**Original Research Article**

**Knowledge, Practices, and Safety Awareness Regarding Household Chemicals Among Saudi Families in Makkah Province: A Cross-Sectional Survey**

**Abstract**

**Background: Household chemical products are widely used for hygiene and cleaning, but their improper use and low awareness level can lead to severe health and safety problems. The current study** **was carried out to assess knowledge and practice regarding household chemical safety among Saudi families in Makkah province.**

**Methods: A cross-sectional survey was conducted from** January to April 2025 **using a structured questionnaire that was distributed in different regions of Makkah province, Saudi Arabia. A total of 163 responses were collected and subsequently analyzed through SPSS software. The questionnaire evaluated the usage patterns, safety measures, and information sources of the participants regarding household chemicals.**

**Results:** Most participants were female (68.1%), aged 18–35 years (58.2%). **Frequent use of chemical cleaning products was experienced by 92.5% of the subjects. While 91.3% acknowledged possible harm due to incorrect use, only 69.6% always read product labels before using them. Risky behaviors, such as keeping chemicals in reachable locations and product mixing, were commonly reported even though participants knew the associated dangers. The main sources of information about chemical safety were social media and informal channels, while awareness of official emergency services, such as the 937 hotlines, was very limited.**

**Conclusion: Saudi Arabian families have a general awareness of the safety of household chemicals but are not always translating this awareness into the practice of safety. Therefore, there is an urgent need for specialized public health education programs and the integration of chemical safety awareness into home and educational settings to foster safer behavior and avoid household hazard.**

**Keywords:** Chemical Safety, Household Chemicals, Saudi Families, Public Health

**1. Introduction**

Domestic chemicals are a part of everyday life, forming an essential element to help in levels of hygiene and cleanliness. Such chemicals as cleaning agents, disinfectants, and insecticides are in widespread use across households worldwide (1). However, despite the essential contribution made by these chemicals in the maintenance of household cleanliness, their misuse and improper handling pose considerable safety and health risks (2). The range of risks extends from mild irritations to severe health problems, such as poisoning, burns, and possibly long-term chronic disease. The growing popularity of these products highlights the necessity for advancing our understanding of household chemical safety knowledge, attitudes, and practices (3).

In the Kingdom of Saudi Arabia, where fast urbanization and adoption of modern lifestyles are the order of the day, the application of domestic chemicals has become almost universal (4). Most Saudi households rely on chemical products for maintaining a hygienic and safe living condition. While the products have gained increased usage, research on safety guidelines that regulate their usage in Saudi Arabian households is scarce. Most of the studies touching on chemical safety have been based on the industrial setting, thereby creating a knowledge gap on the household setting (5,6). This knowledge gap presents the necessity for a study aimed at investigating awareness and home chemical safety practices among the Saudi population.

The present study aims to fill an apparent gap in public health studies by conducting an examination of the knowledge, attitudes, and behaviors of Saudi families concerning chemical safety in their domestic setting. In particular, it plans to evaluate their awareness of dangers associated with domestic chemicals, their attitudes toward these dangers, and the practices they adopt for the use and storage of these substances. The study also questions individuals' knowledge regarding emergency response systems such as poison control hotlines and assesses whether families consider themselves well prepared to deal with chemical emergencies at home. The main goal is to provide information that will guide interventions aimed at specific settings and increase chemical safety measures in Saudi Arabian households.

**2. Methods**

**2.1. Study design and setting**

The current research employed a descriptive cross-sectional design to assess the knowledge level, attitude, and practice on home chemical safety, incident management, and storage among Saudi Arabian citizens lived in Makka Province. The study was conducted from January to April 2025.

**2.2. Study participants**

The study included parents, guardians, or other persons in charge of the household in urban and rural areas throughout Makka Province in Saudi Arabia. The participants were drawn from different socioeconomic backgrounds to make the sample representative of the general population.

**2.3. Sample size calculation and sampling technique**

With an estimated population of 3 million families in Saudi Arabia, the research adopted a sample size of 196 respondents. The sample size was determined based on a response of distribution of 15%, confidence interval of 95%, and a margin of error of 5% (7-9). Non-probability convenient sampling was employed to ensure that the respondents were from various geographical areas, socioeconomic backgrounds, and levels of study. By using this approach, variations in chemical safety awareness and practices across different demographic groups were realized.

**2.4. Data collection method**

The questionnaire was prepared after reading the literature of previously published studies (3,5,10,11), in which validated questionnaires were used, thus following content validity. Reliability was checked using a pilot study on 10 subjects. Internal consistency of the questionnaire was done by using Cronbach's alpha, which was 0.81, showing good reliability. This questionnaire developed to evaluate participants' awareness for the safe handling of domestic chemicals, such as storage behaviors, labeling requirements, and recommended practices for chemical exposure. The survey was conducted through face-to-face contact and internet-based media to achieve broad participant representation.

**2.5. Statistical analyses**

Data analysis was performed using SPSS version 24.0 (IBM SPSS Inc., Chicago, IL). The data were examined by employing descriptive statistics (i.e., frequencies and percentages) and inferential statistics (i.e., Chi-square test) to establish relationships between safety behaviors and demographic factors. Statistical significance was p-value <0.05.

**3. Results**

**3.1. Sociodemographic characteristics of the participants**

Out of 196 distributed questionnaires, 163 were completed and returned by participants, yielding a response rate of 83.2%. Most participants were female (68.1%) and aged 18–35 years (58.2%). A large percentage were university graduates (71.2%). Most resided in urban regions (96.9%), and 30.1% were employed in the healthcare sector. A large percentage had healthcare professionals in their families (69.3%), and 60.1% had children at home (Table 1).

**Table 1.** Sociodemographic characteristics of the participants (n= 163)

|  |  |  |
| --- | --- | --- |
| **Socio-Demographic information** | **Frequency** | **Percent** |
| **Gender** | FemaleMale | 11152 | 68.131.9 |
| **Age** | 18-25 Years26-35 Years36-45 YearsOver 46 Years | 48474127 | 29.428.825.216.6 |
| **Level of education** | High schoolUniversityPostgraduateMiddle school | 27116155 | 16.671.29.23.1 |
| **Marital status** | WidowedSingleMarriedDivorced | 979705 | 5.548.542.93.1 |
| **Work Sector** | GovernmentPrivateOtherNot working | 42541156 | 25.833.16.734.4 |
| **Residency** | VillageCityMountainous area | 31582 | 1.896.91.2 |
| **Do you work in the healthcare sector?** | NoYes | 11449 | 69.930.1 |
| **Does anyone in your family work in the healthcare sector?** | NoYes | 50113 | 30.769.3 |
| **Do you have children at home?** | NoYes | 6598 | 39.960.1 |
| **If you have children, what are their ages?** | No KidsUnder 5 yearsBetween 5 and 12 yearsAbove 12 years | 54265627 | 33.116.034.416.6 |

**3.2. Assessment of awareness and perceptions about chemical exposure risks**

As shown in Tabe 2. Respondents' awareness about chemical exposure risks was mixed: 47.9% reported medium awareness, and only 43.6% had high awareness. Although 94.4% believed household chemicals can cause long-term health damage, 42.9% were unsure of the specific effects. Regarding warning labels, 56.4% noticed them but did not necessarily read them, and 32.5% reported reading them regularly.

**Table 2.** Awareness of Chemicals Substances among the participants (n= 163)

|  |  |  |
| --- | --- | --- |
| **Question** | **Frequency** | **Percent** |
| **How aware are you of the health risks associated with exposure to chemicals?** | MediumHighLow | 787114 | 47.943.68.6 |
| **Do you believe household chemicals can cause long-term health damage?** | No, I don’t think they’re harmfulYes, significantlyYes, but I'm not sure of the details | 98470 | 5.551.542.9 |
| **Are you familiar with the warning signs on household products?** | No, I don’t pay attention to them‎Yes, but I don’t always read themYes, and I always read them | 189253 | 11.056.432.5 |

**3.3. Assessment of storage and safety practices**

Most participants (68.7%) stored chemicals in ventilated, closed cabinets. But 60.1% did not use child-resistant caps, and only 27.6% reported always reading expiration dates. About one-third admitted reading them only occasionally (Table 3).

**Table 3.** Distribution of response to Safe Storage and Use of Chemicals (n= 163)

|  |  |  |
| --- | --- | --- |
| **Question** | **Frequency** | **Percent** |
| **Where do you store household chemicals in your home?** | On a table, accessible to everyoneIn the refrigerator to preserve themIn kitchen cabinets near food itemsIn a closed, well-ventilated cabinet | 5343112 | 3.11.826.468.7 |
| **Do you use child-resistant caps on containers?** | NoYes | 9865 | 60.139.9 |
| **Do you check the expiration dates of household chemicals?** | SometimesAlwaysI don’t do thatRarely | 53454124 | 32.527.625.214.7 |

**3.4. Evaluation of emergency preparedness and knowledge, and responsibility and social perceptions**

As indicated in Table 4. Preparedness for emergencies was low overall. Only 18.4% knew precisely what to do when a child swallowed a chemical, and 50.3% had no emergency plan at all. Although 81% had no history of a household poisoning experience, only 26.4% always read container labels in case of accidents. Alarming was that only 14.7% knew the proper response time (within 10–15 minutes), while 54% did not.

**Table 4.** Distribution of response to Managing Chemical Incidents

|  |  |  |
| --- | --- | --- |
| **Question** | **Frequency** | **Percent** |
| **Do you know what to do if a child swallows a household chemical?** | No, I don’t knowI have a general ideaI’m not sureYes, I know in detail | 36564130 | 22.134.425.218.4 |
| **Do you have emergency numbers or poison control centers saved at home?** | No, I don’t have emergency numbersYes, but I don’t remember where I put themYes, saved in a visible place | 792757 | 48.516.635.0 |
| **In case of a chemical accident, which is the first entity you would turn to?** | Family members or friendsMedical Emergency ServicesPoison Control CenterNearby Hospital | 667783 | 3.741.14.350.9 |
| **Do you have a clear plan for what to do in case of a chemical accident at home?** | No, I don’t have a planI have a general planYes, I have a detailed plan | 826021 | 50.336.812.9 |
| **Has any family member ever been poisoned by a household product?** | NoYes | 13231 | 81.019.0 |
| **If a family member's skin is contaminated with a chemical, what is your first response?** | Wash the skin with water immediatelyUse a special solutionContact emergency services immediatelyWash the skin with water immediatelyI’m not sure | 193810015 | .65.523.361.39.2 |
| **Do you follow the instructions on chemical containers for handling accidents?** | SometimesAlwaysI don’t read themRarely | 63433027 | 38.726.418.416.6 |
| **Do you trust the quality of information on household chemical labels?** | To some extentNo, I think they are insufficientYes, completely | 881956 | 54.011.734.4 |
| **Do you know the time frame within which to act to save someone who has been chemically poisoned?** | No, I don’t knowYes, within 5 minutesYes, within 10-15 minutes | 885124 | 54.031.314.7 |
| **What is your source of knowledge about first aid for chemical accidents?** | Family or friendsTraining coursesI don’t have any sourcesWebsites or educational videos | 31453750 | 19.027.622.730.7 |
| **Do you think society needs more awareness about managing chemical incidents?** | No, the awareness level is sufficientYes, to some extentYes, strongly | 322138 | 1.813.584.7 |

A vast majority (89%) believed that parents had the greatest role to play in keeping children safe from chemicals. Additionally, 84.7% strongly agreed that society needed more awareness about the handling of chemical emergencies (Table 5).

**Table 5.** Family Responsibility and Cleaning (n= 163)

|  |  |  |
| --- | --- | --- |
| **Question** | **Frequency** | **Percent** |
| **Who is usually responsible for household cleaning in your family?** | A family memberI amWe use cleaning services | 595747 | 36.235.028.8 |
| **Who do you think is primarily responsible for keeping children safe in the home concerning chemicals?** | Parents‎ManufacturersStores | 145144 | 89.08.62.5 |

**3.5. Association between knowledge, attitude and practice towards chemical exposure risks with sociodemographic characteristics**

Table 6 presents knowledge score distribution among the various demographic groups. The 36–45-year-old respondents had the highest proportion of adequate knowledge (60.0%), whereas 18–25-year-olds had the highest percentage of insufficient knowledge (22.0%). Nevertheless, there were no statistically significant differences between knowledge status and demographic factors such as age, gender, marital status, area, or level of education (P > 0.05), indicating that demographic variables did not have a great bearing on knowledge of household chemical safety.

**Table 6.** Association between the sociodemographic and awareness to health risks associated with exposure to chemicals

|  |
| --- |
| **How aware are you of the health risks associated with exposure to chemicals?** |
| **Socio-Demographic information** | **Medium** | **High** | **Low** |
| **Gender** | Female | 56 | 51 | 4 |
| Male | 22 | 20 | 10 |
| P-Value | **0.004** |
| **Age** | 18-25 Years | 20 | 23 | 5 |
| 26-35 Years | 22 | 19 | 6 |
| 36-45 Years | 16 | 22 | 3 |
| Over 46 Years | 20 | 7 | 0 |
| P-Value | 0.069 |
| **Level of education** | High school | 13 | 10 | 4 |
| University | 57 | 51 | 8 |
| Postgraduate | 3 | 10 | 2 |
| Middle school | 5 | 0 | 0 |
| P-Value | 0.061 |
| **Marital status** | Widowed | 5 | 4 | 0 |
| Single | 35 | 35 | 9 |
| Married | 34 | 31 | 5 |
| Divorced | 4 | 1 | 0 |
| P-Value | 0.65 |
| **Work Sector** | Government | 22 | 19 | 1 |
| Private | 19 | 27 | 8 |
| Other | 6 | 5 | 0 |
| Not working | 31 | 20 | 5 |
| P-Value | 0.154 |
| **Residency** | Village | 1 | 2 | 0 |
| City | 76 | 68 | 14 |
| Mountainous area | 1 | 1 | 0 |
| P-Value | 0.913 |
| **Do you work in the healthcare sector?** | No | 59 | 46 | 9 |
| Yes | 19 | 25 | 5 |
| P-Value | 0.314 |
| **Does anyone in your family work in the healthcare sector?** | No | 27 | 21 | 2 |
| Yes | 51 | 50 | 12 |
| P-Value | 0.305 |
| **Do you have children at home?** | No | 31 | 28 | 6 |
| Yes | 47 | 43 | 8 |
| P-Value | 0.971 |
| **If you have children, what are their ages?** | No Kids | 26 | 23 | 5 |
| Under 5 years | 13 | 10 | 3 |
| Between 5 and 12 years | 19 | 31 | 6 |
| Above 12 years | 20 | 7 | 0 |
| P-Value | **0.044** |

Table 7 indicates that positive attitudes were common across all demographic groups. The age group of 26–35 years had the highest rate of positive attitudes (80.0%), and males also had a slightly higher percentage of negative attitudes (14.3%) than females (7.8%). Nevertheless, none of the relationships between attitudes and demographic factors were statistically significant (P > 0.05).

**Table 7.** Association between the sociodemographic and the attitude of the household chemicals causing long-term health damage.

|  |
| --- |
| **Do you believe household chemicals can cause long-term health damage?** |
| **Socio-Demographic information** | **No, I don’t think they’re harmful** | **Yes, significantly** | **Yes, but I'm not sure of the details** |
| **Gender** | Female | 6 | 61 | 44 |
| Male | 3 | 23 | 26 |
| P-Value | 0.431 |
| **Age** | 18-25 Years | 2 | 21 | 25 |
| 26-35 Years | 3 | 25 | 19 |
| 36-45 Years | 3 | 24 | 14 |
| Over 46 Years | 1 | 14 | 12 |
| P-Value | 0.763 |
| **Level of education** | High school | 3 | 13 | 11 |
| University | 5 | 61 | 50 |
| Postgraduate | 1 | 8 | 6 |
| Middle school | 0 | 2 | 3 |
| P-Value | 0.837 |
| **Marital status** | Widowed | 0 | 7 | 2 |
| Single | 4 | 38 | 37 |
| Married | 4 | 37 | 29 |
| Divorced | 1 | 2 | 2 |
| P-Value | 0.519 |
| **Work Sector** | Government | 2 | 24 | 16 |
| Private | 5 | 26 | 23 |
| Other | 0 | 6 | 5 |
| Not working | 2 | 28 | 26 |
| P-Value | 0.779 |
| **Residency** | Village | 0 | 2 | 1 |
| City | 9 | 81 | 68 |
| Mountainous area | 0 | 1 | 1 |
| P-Value | 0.973 |
| **Do you work in the healthcare sector?** | No | 9 | 55 | 50 |
| Yes | 0 | 29 | 20 |
| P-Value | 0.094 |  |  |
| **Does anyone in your family work in the healthcare sector?** | No | 4 | 23 | 23 |
| Yes | 5 | 61 | 47 |
| P-Value | 0.500 |
| **Do you have children at home?** | No | 2 | 37 | 26 |
| Yes | 7 | 47 | 44 |
| P-Value | 0.368 |
| **If you have children, what are their ages?** | No Kids | 2 | 28 | 24 |
| Under 5 years | 3 | 13 | 10 |
| Between 5 and 12 years | 4 | 30 | 22 |
| Above 12 years | 0 | 13 | 14 |
| P-Value | 0.579 |

Table 8 examines the connection between demographic factors and practice scores. The 26–35 years age group had the best practices (68.6% were "good"), and those above 45 years had the worst (25%). Slightly better practice scores were associated with males (60.0%) compared to females (52.6%). However, none of these differences were significant (P > 0.05), suggesting demographic factors had little influence on actual chemical safety practice.

**Table 8.** Association between the sociodemographic and the familiarity with the warning on household products.

|  |
| --- |
| **Are you familiar with the warning signs on household products?** |
| **Socio-Demographic information** | **No, I don’t pay attention to them** | **Yes, but I don’t always read them** | **Yes, and I always read them** |
| **Gender** | Female | 8 | 69 | 34 |
| Male | 10 | 23 | 19 |
| P-Value | **0.030** |
| **Age** | 18-25 Years | 4 | 31 | 13 |
| 26-35 Years | 6 | 25 | 16 |
| 36-45 Years | 5 | 19 | 17 |
| Over 46 Years | 3 | 17 | 7 |
| P-Value | 0.686 |
| **Level of education** | High school | 2 | 15 | 10 |
| University | 15 | 66 | 35 |
| Postgraduate | 1 | 9 | 5 |
| Middle school | 0 | 2 | 3 |
| P-Value | 0.768 |
| **Marital status** | Widowed | 0 | 7 | 2 |
| Single | 8 | 51 | 20 |
| Married | 9 | 32 | 29 |
| Divorced | 1 | 2 | 2 |
| P-Value | 0.218 |
| **Work Sector** | Government | 5 | 25 | 12 |
| Private | 9 | 22 | 23 |
| Other | 1 | 7 | 3 |
| Not working | 3 | 38 | 15 |
| P-Value | 0.142 |
| **Residency** | Village | 0 | 2 | 1 |
| City | 18 | 90 | 50 |
| Mountainous area | 0 | 0 | 2 |
| P-Value | 0.331 |
| **Do you work in the healthcare sector?** | No | 13 | 64 | 37 |
| Yes | 5 | 28 | 16 |
| P-Value | 0.975 |  |  |
| **Does anyone in your family work in the healthcare sector?** | No | 8 | 26 | 16 |
| Yes | 10 | 66 | 37 |
| P-Value | 0.394 |
| **Do you have children at home?** | No | 6 | 41 | 18 |
| Yes | 12 | 51 | 35 |
| P-Value | 0.379 |
| **If you have children, what are their ages?** | No Kids | 5 | 38 | 11 |
| Under 5 years | 5 | 10 | 11 |
| Between 5 and 12 years | 5 | 28 | 23 |
| Above 12 years | 3 | 16 | 8 |
| P-Value | 0.112 |

**4. Discussion**

This study presents significant results on the level of public awareness and safety practices towards home chemical exposure among the population of Saudi Arabia. Although the majority were aware of potential hazards, their safety measures and emergency preparedness were poor. While 94.4% were aware of the danger of chemicals, high awareness was noted in just 43.6%, a result like that of Al-Zahrani et al. in Jeddah and to a high perceived risk with low preventive action (4). In Riyadh, a report also noted that while awareness of chemical dangers was high among many, frequent protective actions were not observed (6). This suggests a persisting and concerning gap between what is known and what happens. Knowledge alone does not necessarily lead to safe behavior, suggesting psychological, contextual, or cultural barriers to the uptake of protective behaviors exist.

Both chemical and food safety studies in Saudi Arabia recognize a common problem: while awareness levels in the public are relatively high, these do not automatically result in safe practices. Knowledge levels differ according to gender, age, and level of education but change in behavior is still limited (12). This reveals a need for targeted, detailed public education initiatives, workshops, and campaigns, to raise awareness and tackle behavioral and contextual barriers to safe practices within the home. Programs must include the engagement of behavioral drivers and practical application to affect actual change.

Another cross-national European study revealed that despite high levels of regulation, most consumers are not familiar with chemical hazard symbols and rely on non-scientific cues like packaging or smell to ascertain risk (13). Similar pattern was observed in a study based in the U.S. during the COVID-19 pandemic, which reported an increase in calls to poison centers related to household cleaners and disinfectants, quoting widespread engagement in high-risk and non-recommended cleaning practices, such as using bleach on food or applying disinfectants to the skin (14). A developing body of evidence from Saudi Arabia also demonstrates that safety does not track awareness. This reveals a global issue: safe chemical use requires more than information dissemination, hands-on training that is cognizant of cognitive and behavioral barriers. Public health responses must employ a variety of context-specific strategies to enhance hazard awareness and emergency readiness within households.

Although most participants stored chemicals safely, a large proportion did not use child-resistant caps (60.1%) or check expiration dates on a regular basis. Such findings were replicated in the UAE, where most of households did not follow storage precautions (15). Such lapses heighten the incidence of accidental poisoning within domestic environments, which is consistent with reports of a retrospective study carried out at King Khaled University Hospital. According to the study, young children, particularly those aged below six years, were over proportionately vulnerable to chemical poisoning, and chemical agents accounted for 29% of all pediatric poisoning cases. Most of such cases were by oral ingestion and tended to include ubiquitous household compounds such as pesticides and detergents (16).

Notably, gender variations were apparent regarding both knowledge and attitude. In the current study, females demonstrated a higher degree of concern and caution regarding home chemicals, whereas males demonstrated increased awareness of emergency protocols, possibly associated with job training or classroom experience. These observations are in line with a study conducted in Jazan, wherein it was revealed that Saudi women were at significantly higher odds of concern regarding environmental risk as compared to men (AOR: 1.86, p = 0.004) (17). Similarly, a study in Sudan found that females demonstrated better awareness, attitudes, and practices toward the use of disinfection and sterilization products. (18).

Respondents relied largely on warning labels and internet-based sources of information. Yet, only 34.4% fully trusted the labels. This suspicion is also evident in Kuwaiti consumers who blamed product labels for being either too vague or too technical (19). The necessity is clearly seen for clearer and more user-friendly labeling schemes with compliance to the Globally Harmonized System (GHS). Most of the respondents blamed parents for chemical safety at home, consistent with WHO guidelines for parental responsibility for injury prevention (20). However, there is a concerning gap between perceived responsibility and the implementation of concrete safety measures like emergency preparedness or first aid preparedness.

The study also had several limitations. Firstly, the cross-sectional nature of the study precludes causality among practice, knowledge, and attitude. The evidence was based on self-reported questionnaires subject to social desirability or recall bias. Secondly, the sample was drawn from a single region, so generalizability to all Saudi families is limited. Finally, while the survey examined KAP, it did not account for observing behavior, which would be a more objective data source regarding existing practices. Future research is encouraged to employ experimental or longitudinal designs to establish causality more firmly among KAP components.

**Conclusion**

This study illustrates that while there is a moderate awareness among the population of Saudi Arabia about the dangers of exposure to domestic chemicals, safety practices, emergency preparedness, and label reading literacy are absent. Awareness is influenced by significant demographic factors such as gender, healthcare organizational affiliation, and the presence of children. The findings call for urgent interventions to bridge the gap between awareness and practice.

**Ethical Approval And Consent**

**The study was carried out in compliance with the 1975 Declaration of Helsinki and was approved by the Ibn Sina National College (ISNC) Institutional Research Review Board (IRRB) (IRRB-02-17042025). Written informed consent was provided by all the participants. The participants were made aware of the aims of the research, and participation was strictly voluntary. Anonymity and confidentiality were ensured by omitting any identifiable personal details from the data gathering process.**

**Disclaimer (Artificial intelligence)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

**Conflicting Interest**

We declare no conflict of interest.

**References**

1. Salonen H, Salthammer T, Castagnoli E, Täubel M, Morawska L. Cleaning products: Their chemistry, effects on indoor air quality, and implications for human health. Environ Int. 2024;190:108836. <https://doi.org/10.1016/j.envint.2024.108836>
2. Sawalha AF. Storage and utilization patterns of cleaning products in the home: toxicity implications. Accid Anal Prev. 2007;39(6):1186-91. <https://doi.org/10.1016/j.aap.2007.03.007>
3. Mostafa H, Rizk J, Kanaan E, Hamade H, Kaddoura R, Tamim H, et al. Consumer knowledge and awareness of the toxicity and handling of household products at a tertiary care center in Beirut, Lebanon. Toxicol Ind Health. 2022;38(7):408-416. <https://doi.org/10.1177/07482337221106421>
4. Alzahrani SH, Ibrahim NK, Elnour MA, Alqahtani AH. Five-year epidemiological trends for chemical poisoning in Jeddah, Saudi Arabia. Ann Saudi Med. 2017;37(4):282-289. <https://doi.org/10.5144/0256-4947.2017.282>
5. Alqassim AY. Evaluating Parental Knowledge and Behaviors Regarding Developmental Toxicants in Jazan, Saudi Arabia Using the Prevention of Toxic Chemicals in the Environment for Children Tool (PRoTECT). Healthcare (Basel). 2024;12(17):1764. <https://doi.org/10.3390/healthcare12171764>
6. Albadr T, Alfawzan S, Aljarba B, Alshehri R, Mahboub S. Use of health belief model to explain the behaviour of following safety measures during the use of household chemical products among adult females in Riyadh. Int J Res Med Sci.. 2021;9(1):9-14. <https://doi.org/10.18203/2320-6012.ijrms20205825>
7. Badi S, Abdulraheem MA, Mustafa AA, Matar MS, Yousef BA. Knowledge, attitude, and practice of university students toward COVID-19 in Sudan: an online-based cross-sectional study. Current Medical Issues. 2021;19(2):70-7. <https://doi.org/10.4103/cmi.cmi_155_20>
8. Hussain MA, Mohamed AO, Abdelkarim OA, Yousef BA, Babikir AA, Mirghani MM, et al. Prevalence and Predictors of Antibiotic Self-Medication in Sudan: A Descriptive Cross-Sectional Study. Antibiotics (Basel). 2023;12(3):612. <https://doi.org/10.3390/antibiotics12030612>
9. Matar MS, Eljanzoury AM, Musa SI, Abdulwahaab MA, Mustafa AA, Yousef BA, Badi S. Evaluation of counseling services provided by community pharmacists and patients' satisfaction toward their services: A cross-sectional survey from Sudan. Current Medical Issues. 2021;19(1):24-31. <https://doi.org/10.4103/cmi.cmi_138_20>
10. Tsitsimpikou C, Georgiadis N, Tsarouhas K, Kartsidis P, Foufa E, Bacopoulou F, et al. Children and Parents' Awareness Regarding Potential Hazards Derived from the Use of Chemical Products in Greece. Int J Environ Res Public Health. 2021;18(24):12948. <https://doi.org/10.3390/ijerph182412948>
11. Bearth A, Bosshart N, Wermelinger S, Daum M, Siegrist M. Household chemicals and pre-schoolers: Caretakers’ beliefs and perspectives on risks and responsibilities. Safety science. 2022;154:105864. <https://doi.org/10.1016/j.ssci.2022.105864>
12. Ayad AA, Abdulsalam NM, Khateeb NA, Hijazi MA, Williams LL. Saudi Arabia Household Awareness and Knowledge of Food Safety. Foods. 2022;11(7):935. <https://doi.org/10.3390/foods11070935>
13. Bearth A, Buchmüller K, Bürgy H, Siegrist M. Barriers to the safe use of chemical household products: A comparison across European countries. Environ Res. 2020;180:108859. <https://doi.org/10.1016/j.envres.2019.108859>
14. Gharpure R, Hunter CM, Schnall AH, Barrett CE, Kirby AE, Kunz J, Berling K, Mercante JW, Murphy JL, Garcia-Williams AG. Knowledge and Practices Regarding Safe Household Cleaning and Disinfection for COVID-19 Prevention - United States, May 2020. MMWR Morb Mortal Wkly Rep. 2020;69(23):705-709. <https://doi.org/10.15585/mmwr.mm6923e2>
15. Alwan N, Almazrouei S, Almazrouei M, Aldhaheri J, Alismaili F, Ghach W. Evaluation of public awareness and performance toward the safe use of household disinfectants-cleaners to prevent COVID-19 in the Emirate of Abu Dhabi. Front Public Health. 2023;11:1214240. <https://doi.org/10.3389/fpubh.2023.1214240>
16. Alghadeer S, Alrohaimi M, Althiban A, Kalagi NA, Balkhi B, Khan AA. The patterns of children poisoning cases in community teaching hospital in Riyadh, Saudi Arabia. Saudi Pharm J. 2018 Jan;26(1):93-97. <https://doi.org/10.1016/j.jsps.2017.10.007>
17. Alqassim AY, Alharbi AA, Muaddi MA, Jurebi RM, Daak LI, Moafa AI, et al. Assessing Environmental Health Hazard Awareness for Sustainability: A Survey of Adults in Saudi Arabia. Sustainability. 2024;16(2):593. <https://doi.org/10.3390/su16020593>
18. Badi S, Hamed A, Abualama M, Mustafa M, Abdulraheem M, Yousef B. Knowledge, attitude, and practice of sudanese pharmacists toward COVID-19 in Khartoum State, Sudan: An online-based cross-sectional study. Libyan International Medical University Journal. 2021;6(01):19-26. <https://doi.org/10.4103/LIUJ.LIUJ_42_20>
19. Al-Khamees NA. Knowledge of, Attitudes toward, and Practices regarding Indoor Pollution at Kuwait University. Journal of Geoscience and Environment Protection. 2018;6(12):146. <https://doi.org/10.4236/gep.2018.612011>
20. Winder C, Azzi R, Wagner D. The development of the globally harmonized system (GHS) of classification and labelling of hazardous chemicals. J Hazard Mater. 2005;125(1-3):29-44. <https://doi.org/10.1016/j.jhazmat.2005.05.035>