Prevalence and pattern of ocular disorders due to chronic exposure to arc welding among occupational welders in Western Rajasthan

Praveena¹, Jayshri M. Manoher², Ashok Kumar³

¹Department of Ophthalmology, Sub District Hospital, Didwana, Nagaur, Rajasthan, ²Department of Ophthalmology, Sardar Patel Medical College, Bikaner, Rajasthan, ³Medical Officer, Community Health Centre, Pisangan, Ajmer, Rajasthan, India

ABSTRACT

Background: Arc welders have a higher prevalence of ocular disorders than the general population. The study aimed to determine the prevalence and pattern of ocular disorders due to chronic exposure to arc welding in occupational welders. Methods: Ninety welders and ninety nonwelders took part in this cross-sectional study. Sociodemographic information was obtained in the community, and a detailed ophthalmic examination was done in tertiary care hospitals. Results: The mean (SD) age of the welders was 33.13 (11.57) years, whereas the mean age (SD) of controls was 33.13 (10.57) years (P = 0.901). The majority (93.33%) of welders had at least one ocular manifestation, which was higher than the nonwelders, i.e., 26.67% (P < 0.01). Among welders, the most common conjunctival manifestation was congestion (36.11%). The prevalence of phototoxic maculopathy was found at 56.67% among welders and 7.78% among nonwelders (P < 0.01). All the welders used to wear only goggles as protective equipment. Prevalence of maculopathy was found to be lower among strictly adherent welders than occasional users. None of the sociodemographic variables was found associated with strict usage of goggles among welders. Conclusion: Chronic exposure to arc welding is associated with increased ocular disorders including phototoxic maculopathy. Policies regarding personal protective equipment usage and safety at workplaces should be implemented rigorously, even in small-scale, unorganized sectors.

Keywords: Maculopathy, ocular disorder, personal protective equipment, phototoxic, welder

Introduction

Welding is a process by which more than one part of the metal is joined through either local fusion or melting of the flux-coated electrode. When an electric arc is used for a heat source, it is called metal arc welding. If a gas either inert or active is used, it is termed gas arc welding.[¹]

approximately 11 million workers worldwide are employed in welding activities.[²] The health hazards of welding activities on the skin, respiratory system, and trauma are well studied. [¹‑³] In welding activities, visible light, near and distant infrared, and ultraviolet rays A, B, and C are emitted in varying degrees. Acute exposure to UV radiation causes photokeratitis, also known as the welder's eye. It is a well-studied condition caused by acute exposure to welding activities.[⁴] Long-term exposure to UV radiations is associated with conditions like pterygium, pinguicula, band-shaped keratopathy, phototoxic maculopathy, etc.[⁵‑⁷]

Visible and IR spectrum rays penetrate the eye and reach up to the retina and may cause thermal and photochemical changes. Phototoxic maculopathy is the term used for retinal
damage caused by arc welding. It usually heals spontaneously, but sometimes has a sequel leading to permanent damage to the macula.[7] The prevalence of ocular morbidity is reported higher among welders than the general population in India and elsewhere.[13–5,7] Chronic effects of welding are also reported in some studies.[8,9] The prevalence of ocular disorders is higher in developing countries, due to poor focus on safety measures and such policy implementation.[8] The mainstay of safety measures is the use of personal protective equipment (PPE), i.e., googles, helmets, etc., Poor adherence to PPE was reported in India in the unorganized sector.[1,3,4] It was reported that arc welding was associated with a higher prevalence of ocular disorders than other forms of welding.[6]

Most of these studies are community-based studies, reporting perceived complaints and anterior segment findings. Only a few studies from hospital settings have reported permanent changes in macula by welding activities.[16–7] Detailed ophthalmoscopic examination and spectral-domain-optical coherence tomography (SD-OCT) are sensitive and specific investigations to assess these changes.[7] We did not find any community-based study, which has assessed the spectrum of ocular disorders using such highly sensitive and specific techniques in India. Therefore, this study was aimed to determine the prevalence and pattern of ocular disorders due to chronic exposure to arc welding in occupational welders, and it was compared with nonworkers.

Primary care physicians are the first contact physicians, occupational welders often visit them for ocular complaints. The findings of this study will be useful for primary care physicians, ophthalmologists, and welders in highlighting the significance of periodic screening of eye among welders for early detection of occupation-related hazards and to arrest further complications.

Materials and Methods

This cross-sectional study was done from December 2015 to January 2018, in an urban agglomeration situated in the western part of Rajasthan, India. It has a hot desert climate with little precipitation and extreme temperature. It has a population of about six lacs.[10] It is divided into two legislative assembly segments. These two segments were chosen as two clusters for the sampling technique. After assessing for inclusion and exclusion criteria, consecutive 45 eligible and consenting welders (and nonworkers) were selected from each segment. The first participant in each segment was selected randomly.

Inclusion criteria for welders included being aged 18–60 years old, working in the unorganized workplace, working for at least 2 years. Welders with a history of trauma, any previous ocular surgery, any known fundus disease (such as hereditary maculopathy, intraocular infection, intraocular tumor, and high myopia, i.e., >6D), and diabetes mellitus and hypertension were excluded from the study. Nonworkers were selected from the same region with the same age group, same socioeconomic category, but never been exposed to welding activity. Nonworkers were mostly street vendors and shopkeepers.

Participants were recruited in the community, after obtaining written informed consent data was collected in two parts. First, sociodemographic details and presenting ocular complaints were collected using a pretested, interviewer-administered semistructured questionnaire in the community. Socioeconomic status was assessed using BG Prasad classification. (Consumer Price Index- Industrial worker = 330, December 2019)[11] Second, a detailed ophthalmic examination was done at a tertiary care hospital. In the ophthalmic examination, distant visual acuity was assessed using Snellen’s chart; refraction was done with an automated refractometer, and both uncorrected and best-corrected distant visual acuity were assessed. Best-corrected visual acuity in the better eye from 6/6 to 6/9 was taken as normal, 6/12 to 6/18 was taken as mild visual impairment, and 6/24 to 6/60 was taken as moderate visual impairment.[12] Near visual acuity was assessed using the Jaeger chart. Near visual acuity worse than N6 was taken near vision impairment.[12] Color vision was assessed using the Ishihara chart.

Anterior segment was examined using slit slit biomicroscopy to evaluate lid, conjunctiva, cornea, sclera, anterior chamber, iris, pupil, and lens. Intraocular pressure (IOP) was measured using Goldmann Applanation tonometer, IOP values from 7 to 21 mmHg were taken as normal. Macular function was assessed with Amsler grid in all participants.

Fundus was examined using direct and indirect ophthalmoscope after proper dilatation of the pupil with topical 0.8% tropicamide and 5% phenylephrine. Spectral domain-optical coherence tomography (SD-OCT) was done to confirm the fundus findings of ophthalmoscopy. OCT analysis was done by Heidelberg spectral-domain-OCT after full dilatation of pupil. Macular scan was carried out using a 512 × 128 cubic scan model at intervals of 30°and centered on the fixation point. To verify the accuracy of the OCT findings, the fundus area was additionally scanned with raster scan model horizontally. The diagnosis of maculopathy was based on fundus appearance and OCT evaluation. On the existence of a small, round, or oval, yellow macular lesion or when OCT revealed interruption or defect of the inner segment (IS)/outer segment (OS) layer and of the retinal pigment epithelium (RPE), it was classified as positive. Visual field was assessed using automated perimetry (Humphrey field analyzer).

Data were analyzed using SPSS 20.0. Categorical variables such as sociodemographic characteristics and prevalence were presented as proportion; and continuous variables such as age, working hours, and exposure duration were presented as mean and standard deviation. Association between two categorical variables was assessed by Chi-square test. The mean difference in continuous variables between the two groups was checked by independent t-test. P value less than 0.05 was considered statistically significant.
The study protocol was approved by the Institutional Review Board of the author's institution. (No. 1057/2015)

**Results**

One hundred and two eligible arc welders and 111 matched nonwelders were approached for the study. Five welders and nine nonwelders refused to take part in the study, seven welders and 12 nonwelders did not come for ophthalmic examination. Ninety welders and ninety controls took part in the study. Table 1 shows that all the participants were male. The mean (SD) age of the welders was 33.13 (11.57) years, whereas the mean age (SD) of controls was 33.13 (10.57) years ($P = 0.901$). Nearly 60% of welders and half of nonwelders were residing in urban areas. About half of welders were formally trained for welding work. The majority of the participants belonged to lower and upper-middle lower-middle socioeconomic status categories (one-third in each category) as per BG Prasad classification. About 70% welders and 50% nonwelders were educated up to secondary level, there was no significant difference in education level between the two groups.

The majority (93.33%) of welders had at least one ocular manifestation, whereas a quarter of nonwelders had at least one ocular manifestation. The distribution of ocular complaints and manifestation in two groups is given in Tables 2 and 3. All welders had at least one presenting ocular complaint, whereas 65% of nonwelders did not have any ocular complaint. About one-third of welders and a quarter of nonwelders had mild visual impairment; the remaining were with normal vision. Among welders, the most common conjunctival manifestation was congestion (36.11%). About one-fifth of welders and half of non-welders did not have any remarkable conjunctival finding. The most common corneal manifestation was multiple corneal opacity, i.e., 57.78% in welders and 6.67% in nonwelders. About 40% of welders and 90% of nonwelders did not have any corneal manifestation. Thirteen welders and 11 nonwelders were found with cataractous lens; ($P = 0.66$).

The findings of IOP, lid, pupil, iris, red reflex, color vision, Amsler grid test, and macular perimetry examination were unremarkable in both groups.

On fundus examination, 40% of welders had findings suggestive of maculopathy. The most common finding was a small yellowish lesion at the fovea (22.22) followed by a red lesion with a yellow margin at fovea (16.67%). Fundus findings were unremarkable in all nonwelders. On SD-OCT examination, 56.67% welders and 7.78% nonwelders were found with maculopathy; ($P < 0.01$). On SD-OCT examination, single or multiple RPE defect at fovea (31.11%), IS/OS junction disruption (4.44%), RPE defect at fovea with IS/OS junction disruption (14.44%), and thinning

### Table 1: Sociodemographic characteristics of participants

| Variable                  | Welder (%) | Nonwelder (%) | $P$  |
|---------------------------|------------|---------------|------|
| Residence                 |            |               |      |
| Urban                     | 53 (58.89) | 48 (53.33)    | 0.453|
| Rural                     | 37 (41.11) | 42 (46.67)    |      |
| Age                       |            |               |      |
| 18-40 years               | 67 (74.44) | 69 (76.67)    | 0.729|
| 41-60 years               | 23 (25.56) | 21 (23.33)    |      |
| Mean (SD) years           | 33.13 (11.57) | 33.13 (10.51) | 0.904|
| Socioeconomic status      |            |               |      |
| Lower                     | 28 (31.11) | 17 (18.89)    | 0.06 |
| Upper lower               | 29 (32.22) | 28 (31.11)    |      |
| Lower middle              | 27 (30.0)  | 23 (25.56)    |      |
| Upper middle              | 6 (6.67)   | 22 (24.44)    |      |
| Education                 |            |               |      |
| Up to middle              | 40 (44.44) | 27 (30.0)     | 0.08 |
| Secondary                 | 24 (26.67) | 21 (23.33)    |      |
| Higher secondary          | 11 (12.22) | 29 (32.22)    |      |
| Graduation and postgraduation | 15 (16.67) | 13 (14.44)    |      |
| Formal training           |            |               |      |
| Yes                       | 51 (56.70) | -             |      |
| No                        | 39 (43.30) | -             |      |
| Strict adherence to protective equipment | | | |
| Yes                       | 37 (41.11) | -             |      |
| No                        | 53 (58.89) | -             |      |
| Working duration          |            |               |      |
| Mean (SD) years           | 11.61 (9.60) | -            |      |
| Exposure per day          | 7.20 (1.60) | -             |      |

**Table 2: Comparison of ocular manifestation between welders and nonwelders**

| Variable                  | Welder (n=90) | Nonwelder (n=90) | OR (95% CI) | $P$  |
|---------------------------|---------------|------------------|-------------|------|
| Ocular complaints         |               |                  |             |      |
| Yes                       | 90 (100)      | 23 (25.56)       | -           | <0.01*|
| No                        | 0 (0)         | 67 (74.44)       |            |      |
| Any ocular disorder       |               |                  |             |      |
| Yes                       | 84 (93.33)    | 24 (26.67)       | 38.50       | <0.01*|
| No                        | 6 (6.67)      | 66 (73.33)       | (14.88-99.64) |      |
| BCVA                      |               |                  |             |      |
| Mild visual impairment    | 32 (35.56)    | 21 (23.33)       | 1.81        | 0.072|
| Normal                    | 58 (64.44)    | 69 (76.67)       | (0.95-3.48) |      |
| Conjunctiva               |               |                  |             |      |
| Disease                   | 73 (81.11)    | 19 (21.11)       | 16.05       | <0.01*|
| Unremarkable              | 17 (18.89)    | 71 (78.89)       | (7.72-33.34) |      |
| Cornea                    |               |                  |             |      |
| Disease                   | 53 (58.89)    | 9 (10.0)         | 12.89       | <0.01*|
| Normal                    | 37 (41.11)    | 81 (90.0)        | (5.76-28.88) |      |
| Lens                      |               |                  |             |      |
| Cataractous               | 13 (14.44)    | 11 (12.22)       | 1.21        | 0.66 |
| Transparent               | 77 (85.56)    | 79 (87.78)       | (0.51-2.87) |      |
| Fundus by ophthalmoscopy  |               |                  |             |      |
| Maculopathy               | 36 (40.00)    | 0 (0)            | -           | <0.01*|
| No                        | 54 (60.00)    | 90 (100)         |            |      |
| SD-OCT                    |               |                  |             |      |
| Maculopathy               | 51 (56.67)    | 7 (7.77)         | 15.50       | <0.01*|
| No                        | 39 (43.33)    | 83 (92.22)       | (6.45-37.26) |      |

BCVA, best-corrected visual acuity; CI, confidence interval; OR, Odds ratio; SD-OCT, spectral domain-optical coherence tomography; *statistically significant
of fovea (10%) were taken as signs of maculopathy. Among welders, 48 had bilateral and three had unilateral maculopathy; whereas among nonwelders, three had unilateral and four had bilateral maculopathy [Tables 2 and 3].

All the welders were found using only goggles as protective equipment. About two-fifths were strictly adherent to goggles use, rest were using it occasionally. Prevalence of maculopathy, diagnosed by both fundoscopy as well as SD-OCT was found lower among strictly adherent welders than occasional use welders [Table 4]. None of the sociodemographic variables was found associated with strict usage of goggles among welders [Table 5].

**Discussion**

All the participants were male. The prevalence of at least one ocular disorder was found higher among welders (94%) than nonwelders (27%). Welders are exposed to visible light, near and far infrared, and UV radiations. Chronic exposure to these radiations causes conjunctival, corneal, and retinal damage. In our study, the prevalence of at least one ocular disorder among arc welders was higher than in other reported studies. This could be due to a difference in climatic conditions in the different study settings, at different times of the year.

Conjunctival manifestations were the most common ocular findings in both groups in the current study. This is in agreement with other studies. Among conjunctival disorders, the most common was conjunctival congestion followed by pterygium and pinguecula. This prevalence is higher among arc welders (81%) than nonwelders (21%). Similar findings were also reported from other studies. Prevalence of pterygium and pinguecula was reported to be 28% and 20%, respectively, among arc welders.

**Table 3: Distribution of ocular disorders among welders and nonwelders**

| Variable                          | Welder (%) (n=90) | Nonwelder (%) (n=90) |
|-----------------------------------|------------------|----------------------|
| Complaints                        |                  |                      |
| Redness                           | 4 (4.44)         | 6 (6.67)             |
| FB sensation                      | 15 (16.67)       | 13 (14.44)           |
| DOV                               | 25 (27.77)       | 9 (10.0)             |
| Burning sensation                 | 26 (28.89)       | 3 (3.33)             |
| Watering and itching              | 20 (22.22)       | 0 (0)                |
| No                                | 0 (0)            | 59 (65.56)           |
| BCVA                              |                  |                      |
| Mild visual impairment            | 32 (35.56)       | 21 (23.33)           |
| Normal                            | 58 (64.44)       | 69 (76.67)           |
| Conjunctiva                       |                  |                      |
| Congestion                        | 33 (36.67)       | 15 (16.67)           |
| Allergic conjunctivitis           | 22 (24.44)       | 14 (15.56)           |
| Pterygium                         | 26 (28.89)       | 12 (13.33)           |
| Pinguecula                        | 18 (20.0)        | 9 (10.0)             |
| Not remarkable                    | 17 (18.89)       | 44 (48.89)           |
| Cornea                            |                  |                      |
| Transparent                       | 37 (41.11)       | 81 (90)              |
| Multiple corneal opacity          | 52 (57.77)       | 6 (6.67)             |
| Arcus                             | 10 (11.11)       | 9 (10.0)             |
| Lens                              |                  |                      |
| Transparent                       | 77 (85.55)       | 79 (87.78)           |
| Cataractous                       | 13 (14.44)       | 11 (12.22)           |
| Fundus by ophthalmoscopy          |                  |                      |
| Small yellowish lesion at fovea   | 20 (22.22)       | 0 (0)                |
| Hypopigmentation at fovea         | 4 (4.44)         | 0 (0)                |
| Red lesion with yellow margin at fovea | 15 (16.17)   | 0 (0)                |
| Unremarkable                      | 54 (60.0)        | 90 (100)             |
| Maculopathy in SD-OCT             |                  |                      |
| Yes                               | 51 (56.67)       | 7 (7.77)             |
| No                                | 39 (43.33)       | 83 (92.22)           |
| SD-OCT                            |                  |                      |
| Single RPE defect at fovea        | 25 (27.77)       | 3 (3.33)             |
| IS/OS junction disruption         | 4 (4.44)         | 7 (7.77)             |
| RPE defect at fovea with IS/OS junction disruption | 13 (14.44) | 0 (0) |
| RPE defect at fovea with IS/OS junction disruption with thinning of fovea | 9 (10.0) | 0 (0) |
| Multiple RPE defect               | 7 (7.77)         | 0 (0)                |
| Unremarkable                      | 39 (43.33)       | 83 (92.22)           |

BCVA, best-corrected visual acuity; IS, inner segment; OS, outer segment; RPE, retinal pigment epithelium; SD-OCT, spectral domain-optical coherence tomography.
which is similar to a study from Nigeria.\textsuperscript{8} The prevalence of both disorders was lower in studies done in Kampala and Nigeria.\textsuperscript{5,8,14} Among nonwelders, the prevalence was also found higher than the other studies from India,\textsuperscript{16,17} this could be due to the hot and windy climate in our study setting.

Nearly 60\% of welders and 10\% nonwelders had corneal abnormalities; 58\% in welders and 6.67\% in nonwelders. The higher prevalence among welders may be due to ionizing and nonionizing radiations from welding. The prevalence of corneal opacity in our study was higher than in other studies.\textsuperscript{5,6,8} This may be due to differences in the extent of adherence to PPE.

Cataract among welders was reported in about 15\% of welders, which was similar to a study done in Nigeria.\textsuperscript{8} Lower prevalence among welders was reported in other studies.\textsuperscript{8}

Prevalence of phototoxic maculopathy was found to be 40\% and 51\%, respectively, by ophthalmoscopic examination and

\begin{table}[h]
\centering
\caption{Comparison of ocular disorder between strictly adherent and occasional adherent welders}
\begin{tabular}{|l|c|c|c|c|}
\hline
Variable & Strictly adherent (n=37) & Not strictly adherent (n=53) & Odds ratio (95\% CI) & P \\
\hline
BCVA & & & & \\
Mild visual impairment & 9 (24.32) & 23 (43.40) & 0.42 (0.17-1.06) & 0.063 \\
Normal & 28 (75.68) & 30 (56.60) & & \\
Conjunctiva & & & & \\
Disease & 27 (72.97) & 46 (86.79) & 0.41 (0.14-1.21) & 0.09 \\
Unremarkable & 10 (27.03) & 7 (13.20) & & \\
Cornea & & & & \\
Disease & 15 (40.54) & 38 (71.60) & 0.27 (0.11-0.65) & 0.003* \\
Normal & 22 (59.45) & 15 (28.30) & & & \\
Lens & & & & \\
Cataractous & 4 (10.81) & 9 (16.98) & 0.59 (0.17-2.09) & 0.413 \\
Transparent & 33 (89.18) & 44 (83.01) & & \\
Fundus by ophthalmoscopy & & & & \\
Maculopathy & 4 (10.81) & 32 (60.37) & 0.08 (0.02-0.25) & <0.01* \\
No & 33 (89.18) & 21 (39.62) & & \\
SD-OCT & & & & \\
Maculopathy & 7 (18.91) & 44 (83.01) & 0.05 (0.02-0.14) & <0.01* \\
No & 30 (81.08) & 9 (16.98) & & \\
\hline
\end{tabular}
\textsuperscript{BCVA, best-corrected visual acuity; CI, confidence interval; SD-OCT, spectral domain-optical coherence tomography; *Statistically significant}
\end{table}

\begin{table}[h]
\centering
\caption{Factors associated with strict adherence of personal protective equipment}
\begin{tabular}{|l|c|c|c|c|}
\hline
Factor & Strictly adherent (n=37) & Not strictly adherent (n=53) & Odds ratio (95\% CI) & P \\
\hline
Residence & & & & \\
Urban & 24 (64.86) & 29 (54.71) & 1.52 (0.64-3.63) & 0.336 \\
Rural & 13 (35.13) & 24 (45.28) & & \\
Formal Training & & & & \\
Yes & 22 (59.45) & 29 (54.71) & 1.21 (0.51-2.84) & 0.655 \\
No & 15 (40.54) & 24 (45.28) & & \\
Education & & & & \\
Up to Middle & 17 (45.94) & 23 (43.39) & 0.397 \\
Secondary & 12 (32.43) & 12 (22.64) & & \\
Senior Secondary & 3 (8.11) & 8 (15.09) & & \\
Graduation and above & 5 (13.51) & 10 (18.86) & & \\
Socioeconomic status & & & & \\
Lower & 12 (32.43) & 16 (30.18) & 0.913 \\
Upper lower & 11 (29.72) & 18 (33.96) & & \\
Lower middle & 11 (29.72) & 16 (30.18) & & \\
Upper middle & 3 (8.11) & 3 (5.66) & & \\
Age & & & & \\
Mean (SD) years & 30.97 (10.50) & 34.64 (12.12) & 0.140 \\
Working duration & & & & \\
Mean (SD) years & 71.75 (115.90) & 92.25 (132.88) & 0.449 \\
Exposure per day & & & & \\
Mean (SD) hours & 7.51 (1.26) & 6.98 (1.79) & 0.123 \\
\hline
\end{tabular}
\textsuperscript{CI, confidence interval; *statistically significant}
SD-OCT in the current study, which is higher than those reported by Yang et al\(^7\). In the current study, the prevalence of maculopathy is significantly higher in welders (57%) than nonwelders (8%).

Welding radiations are focused on macula by the refractive system in arc-welders, they may cause thermal or photochemical damage to photoreceptors, RPE, and other layers.\(^5\) Characteristic hyporeflective bands of IS/OS and RPE layers are suggestive of these damages.\(^5,18\)

SD-OCT revealed that nearly half of welders had an interruption of the IS/OS junction and/or defect in the RPE layer in varying degrees. Most of the affected welders had a good BCVA (64.40%), this was consistent with another study.\(^7\) SD-OCT was found more sensitive than the fundus examination to detect these changes.\(^7\) SD-OCT can be used as an effective early diagnosis method for phototoxic maculopathy.

In our study, all welders were using goggles as PPE, but only 40% had strict adherence. This was similar to a study done in southern India.\(^11\) Subjectively, this is because wearing goggles was inconvenient, and participants in the study were engaged in small-scale, unorganized work settings, where safety regulations are followed laxly. There was no association of adherence of PPE use with conjunctival and lens disorders. This may be because our study participant had inadequate PPE (only goggles). However, the prevalence of corneal opacity and phototoxic maculopathy was found lower among strict users. This was similar as reported in another study.\(^11,18\)

We did not find any sociodemographic or occupation-related factor that was associated with strict adherence to PPE usage.

Almost all the reported ocular disorders were found higher among welders than nonwelders. Chronic exposure to the visible, infrared, and UV radiations may be the causative factor for it, but other confounding factors like increased exposure to sun, dust, and metal particles might be responsible. Exposure to these factors could not be quantified in this study.

This study presents evidence regarding ocular morbidity including phototoxic maculopathy among arc welders. Community-based recruitment of participants, detailed ophthalmic examination, and SD-OCT at tertiary care hospitals make the study robust in terms of methodology. This is a cross-sectional study, where only small-scale welders were recruited. A multicentric, follow-up study is needed to generalize the findings.

Primary care physicians being the first contact doctor should routinely screen for occupation-related hazards, so the disease can be detected at its incipient stage and further progress can be arrested. Furthermore, the significance of strict adherence to preventive measures should be conveyed at every contact to prevent occupation-related ocular morbidity.

**Conclusion**

Chronic exposure to arc welding is associated with increased ocular disorders including phototoxic maculopathy. Welders should undergo regular eye check-ups and should be educated about potential ocular hazards related to the occupation. Policies regarding PPE usage and safety at workplaces should be implemented rigorously, even in small-scale, unorganized sectors. Further research is required to quantify the effects of the welding process and duration of exposure on eye health.

**Key Message**

Arc welders have a higher predisposition toward ocular disorders. They should be routinely screened for occupation-related hazards at primary care level. Occupational safety measures should be implemented in all workplaces.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**References**

1. Alexander V, Sindhu KNC, Zechariah P, Resu AV, Nair SR, Kattulla D, et al. Occupational safety measures and morbidity among welders in Vellore, Southern India. Int J Occup Environ Health 2016;22:300-6.
2. Guha N, Loomis D, Guyton KZ, Grosse Y, El Ghissassi F, Bouvard V, et al. Carcinogenicity of welding, molybdenum trioxide, and indium tin oxide. Lancet Oncol 2017;18:581-2.
3. Joseph N, Venkatesh V, Akash SK, Hegde S, Moras E, Shenoy NP. Occupation hazards – pattern, awareness and preventive measures among welders from an unorganized sector in India. J Clin Diagnostic Res 2017;11:23-8.
4. Kumar SG, Dharanipriya A. Prevalence and pattern of occupational injuries at workplace among welders in coastal south India. Indian J Occup Environ Med 2014;18:135-9.
5. Iyiade AA, Olusola JO. Pattern of eye diseases among welders in a Nigeria community. Afr Health Sci 2012;12:210-6.
6. Davies KG, Asanga U, Nku CO, Osim EE. Effect of chronic exposure to welding light on Calabar welders. Niger J Physiol Sci 2007;22:55-8.
7. Yang X, Shao D, Ding X, Liang X, Yang J, Li J. Chronic phototoxic maculopathy caused by welding arc in occupational welders. Can J Ophthalmol 2012;47:45-50.
8. Atukunda I, Lusobya RC, Ali SH, Mukisa J, Otitti-Sengeri J,
9. Mahindrakar A, Toshniwal S, Anthony H, Doongerwala M. Spectralis optical coherence tomography findings in welder's maculopathy. Indian J Ophthalmol 2013;61:238-40.

10. Directorate of Census Operation, Rajasthan. Census of India, 2011: District Census Handbook- Bikaner. Available from: https://censusindia.gov.in/2011census/dchb/DCHB_A/08/0803_PART_A_DCHB_BIKANER.pdf. [Last accessed on 2012 Apr 26].

11. Ministry of Labour & Employment, Government of India. Consumer Price Index for Industrial Workers (CPI-IW)- December, 2019. Press Information Bureau; 2020. Available from: https://pib.gov.in/PressReleasePage.aspx?PRID=1562111. [Last accessed on 2021 Apr 26].

12. World Health Organization. Blindness and vision impairment. Available from: https://www.who.int/news-room/fact-sheets/detail/blindness-and-visual-impairment. [Last accessed on 2021 Apr 26].

13. Chauhan A, Anand T, Kishore J, Danielsen TE, Ingle GK. Occupational hazard exposure and general health profile of welders in rural Delhi. Indian J Occup Environ Med 2014;18:21-6.

14. Omoti AE, Edema OT, Akinsola FB, Aighotsua P. Non-traumatic ocular findings in industrial technical workers in Delta state, Nigeria. Middle East Afr J Ophthalmol 2009;16:25-8.

15. Karl KKT, Richard O, Wisdom KA. Prevalence and factors influencing eye injuries among welders in Accra, Ghana. Adv Prev Med 2020;2020:1-8. doi: 10.1155/2020/2170247.

16. Hashemi H, Khabazkhoob M, Yekta A, Jafarzadehpour E, Ostadimoghaddam H, Kangari H. The prevalence and determinants of pterygium in rural areas. J Curr Ophthalmol 2017;29:194-8.

17. Nangia V, Jonas JB, Nair D, Saini N, Nangia P, Panda-Jonas S. Prevalence and associated factors for pterygium in rural agrarian Central India. The central India eye and medical study. PLoS One 2013;8:e82439.

18. Vukicevic M, Heriot W. Phototoxic maculopathy associated with arc welding: Clinical findings and associated functional vision impairment. Clin Exp Ophthalmol 2008;36:695-7.