of this study is the relatively long period of study. Furthermore, data sorting and analysis using ANACoD and removing duplicates were accomplished with great care by the research team to increase the robustness of the results. However, it was impossible to analyze the results by subgroups in more detail due to the small number of deaths in the subgroups registered in the ICD-10. In some subgroups, the number of registered deaths was extremely small; therefore, it was not statistically justifiable to thoroughly analyze them and investigate their relationship with residence place, age group, seasons, and gender. Regarding traffic accidents, certain information such as the child's place at the crash (e.g., a pedestrian, a bicyclist on a car, and the like), whether the crash was due to the child's carelessness, his/her parent's/guardian's inadvertence, or other individuals involved in the crash were at fault, and high-risk areas for traffic crashes can be of critical importance to health policymakers. Unfortunately, such information is not registered in the death certificates based on current protocols. It is therefore recommended that such information be included in the medical records of the deceased due to traffic accidents and their death certificates to be available to conduct comprehensive studies.

### Conclusion



**Figure 3.** Seasonal Distribution of Mortality in Children Aged 5-14 Years in the Population Covered by Mashhad University of Medical Sciences by Gender in 2013-2019.

**Table 4.** Mortality Rate (per 10000 Population) in the Age Group of 5-14 Years in Iran and Some Neighboring Countries

Year	Iran	Turkey	Afghanistan	Pakistan
2013	71.4	96.2	59.7	58.9
2014	43.4	69.2	7.6	39.9
2015	18.4	46.2	91.5	18.9
2016	96.3	29.2	3.5	97.8
2017	77.3	15.2	87.4	75.8

The three main causes of death in children 5-14 years in northeastern Iran are traffic accidents, cancers, and unexpected events (suffocation, burns, and the like), whose contributions to the mortality rate of the age group are substantially higher than the corresponding statistics in some developing countries, some neighboring countries, and Europe. Given the possibility of taking preventive measures and increasing medical facilities in this regard, it is essential to take further measures to ensure the safety of this age group by making the right policies to eliminate the existing deficiencies.

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### Conflict of Interests Disclosure

There is no conflict of interests to disclose.

### Ethical Approval

Ethical considerations were observed in collecting and publishing the results. The information was disseminated only across the province.

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