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ORIGINAL ARTICLE

Qualitative Dermal Exposure Assessment of Laboratory Technicians in Selected Chemical Laboratories in Eastern Province, Saudi Arabia

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ABSTRACT

Introduction: The assessment of dermal exposure is a complex task. The most commonly used methods have fundamental problems, and there are large gaps in the documentation and validation of the known assessment methods. This study aimed to determine the prevalence of self-reported skin problems in laboratory technicians. Additionally, to determine if there is an association between self-reported skin problems and work tasks and other exposure-related parameters, we developed a simple qualitative questionnaire that may be used for conducting qualitative dermal exposure assessments. **Methods:** A well-structured survey questionnaire was developed and 45 laboratory technicians were interviewed while conducting qualitative dermal exposure assessments in three selected laboratories. The sampling technique was a qualitative survey conducted through interviews. The examined variables included skin problems, work characteristics, and chemicals used. **Results:** This study indicated that 18% of technicians reported having skin problems, most notably inexperienced technicians or technicians with more than 6 years of experience. Skin problems were also identified in technicians who worked between one and eight hours, performed manual operations, and handled solvents. The prevalence of skin problems has also been associated with changing gloves. However, no significant differences were observed between the examined parameters and skin problems ($p > 0.05$). **Conclusion:** The prevalence of self-reported skin problems (18%) among laboratory technicians was not high. The prevalence of dry skin was low (11%). A well-structured questionnaire can be used to conduct a qualitative dermal risk assessment. As this was a cross-sectional study with a small sample size, it was not possible to establish a causative effect between exposure to workplace hazards and dermal problems.

Keywords: dermal exposure assessment, laboratory technician, qualitative

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INTRODUCTION

Exposure to hazardous substances can occur via inhalation, ingestion, or dermal contact. Occupational hygiene professionals have usually focused on the inhalation exposure route because it is considered the most important route. Numerous methods have been developed to assess the risk of inhalation exposure. In contrast, dermal exposure remains a growing field of scientific research and is applied to occupational hygiene. Assessing dermal exposure is a complex task, and the most frequently used methods have fundamental problems because of large gaps in the documentation and validation of sampling methods (Schneider *et al*., 2000).

Laboratory technicians use numerous industrial chemicals to analyze samples, many of which are considered health hazards. During sample processing or analysis, technicians use different chemical reagents, apply heat, or mix them manually or automatically. Many of these chemicals are organic solvents that pose significant health risks (Williams and Burson, 1985). In general, some chemicals damage the cells in the living layer of the epidermis, while some organic solvents may cause denaturation of keratin and delipidation of the lipid bilayer. The organic solvents in question are lipophilic and tend to extract fat upon contact. Thus, the expected biological responses include irritation and defatting

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at the exposure site (Anna, 2011). Occupational skin diseases constitute a significant percentage of workplace illnesses, and the number and frequency of work-related adverse health effects involving the skin are significantly greater than those involving the respiratory system. Generally, three types of chemical–skin interactions are of concern: direct skin effects, immune-mediated skin effects, and systemic effects (Berau of Labor Statistics, 2007).

Assessing dermal exposure to chemicals remains a challenge for occupational hygiene professionals in the workplace because there are significant research gaps in dermal exposure assessment methodologies (Schneider *et al*., 2000). Very few tools are available for occupational hygiene professionals to evaluate dermal exposure, and it is difficult to associate skin contact with chronic disease conditions that occur at low levels over long periods (Ignacio and Bullock, 2006).

In the absence of dermal risk assessment methodologies and management guidelines, some companies cannot assess or manage dermal risks in the work environment. The importance of introducing practical guidelines for employers has been highlighted, with statistics showing that work-related skin diseases are responsible for numerous claims and lost working days. There are very few dermal exposure assessment methods that are either generalized or not thoroughly validated (Callahan *et al*., 1987).

Various exposure assessment models have been proposed to establish dermal exposure assessment guidelines, but none have been officially recognized as standards. Some European models include the Risk Assessment for Occupational Dermal Exposure to Chemicals (RISKOFDERM) and DeRmal Exposure Assessment Model (DREAM) (Van Wendel De Joode *et al*., 2005). The RISKOFDERM was designed to produce a validated prediction model that estimates dermal exposure from qualitative workplace observations in various European countries using an extensive measurement program for dermal exposure during certain activities. The RISKOFDERM model comprises four parts: a qualitative survey of workplace tasks, processes, and determinants relevant to dermal exposure; a quantitative survey on dermal exposure and determinants; the development of a predictive dermal exposure model; and the development of a risk assessment and management tool kit on exposure and control measures (Van Wendel De Joode *et al*., 2005). Similarly, this study suggests characterizing the same set of parameters that are most likely to cause dermal exposure.

DREAM is a semiquantitative exposure assessment tool for chemical and biological agents that uses a scoring system to determine and assess chemical exposure (Van Wendel De Joode *et al*., 2005; Susanto *et al*. ,2020). According to the DREAM approach, the chemical substances used in the workplace and their toxicities are first identified, followed by factors such as tasks, work patterns, and dermal exposure sources. After these factors were established, a structured semiquantitative dermal exposure assessment was performed. If the dermal uptake of hazardous substances cannot be ruled out, a quantitative survey should be conducted on dermal exposure levels and distribution (Van-Wendel-De-Joode *et al*., 2003).

A well-structured questionnaire was developed to collect qualitative information on the substances used, analysis methods, exposure control measures, routes of exposure, and other parameters required for qualitative dermal risk assessment in modeling (Auffarth, 2001; Auffarth *et al*., 2003). Qualified professionals collected all the required information.

This study aimed to 1) determine the prevalence of self-reported skin problems among laboratory technicians; 2) determine if there is an association between self-reported skin problems and identified work tasks, characteristics, and parameters; and 3) develop a simple, structured questionnaire used for conducting qualitative dermal exposure assessments without pursuing further semiquantitative and quantitative exposure assessments.

METHODS

Ethics committee approval was received from the company management, and the employees who participated in the study provided their consent.

Study Design

This study used a descriptive cross-sectional design because it is inexpensive and can be performed faster while providing information about the prevalence of outcomes or exposures. However, since this is a one-time measurement of exposure and outcome, it is difficult to derive causal relationships from cross-sectional analysis. Instead, this type of study can estimate the prevalence of various diseases (Setia, 2016). This study is expected to find a significant relationship between current laboratory work activities and the prevalence of skin-related problems in laboratory technicians. Thus, a cross-sectional study was conducted to obtain a quick and reliable answer to this hypothesis by utilizing well-structured questionnaires. This study complied with the requirements of the institutional review board.

This study included technicians from three chemical laboratories selected and interviewed based on their tasks: handling and analyzing crude oil, crude products, and different water samples. We excluded those who processed gas samples (liquefied petroleum gases and natural gas liquids). Thus, 45 technicians were recruited out of the 160 who worked during 8-hour days or afternoon shifts. In contrast, the night shift was not part of this study, as most lab analysis activities were conducted during the day or afternoon shift.

During each shift, the technicians performed various tasks, such as analyzing the crude oil samples and conducting penetration and viscosity tests. In addition to crude oil, laboratory analyses of fuel products have included diesel, asphalt, jet fuel, kerosene, naphtha, gasoline, and kerosene. Laboratory technicians perform physical tests and various analyses (electrochemical, chemical, chromatographic, spectroscopic, and titrimetric), which involve preparing samples, standards, and reagents, including pouring and transferring samples, mixing and manual shaking of liquids, and dispensing solvent reagents. Various analyses require chemical fume hoods and common laboratory apparatus (water baths, centrifuges, ovens, titration devices, mixers, gas chromatographs, infrared (IR) spectrometers, and X-ray fluoroscopy). In some cases, contaminated rags were used to clean the workbenches, while washing and rinsing glassware involved toluene and acetone for drying. Each task took about 20–25 minutes, with total working hours lasting around 6–7 hours per shift.

During this study, except for personal protective equipment (PPE), specifically gloves, all laboratory control measures, such as ventilation, chemical fume hoods, bench designs, and enclosures, were considered to ensure that these measures do not affect the effectiveness of the study. All three laboratory settings were almost identical, and there were no differences in laboratory functions and designs.

Data Collection

A well-structured questionnaire was developed using RISKOFDERM as a reference (Hebisch and Auffarth, 2001). This questionnaire was created to assess lab technicians' work and hygiene practices related to dermal exposure to chemicals and was made specific to laboratory operations (oil and gas operations). For example, the questionnaires identified the solvent used, specific type of gloves, and specific cleaning method. The questionnaires were pre-tested on a small group of occupational hygienists trained by the Institute of Occupational Medicine. During this step, data on these practices were collected through one-on-one interviews, and most self-reported answers were validated through observation, including skin problems and protective measures. During the interviews, an occupational hygienist (OH) collected data on the respondents' work profile, job title, years employed, and previous work history. Work descriptions included task duration, analysis operation type, workplace, other work sites, arrangements, number of workstations assigned, chemical reagents, and the number and type of sample analysis. Work and personal hygiene practices, usage and type of gloves, and how often they were changed were also included and collected using a questionnaire. The occupational exposure and risks to other body parts exposed to chemicals, frequency, and contact duration were also investigated. The OHs also observed laboratory technicians while receiving and performing sample preparation and analysis to verify the entire process.

Statistical Analysis

Data were processed and analyzed using Stata Version 13 (StataCorp, 2013), and frequencies and percentages were used to summarize the data. Similar to some existing cross-sectional studies, Fisher's exact test was used to analyze the association between self-reported or perceived presence of any skin problems (Akkus and Pinar, 2016; A'Court *et al*., 2011; Ebrahimi *et al*.(2011); Griffiths and Christensen (2000). Owing to the limited number of samples, the categories of variables were collapsed to retain two categories. The two most common tests for determining whether measurements from different groups are independent are the chi-square test and Fisher's exact test. The former applies an approximation assuming a large sample, whereas the latter runs an exact procedure, particularly for small samples. Fisher's exact test also determines whether there is a significant difference between the two proportions or an association between the two characteristics. The Fisher-exact p-value corresponds to the proportion of values of the test statistic that are extreme (i.e., unusual) or more extreme than the observed value of the test statistic. Results with p-values less than the significance level of 0.05, were considered significant.

RESULTS

A total of 45 laboratory technicians participated in this study, one-third of whom had worked in laboratories for more than five years. There were 38 technicians without a previous laboratory work history, meaning that most worked in the same chemistry laboratories. In addition, 42% of the laboratory technicians performed purely manual tasks, and 36% of those technicians handled tasks lasting approximately one to four hours. In contrast, 35% had tasks lasting 15–60 min, 16% handled 15-minute tasks, and 13% had tasks lasting 5–8 h per shift.

The most common chemical reagents used were solvents (47%). Among the chemical reagents used (methanol, octane, butanol, chloroform, carbon disulfide, isooctane, and kerosene) for sample preparation and analysis, the highest percentages of the three solvents used were toluene (20%), xylene (12%), and acetone (10%). Several samples were collected, delivered, and analyzed by technicians. It was found that 42% of the total samples were crude, followed by gasoline (14%), reformate (10%), and sour water (8%).

Most laboratory technicians (68%) had their hands exposed to chemicals. In addition, some had their faces (9%), torso (8%), arms (6%), and lower body (5%) exposed to the chemicals. Notably, 53% of the technicians were exposed to the chemicals for 1–4 h. Among them, 33% were exposed for up to an hour, and 11% were exposed for 5–8 h per shift. Almost all technicians (96%) reported that they were exposed to chemicals daily (4%), once a week.

Furthermore, 92% of the technicians observed washed their hands with soap and water, 67% of whom washed their hands after each task. In addition, 96% of technicians wore chemical gloves to protect their hands. Nitrile gloves were used by 80% of the technicians, which is an ideal alternative for those with latex allergies. In addition, 49% of technicians changed gloves up to four times per shift, whereas 51% changed gloves more than five times per shift.

Of the 45 observed technicians, eight reported some form of skin problems, five of which were dry skin. A simple association analysis using Fisher's exact test was performed to determine whether skin problems were associated with work characteristics and the types of solvent reagents and samples. The frequency and duration of exposure, hand cleaning time and methods, workplace practices involving

Table 1. Prevalence of Self-Reported Skin Problems

Skin Problem	Number of Technicians	% (95% CI)*
Presence of skin problems	8	18 [8–32]
Skin dryness	5	11 [4–24]

*CI = Confidence Interval

Table 2. Prevalence of Self-Reported Skin Problems by Work Characteristics, Solvent Reagents, and Types of Samples

Variable Factors	Number of Technicians	Skin Problem	p-value
Years in Current Job			
0–5 years	30	4 (13)	0.410
6+ years	15	4 (27)	
Duration of Tasks			
Less than 60 minutes	23	4 (17)	1.000
Greater than 60 minutes	22	4 (18)	
Operation			
Manual	19	5 (26)	0.253
Nonmanual	36	3 (8)	
Solvents			
Yes	35	7 (20)	0.661
No	10	1 (10)	
Acetone			
Yes	9	0 (0)	0.179
No	36	8 (22)	
Toluene			
Yes	18	4 (22)	0.694
No	27	4 (15)	
Xylene			
Yes	11	3 (27)	0.382
No	34	5 (15)	
Crude Sample			
Yes	25	6 (24)	0.269
No	20	2 (10)	
Sour Water Sample			
Yes	5	0 (0)	0.568
No	40	8 (20)	

glove use, and frequency of changing gloves were also examined (Table 1).

Skin Problems and Work Characteristics, Solvent Reagents, and Types of Samples

As shown in Table 2, skin problem prevalence was higher in those working for at least six years (27%) than in those working for less than six years (13%) in their current job. The results of the Fisher's exact test showed no significant difference when set with a p-value of 0.41. In addition, tasks longer than 60 min showed a higher percentage of self-reported skin problems (18%) than those with less than 60 min (17%). However, there was no significant difference when the p-value was 1.00. Manual operations showed a higher incidence of self-reported skin problems (26%) than did non-manual operations (8%). However, these differences were not statistically significant (p = 0.25).

Contrary to the expected results, the prevalence of self-reported skin problems was higher, though not significant, in those unexposed to corrosives, cleaning chemicals, and cooling chemicals. Meanwhile, those using solvents had a higher prevalence of self-reported skin problems (20%) than those who did not use solvents (10%). This result was not considered significant when the p-value was 0.661. The prevalence of self-reported skin problems was higher among those exposed to xylene, toluene, and acetone than among those exposed to solvents such as butanol, carbon disulfide, heptane, mixtures, methanol, chloroform, and octane. However, according to Fisher's exact test, these results were insignificant, with p-values of xylene, 0.382, and acetone at 0.692, toluene, and 0.197, respectively. The sample type was not significantly associated with skin problems. None of the highest reported prevalence of self-reported skin problems for technicians handling crude oil and sour water samples compared to other samples, such as gasoline, jet fuel, diesel, and condensate. There was no significant difference after conducting Fisher's exact test; the lowest p-values, 0.296 and 0.568, were reported by technicians handling crude oil and sour water samples.

Table 3. Prevalence of Self-Reported Skin Problem and Duration and Frequency of Exposure and Method of Cleaning

Dermal exposure characteristics	No. of Lab technicians	Skin problem No. (%)	p-value
Duration of Exposure			
15–60 minutes/day	15	3 (20)	1.000
1–8 hours/day	30	5 (17)	
Frequency of Exposure			
Daily	43	8 (19)	1.000
Weekly	2	0 (0%)	
Cleaning after Each Task			
Yes	30	6 (20)	0.699
No	15	2 (13)	
Cleaning after Process Completion			
Yes	7	0 (0)	0.321
No	38	8 (21)	
Method of Cleaning (Washing with Soap and Water)			
Yes	45	8 (18)	1.000
No	**0**	**0 (0)**	
Method of Cleaning (Washing with Sanitizer)			
Yes	3	0 (0)	1.000
No	42	8 (19)	

Skin Problems, Frequency and Duration of Exposure, and Timing and Hand Washing Method

As described in Table 3, the duration and frequency of exposure to chemicals used in the laboratory, and the timing and methods of hand washing were examined to determine the prevalence of self-reported skin problems. Here, 20% of self-reported skin problems reported while performing activities lasting 15–60 min were higher than activities lasting 1¬–8 hours. Fisher's exact test showed no significant difference between self-reported skin problems when the p-value was 1.00. The frequency of chemical exposure was also not significantly associated with self-reported skin problems (p = 1.00). All eight skin problem cases were reported by lab technicians who had daily exposure to chemicals (43) compared to 0 cases with weekly exposure (2).

The timing and method of skin cleaning practices showed that 20% of self-reported skin problems were observed in technicians who cleaned their skin after each activity compared to 13% of technicians who did not practice the same approach. However, a p-value of 0.69 did not show a significant difference. All reported skin problems were observed by eight lab technicians who did not wait to clean their skin after completing the sample analysis. However, the Fisher's exact test results showed no significant difference when the p-value was 0.321. Of the reported skin problems, 21% were observed in technicians who used soap and water to clean their skins. Only three technicians used sanitizers to clean their skin or hands, and no skin problems were reported. A Fisher's exact p-value of 1.00 did not show any significant difference.

Skin Problems and Glove Type and Frequency of Changing Gloves

Table 4 describes the reported skin problems for lab technicians who used nitrile, polyvinyl chloride (PVC), latex, and other gloves. For nitrile gloves, six out of 39 technicians reported skin problems, while two out of seven technicians who used PVC gloves reported skin problems. However, these differences were not statistically significant. Fisher's exact test p-values for latex, nitrile, PVC, and other types of gloves were 1.00, 0.286, 0.590, and 1.00, respectively. All laboratory technicians used PPEs, including gloves, as the standard operating procedure.

DISCUSSION

Skin Problems and Work Characteristics, Solvent Reagents, and Types of Samples

As shown in this study, 67% of laboratory technicians had less than 5 years of work experience in chemistry laboratories, while 33% had more than 5 years of experience working in the laboratories. This outcome implies that most of the observed laboratory technicians were young, which did not lead to more self-reported skin problems and explains why only eight technicians reported skin-related problems. Moreover, the percentage of reported cases is higher in technicians with more work experience than in lab technicians with less experience. Workers with less experience may think that reporting a problem has a negative impact on their performance. Therefore, technicians with more work experience would have self-reported skin problems and a higher potential risk of exposure to chemicals. More work experience in a harmful work environment influences work-related injuries and illnesses. Moreover, dermal exposure to chemicals frequently occurs through direct skin contact, and changing tasks reduces exposure (Trommer and Neubert, 2006).

Tasks that took longer than 60 min were related to more self-reported reported skin problems than tasks that took less than 60 min. This result was expected because longer periods of chemical exposure increase the potential risks of exposure to chemicals and the resulting skin-related problems (Marquart *et al*., 2003). Many studies have shown that exposures vary with tasks, and differences between tasks vary and can be found in various potential determinants of dermal exposure (Voegeli, 2008). Moreover, sample analysis methods play a role in potential chemical exposure. Thus, more self-reported skin-related problems were observed in technicians performing manual tasks because lab technicians were at risk of exposure to chemicals through their skin than those who performed non-manual analysis tasks. Most of the tasks performed by the laboratory technicians in the chemical laboratories were manual processes, including sample receiving, collection, and preparation, some of which were performed under a chemical fume hood. Non-manual or semi-automatic chemical and physical analyses require analytical equipment such as spectrophotometers and gas, high-performance liquid, and ion chromatographs. As previously studied, automation level is likely to be a determinant of dermal exposure, where manual harvesting was compared with an automated process (Lebailly *et al*., 2009). The amount of chemicals deposited on the operator's skin depends on the type of equipment used (Baldi *et al*. (2009); Lebailly *et al*., 2006)).

The prevalence of self-reported skin-related problems for lab technicians using solvents is higher than that for those exposed to corrosives, cleaning chemicals, and cooling chemicals. This could be due to the high frequency and quantity of solvents used compared to other chemical reagents. Laboratory technicians are required to collect and process crude samples and perform chemical analyses using several organic solvents. Most lab analysis operations do not require frequent or large quantities of corrosives and other non-solvent substances. Dermal exposure to solvents has been shown to reduce skin barrier function and promote systemic uptake of solvents, leading to skin diseases (Trommer and Neubert, 2006).

In addition, the prevalence of reported skin problems was higher in those exposed to xylene, toluene, and acetone than in those exposed to other solvents such as butanol, carbon disulfide, heptane, mixtures, methanol, chloroform, and octane. This prevalence likely occurred because of the need to use these solvents during sample preparation and analysis; xylene, acetone, and toluene were used more frequently than the other solvents in the laboratories. Solvents and polycyclic aromatic hydrocarbons (PAHs) are among the main chemicals that cause health problems through dermal absorption (Tielemans *et al*., 2010). The number of self-reported skin problems from handling crude oil and sour water samples was also higher than in other samples, such as gasoline, jet fuel, diesel, and condensate samples. This outcome was observed because more crude oil and sour water samples were delivered to laboratories for analysis. This quantity increases the overall potential exposure of the skin to chemical substances.

Skin Problems and Frequency, Duration of Exposure, Frequency, and Method of Skin Cleaning

Self-reported skin problems were more noticeable with daily exposure than with weekly exposure. Thus, a higher exposure to chemicals increases the likelihood of developing skin-related problems. This observation is in agreement with another study that reported that some studies found a linear relationship between exposure to chemicals and exposure duration (Marquart *et al*., 2003).

Most reported skin problems were observed in laboratory technicians who cleaned their skin frequently or after each activity. Frequent cleaning of the skin or washing hands using soap or detergent may cause skin problems, and unnecessary exposure of the skin to excess detergent causes skin defatting (Voegeli, 2008). All reported skin problems were observed in technicians who used soap and water to clean their skin or to wash their hands. The laboratory technicians reportedly washed their hands with soap and water after each task, which implied that washing their hands several times a day caused dryness. Skin dryness can be caused by harsh soap and detergent; soap and water have been shown to enhance the percutaneous absorption of lipophilic chemicals (Moody, Nadeau and Chu, 1994). An increase in the percutaneous absorption of chemicals contributes to the development of irritants or allergic dermatitis. Thus, the use of harsh detergent cleaners increases the skin absorption potential of the chemicals. In addition to the frequency of skin cleaning, the type of detergent used may have different health (Gfatter, Hackl and Braun, 1997).

In this study, only three technicians used sanitizers to clean their skin, and no skin problems were reported. This outcome was expected because these technicians do not frequently use sanitizers, leading to no reported skin-related problems (Marquart *et al*., 2003). In addition, several studies have found that exposure to complex mixtures, excessive hand washing, hand sanitizers, and other factors may lead to skin diseases (Anderson and Meade, 2014).

Skin Problems and Type and Frequency of Changing Gloves

The results suggest that the laboratory technicians' hands were the most commonly exposed body part and where skin contact occurred most frequently, which agrees with another study that explained how the hands are the most contaminated part of the body (Packham, 2006; Sithamparanadaraj, 2008). Using PPE, such as gloves, substantially decreases the level of actual dermal exposure substantially (Marquart *et al*., 2003).

The technicians' gloves were wetted with crude samples or solvents when preparing samples and adding the solvents manually or touching contaminated objects based on laboratory observations. The gloves were contaminated with crude samples and solvent reagents during pouring, mixing, and manual pipetting with rubber aspirators. Handling contaminated objects such as test tubes, pipets, beakers, flasks, and rubber aspirators contributes to exposure. In addition, many laboratory technicians have reported using chemical gloves despite the possibility of submerging their hands in chemicals.

Although all laboratory technicians are expected to use the recommended gloves before handling any chemicals or starting new sample analyses, this might not be true in all situations. Using proper gloves is expected to reduce potential dermal exposure to chemicals (Galea *et al*., 2018). However, contaminant chemicals may bypass the glove barrier, which flows between the glove and skin (e.g., liquid splash to the forearm may run down the arm and inside the glove) (Cherrie, Semple and Brouwer, 2004). Gloves can also be cut or punctured, resulting in skin contamination. Thus, using an appropriate type of glove is essential because each material has different permeation ratings for specific chemicals. The inappropriate selection or use of gloves may lead to serious health problems. In the 1990s, a well-known case of fatal dimethyl mercury poisoning was caused by inappropriate reliance on gloves (Fenske, 2000). Most of the reported skin problems came from laboratory technicians with skin-related problems who used nitrile gloves. There were no reported skin problems with latex and other types of gloves because they were used as needed following standard operating procedures. Two out of seven technicians for PVC glove users reported skin problems during the study.

The frequency of changing or disposing gloves may affect the presence of skin-related problems. Unfortunately, not all lab technicians follow the proper glove removal methods. Some lab technicians contaminated their hands with contaminated gloves, surfaces, and equipment. The potential exposure to chemicals increases as the glove changes. Thus, frequently changing gloves does not always protect laboratory technicians from chemical exposure. This outcome agrees with other studies showing that repetitive exposure to wet work and glove use are significant factors in the development of occupational irritant contact dermatitis (ICD) among healthcare workers (Visscher and Wickett, 2012; Callahan *et al*., 2014).

CONCLUSION

The prevalence of self-reported skin problems among the studied laboratory technicians was not predominant and skin dryness was low. Chemical solvents caused a high prevalence of skin problems, but there was no significant association with the work experience of lab technicians. None of the examined parameters showed a statistically significant relationship between the skin problems and their causes. This questionnaire may be used to determine the potential dermal exposure risks in the examined laboratories and to identify the relationship between the prevalence of skin-related problems. Interviews with laboratory technicians may provide indications and initial qualitative dermal exposure assessments; however, this method is not comprehensive and cannot fully confirm the causes of skin problems. Thus, semiquantitative and quantitative methods may require more in-depth dermal exposure modeling or biomonitoring approaches.

Limitations of the Study. The cross-sectional study design only measured exposure and outcomes simultaneously at one point. This limitation meant that establishing a causative effect between exposure to workplace hazards and dermal problems was not possible. Moreover, the sample size was limited, with only eight laboratory technicians having skin problems, which may not be sufficient to detect any significance.

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