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ORIGINAL RESEARCH

The epidemiology of poisoning and overdose in Saudi Arabia: exposures, risks, management and outcomes

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Abstract

Poisoning is a major public health concern. In Saudi Arabia, information related to poisoning is limited. Herein, we report a large number of poisoning cases from across The Kingdom of Saudi Arabia. We reviewed cases of poisoning received by the Poison Control Center (PCC) at the Saudi Medical Appointments and referral Center. This was a retrospective review of all documented calls to the PCC between September 2020 and September 2021. A total of 39,439 cases were reported to the PCC during the study period. The mean patient age was 7.1 $\pm$ 12.6 years, 52.8% were men, and 36.9% were women; 10.3% of the study population did not specify their gender. More than half of the cases (61.7%) were children $\leq$5 years-of-age. Public calls accounted for 76.1% of the cases, of which 76.4% were managed at home. Exposures to poisons were mostly acute (84.9%) and unintentional (69.1%). Medications were implicated in 34.7% of cases, the most common medications were analgesics (9.3%). Moderate or major effects were reported by 18.4% of the study population. The vast majority of toxicology consultations received by the PCC involved the accidental exposure of poisons to children less than five years-of-age. Therefore, there is an urgent need to develop educational campaigns targeting the safe use and storage of medications and chemicals in the household. Our findings also demonstrate that PCCs play a major role in reducing visits to the emergency department and will also reduce healthcare cost related to poisoning and overdose.

Keywords

Poisoning; Epidemiology; Exposure; Overdose; Saudi Arabia

1. Introduction

Poisoning is a major global public health concern. According to the United States National Safety Council, the top three leading causes of preventable injury-related deaths in 2021 were poisoning (43.0%), falls (21.0%) and motor vehicle accidents (21.0%) [1]. Between 2019 and 2021, there was a reported increase in deaths caused by drug overdose in the United States of America (USA), including those caused by both illegal substances and prescription opioids, with more than 106,000 deaths reported in 2021 [2]. According to the World Health Organization (WHO), acute poisoning causes $\geq$45,000 fatalities per year among children and those aged $<$20 years-of-age. Moreover, the WHO estimated that in 2016, 6.3 million years of healthy life (disability-adjusted life years) and 106,683 deaths were lost to unintentional poisoning [3]. The underlying causes of poisoning vary between countries and depend on various factors, including demographic characteristics, the socioeconomic status of the local population, educational levels, and local customs and beliefs [4]. The 2021 mortality data released by the WHO showed that the Republic of Moldova and some African countries, including Lesotho, had the highest rates of mortality associated with unintentional poisoning (5.45 and 5.23 deaths due to poisoning per 100,000 of the population, respectively) [5]. The USA has a reported rate of 0.51 deaths per 100,000 of the population [5]. Middle Eastern countries, Oman and Qatar ranked first and second at 0.94 and 0.87 deaths per 100,000 of the population in 2019 [5]. Furthermore, the WHO emphasized the establishment of poison control centers (PCCs) that advise, assist, prevent,

diagnose, and manage cases of poisoning. Currently, the WHO lists around 348 PCCs worldwide (accounting to 47% of WHO member states) but only eight centers are listed in Middle Eastern countries (five, two and one in Saudi Arabia, the United Arab Emirates and Qatar, respectively) [5].

The most common causes of poisoning include analgesics, household cleaning substances, cosmetics and personal care products, illegal drug use and chemicals [6]. In the USA, poisoning became the leading cause of death by injury and almost nine out of 10 poisoning deaths are caused by drugs [7]. The top ten drugs most frequently involved are fentanyl, heroin, cocaine, methamphetamine, alprazolam, oxycodone, morphine, methadone, hydrocodone, and diphenhydramine [8]. Over the past decade, adults aged 55–64 years and non-Hispanic white Americans experienced the greatest increase in mortality rate due to poisoning by opioid analgesics [8].

In Saudi Arabia, medication overdose was the most common cause of poisoning with children <12 years-of-age most commonly affected [9, 10]. A large proportion of children who had been poisoned were exposed to medications [11]. In the majority of cases, the poison was taken *via* the oral route, and 6.8% of cases involved the ingestion of household chemicals (6.8%) [12–15]. Children aged <12 years were the most affected age group and acetaminophen overdose was the most common cause of poisoning [13]. Studies in Saudi Arabia showed that analgesics and non-steroidal anti-inflammatory drugs represented the highest proportion of used medications [13–16]. The Saudi Ministry of Health reported 1474 cases of drug poisoning (mostly unintentional) between 2011 and 2016, mostly in women and young children <12 years old. Most of the reported cases involved analgesic and non-steroidal anti-inflammatory, antiepileptic, antipsychotic, psychoactive and anxiolytic drugs [16].

We conducted this study to review all poisoning cases received by the PCC at Saudi Medical Appointments and Referral Center, Ministry of Health, Riyadh, Saudi Arabia. We aimed to describe the epidemiology of poisoning and overdose, identify populations at risk, common exposures, the treatments provided and outcomes.

2. Materials and methods

This was a retrospective review of all documented calls to the Ministry of Health (MOH) Toxicology Call Center database between September 2020 and September 2021. This center is located in Riyadh, Saudi Arabia and receives consultations from across the country and is available 24 h for 7 days a week. Some major hospitals have their own toxicology services and therefore may not consult the PCC. Consulting the PCC is not obligatory. Specialists in poison information (SPIs), mostly pharmacists and also some nurses, receive calls from both public sites and healthcare facilities. The SPIs gather information from the caller and provide advice if it is within their scope of practice. For example, in cases of accidental exposure to non-toxic substances at home, the SPIs can reassure the caller and advise him/her to stay home and will provide a follow-up call after a few hours to check the status of the patient. The SPIs also consult a medical toxicologist as required. Subsequently, the SPIs feed information into a data-entry software package. The medical toxicologist flags the cases that need follow-up and decide on when the next follow-up call should be conducted. Initially, the data entry was self-controlled in that the SPI would provide data in an allocated location in the software but could leave this data-entry point empty if they wished. However, this led to a significant loss of data. Therefore, the software was modified to make it obligatory to enter certain data; for example, age and sex. Addition data includes the caller's location, exposure substance, type of exposure (acute or chronic), intent of exposure (unintentional or intentional), route of exposure, decontamination method, antidote and outcome. Other pieces of specific information are also required, including the location of the hospital, type of hospital (private or government), management site (home, emergency room), and status (discharged, transferred to ward or the intensive care unit (ICU), or transferred to another hospital).

To describe the medical outcome, we used the National Poison Data System (NPDS) to evaluate the observed effect as no effect, minor, moderate or major. According to the American Association Poison Control Centers (AAPCC) NPDS [17], a patient had "no effect" if they experienced no symptoms at all from the exposure. A "minor effect" referred to a patient experiencing some symptoms that were not bothersome. A "moderate effect" referred to a patient that experienced symptoms that were more severe, more prolonged, or more systemic in nature that required medical attention (*e.g.*, unconsciousness with appropriate response to pain, confusion, localized seizures, bradycardia or tachycardia). A "major effect" referred to a patient experiencing symptoms that were potentially fatal or left them with a significant amount of residual disability or disfigurement (*e.g.*, respiratory insufficiency, deep coma, generalized seizures, myocardial infarction, shock or severe hypoglycemia).

The collected data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 26.0 (IBM-SPSS, Armonk, NY, USA). Descriptive statistics were used to present the demographic characteristics and presented as numbers and frequencies for categorical variables, and as means and standard deviations for continuous variables.

3. Results

A total of 39,439 poisoning cases were reported to the Toxicology Center during the study period (mean age of patients: 7.1 ± 12.6 years). There were 20,835 (52.8%) and 14,534 (36.9%) cases involving male and female individuals, respectively, and 4070 (10.3%) unspecified cases. More than half of the cases (61.7%) were of children aged ≤5 years. Public site callers accounted for 76.1% of all cases. Of the cases reported by the hospital, 9391 cases (96.7%) were non-ICU cases. In contrast, of the 30,018 calls made by the public, the majority (22,934, 76.4%) were managed at home (Table 1).

The route of exposure was oral in 30,938 of cases (78.4%). Most exposures were acute (n = 33,494 cases, 84.9%) and the majority of cases (n = 27,249, 69.1%) were unintentional (Fig. 1). The most commonly identified cause of poisoning was medications (n = 13,670, 34.7%) followed by the use of household and cosmetic products (n = 4942, 12.53%) and

TABLE 1. Demographic profile of poisoning cases reported to the toxicology call center of the ministry of health in Saudi Arabia (September 2020–September 2021).

Characteristic	Description	N	%
Gender			
	Male	20,835	52.8%
	Female	14,534	36.9%
	Unspecified	4070	10.3%
Site of caller			
	Public	30,018	76.1%
	Hospital	9421	23.9%
Site of the hospital			
	Central region	10,101	25.6%
	Peripheral regions	29,338	74.4%
Type of hospital			
	Governmental	30,224	76.6%
	Private	9215	23.4%
Age category distribution			
	<1	1847	4.7%
	1–5	22,484	57.0%
	5–18	3958	10.0%
	>18	5025	12.7%
	Unspecified	6125	15.6%
Management site of calls from the hospital			
	Total Hospital admission	9710	
	Admitted (ICU)	319	3.2%
	Admitted (non-ICU)	9391	96.7%
Management site of calls from the public			
	At home	22,934	76.4%
	Advised to go to the hospital	7084	23.6%
Cases needed transfer to a higher level of care		227	0.6%

ICU: intensive care unit.

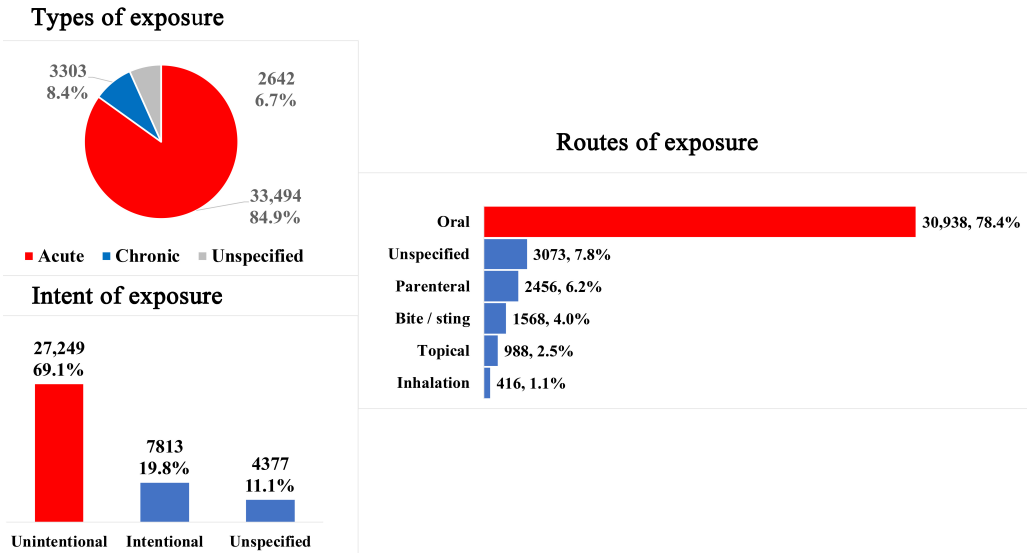

FIGURE 1. Types, routes and intent of exposure to poisoning and the disposition of patients reported to the Toxicology Call Center of the Ministry of Health in Saudi Arabia (September 2020–September 2021).

chemicals (n = 961, 2.4%). The cause of poisoning was not documented for 47.0% of patients (n = 18,525). The most commonly identified medications were analgesics (n = 3662, 9.3%), vitamins (n = 3027, 7.7%), hormones (n = 1489, 3.8%), antihistamines (n = 1288, 3.3%) and cardiovascular medications (n = 1015, 2.6%). Children aged ≤5 years were the most vulnerable to exposure to analgesics (2413/3662 cases, 65.8%), vitamins (2144/3027 cases, 70.8%), and to household products and cleaning solutions (1900/2675 cases, 71.0%). There were 945 (2.4%) cases of bites and envenomation from snakes and scorpions. The identified causes of poisoning are presented in Fig. 2.

Decontamination was performed in only 489 cases (1.2%); the most common decontamination method was the application of activated charcoal as a single or multiple dose (n = 325, 0.8%), gastric lavage (mostly performed prior to PCC consultation) (n = 42, 0.1%), and external decontamination such as dilution, irrigation or washing (n = 38, 0.1%). Other methods that were not recommended by the medical team included induced vomiting (n = 11, 0.03%) and other methods such as the use of salty water and herbs (n = 6, <0.1%). No decontamination method was used in 38,950 cases (98.8%) (Fig. 3).

The majority of poison exposures (n = 35,820, 90.8%) did not require the use of an antidote and were managed symptomatically. Of the remaining 3619 cases of exposure, 2959 (7.5%) received intravenous *N*-acetyl cysteine (NAC) for acetaminophen poisoning. Ethanol was used as an antidote in 226 cases (0.6%). Of the 233 cases involving snakebites, antivenom was administered to 128 (54.9%) patients. Of the 712 cases involving scorpion stings, 112 (15.7%) were administered with antivenom. Hydroxycobalamine, naloxone, flumazenil and fomepizole were administered in 38 (0.1%), 9 (<0.1%) and 4 (<0.1%) cases, respectively (Fig. 4).

There were some documented case-fatalities including a 35-year-old male with methanol toxicity. Also, three male patients died after cobra snakebites; these were five, 28 and 35 years-of-age, respectively. Finally, a 65-year-old female died following an overdose of methotrexate and a 3-year-old boy died due to an overdose of lidocaine.

4. Discussion

Poisoning has emerged as a significant public health issue owing to the rising number of reported cases worldwide. In the USA, poisoning has surpassed traffic accidents as one of the main causes of injury-related deaths that could have been prevented [7]. In the present study, we described the spectrum of poisoning cases that were reported to the PCC at Saudi Medical Appointments and Referral Center within a one-year study period (September 2020 to September 2021). The current study reported the one-year prevalence of 39,439 calls, 48% higher than that reported previously by Al-Mousa *et al.* [14]. This substantial increase is likely to be attributed to the fact that in November 2020 all toxicology consultations regardless of their source (public *vs.* healthcare facilities) started to be directed to a single hotline. This ensures that all data are stored in a single database and allows better toxicovigilance.

A previous successful effort of the Ministry of Health in Saudi Arabia (MOH-KSA) was the introduction of the Poison Control E-System (Awtar) that unified the reporting of poisoning incidents. In 2018, MOH-KSA improved the database, reporting, and access to poisoning cases in an attempt to reduce the response to toxic cases to less than 2 hours [18]. The 12th Middle East and North Africa Clinical Toxicology Association (MENATox2022) recently recommended the integration of poison control initiatives into national strategies and enhancing the work of PCCs in each nation [19].

According to previous reports, the public awareness of poisoning exposures increases with the availability of poison information and aid for poisoning cases, which leads to an increase in the number of persons reporting and calling their respective PCCs [11, 20]. Approximately 23.9% of the cases analyzed in this study were reported from hospitals. The majority of the calls were from public sites (76.1%) and most of these cases were treated at home (76.4%). Therefore, only 23.6% of cases were advised to go to hospital. This di-

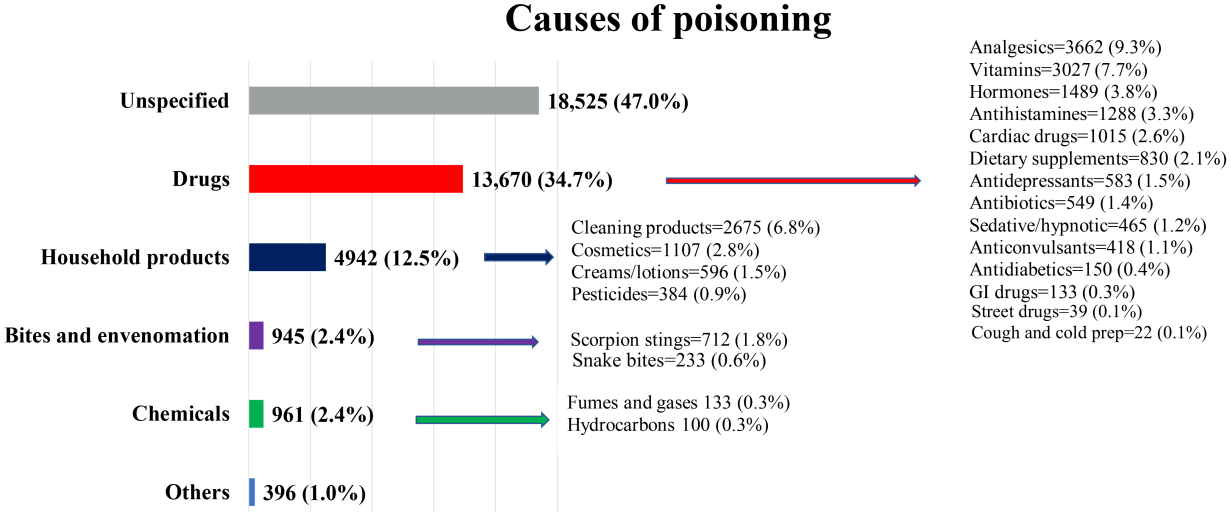

FIGURE 2. Identified causes of poisoning in 39,439 cases reported to the Toxicology Call Center of the Ministry of Health in Saudi Arabia (September 2020–September 2021).

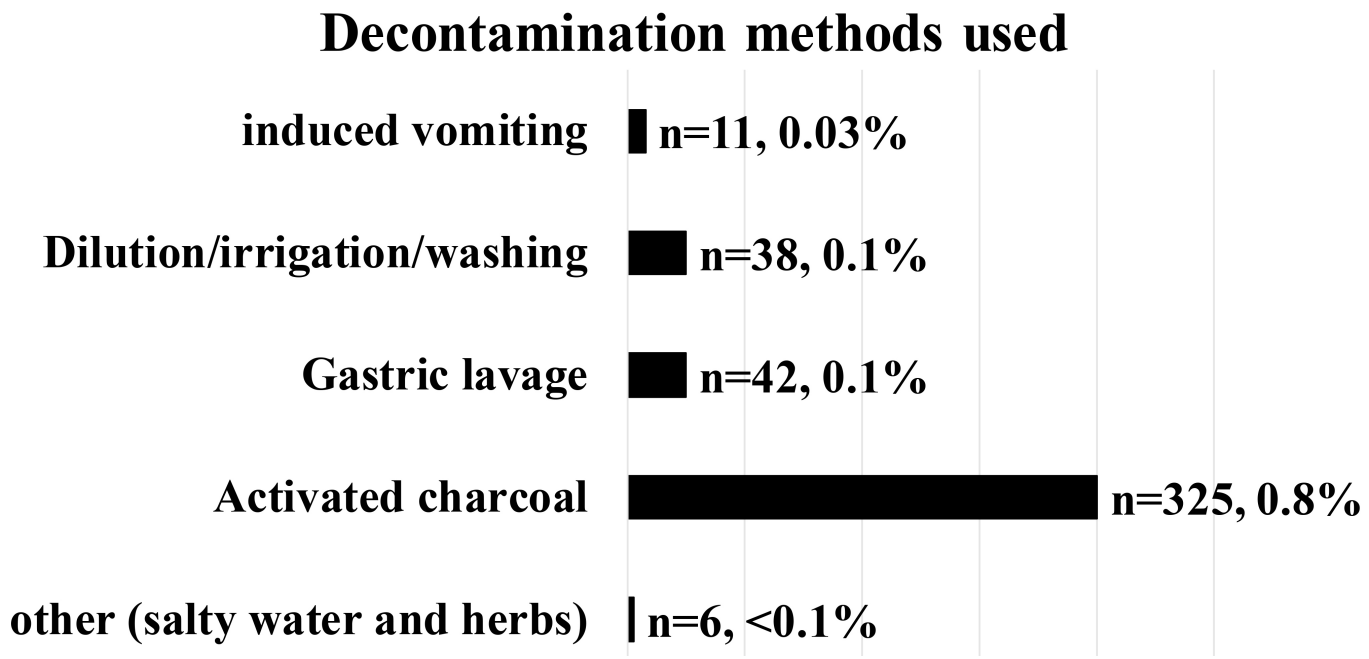

FIGURE 3. The methods of decontamination used in 489 cases.

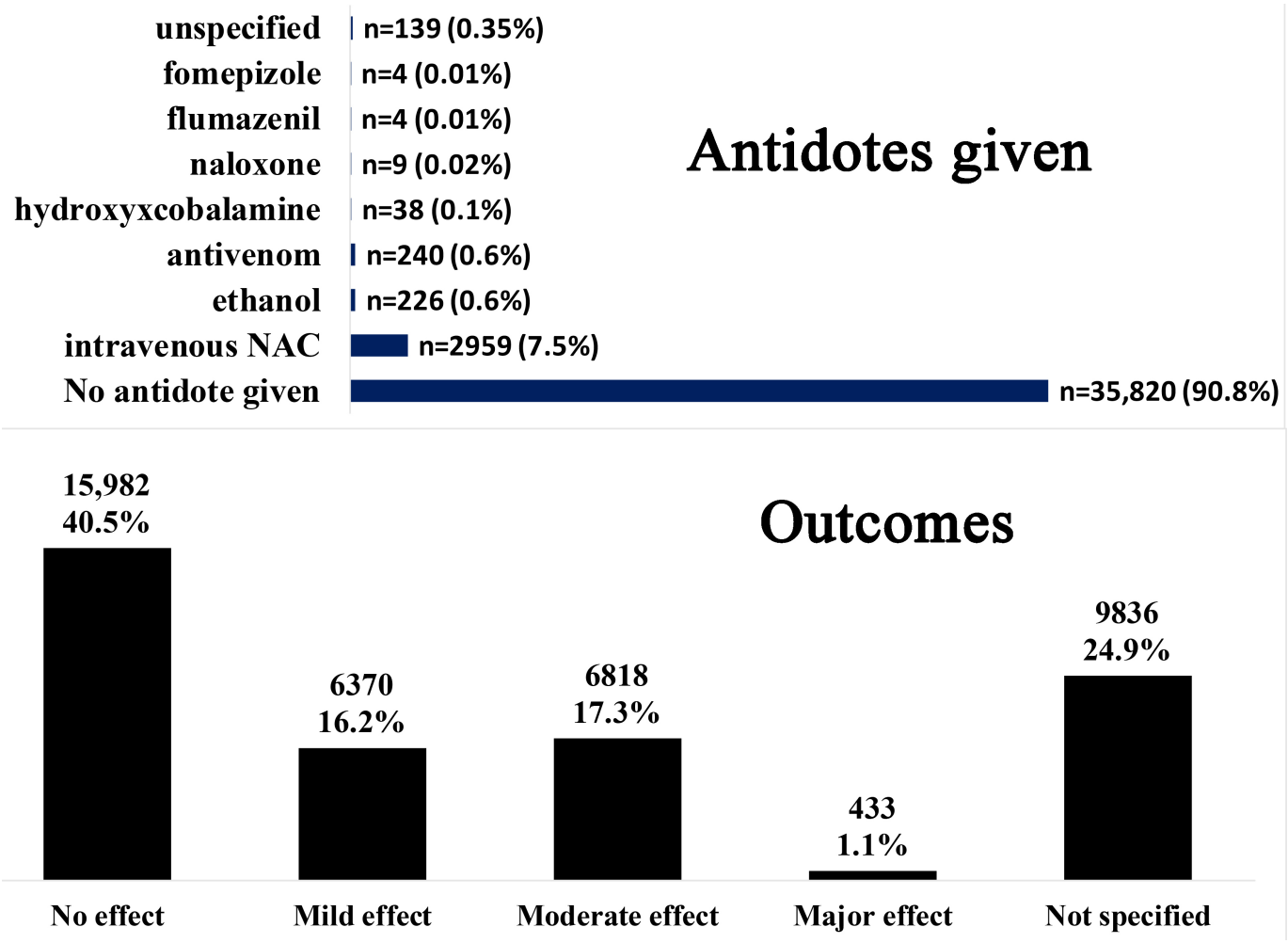

FIGURE 4. Antidotes and outcomes in 39,439 cases reported to the Toxicology Call Center of the Ministry of Health in Saudi Arabia (September 2020–September 2021). NAC: *N*-acetyl cysteine.

rectly affected the financial cost of avoidable hospital referral. According to a Moroccan study, the typical direct medical expense of treating poisoning is 157 USD per child [21].

We found that accidental poisoning was more common in males than in females (23.5% versus 18.3%), as reported previously [22, 23]. In addition, the present study revealed that 61.7% of reported poisoning cases involved children under the age of 5 years; this finding was also consistent with the findings reported by previous studies [11, 24–29]. Children exhibit energetic, exploratory, and inquisitive behaviors and often engage in the act of placing objects in their mouths without contemplating potential consequences. Because of their diminutive size (and proportionately large amount of ingested toxins), easy access to harmful substances, and the lack of oversight from adults, this age group is the most likely to accidentally swallow poisons/medications and become poisoned [24–29]. To stop such occurrences, efforts and programs to educate the public relating to poisoning and drug overdose must be considered. To raise awareness of the risks posed by these substances and urge parents to keep chemicals and medications out of the reach of young children, we recommend the establishment of a widespread community education program. In 78.4% of cases, the principal route of poisoning was the oral route and was inadvertent in most instances involving children <5 years-of-age. However, the proportion of intentional poisoning cases was 19.1% more likely to be suicidal and was primarily observed in adults and youths (aged >13 years-of-age). The 2019 annual report published by the AAPCC showed that suicidal intent was suspected in 13.1% of all poisoning cases [12]. A study from Nepal showed that suicide was the main cause of intentional poisoning in the adult population whereas accidental or unintentional exposure was the main cause of poisoning in children [30].

We found that overdosing on medications was the most frequent cause of poisoning. In particular, acetaminophen was the cause in 9.3% of all cases. This is probably attributed to the fact that this drug is available almost everywhere. According to previous research, analgesics were substance most often involved in approximately 10% of all poisoning cases [13, 24–29]. Investigations have shown that acetaminophen is the most commonly consumed agent as a cause of poisoning or overdose in both the adult and pediatric population [24, 31, 32]. Only 12.5% of such cases were reported in this investigation; previous studies reported that 20–30% of cases involved home products, such as chemicals, cleaning products, and alcohol sanitizers as sources of poisoning other than drugs [33].

When faced with a poisoned patient, physicians typically conduct an assessment that considered a patient's level of consciousness, the substances they consumed, and any symptoms of toxicity. This assessment is performed in accordance with the American Association of Poison Control Centers (AAPCC) NPDS outcome guidelines [17]. In this study, 40.5% of participants experienced no toxic effects while 16.2% experienced only a slight effect from the offending toxin. The lack of adverse effects in our population is consistent with earlier data, and is likely because the majority of poisoning cases were accidental or cases involving the unintentional intake of small amounts of toxins [26, 31–33]. The majority of the patients in this cohort (98.8%) did not undergo any form of decontamination. The advantage of gastrointestinal decontamination may be limited when a patient already exhibits symptoms of poisoning or the timing of consumption is uncertain or remote. In the present study, 90.8% of patients received supportive/symptomatic management as their primary form of care. As analgesics were the most often consumed class of medication, *N*-acetylcysteine (NAC) as an antidote for acetaminophen, was the antidote used in 7.5% of cases [34]. Fomepizole was utilized in only four cases (<0.1%) to treat methanol toxicity, as this drug was not available most of the time and ethanol was used as an alternative. This value could also have been underestimated as some hospitals may have used Formepizole without notifying the PCC. Fomepizole became more available after methanol outbreaks were discovered by toxicovigilance. PCC services have a considerable influence on reducing health care costs by reducing the number of emergency department visits for poisoning and by reducing the length of hospital stay [35, 36].

This study involved some limitations that need to be considered. First, there was a lack of some information relating to the causes of poisoning. Another limitation was the large number of unspecified cases which were caused by unknown toxins, data entry failure, or the data became available later and were not communicated to the poison center. Unfortunately, we believe that we may have missed follow-up data for several fatality cases. Hospitals stopped responding to our follow-up calls when the outcome was not favorable, and sometimes the patient was transferred to another healthcare facility for a higher level of care and follow-up was lost. The documented case-fatalities were definitely an underestimation of the mortality rate. The lack of information is common in PCC data as many patients present with a history of unknown ingestion (such as small children and those with an altered level of consciousness who are often unable to provide information) and were managed solely based on the clinical presentation. Another limitation was the deficiency of follow-up data for some patients owing to the lack of response from the treating team during follow-up calls. In this study, we reported data that were available in the toxicology database; we were not able to access hospital records to retrieve missing data.

As we reported cases from a single country, our findings may lack a broad appeal to readers from other regions. However, it is strongly advised that drug and poisoning information centers should be established in our area and services should be enhanced. This makes poisoning databases available as well as ongoing, methodical data collection. Our experience indicates that the majority of calls were from members of the public. Incomplete information relating to the causes of poisoning, the antidotes administered, and the outcomes of clinical management presented in a number of these cases. Analytical services should be made available in poisoning cases on an emergency basis to aid in diagnosis and treatment. To make the reporting of poisoning cases easier for the public, simple and unique phone numbers should be used. Moreover, training programs must be put in place for every team member so that they can effectively serve the callers, provide guidance on how to treat poisoned patients, and record data accurately and completely.

5. Conclusions

The vast majority of toxicology consultations received by the PCC involved accidental exposure in children aged <5 years. We recommend mandatory educational campaigns targeting the safe use and storage of medications and chemicals in the household. Our analysis also showed that PCCs may play a major role in reducing emergency department visits and the costs of healthcare related to poisoning and overdose.

ABBREVIATIONS

AAPCC, American Association of Poison Control Centers; ICU, intensive care unit; IRB, Institutional Review Board; MOH, Ministry of Health; MOH-KSA, Ministry of Health in Saudi Arabia; NAC, *N*-acetyl cysteine; NPDS, National Poison Data System; PCC, poison control centers; USA, United States of America; WHO, World Health Organization.

AVAILABILITY OF DATA AND MATERIALS

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

AUTHOR CONTRIBUTIONS

BA—research idea, designed the study, data analysis, writing the manuscript. MAlf, AAla—manuscript editing. MAra, AAld and NA—supervised data collection and manuscript editing. AAHos—research proposal, and manuscript editing. AAls—data collection and manuscript editing. AAHar, RA—data collection and analysis. GAla—designing data collection sheet and manuscript editing. MAlh, MAls, AAlt, SA, GAlm, MZ—writing proposal and data collection.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Because of the retrospective nature of the study, informed consent was impracticable. The conduct of the study was approved by the Central Institutional Review Board (IRB) of the Ministry of Health, Saudi Arabia (IRB No. 21-39M, dated 08 November 2022).

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] National Safety Council. Top 10 preventable injuries of 2021, injury facts. 2021. Available at: https://injuryfacts.nsc.org/all-injuries/deaths-by-demographics/top-10-preventable-injuries/#:~:text=The%20top%20three%20leading%20causes,86%25%20of%20all%20preventable%20deaths (Accessed: 15 April 2023).

[2] Centers for Disease Control and Prevention. DOSE dashboard: nonfatal overdose syndromic surveillance data. 2023. Available at: https://www.cdc.gov/drugoverdose/nonfatal/dashboard/index.html (Accessed: 15 April 2023).

[3] World Health Organization (WHO). WHO guidelines for establishing a poison center. 2021. Available at: https://www.who.int/news/item/18-01-2021-who-guidelines-for-establishing-a-poison-centre#:~:text=Poisoning%20is%20a%20significant%20global,of%20emergency%20attendance%20at%20hospitals (Accessed: 15 April 2023).

[4] Mowry J, Spyker DA, Cantilena LR, Bailey JE, Ford M. Annual report of the American Association of poison control centers toxic exposure and surveillance system. Clinical Toxicology. 2012; 51: 949–1229.

[5] World Health Organization (WHO). Poison control and unintentional poisoning. 2023. Available at: https://www.who.int/data/gho/data/themes/topics/indicator-groups/poison-control-and-unintentional-poisoning (Accessed: 15 April 2023).

[6] Gummin DD, Mowry JB, Beuhler MC, Spyker DA, Bronstein AC, Rivers LJ, *et al*. 2020 annual report of the American Association of poison control centers' national poison data system (NPDS): 38th annual report. Clinical Toxicology. 2021; 59: 1282–1501.

[7] Warner M, Chen LH, Makuc DM, Anderson RN, Minino AM. Drug poisoning deaths in the United States, 1980–2008. NCHS Data Brief. 2011; 81: 1–8.

[8] Chen LH, Hedegaard H, Warner M. Drug-poisoning deaths involving opioid analgesics: United States, 1999–2011. NCHS data brief, no 166. Hyattsville, MD: National Center for Health Statistics. 2014.

[9] Abd-Elhaleem ZA, Al Muqhem BA. Pattern of acute poisoning in Al Majmaah region, Saudi Arabia. American Journal of Clinical and Experimental Medicine. 2014; 2: 79–85.

[10] Almutairi SA, Alsaleem JH, Alrashed MA, Alsalim MJ, Al-Qadhi AA, Menezes RG. Pediatric poisoning deaths in Saudi Arabia: a systematic review. Legal Medicine. 2023; 60: 102173.

[11] Al-Barraq A, Farahat F. Pattern and determinants of poisoning in a teaching hospital in Riyadh, Saudi Arabia. Saudi Pharmaceutical Journal. 2011; 19: 57–63.

[12] Gummin DD, Mowry JB, Beuhler MC, Spyker DA, Brooks DE, Dibert KW, *et al*. 2019 Annual report of the American association of poison control centers' national poison data system (NPDS): 37th annual report. Clinical Toxicology. 2020; 58: 1360–1541.

[13] Alghafees MA, Abdulmomen A, Eid M, Alhussin GI, Alosaimi MQ, Alduhaimi GS, *et al*. Poisoning-related emergency department visits: the experience of a Saudi high-volume toxicology center. Annals of Saudi Medicine. 2022; 42: 36–44.

[14] Al-Mousa FA, Gado AM, Attia AM, Tammam HG. Medical toxicology experience: poisoning consultations cases registry in Saudi Ministry of Health—2020 annual report. Toxicology Reports. 2021; 8: 1558–1564.

[15] Alshahrani MM, Albogami HA, Asiri AA, Al Haydhah KS, Aldeailej IM, Aldehaim MA, *et al*. Epidemiological trends of acute chemical poisoning among children over a recent three-year period in Saudi Arabia. Children. 2023; 10: 295.

[16] Alzahrani SH, Alqahtani AH, Farahat FM, Elnour MA, Bashawri J. Drug poisoning and associated factors in Western Saudi Arabia: a five-year retrospective chart review (2011–2016). Pakistan Journal of Medical Sciences. 2017; 33: 1188–1193.

[17] Cairns R, Buckley NA. The poisoning severity score: if it did not exist, we would have to invent it. Journal of Medical Toxicology. 2017; 13: 131–134.

[18] Ministry of Health, Saudi Arabia. Health Minister inaugurates Poison Control E-system. 2018. Available at: https://www.moh.gov.sa/en/Ministry/MediaCenter/News/Pages/News-2018-12-09-002.aspx (Accessed: 15 April 2023).

[19] Ministry of Health. The 12th Middle East and North Africa Clinical Toxicology Association Congress (MENATox2022) concluded yesterday

at Crowne Plaza Hotel. 2022. Available at: https://www.moh.gov.om/en/-/--1748 (Accessed: 15 April 2023).
[20] Arnold JK, Borger J, Nappe TM. Poison control in the United States. StatPearls Publishing: Treasure Island (FL). 2024.
[21] Benabdellah FZ, Soulaymani A, Mokhtari A, Soulaymani-Bencheikh R, Khadmaoui A, Hami H. Economic evaluation of the direct cost resulting from childhood poisoning in Morocco: micro-costing analysis. Archives of Public Health. 2020; 78: 59.
[22] Munema Khan MK, Raza S. Gender based differences in patients of poisoning managed at a Medical Unit. JPMA. 2019; 69: 1025–1028.
[23] Tarvadi PV, Bakkannavar SM, Palimar V, Kumar GP, Shetty M, Badiger S. Gender differences in childhood poisoning. Journal of Health and Allied Sciences NU. 2013; 3: 69–72.
[24] Tobaiqy M, Asiri BA, Sholan AH, Alzahrani YA, Alkatheeri AA, Mahha AM, *et al*. Frequency and management of acute poisoning among children attending an emergency department in Saudi Arabia. Pharmacy. 2020; 8: 189.
[25] Sharma R, Saikia D, Janardhan K. Clinical profile of poisoning due to various poisons in children of age 0–12 years. Journal of Family Medicine and Primary Care. 2020; 9: 2291–2296.
[26] Gaw CE, Curry AE, Osterhoudt KC, Wood JN, Corwin DJ. Characteristics of fatal poisonings among infants and young children in the United States. Pediatrics. 2023; 151: e2022059016.
[27] Soave PM, Curatola A, Ferretti S, Raitano V, Conti G, Gatto A, *et al*. Acute poisoning in children admitted to pediatric emergency department: a five-years retrospective analysis. Acta Bio Medica: Atenei Parmensis. 2022; 93: e2022004.
[28] Alwan IA, Brhaish AS, Awadh AI, Misnan A, Rahim NA, Tangiisuran B, *et al*. Poisoning among children in Malaysia: a 10-years retrospective study. PLOS ONE. 2022; 17: e0266767.
[29] Grabska K, Pilarska I. Acute poisoning among children and adolescents: a narrative review. Medical Science Pulse. 2022; 16: 33–39.
[30] Thapa S, Dawadi BR, Upreti AR. Acute poisoning among patients presenting to the emergency department of a tertiary care center: a descriptive cross-sectional study. Journal of Nepal Medical Association. 2020; 58: 470–473.
[31] Khan LA, Khan SA, AI-Hateeti HS, Bhat AR, Bhat KS, Sheikh FS. Clinical profile and outcome of poisoning in Najran. Annals of Saudi Medicine. 2003; 23: 205–207.
[32] Zhang Y, Yu B, Wang N, Li T. Acute poisoning in Shenyang, China: a retrospective and descriptive study from 2012 to 2016. BMJ Open. 2018; 8: e021881.
[33] Dayasiri MBKC, Jayamanne SF, Jayasinghe CY. Patterns and outcome of acute poisoning among children in rural Sri Lanka. BMC Pediatr. 2018; 18: 274.
[34] Firozian F, Karami S, Ranjbar A, Azandaryani MT, Nili-Ahmadabadi A. Improvement of therapeutic potential N-acetylcysteine in acetaminophen hepatotoxicity by encapsulation in PEGylated nano-niosomes. Life Sciences. 2020; 255: 117832.
[35] Zaloshnja E, Miller T, Jones P, Litovitz T, Coben J, Steiner C, *et al*. The potential impact of poison control centers on rural hospitalization rates for poisoning. Pediatrics. 2006; 118: 2094–2100.
[36] Bunn TL, Slavova S, Spiller HA, Colvin J, Bathke A, Nicholson VJ. The effect of poison control center consultation on accidental poisoning inpatient hospitalizations with preexisting medical conditions. Journal of Toxicology and Environmental Health, Part A. 2008; 71: 283–288.

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