

# The prevalence of head and facial injuries among children in Saudi Arabia following road traffic crashes

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**BACKGROUND:** Motor vehicle crashes (MVCs) are the leading cause of death among children in Saudi Arabia. Childhood injuries can be prevented or minimized if safety measures, such as car seats, are implemented. The literature on the epidemiology of head and facial injury among children is limited, which affects the ability to understand the extent of the burden and hinders investment in public health prevention.

**OBJECTIVE:** Describe the epidemiology of head and facial injuries among children admitted to the hospital following MVCs.

**DESIGN:** Retrospective chart review.

**SETTINGS:** Five hospitals in several regions.

**PATIENTS AND METHODS:** We collected data on all patients ≤16 years old, who were admitted to the hospital following MVCs between 2016-2019. Differences in various characteristics like head injury status and age groups were compared.

**MAIN OUTCOME MEASURES:** Head and facial injuries.

**SAMPLE SIZE:** 253 patients.

**RESULT:** Of the injured population, 97 (38.3%) sustained a head injury, and 88 (34.8%) had a facial injury. Thirteen (9.1%) children were driving the car at the time of the crash. About half of the children were seated in the back (53.8%) without a seatbelt or safety seat.

**CONCLUSION:** The prevalence of head and facial injuries is striking. In addition, the study revealed that driving among children is not uncommon, which warrants monitoring and implementing interventions. Improved documentation of restraint use and police enforcement of safety laws can play a significant role in reducing associated injuries. The study findings highlight the importance of combination or rear seating as well as age-appropriate restraint in order to reduce the likelihood of head or facial injuries among children.

**LIMITATIONS:** Retrospective study using the electronic search system to identify patients, but may have missed cases that were not coded correctly. Large amount of missing data for some variables. Additionally, the analysis was limited to those admitted to the hospital.

**CONFLICT OF INTEREST:** None.

Worldwide, more than 1.3 million victims die every year due to motor vehicle crashes (MVCs).<sup>1</sup> In the United States, MVCs are the leading cause of death among children younger than one year of age and account for about 3% of emergency department visits.<sup>2</sup> MVCs are also the leading cause of death among children and young adults aged 5-29 years, and this will likely remain the case in the future.<sup>3</sup> Although there is a decline in the burden in developed countries, MVC deaths have increased in developing countries.<sup>4</sup> Saudi Arabia is among countries with a high burden of traffic injuries despite being a developed high-income country.<sup>5</sup> It is widely recognized that MVC injuries are preventable. Despite that, the country still lags behind when it comes to investment in primary prevention aimed to reduce the burden of MVCs.<sup>6</sup> This could be due, in part, to the poor understanding of the epidemiologic burden, as is the case in many developing countries.<sup>7,8</sup>

When compared to other body parts, head injuries pose a higher risk for morbidity and mortality in adults.<sup>9,10</sup> This can be pronounced even further in children due to the immaturity of their skeletal system and the larger head-to-body ratio.<sup>11</sup> In addition, head injuries pose a significant burden on healthcare facilities. In the United States, approximately half a million children experience a traumatic brain injury each year.<sup>12</sup> MVCs are a leading cause of head injuries among children. Some studies have found up to 70% of those injured in an MVC sustained head injuries.<sup>13</sup> The use of child restraints, such as car seats, seat boosters, and seatbelts provide good protection from bodily injuries, and decrease the risk of death among infants and young children by 71% and 54%, respectively.<sup>14</sup>

Developed countries have long recognized the value of safety measures to reduce injuries following MVC. In Australia and the United States, both seatbelt and child car seat compliance rates are very high (86-97%).<sup>1</sup> On the other hand, the rate of child restraint use varies from developed to developing countries.<sup>15,16</sup> Despite the fact that using safety measures such as seatbelts and car seats are mandated for children by Saudi law, consistent seatbelt use remains as low as 15.3%.<sup>17</sup> Other self-reported surveys stated that only 43.3% of parents reported using a car seat for their children.<sup>18</sup> Currently, the frequency of use and the consequences of misuse of child restraints are still unknown in the country. More importantly, data published on the epidemiology of MVC injuries among children and their association with restraint use is limited.

Several local studies examined the burden of MVC, but none focused on car seat compliance and their con-

sequences, such as head injuries.<sup>19-21</sup> Moreover, most of the work that was done previously emphasized adult facial injuries due to MVC without a focus on children.<sup>22</sup> Aside from the risk of mortality, nonfatal injuries among children may lead to permanent disabilities that impact the population health and healthcare utilization for extended periods. In this study, we aimed to describe the prevalence of head and facial injuries among pediatric patients following MVC injuries. In addition, we aimed to examine the association between various variables and head or facial injuries among children seeking medical care after traffic crashes.

## METHODS

This was a retrospective study that used the electronic medical record (EMR) system at five hospitals of the National Guard Health Affairs (NGHA) in Saudi Arabia. This network is responsible for providing healthcare services to all National Guard personnel and their families and serves a population of over one million beneficiaries. Care is coordinated via a single EMR system known as BESTCARE. This system was implemented in January of 2016.

For the purpose of this study, we searched the system for all traffic crash-related admissions, and all patients meeting the inclusion criteria were identified. Data captured included five locations: King Abdulaziz Medical City in Riyadh, King Abdulaziz Medical City in Jeddah, King Abdulaziz Hospital in Al Ahsa, Al-Imam Abdulrahman bin Faisal Hospital in Dammam and Prince Mohammad Bin Abdulaziz Hospital in Al-Madinah. Cases from King Abdulaziz Medical City in Jeddah and Prince Mohammad Bin Abdulaziz Hospital in Al Madinah were combined to represent the western region while cases from King Abdulaziz Hospital in Al Ahsa and from Al-Imam Abdulrahman bin Faisal Hospital in Dammam were combined to represent the eastern region.

All patients 16 years of age or younger involved in MVCs as vehicle passengers between 2016-2019 were included in this study. Children who were involved as pedestrians or as motorcycle riders were excluded. In addition, patients who were transferred to another hospital due to ineligibility were excluded from the study due to limited information about whether they were passengers and their health outcomes. Initially, the system identified 1236 patients as children admitted due to any injury. Next, two trained research registrars reviewed all the medical records and identified 253 children who met the inclusion criteria. Excluded patients sustained other mechanisms of injuries such as falls or pedestrian injuries.

A predesigned data collection sheet was used to collect data from the EMR. The data collection sheet included demographics, anatomic, physiologic, and outcome information. In addition, the data included information about the child position, safety measures (car seat or seatbelt), and the description of sustained injuries. This included fractures, contusion, abrasion, and site on the body. This study was reviewed and approved by the King Abdullah International Medical Research Center Institutional Review Board.

All statistical analyses were conducted using STATA 15 for Microsoft. Descriptive statistics were summarized in the form of frequencies or mean (standard deviation). To examine differences across groups, chi-square tests were used. For cell counts of less than five observations we used Fisher's exact test. Statistical significance was set at 5% ( $P < .05$ ). The outcome was the prevalence of facial or head injuries, defined as the proportion of children with such injuries as part of the overall injured population. The prevalence of non-compliance to safety measures was in accordance with the American Academy of Pediatrics (AAP) Recommendations on motor vehicle safety for children.<sup>23</sup> The AAP recommends that all children younger than 13 years of age must be fastened in the back seat of the vehicle.

## RESULTS

We identified 253 patients who met the inclusion criteria and were included in all analyses (Table 1). Most children (43.0%) were between the ages of 6-12, and age ranged from the newly born to 16 years. The mean (SD) was 8.1 (4.6). Over two-thirds of children were males (68.7%). Of the injured children, 190 (75.1%) were from Riyadh, and the remaining were from the other regions. Only four children (1.5%) used safety measures (car seat in one case and seatbelt in three cases), 125 (49.4%) were not restrained, and the remaining 124 (49.0%) did not have documented safety measures. Among those without missing seating information, 41.7% were seated in incorrect positions. Injured children stayed a mean (SD) of 3.7 (8.4) days in the hospital.

Overall, 97 (38.8%) of children sustained head injuries, and 88 (34.7%) sustained facial injuries (Table 1). Among children ages: 0-5, 6-12, and 13-16, the documented prevalence of non-use of a car seat or seatbelt was 56.1%, 44.0%, and 50.0%, respectively (Table 2). Children younger than six years of age were more likely than other age groups to be seated incorrectly ( $P < .01$ ). In addition, they were more likely to be seated in the front seat (24.4%,  $P < .01$ ). Twenty percent of children ages 14 to 16 were drivers, and 21.7% of children aged 0-4 were sitting on the passengers' lap (Table 2).

Of those who sustained head and facial injuries, children aged 6- to 12-years old were the largest group (49.4%). The same was true for patients who sustained facial injuries (Table 3). Males represented the majority of those who sustained head and facial injuries (74.2%, 73.8%, respectively). Six (2.3%) children died due to the injuries. We did not find a statistically significant association between incorrect child seating and head or facial injuries (Table 3).

**Table 1.** Baseline characteristics of the pediatric population admitted to National Guard facilities following motor vehicle crashes (n=253).

Age (years)	8.2 (4.6)/ 8.0 (7)
<b>Age group (years)</b>	
0-5	82 (32.4)
6-12	109 (43.1)
13-16	62 (24.5)
<b>Gender</b>	
Female	79 (31.2)
Male	174 (68.8)
<b>Safety<sup>a</sup></b>	
No	125 (49.4)
Yes	4 (1.6)
Missing	124 (49.0)
<b>Child position</b>	
Correct	85 (33.6)
Incorrect	61 (24.1)
Missing data	107 (42.3)
<b>Head injury</b>	
Yes	97 (38.3)
No	156 (61.7)
<b>Facial injury</b>	
Yes	88 (34.8)
No	165 (65.2)
<b>Head and facial injury</b>	
Yes	87 (34.4)
No	166 (65.6)
Length of stay hospital (days)	3.7 (8.4)

Data are number (%) or mean (standard deviation)/median (interquartile range). <sup>a</sup>Car seat or seatbelt.

**Table 2.** Association between age groups and safety patterns among the study population.

	Age			Total	P value
	0-5	6-12	13-16		
<b>Car seat or seatbelt</b>					.60
No	46 (56.1)	48 (44.0)	31 (50.0)	125 (49.4)	
Yes	1 (1.2)	2 (1.8)	1 (1.6)	4 (1.6)	
Missing	35 (42.7)	59 (54.1)	30 (48.4)	124 (49.0)	
<b>Child position</b>					<.01
Correct	19 (23.2)	34 (31.2)	32 (51.6)	85 (33.6)	
Incorrect	29 (35.4)	20 (18.4)	12 (19.4)	61 (24.1)	
Missing	34 (41.5)	55 (50.5)	18 (29.0)	107 (42.3)	
<b>Child location</b>					<.01
Back	25 (30.5)	34 (31.2)	18 (29.0)	77 (30.4)	
Front	20 (24.4)	19 (17.4)	14 (22.6)	53 (21.0)	
Driver	0 (0.0)	1 (0.9)	12 (19.4)	13 (5.1)	
Missing	37 (45.1)	55 (50.5)	18 (29.0)	110 (43.5)	
<b>Seating status</b>					<.01
On the seat	29 (35.4)	58 (53.2)	44 (71.0)	131 (51.8)	
On lap	21 (25.6)	2 (1.8)	0 (0.0)	23 (9.1)	
Car seat	1 (1.2)	0 (0.0)	0 (0.0)	1 (0.4)	
Missing	31 (37.8)	49 (45.0)	18 (29.0)	98 (38.7)	

Data are number (%).

Of all head injuries, facial trauma accounted for the highest proportions (n=88, 34.8%), followed by brain injury (n=19, 7.5%). Skull fracture, facial fracture, and dental trauma were 3.6%, 2.1%, and 1.6%, respectively. The most common type of facial injury was abrasions, which were sustained in 52/93 (55.9%) of children. The second most common injury was a facial contusion, accounting for 34/59 (57.6%) of facial injuries, followed by laceration among 19/74 (25.6%) of the patients. Equally, 39.2% of children suffered from upper and lower extremities fractures while 17.8% and 10.7% of children sustained rib and spinal fractures, respectively (data not shown).

## DISCUSSION

The study found that over a third of children injured in MVCs sustained head or facial injuries. This prevalence is striking and has major implications on population health. Head injuries are a leading cause of death and disability among children.<sup>24,25</sup> Hence, further investment in traffic safety is warranted to facilitate primary prevention and to reduce preventable injuries. Despite existing laws that

limit driving to those 18 years or above and mandate the use of child safety measures, the high prevalence of these violations may be due to the absence of effective enforcement systems.<sup>26</sup> Saudi Arabia has made traffic safety a high priority by including it in the *Vision 2030 initiative* aimed to improve individual health and prosperity.<sup>27</sup> Therefore, the study findings may support these efforts by engaging the public, clinicians, and policymakers in the implementation of public health interventions. Our findings can serve as a baseline assessment to guide future initiatives to improve the safety and wellbeing of children in the country.

Our findings lend credence to previous literature documenting the burden of injuries following MVCs on children's health.<sup>22,28-30</sup> However, none of the previous national studies have evaluated the prevalence of head or facial injuries among occupants of motor vehicles.

The prevalence of head or facial injuries in the current study was substantially higher than that of other countries such as the United States and Australia.<sup>31</sup>

**Table 3.** Characteristics of the head and facial injuries in the study population.

	Total	Head Injuries		P value	Facial Injuries		P value
		Yes	No		Yes	No	
<b>Age group</b>				.25			.21
0-5	82 (32.4)	27 (27.8)	55 (35.3)		27 (30.7)	55 (33.3)	
6-12	109 (43.0)	48 (49.5)	61 (39.1)		44 (50.0)	65 (39.4)	
13-16	62 (24.5)	22 (22.7)	40 (25.6)		17 (19.3)	45 (27.3)	
<b>Gender</b>				.14			.20
Female	79 (31.2)	25 (25.8)	54 (34.6)		23 (26.1)	56 (33.9)	
Male	174 (68.8)	72 (74.2)	102 (65.4)		65 (73.9)	109 (66.1)	
<b>Region</b>				.86			.83
Riyadh	190 (75.1)	72 (74.2)	118 (75.6)		68 (77.2)	122 (73.9)	
Western	23 (9.1)	10 (10.3)	13 (8.3)		7 (8.0)	16 (9.7)	
Eastern	40 (15.8)	15 (15.5)	25 (16.0)		13 (14.8)	27 (16.4)	
<b>Car seat / seatbelt</b>				.138			.237
Yes (%)	4 (100.0)	0 (0.0)	4 (100.0)		0 (0.0)	4 (100.0)	
No (%)	123 (100.0)	44 (35.8)	79 (64.2)		41 (32.8)	84 (67.2)	
Missing	123 (100.0)	53 (43.1)	70 (57.0)		47 (37.9)	77 (62.1)	
<b>Child position</b>				.31			.58
Correct	85 (33.6)	32 (33.0)	53 (34.0)		30 (34.1)	55 (33.3)	
Incorrect	61 (24.1)	19 (19.6)	42 (27.0)		18 (20.5)	43 (26.1)	
Missing	107 (42.3)	46 (47.4)	61 (39.1)		40 (45.5)	67 (40.6)	
<b>Outcome</b>				.55			.07
Alive	247 (97.6)	94 (97.0)	153 (98.0)		88 (100.0)	159 (96.3)	
Death	6 (2.4)	3 (3.1)	3 (1.9)		0 (0)	6 (3.6)	

Data are number (%).

Among MVC patients, one study found that only 0.07% of children's injuries included facial fractures.<sup>32</sup> Another population-based study of US children between the ages of 0-14 years found the prevalence of head injuries to be around 3%.<sup>33</sup>

Strikingly, only one child (0.4%) was restrained in a car seat. This is negligible compared to previous literature (n=123; 31.9%).<sup>17</sup> A study in the United Arab Emirates found that none of injured children in MVC used car seats.<sup>34</sup> Similar findings were observed in the US by Quiñones-Hinojosa et al stated that only six children (2.3%) were properly restrained.<sup>35</sup> It is essential to recognize that wearing seatbelts among children who are supposed to be in a car seat can still pose a risk for injuries in case of crashes. One study found that children who were restrained in seatbelts were over four times

more likely to sustain a significant head injury than children in a car seat or booster seats.<sup>36</sup> Proper child restraint and seating position could have prevented most injuries, particularly those to the head.

Because as many as 51% of facial injuries among children lead to nose injuries, such injuries can lead to facial disfigurement.<sup>32,37</sup> Consequently, if a disfigurement occurs, this may lead to a negative impact on children's mental health as well as their family.<sup>38</sup> Further research is warranted to estimate the prevalence of permanent disabilities and disfigurement following MVCs in Saudi Arabia.

Our study did not find a significant association between safety measures and head or facial injuries. This does not represent evidence of their lack of benefit. This could be due to the small sample size of the study or missing observations, which leads to a lowering of the

statistical power. Previous studies among children and adults have provided evidence of the value of complying with seatbelt or car seat laws.<sup>39</sup> Arbogast et al found that unrestrained children had a 60% greater risk for facial injuries compared to appropriately restrained children.<sup>32</sup>

In our study, 53 children (20%) were sitting in the front seat. Previous studies suggest that children seated in the front were more likely to sustain more severe injuries.<sup>40</sup> Similarly, another study found that children were at greater risk of serious injury when seated in front.<sup>41</sup> Traffic police ought to investigate the prevalence of front seat violations further and plan for enforcement with public strategies to reduce safety measure violations and, ultimately, childhood injuries.

The prevalence of children in incorrect positions in this study may underestimate the true magnitude of the problem. Even among children seated in the back, they may have been sitting without correct age-appropriate safety measures. This is not in accordance with the AAP recommendations and does pose a risk for injuries and death.<sup>23</sup> Proper car seats are available and affordable on the market, so the continued low compliance rate is unfortunate and poses a major risk to population health.<sup>42</sup> Therefore, much work needs to be done to increase the awareness of parents of the risks associated with placing children in incorrect positions while vehicles are in motion. Moreover, awareness campaigns should be integrated into the school curriculums, and monitoring systems should be modified to ensure proper enforcement.

Public health professionals and clinicians can use the findings presented in this study to educate parents about the significance of proper seating position and age-appropriate restraints. Moreover, policymakers can use the study to facilitate the implementation of traffic safety rules and law enforcement measures that will preserve many lives and hundreds of millions of riyals. The country can also build on experience from neighboring countries, with similar characteristics, that implemented prevention programs to facilitate traffic safety.<sup>43</sup>

The Committee on Injury and Poison Prevention of the AAP states that all hospitals should set policies requiring newborns to be discharged in a car safety seat.<sup>44</sup> This is the current practice in most hospitals in coun-

tries like the United States and Canada. However, this is not the case in Saudi Arabia. Such implementation will likely reduce traffic-related injuries among infants. Like other child protection initiatives, healthcare facilities in the country should push for legislation that ensures that all institutions comply with these guidelines in order to facilitate children's safety.

To our knowledge, this is the first multi-centered study to document the prevalence of facial and head injuries in children in Saudi Arabia. However, the study is not without limitations. One limitation is that it was a retrospective study, and we used the electronic search system to identify patients, so may have missed cases if clinicians had not specified that admissions were crash related. In addition, we limited our population to those admitted to the hospital. Specifically, if a child was injured in an MVC and then treated in the emergency department without inpatient admission, he or she was not captured in our dataset. This, in turn, may underestimate the burden of head or facial injuries. Another limitation was the large amount of missing values for variables such as safety measure use. Missing values remain a major challenge for empirical research on injuries in Saudi Arabia.<sup>45</sup> In order to generate evidence and evaluate risk factors, there needs to be a major investment in comprehensive, high-quality data sources. Many successful examples of registries aimed to improve traffic safety exist in developed countries and can be adapted to support local efforts. Unlike various developed countries, there is yet to exist a national trauma registry in the country.

In conclusion, over a third of children injured following an MVC sustained head or facial injuries. This prevalence reflects the burden and cost of injuries due to MVCs. The study findings highlight the importance of combination or rear seating as well as age-appropriate restraint to reduce the likelihood of head or facial injuries and improve population health. Finally, investment in national registries of traffic injuries can facilitate data-driven decision making to improve traffic safety in Saudi Arabia. We recommended strategies to increase car seat use such as car restraint laws appropriate for age, height and weight, an enhanced enforcement program, wide advertisement in the media and prevention education program for parents and caregivers.

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