



ORIGINAL ARTICLE

# Environmental Hazards as a cause of Pediatric Intensive Care Admission

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## Abstract:

**Background:** Children are exposed to several environmental hazards with variable effects from mild to severe manifestations leading to death. The aim of this study is to study the pattern of Pediatric Intensive Care Unit (PICU) admission due to environmental hazards and its mortality rate.

**Methods:** This is a hospital-based study conducted during a 5 years period in Al-Madinah Al-Munwarah, Saudi Arabia.

**Results:** Out of total PICU admissions, 9% were due to environmental hazards. Bronchial asthma which is triggered mostly by environmental factors, was the most common (35.3%) followed by: trauma (27%), poisoning (15.3%) and submersion injuries (9.7%). Males were significantly more exposed to environmental hazard than females ( $\chi^2= 13$ ,  $p = 0.021$ ). Statistical analysis showed a significant difference in the frequency of environmental hazards between summer and winter ( $\chi^2= 12$ ,  $p = 0.033$ ). Trauma, poisoning, submersion injuries, stings and bites were more in summer compared to winter. However, bronchial asthma had higher frequency in winter. The Median length of PICU stay ranges from 1.6 – 12.5 days depending on the type of hazard. Overall mortality rate was 8.8% with the highest rate among trauma followed by submersion injury patients with no fatality in drug ingestion or food poisoning.

**Conclusion:** Environmental hazards represent a preventable major health problem with significant mortality and burden in health economics by long PICU stay and its sequel.

**Key words:** Environmental hazards, Admission, PICU, Mortality

## 1. Introduction

Environmental hazards can be chemical, physical, mechanical, biological and psychosocial. The patterns of illness in pediatric population in the developing countries can be considered in the double burden category where the emerging pattern of civilization of chronic disabling health problems is increasing and the communicable diseases still exist in a significant prevalence (1). Environmental hazards are among the contributing etiologies for this double burden. The United Nations Environment Programs (UNEP) and World Health Organization (WHO) are taking in consideration these changes (2).

In developed countries, the communicable diseases have dramatically declined while the diseases of environmental origin are increasing which warranted the establishment of the Children's Environmental Health Network (CEHN) in USA (3). The child environment starts primarily at home then extend to outdoor. It has been estimated that 25-33% of the global burden of diseases can be attributed to environmental risk factors. Children under 5 years of age seem to bear the largest environmental burden (4). The spectrum of environmental hazards is so wide ranging from simple transient trigger of bronchial asthma and other respiratory diseases (5) to life threatening events (6, 7), going through structural and DNA changes (8-13) leading to lifelong effects. In spite of the known wide spectrum of environmental hazards, their impact on the pediatric intensive care (PICU) is not well known, particularly in the Arabian Peninsula. Thus, the objective of this study was to identify the pattern of admission to the PICU due to the environmental hazards and the magnitude of this problem and its contribution to the mortality rate.

## 2. Methods

### *Subjects*

A retrospective hospital-based study was conducted in the Madinah al-Munwarah, Saudi Arabia. All the cases admitted to the pediatric intensive care unit (PICU) due to environmental hazards were identified from the admission and discharge log book in the PICU. The study included the cases admitted during a 5 years period from 2007 to 2011. The medical charts were reviewed for age, sex, nationality, type of hazard, length of PICU stay, and outcome. Because of the ill-defined clear demarcation between the four seasons, the year was divided into two periods to encompass the two main climate changes in the area which are the summer (May till October) and the winter (November till April). This study was approved by the hospital ethical committee.

### *Data analysis*

The data were collected in excel sheet and cross-checked for accuracy. Data analysis was performed by using Statistical Package for Social Sciences for Windows (SPSS) version 21. Association between variables was tested using Pearson Chi-Square test where applicable.

## 3. Results

During the study period, there were 216 patients admitted to the PICU due to or triggered by the environmental hazards, which represented about 9% of the total admission to the PICU. Of the 216, 127 (60%) were males and 68 (40%) were females. The median of age was 3.7 months with inter quartile range (IQR = 0.1 – 10.8). These hazards included bronchial asthma (35.3%); trauma (26.9%); poisoning (15.3%); submersion injuries (9.7%); miscellaneous (6.9%); and bites and stings (5.9%). The Median of length of stay in the PICU ranges from 1.6 - 12.5 days depending on the type of hazard (Table 1). Trauma was

commonly due to Road Traffic Accident (RTA) (77%) followed by fall (21%) with 80% of these events being affected the head. Poisoning included drug ingestion (9.3%), Carbon monoxide (3.7%) and food (2.3%). Bites and stings included scorpion stings (4.6%) and snake bites (1.3%). Miscellaneous included strangulation (2.8% and all were males), burn (2.8%); mostly males and caused by flames with one electrical burn, and foreign body aspiration (1.3%) with mean age of 27 months.

**Table 1.** Frequency of environmental hazard leading to PICU admission, median age and length of stay in the PICU (n = 216)

Type of hazard	Frequency n (%)	Age Median (IQR)	PICU Los © Median (IQR)
Bronchial asthma	76 (35.3)	2.5 (1.5 – 7.5)	2.0 (1.0 – 3.80)
Trauma	58(26.9)	3.8 (1.6 – 5.8)	3.5 (2.0 – 13.8)
Poisoning ◊	33(15.3)	2 (0.10 – 7.0)	1.6 (0.9 – 4.6)
Submersion injuries	21(9.7)	2.5 (1.7 – 7.0)	2 (1.0 – 20.0)
Snake bites and scorpion stings	13(5.9)	5.5 (0.79 – 8.8)	1.6 (0.4 – 3.0)
Miscellaneous *	15(6.9)	6 (2.5 – 10.8)	12.5 (3.4 – 20)

© PICU Los: Length of stay in Pediatric Intensive Care Unit

◊ Poisoning included: Drugs, Foods, Carbon-monoxide.

\*Miscellaneous included: Burn, Strangulation, Foreign body aspiration.

This study showed that males are more exposed to submersion injuries, bronchial asthma and miscellaneous compared to females. However, females had higher proportion of Scorpion stings and snake bite. The difference between males and females in the exposure to the environmental hazards was statically significant ( $\chi^2= 13$ ,  $p= 0.021$ ) (Table 2).

Statistical analysis showed a significant difference in the frequency of environmental hazards between summer and winter ( $\chi^2= 12$ ,  $p= 0.033$ ). Trauma, poisoning, submersion injuries and stings and bites were more in summer compared to winter. However, bronchial asthma had higher frequency in winter (Table 3). The overall mortality rate was 8.8% with the highest

rate among trauma followed by submersion injury patients but no fatality in drug ingestion or food poisoning (Table 4).

**Table 2.** Sex distribution of patients admitted to the PICU due to environmental hazard

Type of Hazard	n	Males n (%)	Females n (%)
Bronchial asthma	75	49 (65.3)	26 (34.7)
Trauma	57	28 (49.1)	29 (50.9)
Scorpion stings and snake bite	13	5 (38.5)	8 (61.5)
Poisoning ◊	33	17 (51.5)	16 (48.5)
Submersion injuries	21	16 (76.2)	5 (23.8)
Miscellaneous*	14	12 (85.7)	2 (14.3)

◊ Poisoning included: Drugs, Foods, Carbon-monoxide.

\*Miscellaneous included: Burn, Strangulation, Foreign body aspiration.

$\chi^2= 13$ ,  $P = 0.021$

**Table 3.** Seasonal variation among patients admitted to the PICU due to environmental hazard

Type of hazards	N	Summer N (%)	Winter N (%)
Bronchial asthma	75	32 (42.7)	43 (57.3)
Trauma	57	36 (63.2%)	21 (36.8%)
Poisoning	32	21 (65.6%)	11 (34.4%)
Submersion injuries	21	16 (76.2%)	5 (23.8%)
Scorpion stings and snake bite	13	9 (69.2%)	4 (30.8%)
Miscellaneous	14	8 (57.1%)	6 (42.9%)
Total	212	122 (57.5)	90 (42.5)

$\chi^2= 12$ ,  $P = 0.033$

**Table 4.** Mortality rate among patients admitted to PICU due to environmental hazard

Type of Hazard	Total number of patients	Mortality rate n (%)
Bronchial asthma	76	1 (1.3)
Trauma	58	9 (16)
Submersion injuries	21	5 (24)
Drug poisoning	20	0 (00)
Scorpion stings	10	0 (00)
Carbon monoxide poisoning	8	1 (13)
Strangulation	6	1 (17)
Burn	6	1 (17)
Food poisoning	5	0 (00)
Snake bites	3	0 (00)
Foreign body aspiration	3	1 (33)
Total	216	19 (8.8)

#### 4. Discussion

This study was conducted to identify the pattern of admission to the PICU due to the environmental hazards. In this study asthma was the most common cause of admission to PICU among the environmental related hazards which was not surprising. There is a consistent and strong association between childhood hospital admission due to asthma exacerbation and outdoor air pollution independent of any temperature variation (16). Asthma could be triggered by a variety of pollutants which stimulate an acute attack, including tobacco smoke, traffic-related pollution, synthetic bedding and furry pets, particle components as in diesel and gasoline exhaust and wood smoke (17-21).

Childhood injuries were widely studied in the primary care (22), but less in intensive care setting. The reported usual causes of trauma are RTA as the most common cause followed by water related injuries, and burn with variations according to the age groups (23) which is consistent with the pattern of incidence in this study. In infants, falls incidence was reported to be the most common followed by ingestion and burn (23). However, in this study, trauma due to RTA was predominant, highlighting RTA as a major health problem in the region. Other causes were reported to be significant as Bicycle-related injuries among children 5 years or older, with a majority suffered from head and skull injuries (25, 26). The head injury was the most common type of injury in this study which could be explained by the importance of admitting these patients to the PICU not necessarily for intervention but could be only for close observation compared to most of the other body parts trauma. The age pattern of the strangulation subgroup was similar to previous studies but none occurred in a school which is not in agreement with other reports (27, 28).

Burn patients showed a similar sex distribution but higher age group and difference in the underlying cause of burn compared to other studies which showed the majority as scald burn (29, 30). Electrical injury reported to be predominantly in young children with high mortality and morbidity rate (31, 32). In this study there was only an eight years old child who suffered this event in a garden due to exposed electrical wire resulted in significant morbidity.

The majority of poisoning conditions in this study were accidental caused by drugs and carbon monoxide with younger age, which is similar to several other studies (33, 34). The effect of drug ingestion varies from mild to severe manifestations (35, 36). However, no significant sequel from drug ingestions, snake bites and scorpion stings was noted in this study, which could be due to the rapid access to health care services, which was not the case in other reports (37).

The majority of submersion injuries took place in swimming pools similar to previous studies (7). Submersion injuries are still representing a significant health problem because water safety practices were lacking in most cases as evidenced by the fact that most of the victims were not properly supervised at the time of swimming (7). In our patients with foreign body aspiration was of similar sex and age pattern to previous reports (38), and formed the highest rate of mortality.

The seasonal variation in trauma; asthma; drug poisoning; snake bite and scorpion sting, were all previously reported (39-43). The significant difference in the higher summer incidence in trauma, poisoning, submersion injuries and stings and bites, could be explained by the longer time of outdoor exposure and free playing time with may be less parental supervision during school vacation.

The overall mortality rate from the environmental hazards admitted to the PICU was higher than the mortality rate among all PICU admissions. In this study, trauma was the most common cause of death followed by submersion injuries both forming 73% of the mortalities due to the environmental hazards. There were no deaths in drugs ingestion, and food poisoning, similar to previous studies (44). Though scorpion stings were a known cause of mortality due to heart failure and pulmonary edema (45), there were no deaths in our study which could be explained by small number of cases and rapid access to health care services. This loss of life's in combination with long PICU stay, that lead to loss of expenses, represent an important burden to the health care services with a special concern being a preventable problems.

## 5. Conclusion

Environmental hazards represent a major health problem particularly during summer in most of these hazards with significant mortality and burden in health economics by long PICU stay. These hazards are avoidable. Thus, preventive measures should be implemented to reduce these hazards such as organizing educational programs in schools prior summer vacation.

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