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Assessment of Awareness and Usage of Personal Protective Eyewear Among Workers of Small-Scale Enterprises in Jimma City, Ethiopia: Cros-sectional study Design

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Abstract

Background

Eye injuries are a leading cause of preventable blindness worldwide, with occupational exposures accounting for a substantial proportion. Small-scale enterprise workers, particularly welders and woodworkers, face significant ocular hazards. This study assessed awareness and personal protective eyewear usage among workers in small-scale enterprises in Jimma city, Ethiopia.

Methods

A community-based cross-sectional study was conducted from May to August 2021 among 214 workers from randomly selected small-scale enterprises in Jimma city. Data were collected using a structured questionnaire and direct observation. Descriptive statistics and logistic regression analyses were performed using SPSS version 26.0.

Results

All participants were male with mean age of 27.4 ± 7.2 years and mean work experience of 4.7 ± 4.7 years. Flying metallic chips, excessive light, and chemical fumes were identified as hazards by 98% of welders, while impact and dust particles were by 94% of woodworkers. All workers believed ocular hazards were preventable. About 47% of workers reported using PPE during work mostly by welders with 10.7% of them used it consistently and only 15.6% wore recommended standard equipment. Reasons for inconsistent use were forgetting, negligence/ perceived low-risk activity, and discomfort. History of ocular injury was reported by 86.6% of workers, with 88.3% were not wearing PPE at the time of injury. Consistent PPE use was significantly associated with reduced ocular injury occurrence ($p < 0.001$).

Conclusions

Despite high awareness of ocular hazards, standard PPE usage among small-scale enterprises remains suboptimal. Targeted interventions including training, supervision, and enforcement of safety regulations are urgently needed to reduce occupational eye injuries.

Introduction

The workplace is a priority setting for health promotion in the twenty-first century, according to the World Health Organization (WHO). The workplace, like other places where WHO has established health-promoting efforts (schools, cities, hospitals, and businesses), may have a huge impact on the health and well-being of workers, their families, communities, and society at large (1).

For greater production and productivity, safe work and workplace are required, and so promotion and protection of safe work and workplace are complementary parts of industrial development. Industrial jobs, on the other hand, may produce hazardous labor and working conditions due to intrinsic hazards in their materials, processes, technology, or products. People working at industrial facilities, as well as the general public in the surrounding area and the environment in general, may be at risk of accidents and work-related diseases (2).

Ocular trauma is the most common cause of unilateral blindness today, with 1.6 million persons blind, 2.3 million visually impaired bilaterally owing to eye injuries, and another 19 million having unilateral vision loss (3).

Despite health education and other primary prevention efforts, ocular injuries, particularly work-related accidents, are still common today, and the eye is a high-risk organ for such an accident. Ocular injuries is extremely common, while accounting for only 0.27 percent of total body area and 4% of facial area (4). Some of the established risk factors for ocular trauma include male gender, poorer socioeconomic level, younger age, and occupation (5).

Classifying enterprises into small and large scale is not an easy matter. The World Health Organization suggests that any enterprise employing less than 50 workers should be considered as Small Scale Enterprises or Industries (6).

Currently, data received from Jimma city small-scale enterprises and industries admiration shows that 38 Metalwork and 30 Woodwork small scale enterprises (a total of 68) are found in Jimma city. With regard to Jimma university, department of ophthalmology, it is common to encounter patients presenting with complaint of ocular injury at work place. Workers' level of awareness of workplace dangers, adherence to safety measures addressing ocular trauma exposure, and use of ocular personal protective eyewear (PPE) were inquired. This study aims to answer questions that arise concerning PPE usage and awareness of workers on ocular hazards at work place and preventive measure.

Methodology

Study Area, period and Design

It was conducted in Jimma City, one of the zones of Ethiopia's Oromia Region, 352 kilometers south of Addis Ababa and at an elevation of 1760 meters. The city covers 44.8 square kilometers in size and has a total population of 120,960 people, according to the Central Statistical Agency (CSA, 2007), with 60,824 men and 60,136 women (25). Study was conducted from May 2021 to August 2021. Community-based cross-sectional study design was employed.

Source and Study Population

All workers in small-scale workshops that are found in Jimma city. Workers in wood and metal small-scale workshops in Jimma city who are active during the study period and that works in welding, carpentries

Inclusion and Exclusion Criteria

Inclusion criteria

- Workers who have an active involvement in a workshop as a main or a coworker.

Exclusion criteria

- Workers working in multiple metal or woodwork small-scale enterprises are excluded.

Sample Size Determination and Sampling Technique

Single population proportion formula was used taking prevalence of workplace ocular injury in study done among welders in tier two city, South India, 67% and 95% confidence interval, taking margin of error 5%.

$n = (z\frac{\propto}{2})^2$ *p (1-p)/d^2

Where, n = the required sample size, d = margin of error, Z α/2 = 95%confidence interval = 1.96, P= proportion from other similar areas of population = 0.67

Then n= $(1.96)^2$*0.67*0.33/0.05^2=3.8416*0.22/0.0025 = **339**

Since total number of study population is below 10,000 (which is 567), using correction formula N = 567 (data received from Jimma city small scale enterprises administration)

N_f =n/ (1 + n/N) = 339/ (1 + 339/567) = 213

Taking each work shop as a cluster and taking the average number of workers in each workshop which is 8 workers, 30 workshops are selected by simple random sampling and data is collected from all workers.

Variables

Dependent variables

Usage of Personal Protective Eyewear (Yes/No)

Independent variables

Age, sex, educational level, type of SSE, work experience, formal training, substance use (alcohol, smoking, khat), awareness of hazards, attitude toward PPE, history of ocular injury, availability of PPE, and reasons for non-use.

Data Collection Procedure

Data were collected using a pretested structured questionnaire administered by trained ophthalmic nurses. The questionnaire captured socio-demographic characteristics, work history, awareness of ocular hazards, PPE usage patterns, reasons for non-use, and history of ocular injury. Direct observation was conducted to verify PPE usage and compliance with recommended standards (Occupational Safety and Health Administration [OSHA] guidelines).

Data Analysis

The data collected was exported to SPSS after entered into Epidata version 3.1. It was cleaned and coded using SPSS version 26.0 for analysis. Descriptive statistics (frequencies and percentages) was analyzed to show the picture of the data. Analysis for crude and adjusted odds ratios together with their corresponding 95% confidence was done at a P value < 0.05. Initial binary logistic analysis for dependent variables was done and those with p value of 0.25 were included in multivariate analysis.

Operational Definitions

Small-scale enterprise

Workshop employing fewer than 50 workers [6]

PPE usage

Wearing OSHA-standard protective eyewear for the specific work activity

Awareness of hazards

Ability to mention at least one possible ocular hazard at the workplace

Awareness of PPE

Ability to mention the recommended type of PPE for the specific activity

Use of standard PPE

Wearing equipment meeting OSHA specifications for the specific task

Result

Socio-demographic Characteristics

Out of the 214 workers, 82 (38.3%) were welders and 125(58.4%) wood work while 7(3.3%) works in both metal and wood work Enterprises. All workers were men with a mean age of 27.35 ± 7.225 years. Almost half (46.73%) of the workers were in the age group of 18-25years, 42.06% are in the age range of 26–35 while 11.21% are above 35 years. Sixty one percent of workers have completed high school while 21% and 16.8% of them have educational level of elementary school and diploma and above respectively. The majority of workers (69.63%) have work experience of less than 5 years. There were 8.8% of workers working for more than 10 years. The mean duration of employment of the welders in years in this study was 4.7 ± 4.7 years (Table 1).

Table 1
Socio-demographic Characteristics of SSE Workers

Variables		Wood work	Welding	Both type
Age	18–25	64 (51.2%)	32 (39%)	4 (57.14%)
	26–35	53 (42.4%	35 (42.6%)	2 (28.6%)
	> 35	8 (6.4%)	15 (18.28%)	1 (14.3%)
	Mean ± SD	27.35 ± 7.22		
Educational level	Elementary	21 (16.8%)	23 (28%)	1 (14.3%)
	High school	83 (66.4%)	45 (54.8%)	5 (71.4)
	Diploma and above	21 (16.8%)	14 (17%)	1 (14.3%)
Duration on work (in Years)	0–5	95 (76%)	49 (59.7%)	5 (71.4)
	6–10	23 (18.4%)	22 (26.8%)	1 (14.3%)
	> 10	7 (5.6%)	11 (13.4%)	1 (14.3%)
	Mean ± SD	4.7 ± 4.7		
Marital status	Single	89 (71.2%)	46 (56%)	6 (85.7%)
	Married	36 (28.8%)	33 (40.24%)	1 (14.3%)
	Divorced	0	3 (3.6%)	0
Habits	Use substance [a]	64 (51.2%)	59 (71.9%)	3 (42.8%)
	Do not use	61 (48.8%)	23 (28%)	4 (57.1%)
Formal training [b]	Trained	19 (15.2%)	13 (15.8%)	0
	Not trained	106(84.8%)	69 (84.1%)	7 (100%)

Awareness of possible ocular hazards and types of PPE

The study showed that all of the workers were aware of one or more workplace associated ocular hazards at work place. Impact (98.8%), excessive light (96.4%) and chemical fumes (72.3%) were the most common hazards identified by the welders while dust (94.4%) and impact (90.3%) were the most common hazards identified by wood workers. Most workers (97.7%) were aware of at least one kind of PPE for the specific type of SSE and eye goggle (98.6%) is mentioned by workers in wood work and eyeglass (87.8) by welders (Table 2).

Table 2
Awareness of ocular hazards, types of PPE and PPE usage among welders

Variables		Workers numbers (percent)		
		Wood work	Welding	Both type
Possible ocular hazards mentioned by workers*	Impact	113 (90.4%)	81 (98.8%)	6 (85.7%)
	Dust	117 (93.6%)	24 (29.2%)	6 (85.7%)
	Chemical fumes	52 (41.6%)	60 (73.1%)	2 (28.6%)
	Excessive light	0	79 (96.3%)	2 (28.6%)
Use PPE during working	Yes	22 (17.6%)	79 (96.3%)	2 (28.6%)
	No	103 (82.4%)	5 (6%)	5 (71.4%)
Types of PPE usage	Eye glass	0	79 (96.3%)	1 (14.3%)
	Eye goggle	21 (16.8%)	0	1 (14.3%)
	Welding helmet	0	5 (6%)	0
	Face shields	1 (0.8%)	0 (	0
	Not using	103 (82.4%)	5 (6%)	5 (71.4%)
Frequency of PPE usage	Always	2 (1.6%)	9 (11%)	0
	Usually	2 (1.6%)	69 (84.1%)	2 (28.6%)
	Some times	14 (11.2%)	0	0
	Rarely	4 (3.2%)	1 (1.2%)	0
	Not using	103 (82.4%)	3 (3.6%)	5 (71.4%)
Recommended standard used on observation	Yes	3 (2.4%)	12(15.6%)	1 (14.3%)
	No	0	77 (93.9%)	1 (14.3%)

Type of ocular injury sustained on work	Dust	116(92.8%)	31 (37.8%)	4 (57.1%)
	Metallic chips	0	70(85.4)	3 (42.8%)
	Chemical fumes	26(20.8%)	33(40.24%)	4 (57.1%)
	Blunt trauma	13(10.4%)	1(1.2%)	0
	Excessive light	0	58(70.7%)	4 (57.1%)

Usage of PPE

Only 47.7% of workers used at least one kind of PPE during work. However, within the specific type of SSE, 96.6% of welders use PPE, among which eye glasses (96.3%) were the most commonly reported PPE for use. Only 16.8% of workers in wood work used PPE and the most commonly worn PPE was eye goggle (95%).

Observation of workers who are found wearing PPE during interviewing, found that only15.6% of them used the recommended type. Sunglasses were considered protective and were used as a personal protective device by 84.3% of the welders. None of them was observed using welding helmet or face shield. Only 10.7% were using PPE always. About 95% of welders often used PPE out of which 11.5% used it on always basis. Only 17.6% of wood workers occasionally used PPE.

Reasons for Inconsistent PPE Use

The most frequently mentioned reason for not always using PPE being negligence or unrealistic thought of being involved in low-risk activities (50%), forgetting (22.1%) and not being comfortable while using PPE (22.6%), ($p < 0.001$) (Table 3).

Table 3
Reason for not using PPE always against type of SSE for welders and wood workers

		Reason for not using PPE on always basis				
		Negligence	**Not being comfortable**	**Owner not providing**	**Forgetting**	**P-Value ***
Type of SSE	welding	24 (23%)	3 (6.5%	3	43 **(95.5%)**	P < 0.001
	Wood work	**76 (73%**	**42 (91.3%**	5	0	
	Wood work and welding	4 (3.8%	1	0	2	
Total		104 (51.2%	46 (22.6)	8 (3.9%)	45 (22.1)	

*Fisher exact test indicates the significant difference in distribution of variable 'reason for not using PPE always'

Level of education, being in different age groups, having formal training, type of SSE, marital status and using substance have showed association with use of PPE during working (Table 4).

About 87% of workers have sustained one or more type of ocular injury during the working time; most of injuries (89%) were occurred while working without using PPE, p = 0.007. Most workers 78.7% sustained injury while working by themselves and 16.5% of them were while assisting others. Metallic chip foreign body was the most frequently encountered injury for welders (p < 0.001) and dust particles foreign body was the most frequently encountered by woodwork workers, p < 0.001 (Table 5).

Table 4
factors with PPE usage among SSE workers among workers of SSE

Variables	PPE usage		
	yes	No	p-value*
Age in range			0.018
18–25	38 (36.9%)	62 (55.8%)	
26–35	50 (48.5%)	40 (36%)	
>35	15 (14.6%)	9 (8.1%)	
Level of education			0.039
elementary	27 (26.2%)	18 (16.2%)	
High School	55 (53.4%)	78 (70.3%)	
Diploma and above	21 (20.4%)	15 (13.5%)	
Having formal training [a]			0.016
yes	20 (19.4%)	9 (8.1%)	
no	83 (80.6%)	102 (91.9%)	
Work experience			0.068
0–5	64 (62.1%)	85 (76.6%)	
6–10	27 (26.2%)	19 (17.11%)	
> 10	12 (11.6%)	7 (6.3%)	
Marital status			0.003
single	57 (55.3%)	84 (75.7%)	
married	43 (41.7%)	27 (24.3%)	
divorced	3 (2.9%)	0	
Use substance [b]			< 0.001
yes	76 (73.8%)	51(45.9%)	
no	27 (26.2%)	60 (54%)	
Type of SSE			< 0.001
welding	79 (76.7%)	3 (2.7%)	
Wood work	22 (21.3%)	103 (92.8%)	

Metal and wood work	2 (1.9%)	5 (4.55)

Table 5
Type of SSE against type of injury for those who sustain injury

Metallic chip	**Welding (N = 71)**	**Woodwork (N = 111)**	**Both wood work and welding (N = 6)**	**P-Value ***
	70 (98.6%)	**0**	**3 (50%)**	**< 0.001**
Dust	0	111(100%)	4 (66.7%)	< 0.001
Chemical fumes	33 (46.5%)	26 (23.4%)	4 (66.7%)	0.006
Excessive light	58 (81.7%)	0	4 (66.7%)	0.162
Blunt injury	1	13 (11.7%)	0	0.358
*=fisher exact test				

Multivariable Analysis for Factors Affecting PPE Usage

The study found that type of SSE and having formal training are among the factors that have strong association with PPE usage at work place. Workers that have formal training are more likely to use PPE at work place ($p < 0.001$) and welders are the most frequent users of PPE ($p < 0.001$ AOR = 60.3). For workers who claims using PPE, multivariable analysis shows that, workers that have formal training are more likely to use the standard PPE ($P = 0.008$, AOR = 31.03) (Table 6).

Consistent ("always") PPE use was strongly associated with reduced occurrence of ocular injury (AOR = 0.006, 95% CI: 0.000-0.193, $p = 0.004$). Educational level also showed significant association with injury occurrence ($p = 0.036$). Use of standard PPE did not show a statistically significant association with reduced injury occurrence when controlling for frequency of PPE use.

Table 6
Multivariate logistic regression for factors affecting PPE usage among workers of SSE

Variables	**Response for PPE usage at work (Yes)**		
		P- value	**AOR, 95%CI**
Type of SSE	Welding	< 0.001	60.301 (6.92, 525.457)
	Wood work	0.216	0.304 (0.04, 2.002)
	Both		1
Formal training	Yes	**< 0.001**	**9.77 (2.81–34.11)**
Using substance	Yes	0.073	0.338 (0.104–1.104)
Educational level	Elementary		1
	High school	0.798	0.362 (0.072–1.815)
	>= Diploma	0.188	0.272 (0.078–0.950)
Work experience (in years)	0–5		1
	6–10	0.017	5.640 (1.364–23.317)
	>10	0.785	0.776 (0.126–4.798)
Variables	Response for Standard PPE usage (Yes)		
		P- value	AOR, 95%CI
Formal training	Yes	0.008	31.03 (2.489–386.88)
Using substance	Yes	0.641	
Educational level	Elementary		1
	Highschool	0.084	25.16 (0.649–976.02)
	>= Diploma	0.872	0.824 (0.547–2.638)
Work experience (in years)	0–5		1
	6–10	0.671	0.551 (0.035–8.601)
	> 10	0.127	11.987 (0.495–290.43)
Age category	18–25		1
	26–35	0.123	0.151 (0.014–1.664)
	> 35	0.090	0.033 (0.001–1.711)

Discussion

The welders in this study were relatively younger (mean age = 27.35 ± 7.22years) than the welders in a study done in Sokoto, Nigeria that reported a mean age of 30.98 ± 9.42 years, mean age of 29.43 ± 12.86 years in tier 2 city south India, and mean age of 31.29 ± 6.57 years from study done in southern Nepal (18). All the respondents were males, whereas this is in consonance with the finding in a study among welders in Sokoto, Nigeria (22), tier 2 city south India (20), and study done in southern Nepal (18).

Almost all of our workers are literate which is higher than the study done in India in which (85%) were literate and a 93% in study by Budhathoki SS et al.(18) Most of the workers were educated up to secondary level (55%) for the study done by Budhathoki SS et al.(18), which is close to the finding of our study (65%).

Among 214 workers, only 32 (15%) of workers;13/82 (15.8%) of welders and 19/125 (15.2%) of wood work workers) have formal training which is much less than 41.7% of welders reported by study done in a tier 2 city, south India (20), 82% in study by Lombardi DA, et, al(27), and 19% in study by Kumar, et, al. (28). The awareness of at least one type of workplace hazards by almost all the respondents in this study is comparable with the 90.7% awareness of workplace hazards obtained in study done among welders in Nepal (18), and the 86.5% awareness obtained among welders in Addis Ababa, Ethiopia (25), and 95% awareness obtained among welders in tier 2 city, south India (20).

This study shows only 10.7% of the welders used PPE always which is close to the finding of study done in Sokoto, Nigeria, which is 9.6%. Among 82 welders 73 (89%) reported that they usually use PPE which is higher than 45% of 60 welders that said they use PPE usually in study done in tier 2 city, south India (20).

The inconsistent use was mainly attributed to negligence or unrealistic thought of that they are involved in low risk activity, forgetting, discomfort and poor vision or fogging which is comparable with the finding of the study done among welders in Sokoto, Nigeria (22), According to Lombardi DA et. al (27), poor fit, poor visibility due to fogging were the main reasons for not using PPE. Absence of reinforcement and presumed low risk task were the main reasons for non-usage in study done in south India (20).

Despite high levels of awareness of workplace accidents and injuries, poor utilization of personal protective equipment resulted in high work place associated ocular injury. Previous history of injuries was seen in 86.6% of the welders in our study which is higher as compared to 66.9% in Sokoto, Nigeria (22), 36.7%) India (12), and 71.7% in study by Lombardi DA et. al (27). Metallic chip foreign body was the most frequently encountered injury for welders ($p < 0.001$) and dust particles foreign body was the most frequently encountered by woodwork workers ($p < 0.001$).

This study also showed that use of recommended standard of PPE always is associated with significant reduction of ocular injury at workplace. However, only 15.6% of welders used the recommended standard of PPE, mentioning good vision and being more comfortable when using sunglass as PPE. The

most commonly used eyewear was eyeglass which is sun glass for 84.4% welders, which is comparable with the finding reported by study done among 60 welders in tier 2 city south India in which, eyeglasses/goggles (73.3%) were the most commonly used PPE followed by face shield (65%) and helmets (45%). Welding helmet was used by only 5/82 (6%) of welders in this study which is much less than 45% in the study done in India (20).

They also mentioned the sunglass to be protective of flying tiny metallic chips when grinding even if the long-term effect of UV light for which the sunglass may not be protective needs further research. Agreeably, most sunglasses with less than 1% UV-B and UV-A transmittance can provide adequate protection against ultraviolet radiation, they are usually limited when used during welding (29). Also, their lack of side shields for protection against flying particles, dust and fumes is a major limitation which may cause serious injuries to the eye.

Strength and Limitation

This study is the first for its kind to be done in Jimma university with regard to awareness and usage of personal protective eyewear (PPE) among welders and woodworkers in Jimma city. The limitation is using only small number of participants and being crossectional study design.

Conclusion and Recommendations

The practice of using PPE among welders was very poor with regard to using it on always basis. They also mentioned the sunglass to be protective of flying tiny metallic chips when grinding even if the long-term effect of UV light for which the sunglass may not be protective needs further research. The study showed that using PPE always during working is associated with decreased occurrence of ocular injury at work.

It is not only enough to have the knowledge and attitude but the practice also needs to be monitored. This study showed that even sun-glasses are protective at least to flying tiny metallic foreign bodies and dust if worn on regular basis. It is crucial for bystanders and assistants as well to wear PPE. The long-term effect of UV light to the eyes of welders not always using PPE and sunglasses as PPE needs more extensive study and awareness creation measures needs to be implemented regularly. Strict supervision by supervisors and mandatory laws may help the welders to improve the use of PPE.

Declarations

Human Ethics and Consent to Participate: The study received ethical approval from the Jimma University College of Health Sciences Ethical Review Committee. Written informed consent was obtained from all participants. Participants were informed of their right to withdraw at any time. Confidentiality was maintained throughout data collection, analysis, and dissemination.

Consent for publication: Not applicable

Data Availability: Data supporting these findings are available from the corresponding author upon reasonable request.

Conflict of Interest: The authors declare no conflicts of interest.

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