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ORIGINAL PAPER

CHEMICAL RISK ASSESSMENT IN HOSPITAL SETTINGS: A COMPARISON OF WORKERS' PERCEPTIONS, EXPERT OPINIONS, AND OCCUPATIONAL HYGIENE MEASUREMENTS

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Abstract

Background: Harmful chemicals are used in various forms from different sources in hospital settings. The standard gold method in risk control studies still determines exposure by personal or ambient measurements. In the absence of trained personnel, resources, or sufficient time, qualitative methods should be used to assess exposure. This study aims to compare quantitative and qualitative results of chemical risk exposure. **Material and Methods:** Both qualitative (perceptions without monitoring data of the workers and experts) and quantitative perceptions (perceptions with monitoring data) were recorded. Two experts were asked to evaluate exposure intensity in pathology department workers, secretary workers, and cleaning workers. Occupational hygiene measurements were taken based on the occupational health and safety department risk assessment results, expert job analysis, and pilot study measurements. **Results:** While most workers reported feeling highly exposed to chemical risks, the majority of experts reported medium-risk exposures and high-risk exposures. Three occupational hygiene measurements (6.6%) exceeded the permissible time-weighted average, and the other results were within the acceptable range. **Conclusions:** There was a significant difference between the estimated exposure and the measured exposure in hospital settings. A correlation was not found between workers' perceptions of chemical risk exposure and the chemical risk levels measured in this study. Med Pr Work Health Saf. 2023;74(4):241–50.

Key words: occupational exposure, risk perception, chemical risk, quantitative assessment, health care workers, occupational hygiene measurement

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INTRODUCTION

It is important to note that health care workers (HCWs) are exposed to a wide range of workplace hazards, such as ergonomic, sharp injuries, violence and stress, back injuries, ionization radiation, and thermal hazards. There has been a great deal of research and safety programs devoted to biological agents such as hepatitis B and C, influenza, and HIV [1]. Since the outbreak of the pandemic, this topic has gained popularity. Conversely, it is well known that HCWs are exposed to chemical risks at low doses, which are strongly associated with many health problems, such as dermatitis, latex allergy, irritation, asthma, and hearing loss [2,3]. Histology and pathology laboratories use formaldehyde, toluene, xylene, and methacrylates to embed media for light and electron microscopy examinations. Various chemicals are used in cleaning, including alkaline dust, solvents, and bleaches. In most cases, cleaning products contain a variety of chemical agents, some of which are sensitizing [4–8].

Assessing the risks associated with the hazards on site is a critical part of risk management. Organizations can proactively mitigate occupational or work-related diseases through an adequate risk assessment [9,10]. Most established strategies for measuring and managing occupational inhalational exposures rely on air sampling as the gold standard. It should be noted, however, that certain of these strategies may only be applicable under certain circumstances. Alternatively, it is one of the proposed qualitative methods based on obtaining expert opinion, workers' perceptions, or employer opinion about the risk. The risk perceptions of workers refer to their subjective assessment of the characteristics and severity of a particular risk. Recently, using expert or worker perceptions as a source of information in exposure assessments has gained popularity due to its cost-effectiveness. In most cases, expert or worker ratings may be the best exposure indicator without measurement data, especially in retrospective evaluations [11,12]. This is due to the fact that factors such as a lack of economic resources, a lack of experience, and a lack of experts are essential constraints, especially for developing countries. As a cost-effective method, subjective opinions have been used by workers or experts, which could enhance the quality of exposure data. In spite of the widespread practice of occupational hygiene, no systematic comparison has been conducted between "expert opinions" or "art" of occupational hygiene and measurements [13].

Literature indicates a wide variation in the degree of agreement between the expert or workers' perceptions and the actual measurements. Occupational health and safety (OHS) professionals tend to rely heavily on their past experiences to make subjective decisions. Additionally, the perceptions and feedback of the workers also contribute to the degree of risk. People perceive risk differently, and it is a cognitive appraisal process that can reflect how individuals evaluate risk. Studies have shown it to depend on environmental, demographic, and psychological factors, including gender, educational level, experience, and odor of the contamination [14,15].

Regardless of the method, the risk assessment should be the central component of occupational health and safety services. It is hypothesized that risk assessment is neither subjective nor objective absolutely. A decision maker's perception may be partly influenced by subjective evaluations, which play a role in objective risk estimations [16].

The main objectives of this study were to explore occupational exposure to hazardous chemical substances among HCWs, to assess their perceptions regarding chemical hazards, and compare occupational experts' and workers' perceptions in occupational exposure assessment. Both workers' and experts' opinions were compared to air sampling data in the units. By comparing worker perceptions of risk with occupational hygiene measurements, OHS professionals discuss the applicability of qualitative and quantitative risk assessment methods.

MATERIAL AND METHODS

The present cross-sectional study was conducted in the university hospital between 2021 and 2022 among pathology laboratory staff, cleaners, and secretaries. A questionnaire was used to collect general demographic information, work-life variables, and exposure perceptions of workers. Based on a literature review of comparable studies, the questionnaire was developed and completed by HCWs during face-to-face interviews. Surveys and literature reviews were used to obtain the opinions of the OHS experts. The first step involved experts visiting the units and rating the exposure levels as low, medium, and high. A checklist was used during their visit, and more than 2 visits were performed in the departments. To minimize the inter-rater reliability error, the final decision was decided by hygienists working together.

Occupational hygiene measurements have been determined based on the pilot study, the risk assessment of the OHS department and TSI EN 689:2018 regulations [17,18]. Accordingly, pathology department workers (group 1) and cleaning personnel (group 2), whose exposure to volatile organic compounds (VOCs) and alkaline dust is above the permissible limit value, are the groups with high exposure to chemical risks. According to the OHS risk assessment result, the group with a low risk of exposure to VOCs or alkaline dust is determined as medical secretaries (group 3). As part of the study, questions were asked regarding smoking, alcohol use, physical activity, lifetime cancer treatment, severe infections requiring antibiotics within the past month, and pregnancy status of the exposed (groups 1 and 2) and unexposed (group 3) groups. These cases were excluded from the study due to possible confounding effects. With and without exposure to the agent, groups with similar age, gender, and body mass index (BMI) characteristics were formed. During the measurement period, workers were asked not to use deodorant and perfume and not to smoke. The workers participating in the study were informed in advance, and their verbal consent was obtained for personal VOCs measurement on the measurement day. A preliminary sampling was conducted at different times to develop appropriate sampling protocols and refine the sampling and analysis methods. The preliminary sampling results indicated that cleaning and pathology workers were exposed to elevated concentrations of chemical hazards [17]. There was a plan to measure VOCs and formaldehyde in the pathology department, with at least 1 ambient and 1 personal measurement in each department. Accordingly, a total of 45 occupational hygiene measurements were performed: 12 VOCs measurements, including 6 personal and 6 ambient measurements, and 12 formaldehyde measurements, including 8 ambient and 4 personal measurements in pathology workers. It was planned to carry out total Volatile Organic Compounds (TVOCs) and alkaline dust measurements in cleaning workers, including personal and ambient measurements. Accordingly, a total of 21 occupational hygiene measurements were planned, including 9 personal TVOCs measurements and 12 alkaline dust measurements.

Measurement of VOCs exposure
Based on TS ISO 16200-1, VOC levels were measured in the air [19]. Before each measurement, a handheld temperature, humidity, and airflow velocity meter (temperature, humidity, and pressure values of the environment were measured and recorded, and 1 witness tube was placed in the sampling environment before the measurement process. A low flow rate (200 ml/min flow rate) was used with an active sampling pump for personal exposure measurement. A rotameter was used to verify flow before each measurement, every 2 h if the measurement period exceeded 2 h, and at the end of each measurement. The low flow rate active sampling pump was attached to the workers' breathing zone to be sampled with the sampler carbon tubes with silicone hose and tube holder cap. After the sampling process was completed, the mouths of the carbon tubes were closed with a rubber stopper and sent to the analysis laboratory with a refrigerated carrying bag. The samples were analyzed by gas chromatography-flame ionization detector (GC-FID). The Regulation on Health and Safety Measures at Work with Chemical Substances [20] and The National Institute for Occupational Safety and Health (NIOSH) Pocket Guide Chemical Hazards standards were used for the permitted limit values [21].

Alkaline dust measurement
It was conducted in accordance with NIOSH 7401 measurement of alkaline dust (NaOH, LiOH, KOH) [22]. Before starting the measurement process, the pump was verified with a rotameter. A 1 μm PTFE Membrane filter was used as a filter. The pump flow rate was between 1–4 l/min, and the total volume to be drawn was between min. 70 l max 1000 l. Samples were taken, and personal exposure was measured. Samples were analyzed by acid-base titration method. Limit values were taken from NIOSH 7401 standard (2 mg/m^3) [22].

Workers' perception of chemical risk
The chemical risk perception of the workers was measured with the question, "How much chemical exposure do you think you have while working?" The answers were grouped as "none," "I am exposed to a little," "I am exposed to medium," "I am exposed to a lot."

OHS professional risk assessment
The chemical risk status of the working environment was grouped as low, medium, and high by 2 experts with experience in occupational hygiene.

Ethics committee approval
The form was approved by Dokuz Eylül University Interventional Ethics Committee (486-SBKAEK). The project was supported by Dokuz Eylül University Scientific Research Project (project No. 2020.KB.SAG.023).

Statistics
Frequencies and percentages were used for categorical data, and for continuous data, mean and standard deviation were calculated using SPSS (Statistical Package for Social Sciences) 16.0. Frequency data were presented in descriptive analyses as number (N) and percentage (%), while numerical data were presented as arithmetic mean ± standard deviation (M±SD) and median (min.–max). The χ^2 and Fisher's exact χ^2 tests were used to compare categorical data. For numerical variables that did not conform to a normal distribution, the Mann-Whitney U test was used to compare 2 groups, and the Kruskal-Wallis test was used to compare >2 groups. In the groups with a significant difference due to Kruskal-Wallis, the group/groups that caused the difference were identified using the *post hoc* test, and Dunn-Bonferoni correction was conducted. The relationship between 2 non-normally distributed numerical variables was analyzed by Spearman's correlation analysis. The statistical significance level was accepted as $p < 0.05$ for all tests.

RESULTS

A total of 90 HCWs, including 29 pathology workers, 31 cleaning workers, and 30 secretarial workers, were included in the study conducted at Dokuz Eylül University Hospital. Of the pathology workers, 72.4% (N = 21) were female with a mean age of 40.1±8.3 years, and 87.1% (N = 27) were female with a mean age of 41.3±9.7 years in cleaning workers. Among pathology workers, 31% (N = 9) smoked, 62.1% (N = 18) drank alcohol, and the mean duration of employment was 11.3±10.7 years. Among medical secretaries, 40% (N = 12) smoked cigarettes, and 53.3% (N = 16) drank alcohol. The mean duration of employment of medical secretaries was 7.9±7.1 years. Age and gender distribution were statistically similar between these groups ($p > 0.05$). Except for alcohol use and sports participation, there were no statistically significant differences in the distribution of sociodemographic characteristics according to the worker groups ($p > 0.05$) (Table 1).

Among pathology workers who self-assessed their exposure to chemicals, 44.8% (N = 13) had very high levels of chemical risk exposure, while 31% (N = 9) had moderate levels. A qualitative risk assessment by experts indicated that 20.7% (N = 6) of pathology workers worked in high-risk, 51.7% (N = 15) in medium-risk, and 27.6% (N = 8) in low-risk departments. The self-assessment of cleaning workers revealed that 71% (N = 22) reported a high level of chemical risk exposure, while 25.8% (N = 8) reported a moderate level of chemical risk exposure. The level of chemical risk exposure was considered low by 43.4% (N = 13) of the medical secretaries. Medical secretaries reported that 40% (N = 12) have never been exposed to chemical risks. Based on hospital worker groups, there was a statistically significant difference in rates of chemical risk exposure ($p < 0.001$). It was found that medical secretaries were more likely to report no or little exposure to chemical risks than cleaning and pathology workers ($p = 0.019$) (Table 2).

The relationship between the experts' risk opinion result and the level of chemicals measured in the environment was analyzed. Qualitative job analysis and methanol levels showed a good negative correlation ($r = -0.624$, $p = 0.030$). The correlation between other chemicals and qualitative job analysis was insignificant ($p > 0.05$). The perception of the risk of exposure to chemical hazards by workers and the measured levels of chemical hazards did not show a significant correlation. While a significant proportion of workers estimated that they were exposed to moderate or higher levels of chemical risk, only 3 results of occupational hygiene measurements exceeded the time-weighted average. In addition, expert risk perception did not correlate with worker risk perception. Unlike workers, experts more frequently identified a medium risk level in their assessment of chemical risk exposure (Table 3).

Pm-xylene was elevated in molecular pathology (ambient) and histotechnical laboratories (personal

Table 1. Comparison of demographic characteristics of health care workers by worker groups, study conducted at Dokuz Eylül University Hospital, Turkey, 2021–2022

Variable	Participants (N = 90)			
	pathology workers (N = 29)	cleaning workers (N = 31)	medical secretaries (N = 30)	p
Age [years] (Me (min.–max))	39 (34.5–46)	43 (32.0–50)	43.0 (34.7–47.2)	0.597[a]
Gender [n (%)]				
female	21 (72.4)	27 (87.1)	27 (90.0)	0.152[b]
male	8 (27.6)	4 (12.9)	3 (10.0)	
Smoking [n (%)]				
yes	9 (31.0)	10 (32.3)	12 (41.4)	0.663[b]
no	20 (69.0)	21 (67.7)	17 (58.6)	
Chronic disease [n (%)]				
yes	16 (55.2)	17 (54.8)	12 (40.0)	0.406[b]
no	13 (44.8)	14 (45.2)	18 (60.0)	
Doing sports [n (%)]				
yes	11 (37.9)[c]	2 (6.5)	4 (13.3)	**0.005[a]**
no	18 (62.1)	29 (93.5)	26 (86.7)	
Cigarettes [pack year] (M±SD (min.–max))	6.5±5.3 (1–22.5)	8.9±9.6 (0.5–30)	6.4±5.3 (0.1–15)	0.700[c]
Total working time as a hospital worker [years] (M±SD (min.–max))	10.0±10.66 (2.0–19.5)	5.0±5.91 (1.0–10.0)	5.5±7.10 (2.2–13.7)	0.226[c]
Weekly working time [h] (Me (min.–max))	45.0 (40.0–45.0)	45.0 (40.0–45.0)	40.0 (40.0–45.0)	0.086[c]

Bolded values are statistically significant.
[a] Pearson's χ^2 test. [b] Group from which the difference originate. [c] Kruskal-Wallis test.

Table 2. Comparison of chemical substance levels measured in the working environment according to chemical risk exposure, study conducted at Dokuz Eylül University Hospital, Turkey, 2021–2022

Substance	Chemical risk exposure [mg/m³] (Me±SD)			p[a]
	no and low	medium	high	
Isopropylbenzene (13 measurements)	1.13±0.76	1.22±1.67	0.59±0.18	0.343
Toluene (13 measurements)	2.10±0.29	1.55±0.66	2.47±4.48	0.406
2-Chlorotoluene (13 measurements)	0.99±0.06	0.81±0.11	0.79±0.19	0.142
Trichlorobenzne (13 measurements)	0.92±0.10	0.91±0.15	0.89±0.16	0.688
Oxylene (13 measurements)	50.12±67.90	9.05±6.68	981.71±2908.32	0.433
Pm-xylene (13 measurements)	89.88±73.32	107.83±52.93	2155.75±6915.82	0.646
Dichlorobenzene (11 measurements)	1.34±0.53	1.39±1.22	0.73±0.15	**0.032**
Ethanol (11 measurements)	28.35±3.3	29.60±4.62	28.55±4.22	0.836
Methanol (9 measurements)	3.89±1.02	8.00±5.76	4.50±2.34	0.575
Tertbutilbenzen (9 measurements)	2.84±0.23	2.75±0.37	2.68±0.43	0.688

Bolded values are statistically significant.
[a] Kruskal-Wallis test.

Table 3. Relationship of chemical substance levels measured in the environment according to exposure to chemical risk, study conducted at Dokuz Eylül University Hospital, Turkey, 2021–2022

Substance	Chemical risk exposure	
	r	p[a]
Isopropylbenzene (13 measurements)	–0.263	0.238
Toluene (13 measurements)	–0.252	0.258
2-Chlorotoluene (13 measurements)	–0.408	0.074
Trichlorobenzene (13 measurements)	–0.193	0.414
Oxylene (13 measurements)	–0.022	0.929
Pm-xylene (13 measurements)	–0.148	0.521
Dichlorobenzene (11 measurements)	**–0.594**	**0.006**
Ethanol (11 measurements)	0.081	0.774
Methanol (9 measurements)	–0.174	0.589
Tertbutylbenzene (9 measurements)	–0.301	0.318

Bolded values are statistically significant.
[a] Spearman's correlation test.

measurement). Experts and workers rated pm-xylene as medium risk. Formaldehyde (ambient) levels exceeded the permissible limit in the macroscopy department, and experts deemed it to be a high safety risk. Approximately 44.8% (N = 13) of pathology workers considered their exposure to chemical risk very high, and 31% (N = 9) considered it moderate. A qualitative job analysis revealed that 20.7% (N = 6) of pathology workers performed high-risk jobs, 51.70% (N = 15) performed medium-risk jobs, and 27.6% (N = 8) performed low-risk jobs. In the pathology department, the number of measurements with time-weighted average (TWA) values above the permissible limit value is 3 in total. Two of these are pm-xylene personal exposure measurements and 1 formaldehyde ambient measurement. The expert opinion on measuring ambient formaldehyde was described as high risk. None of the TWA ambient or personal measurements resulted in cleaning workers exceeding the permissible limit value. It was noted, however, that based on the results of the job analysis, 41.9% (N = 13) of the cleaning workers were assigned jobs with high risk, 32.3% (N = 10) were assigned jobs with medium risk, and 25.8% (N = 8) were assigned jobs with low risk (Table 4).

The average result of isopropyl benzene detected in the environment where a total of 13 pathology workers worked was 1.04±1.3 mg/m^3, and the toluene average was 2.7±4.2 mg/m^3. In the occupational hygiene measurements performed in cleaning workers, the mean of personal alkaline dust measured in 12 people was 1.4±0.3 mg/m^3, the mean of alkaline dust measured in the working environment was 1.4±0.3 mg/m^3, the mean result of isopropylbenzene was 0.6±0.2 mg/m^3, the mean of toluene was 1.2±0.8 mg/m^3, the mean of dichlorobenzene was 1.1±1.19 mg/m^3.

DISCUSSION

Currently, this study represents one of the few attempts to assess the perceptions of workers and experts regarding occupational hygiene in hospital settings. In this study it is found no correlation between occupational hygiene measurement results and workers' risk perception and expert opinion. Occupational hygiene measurements revealed that workers were predominantly perceived to be at high risk and experts at medium risk, whereas only 3 measurement results exceeded the TWA value. The perception of the workers in the macroscopy department of the pathology laboratory is correlated with the expert opinion, which indicates a high level of risk.

According to the results of this study, although both the risk perception of the workers and the expert opinion are very valuable in defining the exposure, they can make a limited contribution to the results. It would be appropriate to make occupational hygiene measurements when defining exposure. In order to determine whether to conduct a qualitative risk assessment or a quantitative risk assessment, several factors must be considered. If no data are available to make inferences, then a quantitative risk assessment would not be possible. A quantitative risk assessment may be impossible due to factors such as data quality, time, personnel, or resource constraints. However, data gaps are not necessarily a barrier to quantitative risk assessment [23]. A number of factors influence people's perception of risk. Several theories have been proposed to explain why different people make different estimates of the magnitude of risks. Three major families of theory have been stated: anthropology/sociology approaches (cultural theory), psychology approaches (heuristics and cognitive), and interdisciplinary approaches (social amplification of risk framework). A vital component of the interdisciplinary approach is the belief that individuals and groups can influence each other's risk perception [24,25]. With the pandemic outbreak, the number of studies on worker risk perception has increased significantly. The increase in the number of studies conducted during the pandemic on HCWs may have led to an increase in risk perception [26]. As part of the survey, respondents were asked to indicate the level of risk associated with different trades based on their experience and professional opinions. There was a high level of risk in the workplace, even according to the medical secretary of the workers.

In their study of occupational hygienists' risk perceptions, the study by Lowry et al. [27] concluded that experts tend to identify more risks than are actually present and described some intellectual biases that contribute to this. In this respect, some mental shortcuts lead to prejudices and identification errors. Individuals' experiences and memories may be used in their decision-making; for instance, an expert with a family history of asbestos-related diseases may offer a higher risk score due to his sensitivity to the subject [27]. There are other studies on possible errors and biases. It is generally accepted that "the best predictor of future behaviour is the past behaviour" [10,11,24]. However, most risk assessments are generally based on the limited historical accident data available, while other factors are ignored. Experience and knowledge in a particular field may affect a person's risk perception. The study conducted by Boyacı et al. [28] examined the risk perception of laboratory workers in a hospital and found a significant relationship between the perception of risk and the length of time employed in the department. The highest risk perception was found in workers with 11–16 years of experience [28].

It should be noted, however, that high perceptions of risk do not necessarily equate to high compliance with measures. Thus, it is also questionable whether this perception reflects the actual thinking of the individual. There is no guarantee that workers exposed to a known high-risk agent will comply more closely with workplace precautions.

The authors' study found that exposed and non-exposed groups used personal protective equipment (PPE) differently in this study. However, Papadopoli et al. [29] found that 54.4% of the 237 enrolled workers were exposed to chemical risk. They highlighted significant gaps in knowledge and scarce preparedness in the adherence to safety processes to prevent and contain risks. One of the major limitations of the study

Table 4. Workers perception, expert opinion and measured chemicals in workers, study conducted at Dokuz Eylül University Hospital, Turkey, 2021–2022

Workers	Workers perception	Job analysis	Measured chemical
Pathology workers (N = 29)			
lecturer, research assistant, specialist (N = 5)	no (N = 1) low (N = 2) moderate (N = 1) high (N = 1)	low (N = 3) moderate (N = 2)	isopropylbenzene, toluene, 2-chlorotoluene, trichlorobenzene, tertbutylbenzene, oxylene, pm-xylene, ethanol, methanol, dichlorobenzene, formaldehyde ambient
other (N = 9)[a]	no (N = 2) low (N = 1) moderate (N = 4) high (N = 2)	low (N = 5) moderate (N = 4)	isopropylbenzene, toluene, 2-chlorotoluene, trichlorobenzene, tertbutylbenzene, oxylene, pm-xylene, ethanol, methanol, dichlorobenzene, formaldehyde personal, formaldehyde ambient
histotechnical department workers (N = 4)	moderate (N = 1) high (N = 3)	moderate (N = 4)	isopropylbenzene, toluene, 2-chlorotoluene, trichlorobenzene, tertbutylbenzene, oxylene, pm-xylene, ethanol, methanol, dichlorobenzene
cytology and immunohistochemistry department workers (N = 6)	moderate (N = 1) high (N = 5)	moderate (N = 4) high (N = 2)	isopropylbenzene, toluene, 2-chlorotoluene, trichlorobenzene, tertbutylbenzene, oxylene, pm-xylene, ethanol, methanol, dichlorobenzene, etilbenzen
macroscopy department workers (N = 5)	low (N = 1) moderate (N = 2) high (N = 2)	moderate (N = 1) high (N = 4)	isopropylbenzene, toluene, 2-chlorotoluene, trichlorobenzene, tertbutylbenzene, oxylene, pm-xylene, ethanol, methanol, dichlorobenzene, formaldehyde ambient
Cleaning workers (N = 31)	low (N = 1) moderate (N = 8) high (N = 22)	low (N = 8) moderate (N = 10) high (N = 13)	alkaline dusts-personal, isopropylbenzene, toluene, dichlorobenzene, pm-xylene, 2-chlorotoluene, trichlorobenzene, oxylene, tertbutylbenzene, ethanol, methanol, ethyl benzene

Measurement results that exceed the permissible limit value are highlighted in bold.
[a] Other workers contain: archive officer, department secretary, report secretary.

was the absence of any hygiene measurements [29]. In a scenario where occupational hygiene measurements cannot be made in daily practice due to resource constraints; it can be difficult for workers to grasp risk assessments that cannot be quantified. However, expert opinion is often used when measurements cannot be made. In the literature, Sahkvidi et al. [25] performed an experimental study to determine the applicability and accuracy of an occupational hygienist's expert opinions in occupational exposure assessment. In this study, occupational hygienist (OH) opinions were compared with air sampling data. It was found that experienced subjects were better able to predict the intensity of the exposure. In lower concentrations, the rating error increased significantly. Ratings and actual measurements were found to be highly correlated. The authors concluded that expert rating is one of the most effective methods for assessing occupational exposures when data is unavailable [25]. In some cases, huge errors were observable. Several factors appear to have contributed to the raters' error. One of the most important reasons was that they asked hygienists to make a quantitative assessment (they asked them to estimate the amount of dust in milligrams/square meter). It was found that as the assessor's experience increased, accuracy increased as well. They also stated that the field experience of the experts was decisive for their opinions about exposure and that the margin of error of expert opinions was high for exposures at low concentrations [25]. It is important to note that the chemical risks measured in this study were at low concentrations. There may have been similar reasons for this study study's inability to demonstrate a significant correlation between measured exposure and expert opinion. Only 2 evaluators were rated as experts. Due to the lack of a defined specialty in occupational hygienists in Turkey, only a few experts are involved in this field. As a result, a limited number of experts could be involved in the study. Moon et al. [30] compared the results of Korean Occupational Health and Safety Agency (KOSHA) 4-step qualitative and quantitative risk assessment methods for 36 items. Similar to this study, they found no agreement between the qualitative and quantitative methods [30].

Another significant result of this study is the discrepancy between workers' risk perception and experts' risk perception. While workers reported predominantly high-risk exposures in this study, experts interpreted this as medium-risk exposure. To explain the difference between expert and worker assessments, some hypotheses were proposed. It was stated that experts might rate the risk lower than workers because they take into account the protective measures in the environment. They emphasized that the number of the expert group should be sufficient [31].

The concept of need for cognition (NFC), or need for cognition, is discussed by some researchers among the factors affecting expert opinions. The NFC refers to intrinsic motivation for working and enjoyment of thinking. Some studies have evaluated this concept with various scales. In this research, no evaluation was made in this regard. Nevertheless, since it is likely to have an effect, it may be considered for measurement in future studies [13].

There are some limitations in this study. First, the cross-sectional nature of the design allows only the investigation of associations between the variables of interest. Likert-type survey questions may overestimate the extent of worry about risks. This research was conducted after COVID-19, which may have caused workers to evaluate risk perception more sensitively. The exposure measurements in this study were based on continuous air sampling over a long period of time, but day-to-day variation is an essential factor in interpreting occupational exposure data. Cleaning workers and medical secretaries work under subcontractor status as contracted workers and receive inadequate occupational health and safety services. In this regard, these 2 groups of workers may perceive themselves as being more exposed to risk than others (bias against to null). Also, number of eligible workers may have been insufficient to show the relationship, larger studies should be planned in the future.

CONCLUSIONS

The results of this study revealed significant gaps between the estimated and measured exposures in hospital settings. The existing deficiencies regarding the risks faced and perceived by HCWs should be addressed in future studies. The reasons for this difference should be investigated, and necessary precautions should be planned. Experienced raters appear to be an alternative choice in the field of exposure rating. It should be noted, however, that the exposure results are interpreted in light of the actual exposure level. Experts are more likely to make errors at lower concentrations. The results of this study indicate that workers and experts need to be trained to inform and refresh their knowledge.

Author contributions
Research concept: Ayşe Coşkun Beyan, Gamze Tuna, Esra Emerce, Gül İşlekel
Research methodology: Ayşe Coşkun Beyan, Gamze Tuna, Esra Emerce, Gül İşlekel
Collecting material: Ayşe Coşkun Beyan
Statistical analysis: Ayşe Coşkun Beyan
Interpretation of results: Ayşe Coşkun Beyan, Gamze Tuna, Esra Emerce, Gül İşlekel
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REFERENCES

1. Rai R, Zaemey S, Dorji N, Rai B, Fristhc L. Exposure to Occupational Hazards among Health Care Workers in Low- and Middle-Income Countries: A Scoping Review. Int J Environ Res Public Health. 2021;5;18(5):2603. https://doi.org/10.3390/ijerph18052603.
2. Ratner PA, Spinelli JJ, Beking K, Lorenzi M, Chow Y, Teschke K, Le ND, Gallagher RP, Dimich-Ward H. Cancer incidence and adverse pregnancy outcome in registered nurses potentially exposed to antineoplastic drugs. BMC Nurs. 2010;16;9:15. https://doi.org/10.1186/1472-6955-9-15.
3. Coggon D, Harris EC, Poole J, Palmer KT. Mortality of workers exposed to ethylene oxide: extended follow up of a British cohort. Occup Environ Med. 2004;61(4):358–62. https://doi.org/10.1136/oem.2003.008268.

4. Videnros C, Selander J, Wiebert P, Albin M, Plato N, Borgquist S, et al. Investigating the risk of breast cancer among women exposed to chemicals: a nested case-control study using improved exposure estimates. Int Arch Occup Environ Health. 2020;93(2):261–269. https://doi.org/10.1007/s00420-019-01479-4.
5. Vincent MJ, Bernstein JA, Basketter D, LaKind JS, Dotson GS, Maier A. Chemical-induced asthma and the role of clinical, toxicological, exposure and epidemiological research in regulatory and hazard characterization approaches. Regul Toxicol Pharmacol. 2017;90:126–132. https://doi.org/10.1016/j.yrtph.2017.08.018.
6. Phaswana SM, Naidoo S. The prevalence of latex sensitisation and allergy and associated risk factors among healthcare workers using hypoallergenic latex gloves at King Edward VIII Hospital, KwaZulu-Natal South Africa: a cross-sectional study. BMJ Open. 2013 9;3(12):e002900. http://dx.doi.org/10.1136/bmjopen-2013-002900.
7. Supapvanich C, Povey A, Vocht F. Latex sensitization and risk factors in female nurses in Thai governmental hospitals. Int J Occup Med Environ Health. 2014;27(1):93–103. https://doi.org/10.2478/s13382.
8. Suleiman AM, Svendsen KVH. Are safety data sheets for cleaning products used in Norway a factor contributing to the risk of workers exposure to chemicals? Int J Occup Med Environ Health. 2014;27(5):840–853. https://doi.org/10.2478/s13382-014-0302-8.
9. Owie H, Apanga P. Occupational health hazards prevailing among healthcare workers in developing countries. J AIDS Clin Res. 2016;7:596.
10. Zisook RE, Monnot A, Parker J, Gaffney S, Dotson S, Unice K. Assessing and managing the risks of COVID-19 in the workplace: Applying industrial hygiene (IH)/occupational and environmental health and safety (OEHS) frameworks. Toxicol Ind Health. 2020;36(9):607–618. https://doi.org/10.1177/0748233720967522.
11. Friesen MC, Pronk A, Wheeler DC, Chen YC, Locke SJ, Zaebst DD, Schwenn M, Johnson A, Waddell R, Baris D, Colt JS, Silverman DT, Stewart PA, Katki HA. Comparison of algorithm-based estimates of occupational diesel exhaust exposure to those of multiple independent raters in a population-based case-control study. Ann Occup Hyg. 2013;57(4):470–81. https://doi.org/10.1093/annhyg/mes082.
12. Ramachandran G, Banerjee S, Vincent JH. Expert judgment and occupational hygiene: application to aerosol speciation in the nickel primary production industry. Ann Occup Hyg. 2003;47(6):461–75. https://doi.org/10.1093/annhyg/meg066.
13. Vadali M, Ramachandran G, Banerjee S. Effect of training, education, professional experience, and need for cognition on accuracy of exposure assessment decision-making. Ann Occup Hyg. 2012;56(3):292–304. https://doi.org/10.1093/annhyg/mer112.
14. Alrawad M, Lutfi A, Alyatama S, Elshaer I, Almaiah M. Perception of Occupational and Environmental Risks and Hazards among Mineworkers: A Psychometric Paradigm Approach. Int J Environ Res Public Health. 2022;19:3371. https://doi.org/10.3390/ ijerph19063371.
15. Wild P, Sauleau EA, Bourgkard E, Moulin JJ. Combining expert ratings and exposure measurements: a random effect paradigm. Ann Occup Hyg. 2002;46(5):479–87. https://doi.org/10.1093/annhyg/mef052.
16. Ferrer R, Klein WM. Risk perceptions and health behavior. Curr Opin Psychol. 2015;5:85–89. https://doi.org/10.1016/j.copsyc.2015.03.012. PMID: 26258160; PMCID: PMC4525709.
17. Coşkun Beyan A, Arkan Erdoğan G, Demiral Y. Evaluation Of Volatile Organıc Compounds In Hospital Settings Occupational Hygiene Measurament. IETOX International Congress; 2019 Nov 21–24; Antalya, Turkey.
18. TSI EN 698:2018. Workplace exposure – Measurement of exposure by inhalation to chemical agents – Strategy for testing compliance with occupational exposure limit values. Available from: https://intweb.tse.org.tr/standard/standard/Standard.aspx?053107106111065067115113049116090107100056052055108081090071086075069085047110067109075073081116103090081086073108065117084119102076115078112073043076102117051071068107085112101077120085088050.
19. Workplace air quality – Sampling and analysis of volatile organic compounds by solvent desorption/gas chromatography – Part 1: Pumped sampling method [Internet]. TSE – TS ISO 16200-1 [cited 2023 Jun 15]. Available from: https://www.iso.org/standard/30187.html.
20. Republic of Turkey. The Regulation on Health and Safety Measures at Work with Chemical Substances. 2018.
21. The National Institute for Occupational Safety and Health (NIOSH). Pocket Guide to Chemical Hazards [cited 2023 May 15]. Available from: https://www.cdc.gov/niosh/npg/default.html.
22. Alkaline dusts measurement. Number: 7401. NIOSH [cited 2023 Jun 15]. Available from: https://www.cdc.gov/niosh/docs/2003-154/pdfs/7401.pdf.
23. Paek H, Hove T. Risk Perceptions and Risk Characteristics. Health Commination 2017. https://doi.org/10.1093/acrefore/9780190228613.013.283.
24. Slovic P. Understanding Perceived Risk: 1978–2015. Environment: Sci Policy Sustain Develop. 2016;58(1):25–29. https://doi.org/10.1080/00139157.2016.1112169.
25. Sakhvidi MJ, Mihanpoor H, Mostaghaci M, Mehrparvar A, Barkhordari A. Determinants of the accuracy of occupa-

tional hygiene expert judgment. Ind Health. 2015;53(2): 184–91. https://doi.org/10.2486/indhealth.2014-0066.
26. Le XTT, Nguyen QT, Onyango B, Nguyen QN, Pham QT, Ta NTK, et al. Perception toward exposure risk of COVID-19 among health workers in Vietnam: status and correlated factors. Front Public Health. 2021:(9):589317. https://doi.org/10.3389/fpubh.2021.589317.
27. Lowry DM, Fritschi L, Mullins BJ, O'Leary RA. Use of expert elicitation in the field of occupational hygiene: Comparison of expert and observed data distributions. PloS One 2022. https://doi.org/10.1371/journal.pone.0269704.
28. Boyacı H, Dündar G, Şenel İ. Laboratory employees' perception of occupational risk factors. Int J Med Biochem. 2021;4(2):61–66. https://doi.org/10.14744/ijmb.2021.02886.
29. Papadopoli R, Nobile CGA, Trovato A. Chemical risk and safety awareness, perception, and practices among research laboratories workers in Italy. J Occup Med Toxicol. 2020;15,17.
30. Moon HI, Han SW, Shin S, Byeon SH. Comparison of the Qualitative and the Quantitative Risk Assessment of Hazardous Substances Requiring Management under the Occupational Safety and Health Act in South Korea. Int J Environ Res Public Health. 2021;2;18(3):1354. https://doi.org/10.3390/ijerph18031354.
31. Logan PW, Ramachandran G, Mulhausen JR, Banerjee S, Hewett P. Desktop study of occupational exposure judgments: do education and experience influence accuracy? J Occup Environ Hyg. 2011;8(12):746–58. https://doi.org/10.1080/15459624.2011.628607.

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