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Assessment of the Use of Household Chemicals in Al-Karak Governate, Jordan

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Abstract: The objective of this study was to evaluate the major factors that influence the correctness of household chemical utilization in the Jordanian households. The practices in the use of household chemicals of 1200 women in Al-Karak Governate of the country of Jordan were surveyed through a quantitative questionnaire in 2009. The results were analyzed in population sets grouped by different demographic relationships (i.e., age, level of education, family size, number of working members and geographic location). Analysis of Variation (ANOVA) of the population means based on these groupings was conducted. The results indicated that age, level of education, family size and number of working members were all important and statistically significant factors in the proper use of household chemicals in the study area. The means of the population sets based on geographic distribution did not vary significantly indicating that education on the proper use of household chemicals is needed throughout Jordan.

Key words: Household, hazardous, chemicals, ANOVA, cleaners, disinfectants, Jordan

INTRODUCTION

Many products used each day inside the home as well as lawn and garden products contain hazardous chemicals. All-purpose cleaners, ammonia-based cleaners, bleach, dishwashing detergents, disinfectants, drain cleaners, glass cleaners, oven cleaners and toilet cleaners may contain dangerous chemicals that cause irritation when they come into contact with the skin. Further, the fumes of these chemicals like chlorine and ammonia are very irritating and corrosive to the eyes, nose and airways and may cause a burning sensation, coughing, wheezing, shortness of breath, laryngitis and watery eyes even at low levels, especially with inadequate ventilation (Rosenblith, 2005). These products can be found stored and used in various locations throughout people's homes (in special storage cabinets, in the basement, under the kitchen sink and in the bathroom). The hazardous materials in these products are harmful to the public health and the environment when improperly used or disposed. Also, improper mixing of household cleaning products such as strong acids and bases can result in releasing poisonous gases which cause very serious breathing problems (Rosenblith, 2005).

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Studies have not been made to estimate the amount of waste stored in homes, disposed of improperly, or put out for collection. The residential waste stream includes everything put out in the trash, poured down the drain, or dumped on the ground (Shah, 2000). Household hazardous wastes are outside the normal control system in most countries. Federal law in the United States (US) specifically exempts household hazardous waste from regulation. There have been continual efforts in the US and Europe over the past 20 years to collect household hazardous waste separately from regular municipal waste so that it can be treated with other hazardous wastes (LaGrega *et al*., 2001).

The amount of hazardous material found in residential and commercial municipal solid waste in the US ranges from 0.075 to 2.0% by weight. Approximately, 75 to 85% of this is generated at residential homes (Tchobanoglous and Theisen, 1993). Data from studies suggested that household hazardous waste amounts to a significant quantity, perhaps as much as all of that represented by small industrial generators (less than 100 kg month^{-1}) (Environmental Resources Management, 1985). The relative distribution of the amount of hazardous waste generated has been shown in the US to vary with the season of the year (USEPA, 2002). There were more than one million exposures of children under the age of 5 years to toxic household chemicals reported in 1995 in the US and more than 100,000 children accidentally ingest pesticides each year (National Wildlife Federation, 1997).

Research in Jordan has shown that environmental awareness of the population in relation to issues of air pollution, water pollution and solid waste management vary with location, age, sex and education (Ziadat, 2010). One of the issues established in the environmental awareness study for Jordan is that the women are generally more aware of environmental issues than the men. The authors are aware of no research being conducted throughout the Middle East regarding the use, storage and disposal of household chemicals. The purpose of this study was to assess the use, management and disposal of household hazardous chemicals by female heads of households in Jordan, who are most responsible for these activities in the home and workplace. The results of the study will be used to formulate educational outreach programs to increase the knowledge base for household chemicals.

Saarinen (1990) investigated strategies for the public to use to prevent hazardous waste contamination of drinking water. Educational outreach programs maybe a means to direct the public to avoid pouring hazardous chemicals down the drain and to make use of licensed contractors for the ultimate disposal of hazardous household wastes. Bacard (1993) stated that use of household hazardous chemicals is one of the areas in life that people have to be challenged to create a cleaner environment to live in Hanscom (1992) stated that household hazardous waste is aiding in the destruction of our environment and that although, the amount may be too small to regulate, it is too dangerous to ignore.

The determination of quantitative and qualitative value of risk related evident of recognized environmental hazardous threat (full-scale risk assessment) of household chemicals is very difficult to accomplish due to lack of current data as it is almost impossible to evaluate the risk of the misuse of each chemical in every household of a community. Slack *et al*. (2005) conducted a pilot study of 400 households in Southeast England to assess the amounts of hazardous chemicals used and stored in households along with potential disposal routes. Demographic differences were found relating to community size and length of residence time in the area.

The Canadian province of British Columbia is making use of the concept of Extended Producer Responsibility (EPR) for the management of household hazardous wastes (Driedger, 2001). Although, the regulations appear to have had mixed results in leading consumers to avoid purchasing products containing hazardous chemicals, local government

Table 1: Household chemical products and health issues (Rosenblith, 2005)

Chemical	Product	Health issue
Sodium hypochlorite	Chlorine bleach	Lung, skin, eye irritant Most common cleaner accidentally swallowed by children Mixed w/ammonia or acid based cleaners produce toxic gas
Petroleum distillates	Metal polishes	Short term, temporary eye clouding Long term, damage to skin, nervous system, kidneys, eyes
Phenol and cresol	Disinfectants	Diarrhea, fainting, dizziness, kidney and liver damage
Nitrobenzene	Floor and furniture polish	Shallow breathing, vomiting, death, cancer, birth defects
Formaldehyde	Paints, coatings, cosmetics, glue, nail enamels	Probable human carcinogen, respiratory reactions, vomiting, coma, death
Ammonia	Glass cleaners	Skin, eyes, airways, nose irritant

costs for managing hazardous household chemicals and the amount of household chemicals being identified in municipal waste at sanitary landfills have both declined. Farrell (1995) reported that Chittenden County, Vermont created a mobile unit as part of a comprehensive collection system for household hazardous chemicals. The European Committee of Surfactants and their Organic Intermediates recommended that the European Commission should not regulate the production and use of surfactants (a major chemical component of most household detergents and soaps) solely based on their biodegradability as better performing surfactants can lower energy and water consumption if properly used (Chemical Week, 2003). The European Commission reported that quantitative targets for reducing the use of household detergents and cleaners have been exceeded in the aggregate resulting in a net benefit to the environment.

The concept of using chemicals for cleaning and disinfection can trace its beginning to the Phoenicians and is currently a multi-billion dollar industry annually (Friedman and Wolf, 1996). The US detergent market alone was $3.7 billion and the worldwide surfactant industry was over 11 million tones in 2002 (Chemical and Engineering News, 2003). There is little argument in the literature that detergents are needed for cleaning and that disinfectants are necessary for limiting the spread of pathogens (Terpstra, 2001; Exner *et al*., 2004; Hannuksela and Hannuksela, 1996). The main problem with the use of disinfectants related to household cleaning has been the improper mixture of the disinfectants with acidic cleaners and descalers forming toxic gases (Emsley, 1998). The effects of the use of soaps, detergents and various chemical cleaners on the population have been shown to be related to age (Brown, 1996). Wolf *et al*. (2001) stated that doctors need to be educated in the proper use of chemical agents in the home, including chemical composition, application, safety and potential hazards.

Rosenblith (2005) indicated that the misuse of commonly used household chemicals at homes can cause harmful effect to human health especially children. For example, the excessive use and high concentration of chlorine bleach could have a direct effect on skin and lungs and can cause eye irritation. Meanwhile, floor and furniture polish, might cause shallow breathing, cancer, or birth defects. A list of other household chemicals, product and potential health issues are shown in Table 1.

Cheng and Ding (2002) reported that the use of detergents containing Nonylphenol polyethoxylates (NPEOs) are not removed in standard wastewater treatment, are persistent in surface waters and sediments and are a significant surface water contaminant in developing countries.

The Study Area

The study area covered Al-Karak Governate, which is located 150 km South of Amman, the capital of Jordan. While, the country's total population is currently estimated at

5.76 million people, the Karak Governate was estimated to be approximately 214,200 people in 2002, within a land area of 3495 km^2 (Department of Statistics, 2004). For the purposes of this study, the governate was divided into the following geographic areas: Downtown Karak, North Karak, South Karak, Wadi Karak and The Valley. The Karak Governate is one of the more populated areas in the Southern region of Jordan and is representative of the diverse demographics of the country for urban and rural life styles, including agricultural and commercial business operations. Mutah University, which currently has approximately 18,000 students, is a major economic center in the region located approximately 15 km from downtown Al-Karak.

Survey Design and Implementation

In 2009, a questionnaire covering the use, storage and disposal of household chemicals in the Karak Governate was formulated by the authors and distributed throughout the study area to 1200 females having responsibility for the management of these chemicals in the home and workplace. Demographic data was collected regarding the following information about the women: location in the country, age, level of education, current profession, number of family members, children under the age of 6 years and number of family members currently employed. Questions were written to evaluate the types of cleaners used in the Jordanian households, along with how they are generally used, what precautions are taken in their use, where and how they are stored, under what level of supervision and at what age are children allowed to use the chemicals and the kinds of problems that may have occurred with their use.

The questionnaire was evaluated by professionals for its contents, clarity of language and appropriateness of length prior to conducting the study survey using an initial draft form. Fifty individuals with a variety of backgrounds, education levels, age and gender from the same regional area were chosen for the draft evaluation. The pre-tested sample was excluded from the actual survey. The questionnaire was subsequently evaluated based on the pre-test and revised to its final format. The test-retest reliability coefficient Cronpanch Alpha (α) was used to test the reliability of the scale and the internal consistency of the questionnaire, which was calculated to be (0.74). From the statistical perspective, this is a reliable result as it exceeds 0.60 (George and Mallery, 2003; Blalock, 1970).

Quantitative scores were assigned to each question based on how environmentally correct the response was. Six questions were included as survey indicator questions to gage the extent of the women's activities with various chemicals. These questions were not scored quantitatively in the index formation, but were used along with the demographic data in the analysis of variation conducted. Quantitative scores were used to develop an overall index that was used in conjunction with the sample populations formed by various groupings of demographic data. Survey participants were also given the opportunity to provide narrative comments.

RESULTS AND DISCUSSION

A quantitative summary score was developed for each of the surveys received. These scores were then grouped based on the different demographic relationships of the survey (i.e., age, level of education, family size, number of working members and geographic location).

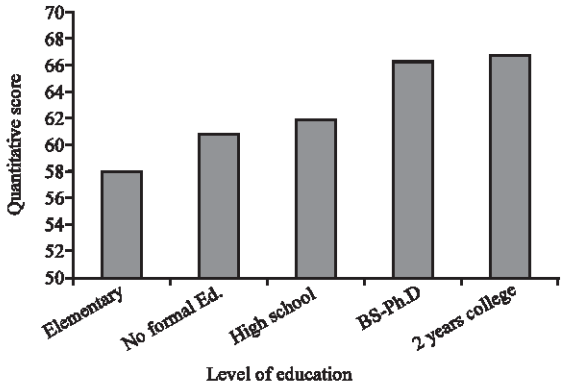

Fig. 1: Variation in quantitative score with level of education

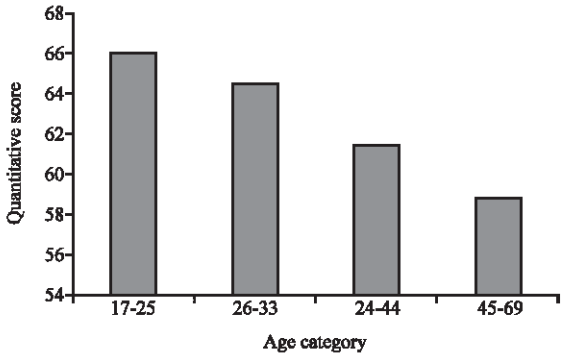

Fig. 2: Variation in quantitative score with age

Table 2: The p-values for one-way ANOVA at level $\alpha = 0.05$

Population groupings	p-value
Education	0.000178
Age	0.000312
Family size	0.000131
No. of working members	0.001206
Geographic location	0.1403*

*Not significant at $\alpha = 0.05$

The variation in correctness of use of household chemicals (Fig. 1) appears to vary with level of education. One way Analysis of Variation (ANOVA) showed that these variations are statistically significant at level $\alpha = 0.05$ ($p = 0.00018$) (Table 2). It is worth mentioning that the variation is not linear with level of education as the women with no formal education scored higher than the women completing the elementary level of education. This result may reflect that a certain higher degree of education and knowledge must be obtained before the benefit of education is reflected in the understanding and correct use of chemicals. Additionally, the women with no formal education may have had better life experiences than the women with only an elementary level of education.

The correctness of chemical utilization appears to vary with age of the survey participants as shown in Fig. 2. This variation is confirmed to be statistically significant with

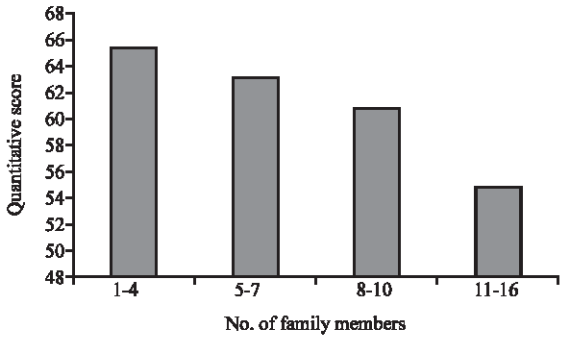

Fig. 3: Variation in quantitative score with number of family members

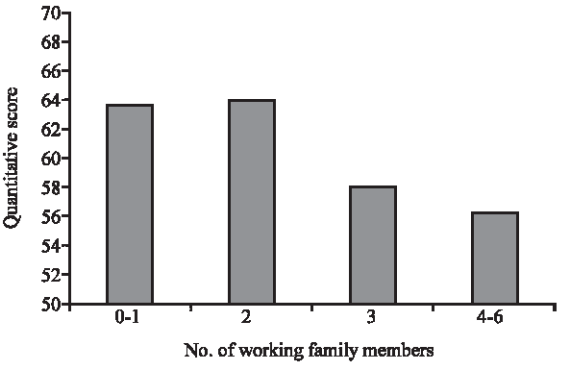

Fig. 4: Variation in quantitative score with number of working family members

ANOVA at level $\alpha = 0.05$ ($p = 0.0003$) (Table 2) and appears to be linearly decreasing with age. On the other hand, the correctness of chemical utilization decreased with the increasing number of family members (Fig. 3). This could be attributed to the various activities taking place at home by each family member at the same time leading to higher level mismanagement usage of household chemicals. This variation is confirmed with ANOVA at level $\alpha = 0.05$ ($p = 0.00013$) as shown in Table 2. Further, the correctness of chemical use appears to vary with number of family members that are employed (Fig. 4). This variation is confirmed by ANOVA at level $\alpha = 0.05$ ($p = 0.001$) as shown in Table 2. It is worth noting that the correctness of use increases slightly for two people working versus zero or one, but then varies inversely with the increasing number of working members. The decreasing value of correct usage with increasing family size and increasing number of working family members may both be representative of less continuity in the family structure and activities. Working family members generally may feel more hurried and don't take sufficient time to handle the chemicals properly or to teach younger family members the proper procedures.

The results of the study indicated that there is no consistent variation with geographical locations in the study area as shown in Fig. 5. This could be attributed to the fact that the majority of people in the country in Jordan have the same traditional background, habits and lifestyle. This is confirmed with ANOVA at level $\alpha = 0.05$ ($p = 0.1403$) as shown in Table 2. This finding may represent that there is a need throughout Al-Karak region for educational and training programs on the proper usage of household chemicals at homes.

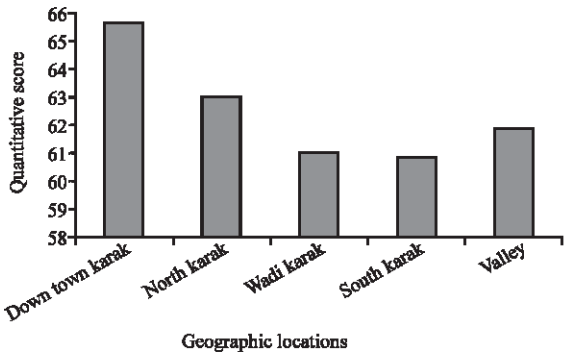

Fig. 5: Variation in quantitative score with location

Some informative results of this research are summarized as follows:

- Forty five percent of the participants stored chemicals in the kitchen, 20% under the sink and 20% in the bathroom and only 15% in special cabinet
- Sixty three percent of the participants considered that mixing more than one type of chemicals would increase cleaning efficiency
- Seventy five percent of the participants read the instructions that exist on the cleaner containers but only 46% followed these instructions
- Seventy percent of the participants used concentrated chlorine in the cleaning operations and for removing fungus from house walls
- Only 40% of the participants wore gloves to protect their skin from irritation and burning during use of household chemicals
- Seventy percent of the participants were affected by inhalation of the chemical vapors
- Twenty eight percent of the of the participants reported that their children were hurt by misuse of the household chemicals
- Fifty seven percent of the housewives participants instructed their children how to use and protect themselves from household chemicals and 85% of the responders indicated that they would not let children under the age of 10 use household chemicals without instruction
- Forty five percent of the participants indicated that they currently use 6 or more household chemicals in their cleaning and approximately the same number indicated that the number of chemicals that they use every year is increasing

CONCLUSIONS AND RECOMMENDATIONS

Analysis of results of a survey of the practices of 1200 women using household chemicals in the Karak Governate in Jordan have led to several conclusions: Even though increasing levels of education beyond the elementary level were associated with more correct chemical usage, the level of correctness of chemical use declined significantly with increasing age. The level of correctness of chemical use declined with increasing family size and with increasing number of people working. The level of correctness of chemical use did not vary geographically throughout the region.

These results indicate that continuing education presentations on correct household chemical use should be developed and presented in conveniently located population centers

throughout the region. Further, these presentations should be designed to target middle-aged and older people and they should be made available in such a way to be very economical for larger families to attend. Finally, the presentations should be conveniently scheduled for working people to attend, which would indicate opportunities to partner with companies to offer continuing education seminars during the working day.

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