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Original article

Assessment of personal protective equipment use and occupational exposures in small industries in Jeddah: Health implications for workers

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ABSTRACT

Small-scale industries account for a large proportion of jobs and play a vital role in most countries' economic growth and prosperity. Due to the very low use of personal protective equipment (PPEs), employees are exposed to numerous physical, chemical, and accidental hazards in small-scale industries. PPEs are very effective in minimizing occupational injuries, accidents, and other hazards which otherwise result in substantial manpower and financial losses. The study objective was to assess the availability and use of PPEs as well as self-reported occupational exposures among workers in surveyed small industries in Jeddah. The study involved 102 workers from 28 small-scale industries (vehicle repair, welding, and paint). A survey was conducted to gather data of socio-demographic characteristics, self-reported occupational exposures, and frequency of PPEs used by workers. The occupational exposures (never exposed, sometimes exposed and always exposed) were reported in percentages including; noise exposure (19.6, 73.5 and 6.9%); dust/smoke exposure (9.8, 69.6 and 20.6%); vapors/fumes exposure (11.8, 60.8 and 27.5%); and direct sunlight (43.1, 56.9 and 0%), respectively. The reported use of different PPEs in descending order was; knee joints mats (50%), welding shields (50%), safety glasses (33.3%), gloves (27.5%), face masks (26.5%), safety shoes (10.8%) and earplugs/ muffs (8.8%). On the basis of this study findings, hand hygiene and general OSH awareness like interventions can be developed which will help in minimizing workplace exposures among small-scale industry workers.

1. Introduction

Small-scale industries account for a large proportion of jobs and play a very vital role in most countries' economic growth and prosperity, but in many cases the jobs are low-paid and the job security is poor (Ahmad et al., 2017). According to Webster's New World Finance and Investment Dictionary (2010), a privately-owned and operated business/activity with relatively small turnover and staff numbers is termed as the small industry. The small-scale industry can also be defined as non-manufacturing industries employing less than 20 employees and manufacturing industries with less than 100 employees (Seneviratne and Phoon 2006). The main characteristics of the small-scale industries include; operated and owned independently, closely controlled by managers/owners who contribute to the operating capital and are the principal decision makers (Ahmad et al., 2017). There is a dearth of actual and reliable data available to the public on the number of workers in informal small repair workshops in the Kingdom of Saudi Arabia (KSA). According to labor force survey in 2016, the wholesale trade, retail trade and vehicle repair workshops employ around 18.4% of the total labor force.

Small-scale industry employees are routinely and regularly exposed to numerous physical, chemical and accidental hazards, which makes them a vulnerable occupational group. The main reasons for their vulnerability are a lack of education, insufficient knowledge, a dearth of awareness of OSH hazards, and non-availability or use of personal protective equipment's (PPEs). Small-scale industry workers are least aware of safety and health outcomes resulting from the workplace exposures, activities, and

Abbreviations: DSR, Deanship of Scientific Research; HSE, Health and Safety Executive; KAU, King Abdulaziz University; KSA, Kingdom of Saudi Arabia; OHS, Occupational Health and Safety; OSH, Occupational Safety and Health; OSHA, Occupational Safety and Health Administration; PPE, Personal Protective Equipment.

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materials (Ahmad et al., 2017). Literature proved that there is a deficiency of understanding, knowledge, and information on proper use of PPEs among such workers and the use of PPEs in small-scale industries is very low (Ahmad et al., 2017; Taha, 2000). Also low education level may contribute to non-use of personal protective measures, as they don't know, recognize and appreciate the significance of PPEs (Taha, 2000).

Though PPEs are used as the last measure for workplace hazards control and are used in the case where managerial and engineering control measures are already in place. PPEs have proved to be the most decent measure of protection for workers in small-scale industries where conventional hazards control measures and programs remain a challenge to implement (Ahmad et al., 2017; Kamal et al., 2016). Non-use of PPEs can expose workers to many safety and health hazards and risks which ultimately can cause serious health implications (Ahmad et al., 2016). PPEs can play a vital role in minimizing occupational injuries and accidents which otherwise result in substantial human sufferings and financial losses due to lowered production, hefty fines, health and insurance claims, and absenteeism (Taha, 2000).

The workers in small-scale industries such as welding, auto repair, and body paint workshops, work in unhygienic conditions, are daily exposed to fuels and chemicals, and rarely use PPEs and other protective measures that can minimize health risks (Kamal et al., 2016). The common hazards are falling and flying objects, sharp edges, dust, vapors and fumes/odors from chemicals, heat, and noise (Ahmad et al., 2016; Ali et al., 2016). The use of engineering controls and PPEs have been well documented at small workshops (Velazquez et al., 2008; Brosseau et al., 2014). Use of PPEs is one of the key components of workplace health and safety practices to ensuring overall health and safety of workers (Apreko et al., 2015). PPE is defined in the UK, Personal Protective Equipment Regulations 2002 and the Personal Protective Equipment at Work Regulations 1992 as, "all equipment which is intended to be worn or held by a person at work and which protects him against one or more hazards and risks to his health or safety" e.g. gloves, goggles, respirators, earplugs, hard hats, knee coverings, face shields, full body covers, safety footwear, and safety harnesses. Where health risks cannot be avoided or processes cannot be improved, the use of appropriate PPEs can be an effective measure to protect the health of workers (Apreko et al., 2015).

The Occupational Safety and Health Administration (OSHA) call for all possible measures to be adopted for health and safety of workers from workplace hazards and risks. Depending upon type and level of hazards, OSHA recommends employing different control measures (elimination, substitution, engineering, administrative, PPEs) to eliminate or minimize hazards to the greatest extent possible (OSHA, 2004). In case technological and administrative controls measures don't perform well in providing sufficient protection, workers should be provided with PPEs and training for their use. In the Kingdom of Saudi Arabia (KSA), the small-scale industry employs diverse international labor force which is more prone to risks due to sociodemographic as well as local climatic and geographical factors (Ahmad et al., 2016).

Jeddah is the second largest industrial and developed city of KSA, having an estimated population of around 4.03 million situated at Eastern Coast of the Red Sea at Latitude 29.2° North and Longitude 39.7° East. Jeddah environment and meteorological conditions are characterized by dust storms, high solar radiation, low wind speed, arid environment, least precipitation rate, bulk vehicular emissions, hot summers, fewer herbs and plantation, and high humidity (Ahmad et al., 2016, 2017). In Jeddah, there is an information gap on occupational hazards, risks and their health effects and utilization and effectiveness of safety measures among small-scale workshops employees. The vulnerability of this occupational group would be even higher in Jeddah due to harsh climatic, geographic and working conditions as well as their sociodemographic background as the majority workers are expatriates (Ahmad et al., 2016, 2017). Such research studies are instrumental in health status evaluation of workers but their importance become many folds in the studied informal, self-employed small-scale industries (Ahmad et al., 2017).

There is no any comprehensive study published on the use of PPEs and occupational exposures assessment in small-scale industries in Jeddah (Ahmad et al., 2016, 2017; Khasawneh 2014). The objective of this study was to assess the frequency of use of PPEs and workplace exposures among motor mechanics, welders, painters and panel beaters working in small workshops in Jeddah. The research outcomes are important for OSH professionals, PPEs suppliers, workers, local and national administrative bodies, researchers and other stakeholders. A hand hygiene and awareness raising program can be developed on the basis of study findings to minimize workplace exposures and their health implications among the studied population.

2. Material and methods

2.1. Study area and research protocol

This non-experimental, non-clinical exploratory and descriptive survey study was conducted at different small-scale industries in Jeddah, KSA. For study sample, 37 small-scale industries (vehicle repair, welding, and body paint workshops) situated in urban premises of Jeddah, were randomly selected and invited for participation. With repeated follow up, continuous phone calls and personal visits only 28 small workshops could be recruited successfully while others excused participation due to retaliation fear and some other personal reasons. A flowchart of the workshops selection and study participants is depicted in Fig. 1. This study was reviewed and approved by the Institutional Review Committee of Faculty of Meteorology, Environment, and Arid Land Agriculture King Abdul-Aziz University (KAU) Jeddah. An informed consent was obtained from participants and managers as well as ethical approval was obtained from the Research Ethics Committee, KAU Hospital Jeddah. Almost at all the workshops, the employees were expatriates belonging to different countries like Pakistan, India, Yemen, and Syria. The interviews were made in the native language of the workers.

2.2. Survey tool and pilot study

A custom developed questionnaire was used that composed of 3 sections; (1) sociodemographic characteristics (job type, age, residence status, education level, job experience, marital status, work days/week, work hours/day, and smoking habits); (2) different types of routine occupational exposures to which study participants are exposed; (3) self-reported frequency of use of different types of necessary PPEs. Self-administered as well as assisted questionnaire completion method was employed for this study as being the most suitable, confidential, and accurate data collection method (Ahmad et al., 2016).

A pilot study was conducted to validate the process, to identify challenging elements and to review ease, clarity, and questionnaire completion average time. For measuring questionnaire reliability, Cronbalch's alpha was executed, α value was 0.7 which indicates that scores variance is explainable (Rocha et al., 2014; Silveira, 1999). A preplanned script was employed to monitor observation related to research. On average it took 15 min for observation and interview for each participant. Interviews were performed during working hours, between 9 am and 4 pm.

Observations and answers to the preplanned script were noted and recorded in the field logbook. The research data was reasonably applicable for the analysis as the case-to-variable ratio was

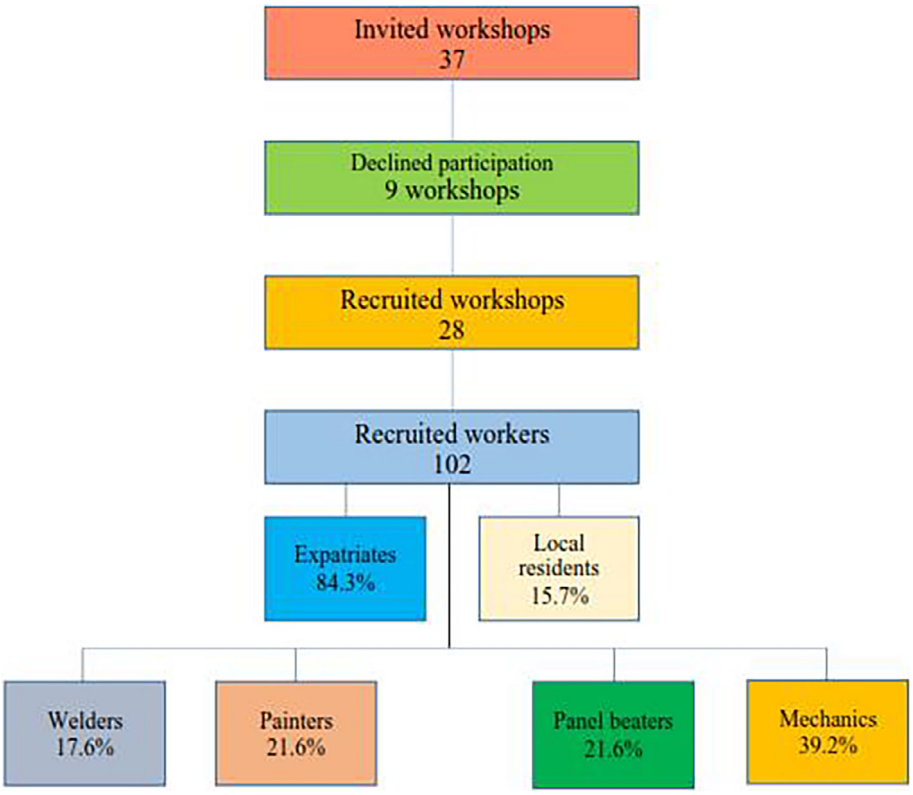

Fig. 1. Flowchart diagram of selection of workshops and study participants.

according to the minimum requirement of 5:1 (Silveira, 1999). Questions for perceived or actual occupational exposures (vehicle smoke, workplace dust, noise, fuel/welding/paints vapors and fumes, direct sunlight and heat) were asked to the workers i.e. how often do you expose to these workplace exposures?, The answers were given within three categories; never exposed, sometimes exposed and always exposed. The questions related to the use of PPEs were as follows;

- Do you use safety glasses and/or goggles as needed?
- Do you utilize earplugs/muffs when required?
- Do you wear hand gloves when necessary?
- Do you wear safety boots/shoes as required?
- Do you wear face masks as needed?
- Do you use a welding shield, apron, and curtain as needed?
- Do you use knee and joint protecting mats as needed?

2.3. Statistical analysis

The data was organized and analyzed using statistical software (Statistical Package for Social Sciences (SPSS), version 20.0). Descriptive analysis i.e. mean, frequency, standard deviation, and percentage were recorded. Association of education and job experience with different reported workplace exposures and reported use of PPEs was studied employing the Chi-square test, the significance level was set at 0.05.

3. Results and discussion

3.1. Sociodemographic characteristics of recruited participants

Through this survey study, sociodemographic characteristics of employees in small-scale industries situated in Jeddah were recorded. Among 102 surveyed workers, there were 40 mechanics (39.2%), 18 welders (17.6%), 22 painters (21.6%), and 22 panel beaters (21.6%) having a mean age of 34.9 years (range 21–52). Of the total sample size, expatriate workers were 84.3% while rests were local workers having mean job experience of 10.6 years (range 1–31). Surveyed population education, marital status, job experience, working durations, and smoking habits details are shown in Table 1.

The results indicated that among the surveyed population the maximum population i.e. 84.3% were expatriates, this fact is also endorsed by some other studies in KSA as well (Taha 2000; Ahmad et al., 2016, 2017). The average working hours per day were found to be 11.4. According to KSA amended labor law 2015, the maximum permissible working hours are 12 for journal labors but in occupations like diesel engine mechanics the maximum working hours per day is 10 with compulsory 1 hour break for rest, lunch and prayer (Resolution 258, of amended labor law 2015). Through this survey, breaches of working hours' limits were observed at studied small workshops. The employers have an obligation to ensure OSH of workers as being mentioned in the article on the hazardous work of the labor law. But in some workplaces, this responsibility was being ignored, either involuntarily or otherwise, their legal and ethical obligations toward their employees (Khasawneh, 2014).

The survey shows that policies and measures for delivery of OSH services are limited and deficient for the studied population. Even though the laws, regulations, and policies are in place but their implementation, inspection, and audits for proper adherence to standards are needed to be improved in the studied workshops.

3.2. Self-reported occupational exposures

The different workplace exposures among recruited participants were assessed and reported in percentages in three categories i.e. never exposed, sometimes exposed and always exposed, the details are given in Table 2. The results included;

Table 1
Sociodemographic characteristics of the small industries workers in Jeddah.

Sociodemographic Characteristics		N (%)
Job type	Mechanic	40 (39.2)
	Welder	18 (17.6)
	Painter	22 (21.6)
	Panel beater	22 (21.6)
Age of subjects (y)	Mean	34.9
	Max	52.00
	Minimum	21.00
Residence status	Expatriate	86 (84.3)
	Local resident	16 (15.7)
Education level	No	29 (28.4)
	Primary	12 (11.8)
	Middle	10 (9.8)
	Secondary	37 (36.3)
	College	14 (13.7)
Job experience (y)	Mean	10.6
	Max	31
	Minimum	1
Marital status	Single	12 (11.8)
	Married	88 (86.2)
	Divorced	2 (2)
Work days/week	5	2 (2)
	6	100 (98)
Smoking	No	34 (33.3)
	Yes	68 (66.7)
Work hours/day (mean ± S.D)	11.4 ± 1.4	

Table 2
Self-reported occupational exposures among small industries workers in Jeddah.

Types of occupational exposures		N (%)
Noise	Never	20 (19.6)
	Sometimes	75 (73.5)
	Always	7 (6.9)
Dust/smoke	Never	10 (9.8)
	Sometimes	71 (69.6)
	Always	21 (20.6)
Vapors/fumes	Never	12 (11.8)
	Sometimes	62 (60.8)
	Always	28 (27.5)
Direct sunlight/Heat	Never	44 (43.1)
	Sometimes	58 (56.9)
	Always	0.0

noise exposure (19.6, 73.5 and 6.9%); smoke and dust exposure (9.8, 69.6 and 20.6%); vapors and fumes exposure (11.8, 60.8 and 27.5%); direct sunlight and heat exposure (43.1, 56.9 and 0%), respectively.

The association between the education of workers and their reported workplace exposures are shown in Table 3. In the Pearson Chi-square test, the p-values of vapors /fumes ($p = 0.002$) were statistically significant with education while no statistically significant association could be established for other workplace exposures.

In this study, the reported exposures to vapors and fumes of chemicals, fuels (diesel, gasoline) and paints were high, which can have many detrimental effects on the health of workers. Vehicle-repair workers, welders, and car painters routinely come in contact with gasoline and diesel exhausts, welding fumes, mineral oil and organic solvents while performing their jobs. These workplace chemicals and pollutants can enter into the human body through ingestion, inhalation, and dermal routes (Hansen, 1989; Eqani et al., 2016; Munir et al., 2016). Many health outcomes (cancers, lung ailments, eczema, dermatitis and malignant mesothelioma) are associated with exposures to such substances. These symptoms have been reported by many studies (Taha, 2000; Ebeid, 1987; Cheng and Okelly, 1986). Even the actual number of exposures or hazards could be greater than reported but workers might be reluctant to mention it, possibly due to the fear of losing their jobs or restrictions from management (Taha, 2000).

Table 3
Association between Education and workplace exposures.

Workplace exposures	Pearson Chi-square test		
	p-value	Chi-square Value	df
Noise	0.493	7.412[a]	8
Dust/smoke	0.165	11.702[a]	8
Vapors/fumes	0.002	24.167[a]	8
Direct sunlight/heat	0.142	6.889[a]	4

In this survey, 73.5% of subjects reported that they have been exposed to noise sometimes. A study at Université de Montréal indicated that at vehicle repair workshops exposure to noise is often more than 90 dB. Different operations and tools such as air hoses, electric and pneumatic grinders, chisels, and sanders contribute to it, i.e. they produce sounds that sometimes may be as loud as 100 dBA (Bejan et al., 2011). A study at small-scale industries in China reported that at least one type of hazard was prevalent among 83% of surveyed industries across the country. The same study reports that hearing loss due to noise was one among seven types of occupational diseases in the studied population (Zhi et al., 2000). According to study findings in Norway at small mechanical enterprises, hazards and risks can be reduced by appropriate use of PPEs (Bull et al., 2002). Smoking at small workshops can be very dangerous and risky as working environment contains multiple ignition sources like trash, fuel oils, dust, rags, papers, acids etc. The majority of workers still smoke, which can contribute to the non-use of PPEs, fire incidences, burns, injuries, accidents and excess sick leave in industries (Taha, 2000). According to our study findings among the surveyed population, 66.7% were smokers as compared to another previous study in another city of KSA where 58% of studied workers reported smoking (Taha, 2000).

3.3. Use of personal protective equipment among workers

The self-reported use of PPEs among workers in small industries in Jeddah is shown in Fig. 2. The surveyed workers among selected small industries reported the use of safety glasses (33.3%), earplugs/muffs (8.8%), gloves (27.5%), safety shoes (10.8%), and face masks (26.5%). The reported usage of welding shields/screens and mats for knee joints protection was 50% and 50% among welders, and mechanics respectively. Nevertheless, the type and quality of mats used were poor and unsatisfactory as the rags, plastic, and paper sheets etc. were used for this purpose at many sites which cannot provide adequate protection.

The association between education of workers and their reported frequency of use of PPEs is shown in Table 4. In the Pearson Chi-square test, the p-values of "use of safety glasses" ($p = 0.010$), "use of face masks" ($p = 0.000$), and "use of knee joint protection mats" ($p = 0.000$), were statistically significant with workers education level while no statistically significant association could be established for other types of PPEs used.

The maximum reported positive response of 50% was for the use of knee joint protection mats while working under the vehicles and welding shields whereas the lowest positive response of 8.8% was reported for the use of earplugs and muffs for the protection of ears against the noise.

On average less than a third (29.7%) of interviewed workers reported employing PPEs among surveyed small industries, although these industries pose enormous physical and chemical hazards to workers. Moreover, among this recorded proportion, none of the studied subjects were found to use the full complement

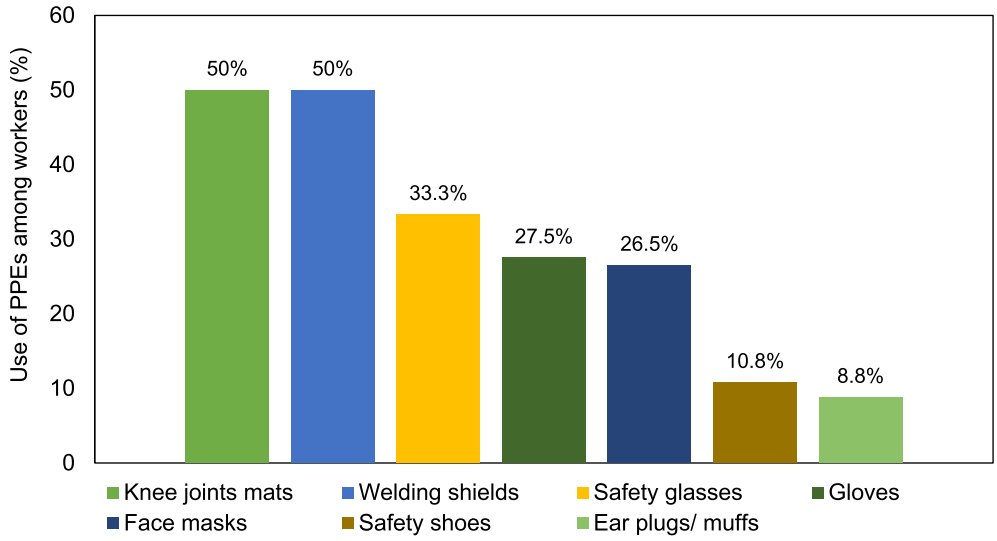

Fig. 2. Use of PPEs among workers in small industries in Jeddah.

Table 4
Association between education and use of PPEs.

Use of PPEs	Pearson Chi-square test		
	p-value	Chi-square Value	df
Use of safety glasses	0.010	13.374	4
Use of ear plugs/muffs	0.096	7.889	4
Use of hand gloves	0.204	5.935	4
Use of safety shoes	0.282	5.054	4
Use of face masks	0.000	20.459	4
Use of welding shields	0.562	6.767	8
Use Knee joint protection mats	0.000	40.963	8

of the required PPEs i.e. boots, shields, goggles, masks, overalls, gloves, and respirators. A study in Ghana reported that only 8% of welders were using goggles while the use of face masks was 56% among sprayers (Monney et al., 2014). Surprisingly welders and sprayers think that the use of just face shields and masks was sufficient against workplace exposures. However this type of protection is not adequate as other parts such as hands, arms, body, and clothes are equally exposed to workplace chemicals, fumes, vapors and radiations (Monney et al., 2014).

Our study showed that the storage of PPEs in all surveyed industries was poor and inadequate. In most of the visited workshops, no proper storage places were managed, most of the PPEs were left lying in open dusty oily ground or working benches or clustered cabinets. PPEs physical condition and maintenance were also observed, these were found to be in a poor state of maintenance, for instance, missing headbands/straps for welding helmets, and missing filters of masks. Another published study revealed that the practice of OSH in KSA is not promising in general with a poor accomplishment of hazard identification and risk assessment (Kadasah, 2015). A special characteristic of the studied small-scale industries in Jeddah is that it's dominant by expatriate workers. As per survey results, 84.3% among working population were reported to be expatriates. According to Health and Safety Executive (HSE) and OSHA, the expatriate workers are at increased risk from safety and health point of view. The factors cited for the increased vulnerability of expatriates are language and communication problems (85% of cases), being new to a job, and some other cultural factors. Despite this, 50% of employers do nothing different and special for migrant workers health and safety than they do for other workers (HSE, 2009). This can cause gaps in communication and understanding of hazards and preventive measures, along with some other social barriers and lack of education that could contribute toward ineffective health education messages. Among such workers low education level may contribute to non-use of personal protective measures, as they don't know, recognize and appreciate the significance of PPEs (Ahmad et al., 2017). Their knowledge regarding hazards protective measures is inadequate, many of them don't use self-protective gadgets (Taha, 2000).

4. Health implications for workers

The small industry workers are among more vulnerable occupational groups due to many reasons such as deficient resources, negligence and passive attitude of employees and employers, lack of education and awareness, ineffective legislation and monitoring, and non-availability or use of PPEs. For example, lack of education limits workers accessibility to knowledge, information and training prospects along with putting them at a greater risk of injuries, diseases, and other negative health outcomes. Studies proved that small-scale industry workers have a deficiency of understanding, knowledge, and information on proper use of PPEs and are least aware of health effects resulting from the workplace exposures, activities and materials (Ahmad et al., 2017; Kumar et al., 2013). Although PPEs are considered as the last resort for workplace hazards control and are placed in the case where managerial and engineering control measures have been put in place already. PPEs stand out as the most decent measure of protection for small-scale enterprises where conventional hazards control techniques and programs remain a challenge to implement (Ahmad et al., 2017). In Jeddah, there is an information gap among small-scale workshops employees on occupational hazards, risks, their health effects, utilization and effectiveness of safety measures and level of awareness. OSH information is very important to understanding and combating workplace hazards and risks, it can also be vital for designing intervention plans for promoting and upholding good OSH standards at small informal industries (Zgambo, 2015).

Non-use of PPEs leads to accidents, cut injuries and other hazards in small industries. The contributing factors comprise lack of education, training and awareness, negligence, employees and employer's passive attitude, PPEs unavailability, legislation and lack of regular monitoring and inspections (Taha, 2000; Ahmad et al., 2016). It was observed during this study survey that workers sometimes employ unconventional and nonstandard PPEs, whose protection level is less or minimum for example a piece of cloth

for a nose, sunglasses for eyes, plastic or paper sheets/rags/mat for knee joint protection. Out of order PPEs like broken glasses, damaged headbands for welding shields, worn and torn gloves and masks were also observed. The use of such type of PPEs among small industries employees is common in low-income countries contrary to KSA which is a high-income country. A study from Nepal found that welders were found to use sunglasses which they considered protective. The use of different types and quality of PPEs can be attributed to their availability and easy access, disparities in a work environment and cultures, safety practices, working procedures adopted, comfortable to use and cheap price, as has been observed in Nigeria (Sabitu et al., 2009; Ajayi et al., 2011). In addition, for PPEs to be effective, it is important to ensure that the workers are aware of PPEs and its guidelines while they deal with harmful substances or situations (Ahmad et al., 2017).

5. Conclusions

The study presents the assessment results of occupational exposures and the use of PPEs among workers in small industries (vehicle repair, welding, and paint workshops) in Jeddah, KSA. Self-reported occupational exposures were found to be high including noise exposure (73.5%), smoke exposure (69.6%), vapors and fumes exposure (60.8%), direct sunlight and heat exposure (56.9%). It was also found that the highest self-reported use of PPEs i.e. 50% was for the use of knee joint protection mats and welding shields whereas the lowest reported use of 8.8% was for the use of earplugs and muffs. The use of other PPEs showed positive responses of 33.3% for safety glasses, 27.5% for gloves, 26.5% face masks and 10.8% for safety shoes. This study provides the baseline for elaborative studies in the future. This research study is instrumental in health status evaluation of workers, especially in informal, small and self-employed small-scale industries. The findings of this study can be used to update the health and safety conditions at different workplaces, achieving many socio-economic benefits for KSA. Intervention plans like education, awareness, and regular medical checkups should be advocated which help in prevention and minimizing workplace exposures. The identification and prevention of work-related health costs could result in substantial savings for the national health system, leading to the more sustainable social system.

6. Limitations

The current study depends on subjective reporting of workers which can possibly be biased in some cases. As the study was conducted in the winter season, due to harsh climatic and hot weather conditions in Jeddah in summer, the use of PPEs and perception of workplace exposures among study subjects might vary. Shortcomings of the employed cross-sectional design can be another limitation.

Being a survey study; it might reflect the attitude and perception of participants for the reported use of PPEs. Thus, the reported use and need for PPEs as well as the workplace exposures among study subjects in other regions might be different having diverse attitudes and perception even though exposed to a similar level of workplace exposures, hazards, and risks. Further studies are required to accurately assess the OSH conditions and practices in small industries in KSA.

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Conflict of interest

None.

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