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A study of awareness and use of personal protective eyewear among welders in a tier 2 city in South India

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Abstract

Background: Ocular injuries are one of the most common health hazards among welders all over the world. Usage of personal protective eyewear (PPE) plays a key role in occupational safety and welfare of welders.

Aim: To assess the awareness and use of PPE among welders in a tier 2 city and the factors influencing it.

Design: Analytical, cross sectional study.

Materials and Methods: This study was conducted among 60 welders in a tier 2 city in the month of May 2017.The study included a semi structured questionnaire based on demographic details, literacy levels, awareness of eye hazards, PPE awareness and use with factors influencing it. Previous history of common eye problems faced was noted and their eyes were examined to assess their ocular health status.

Statistical analysis used: Chi Square test, Fisher's Exact probability test, Odds ratios and Logistic regression analysis.

Results: The awareness of eye hazards and PPE awareness was seen in 95% of the welders; however the regular use of PPE was noted only in 45% of them. The most important factors for using PPE were higher level of literacy and formal training in industrial work as noted in ITI (industrial training institute) workers. The reasons for not using PPE were absence of reinforcement and a non-tenable presumption that they were involved in a relatively low risk task.

Conclusion: The usage of PPE was found to be poor although the awareness regarding PPE was good. There was a large gap between awareness and use of PPE. This study stresses the need for positive reinforcement, education and training to welders to lessen this gap.

Keywords: Awareness, Protective eyewear, welders, South India, PPE awareness, Use of PPE.

Introduction

Eye injuries are common cause of visual morbidity occurring at workplace worldwide. According to the statistics from U.S. Bureau of Labor, around 20,000 eye injuries occur annually during work. Occupational eye injuries cause an economic loss of around $300 million a year according to OSHA (Occupational Safety and Health Administration).[(1)] Moreover occupational injuries are under- reported, especially in developing countries like India. Welders are one of the important sectors involved in risk of occupational injuries. Every year around 2000 eye injuries occur due to welding in United States and account for almost 1/4th of work related insurance claims.[(2)]

The occupational eye injuries which welders get exposed to welding flash burns, foreign bodies, pterygium, cataract, retinal damage, etc. These hazards are due to exposure to ultraviolet and infrared radiation exposure, harmful metal fumes and particulate matter, thermal burns etc. As eye is a vital organ, eye injuries lead to significant morbidity among the workers.[(3)]

These injuries can be prevented if appropriate safety measures are taken. As welders come under non organized sector, implementation of safety practices are largely dependent on the private owners who own the small scale industries or the knowledge and safety practices incorporated by free lancers.

In India very few studies have been done on welders. Hence this study was conducted among welders to assess their awareness regarding hazards, the need to wear Personal Protective Eyewear (PPE) and the factors influencing it. The ocular health status was also studied.

Materials and Methods

This cross sectional analytical study was done among 60 welders working in small scale industries and free lancers working in Dharwad city which is a tier 2 city in South India. Written, informed consent was obtained from all subjects and the study was performed in accordance with the tenets of the Declaration of Helsinki. The protocol of the study was approved by the Institutional ethics committee.

Sample size calculation: The observed frequency of awareness among the welders is 95%. Considering the proportion of awareness as 90% for a population survey or a descriptive study, the sample size works out to 59 numbers at an alpha error of 5% and a power of 80%. This sample size was read from CDC's Stat Calc®.

The data was collected using a brief, pre-tested semi structured open-ended questionnaire based on demographic details, literacy levels, awareness of eye hazards, the need to wear PPE and the factors associated with its use, past history of eye injuries and its details. The visual acuity of the welders were tested

using Snellen's distant and near vision charts. Eyes were examined with torch and ophthalmoscope to know their ocular health status and if needed they were examined in detail with spectacle corrections being given in hospital.

The questionnaire was initially developed in English and all the questions were translated into the two common languages used in this region, Kannada and Hindi if the subjects could not follow English. The questionnaire was interviewer – administered and done by a single investigator.

Analysis was performed using the statistical software IBM –SPSS-Statistics-version 20 ©copyright IBM Corporation 2010, New York- 10589- USA licensed to SDM College of Medical Sciences, Dharwad-580009 India. The Chi Square test and Fisher Exact probability test were used to look for associations in awareness and use of PPE and logistic regression analysis was done for comparison of factors related to non-use of PPE.

Results

A total of 60 welders were given the questionnaire and their answers were analyzed. Table 1 shows the socio-demographic and occupational variables of all welders. All were males. Their age ranged from a minimum of 18 years to maximum of 65 years with a mean age of 29.43 ± 12.86 years. Half of them (51.7%) were in the age group of 18 to 25 years. The urban: rural ratio was 57: 43. Majority of them were Hindus (75%) and Kannada speaking (73.3%), the latter being the local language. Among the welders, 33(55%) received secondary education and 14(23.3%) were college educated.

Table 1: Socio-demographic and occupational variables

Variables	Total number, n =60
Age (years)	
18-25	31 (51.7%)
26-30	6 (10%)
31-40	11 (18.3%)
41-50	7 (11.7%)
50+	5 (8.3%)
Gender	
Male	60 (100%)
Region	
Urban	34 (56.7%)
Rural	26 (43.3%)
Religion	
Hindu	45 (75%)
Muslim	14 (23.3%)
Others	1 (1.7%)
Literacy	
Illiterate	9 (15%)
Primary	4 (6.7%)
Secondary	33 (55%)
XI - Degree	14 (23.3%)
ITI training	
Yes	25(41.7%)
No	35 (58.3%)
Mother tongue	
Kannada	44 (73.3%)
Hindi	8 (13.3%)
Others	8 (13.3%)
Industry	
Free lancer	14 (23.3%)
Small scale	46 (76.7%)
Occupation	
Construction	14 (23.3%)
Production	30 (50%)
Maintenance	16 (26.7%)
Type of welding	
Arc	24 (40%)
Gas	5 (8.3%)
Both	31 (51.7%)
Experience (years)	
<2	22 (36.7%)
2-5	7(11.7%)
6-16	10(16.7%)
>10	21 (35%)

Only 25(41.7%) welders had training from ITI (industrial training institute). A large proportion of welders (76.7%) were working in small scale industries and half of them in production (50%). Most of the welders (51.7%) were doing both arc and gas welding. Among the welders, 22 (36.7%) had an experience of less than two years and 21(35%) had an experience of more than ten years.

Majority (95%) of the welders were aware that eyes could be damaged by welding and the same people were also aware of the need to wear PPE while welding. The main source of awareness was from colleagues followed by teacher. Free-lancers versus small scale workers differed in their awareness of PPE. Free lancers had less awareness compared to small scale workers. This difference tends towards significance (p=0.06, dF= 1).

Among the PPE used, goggles (73.3%) were the most commonly used PPE followed by face shield (65%) and helmets (45%). Among 60 welders, 27(45%) said that they used PPE most of the times, 16 welders (26.7%) used it occasionally whereas 17 welders (28.3%) never used any type of PPE while working.

The factors associated with use of PPE were

a. Age- Young age (18-25 years) but the confounding variable was ITI training
b. Literacy – literates with secondary+ education demonstrate usage 51.5%-64.3% versus illiterate's 0%-11%. p value = 0.015 by Fisher's Exact.(Table 2)
c. ITI training was associated with use in 92% v/s Lack of ITI training usage with 11.4% yielding p

value = 0.000 (Table 3). The ITI training was the most important factor which determined usage.

d. Type of welding – those who were involved in exclusive gas welding did not use PPE (0/5). This is wrong. Although gas welding appears less hazardous than arc welding, it is also hazardous to the eye.
e. Experience: the young cohorts (ITI trained) use PPE to the extent of 90.9%. This level was not observed among any of the experienced cohorts with more than 2 years' experience. This anomalous observation was because only the young cohorts (<2 years' experience) were ITI trained and hence it was wrong to compare them with the seniors.
f. Having awareness that welding can damage eyes was associated with constant use of PPE among 27/60 workers (47.4%). Thus the awareness of 95% level among the sample doesn't assure a comparable level of practice; in fact the practice reduces to 47.4% only. Similar observation is true with regard to the awareness that PPE are required to protect the eyes.

Factors which were not associated with usage were: region (p= 0.44), religion (p= 0.14), type of industry and type of occupation.

33(55%) of the welders said that they regularly ask for relevant PPE while working. Around half of the welders (56.7%) motivated their co-workers to use relevant PPE, however they felt motivation by supervisors was poor (36.7%). 34 welders (56.7%) possessed at least one type of PPE.

The reasons for not wearing PPE have been summarized in Table 4. Short duration of task was the most common reason for not using PPE among welders who used PPE most of the times. In occasional users, no reinforcement by superiors was the most common reason for not using PPE. Welders who never used any PPE felt that there was no perceived need to wear PPE while working.

Table 2: Cross-tabs of literacy against frequency of usage of PPE

Literacy	Frequency of use of PPE		Total
	Occasional	Most of the times	
Illiterate	8	1	9
Primary	4	0	4
Secondary	16	17	33
XI - Degree	5	9	14
Total	33	27	60

Chi –square = 10.119
df = 3
p value = 0.015 (Fisher's Exact)

Table 3: Cross-tabs of ITI training against frequency of usage of PPE

ITI training	Frequency of use of PPE		Total
	Occasional	Most of the times	
No	31	4	35
Yes	2	23	25
Total	33	27	60

Chi –square = 38.251
df = 1
p value = 0.000

Table 4: Reasons for not wearing PPE among welders

Reasons ascribed for non-use	Class of welders			Total number ascribed to non-use (%)
	Never users	Occasional PPE users	User - most of the times	
No perceived need	11	1	0	12(20)
Poor fit	3	1	0	4(6.6)
Low risk task	5	7	5	17(28.3)
Short duration of task	6	5	8	19(31.6)
No accessibility	3	9	0	12(20)
No availability	6	7	0	13(21.6)
No reinforcement	1	12	1	14(23.3)
Difficulty in working	2	4	2	8(13.3)
Poor visibility	2	5	0	7(11.6)
Forgetfulness	1	0	4	5(8.3)
Hurry	1	2	3	6(10)
Somatic	0	1	1	2(3.3)
Cost	0	1	0	1(1.6)

Table 5: Ocular examination findings

Ocular finding	Number of welders	Percentage (%)
Refractive errors	7	11.6
Presbyopia	12	20
Pterygium	1	1.6
Corneal opacity	1	1.6
Posterior lamellar cataract	1	1.6

A logistic regression analysis was conducted to predict the factors associated with failing to use the PPE in 60 welders using the six factors as predictors. The six factors were no perceived need, no availability, no reinforcement, low risk task, short duration of task and no accessibility. The results were compared between the Enter method and then followed by the Forward and Backward Stepwise LR models in order to reach the most stable factors which remained in both the forward and backward elimination methods. Considering the factors with significant Odds ratios only amounted to using all 6 factors in the Logistic regression model with Enter method but the latter could not give a model as strong as the ones with the Forward and Backward stepwise LR methods.

A test of the full model against a constant only model was statistically significant, indicating that the predictors as a set reliability distinguished between the past use and non-use of PPE as associated factors (chi square= 48.82, p<0.000 with df = 04).

Nagelkerke's $R^{(2)}$ of .745 indicated a fairly strong relationship between prediction and grouping. Prediction success overall was 86.7% (93.9% for occasional or non- use and 77.8% for most of the times -use). The Wald criterion (7.77 and 7.02) demonstrated that two factors made a significant contribution to prediction (p= .005 and .008 respectively). They were No reinforcement and Low risk task respectively. EXP (B) value indicates that when the 'No reinforcement' factor increases by one unit, the odds ratio is 42 times as large for Non- use and the same is 12.6 times for one unit increase in the presumption of 'Low risk task'.

Among 60 welders, majority (51/60=85%) had previous history of ocular injury. Whereas 48(80%) welders experienced painful red eye (flash burns) and foreign body was noticed in 22 (36.7%) welders. During the time of injury most of them were not using PPE (76.7%). Bilateral injuries were seen in 46 (76.7%) workers. Injuries were more common while welding (73.3%) followed by cutting (25%), grinding (20%) and drilling (1.7%). Injuries were seen in welders both while doing welding themselves and even when they were bystanders.

The factors associated with past history of injury were studied. They have been tabulated with the number of their frequency and the comparison of their proportion with the non-injured employees and the chi square value and the probability.

1. Painful red eye injuries 48/48 versus 3/12 non red eye injures (p<0.001)
2. Foreign body 22/22 versus 29/38 (70%) who had past history of injury without foreign body (p=0.013)
3. 44/44 had injury while welding versus 7/16 (44%) who had injury during non- welding (p=0.001)
4. Unilateral injury 20/20 versus 31/40 rest of injuries (p=0.021)
5. Bilateral 46/46 versus 5/14 rest of injuries (p<0.001)

Among these five factors, only three factors namely painful red eye, foreign body and uni-laterality were found to be significantly associated with past history of injury by virtue of their odd's ratios as well as the significance obtained by the Enter method of Logistic Regression.

On ocular examination, 7(11.6%) had refractive errors, 12(20%) had presbyopia and corneal opacity, pterygium and posterior lamellar cataract were seen in one each (1.6%) respectively as shown in table 5. Best corrected visual acuity was 6/6 and N6 in all patients. In the person who had cataract, it did not interfere with his vision. Ophthalmoscopic examination revealed normal fundus in all patients.

Discussion

The awareness of welding hazard and the need to wear PPE was seen in 95% which was similar to studies done by Budhathoki SS et al (90.7%), Eze BI et al (99.4%), Isah EC et al (91.6%) and more than Kumar GS et al (83.25%), Sabitu K (77.9%) and Shaikh MA (49.5%).[4,5,6,7,8,9] The regular use of PPE was 45% in our study as compared to 47.7% done by Budhathoki SS et al. and 34.2% done by Sabitu K. and 66.5% done by Eze BI et al. Half of the welders in our study were in the age group of 18-25 years which was similar to studies done by Isah EC but the age group was higher in Budhathoki SS et al.(30-39 years).

The determinant of use of PPE was education in a study done by Budhathoki SS et al which was similar to our study. 85% were literate as compared to 93% in Budhathoki SS et al. Most were secondary educated (55%) which was similar to Eze BI et al (59.8%). According to Chauhan A et al 27% were illiterate, in our study 15% were illiterate. According to Lombardi DA, 82% received safety training as compared to studies done by Kumar GS et al (19.1%) and our study (41.7%). This shows that trained welders are less in India compared to developed country like USA. According to Lombardi DA et al, poor fit, poor visibility due to fogging were the main reasons for non-usage and according to Eze BI et al, user inconvenience and presumed lack of protective benefit, but in our study absence of reinforcement and presumed low risk task were the main reasons for non-usage.[10,5]

We found that literacy, ITI training as well as reinforcement during the work by supervisors were

important factors. Literacy and ITI training were the fundamental background. Supervisors with reinforcement were the positive enabling factor in achieving the usage of PPE. Thus all the three factors were important.

Previous history of injuries was seen in 85% of the welders in our study as compared to 66.9% in Nigeria as done by Ademola-popoola DS et al.[11] Injuries while welding were more (73.3%) common in our study compared to Lombardi DA et al (31.9%) but injuries with grinding(20%) and drilling(1.7%) were similar in both studies.[12] Flash burns in ours (80%) were similar to studies done by Kumar GS et al (82.8%) but more common compared to 22.2% as done by Lombardi DA et al. Foreign body was seen in 36.7% which is less compared to studies done by Kumar GS et al (93.3%) and Lombardi DA et al(71.7%). In ours bilateral injuries were more common (76.7%) than Lombardi DA et al (17.6%). This is because in ours flash burns due to welding were more common than foreign bodies which are more commonly seen in unilateral injury.

According to Ademola-popoola DS, presbyopia was seen in 11.3%, pterygium in 2.8%, ametropia in 20.6% whereas in our study it was 20%, 1.6% and 11.6% respectively. Though history of corneal foreign body was seen in 22(36.7%) welders, corneal opacity was seen in only one (1.6%) worker. This might be due to the fact that most of the foreign bodies were superficial and not involving the deeper layers of the cornea to remain as corneal opacity later.

Limitations of our study were 1. although the optimum sample size was achieved, it was reached by convenient sampling and 2. the working condition of welders as in a large scale industry were not available for comparison.

To conclude, the practice of using PPE among welders was very poor. Strict supervision by supervisors and mandatory laws may help the welders to improve the use of PPE. The free-lancers should be educated regarding the serious ocular hazards. Since most of the injuries recorded were of less severe nature, they think it is not necessary to wear. But in reality, severe injuries might have been missed because the victims might have discontinued thereon from the scene. Moreover experienced workers feel that their use depends on the situation. If they are in a hurry or the task is of short duration or low risk, they do not feel the need to wear. This prejudice in the long run may prove very harmful. Even if one gas explosion or corneal laceration occur, they may lose their vision permanently especially in their young age and become an economic burden to the society. The fact that all this could be prevented cannot be overemphasized.

It is recommended that it is not only enough to have the knowledge and attitude but the practice also needs to be monitored. This has to be achieved by strict supervision and statutory inspections at random times encompassing penalty for noncompliance.

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