

ORIGINAL ARTICLE

Occupational Safety and Health (OSH) Knowledge, Practices and Injury Patterns among Solvent Manufacturing Workers: A Cross-sectional Study

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ABSTRACT

Introduction: Adequate knowledge and practice of Occupational Safety and Health (OSH) is essential to reduce workplace injuries. This cross-sectional study aims to examine the relationship between sociodemographic factors and the level of knowledge, practice, and injury patterns related to OSH among workers in a solvent manufacturing factory. **Methods:** Purposive sampling was used to select 286 respondents who were given validated self-administered questionnaires through WhatsApp and paper. Secondary data on workplace injuries were also collected between December 2021 and October 2022. The collected data was then analyzed using SPSS Version 27. **Results:** The majority of the workers exhibited good knowledge levels of OSH at their workplace, with all workers showing moderate to good levels of OSH practices. There was no significant association between gender, age, education level, and work experience with the level of OSH knowledge. However, significant associations were observed between gender and age with the level of OSH practices with $p = <0.001$ for both factors, while no significant association was found between working experience and education level with the level of OSH practices. Moreover, the study found no significant association between knowledge and practice, knowledge and injury, as well as practice and injury. Over 11 months, three incidents were reported, with acute injuries caused by chemical hazards and physical risks. Workers also reported issues related to the enforcement of Personal Protective Equipment (PPE), ergonomic problems, environmental factors, and the condition of their workstations. **Conclusion:** The study highlights the need for safety and health training to improve the workers' OSH practices and reduce the incidence of workplace injuries in the manufacturing factory.

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industrialization, technological advancements, and globalization (3).

INTRODUCTION

The safety and health of workers in the manufacturing industry have been a significant concern globally. According to Statista Research Department (1), approximately 3.29 billion people worldwide were working in 2021, spending a third of their lives in the workplace. As such, it is the responsibility of employers to ensure that their workers are provided with safe and healthy working environments that are free from known hazards. The United Nations (2) has recognized this as a basic human right for workers. Despite this recognition, workers worldwide continue to face a range of occupational hazards, particularly in developing countries, as a result of rapid

Manufacturing industries, in particular, are essential for a country's economic development, but they are also major contributors to occupational injuries compared to other industries (4). For instance, among all other manufacturing sectors, the solvent factory is particularly concerning because solvents are one of the most prevalent chemical health risks at the workplace. Exposure to solvents and other organic liquids can harm the liver, kidneys, heart, blood vessels, bone marrow, and neurological system. Solvents are also combustible, and are frequently highly volatile, posing a major threat to safety and health (5). Although workplace accidents in the manufacturing sector have decreased over time, they still remain the primary cause of industrial accidents. Research conducted by Chetty (6) found that workers in the beverage industry had inadequate knowledge of occupational safety and

health (OSH) practices, with 51.3% of workers lacking sufficient knowledge. Additionally, 22% of workers were involved in injuries during the study period, with 4.2% of injuries resulting in permanent harm. This underscores the need for education and training on OSH practices.

Workplace accidents and mishaps in the manufacturing industry could be due to various reasons, such as inadequate standard operating procedures (SOPs), non-compliance with the company's SOPs, and improper maintenance. These issues affect workers around the world, highlighting the need for organizations to take a proactive approach toward workplace safety. The International Labour Organization (ILO), for instance, has identified several global trends and challenges regarding issues in OSH, including the need for better management systems, and the impact of new technologies (7). In Malaysia, these inadequacies seem to result from a lack of safety culture and the implementation of the Occupational Safety and Health Act 1994 (8). Consequently, these workplace accidents have caused Malaysia's economy to suffer (9). Hence, it is the employer's responsibility to ensure a safe and healthy working environment for employees in the manufacturing industry, as mandated by Section 15 of the Occupational Safety and Health Act 1994 (10).

As more management systems are introduced in organizations, the issue of their implementation and ongoing compliance with the requirements has become more critical (11). Risks are present in all organizational activities, and a management system must ensure that a manufacturing process meets its intended use without introducing any risks or unfavorable failures (12). The development of management systems, particularly the quality management systems (ISO 9000) and environmental management systems (ISO 14000), is linked to the history of safety and health management systems (ISO 45001). As in the worldwide, the ILO has also held several World Congresses on Safety and Health at Work, in which to discuss these emerging issues and initiatives including reinforcing organizations' safety culture, incorporating smart personal protective equipment (PPE) and using safety data for predictive analytics (7).

One way to prevent workplace accidents and injuries is by providing employees and employers with adequate training on safety and health in the workplace. Knowledge and practice (KP) in OSH are critical factors in preventing workplace injuries. Therefore, this study aims to assess solvent manufacturing workers on their level of knowledge, practice, and injury patterns towards OSH.

MATERIALS AND METHODS

A cross-sectional study was conducted at a solvent manufacturing company to assess the level of knowledge, practices, and injury pattern related to OSH among workers in a solvent manufacturing factory from December 2021 to October 2022. The dependent variables under investigation were the knowledge, practices, and injury pattern among the manufacturing workers, while the independent variables were sociodemographic factors, including gender, age, working experience, and education level.

Data were collected using a quantitative research design, which involved administering a questionnaire to determine worker knowledge and practices related to OSH, as well as a retrospective study component to document the injury patterns of workers who reported to clinics or hospitals over an 11-month period. The inclusion criteria comprised all local workers aged 20 to 60 who consented to and were capable of participating in the study, while the exclusion criteria included workers with a history of accidents outside of normal working hours. The rationale for these criteria is to ensure the participants are representative of the population and to minimize the impact of confounding factors that could affect the study results. By limiting the age range of participants, the study can focus on a specific age group that may be more susceptible to certain workplace hazards. Similarly, by excluding workers with accidents outside of normal working hours, the study can focus on accidents that are more likely to be related to workplace conditions.

Study instrument

A self-administered questionnaire with three sections was used to assess OSH knowledge and practices among workers. Section A consisted of ten questions on sociodemographic characteristics such as gender, age, education level, and nature of employment. Section B is related to the employee's knowledge on occupational safety and health. It consists of nine questions that require the employee to agree or disagree with statements related to workplace safety. The questions cover topics such as reporting accidents to the safety and health officer, fire safety, handling chemicals, and emergency response plans. The last two questions in this section require the employee to think if there are any issues of workplace safety and health that need to be addressed and if they have any recommendations regarding the improvement of safety and health within their company. While Section C is related to the employee's practices on occupational safety and health. It consists of ten questions that require the employee to rate their level of agreement with statements related to workplace safety and health practices. The questions cover topics such as wearing

personal protective equipment, reading safety data sheets, attending safe working practices training, communicating with supervisors and managers in case of accidents, and ensuring effective air circulation in the workplace.

The content validation was performed by two experienced internal department lecturers from the Faculty of Medicine and Health Sciences, Universiti Putra Malaysia. A pre-test was conducted on 10% of the sample size calculation and the questionnaire was found reliable with a Cronbach Alpha of 0.93. The questionnaire was distributed through the WhatsApp platform and on physical paper, with a consent form and a declaration about data protection.

Data analysis

The Statistical Package for the Social Science (SPSS) version 27.0 was used for data analysis. Descriptive analysis using frequency and percentage was performed to describe sociodemographic characteristics, knowledge, and practices regarding OSH among workers. Chi-Square tests were used to determine associations between knowledge level, practice level and injury data towards OSH, and sociodemographic variables. Those respondents who obtained knowledge scores below 3 were categorized as poor, while the scores between 4 to 6 were considered to have moderate knowledge. The score above 7 was considered to have a good knowledge level. For the practice, scores less than 22 were classified as poor, scores between 23 to 36 were classified as moderate and scores more than 37 were classified as high practices. These levels of knowledge and practice categories were determined by class frequencies. The confidence interval selected was 95%, and results were considered significant at $p < 0.05$. The open-ended questions were optional, but they aimed to learn more about workers' perspectives on OSH concerns and suggestions for enhancing safety and health at the factory.

Ethical consideration

This study was approved by the JEKUPM Ethics Committee Involving Human Subjects, Universiti Putra Malaysia (JKEUPM-2022-392).

RESULTS

Sociodemographic characteristics

Out of 292 of the study population, 286 (97%) participants completed and returned the distributed questionnaires. The socio-demographic characteristics (Table 1) of the study participants were 72.4% male and 27.6% female. The age of the participants ranged from 21 to 60 years, with the majority in the 31-40 age group (33.9%). In terms of working experience, the largest proportion of participants (36.0%) had worked between 6 and 10 years. The education level

of participants varied, with 33.9% holding a degree and 40.6% holding a pre-university qualification. The majority of participants worked 1-8 hours a day (80.4%) and 1-5 days a week (79.7%). In terms of departments, the largest number of participants worked in Production (70.3%), followed by Technical, Marketing, Logistics and QA/QC which had 12.6%, 7.7%, 4.9% and 3.5%, respectively. Most participants (98.6%) worked full-time, with only 4 participants working part-time.

Table 1 : Frequency and percentage solvent manufacturing workers' sociodemographic characteristics (n=286)

Variable	Frequency (N)	Percentage (%)
Gender		
Male	207	72.4
Female	79	27.6
Age		
21-30	80	28.0
31-40	97	33.9
41-50	65	22.7
51-60	44	15.4
Working experience		
1-5	59	20.6
6-10	103	36.0
11-15	51	17.8
16-20	44	15.4
21-25	29	10.1
Education level		
Secondary school	72	25.2
Pre- University	116	40.6
Degree	97	33.9
Master/PhD	1	0.3
Working hours in a day		
1-8 hours	230	80.4
9 hours and above	56	19.6
Working days in a week		
1-5 days	228	79.7
6-7 days	58	20.3
Departments		
Marketing	22	7.7
Production	201	70.3
QA/QC	10	3.5
IT	3	1.0
Logistics	14	4.9
Technical	36	12.6
Nature of work		
Full time	282	98.6
Part-time	4	1.4

DISCUSSION

The level of knowledge and practices regarding OSH

252 (88.1%) of the workers showed a good level of OSH knowledge, 28 (9.8%) had moderate OSH knowledge level, and only 6 (2.1%) had poor OSH knowledge level. In terms of practice level, the majority of the workers exhibited a good level of practice and the remaining workers had a moderate level of practice, 197 (68.9%) and 89 (31.1%) respectively.

It was observed that several factors may contribute to these trends. One factor may be due to the fact that the company has conducted several trainings and programs based on training needs analysis to address specific needs of the workers. These training programs cover topics including chemical handling, forklift operation, working at heights, dust collector awareness, scheduled waste disposal, restricted spaces, and work permits, which are held frequently, at least once a month. In addition, regular safety toolbox meetings are also held once a week to review safety procedures. The combination of training and safety initiatives may have helped to create a safety culture within the company and contributed to the good level of OSH knowledge and practices.

Injury patterns

Three occurrences were reported over an 11-month period, two of which happened in the raw material warehouse and one in the emulsion plant. All three incidents involved acute injuries, with one related to a chemical hazard and the other two to physical hazards. In the first incident, an employee suffered a minor eye injury due to exposure to chemical leakage, resulting in three days off from work. The second incident involved a piece of metal wire rope that snapped and poked an employee's hand, requiring immediate medical attention and two days off from work. However, the employee had to be hospitalized for surgery. The third incident involved an employee who suffered a fracture in their right arm due to a pallet of empty plastic pails toppling over him, resulting in 15 days off from work. The worker received medical attention in an in-house clinic before being transferred to the General Hospital.

These internal injury data indicate that the manufacturing sector is particularly vulnerable to hazards and risks. Similarly, recent statistics reported in the OSH Act 1994 show that the manufacturing sector recorded the most workplace injuries in 2021 with 7,994 cases, followed by services (4,299 cases), construction (2,297 cases), and wholesale and retail trade (1,979 cases) (13). Therefore, companies in the manufacturing sector must ensure that their employees comply with OSH regulations and SOPs to minimize accidents.

The association between factors (gender, age, working experience and education level) and the level of OSH knowledge

The study found there were no statistically significant associations between the level of knowledge regarding OSH to each of the factor (gender, age, working experience, education level) with their p-values of ($p = 0.721$), ($p = 0.332$), ($p = 0.894$), and ($p = 0.703$) respectively (Table II). These findings were in accordance with other studies conducted in Malaysia. In a prior study by Paul et al. (14), it was found that there was also no correlation between knowledge level and independent variables like gender, work experience, and safety training on OSH among laboratory workers at particular public universities in Malaysia. Krishnan (15) also reported the findings of demographic factors like age and gender to have no significant influence on the application and acceptance of OSH.

The association between factors (gender, age, working experience and education level) and the level of OSH practices

There was a statistically significant association between level of practice and gender, as well as between the level of practice and age; with both of the p-values of 0.001. Despite this, the current study found that there was no statistically significant association between the level of practice and sociodemographic factors (working experience and education level) with p-values of 0.327 and 0.675, respectively (Table III). These findings are in contrast with the previous studies. Islam et al., (16) and Quartey et al., (17) showed that gender and age were found to be not significantly correlated to OSH practices. The finding from Garcia et al., (18) found that there were no differences in safety climate index scores according to age and education with safe work practices. The study found that the respondents under the age of 40 were reported to have a high practical level of safety compared to workers over 40 years old. The physiological systems of older workers, including their cognitive abilities like reaction time to near-misses, may be reduced (19). The age groups in an organization are therefore likely to have an impact on OSH practices.

The association between factors (gender, age, working experience and education level) and injury patterns

The study found there were no statistically significant associations between the injury patterns to each of the factor (gender, age, working experience, education level) with their p-values of ($p = 0.282$), ($p = 0.716$), ($p = 0.250$), and ($p = 0.988$) respectively (Table IV).

The association between the level of knowledge and practices and affect on injury data

The study found that there was no statistically significant association between the knowledge-

Table II : Association between sociodemographic factors and level of knowledge towards OSH

Variable		Level of Knowledge						Total	p-value
		Poor		Moderate		Good			
		n	(%)	n	(%)	n	(%)		
Gender	Male	5	2.4	19	9.2	183	88.4	207	0.721
	Female	1	1.3	9	11.4	69	87.3	79	
Age (year)	21 - 30	1	1.3	12	15.0	67	83.8	80	0.332
	31 - 40	3	3.1	7	7.2	87	89.7	97	
	41 - 50	0	0.0	5	7.7	60	92.3	65	
	51 - 60	2	4.5	4	9.1	38	86.4	44	
Working Experience (year)	1 - 5	0	0.0	2	6.9	27	93.1	29	0.894
	6 - 10	3	2.9	9	8.7	91	88.3	103	
	11 - 15	2	3.9	5	9.8	44	86.3	51	
	16 - 20	0	0.0	5	11.4	39	88.6	44	
	21 - 25	1	1.7	7	11.9	51	86.4	59	
Level of Education	Secondary	2	2.8	5	6.9	65	90.3	72	0.703
	Pre-University	2	1.7	16	13.8	98	84.5	116	
	Degree	2	2.1	7	7.2	88	90.7	97	
	Master/PhD	0	0.0	0	0.0	1	100.0	1	

Table III : Association between sociodemographic factors and level of practice towards OSH

Variable		Level of Practice						Total	p-value
		Poor		Moderate		Good			
		n	(%)	n	(%)	n	(%)		
Gender	Male	0	0.0	51	24.6	156	75.4	207	<0.001
	Female	0	0.0	38	48.1	41	51.9	79	
Age (year)	21 - 30	0	0.0	17	21.3	63	78.8	80	<0.001
	31 - 40	0	0.0	24	24.7	73	75.3	97	
	41 - 50	0	0.0	19	29.2	46	70.8	65	
	51 - 60	0	0.0	29	65.9	15	34.1	44	
Working Experience (year)	1 - 5	0	0.0	9	31.0	20	69.0	29	0.327
	6 - 10	0	0.0	28	27.2	75	72.8	103	
	11 - 15	0	0.0	22	43.1	29	56.9	51	
	16 - 20	0	0.0	14	31.8	30	68.2	44	
	21 - 25	0	0.0	16	27.1	43	72.9	59	
Level of Education	Secondary	0	0.0	26	36.1	46	63.9	72	0.675
	Pre-University	0	0.0	34	29.3	82	70.7	116	
	Degree	0	0.0	29	29.9	68	70.1	97	
	Master/PhD	0	0.0	0	0.0	1	100.0	1	

Table IV : Association between sociodemographic factors and injury pattern towards OSH

Variable		Injury Pattern				Total	p-value
		No		Yes			
		n	(%)	n	(%)		
Gender	Male	204	98.6	3	1.4	207	0.282
	Female	79	100.0	0	0.0	79	
Age (year)	21 - 30	79	98.8	1	1.3	80	0.716
	31 - 40	96	99.0	1	1.0	97	
	41 - 50	65	100.0	0	0.0	65	
	51 - 60	43	97.7	1	2.3	44	
Working Experience (year)	1 - 5	29	100.0	0	0.0	29	0.250
	6 - 10	103	100.0	0	0.0	103	
	11 - 15	50	98.0	1	2.0	51	
	16 - 20	44	100.0	0	0.0	44	
	21 - 25	57	96.6	2	3.4	59	
Level of Education	Secondary	71	98.6	1	1.4	72	0.988
	Pre-University	115	99.1	1	0.9	116	
	Degree	96	99.0	1	1.0	97	
	Master/PhD	1	100.0	0	0.0	1	

Table V : Association between knowledge, practice and injury pattern towards OSH

Variable		Injury Pattern				Total	p-value
		No		Yes			
		n	(%)	n	(%)		
Level of Knowledge	Poor	6	100.0	0	0.0	6	0.815
	Moderate	28	100.0	0	0.0	28	
	Good	249	98.8	3	1.2	252	
Level of Practice	Poor	0	0.0	0	0.0	0	0.242
	Moderate	89	100.0	0	0.0	89	
	Good	194	98.5	3	1.5	197	

Variable		Level of Practice						Total	p-value
		Poor		Moderate		Good			
		n	(%)	n	(%)	n	(%)		
Level of Knowledge	Poor	0	0.0	0	0.0	6	0.0	6	0.179
	Moderate	0	0.0	7	25.0	21	25.0	28	
	Good	0	0.0	82	32.5	170	32.5	252	

practices, knowledge-injury and practices-injury with the p-values of ($p=0.179$), ($p=0.815$) and ($p=0.242$) respectively (Table V).

This finding further supports the study by Ngah et al., (20), in which discovered that knowledgeable workers did not exhibit any association with their practice of Safe Working in confined spaces among male water services workers in the central region of Malaysia. The company must quickly monitor and supervise personnel to make sure they adhere to the guidelines as well as to avoid or minimize workplace accidents. According to Zahiri Harsini et al., (21), poor direct safety management and monitoring, managers' lack of authority and power, and a lack of specialized funding for workplace safety, all contributed to the prevalence of risky behaviour and accidents.

Moreover, this study found that the knowledge and practices did not have any relationship with the injury that happened in this factory as only three accidents during the 11-months of period starting from December 2021 until October 2022. This showed that the workers have a good knowledge and practices of OSH but at the same time the top management should take action to improve the injury data to 0% of injury at this factory. A zero-injury year is unlikely to occur in a workplace if everyone does not think it is possible. The thoughts and beliefs frequently manifest in individual behaviour as well as the perspective of an individual is important in order to accept the possibility that, despite any difficulties, obtaining zero injuries is at least achievable. Therefore, injury prevention initiatives should include establishing safety and health education programs as well as putting them into practice and evaluating their effectiveness.

The issues and recommendations at the workplace

The questionnaire included two open-ended questions on the workplace safety and health issues that needed to be addressed and the suggestions for how to enhance safety and health at this solvent manufacturer. The majority of the respondents who responded to these issues expressed similar points. The feedback showed that workers in technical and production areas found that there is a widespread lack of PPE enforcement. They reported that the workers only wear PPE when the manager or safety officer is inspecting. Additionally, many respondents expressed discomfort and irritation with wearing PPE, such as respiratory masks and protective helmets, for extended periods of time. Workers may find PPE uncomfortable to wear especially if it is not properly sized or due to the material itself. In addition, some workers may feel that PPE is too heavy, difficult to wear or puts pressure on the body. Another reason is perceived low risk or necessity in which workers may assume the risk of solvent exposure is low,

hence PPE is unnecessary. The lack of PPE enforcement is a safety hazard for workers. Employers should provide proper training, appropriate PPE, encourage compliance and address workers' concerns so that the risk of solvent exposure may be reduced.

Prolonged sitting is another concern raised by workers. This is a common ergonomic risk factor in paint mixing and clerical work which leads to tiredness, muscle imbalances, and strain in the muscles and eventually can have a negative impact on workers' proactiveness and productivity. The supervisor should conduct an assessment of the workstations in these workplaces to ensure that they are designed to fit the workers comfortably. The safety officer should also educate the workers on ergonomics and how to implement it at their workstations.

Toolbox meetings are an important part of workplace safety programs. They are a casual way to inform employees about safety and help organizations stay in compliance with OSH Act 1994. Although the meeting is held weekly, however, the feedback revealed that some workers may ignore the toolbox meeting, which can be a safety hazard. To ensure that workers are attending toolbox meetings, the supervisor should make an attendance list and check on them. The information addressed during the meeting must have been available to every employee. There were also other concerns regarding the physical environment of the workplace. Therefore, employers should take the OSH issue seriously so that they can minimize expenses associated with injury and illness, lower absenteeism and turnover, as well as boost their performance quality. By addressing these issues, the company can help ensure that workers have the knowledge and skills necessary to maintain a safe and healthy work environment, which can ultimately lead to improved productivity and job satisfaction.

CONCLUSION

In conclusion, the study clearly demonstrated that most workers possessed a good knowledge level of OSH at their workplace. It was also noteworthy that all workers revealed good and moderate levels towards OSH practices. These findings show that in general, solvent manufacturing employees are well-educated in OSH with good practicality in the workplace following OSH regulations. The study pointed out that there was a statistically significant association observed between two factors of sociodemographic characteristics which were gender and age with the level of practices on OSH. However, there was no statistically significant association found between all sociodemographic characteristics with the level of knowledge of OSH. In addition, the analysis between knowledge and practice, knowledge and injury patterns, as well as and practice and injury patterns

showed no statistically significant association.

Although this study focuses on assessment of knowledge and practices level, the findings may well have a bearing on the importance of prioritizing OSH in workplaces to help reduce risks, accidents, and injuries by mitigating hazards. Additionally, prioritizing OSH can reduce the number of employees absent due to injuries, which can improve productivity. Therefore, it is important for employers to consider the implications of this study and prioritize OSH in their workplaces.

However, the findings of this study should be regarded with caution as there are few limitations. Due to the sample size that was restricted to solvent manufacturing employees in Shah Alam, Selangor, therefore, this study may not be generalized to manufacturing employees working in companies providing different services. In terms of directions for future research, more in-depth research is needed to include surveys for data injury within a five year period to get a comparative statistic. Comparative data can highlight trends or patterns of injuries recorded yearly, which a researcher can use as supporting data in analyzing the level of knowledge and practice of OSH among employees. This recommendation can give readers a detailed insight in understanding the importance of knowledge and practice of OSH when exposed to high-risk and hazardous works, such as manufacturing.

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