

## Five-year epidemiological trends for chemical poisoning in Jeddah, Saudi Arabia

Sami Hamdan Alzahrani,<sup>a</sup> Nahla Khamis Ibrahim,<sup>a,b</sup> Mohammed Abdel Elnour,<sup>c</sup> Ali Hassan Alqahtani<sup>c</sup>

From the <sup>a</sup>Department of Family and Community Medicine, King Abdulaziz University, Jeddah, Saudi Arabia; <sup>b</sup>Epidemiology Department, High Institute of Public Health, Alexandria University, Alexandria, Egypt; <sup>c</sup>Public Health Administration, Ministry of Health, Jeddah, Saudi Arabia

Correspondence: Dr. Sami H. Alzahrani · Department of Family and Community Medicine, King Abdulaziz University, Abdullah Sulayman, 22254, Jeddah 21441, Saudi Arabia · T: +966126408403 · drsamihz@gmail.com · ORCID: <http://orcid.org/0000-0001-6786-7184>

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**BACKGROUND:** Poisoning is a significant global public health challenge in terms of morbidity and mortality. We conducted this study because of the lack of large population-based studies on chemical poisoning in Saudi Arabia.

**OBJECTIVE:** Describe epidemiological trends, associated factors, and outcomes of chemical poisoning cases reported to the Jeddah Health Affairs Directorate, Saudi Arabia.

**DESIGN:** Descriptive, retrospective medical record review.

**SETTING:** Population database for the Jeddah Governorate.

**METHODS:** For chemical poisoning cases reported from January 2011 to December 2015, data was collected using a standardized, validated data collection sheet. Data was collected on personal characteristics, type of chemical poisoning and outcome.

**MAIN OUTCOME MEASURE(S):** Descriptive epidemiological data and statistical comparisons.

**RESULTS:** For 994 chemical poisoning cases, an increasing trend was observed from 2011 to 2013 followed by some reduction during 2014 and 2015. The highest percentage of cases occurred during July followed by March for the cumulative total cases by month for all years. More than half of the cases involved males (55%), and children aged less than 5 years (56.6%). About three-fourths of the cases occurred accidentally and through ingestion. The most common poisonous agents were detergents (36.0%). Poisoning with addictive drugs occurred in 13 cases (1.3%). Only 1.1% of cases received a poisoning specific antidote, and the same percentage died because of poisoning. Gender, age, nationality, the route and the circumstances of the exposure were significantly associated with the type of poisoning ( $P < .001$ ).

**CONCLUSION:** Most of chemical poisoning cases were accidental, occurred during summer, were caused by detergents, affected children <5 years of age, and occurred via ingestion. Educational programs are needed to raise public awareness about poisoning, and to minimize the access of children to poisonous agents, especially detergents. Such measures could contribute toward a further reduction of the chemical poisoning burden.

**LIMITATIONS:** Some key statistics not reported. Information bias may have affected results.

Poison is capable of producing injury or dysfunction in the body as a result of chemical action.<sup>1,2</sup> It is a significant global public health challenge in terms of morbidity and mortality.<sup>1</sup> Acute poisoning cases are the second largest cause worldwide of morbidity, following road traffic accidents. However, the problem of poisoning is often neglected.<sup>3</sup> Poisoning is estimated

cause more than 340000 unintentional deaths and can lead to the loss of more than 7.4 million years of healthy life globally (disability adjusted life years, DALYs).<sup>1</sup> Furthermore, about 2 million intentional cases of poisoning occur yearly, resulting in approximately 200000 associated deaths.<sup>4</sup>

Chemical substances are extensively used in the

medical, agricultural, and industrial fields.<sup>2</sup> Chemical poisoning is one of the major causes of admission to emergency rooms and hospitalization in both developed and developing countries.<sup>5</sup> The incidence of chemical poisoning varies by geographic region due to differences in socioeconomic status and other factors.<sup>6</sup> Different studies have revealed factors that can influence the incidence of chemical poisoning, including age, nature, and amount of poison, route of administration, lifestyle, and socio-psychological pressures.<sup>4,6</sup> In addition, mortality attributed to chemical poisoning differs according to the victim's age, the route of administration, and other factors.<sup>7</sup> Chemical poisoning occurs accidentally in most cases, especially those involving children, and these cases could essentially be prevented by placing greater attention on preventative measures.<sup>6,8</sup>

An observational study in an Indian tertiary care hospital found that poisoning cases were a huge burden for hospital emergency departments, and few preventative measures had been taken.<sup>9</sup> A review of acute chemical poisoning cases reported to the Preventive Medicine Department in the Al-Qassim Region, Saudi Arabia, between 1999–2003 revealed that pesticides were the most common source of poison and that ingestion was the most frequent route.<sup>8</sup>

Adequate knowledge of patterns of chemical poisoning can help to detect risk factors, achieve an early diagnosis, and correctly manage the course of treatment, thereby decreasing rates of morbidity and mortality. However, only a limited number of recent studies have assessed the problem of chemical poisoning. Most are hospital-based rather than population-based. The objectives of the present study were to investigate epidemiological trends for chemical poisoning as well as associated factors and outcomes for cases reported to the Health Affairs Directorate, Jeddah, Saudi Arabia, during a five-year period from 2011–2015.

## METHODS

This study was a retrospective review of chemical poisoning cases that occurred during the 5-year period from January 2011 to December 2015. The cases were reported to the Chemical Safety Office of Environmental and Occupational Health Department of Public Health Department, Directorate of Jeddah Health Affairs, Ministry of Health (MOH), Saudi Arabia as part of a system of epidemiological surveillance developed in the year 2000 for chemical poisoning cases (excluding cases of drug overdose). The purpose of the system is to record the adverse effects of chemicals on humans and the environment in the near and

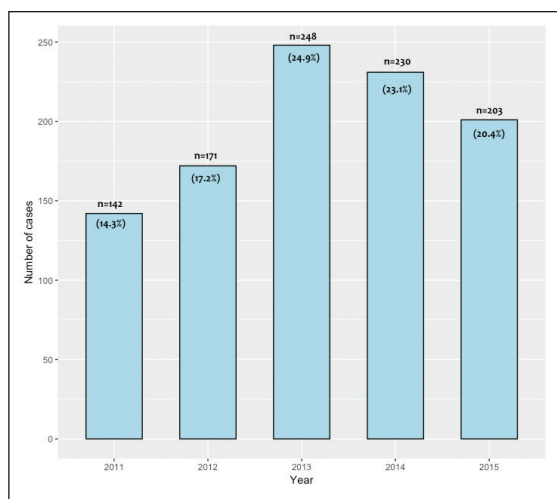
long term and during production, storage, transport and use. The reporting system is mandatory for each poisoning case by all health care providers. All cases are saved in Microsoft Excel. The study was approved by the Institutional Review Board of King Abdulaziz University Hospital (KAUH), with reference number 422-16. Approval was also obtained from the Jeddah Health Affairs Directorate (Ministry of Health).

A data collection sheet constructed by the head of the Environmental Health Department at the Public Health Directorate (a member of our team) was used to record personal and sociodemographic information such as age, gender, and nationality; exposure route: ingestion (oral), inhalation, intravenous, etc.; poison category (detergents, disinfectants, pesticides, fuels, etc.); the name of the chemical; the precipitating cause of poisoning (either intentional or non-intentional); use of addictive substances (narcotics such as cannabis, heroin, cocaine, etc. or stimulants, such as amphetamine); whether poisoning specific antidotal therapy was given; and patient outcome (whether recovered or died).

The face and content validity of the data collection sheet were assessed by two experts, and the internal consistency reliability assessed by Cronbach's alpha was 80%. Data was analyzed by SPSS software version 21 (IBM SPSS Statistics 21, IBM Corporation, Armonk, NY, USA, 2014). Descriptive statistics were generated as simple frequency tables and as means and standard deviations. For inferential statistics, chi-square tests were used to compare categorical variables. Statistical significance was set at  $P < .05$ .

## RESULTS

During the period from January 2011 to December 2015, 994 chemical poisoning cases were reported to the Jeddah Directorate of Health Affairs. Signs and symptoms of chemical poisoning ranged from simple poisoning reaction to severe respiratory distress and failure. There was an increasing trend of chemical poisoning cases from 142 (14.3% of the total cases) in 2011 to a peak of 248 (24.9%) in 2013 (**Figure 1**). Some reduction occurred during 2014 (23.1%) and 2015 (20.4%). About two-thirds (65.9%) of chemical poisoning cases occurred among Saudi citizens (**Table 1**). More than half of the cases were males (54.6%) with a male to female ratio of 1.2:1. More than half of the cases (56.6%) occurred among children less than 5 years old. Most of the chemical poisoning cases occurred accidentally (77.3%), while 15.9% were intentional. Ingestion (oral route) was the most common route of intoxication (77.4%), while 20.6% of the cases occurred via inhalation. Of all cases, only 1.5% had laboratory in-



**Figure 1.** Number of cases of poisoning reported to the Jeddah Directorate of Health Affairs from 2011 to 2015.

investigation requests, and all revealed negative laboratory findings for detecting certain chemical poisoning. Similarly, in 1.1% of cases, patients received a specific poisoning antidote. Nearly all experienced complete recovery (983 cases; 98.9%). Only 11 patients died (7 cases of exposure to aluminum phosphate, two cases of exposure to insecticides, and one case of exposure to methanol). The highest percentage of poisoning cases occurred during summer followed by spring for the total cumulative cases for all years (Table 2). Cases per month for each year are shown in Figure 2. More than one-third (36.0%) of poisoning cases were associated with detergents, followed by both disinfectants and antiseptics (10.6%), insecticides (9.4%), pesticides (8.6%), fuels (5.6%), organic solvents (2.5%), and addictive substances (1.3%) (Table 3).

Clorox was the most common (66.0%) type of detergents implicated in chemical poisoning (Table 4). For disinfectants and antiseptics, 30.5% and 17.1% of the cases were caused by Dettol and Dac, respectively. For pesticides, more than one-fourth of the cases occurred due to diazinon (29.9%) and organophosphorus poisoning (26.4%). Kerosene caused 48.3% of cases. A brand of lacquer thinner (Tenner) was reported to cause 48.4% of cases of organic solvent poisoning. Cannabis was the most common means of intoxication (69.2%).

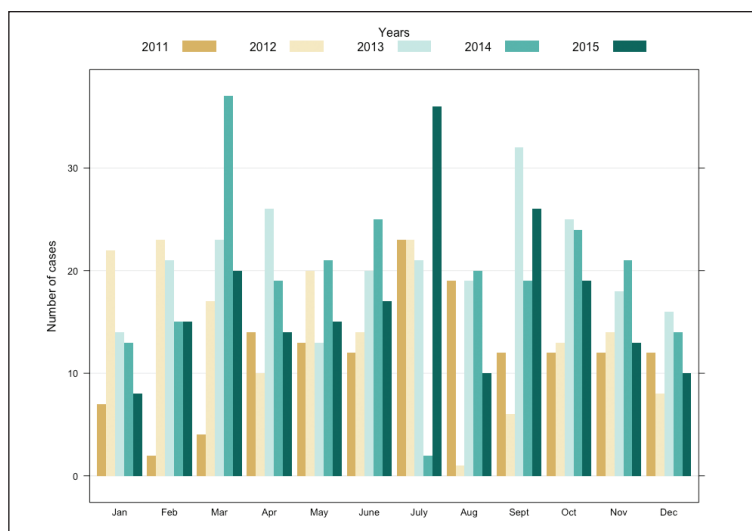
There were statistically significant associations between the type of chemical poisoning and gender ( $\chi^2=32.58$ ,  $P<.001$ ) (Table 5). The rate of poisoning by detergents was much higher among females (44.1%) compared to males (29.3%). On the other hand, the rate of poisoning by insecticides and pesticides was higher among males (19.7%) compared to females

**Table 1.** Characteristics of chemical poisoning cases according to the study variables.

Variables	No. of cases (N=994)	%
<b>Gender</b>		
Male	543	54.6
Female	451	45.4
<b>Age</b>		
>5 years	560	56.3
5–14 years	90	9.1
15–24 years	106	10.7
<24	238	23.9
<b>Nationality</b>		
Saudi	654	65.8
Non-Saudi	340	34.2
<b>Exposure circumstances</b>		
Accidental	768	77.3
Intentional	158	15.9
Unknown	68	6.8
<b>Exposure route</b>		
Oral	769	77.4
Inhalation	205	20.6
Dermal	15	1.5
Other	5	0.5
<b>Laboratory results</b>		
Negative detection of chemical poisoning	15	1.5
No request	979	98.5
<b>Receiving poisoning specific antidotal therapy</b>		
Yes	11	1.1
No	983	98.9
<b>Outcomes</b>		
Recovery	983	98.9
Death	11	1.1

**Table 2.** Total cases for each month for all years.

Month	Cases (%)
January	64 (6.4)
February	76 (7.6)
March	101 (10.2)
April	83 (8.4)
May	82 (8.2)
June	88 (8.9)
July	105 (10.6)
August	69 (6.9)
September	95 (9.6)
October	93 (9.4)
November	78 (7.8)
December	60 (6.0)



**Figure 2.** Number of cases of chemical poisoning by month of occurrence for each year.

(16.6%). In addition, a highly statistically significant association ( $P < .001$ ) was found between age and type of chemical agent. Concerning children aged less than 5 years, detergents were the commonest cause of poisoning (36.2%), followed by insecticide and pesticides (14.1%), then disinfectants and antiseptics (13.4%) and fuels and organic solvents (11.1%). On the other hand, detergents were responsible for only 22.3% of cases of poisoning among adults aged 24 years and older. The table also shows that the incidence of chemical poisoning was significantly higher among Saudi citizens in comparison with non-Saudi residents ( $\chi^2 = 54.4, P < .001$ ). These higher rates among Saudis were observed in most poisoning categories, especially in the detergents (41.7% versus 25.0%). Poisoning by detergents significantly represented the highest share (31.6%) of accidental poisoning ( $P < .01$ ). A statistically significant association was present between the type of poisoning and the route of exposure ( $P < .001$ ).

## DISCUSSION

Our results revealed an increasing rate of chemical poisoning cases between 2011 and 2013. The cause of this increase may be attributed to continuous changes in lifestyle and social behavior of the population.<sup>2</sup> However, the number of cases decreased again in 2014 and 2015, which may be due to the increasing awareness of the population about the problem of chemical poisoning, its complications and the methods of prevention through activities of MOH. Another reason may be because of the increasing population of Saudi Arabia.

**Table 3.** Distribution of chemical poison agents per category in cases reported to the Jeddah Directorate of Health Affairs from 2011 to 2015.

Category	No.	%
Detergents	358	36.0
Disinfectants and antiseptics	105	10.6
Insecticides	93	9.4
Pesticides	85	8.6
Fuels	56	5.6
Organic solvents	25	2.5
Addictive substances	13	1.3
Hair dyes	6	0.6
Perfumes	6	0.6
Agricultural pesticides	3	0.3
Veterinary drugs	1	0.1
Unknown	114	11.5
Others	129	12.9
<b>Total</b>	<b>994</b>	<b>100</b>

During the 5-year period, chemical poisoning cases had one cumulative peak (for all the years) during the summer, especially in July, which is also apparent in 2014. Similar results were found between 129 poisoning cases admitted to the King Khalid National Guard

**Table 4.** Types and names of chemical poisoning agents in cases reported to the Jeddah Directorate of Health Affairs from 2011 to 2015.

Type of chemical poison	No.	%
<b>Detergents (358)</b>		
Clorox	236	66.0
Detergents (no specific name)	75	20.9
Flash	10	2.9
Cleaning substance	8	2.4
Vanish	7	1.9
Others	22	6.4
<b>Disinfectants and antiseptics (n=105)</b>		
Disinfectants (non-specific name)	50	47.6
Dac	32	30.5
Dettol	18	17.1
Others	5	4.8
<b>Insecticides (n=93)</b>		
Insecticide (no specific name)	64	68.8
Naphthalene	9	9.7
Others	20	21.5
<b>Pesticides (n=85)</b>		
Diazinon	26	30.5
Rodenticides	27	31.8
Organophosphorus	23	27.0
Others	9	10.7
<b>Fuels (n=58)</b>		
Kerosene	28	48.3
Fuel	15	25.9
Benzene	7	12.1
Gasoline	5	8.6
Others	3	5.1
<b>Organic solvents (n=31)</b>		
Tenner	15	48.4
Acetone	9	29.0
Alcohol including methanol & ethanol	5	16.1
Others	2	6.5
<b>Addictive drugs (narcotics and stimulants) (n=13)</b>		
Cannabis	9	69.2
Others (heroin, cocaine, amphetamine, shammah)	4	30.8

Hospital, Jeddah, from 2008–2012.<sup>6</sup> Comparable results were obtained also from the study of Makkah<sup>10</sup> and from a recent study done in Tabriz, Iran.<sup>2</sup> Our results also found that children were the most commonly exposed group. Most of the cases occurred during summer, maybe because of summer vacation when families spend more time outdoors. Another factor may be because the parents are usually busy with jobs and social events, which usually increase during the summer. Therefore, they may leave their young children under the supervision of elder siblings or servants. These factors may result in the inadvertent exposure of children to poisons, especially during the summer months.<sup>6</sup> Another notable peak occurred during March, which also corresponds to the spring mid-year vacation, and this finding can be similarly explained.

Children aged less than 5 years of age were the most commonly exposed group to chemical poisoning. Other Saudi studies from Riyadh,<sup>11</sup> Jeddah's National Guard Hospital,<sup>6</sup> and Al-Qassim<sup>8</sup> reported similar findings. This could be attributed to the exploratory behaviors and curiosity of children, who have a tendency to put everything into their mouths and are unable to distinguish between unsafe and safe products,<sup>12</sup> or due to lack of adequate supervision. In addition, most chemical poison containers are not child-proof.<sup>6,8,11</sup> These findings raise very important issues regarding the importance of educating families on how to prevent chemical poisoning cases among children, especially via detergents. On the other hand, a recent study from India<sup>3</sup> reported that the highest number of chemical poisoning cases occurred among adults aged 21–30 years. This inconsistency may be because about two-thirds (68.3%) of the Indian cases occurred due to suicide, which usually occurs among adults and not children. Similarly, the reported incidence of poisoning cases was also higher among adults in other Indian,<sup>13</sup> Malaysian<sup>14</sup> and Saudi Arabian<sup>12</sup> studies.

Our study found a slight predominance in a number of chemical poisoning cases among males compared with females, which coincides with results from an Indian tertiary care hospital.<sup>9</sup> On the other hand, results from the National Guard Hospital in Jeddah<sup>6</sup> as well as those from Al-Qassim,<sup>8</sup> Riyadh,<sup>11</sup> India,<sup>13</sup> and Malaysia<sup>14</sup> reported a higher rate among females. This trend might be related to the target populations for many chemical products, the rate or site of reporting cases, socioeconomic status, or violence and social hierarchy.<sup>6,8,10,13,14</sup>

We also found a statistically significant association between gender and type of chemical poisoning. Females were more prone to being poisoned by

**Table 5.** Types of chemical poisoning by age, gender and other variables among cases reported to Directorate of Jeddah Health Affairs from 2010 to 2015.

Variables	Disinfectants and antiseptics		Detergents		Insecticide and pesticides		Fuel and organic solvents		Unknown		Others		Total	X <sup>2</sup> (P)
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%		
<b>Gender</b>														
Male	53	9.8	159	29.3	107	19.7	46	8.5	78	14.4	100	18.4	543	32.58 (<.001)
Female	52	11.5	199	44.1	75	16.6	35	7.8	36	8.0	54	12.0	451	
<b>Age (years)</b>														
>5	75	13.4	203	36.2	79	14.1	62	11.1	56	10.0	85	15.2	560	116.7 (<.001)
5-14	9	10.0	40	44.4	22	24.4	3	3.3	5	5.6	11	12.2	90	
15-24	13	12.3	62	85.5	9	8.5	5	4.7	6	5.7	11	10.4	106	
> 24	8	3.4	53	22.3	72	30.3	11	4.6	47	19.6	47	19.6	238	
<b>Nationality</b>														
Saudi	79	12.1	273	41.7	105	16.1	49	7.5	49	7.5	99	15.1	654	54.4 (<.001)
Non-Saudi	26	7.6	85	25.0	77	55.6	32	9.4	65	19.1	55	16.2	340	
<b>Exposure route*</b>														
Ingestion (oral)	99	12.9	339	44.1	93	12.1	79	10.3	62	8.1	97	12.6	769	222.6 (<.001)
Other	6	2.7	19	8.4	89	39.6	2	0.9	52	23.1	57	25.3	228	
<b>Exposure circumstances</b>														
Accidental	88	11.5	243	31.6	149	19.4	63	8.2	98	12.8	127	16.5	768	40.5 (<.001)
Intentional	12	7.6	89	56.3	20	12.7	13	8.2	6	3.8	18	11.4	158	
Unknown	5	7.4	26	38.2	13	19.1	5	7.4	10	14.7	9	13.2	68	

\* Fisher's exact test

detergents, antiseptics, and fuels. On the other hand, males were more vulnerable to the other poisonous agents. Similar results were reported in other Saudi studies from Makkah<sup>10</sup> and Al Majmaah.<sup>12</sup> This could be attributed to the fact that women in Saudi Arabia spend most of their time at home with families, making them more prone to indoor chemical poisoning. On the other hand, males of working age tend to spend most of their time in outdoor activities, making them more vulnerable to other types of chemical substances. Similar findings were reported by a Zambian study.<sup>1</sup>

We also found that most of chemical poisoning cases occurred among Saudis, which likely reflects the population distribution in Saudi Arabia, a finding that coincides with other studies conducted in Saudi Arabia.<sup>6,8,10,11</sup>

Our findings showed that the percentage of chemical poisoning cases reported as intentional was only 15.5%. This rate is lower than rates reported by previous studies from Jeddah's National Guard Hospital,<sup>6</sup> Riyadh,<sup>11</sup> Nepal,<sup>15</sup> and India.<sup>13</sup> These discrepancies may be attributed to differences between study populations or differences between reporting sites or reporting rates. The current study involved all cases reported to the Directorate of Health Affairs and not only cases admitted to emergency rooms in hospitals. Most of chemical poisoning cases in our study occurred through ingestion, which agrees with results from Al-Qassim,<sup>8</sup> Makkah,<sup>10</sup> and India.<sup>13</sup>

Intoxication by poisonous agents demonstrates geographical variation that is likely influenced by socioeconomic level.<sup>12</sup> Our results showed that detergents, followed by disinfectants and antiseptics, insecticides, pesticides, and fuels, were the common agents of chemical poisoning. Detergents were the commonest implicated agents due to the etiology of chemical poisoning, in which most cases occurred accidentally and among children in the current study. Similar findings were reported from Al-Qassim<sup>8</sup> and Makkah.<sup>10</sup> However, studies from Al Majmaah,<sup>12</sup> Zambia,<sup>1</sup> India,<sup>13</sup> and Nepal<sup>15</sup> reported that pesticides were the most common poisonous agents. These inconsistencies may be attributed to economic differences. For agriculturally-based populations, pesticides may be among the most common chemical poisoning agents.

The present study revealed that Clorox was the commonest detergent implicated in chemical poisoning, which agrees with the results of a study done about chemical poisoning in children in Qatar.<sup>16</sup> On the other hand, kerosene was the main cause of poisoning among children from Nigeria<sup>7</sup> and North India.<sup>17</sup> The cause of such a discrepancy between the current study and the two aforementioned studies may be related to the time of the study and differences in socioeconomic levels, target populations, and types of commonly used chemicals. In Jeddah, for example, kerosene is not commonly used for fuel at homes.

Only 1.1% patients received poisoning specific antidotal therapy. Most patients recovered, while only 1.1% died, a finding that coincides with the results (1% deaths) from Makkah.<sup>10</sup> However, these rates are lower than those reported in Al-Qassim, Saudi Arabia (2.2%),<sup>8</sup> Zambia (2.6%),<sup>1</sup> and Nepal (3%).<sup>15</sup> Most of the cases (77.3%) occurred accidentally. Similarly, two other Saudi studies from Al-Qassim<sup>8</sup> and Al Majmaah<sup>12</sup> reported that all poisoning cases occurred among children were accidental.

We were unable to measure certain key statistics including the hospitalization rate, management, and specific poisoning antidotes, the place where the poisoning occurred, and employment of patients are not reported to the program. Minor cases may not have been reported to the Public Health Department of the Jeddah Health Affairs resulting in information bias.

In conclusion, most cases of chemical poisoning were accidental, occurred during the summer, were caused by detergents, affected children younger than 5 years of age, and occurred via ingestion. Our results indicate that more educational programs are needed to increase awareness of public about chemical poisoning and their effects. These programs can be delivered through mass media or in shopping malls, through street advertisements, and in school and work places. Such programs need to focus on recommendations for suitable ways of storing chemical products and how to protect children. Intensive supervision of children is needed.

#### **Conflict of interest**

*The authors declare no conflicts of interest.*



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