

HOSTED BY



Contents lists available at ScienceDirect

International Journal of Pediatrics and Adolescent Medicine

journal homepage: <http://www.elsevier.com/locate/ijpam>

Original article

Child mortality in Saudi Arabia: Time for action at all levels

Maha Almuneef^{a, b, c, *}, Hassan Saleheen^{a, b}, Fadia AlBuhairan^{d, e}, Majid Al-Eissa^{a, b, c},
Manal Al Muntaser^c, Hala Al Alem^{a, c}, Ahmad Othman^{a, c}, Tarek Al Abrash^{a, c},
Saif Al Saif^{a, c}, Beverly Baylon^c



^a King Abdullah International Medical Research Center, King Saud Bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia

^b National Family Safety Program, King Abdulaziz Medical City - Ministry of National Guard Health Affairs, Riyadh, Saudi Arabia

^c Department of Pediatrics, King Abdullah Specialized Children's Hospital, Riyadh, Saudi Arabia

^d Department of Pediatrics & Adolescent Medicine, Aldara Hospital and Medical Center, Riyadh, Saudi Arabia

^e Department of Population, Family, and Reproductive Health, Bloomberg School of Public Health, Johns Hopkins University, Baltimore, USA

ARTICLE INFO

Article history:

Received 25 November 2019

Received in revised form

3 May 2020

Accepted 28 June 2020

Available online 7 July 2020

Keywords:

Child death
Preventable
Saudi Arabia
Children

ABSTRACT

Background and Objectives: Although child mortality is declining in Saudi Arabia, new trends and causes are emerging. The objective of the study is to determine the causes of child death in a tertiary care hospital in Saudi Arabia and to identify its preventable causes and associated risk factors.

Methods: A modified UNICEF Multiple Indicator Cluster Survey (MICS) was used to analyze all deaths among children under the age of 18 which occurred at the King Abdullah Specialized Children's Hospital (KASCH) between 2010 and 2016.

Results: After reviewing all the death charts of 1138 children, the team determined that 15% (172) of all deaths could have been prevented and the preventability increased with age. Only 2% of the neonates died of preventable causes, while 53% of the children of 6 years of age or older died of preventable causes. The highest percentage of preventable deaths occurred in children aged 13–18 years (39.3%), followed by the age group of 6–12 years (32.4%) and the age group of 29 days to 5 years (13.9%). All 966 (85%) deaths from biological causes were considered to be unpreventable. Among the preventable causes, 142 (82.5%) had injuries and 30 (17.4%) were sudden unexpected infant death (SUID) with no documented autopsy or death scene investigation, and thus it was considered preventable by the researchers. The 5 major causes of deaths secondary to injuries were motor vehicle accidents (MVA) accounting for 86 deaths (60.6%), followed by drowning accounting for 19 deaths (13.4%), child maltreatment accounting for 13 deaths (9.2%), fire and weapon accounting for 12 deaths (8.5%), and finally home accident (fall, poisoning, suffocation) accounting for 12 deaths (8.5%).

Conclusion: The State Child Death Reviews Board should thoroughly investigate deaths due to SUID and injuries by identifying the factors that contribute to the implementation of preventive strategies.

© 2020 Publishing services provided by Elsevier B.V. on behalf of King Faisal Specialist Hospital & Research Centre (General Organization), Saudi Arabia. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Introduction

The death of any child is a tragedy for the family and the community [1]. Although childhood mortality has declined

substantially at very low rates in many parts of the world, it is still considered a topic of great impact without simple solutions. Since 1990, substantial global progress has been made in reducing child deaths. The total number of under-5 deaths worldwide has declined from 12.6 million in 1990 to 5.4 million in 2017. In another words, the under-5 mortality rate has fallen by 58%, from an estimated rate of 93 deaths per 1000 live births in 1990 to 39 deaths per 1000 live births in 2017 [2]. Different health institutions around the world have been accelerating progress in reducing child mortality; however, disparities in the child mortality rate exist across different nations and regions of the world. There are many underlying and interacting variables that affect childhood and adolescent

* Corresponding author. Child care section-Pediatric department King Abdullah Specialized Children's Hospital (KASCH), King Saud bin Abdulaziz University for Health Sciences (KSU-HS), P.O. Box 22490, Riyadh, 11426, Saudi Arabia.

E-mail addresses: muneefm@ngha.med.sa, mahamuneef@gmail.com (M. Almuneef).

Peer review under responsibility of King Faisal Specialist Hospital & Research Centre (General Organization), Saudi Arabia.

mortality, some of which are inherent (age, gender, genetics, etc.), and other environmental and social factors are subject to modifications and appropriate interventions [3].

In an effort to understand the pattern and nature of child death, many high-income countries are adopting standardized procedures for the review of child deaths. A series of review articles analyzed published data from different countries and revealed that the highest rate of deaths outside infancy is prominent in adolescents, and at all ages, death rates tend to be higher in males compared to females [1,4]. Researchers also highlighted disparities in cause of deaths across different age groups. In infants, the factors that lead to death are genetics, prematurity, and infections, and 85% of deaths before the age of one month are due to causes related to pregnancy and childbirth. From 1 to 11 months, diarrheal and respiratory system diseases cause 43% of all deaths, and the incidence of measles follows with 32%. For children aged 1–4 years, 39% of all mortality is caused by unintentional injuries with drowning being the leading cause of injury in many countries [5]. Furthermore, drowning is the third leading global cause of death among children aged 5–14 years after tuberculosis (TB) and measles, with over 90% of drowning deaths occurring in low- and middle-income countries. Unintentional injuries were also the leading cause of death in the United States amidst all age groups over 1 year of age [6]. Injuries account for 9% of the world's deaths, which is almost 1.7 times the number of fatalities caused by HIV/AIDS, tuberculosis, and malaria combined [7].

Nowadays, children's death from external causes, such as violence and injuries, predominate in the older age group. In children older than 5 years (6–18 years old), injuries (including road traffic injuries, drowning, burns, and falls) are the leading causes of death among children and rank among the top causes of lifelong disability in this age group. In 2017, the Centers for Disease Control and Prevention (CDC) report indicated that drowning was the leading cause of injury deaths for those from 1 to 4 years of age, and motor vehicle accident (MVA) was the most common cause of injury deaths in the age group of 5–19 years in the US [8].

The patterns of death in older children and adolescents reflect the underlying risk profiles of the age groups, with a shift away from medical reasons towards accidents and injuries, which are a result of individual behaviors. In New Zealand, for instance, unintentional injuries account for 48.1% of adolescent deaths aged 15–19 years [9]. In the United States, the high rate of violent deaths resulting from firearms accounted for at least 80% of all youth homicides annually. As for Australia, a higher proportion of deaths due to external causes in the age group 15–19 years are related to MVA and suicide [10]. In the United Kingdom, MVA also contributes to the highest number of child deaths due to external causes in older children and adolescents [3,11]. These injuries and accidents in older children are particularly tragic because most of them can be prevented with simple and affordable interventions. Findings from the Child Death Review Board (CDRB) have consistently shown that the causative factors of child deaths could potentially be modified to reduce future fatalities [12,13].

In the last two decades, remarkable progress and a significant improvement have been made in the health of children and adolescents in Saudi Arabia, notably in the control of diarrhea, malnutrition, and in the vaccination of communicable diseases. These positive developments have led to a decline in the under-5 mortality rate from 159/1000 in 1970 to 7.4/1000 in 2017, which is equivalent to an 80% improvement [5]. However, there have been noticeable shifts in the epidemiological pattern of child death; although great progress has been made in the prevention of communicable diseases, the exposure of children and adolescents to external factors such as accidents and injuries seems to be increasing and will continue to do so in the future if serious measures and interventions

are not taken. Due to scarcity of data across the age spectrum of childhood and adolescence, the issue of child injuries and the preventable causes of death is often absent from the discussion and is largely invisible in the country's policies. Furthermore, to the best of our knowledge, there is no formal mechanism to review child deaths in the country. The aim of this study is to review all cases of child fatality (birth–18 years) in a large tertiary-care children's hospital in the capital city of Riyadh. The findings of this study will assist in building a growing pool of knowledge about how children have died in Saudi Arabia and if there were any factors or early warning signs that could have prevented death.

2. Methods

2.1. Study design and sample selection

A retrospective chart review was conducted at the King Abdullah Specialized Children's Hospital (KASCH) in Riyadh, Saudi Arabia. Any death of a child under the age of 18 years that occurred during the period from January 1, 2010 to December 31, 2016 was included. Stillbirths and pregnancies that were planned to be terminated (due to poor prognosis) were excluded from the study.

2.2. Procedures

The hospital's statistics revealed that during the period 2010–2016, a total of 1138 child deaths occurred based on death certificates within an electronic medical record (EMR). Data was collected by physicians through the review of the electronic health records of the eligible participants. Prior to the data collection, the research team and the information technology department conducted a comprehensive training of data collectors to present the objectives of the study, the modified UNICEF Multiple Indicators Cluster Survey (MICS) data collection tool (MICS-6 tool), how to retrieve the data, and how to make a decision about the cause of death. A child's death was defined as preventable if an individual or community could reasonably have done something that would have changed the circumstances that led to the child's death. In this study, deaths attributed to medical conditions were far less likely to be considered preventable, whereas deaths labeled as Sudden Unexpected Infant Death (SUID) without investigations or autopsy were considered preventable, as they were unnatural deaths and it was difficult to determine the cause of death due to lack of data. The study also evaluated the reliability of the data abstraction sheet and assessed the frequency with which items were missing from the chart. The data was electronically documented with the use of tablets. The electronic data collection tool reduced data entry errors because most of the categories were a drop-down menu with a comment if the choice was not listed, thus improving the quality of our data. After entering the data, members of the research team performed a cross-check to verify its integrity and identify the missing values and anomalies before transferring the data to the statistical software.

2.3. Measures

A data collection form consisting of 7 sections and 50 question items was designed to gather information for this study. The instrument includes information on the socio-demographic characteristics of the child, childbirth, medical history of the mother, pregnancy care, incident information, investigation performed, and detailed data on the causes of child death. There was also a detailed sheet of eight common preventable causes and injuries, which include MVA, drowning, fire and burns, weapon and firearms, child maltreatment, falls, poisoning, and finally SUID.

2.4. Data analysis

Descriptive statistics were calculated for the study variables. Data on child deaths were described with respect to socio-demographic status (e.g. age, gender). The data were analyzed and presented in 5 age groups: 0–28 days, 29 days–1 year, 2–5 years, 6–12 years, and 13–18 years. The deaths were categorized by types of initial diagnosis and causes of death. Differences between causes of death were compared by demographic variables. All data were analyzed using SPSS software version 21.0 [14].

2.5. Ethical considerations

The study obtained ethical clearance from the Institutional Review Board (IRB) of the King Abdullah International Medical Research Center (KAIMRC) in Saudi Arabia. Hospital medical record numbers were used without any identification material. The data was collected only for research purposes and was not used for other purposes. A series of measures were taken to ensure the protection of confidentiality. The data did not contain the names of the deceased, but were labeled with a reconstructable personal alphanumeric identifier. All data were stored on a designated computer with an access-limited locked hard drive.

3. Results

3.1. Total fatality rate and preventable fatality rate per admissions

Between 2010 and 2016, there were 1138 deaths in children under the age of 18 at KASCH, with an overall fatality rate of 31.6/1000 admissions. The fatality rate for preventable causes of deaths per admissions was highest in 2010 at 6/1000 and lowest in 2015 at 1.8/1000, with an overall preventable fatality rate of 4.8/1000 admissions (Table 1).

3.2. Demographic characteristics of all deaths

The socio-demographic characteristics of these children are shown in Table 2. Nearly one-third (30.7%) were neonates (0–28 days old), followed by the age groups 29 days–1 year (25.3%), 2–5 years old (21.5%), 6–12 years (12.2%), and 13–18 years (10.3%). A little over half (54%) were male, and over one-third (34.2%) had an underlying disability. Medical diseases were the most common causes of death, accounting for 966 deaths (85%), followed by preventable causes which resulted in 172 deaths (15%). Of the preventable causes, the majority of 142 (82.6%) were due to injuries, while 30 (17.4%) were labeled as SUID without investigations such as scene investigations or autopsy performed. SUID was defined as the sudden and unexpected death of a baby under a year old in whom the cause was not obvious prior to the investigation [15]. Excluding neonates (0–28 days), 21% of all deaths occurring in children over one month of age and 53% of deaths occurring over 6

Table 2

Demographic characteristics of all deaths from 2010 to 2016.

Parameters	Number (%)
Age group	
0–28 days	349 (30.7)
29 days - 1 year	288 (25.3)
2–5 years	245 (21.5)
6–12 years	139 (12.2)
13–18 years	117 (10.3)
Gender	
Male	615 (54.0)
Female	523 (46.0)
Nationality	
Saudi	1039 (91.3)
Non-Saudi	99 (8.7)
Underlying disability	
Yes	389 (34.2)
No	749 (65.8)
Cause of death	
Medical	966 (85.0)
Preventable	172 (15.0)
Type of preventable causes	
Injuries	142 (82.6)
Others (SUID)	30 (17.4)
Type of medical causes	
Congenital diseases [†]	521 (45.8)
Acute illnesses [‡]	280 (24.6)
Chronic illnesses [§]	159 (14.0)
Unknown diagnosis	178 (15.6)

SUID: Sudden Unexpected Infant Death.

[†]A congenital disease is a medical condition that is present at or before birth.

[‡]Acute illnesses generally develop suddenly and last a short time.

[§]Chronic illnesses develop slowly and may worsen over an extended period of time.

years of age can be prevented. Congenital diseases contributed to the highest percentage (45.8%) of medical causes of death, followed by acute illnesses (24.6%), unknown medical diagnosis (15.6%), and complications of a chronic disease (14%).

3.3. Categories of the preventable cause of death

Table 3 shows that the leading preventable causes of death were MVA (50%), SUID (17.4%), drowning (11%), abuse (7.6%), fire, burns and weapons (7.0%), and household accidents such as strangulations, poisoning, and falls (7.0%). The preventable cause of child death in different age groups is shown in Table 4. In the age group of 0–28 days, SUID was the most common (85.7%), followed by abuse (14.3%). In the 29 days - 5 years age group, MVA was the most common (31.1%), followed by SUID (29.7%) and drowning (13.5%). In the age group of 6–12 years, although MVA was also the leading preventable cause of death, the proportion was higher (57.8%) as compared to the previous age group; drowning (20%) was the second most prominent cause. In the age group of 13–18 years, MVA was also the most common cause of preventable death

Table 1

Total fatality rate and preventable causes fatality rate per admissions from 2010 to 2016.

Year	No. of admissions	No. all deaths	Total fatality rate per admissions	No. of preventable deaths	Fatality rate of preventable causes per admission
2010	5447	204	37.5/1000	33	6/1000
2011	5608	183	32.6/1000	30	5.4/1000
2012	4978	149	30/1000	23	4.6/1000
2013	4536	128	28/1000	25	5.5/1000
2014	4101	168	41/1000	21	5.1/1000
2015	5522	128	23/1000	10	1.8/1000
2016	5729	175	30.5/1000	30	5.2/1000
Total	35921	1135	(31.6/1000)	172	(4.8/1000)

Table 3
Categories and characteristics of the preventable causes of death 2010–2016.

Category of preventable causes	Number (%) ^a
Motor Vehicle Accident (MVA)	86 (50.0)
Child Drivers	12 (14.0)
Passengers	45 (52.3)
Pedestrians	25 (29.1)
Sudden Unexpected Infant Death (SUID)	30 (17.4)
Crib	11 (36.6)
Adult bed	7 (23.3)
Unknown	12 (40.1)
Drowning	19 (11.0)
In house swimming pool	2 (10.5)
Chalet swimming pool	10 (52.6)
Other places	7 (36.8)
Abuse	13 (7.6)
Physical abuse	8 (61.6)
Neglect	5 (38.5)
Fire, Burn, Weapon	12 (7.0)
Fire in house	4 (33.3)
Electrocution	2 (16.6)
Weapon	6 (50.0)
Household accident	12 (7.0)
Strangulation/suffocation	4 (33.3)
Fall	6 (50.0)
Scald burn	1 (8.3)
Poisoning	1 (8.3)

^aPercentages may not add to 100 due to missing data.

(80.4%), followed by abuse (6.5%) and fire, burns and weapons (6.5%). The distribution of medical and preventable causes of death based on age is shown in Fig. 1. In all age groups, there were higher percentages of medical causes compared to preventable causes of death. As the child grew older, the percentage of medical causes of death decreased, while the percentage of preventable causes of death increased.

Significant age and gender differences were found in terms of different types of preventable injuries. SUID, drowning, abuse, and household accidents were found to be higher among young children compared to the older age group ($P < .01$). With regard to gender, it was found that MVA, drowning, abuse, and household accidents were higher among males compared to females ($P < .01$) (Table 5).

3.4. Detailed report on different types of preventable injuries

Motor Vehicle Accidents (MVA): MVA was the leading cause of preventable death for all children over one year of age, with only 2.3% involving infants under one year old. The occurrence of MVA death increased with age and was the highest among adolescents aged 13–18 years (80.4%), followed by children aged 6–12 years (57.8%), and toddlers aged 1–5 years (31.1%). Further details demonstrate that most MVA deaths involve child passengers (52.3%), followed by pedestrians (29.1%) and child drivers (14%). Of the 86 deaths caused by MVA, 79% were male and 21% were female. Information on car seat/seat belt usage was not available for all 86

patients, and the majority (91%) involved cars, while a few (3.5%) involved motorcycles, and 1.5% involved 4-wheeled motorcycles.

Sudden Unexpected Infant Death (SUID): Out of the 30 SUIDs, 11 (36.6%) of the deaths occurred in the crib, followed by in adult bed (23.3%), and sleeping place was not documented in 12 (40.1%). SUID was more common among females (73.4%) compared to males (26.6%), with the majority (93.3%) being less than 6 months of age. There is no information on co-sleeping with adults or unsafe sleeping environment, and none of the patients underwent autopsy or death scene investigation through forensic medicine.

Drowning: This child injury was the third most common cause of preventable death, accounting for 11% of all preventable causes, with typical victims being males (74%) and toddlers under 5 years of age (53%). More than half (52.6%) of the incidents occurred in a resort (chalet) swimming pool, followed by indoor swimming pool (10.5%), and 36.8% of the locations were not documented. Nearly half (47%) were found to be submerged in the pool without a floating device, and in 95% of cases, it was noticed that the pool was not fenced.

Child Maltreatment: Child abuse and neglect were the fourth cause of preventable death, resulting in 13 (7.6%) preventable deaths. The majority was due to physical abuse (61.6%), followed by neglect (38.5%). Over half of the abuse cases (54%) occurred in children under 5 years of age.

Falls and household accidents: Household accidents were the fifth cause of preventable death, resulting in 12 (7%) deaths, where fall was the most common cause of household accident and was responsible for 6 (50%) deaths and occurred in toddlers ≤ 5 years old. Strangulations by a curtain's robe were the second household accident and accounted for 3 (25%), followed by scald burns (8.3%). All household accidents occurred in children under 6 years of age, whereas 1 case of strangulation occurred due to choking game (8.3%) and 1 case of poisoning (8.3%) occurred in adolescents.

Fire and Burns: Fire and burns resulted in 6 (3.5%) of all preventable deaths. Of those, one third (33.3%) was due to smoke inhalation, followed by electrocution (16.6%). The majority of the victims (66.6%) were over 5 years old and there was equal gender distribution.

Weapon: Weapons represented another 6 (3.5%) preventable deaths, in which four deaths were attributed to firearms, one to sharp instruments, and in one case, the data on the type of weapon was not available. No further details were available for all weapon-related deaths regarding the place of the incident or whether it is homicide, suicide, or unintentional.

4. Discussion

This study indicates that one out of seven children who died in a tertiary care hospital in SA died of preventable causes, and that injury was the leading cause of death. In the last two decades, the Arab world has witnessed a significant decrease in the infant mortality rate (IMR); however, the size of the decrease varied substantially across countries. The infant mortality rate in the gulf

Table 4
Different types of preventable injuries in different age groups.

Category of preventable causes	0–28 days (%)	29 days - 5 years (%)	6–12 years (%)	13–18 years (%)	Total preventable cause of death (n = 172)
Motor Vehicle Accident (MVA)	0	23 (31.1)	26 (57.8)	37 (80.4)	86 (50.0)
SUID	6 (85.7)	22 (29.7)	1 (2.2)	1 (2.2)	30 (17.4)
Drowning	0	10 (13.5)	9 (20.0)	0	19 (11.0)
Abuse	1 (14.3)	6 (8.1)	3 (6.7)	3 (6.5)	13 (7.6)
Fire, burn, weapon	0	4 (5.4)	5 (11.1)	3 (6.5)	12 (7.0)
Household accidents (strangulation, fall etc.)	0	9 (12.2)	1(2.2)	2(4.3)	12 (7.0)
Total preventable injuries	7 (4.1)	74 (43.0)	45 (26.0)	46 (27.0)	172 (100.0)

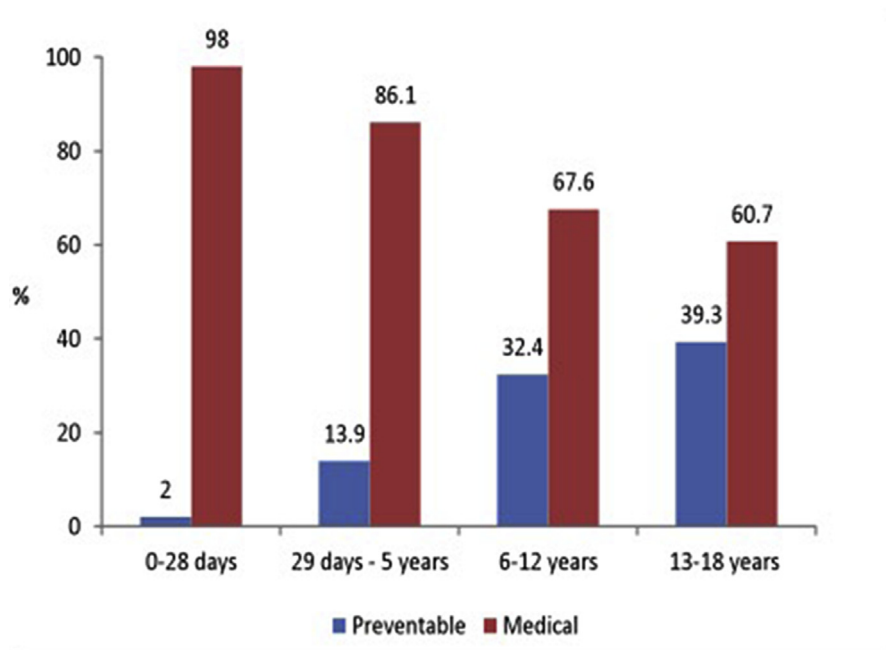


Fig. 1. Medical and preventable death by age group.

Table 5

Different types of preventable injuries by age, gender, and underlying disabilities (N = 172).

Category of preventable causes	Age*		Gender*		Disability		Total
	≤5	>5	Male	Female	Yes	No	
Motor Vehicle Accident (MVA)	23 (26.7)	63 (73.3)	68 (79.1)	18 (21)	2 (2.3)	84 (97.7)	86 (50.0)
SUID	28 (93.3)	2 (6.6)	8 (26.6)	22 (73.4)	5 (17)	25 (83)	30 (17.4)
Drowning	10 (53)	9 (47)	14 (74)	5 (26)	1 (5)	18 (95)	19 (11.0)
Abuse	7 (54)	6 (46)	7 (54)	6 (46)	2 (15.9)	11 (84.6)	13 (7.6)
Fire, burn, weapon	4 (33.3)	8 (66.6)	6 (50)	6 (50)	0	12 (100)	12 (7.0)
Household accidents	9 (75)	3 (25)	8 (66.6)	4 (33.3)	1(16)	10 (83)	12 (7.0)

*p < 0.01.

countries (Saudi Arabia, Kuwait, Bahrain, Qatar, and the United Arab Emirates - UAE) has declined dramatically since 1990 to an average of 6/1000 live births in 2017, with a reduction rate of at least 50% [5]. Regional studies and available data that attempt to identify causes of death are broadly limited to children under 5 years of age. It is worth noting that these mortality data reflect factors associated with pregnancy and delivery such as the duration of gestation, prenatal care, single or multiple births, infant's health status and weight at birth, delivery conditions, and postnatal care. A better picture of the status of child protection in a country can be seen when examining mortality for the age range from birth to 18 years. This is very important in our region as children under 18 years of age constitute over one third of the population in the Arab world and in the Gulf countries in particular [16]. Furthermore, national statistics are often classified by aggregating data into age groups <15 or ≥15 years such that adolescent data are diluted with adult data, making it difficult to have a full picture of childhood data. Practice further contributes to this dilemma as any patient >14 years is considered to be an 'adult' and is managed by adult specialty physicians. The exception is a few healthcare institutions with available adolescent medicine specialists and who define a child as anyone less than 18 years of age; however, such institutions are extremely limited in the country. There is a paucity of data on the causes of child death in the Arab region, especially in children over 5 years of age, with a limited number of research and studies

[5]. Although the IMR is a good indicator of the country's health system with respect to improved immunization rates, prenatal care, and screening of genetic disorders, a shift of deaths to older age groups and alternative causes of death is being observed.

This study examined the causes of death among different age groups of children from 0 to 18 years of age. The finding that 15% of all deaths can be prevented is of great concern. In Iraq, a national study revealed that the leading cause of death among children under 5 years of age is childhood illnesses (81%), followed by SUID (8.9%) and household accidents (3.3%) [17]. In Qatar, a retrospective study conducted at the women's hospital between 1977 and 2007 revealed that prematurity was the leading cause of death of neonates (42.6%), followed by congenital anomalies (28%) [18]. It is clear that all available studies in the Arab region focus on children under 5 years of age, especially neonatal deaths, and on the biological and genetic causes of death. Alsaif et al. (2018) from SA studied all unnatural child deaths reported to the Center of Forensic and Legal Medicine in the city of Dammam in the eastern province of the country. Of the 157 suspected criminal referrals, only 33% underwent an autopsy, and accidental death (injuries) was the most common cause, accounting for 51%. The circumstances of the deaths are reported as follows: accidental drowning is the most common (23%), followed by firearms (10%), hanging (8%), and abuse (6%) [19].

The preventable causes of death identified in each age group are aligned with the developmental stages and changes of the children,

i.e. the exploratory and risk-taking behaviors that emerge in toddlers and adolescents, respectively. Therefore, it is not surprising that children of varying age groups will engage in certain behaviors; however, the concern lies in the fact that the behaviors resulted in a fatality that could have been prevented if there had been an intervention.

MVA and injuries are the second leading cause of death in Saudi Arabia, accounting for 32.3% of all adult mortality in the country [20]. In this study, MVA was the leading cause of preventable deaths among Saudi children, indicating poor child restraint and compliance with the law. Alsanea et al. (2018) observed the use of restraint system among families in the city of Riyadh and found that only 36.6% use the child restraint system, and the majority use it inconsistently. Sitting on the lap of an adult passenger on the front seat was noticed at 54.5%, and only 15.3% of adults use seat belts [21]. In JEELUNA, a national study on adolescent health, 35.4% of adolescents (N = 12,575) reported having been involved in an MVA. Unfortunately, only 13.8% use seat belts sometimes/always. Furthermore, the majority of the adolescents were underage for driving; despite this, 18% reported having driven a car without parental permission [22]. Our data indicate that in 14% of all children's MVA, the child was the driver, even though the Saudi child protection law and road traffic law prohibits such action; this and absence of child restraint systems while driving reflect the need for further law enforcement and monitoring.

Drowning also deserves focused attention as 11% of the preventable mortality cases in our study are attributed to it. Swimming is a life skill; children starting in early childhood need to learn/be taught this skill. An extremely limited number of schools in the country teach their students how to swim, and this is limited to private schools. Swimming lessons are available mainly in large cosmopolitan cities and are often offered at prices unaffordable to many. The pools at the chalets where most drowning occurred in our review are not designed for children. They often lack safety measures (fences or floatation devices) and there are no lifeguards to watch over the swimmers. A limited number of the public are trained to provide basic life support techniques in the event of drowning, and bystanders usually rush the drowned child to the nearest health care facilities, which are usually a significant distance away. Therefore, parental and adult supervision, as well as training in child resuscitation and the provision of safety measures in these pools, are invaluable.

Despite the low number of household accidents identified in this review, it is not clear what the actual cause of death is. For instance, three children were documented to have undergone strangulation by the robe of a window curtain. It is not clear if this strangulation is suicidal, non-suicidal, or homicidal. In this review, we identified a case of non-suicidal self-strangulation, also known as the 'choking game', which was previously reported [23]. Hospital policies and procedures should be implemented to document causes of death from household accidents with further investigation of each case. Therefore, having a fatality review board in each health care facility will identify the risk factors for these deaths in order to implement proper prevention programs.

Thirty cases (17%) of our death review were labeled as SUID because no autopsy or death scene investigations were conducted. In Saudi Arabia, all cases of unexpected unnatural deaths that occurred in health care facilities should be referred to forensic medicine for autopsy and/or death scene investigations. However, the reviewed charts of the 30 cases included in this review did not indicate any referral for autopsy or investigation of the death scene, and hence were classified as SUID according to the CDC classification [24]. Should further investigation and forensic referral of all SUIDs be carried out? Absolutely—however, we should not forget that in Islamic culture the body of a deceased is highly respected

and the burial is recommended as soon as possible after death. This cultural issue, as well as the scarcity of forensic physicians who perform such investigations and of forensic medicine centers, may have prevented the professionals from submitting the cases for autopsy. In addition, there is no consistent approach for requesting/conducting autopsies in different hospitals in Saudi Arabia.

In addition to enforcement of policies to investigate every unexpected death, further education and awareness of the specific needs or indications for autopsy are required and encouraged, while also recognizing the uncertainty about the contribution of asphyxiation and suffocation to death, and accounting for variations in case investigations [24].

4.1. Prevention is the way

Simple means can prevent 71–95% of all injuries. Many countries have demonstrated that this has successfully reduced the mortality rate of accidental injuries by 10–20%. For example, in the United States, the percentage was reduced to about 35% in a decade. In Sweden, 3 decades of constant preventive efforts and close monitoring of data have proven to have effectively reduced the mortality rate due to accidental injuries in children by 80% [25].

The strategies that have proven to be effective are education and public campaigns, safer products and surroundings, promotion of public policies, enforcement, data collection, research and evaluation, and empowerment [26]. A combination of strategies is the most effective. Despite the dismal picture, accidental injuries in children can be prevented and are not inevitable. It is advisable to consider injuries as a heterogeneous group of illnesses, with different etiology, risk groups, and 'preventive treatments'- a group of preventable diseases. It is very important to establish a national strategy for child safety accompanied by an adequate budget. Most importantly, it requires a lot of perseverance and commitment.

To the best of our knowledge, this is the first study in the country that addresses child mortality in children from 0 to 18 years old; however, it has some limitations. First, this is a single center study and the result cannot be reflected as representative of the whole country. Second, the source of data were the hospital's medical records which, due to lack of access, did not include the post-mortem examination findings if they were ever performed, and hence the cause of death was determined based on the clinical findings and the data collectors, to the best of their knowledge. Third, chart documentations are of poor quality and insufficient or missing data, especially for those labeled as dead on arrival, or SUID considering the limited time and circumstances. Finally, this study can identify potential associations but cannot establish true cause-and-effect relationships.

5. Conclusion

Although mortality for infant and under-5 children has significantly declined in Saudi Arabia, we do not know what the trend of child mortality in general has been. Through this study, we have identified the mortality rates of children of various age groups and have identified the causes of death. Preventable mortality constitutes a significant portion of these deaths, and focused attention and efforts are needed at all levels. This starts with further legislation, including laws and processes that mandate the review of all child deaths. For existing laws, attention is needed towards enforcement and monitoring of these laws. Education and awareness of children, adolescents, parents, and professionals working with/caring for children are needed in many areas and will support the prevention of these deaths. Integrating these into schools and communities is very important. The role of the media in supporting these campaigns, whether for legislation, training, or education is essential.

Funding

The authors would like to thank King Abdullah International Medical Research Center (KAIMRC) for their financial support of this study with grant number - RC15/082.

Ethical statement

The study obtained ethical clearance from the Institutional Review Board (IRB) of the King Abdullah International Medical Research Center (KAIMRC) in Saudi Arabia. Hospital medical record numbers were used without any identification material. The data was collected only for research purposes and was not used for other purposes. A series of measures were taken to ensure the protection of confidentiality. The data did not contain the name of the deceased, but were labeled with a reconstructable personal alphanumeric identifier. All data were stored on a designated computer with an access-limited locked hard drive.

Authors contribution

Maha Almuneef is the principal investigator of the study, acquired the funding, and participated in the design, analytic plan, and drafting the article. Hassan Saleheen carried out the analysis of the data and wrote the sections on the results. Fadia AlBuhairan prepared aspects of the discussion and the literature review. Majid Al-Eissa contributed to the discussion section. Manal Al Muntaser prepared the data for analysis and wrote sections of the methods. Hala Al Alem contributed to the background section. Tarek Al Abrash contributed to the background section and the literature review. Saif Al Saif contributed to the discussion section and over saw the production of the data. Beverly Baylon contributed to the method section.

Declaration of competing interest

This is to declare that all authors have no conflict of interest.

Visual abstract

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jpam.2020.06.003>.

References

- [1] Fraser J, Sidebotham P, Frederick J, Covington T, Mitchell E. Learning from child death review in the USA, England, Australia, and New Zealand. *Lancet* 2014;384(9946):894–903. [https://doi.org/10.1016/S0140-6736\(13\)61089-2](https://doi.org/10.1016/S0140-6736(13)61089-2).
- [2] World Health Organization (WHO). Children: reducing mortality. 2019 [Retrieved 19 September 2019]. Available from: <https://www.who.int/news-room/fact-sheets/detail/children-reducing-mortality>.
- [3] Sidebotham P, Fraser J, Covington T, Freemantle J, Petrou S, Pulikottil-Jacob R, et al. Understanding why children die in high income countries. *Lancet* 2014a;384(9946):915–27.
- [4] Sidebotham P, Fraser J, Fleming P, Ward-Platt M, Hain R. Patterns of child death in England and Wales. *Lancet* 2014b;384(9946):904–14. [https://doi.org/10.1016/S0140-6736\(13\)61090-9](https://doi.org/10.1016/S0140-6736(13)61090-9).
- [5] World Bank. Mortality rate, infant (per 1000 live births) - world Bank Open data. 2017 [Retrieved 15 March 2019]. Available from: <https://data.worldbank.org/indicator/sp.dyn.imrt>.
- [6] Centers for Disease Control and Prevention (CDC). Ten leading causes of death and injury. 2019 [Retrieved 1 May 2019]. Available from: <https://www.cdc.gov/injury/wisqars/LeadingCauses.html>.
- [7] World Health Organization (WHO). Injuries and violence of the facts. 2014 [Retrieved 12 February 2019]. Available from: https://apps.who.int/iris/bitstream/handle/10665/149798/9789241508018_eng.pdf;jsessionid=64F3C5537_B37AA624C75D659AC895E9E?sequence=1.
- [8] Centers for Disease Control and Prevention (CDC). Childhood injury report: patterns of unintentional injuries among 0-19 Year olds in the United States, 2000-2006. 2008 [Retrieved 5 January 2019]. Available from: <https://www.cdc.gov/safecchild/pdf/cdc-childhoodinjury.pdf>.
- [9] Richardson EG, Hemenway D. Homicide, suicide, and unintentional firearm fatality: comparing the United States with other high-income countries 2003. *J Trauma* 2011;70:238–43. <https://doi.org/10.1097/TA.0b013e3181dbaddf>.
- [10] Australian Bureau of Statistics. 3302: 0-Deaths, Australia. 2009 [Retrieved 15 July 2019]. Available from: <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3302.02009;2011>.
- [11] Department of Education UK. Child death reviews: year ending 31 March 2011. 2011 [Retrieved 1 October 2019]. Available from: <https://www.gov.uk/government/statistics/child-death-reviews-completed-in-england-year-ending-31-march-2011>.
- [12] Desapriya E, Sones M, Ramanzin T, Weinstein S, Scime G, Pike I. Injury prevention in child death review: child pedestrian fatalities. *Inj Prev* 2011;17(suppl 1):i4–9. <https://doi.org/10.1136/ip.2010.026914>.
- [13] Rimsza ME, Schackner RA, Bowen KA, Marshall W. Can child deaths be prevented? The Arizona child fatality review program experience. *Pediatrics* 2002;110:e11. <https://doi.org/10.1542/peds.110.1.e11>.
- [14] Statistical Package for the Social Sciences. Version SPSS 20.1 for windows. 2014 [Chicago, IL].
- [15] Centers for Disease Control and Prevention (CDC). Sudden unexpected infant death and sudden infant death syndrome. 2018 [Retrieved 10 July 2019]. Available from: <https://www.cdc.gov/sids/about/index.htm>.
- [16] Arab Council for Childhood and Development. Annual performance report. 2013 [Retrieved 5 September 2019]. Available from: http://english.arabccd.org/page/1353_Annual_Performance_Report.
- [17] Awqati NA, Ali MM, Al-Ward NJ, Majeed FA, Salman K, Al-Alak M, et al. Causes and differentials of childhood mortality in Iraq. *BMC Pediatr* 2009;22(9):40. <https://doi.org/10.1186/1471-2431-9-40>.
- [18] Salameh K, Rahman S, Al-Rifai H, Masoud A, Lutfi S, Abdouh G, et al. An analytic study of the trends in perinatal and neonatal mortality rates in the State of Qatar over a 30-year period (1977 to 2007): a comparative study with regional and developed countries. *J Perinatol* 2009;29(11):765–70. <https://doi.org/10.1038/jp.2009.89>.
- [19] Alsaif DM, Almadani OM, Almoghannam SA, Hamdi D, Al-Farayedhi MA, Kharosha MA. Child fatalities in Dammam: a call for child fatality reviews in Arab countries. *J Forensic Sci* 2018;63(4):1171–5. <https://doi.org/10.1111/1556-4029.13685>.
- [20] Pearson GA, Ward-Platt M, Harnden A, Kelly D. Why children die: avoidable factors associated with child deaths. *Arch Dis Child* 2011;96:927–31. <https://doi.org/10.1136/adc.2009.177071>.
- [21] Alsanea M, Masuadi E, Hazwani T. Use of child restraint system and patterns of child transportation in Riyadh, Saudi Arabia. *PLoS One* 2018;13(1):e0190471. <https://doi.org/10.1371/journal.pone.0190471>.
- [22] AlBuhairan FS, Tamim H, Al Dubayee M, AlDhukair S, Al Shehri S, Tamimi W, et al. Time for an adolescent health surveillance system in Saudi Arabia: findings from "Jeeluna". *J Adolesc Health* 2015a;57(3):263–9. <https://doi.org/10.1016/j.jadohealth.2015.06.009>.
- [23] AlBuhairan FS, AlMutairi A, Al Eissa MA, Naeem M, Almuneef M. Non-suicidal self strangulation among adolescents in Saudi Arabia: case series of the choking game. *J Forensic Leg Med* 2015b;30:43–5. <https://doi.org/10.1016/j.jflm.2014.12.015>.
- [24] Shapiro-Mendoza CK, Camperlengo L, Ludvigsen R, Cottengim C, Anderson RN, Andrew T, et al. Classification system for the sudden unexpected infant death case registry and its application. *Pediatrics* 2014;134:e210–9. <https://doi.org/10.1542/peds.2014-0180>.
- [25] Hemmo-Lotem M, Danon Y. Childhood injuries in Israel: status and prevention strategies. *Harefuah* 2003;142(8–9):609–11.
- [26] United Nations Development Program (UNDP). Reduce child mortality report. 2014 [Retrieved 10 July 2019]. Available from: http://www.sa.undp.org/content/saudi_arabia/en/home/mdgoverview/overview/mdg4.html.