



**Awareness of occupational hazards and use of safety measures among welders in eastern Nepal.**

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## TITLE PAGE

**Title: Awareness of occupational hazards and use of safety measures among welders in eastern Nepal.**

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## ABSTRACT

**Title: Awareness of occupational hazards and use of safety measures among welders in eastern Nepal.**

### **Objective:**

Welders are exposed to a wide variety of hazards resulting in adverse health effects and disease conditions. Proper use of safety measures among welders are important ways of preventing and/or reducing the health hazards associated with this occupation. We designed a study to assess the awareness of occupational hazards and safety measures among welders. We also aimed to find the relation between awareness and actual use of personal protective equipment (PPE) among welders of eastern Nepal.

### **Materials and Methods:**

A descriptive study to do face-to-face interview with 300 welders in three districts of eastern Nepal using semi-structured questionnaire was designed. The study respondents were selected through simple random sampling. Data regarding socio-demographic characteristics, awareness of hazards, safety measures and the actual use of safety measures were recorded.

### **Results:**

Overall, 272 (90.7%) welders were aware of at least one hazard of welding and ninety per cent of welders were aware of at least one PPE. However, only 47.7% used one or more type of PPE. Education and duration of employment were both significantly associated with the awareness of hazard, awareness of PPE and the use of PPE. The welders who were aware of the hazards

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2  
3 were more than two times more likely to use PPE compared to welders who were not aware  
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6 (OR= 2.528; CI= 1.099-5.813). The odds of PPE use among welders who were aware of the PPE  
7  
8 during welding was five times more compared to welders who has no idea about PPE (OR=  
9  
10 5.136; CI= 2.342-11.263) .  
11

### 12 13 **Conclusion:**

14  
15  
16 The welders who are aware are more likely to protect themselves from harmful effects of  
17  
18 welding. Thus, to ensure occupational safety and health of the welders more awareness  
19  
20 campaigns and programmes can be designed.  
21

22  
23 **Key words:** *Awareness, Use, Welders*  
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## 29 30 **ARTICLE SUMMARY**

### 31 32 **STRENGTHS OF THE STUDY**

- 33  
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35
- 36 • Based on occupation health and safety which is a neglected area of research in Nepal.
  - 37 • Study methodology: use of pre-tested questionnaire, scientific calculation of sample  
38 size, random sampling and calculation of odds ratios.
  - 39 • Makes an attempt to bridge the information gap on the prevalence of use and effect of  
40 awareness on use of PPE among welders in this part of the world.
  - 41 • The study highlights frequent use of sun glasses and cloth masks as personal protective  
42 equipment which is not recommended.
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### 51 52 **LIMITATIONS OF THE STUDY**

- 53  
54
- 55 • The sample size of the current study is small which is reflected by confidence intervals.
  - 56
  - 57
  - 58
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  - 60

- The external validity of the study is questionable especially in context of urban cities which has more workshops and more welders.

## SUMMARY BOX

Present state of scientific knowledge before the study was done.

- Occupational health and safety is a major concern in the South East Asian region which has a workforce of about 500 million people (2011).
- Welders of the South east Asian region are exposed to a wide range of occupational hazards and risks.

Need for the study

- The concept of occupational health and safety is relatively new which is exemplified by very few number of studies related to working conditions of the working population.
- In eastern region of Nepal, there is no organized occupational health service and their adherence to safety measures is unknown.

Results which were not known before

- There is a gap between knowledge and practice among welders in eastern Nepal. Awareness does not necessitate practice of protective equipment.
- Sun glasses and cloth masks are being considered as personal protective equipment which is not recommended.

Policy and Practice implications

- Adherence to the occupational safety and health measures needs to be stressed and enforced by the Ministry of Labor and Transport Management in Nepal.

## Introduction

Occupational Health aims at the promotion and maintenance of the highest degree of physical, mental and social wellbeing of workers in all occupations.<sup>1</sup> Welding, a skilled profession has been in use since the ancient times.<sup>2</sup> Welders join and cut metal parts using flame or electric arc and other sources of heat to melt and cut or to melt and fuse metal.<sup>3</sup>

Welding being a hazardous profession with a multiplicity of factors that can endanger the health of a welder, such as heat, burns, radiation (ultraviolet, visible and infrared), noise, fumes, gases, electrocution, and even the uncomfortable postures involved in the work; the high variability in chemical composition of welding fumes, which differs according to the work-piece, method employed, and surrounding environment; and the routes of entry through which these harmful agents access the body.<sup>4</sup> Some of the health effects of welding on health includes photo-keratitis or arc eye, metal fume fever, decrease in lung function, pneumoconiosis, asthma, photo-dermatitis and fertility abnormalities.<sup>5-11</sup>

Hazards arising from workplaces could impair the health and wellbeing of the workers, therefore it is necessary to anticipate, recognize, evaluate and control such hazards.<sup>12</sup> The use of Personal Protective Equipment (PPE) at all times is a good safe practice by welders to protect from exposure to the hazards and injuries during welding or cutting.<sup>13</sup>

Occupational Health and Safety (OSH) is not a old science however, the working conditions of workers in general and welders in particular is unsatisfactory. Welders in our study area do not

1  
2  
3 have organised occupational health services and to make matters worse there is lack of  
4  
5 awareness regarding the importance of occupational safety at the workplace. The literature  
6  
7 search showed that studies in Nepal have not tried to find the use of protective measures and  
8  
9 the factors which facilitate their use. Thus, the current study was designed to assess awareness  
10  
11 of occupational hazards and protective measures among welders working in three districts of  
12  
13 eastern Nepal. We also tried to find the possible relationship of awareness with the actual use  
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15 of PPE. This study was envisioned to highlight the need for research in the area of occupational  
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17 health which is a neglected issue in our country.  
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## 26 **Materials and Methods**

27  
28 A descriptive study was planned on welders working in three districts of eastern Nepal namely  
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30 Jhapa, Morang and Sunsari for the period of July 2010 to July 2011.  
31

32  
33 According to the available literature ( Isah et al )<sup>15</sup>, the most prevalent health complaints were  
34  
35 arc eye injuries, followed by foreign bodies in the eyes, back/waist pain, metal fume fever,  
36  
37 cuts/injuries from sharp metals etc. Among which, the least prevalent work related complaint is  
38  
39 determined as Cut injuries from sharp metals which is 37.7%.  
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42  
43 Thus, Prevalence (p) = 37.7%

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45 Compliment of prevalence (q) = 100-37.7 = 62.3%

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47 Permissible Error (PE) at 15%, L = 15% of 37.7= 5.655

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49 Sample size (n) =  $(Z_{1-\alpha})^2 * pq/L$

$$50 = (1.96)^2 * 37.7 * 62.3 / 5.655$$

$$51 = 283 \text{ (Approx.)}$$

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3 Inflating the sample size by 5% we got the estimated sample size of 298. We planned to  
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5 interview 300 grill workers, 100 from each district.  
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8 Average number of welders present per shop was three. (Results based on preliminary survey  
9  
10 of 15 workshops of the study area). Taking 3 welders per shop, the number of workshops  
11  
12 required for survey is =  $298/3 = 100$  Workshops i.e. number of work shop per district is =  $100/3$   
13  
14 = 34 shops per district. So, the workshops were selected through a simple random sampling  
15  
16 from list of metal workshops provided by the Metal Workshops' Association (GRILL BYABASAYI  
17  
18 SANGH) using computer generated random numbers.  
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23 Ethical clearance was taken from the Institutional Ethical Review Board of BPKIHS. Face to face  
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25 interviews were done with the study participants with the help of a pre-tested semi structured  
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27 questionnaire at their respective welding workshop. All the welders working who gave  
28  
29 informed consent were included in the study. Verbal consent was also taken from the  
30  
31 employers. The information regarding their demographic characteristics, awareness of hazards,  
32  
33 awareness and use of PPE was assessed. Confidentiality and anonymity was promised and  
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35 maintained.  
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40  
41 Data processing and analysis were done using Statistical Package for Social Sciences (SPSS)  
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43 version 11.5  
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## 46 **Results**

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48 A total of 300 welders who agreed to participate became the study respondents. All welders  
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50 were male with a mean age of 31.29 years with a standard deviation of 6.57 years. Almost half  
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52 (48%) of the welders were in the age group of 30-39 years. In total 93% of the welders in this  
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3 study were literate. There were 16.3% of welders working for more than 10 years. The mean  
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5 duration of employment in years of the welders in this study was 6.94 years.  
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8  
9 The study showed that 90.7% of welders were aware of one or more hazards of welding.  
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11 Excessive brightness (90.7%) was the most common hazard identified by the welders working in  
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13 the area followed by sharp metals (86.7%), heat (83.7%), physical environment (83.3%),  
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15 electrical current (80.30%), noise (75.70%), welding fumes (51.70%), sparks (44.3%) and  
16  
17 vibration (17%).  
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20  
21 Table 1 shows that 90% of welders were aware of at least one kind of PPE while only 47.7% of  
22  
23 welders use at least one kind of PPE during work. Sun glasses were considered protective and  
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25 was the most frequently used personal protective device (74.3%) by the welders of eastern  
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27 Nepal. Welders with primary education were more aware of hazards of welding in comparison  
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29 to the illiterate welders (OR= 7.621; CI= 2.738-21.208). The welders with secondary level or  
30  
31 more education were sixty times more aware of the hazards of welding than the illiterate  
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33 welders (OR= 60.5; CI= 14.517-252.132). The duration of employment was also seen to be  
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35 negatively associated with the awareness of hazards among the welders ( $p < 0.05$ ) i.e. the  
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37 welders who worked for six or more years were less likely to be aware of hazards related to  
38  
39 welding compared to welders who worked for five or less years as shown in table 2.  
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47 Table 3 entails that awareness regarding use of PPE was significantly associated with education.  
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49 The welders who received secondary or more education were almost five times more likely to  
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51 be aware of PPE compared to welders who did not receive any formal education. However, the  
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53 duration of employment could not find any statistical significance with awareness of PPE. The  
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55 welders with higher education were two times more likely to use PPE compared to those  
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3 welders who did not go to school at all (OR= 2.167; CI= 1.865-5.430). The duration of  
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5 occupation was associated with PPE use. The welders working for 6 to 10 years and those  
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7 working for 11 years or more were more likely to use PPE compared to those who worked for  
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9 five or less years shown in table 4. The welders who were aware of the hazards were more than  
10  
11 two times more likely to use PPE compared to welders who were not aware (OR= 2.528; CI=  
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13 1.099-5.813). The odds of PPE use among welders who were aware of the PPE during welding  
14  
15 was five times more compared to welders who has no idea about PPE (OR= 5.136; CI= 2.342-  
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17 11.263) as shown in table 5.  
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24 All welders learned their welding skills working as an apprentice to an experienced welder. They  
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26 had not had any formal training on welding, health and safety. The knowledge on hazards, PPE  
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28 and use of PPE were all limited to self-learning on the job.  
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**Table 1: Distribution of welders according to Awareness and Use of PPE (N=300)**

| <b>Awareness among welders</b> |                                      |                            |
|--------------------------------|--------------------------------------|----------------------------|
| <b>PPE types</b>               | <b>Number of welders<sup>#</sup></b> | <b>Percent<sup>#</sup></b> |
| At least one                   | 270                                  | 90.0                       |
| Welding goggles/ eye shield    | 260                                  | 86.7                       |
| Protective Gloves              | 255                                  | 85.0                       |
| Sturdy footwear                | 244                                  | 81.3                       |
| Welding helmet/Face shield     | 162                                  | 54.0                       |
| Apron                          | 161                                  | 53.7                       |
| Masks                          | 156                                  | 52.0                       |
| Earmuffs                       | 59                                   | 19.7                       |
| <b>Use Among the welders</b>   |                                      |                            |
| At least one                   | 143                                  | 47.7                       |
| Masks                          | 135                                  | 45.0                       |
| Sturdy footwear                | 122                                  | 40.7                       |
| Protective Gloves              | 70                                   | 23.3                       |
| Welding goggles/ eye shield    | 54                                   | 18.0                       |

|                            |    |       |
|----------------------------|----|-------|
| Apron                      | 50 | 16.67 |
| Welding helmet/Face shield | 19 | 6.3   |
| Earmuffs                   | 16 | 5.3   |

# Multiple responses

**Table 2: Factors associated with awareness of hazards among welders of eastern Nepal.**

| Variables              | Aware of Hazards |    | p Value | Unadjusted Odds Ratio |                |
|------------------------|------------------|----|---------|-----------------------|----------------|
|                        | Yes              | No |         | OR                    | 95% CL         |
| Education              |                  |    |         |                       |                |
| Illiterate             | 10               | 11 | <0.001  | 1.00                  |                |
| Primary                | 87               | 14 |         | 7.62                  | 2.74 - 21.21   |
| Secondary and Above    | 165              | 3  |         | 60.50                 | 14.52 - 252.13 |
| Duration of Employment |                  |    |         |                       |                |
| 1-5 years              | 157              | 9  | 0.012   | 1.00                  |                |
| 6-10 years             | 73               | 12 |         | 0.34                  | 0.14 - 0.86    |
| 11 years and more      | 42               | 7  |         | 0.34                  | 0.12 - 0.97    |

**Table 3: Factors associated with awareness of PPE among welders of eastern Nepal.**

| Variables  | Aware of PPE |    | p Value | Unadjusted Odds Ratio |        |
|------------|--------------|----|---------|-----------------------|--------|
|            | Yes          | No |         | OR                    | 95% CL |
| Education  |              |    |         |                       |        |
| Illiterate | 16           | 5  | 0.004   | 1.00                  |        |

|                               |     |    |       |      |              |
|-------------------------------|-----|----|-------|------|--------------|
| Primary                       | 96  | 15 |       | 2.00 | 0.63 - 6.26  |
| Secondary and Above           | 158 | 10 |       | 4.93 | 1.50 - 16.23 |
| <b>Duration of Employment</b> |     |    |       |      |              |
| 1-5 years                     | 145 | 21 |       | 1.00 |              |
| 6-10 years                    | 80  | 5  | 0.220 | 2.13 | 0.84 - 6.38  |
| 11 years and more             | 45  | 4  |       | 1.62 | 0.53 - 4.99  |

**Table 4: Factors associated with use of PPE at work among welders of eastern Nepal.**

| Variables                     | Use of PPE at Work |     | p Value     | Unadjusted Odds Ratio |             |
|-------------------------------|--------------------|-----|-------------|-----------------------|-------------|
|                               | Yes                | No  |             | OR                    | 95% CL      |
| <b>Education</b>              |                    |     |             |                       |             |
| Illiterate                    | 9                  | 12  |             | 1.00                  |             |
| Primary                       | 30                 | 81  | <0.001      | 0.49                  | 0.18-1.29   |
| Secondary and Above           | 104                | 64  |             | 2.16                  | 0.86 -5.43  |
| <b>Duration of Employment</b> |                    |     |             |                       |             |
| 1-5 years                     | 64                 | 102 |             | 1.00                  |             |
| 6-10 years                    | 44                 | 41  | 0.0000<br>5 | 1.71                  | 1.00 - 2.89 |
| 11 years and more             | 35                 | 14  |             | 3.98                  | 1.99 - 7.97 |

**Table 5: Association of awareness regarding hazards and PPE with use of PPE at work.**

| Awareness       | Use of PPE at Work |    | p value | Unadjusted Odds Ratio |        |
|-----------------|--------------------|----|---------|-----------------------|--------|
|                 | Yes                | No |         | OR                    | 95% CL |
| Aware of Hazard | 18                 | 10 | 0.0465  | 1.00                  |        |

|                  |     |    |         |      |             |
|------------------|-----|----|---------|------|-------------|
| Not Aware        |     |    |         |      |             |
| Aware            | 223 | 49 |         | 2.52 | 1.09 - 5.81 |
| Aware of PPE Use |     |    |         |      |             |
| Not Aware        | 15  | 15 | 0.00003 | 1.00 |             |
| Aware            | 226 | 44 |         | 5.13 | 2.34 -11.26 |

## Discussion

Almost half (48%) of the welders were in the category of 30-39 years, similar to the finding by Sabitu et al<sup>14</sup>, where majority (44.5 %) fall in the same category but differs with the study by Isah et al<sup>15</sup> in the same country where higher proportion of welders (40.3%) were in the 20-29 years category. Although 93% of the welders in the study had some schooling, only 90% of the welders had knowledge of one or more hazards of welding. Findings are similar to the study by Singh SB on jute mill workers of the same region.<sup>16</sup>

The working population in this profession has high turnover in this area with a very small number working for a longer duration in this profession. However, studies in Nigeria by Isah<sup>15</sup> shows 74.8% welders with experience of more than 10 years including 24.7% of welders with experience of more than 21 years. Similarly, a Canadian study by El-Zein et al<sup>17</sup> shows 81.8% welders working for 10 years and more with 22.8% of welders aged 30 years and above and were working for 20.33 years in this profession. The studies by Isah et al<sup>15</sup> and Sabitu et al<sup>14</sup> in Nigeria which show there are welders in even in the above 60 years category. The reasons for absence of welders above 49 in this study could be due to migration of skilled experienced welders to other areas for better wages and opportunities.

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3 This profession is regarded as the most hazardous profession and not all of the welders are  
4 aware of all the hazards.<sup>18</sup> In our study, ninety percent of welders were aware of at least one  
5 hazard of welding. The comparison with other studies showed inconsistent results. The study by  
6 Isah EC et al<sup>15</sup> in Benin, Nigeria showed 91.6% of welders being aware of one or more hazard of  
7 welding while another study in Kaduna, Nigeria by Sabitu K et al<sup>14</sup> showed 77,9% of awareness  
8 of one or more hazards of welding in welders.  
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18 Excessive brightness was the most frequently identified hazard by the welders in our study.  
19 Welding fumes which is regarded as the combination of highly toxic metals and their oxides<sup>19</sup>  
20 was identified as a hazard by 51.7% of the welders. There are also 9.3% of welders who were  
21 not aware of any specific hazard at their work. They could not think of any harmful factor in  
22 welding.  
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33 In the study, 90.7% of welders were aware of welding goggles/eye shield to protect eyes. The  
34 same the percentage of welders were aware of at least one PPE. Although 75% of the welders  
35 identified noise as hazard at their working place only 19.7% were aware about earmuffs. The  
36 utilisation of at least one PPE among the welders was 47.7%, as compared to the study by  
37 Sabitu K et al (34.2%)<sup>14</sup> and the study by Isah EC et al<sup>15</sup> (35.9%) in Nigeria. The most commonly  
38 used PPE was masks (45%), whereas the most common PPE worn were Welding goggles in both  
39 Nigerian studies; 60.9% by Sabitu K et al<sup>14</sup> and 35.9% by Isah EC et al<sup>15</sup>. Welding goggles/ face  
40 shield use was seen among only 18% of the welders in the current study.  
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53 It was found that a very high proportion of welders (74.3%) used the general sunglasses  
54 regularly at work. Sunglasses are not among the recommended PPE<sup>20</sup> to protect from welding  
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3 radiation to the eye. The reason for provision of the sunglasses by the employer may be due to  
4 being cheaper, easy available and comfortable. The sunglasses used were also not certified for  
5  
6 UV protection. Mask used by the welders in this study is also the commonly used cotton mask.  
7  
8 This also does not meet the requirement<sup>21</sup> as a respirator for use during welding. It was also  
9  
10 seen that more than half of the welders (52.3%) did not use any PPE during work.  
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17 Level of education had a significant relationship with awareness of hazard ( $P < 0.001$ ), awareness  
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19 of PPE ( $P < 0.05$ ) and use of PPE ( $P < 0.001$ ) in this study. This showed that with increase in  
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21 education among population awareness and practices increased. Educated people have the  
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23 tendency to read news, get updates increases the awareness of hazards & PPE, and they tend  
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25 to increase the practice of use of PPE as well. Sabitu et al<sup>14</sup> also showed that awareness  
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27 increased significantly with increase in education level.  
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32 Awareness on hazard ( $P < 0.05$ ) and awareness on PPE ( $P < 0.001$ ) both when compared with the  
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34 use of PPE at work showed significant relationship. This shows that being aware has positive  
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36 effect on practice. In this study we can see that more the people are aware of the hazard and  
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38 aware of equipment to protect from it, more is the tendency to use those equipment increases.  
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43 All welders learned welding through apprenticeship under an experienced welder for few years.  
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45 No welders in had any vocational training as compared to Sabitu et al<sup>14</sup> finding where 8.5% of  
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47 welders of Kaduna, Nigeria went to welding school. Learning by apprenticeship is a common  
48  
49 practice in welding here and also in data by Sabitu K et al<sup>14</sup> in Kaduna also show more than 90 %  
50  
51 welders learnt by apprenticeship. There is no vocational training course or welding school so far  
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53 for learning welding skills in this area.  
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3 The welders were also not trained or oriented regarding hazards and safety measures at work  
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5 including basic first aid at work. This is also one of the reasons they are not aware of many  
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7 hazards of the profession and about protective measures.  
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10  
11 There are a few limitations of the study. Though, the sample size was calculated with a scientific  
12  
13 formula the width of the confidence intervals show that the sample size is inadequate. A study  
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15 with a larger sample size might provide a more accurate estimate of the study variables.  
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17 Generalizability of this study to the other parts of Nepal, predominantly to urban cities is  
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19 limited as these cities have more workshops, more welders and therefore, can have different  
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21 working conditions.  
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28 Welding is a hazardous profession which exposes the workers to various kinds of physical and  
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30 chemical hazards in absence of judicious and effective use of personal protective equipment.  
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32 The unwanted exposure can lead to variety of disease conditions among the welders. The use  
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34 of recommended PPE at all times minimizes the exposure to these hazards. All the welders in  
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36 three districts of eastern Nepal are not aware of the hazards. Many welders are still not aware  
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38 of the PPE and a much smaller proportion among them actually use PPE during welding. The  
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40 mask and sunglasses being used are not the recommended PPE - respirators and welding  
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42 goggles should be used instead.  
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49 Welders in the study area are not trained and have acquired their welding skills while working  
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51 on the job. There is no culture of occupational safety and health among the welders and their  
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53 employees. This study provides only a glance of the actual problems and risks involved in this  
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55 profession. Awareness programs need to be organised for the employers and employees  
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3 regarding safety culture with special emphasis on harmful impacts on overall health of a  
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6 worker. Occupational health and safety needs to be promoted by the labour organizations in  
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9 Nepal and should be highlighted by the public health agencies which can make this a priority  
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11 issue among our policy makers.  
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For peer review only

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**Conflicting interests:** none declared.

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**Data :** No additional data available.

## Authors Contributions:

SS Budhathoki was responsible for conceptualizing the research, data collection, data analysis and writing preliminary drafts.

SB Singh was instrumental in refining the research idea, questionnaire designing and review of drafts.

Sagtani RA worked partly on the statistical analysis and reviewing and preparing the final draft of the manuscript.

SR Niraula was responsible for study design, questionnaire designing and the statistical analysis.

PK Pokharel was instrumental in supervision of all the aspects - refining the research idea, approving the questionnaire and critical appraisal of preliminary drafts.

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## STROBE STATEMENT FOR THE STUDY

Title : **Awareness of occupational hazards and use of safety measures among welders in eastern Nepal.**

| Item No                             | Recommendation   | Main Document (page no.) |
|-------------------------------------|--|--------------------------|
| <b>Title and abstract</b> [1]       | (a) Indicate the study's design with a commonly used term in the title or the abstract.  | addressed                |
|                                     | (b) Provide in the abstract an informative and balanced summary of what was done and what was found  | addressed                |
| <b>Introduction</b>                 |  |                          |
| Background [2]                      | Explain the scientific background and rationale for the investigation being reported   | Pg-6                     |
| Objectives [3]                      | State specific objectives, including any pre specified hypotheses  | Pg-7                     |
| <b>Methods</b>                      |  |                          |
| Study design [4]                    | Present key elements of study design early in the paper  | Pg 7                     |
| Setting [5]                         | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection  | Pg 7                     |
| Participants [6]                    | Give the eligibility criteria, and the sources and methods of selection of participants  | Pg 7                     |
| Variables [7]                       | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable   | -                        |
| Data sources/ measurement [8]       | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group                         | Pg 8                     |
| Bias [9]                            | Describe any efforts to address potential sources of bias  | -                        |
| Study size [10]                     | Explain how the study size was arrived at  | Pg 8                     |
| Quantitative variables [11]         | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why   | -                        |
| Statistical methods [12]            | (a) Describe all statistical methods, including those used to control for confounding  | Pg 8                     |
|                                     | (b) Describe any methods used to examine subgroups and interactions  | -                        |
|                                     | (c) Explain how missing data were addressed  | -                        |
|                                     | (d) If applicable, describe analytical methods taking account of sampling strategy   | Pg 8                     |
|                                     | (e) Describe any sensitivity analyses  | -                        |
| <b>Results</b><br>Participants [13] | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed            | Pg 8                     |
|                                     | (b) Give reasons for non-participation at each stage   | -                        |
|                                     | (c) Consider use of a flow diagram   | -                        |
| Descriptive data [14]               | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders   | Pg 8-9                   |
|                                     | (b) Indicate number of participants with missing data for each variable of interest  | -                        |
| Outcome data [15]                   | Report numbers of outcome events or summary measures   | Pg 9-10                  |
| Main results [16]                   | (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | Pg 10                    |
|                                     | (b) Report category boundaries when continuous variables were categorized  | addressed                |
|                                     | (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period   | -                        |
| Other analyses [17]                 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses   | -                        |

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|----|--------------------------|--|----------|
| 1  |                          |  |          |
| 2  | <b>Discussion</b>        |  |          |
| 3  | Key results [18]         | Summarise key results with reference to study objectives   | Pg 14-16 |
| 4  | Limitations [19]         | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias                 | Pg 14-16 |
| 5  | Interpretation [20]      | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | Pg 14-16 |
| 6  | Generalisability [21]    | Discuss the generalisability (external validity) of the study results  | Pg 17    |
| 7  | <b>Other information</b> |  |          |
| 8  | Funding [22]             | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based              | Pg 18    |
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# BMJ Open

## Awareness of occupational hazards and use of safety measures among welders : a cross-sectional study from eastern Nepal.

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|---------------------------------|--|
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| Secondary Subject Heading:      | Public health  |
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## TITLE PAGE

**Title: Awareness of occupational hazards and use of safety measures among welders : a cross-sectional study from eastern Nepal.**

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## ABSTRACT

### Objective:

Proper use of safety measures among welders are important ways of preventing and/or reducing a variety of health hazards, the welders are exposed to during welding. Knowledge of hazards, personal protective equipments (PPE) and use of PPE among the welders in Nepal is not known. We designed a study to assess the awareness of hazards, awareness of PPE and its use among welders; and to find the relation between awareness and use of PPE among welders of eastern Nepal.

### Materials and Methods:

A cross-sectional study was conducted among 300 welders selected using simple random sampling from three districts of eastern Nepal was conducted using a semi-structured questionnaire. Data regarding age, education level, duration of employment, awareness of hazards, safety measures and the actual use of safety measures were recorded.

### Results:

Overall, 272 (90.7%) welders were aware of at least one hazard of welding and similar proportion of welders were aware of at least one PPE. However, only 47.7% used one or more type of PPE. Education and duration of employment were both significantly associated with the awareness of hazard, awareness of PPE and the use of PPE. The welders who reported using PPE during welding were two times more likely to have been aware of the hazard and five times more likely to have been aware of PPE compared to the welders who did not report the use of PPE.

**Conclusion:**

The welders who are using the PPE are those who were aware of hazards and the PPE. There is gap between being aware of hazard or PPE (90%) and the use of PPE (47%) at work. Further researches needs to be done for identifying the factors leading to low utilisation of PPE despite a high knowledge among the welders of eastern Nepal.

**Key words:** *Awareness, Use, Welders*

**ARTICLE SUMMARY****STRENGTHS OF THE STUDY**

- Based on occupation health and safety which is a neglected area of research in Nepal.
- Study methodology: use of pre-tested questionnaire, scientific calculation of sample size, random sampling and calculation of odds ratios.
- Makes an attempt to bridge the information gap on the awareness and practice of use PPE among welders in this part of the world.
- The study highlights frequent use of sun glasses and cloth masks as personal protective equipment which is not recommended.

**LIMITATIONS OF THE STUDY**

- The sample size of the current study is small which is reflected by confidence intervals.
- The external validity of the study is questionable especially in context of urban cities which has more workshops and more welders.

**SUMMARY BOX**

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4 Present state of scientific knowledge before the study was done.

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  - Occupational health and safety is a major concern in the South East Asian region which has a workforce of about 500 million people (2011).
  - Welders of the South east Asian region are exposed to a wide range of occupational hazards and risks.

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14 Need for the study

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  - The concept of occupational health and safety is relatively new which is exemplified by very few number of studies related to working conditions of the working population.
  - In eastern region of Nepal, there is no organized occupational health service for welders and their adherence to safety measures is also unknown.

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23 Results which were not known before

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  - There is a gap between knowledge and practice among welders in eastern Nepal. Awareness does not necessitate practice of protective equipment.
  - Sun glasses and cloth masks are being used as personal protective equipment which is not recommended.

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32 Policy and Practice implications

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  - Use and adherence to the occupational safety and health measures needs to stressed and enforced by the Ministry of Labor and Transport Management in Nepal.

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56 **Introduction**  
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3 Occupational Health aims at the promotion and maintenance of the highest degree of physical,  
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5 mental and social wellbeing of workers in all occupations.<sup>1</sup> Welding, a skilled profession has  
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7 been in use since the ancient times.<sup>2</sup> Welders join and cut metal parts using flame or electric  
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9 arc and other sources of heat to melt and cut or to melt and fuse metal.<sup>3</sup>  
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14 Welding being a hazardous profession with a multiplicity of factors that can endanger the  
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16 health of a welder, such as heat, burns, radiation (ultraviolet, visible and infrared), noise,  
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18 fumes, gases, electrocution, and even the uncomfortable postures involved in the work; the  
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20 high variability in chemical composition of welding fumes, which differs according to the work-  
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22 piece, method employed, and surrounding environment; and the routes of entry through which  
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24 these harmful agents access the body.<sup>4</sup> Some of the health effects of welding on health includes  
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26 photo- keratitis or arc eye, metal fume fever, decrease in lung function, pneumoconiosis,  
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28 asthma, photo-dermatitis and fertility abnormalities.<sup>5-11</sup>  
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35 Hazards arising from workplaces could impair the health and wellbeing of the workers,  
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37 therefore it is necessary to anticipate, recognize, evaluate and control such hazards.<sup>12</sup> The use  
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39 of Personal Protective Equipment (PPE) at all times is a good safe practice by welders to protect  
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41 from exposure to the hazards and injuries during welding or cutting.<sup>13</sup>  
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45 Occupational Health and Safety (OSH) is not a old science however, the working conditions of  
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47 workers in general and welders in particular is unsatisfactory in Nepal. Welders in our study  
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49 area do not have organised occupational health services and to make matters worse there is  
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51 lack of awareness regarding the importance of occupational safety at the workplace. The  
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53 literature search showed that studies in Nepal have not tried to find the use of protective  
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measures and the factors which facilitate their use. Thus, the current study was designed to assess awareness of occupational hazards and protective measures among welders working in three districts of eastern Nepal. We also tried to find the possible relationship of awareness with the actual use of PPE. This study was envisioned to highlight the need for research in the area of occupational health which is a neglected issue in our country.

### Materials and Methods

A cross-sectional study was planned on welders working in three districts of eastern Nepal namely Jhapa, Morang and Sunsari for the period of July 2010 to July 2011.

According to the available literature ( Isah et al ), the most prevalent health complaints were arc eye injuries, followed by foreign bodies in the eyes, back/waist pain, metal fume fever, cuts/injuries from sharp metals etc. Among which, the least prevalent work related complaint is determined as Cut injuries from sharp metals which is 37.7%.

Thus, Prevalence (p) = 37.7%

Compliment of prevalence (q) = 100-37.7 = 62.3%

Permissible Error (PE) at 15%, L = 15% of 37.7= 5.655

$$\begin{aligned}\text{Sample size (n)} &= (Z_{1-\alpha})^2 * pq/L \\ &= (1.96)^2 * 37.7 * 62.3 / 5.655 \\ &= 283 \text{ (Approx.)}\end{aligned}$$

Inflating the sample size by 5% we got the estimated sample size of 298. We planned to interview 300 grill workers, 100 from each district.

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3 Average number of welders present per shop was three. (Results based on preliminary survey  
4 of 15 workshops of the study area). Taking 3 welders per shop, the number of workshops  
5 required for survey is =  $298/3 = 100$  Workshops i.e. number of work shop per district is =  $100/3$   
6 = 34 shops per district. So, the workshops were selected through a simple random sampling  
7 from list of metal workshops provided by the Metal Workshops' Association (GRILL BYABASAYI  
8 SANGH) using computer generated random numbers.  
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11 All welders working in the workshops listed in the Metal Workshops' Association were included  
12 in the study. The workshop was visited with prior appointment with the workshop  
13 administration. The investigators conducted individual interviews of 45-90 minutes with the  
14 welders using a semi-structure questionnaire. The questionnaire comprised of open questions  
15 on age, level of education and duration of employment in years. These variables were divided  
16 into categories during analysis. Questions on awareness of hazards of welding, awareness of  
17 PPE and use of PPE were structured. The welders were first asked to list the hazards of welding.  
18 Followed by which probing questions on specific hazards light/radiation, welding fumes, sharp  
19 metals, electric current, heat, noise, sparks, vibration and physical environment at work were  
20 asked as a yes/no answers were asked. Similarly for awareness and use of PPE, the welders  
21 were asked to list any PPE they were aware of and they used. This was again followed by yes/no  
22 option for welding helmet/faceshield, protective gloves, welding goggles/eyeshield,  
23 respirators/masks, sturdy footwear, apron, ear muffs and an open option for any other  
24 equipment they wore for their protection. The welders were asked to show us the PPE they  
25 used during the welding.  
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3 Data collected were entered into an excel sheet and analysed using SPSS 11.5. Bivariate analysis  
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5 for categorical data was done using chi square test ( $\chi^2$ ). The strength of association was  
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7 calculated using Odds Ratio (OR). The probability of significance was set at 5% level of  
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9 significance and 95% Confidence Interval. Data processing and analysis were done using  
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11 Statistical Package for Social Sciences (SPSS) version 11.5  
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16 The approval for the study was taken from the Institutional Ethical Review Board of B P Koirala  
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18 Institute of Health Sciences. Informed consent was taken from the participants ensuring  
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20 confidentiality and anonymity of the participants. Permission was sought from the welders in  
21  
22 the picture to use it for scientific publication.  
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## 25 26 **Results**

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28 The data was collected from a total of 300 welders who agreed to participate became the study  
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30 respondents. The response rate was 100%. All welders were male with a mean age of 31.29  
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32 years with a standard deviation of 6.57 years. Almost half (48%) of the welders were in the age  
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34 group of 30-39 years. In total 93% of the welders in this study were literate. There were 16.3%  
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36 of welders working for more than 10 years. The mean duration of employment in years of the  
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38 welders in this study was 6.94 years.  
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43 The study showed that 90.7% of welders were aware of one or more hazards of welding.  
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45 Excessive brightness (90.7%) was the most common hazard identified by the welders working in  
46  
47 the area followed by sharp metals (86.7%), heat (83.7%), physical environment (83.3%),  
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49 electrical current (80.30%), noise (75.70%), welding fumes (51.70%), sparks (44.3%) and  
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51 vibration (17%).  
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3 Table 1 shows that 90% of welders were aware of at least one kind of PPE while only 47.7% of  
4  
5 welders use at least one kind of PPE during work. While welding goggles/eye shields (86.7%)  
6  
7 were the most commonly reported PPE for use, the most commonly worn PPE was sturdy  
8  
9 footwear (40.7%)  
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11  
12 Sun glasses were considered protective and was used as a personal protective device by 74.3%  
13  
14 of the 260 welders who reported being aware about the welding goggles/eye shields as a PPE.  
15  
16 None of the welders used welding masks while cotton mask was used by 45% of the 300  
17  
18 welders in place of the welding masks they reported they were aware of. The sunglasses and  
19  
20 cotton masks are however not included in the table, as they are not recommended PPE for  
21  
22 welding. The illustration of the sun glasses and cotton mask used by the welders in Nepal is  
23  
24 depicted in figure 1.  
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31 There was a positive association between level of education and the awareness of hazards  
32  
33 among the welders ( $p < 0.05$ ). The welders who reported as being aware of the hazards of  
34  
35 welding were seven times more likely to have had at least primary level education (OR= 7.621;  
36  
37 CI= 2.738-21.208 ) and sixty times more likely more likely to have had secondary level or more  
38  
39 education (OR= 60.5; CI=14.517-252.132) compared to those welders who did not report as  
40  
41 being aware of the hazards of welding. The duration of employment was also seen to be  
42  
43 negatively associated with the awareness of hazards among the welders ( $p < 0.05$ ) i.e. the  
44  
45 welders who reported as being aware of the hazards were more likely to have been working for  
46  
47 longer duration as shown in table 2.  
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52  
53 Table 3 entails that awareness regarding use of PPE was significantly associated with level of  
54  
55 education ( $p < 0.05$ ). The welders who reported as being aware of the PPE were five times more  
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3 likely to have received education up to secondary level or more compared to those welders  
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5 who did not report as being aware of the PPE. This association was not found to be statistically  
6  
7 significant.  
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10  
11 There was a significant positive relation between welders who reported use of PPE and the  
12  
13 welders who attended higher education ( $p < 0.05$ ). The welders who reported using PPE at work  
14  
15 were two times more likely to have had attended secondary education or more (OR= 2.167; CI=  
16  
17 1.865-5.430). The reported use of PPE by the welders was seen to be more among the welders  
18  
19 who had been working for a longer duration in years ( $p < 0.05$ ). The welders who reported using  
20  
21 PPE at work were almost four times more likely to have been working for 11 years or  
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23 more (OR=4.98; CI= 1.99-7.97) as shown in table 4.  
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30 Table 5 shows that odds of finding a welder who was aware of the hazards among the welders  
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32 who reported using PPE during welding is twice the odds of finding a welder who was aware of  
33  
34 hazards among those who did not report using PPE during welding (OR= 2.52; CI= 1.09-5.81). It  
35  
36 was also seen that the odds of finding a welder who was aware of PPE for welding was among  
37  
38 the welders who reported using a PPE is five times the odds of finding a welder who was aware  
39  
40 of the PPE among the welders who did not report the use PPE during welding (OR= 5.13; CI=  
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42 2.34-11.26).  
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48 All welders learned their welding skills working as an apprentice to an experienced welder. They  
49  
50 had not had any formal training on welding, health and safety. The knowledge on hazards, PPE  
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52 and use of PPE were all limited to self-learning on the job.  
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3 **Figure 1: Welders at work using only sunglasses and cotton mask during welding in Nepal**  
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7 **(Separate JPEG file attached "Welder PPE PIC.jpg")**  
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20 **Table 1: Distribution of welders according to Awareness and Use of PPE (N=300)**  
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| Awareness among welders     |                                |                      |
|-----------------------------|--------------------------------|----------------------|
| PPE types                   | Number of welders <sup>#</sup> | Percent <sup>#</sup> |
| At least one                | 270                            | 90.0                 |
| Welding goggles/ eye shield | 260                            | 86.7                 |
| Protective Gloves           | 255                            | 85.0                 |
| Sturdy footwear             | 244                            | 81.3                 |
| Welding helmet/Face shield  | 162                            | 54.0                 |
| Apron                       | 161                            | 53.7                 |
| Masks                       | 156                            | 52.0                 |
| Earmuffs                    | 59                             | 19.7                 |
| Use Among the welders       |                                |                      |
| At least one                | 143                            | 47.7                 |
| Sturdy footwear             | 122                            | 40.7                 |

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|-----------------------------|----|-------|
| Protective Gloves           | 70 | 23.3  |
| Welding goggles/ eye shield | 54 | 18.0  |
| Apron                       | 50 | 16.67 |
| Welding helmet/Face shield  | 19 | 6.3   |
| Earmuffs                    | 16 | 5.3   |

# Multiple responses recorded per welder

**Table 2: Factors associated with awareness of hazards among welders of eastern Nepal.**

| Variables              | Aware of Hazards |    | p value* | Unadjusted Odds Ratio |                |
|------------------------|------------------|----|----------|-----------------------|----------------|
|                        | Yes              | No |          | OR                    | 95% CL         |
| Education              |                  |    |          |                       |                |
| Illiterate             | 10               | 11 | 0.000    | 1.00                  |                |
| Primary                | 87               | 14 |          | 7.62                  | 2.74 - 21.21   |
| Secondary and Above    | 165              | 3  |          | 60.50                 | 14.52 - 252.13 |
| Duration of Employment |                  |    |          |                       |                |
| 1-5 years              | 157              | 9  | 0.012    | 1.00                  |                |
| 6-10 years             | 73               | 12 |          | 0.34                  | 0.14 - 0.86    |
| 11 years and more      | 42               | 7  |          | 0.34                  | 0.12 - 0.97    |

\* Calculated using  $\chi^2$  at  $df=2$

**Table 3: Factors associated with awareness of PPE among welders of eastern Nepal.**

| Variables | Aware of PPE | p value* | Unadjusted Odds Ratio |
|-----------|--------------|----------|-----------------------|
|-----------|--------------|----------|-----------------------|

|                               | Yes | No |       | OR   | 95% CL       |
|-------------------------------|-----|----|-------|------|--------------|
| <b>Education</b>              |     |    |       |      |              |
| Illiterate                    | 16  | 5  |       | 1.00 |              |
| Primary                       | 96  | 15 | 0.004 | 2.00 | 0.63 - 6.26  |
| Secondary and Above           | 158 | 10 |       | 4.93 | 1.50 - 16.23 |
| <b>Duration of Employment</b> |     |    |       |      |              |
| 1-5 years                     | 145 | 21 |       | 1.00 |              |
| 6-10 years                    | 80  | 5  | 0.220 | 2.13 | 0.84 - 6.38  |
| 11 years and more             | 45  | 4  |       | 1.62 | 0.53 - 4.99  |

\*Calculated using  $\chi^2$  at  $df=2$

**Table 4: Factors associated with use of PPE at work among welders of eastern Nepal.**

| Variables                     | Use of PPE at Work |     | p value * | Unadjusted Odds Ratio |             |
|-------------------------------|--------------------|-----|-----------|-----------------------|-------------|
|                               | Yes                | No  |           | OR                    | 95% CL      |
| <b>Education</b>              |                    |     |           |                       |             |
| Illiterate                    | 9                  | 12  |           | 1.00                  |             |
| Primary                       | 30                 | 81  | 0.000     | 0.49                  | 0.18-1.29   |
| Secondary and Above           | 104                | 64  |           | 2.16                  | 0.86 -5.43  |
| <b>Duration of Employment</b> |                    |     |           |                       |             |
| 1-5 years                     | 64                 | 102 |           | 1.00                  |             |
| 6-10 years                    | 44                 | 41  | 0.000     | 1.71                  | 1.00 - 2.89 |
| 11 years and more             | 35                 | 14  |           | 3.98                  | 1.99 - 7.97 |

\*Calculated using  $\chi^2$  at  $df=2$

**Table 5: Association of awareness regarding hazards and PPE with use of PPE at work.**

| Awareness        | Use of PPE at Work |    | p value* | Unadjusted Odds Ratio |             |
|------------------|--------------------|----|----------|-----------------------|-------------|
|                  | Yes                | No |          | OR                    | 95% CL      |
| Aware of Hazard  |                    |    |          |                       |             |
| Not Aware        | 18                 | 10 | 0.046    | 1.00                  |             |
| Aware            | 223                | 49 |          | 2.52                  | 1.09 - 5.81 |
| Aware of PPE Use |                    |    |          |                       |             |
| Not Aware        | 15                 | 15 | 0.000    | 1.00                  |             |
| Aware            | 226                | 44 |          | 5.13                  | 2.34 -11.26 |

\* Calculated using  $\chi^2$  at  $df=1$

## Discussion

Almost half (48%) of the welders were in the category of 30-39 years, similar to the finding by Sabitu et al<sup>14</sup>, where majority (44.5 %) fall in the same category but differs with the study by Isah et al<sup>15</sup> in the same country where higher proportion of welders (40.3%) were in the 20-29 years category. Although 93% of the welders in the study had some schooling, only 90% of the welders had knowledge of one or more hazards of welding. Findings are similar to the study by Singh SB on jute mill workers of the same region.<sup>16</sup>

The working population in this profession has high turnover in this area with a very small number working for a longer duration in this profession. However, studies in Nigeria by Isah<sup>15</sup>

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2  
3 shows 74.8% welders with experience of more than 10 years including 24.7% of welders with  
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5 experience of more than 21 years. Similarly, a Canadian study by El-Zein et al<sup>17</sup> shows 81.8%  
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7 welders working for 10 years and more with 22.8% of welders aged 30 years and above and  
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9 were working for 20.33 years in this profession. The studies by Isah et al<sup>15</sup> and Sabitu et al<sup>14</sup> in  
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11 Nigeria which show there are welders in even in the above 60 years category. The reasons for  
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13 absence of welders above 49 in this study could be due to migration of skilled experienced  
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15 welders to other areas for better wages and opportunities.  
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21 This profession is regarded as the most hazardous profession and not all of the welders are  
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23 aware of all the hazards.<sup>18</sup> In our study, ninety percent of welders were aware of at least one  
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25 hazard of welding. The comparison with other studies showed inconsistent results. The study by  
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27 Isah EC et al<sup>15</sup> in Benin, Nigeria showed 91.6% of welders being aware of one or more hazard of  
28  
29 welding while another study in Kaduna, Nigeria by Sabitu K et al<sup>14</sup> showed 77.9% of awareness  
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31 of one or more hazards of welding in welders.  
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37 Excessive brightness was the most frequently identified hazard by the welders in our study.  
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39 Welding fumes which is regarded as the combination of highly toxic metals and their oxides<sup>19</sup>  
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41 was identified as a hazard by 51.7% of the welders. There are also 9.3% of welders who were  
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43 not aware of any specific hazard at their work. They could not think of any harmful factor in  
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45 welding.  
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51 In the study, 90.7% of welders were aware of welding goggles/eye shield to protect eyes. The  
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53 same the percentage of welders were aware of at least one PPE. Although 75% of the welders  
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55 identified noise as hazard at their working place only 19.7% were aware about earmuffs. The  
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3 utilisation of at least one PPE among the welders was 47.7%, as compared to the study by  
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5 Sabitu K et al (34.2%)<sup>14</sup> and the study by Isah EC et al<sup>15</sup> (35.9%) in Nigeria. The most commonly  
6  
7 used PPE was masks (45%), whereas the most common PPE worn were Welding goggles in both  
8  
9 Nigerian studies; 60.9% by Sabitu K et al<sup>14</sup> and 35.9% by Isah EC et al<sup>15</sup>. Welding goggles/ face  
10  
11 shield use was seen among only 18% of the welders in the current study.  
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17 It was found that a very high proportion of welders (74.3%) used the general sunglasses  
18  
19 regularly at work. Sunglasses are not among the recommended PPE<sup>20</sup> to protect from welding  
20  
21 radiation to the eye. The reason for provision of the sunglasses by the employer may be due to  
22  
23 being cheaper, easy available and comfortable. The sunglasses used were also not certified for  
24  
25 UV protection. The mask used by the welders in this study is also the commonly used cotton  
26  
27 mask. This also does not meet the requirement<sup>21</sup> as a respirator for use during welding. It was  
28  
29 also seen that more than half of the welders (52.3%) did not use any PPE during work.  
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35 Level of education had a significant relationship with awareness of hazard ( $p < .05$ ), awareness of  
36  
37 PPE ( $p < 0.05$ ) and use of PPE ( $p < 0.05$ ) in this study. This showed that with increase in level of  
38  
39 education among population awareness and practices increased. Welders who have had higher  
40  
41 level of education have the tendency to read news, get updates increases the awareness of  
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43 hazards & PPE, and they tend to increase the practice of use of PPE as well. Sabitu et al<sup>14</sup> also  
44  
45 showed that awareness increased significantly with increase in education level.  
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51 It was found that welders who were employed for a longer duration reported being less aware  
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53 of the hazards of welding. It is maybe generally expected for the opposite to be true. The  
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55 reason for such findings in this study could be due to welders working for longer duration failing  
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3 to recognise the exposure as hazard after being exposed to them for many years. However this  
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5 is just a possible explanation which needs to be further explored. However in terms of using  
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7 PPE at work, the welders who have been working for longer duration report more use of PPE. It  
8  
9 is seen that welders who have been working for shorter duration are more aware of hazard but  
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11 use of PPE is lower. One possible reason for this may be younger people having the tendency of  
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13 having more risk taking behavior. However this also needs to be explored further in future  
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15 studies.  
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21 Awareness on hazard ( $p < 0.05$ ) and awareness on PPE ( $p < 0.05$ ) both when compared with the  
22  
23 use of PPE at work showed significant relationship. This shows that being aware has positive  
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25 effect on practice. In this study we can see that more the people are aware of the hazard and  
26  
27 aware of equipment to protect from it, more is the tendency to use those equipment increases.  
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32 All welders learned welding through apprenticeship under an experienced welder for few years.  
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34 No welders in had any vocational training as compared to Sabitu et al<sup>14</sup> finding where 8.5% of  
35  
36 welders of Kaduna, Nigeria went to welding school. Learning by apprenticeship is a common  
37  
38 practice in welding here and also in data by Sabitu K et al<sup>14</sup> in Kaduna also show more than 90 %  
39  
40 welders learnt by apprenticeship. There is no vocational training course or welding school so far  
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42 for learning welding skills in this area.  
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49 The welders were also not trained or oriented regarding hazards and safety measures at work  
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51 including basic first aid at work. This is also one of the reasons they are not aware of many  
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53 hazards of the profession and about protective measures.  
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3 There are a few limitations of the study. Though, the sample size was calculated with a scientific  
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5 formula the width of the confidence intervals show that the sample size is inadequate. A study  
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7 with a larger sample size might provide a more accurate estimate of the study variables.  
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9 Generalizability of this study to the other parts of Nepal, predominantly to urban cities is  
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11 limited as these cities have more workshops, more welders and therefore, can have different  
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13 working conditions.  
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19 Welding is a hazardous profession which exposes the workers to various kinds of physical and  
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21 chemical hazards in absence of judicious and effective use of personal protective equipment.  
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23 The unwanted exposure can lead to variety of disease conditions among the welders. The use  
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25 of recommended PPE at all times minimizes the exposure to these hazards. All the welders in  
26  
27 three districts of eastern Nepal are not aware of the hazards. Many welders are still not aware  
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29 of the PPE and a much smaller proportion among them actually use PPE during welding. The  
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31 mask and sunglasses being used are not the recommended PPE - respirators and welding  
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33 goggles should be used instead.  
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40 Welders in the study area are not trained and have acquired their welding skills while working  
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42 on the job. There is no culture of occupational safety and health among the welders and their  
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44 employees. This study provides only a glance of the actual problems and risks involved in this  
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46 profession. There is a gap between the knowledge the welders report on awareness of hazard  
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48 and PPE with the actual using of PPE at work by the same welders. This gap needs to be further  
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50 explored so that appropriate interventions can be planned to close this gap. With a high level of  
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52 awareness present in this group an intervention to increase the use of PPE is needed.  
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3 Occupational health and safety needs to be promoted by the labour organizations in Nepal and  
4  
5 should be highlighted by the public health agencies which can make this a priority issue among  
6  
7  
8 our policy makers.  
9

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20 important insight into the area and the work practices.  
21  
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27  
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32

33  
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35  
36

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38  
39 SS Budhathoki was responsible for conceptualizing the research, data collection, data analysis  
40  
41 and writing preliminary drafts.  
42

43 SB Singh was instrumental in refining the research idea, questionnaire designing and review of  
44  
45 drafts.  
46

47 Sagtani RA worked partly on the statistical analysis and reviewing and preparing the final draft  
48  
49 of the manuscript.  
50

51 SR Niraula was responsible for study design, questionnaire designing and the statistical analysis.  
52

53 PK Pokharel was instrumental in supervision of all the aspects - refining the research idea,  
54  
55 approving the questionnaire and critical appraisal of preliminary drafts.  
56

57 All the authors have read this manuscript and approved for publication.  
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## TITLE PAGE

**Title: Awareness of occupational hazards and use of safety measures among welders : a cross-sectional study from eastern Nepal.**

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## AUTHOR CONTRIBUTIONS

- SS Budhathoki developed the research idea, designed the questionnaire, collected data and wrote the preliminary drafts.
- SB Singh was responsible for streamlining the research idea, finalizing the questionnaire and critiquing the drafts.
- RA Sagtani was involved in organising data, writing and critiquing the drafts.
- SR Niraula was responsible for study designing and statistical analysis.
- PK Pokharel was involved and supervised the research idea, data measurement and appraisal of written drafts.

## ABSTRACT

**Title: Awareness of occupational hazards and use of safety measures among welders : a cross-sectional study from eastern Nepal.**

### Objective:

Proper use of safety measures among welders are important ways of preventing and/or reducing a variety of health hazards, the welders are exposed to during welding. Knowledge of hazards, personal protective equipments (PPE) and use of PPE among the welders in Nepal is not known. We designed a study to assess the awareness of hazards, awareness of PPE and its use among welders; and to find the relation between awareness and use of PPE among welders of eastern Nepal.

### Materials and Methods:

A cross-sectional study was conducted among 300 welders selected using simple random sampling from three districts of eastern Nepal was conducted using a semi-structured questionnaire. Data regarding age, education level, duration of employment, awareness of hazards, safety measures and the actual use of safety measures were recorded.

### Results:

Overall, 272 (90.7%) welders were aware of at least one hazard of welding and similar proportion of welders were aware of at least one PPE. However, only 47.7% used one or more type of PPE. Education and duration of employment were both significantly associated with the awareness of hazard, awareness of PPE and the use of PPE. The welders who reported using PPE during welding were two times more likely to have been aware of the hazard and five times

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3 more likely to have been aware of PPE compared to the welders who did not report the use of  
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6 PPE.  
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### 8 **Conclusion:**

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11 The welders who are using the PPE are those who were aware of hazards and the PPE. There is  
12  
13 gap between being aware of hazard or PPE (90%) and the use of PPE (47%) at work. Further  
14  
15 researches needs to be done for identifying the factors leading to low utilisation of PPE despite  
16  
17 a high knowledge among the welders of eastern Nepal.  
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21 **Key words:** *Awareness, Use, Welders*  
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## 24 25 26 27 **ARTICLE SUMMARY**

### 28 29 30 **STRENGTHS OF THE STUDY**

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- Based on occupation health and safety which is a neglected area of research in Nepal.
  - Study methodology: use of pre-tested questionnaire, scientific calculation of sample size, random sampling and calculation of odds ratios.
  - Makes an attempt to bridge the information gap on the awareness and practice of use PPE among welders in this part of the world.
  - The study highlights frequent use of sun glasses and cloth masks as personal protective equipment which is not recommended.

### 49 50 **LIMITATIONS OF THE STUDY**

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- The sample size of the current study is small which is reflected by confidence intervals.
  - The external validity of the study is questionable especially in context of urban cities which has more workshops and more welders.

## SUMMARY BOX

Present state of scientific knowledge before the study was done.

- Occupational health and safety is a major concern in the South East Asian region which has a workforce of about 500 million people (2011).
- Welders of the South east Asian region are exposed to a wide range of occupational hazards and risks.

Need for the study

- The concept of occupational health and safety is relatively new which is exemplified by very few number of studies related to working conditions of the working population.
- In eastern region of Nepal, there is no organized occupational health service for welders and their adherence to safety measures is also unknown.

Results which were not known before

- There is a gap between knowledge and practice among welders in eastern Nepal. Awareness does not necessitate practice of protective equipment.
- Sun glasses and cloth masks are being used as personal protective equipment which is not recommended.

Policy and Practice implications

- Use and adherence to the occupational safety and health measures needs to stressed and enforced by the Ministry of Labor and Transport Management in Nepal.

## Introduction

Occupational Health aims at the promotion and maintenance of the highest degree of physical, mental and social wellbeing of workers in all occupations.<sup>1</sup> Welding, a skilled profession has been in use since the ancient times.<sup>2</sup> Welders join and cut metal parts using flame or electric arc and other sources of heat to melt and cut or to melt and fuse metal.<sup>3</sup>

Welding being a hazardous profession with a multiplicity of factors that can endanger the health of a welder, such as heat, burns, radiation (ultraviolet, visible and infrared), noise, fumes, gases, electrocution, and even the uncomfortable postures involved in the work; the high variability in chemical composition of welding fumes, which differs according to the work-piece, method employed, and surrounding environment; and the routes of entry through which these harmful agents access the body.<sup>4</sup> Some of the health effects of welding on health includes photo-keratitis or arc eye, metal fume fever, decrease in lung function, pneumoconiosis, asthma, photo-dermatitis and fertility abnormalities.<sup>5-11</sup>

Hazards arising from workplaces could impair the health and wellbeing of the workers, therefore it is necessary to anticipate, recognize, evaluate and control such hazards.<sup>12</sup> The use of Personal Protective Equipment (PPE) at all times is a good safe practice by welders to protect from exposure to the hazards and injuries during welding or cutting.<sup>13</sup>

Occupational Health and Safety (OSH) is not a old science however, the working conditions of workers in general and welders in particular is unsatisfactory in Nepal. Welders in our study area do not have organised occupational health services and to make matters worse there is lack of awareness regarding the importance of occupational safety at the workplace. The

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2  
3 literature search showed that studies in Nepal have not tried to find the use of protective  
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5 measures and the factors which facilitate their use. Thus, the current study was designed to  
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7 assess awareness of occupational hazards and protective measures among welders working in  
8  
9 three districts of eastern Nepal. We also tried to find the possible relationship of awareness  
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11 with the actual use of PPE. This study was envisioned to highlight the need for research in the  
12  
13 area of occupational health which is a neglected issue in our country.  
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## 20 **Materials and Methods**

21  
22 A **cross-sectional** study was planned on welders working in three districts of eastern Nepal  
23  
24 namely Jhapa, Morang and Sunsari for the period of July 2010 to July 2011.  
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28 According to the available literature ( Isah et al )<sup>15</sup>, the most prevalent health complaints were  
29  
30 arc eye injuries, followed by foreign bodies in the eyes, back/waist pain, metal fume fever,  
31  
32 cuts/injuries from sharp metals etc. Among which, the least prevalent work related complaint is  
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34 determined as Cut injuries from sharp metals which is 37.7%.  
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37  
38 Thus, Prevalence (p) = 37.7%

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40 Compliment of prevalence (q) = 100-37.7 = 62.3%

41  
42 Permissible Error (PE) at 15%, L = 15% of 37.7= 5.655

$$\begin{aligned} 43 \text{ Sample size (n)} &= (Z_{1-\alpha})^2 * pq/L \\ 44 &= (1.96)^2 * 37.7 * 62.3 / 5.655 \\ 45 &= 283 \text{ (Approx.)} \end{aligned}$$

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53 Inflating the sample size by 5% we got the estimated sample size of 298. We planned to  
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55 interview 300 grill workers, 100 from each district.  
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3 Average number of welders present per shop was three. (Results based on preliminary survey  
4 of 15 workshops of the study area). Taking 3 welders per shop, the number of workshops  
5 required for survey is =  $298/3 = 100$  Workshops i.e. number of work shop per district is =  $100/3$   
6 = 34 shops per district. So, the workshops were selected through a simple random sampling  
7 from list of metal workshops provided by the Metal Workshops' Association (GRILL BYABASAYI  
8 SANGH) using computer generated random numbers.  
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18 All welders working in the workshops listed in the Metal Workshops' Association were included  
19 in the study. The workshop was visited with prior appointment with the workshop  
20 administration. The investigators conducted individual interviews of 45-90 minutes with the  
21 welders using a semi-structure questionnaire. The questionnaire comprised of open questions  
22 on age, level of education and duration of employment in years. These variables were divided  
23 into categories during analysis. Questions on awareness of hazards of welding, awareness of  
24 PPE and use of PPE were structured. The welders were first asked to list the hazards of welding.  
25 Followed by which probing questions on specific hazards light/radiation, welding fumes, sharp  
26 metals, electric current, heat, noise, sparks, vibration and physical environment at work were  
27 asked as a yes/no answers were asked. Similarly for awareness and use of PPE, the welders  
28 were asked to list any PPE they were aware of and they used. This was again followed by yes/no  
29 option for welding helmet/faceshield, protective gloves, welding goggles/eyeshield,  
30 respirators/masks, sturdy footwear, apron, ear muffs and an open option for any other  
31 equipment they wore for their protection. The welders were asked to show us the PPE they  
32 used during the welding.  
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3 Data collected were entered into an excel sheet and analysed using SPSS 11.5. Bivariate analysis  
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6 for categorical data was done using chi square test ( $\chi^2$ ). The strength of association was  
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8 calculated using Odds Ratio (OR). The probability of significance was set at 5% level of  
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10 significance and 95% Confidence Interval. Data processing and analysis were done using  
11  
12 Statistical Package for Social Sciences (SPSS) version 11.5  
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15  
16 The approval for the study was taken from the Institutional Ethical Review Board of B P Koirala  
17  
18 Institute of Health Sciences. Informed consent was taken from the participants ensuring  
19  
20 confidentiality and anonymity of the participants. Permission was sought from the welders in  
21  
22 the picture to use it for scientific publication.  
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24

## 25 26 Results

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28 The data was collected from a total of 300 welders who agreed to participate became the study  
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30 respondents. The response rate was 100%. All welders were male with a mean age of 31.29  
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32 years with a standard deviation of 6.57 years. Almost half (48%) of the welders were in the age  
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34 group of 30-39 years. In total 93% of the welders in this study were literate. There were 16.3%  
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36 of welders working for more than 10 years. The mean duration of employment in years of the  
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38 welders in this study was 6.94 years.  
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43 The study showed that 90.7% of welders were aware of one or more hazards of welding.  
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45 Excessive brightness (90.7%) was the most common hazard identified by the welders working in  
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47 the area followed by sharp metals (86.7%), heat (83.7%), physical environment (83.3%),  
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49 electrical current (80.30%), noise (75.70%), welding fumes (51.70%), sparks (44.3%) and  
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51 vibration (17%).  
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3 Table 1 shows that 90% of welders were aware of at least one kind of PPE while only 47.7% of  
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5 welders use at least one kind of PPE during work. While welding goggles/eye shields (86.7%)  
6  
7 were the most commonly reported PPE for use, the most commonly worn PPE was sturdy  
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9 footwear (40.7%)  
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12 Sun glasses were considered protective and was used as a personal protective device by 74.3%  
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14 of the 260 welders who reported being aware about the welding goggles/eye shields as a PPE.  
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16 None of the welders used welding masks while cotton mask was used by 45% of the 300  
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18 welders in place of the welding masks they reported they were aware of. The sunglasses and  
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20 cotton masks are however not included in the table, as they are not recommended PPE for  
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22 welding. The illustration of the sun glasses and cotton mask used by the welders in Nepal is  
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24 depicted in figure 1.  
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31 There was a positive association between level of education and the awareness of hazards  
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33 among the welders ( $p < 0.05$ ). The welders who reported as being aware of the hazards of  
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35 welding were seven times more likely to have had at least primary level education (OR= 7.621;  
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37 CI= 2.738-21.208 ) and sixty times more likely more likely to have had secondary level or more  
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39 education (OR= 60.5; CI=14.517-252.132) compared to those welders who did not report as  
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41 being aware of the hazards of welding. The duration of employment was also seen to be  
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43 negatively associated with the awareness of hazards among the welders ( $p < 0.05$ ) i.e. the  
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45 welders who reported as being aware of the hazards were more likely to have been working for  
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47 longer duration as shown in table 2.  
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54 Table 3 entails that awareness regarding use of PPE was significantly associated with level of  
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56 education ( $p < 0.05$ ). The welders who reported as being aware of the PPE were five times more  
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3 likely to have received education up to secondary level or more compared to those welders  
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5 who did not report as being aware of the PPE. This association was not found to be statistically  
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7 significant.  
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11 There was a significant positive relation between welders who reported use of PPE and the  
12  
13 welders who attended higher education ( $p < 0.05$ ). The welders who reported using PPE at work  
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15 were two times more likely to have had attended secondary education or more (OR= 2.167; CI=  
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17 1.865-5.430). The reported use of PPE by the welders was seen to be more among the welders  
18  
19 who had been working for a longer duration in years ( $p < 0.05$ ). The welders who reported using  
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21 PPE at work were almost four times more likely to have been working for 11 years or  
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23 more (OR=4.98; CI= 1.99-7.97) as shown in table 4.  
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30 Table 5 shows that odds of finding a welder who was aware of the hazards among the welders  
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32 who reported using PPE during welding is twice the odds of finding a welder who was aware of  
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34 hazards among those who did not report using PPE during welding (OR= 2.52; CI= 1.09-5.81). It  
35  
36 was also seen that the odds of finding a welder who was aware of PPE for welding was among  
37  
38 the welders who reported using a PPE is five times the odds of finding a welder who was aware  
39  
40 of the PPE among the welders who did not report the use PPE during welding (OR= 5.13; CI=  
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42 2.34-11.26).  
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48 All welders learned their welding skills working as an apprentice to an experienced welder. They  
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50 had not had any formal training on welding, health and safety. The knowledge on hazards, PPE  
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52 and use of PPE were all limited to self-learning on the job.  
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**Figure 1: Welders at work using only sunglasses and cotton mask during welding in Nepal**

(Separate JPEG file attached "Welder PPE PIC.jpg")

**Table 1: Distribution of welders according to Awareness and Use of PPE (N=300)**

| Awareness among welders     |                                |                      |
|-----------------------------|--------------------------------|----------------------|
| PPE types                   | Number of welders <sup>#</sup> | Percent <sup>#</sup> |
| At least one                | 270                            | 90.0                 |
| Welding goggles/ eye shield | 260                            | 86.7                 |
| Protective Gloves           | 255                            | 85.0                 |
| Sturdy footwear             | 244                            | 81.3                 |
| Welding helmet/Face shield  | 162                            | 54.0                 |
| Apron                       | 161                            | 53.7                 |
| Masks                       | 156                            | 52.0                 |
| Earmuffs                    | 59                             | 19.7                 |
| Use Among the welders       |                                |                      |
| At least one                | 143                            | 47.7                 |
| Sturdy footwear             | 122                            | 40.7                 |

|                             |    |       |
|-----------------------------|----|-------|
| Protective Gloves           | 70 | 23.3  |
| Welding goggles/ eye shield | 54 | 18.0  |
| Apron                       | 50 | 16.67 |
| Welding helmet/Face shield  | 19 | 6.3   |
| Earmuffs                    | 16 | 5.3   |

# Multiple responses recorded per welder

**Table 2: Factors associated with awareness of hazards among welders of eastern Nepal.**

| Variables              | Aware of Hazards |    | p value* | Unadjusted Odds Ratio |                |
|------------------------|------------------|----|----------|-----------------------|----------------|
|                        | Yes              | No |          | OR                    | 95% CL         |
| Education              |                  |    |          |                       |                |
| Illiterate             | 10               | 11 | 0.000    | 1.00                  |                |
| Primary                | 87               | 14 |          | 7.62                  | 2.74 - 21.21   |
| Secondary and Above    | 165              | 3  |          | 60.50                 | 14.52 - 252.13 |
| Duration of Employment |                  |    |          |                       |                |
| 1-5 years              | 157              | 9  | 0.012    | 1.00                  |                |
| 6-10 years             | 73               | 12 |          | 0.34                  | 0.14 - 0.86    |
| 11 years and more      | 42               | 7  |          | 0.34                  | 0.12 - 0.97    |

\* Calculated using  $\chi^2$  at  $df=2$

**Table 3: Factors associated with awareness of PPE among welders of eastern Nepal.**

| Variables | Aware of PPE | p value* | Unadjusted Odds Ratio |
|-----------|--------------|----------|-----------------------|
|-----------|--------------|----------|-----------------------|

|                               | Yes | No |       | OR   | 95% CL       |
|-------------------------------|-----|----|-------|------|--------------|
| <b>Education</b>              |     |    |       |      |              |
| Illiterate                    | 16  | 5  |       | 1.00 |              |
| Primary                       | 96  | 15 | 0.004 | 2.00 | 0.63 - 6.26  |
| Secondary and Above           | 158 | 10 |       | 4.93 | 1.50 - 16.23 |
| <b>Duration of Employment</b> |     |    |       |      |              |
| 1-5 years                     | 145 | 21 |       | 1.00 |              |
| 6-10 years                    | 80  | 5  | 0.220 | 2.13 | 0.84 - 6.38  |
| 11 years and more             | 45  | 4  |       | 1.62 | 0.53 - 4.99  |

\*Calculated using  $\chi^2$  at  $df=2$

**Table 4: Factors associated with use of PPE at work among welders of eastern Nepal.**

| Variables                     | Use of PPE at Work |     | p value * | Unadjusted Odds Ratio |             |
|-------------------------------|--------------------|-----|-----------|-----------------------|-------------|
|                               | Yes                | No  |           | OR                    | 95% CL      |
| <b>Education</b>              |                    |     |           |                       |             |
| Illiterate                    | 9                  | 12  |           | 1.00                  |             |
| Primary                       | 30                 | 81  | 0.000     | 0.49                  | 0.18-1.29   |
| Secondary and Above           | 104                | 64  |           | 2.16                  | 0.86 -5.43  |
| <b>Duration of Employment</b> |                    |     |           |                       |             |
| 1-5 years                     | 64                 | 102 |           | 1.00                  |             |
| 6-10 years                    | 44                 | 41  | 0.000     | 1.71                  | 1.00 - 2.89 |
| 11 years and more             | 35                 | 14  |           | 3.98                  | 1.99 - 7.97 |

\*Calculated using  $\chi^2$  at  $df=2$

**Table 5: Association of awareness regarding hazards and PPE with use of PPE at work.**

| Awareness        | Use of PPE at Work |    | p value* | Unadjusted Odds Ratio |             |
|------------------|--------------------|----|----------|-----------------------|-------------|
|                  | Yes                | No |          | OR                    | 95% CL      |
| Aware of Hazard  |                    |    |          |                       |             |
| Not Aware        | 18                 | 10 | 0.046    | 1.00                  |             |
| Aware            | 223                | 49 |          | 2.52                  | 1.09 - 5.81 |
| Aware of PPE Use |                    |    |          |                       |             |
| Not Aware        | 15                 | 15 | 0.000    | 1.00                  |             |
| Aware            | 226                | 44 |          | 5.13                  | 2.34 -11.26 |

\* Calculated using  $\chi^2$  at  $df=1$

## Discussion

Almost half (48%) of the welders were in the category of 30-39 years, similar to the finding by Sabitu et al<sup>14</sup>, where majority (44.5 %) fall in the same category but differs with the study by Isah et al<sup>15</sup> in the same country where higher proportion of welders (40.3%) were in the 20-29 years category. Although 93% of the welders in the study had some schooling, only 90% of the welders had knowledge of one or more hazards of welding. Findings are similar to the study by Singh SB on jute mill workers of the same region.<sup>16</sup>

The working population in this profession has high turnover in this area with a very small number working for a longer duration in this profession. However, studies in Nigeria by Isah<sup>15</sup>

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2  
3 shows 74.8% welders with experience of more than 10 years including 24.7% of welders with  
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5 experience of more than 21 years. Similarly, a Canadian study by El-Zein et al<sup>17</sup> shows 81.8%  
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7 welders working for 10 years and more with 22.8% of welders aged 30 years and above and  
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9 were working for 20.33 years in this profession. The studies by Isah et al<sup>15</sup> and Sabitu et al<sup>14</sup> in  
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11 Nigeria which show there are welders in even in the above 60 years category. The reasons for  
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13 absence of welders above 49 in this study could be due to migration of skilled experienced  
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15 welders to other areas for better wages and opportunities.  
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21 This profession is regarded as the most hazardous profession and not all of the welders are  
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23 aware of all the hazards.<sup>18</sup> In our study, ninety percent of welders were aware of at least one  
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25 hazard of welding. The comparison with other studies showed inconsistent results. The study by  
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27 Isah EC et al<sup>15</sup> in Benin, Nigeria showed 91.6% of welders being aware of one or more hazard of  
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29 welding while another study in Kaduna, Nigeria by Sabitu K et al<sup>14</sup> showed 77.9% of awareness  
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31 of one or more hazards of welding in welders.  
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37 Excessive brightness was the most frequently identified hazard by the welders in our study.  
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39 Welding fumes which is regarded as the combination of highly toxic metals and their oxides<sup>19</sup>  
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41 was identified as a hazard by 51.7% of the welders. There are also 9.3% of welders who were  
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43 not aware of any specific hazard at their work. They could not think of any harmful factor in  
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45 welding.  
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51 In the study, 90.7% of welders were aware of welding goggles/eye shield to protect eyes. The  
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53 same the percentage of welders were aware of at least one PPE. Although 75% of the welders  
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55 identified noise as hazard at their working place only 19.7% were aware about earmuffs. The  
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3 utilisation of at least one PPE among the welders was 47.7%, as compared to the study by  
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5 Sabitu K et al (34.2%)<sup>14</sup> and the study by Isah EC et al<sup>15</sup> (35.9%) in Nigeria. The most commonly  
6  
7 used PPE was masks (45%), whereas the most common PPE worn were Welding goggles in both  
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9 Nigerian studies; 60.9% by Sabitu K et al<sup>14</sup> and 35.9% by Isah EC et al<sup>15</sup>. Welding goggles/ face  
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11 shield use was seen among only 18% of the welders in the current study.  
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17 It was found that a very high proportion of welders (74.3%) used the general sunglasses  
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19 regularly at work. Sunglasses are not among the recommended PPE<sup>20</sup> to protect from welding  
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21 radiation to the eye. The reason for provision of the sunglasses by the employer may be due to  
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23 being cheaper, easy available and comfortable. The sunglasses used were also not certified for  
24  
25 UV protection. The mask used by the welders in this study is also the commonly used cotton  
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27 mask. This also does not meet the requirement<sup>21</sup> as a respirator for use during welding. It was  
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29 also seen that more than half of the welders (52.3%) did not use any PPE during work.  
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35 Level of education had a significant relationship with awareness of hazard ( $p<0.05$ ), awareness of  
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37 PPE ( $p<0.05$ ) and use of PPE ( $p<0.05$ ) in this study. This showed that with increase in level of  
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39 education among population awareness and practices increased. Welders who have had higher  
40  
41 level of education have the tendency to read news, get updates increases the awareness of  
42  
43 hazards & PPE, and they tend to increase the practice of use of PPE as well. Sabitu et al<sup>14</sup> also  
44  
45 showed that awareness increased significantly with increase in education level.  
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50  
51 It was found that welders who were employed for a longer duration reported being less aware  
52  
53 of the hazards of welding. It is maybe generally expected for the opposite to be true. The  
54  
55 reason for such findings in this study could be due to welders working for longer duration failing  
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3 to recognise the exposure as hazard after being exposed to them for many years. However this  
4  
5 is just a possible explanation which needs to be further explored. However in terms of using  
6  
7 PPE at work, the welders who have been working for longer duration report more use of PPE. It  
8  
9 is seen that welders who have been working for shorter duration are more aware of hazard but  
10  
11 use of PPE is lower. One possible reason for this may be younger people having the tendency of  
12  
13 having more risk taking behavior. However this also needs to be explored further in future  
14  
15 studies.  
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20  
21 Awareness on hazard ( $p < 0.05$ ) and awareness on PPE ( $p < 0.05$ ) both when compared with the  
22  
23 use of PPE at work showed significant relationship. This shows that being aware has positive  
24  
25 effect on practice. In this study we can see that more the people are aware of the hazard and  
26  
27 aware of equipment to protect from it, more is the tendency to use those equipment increases.  
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31  
32 All welders learned welding through apprenticeship under an experienced welder for few years.  
33  
34 No welders in had any vocational training as compared to Sabitu et al<sup>14</sup> finding where 8.5% of  
35  
36 welders of Kaduna, Nigeria went to welding school. Learning by apprenticeship is a common  
37  
38 practice in welding here and also in data by Sabitu K et al<sup>14</sup> in Kaduna also show more than 90 %  
39  
40 welders learnt by apprenticeship. There is no vocational training course or welding school so far  
41  
42 for learning welding skills in this area.  
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48  
49 The welders were also not trained or oriented regarding hazards and safety measures at work  
50  
51 including basic first aid at work. This is also one of the reasons they are not aware of many  
52  
53 hazards of the profession and about protective measures.  
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3 There are a few limitations of the study. Though, the sample size was calculated with a scientific  
4  
5 formula the width of the confidence intervals show that the sample size is inadequate. A study  
6  
7 with a larger sample size might provide a more accurate estimate of the study variables.  
8  
9 Generalizability of this study to the other parts of Nepal, predominantly to urban cities is  
10  
11 limited as these cities have more workshops, more welders and therefore, can have different  
12  
13 working conditions.  
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18  
19 Welding is a hazardous profession which exposes the workers to various kinds of physical and  
20  
21 chemical hazards in absence of judicious and effective use of personal protective equipment.  
22  
23 The unwanted exposure can lead to variety of disease conditions among the welders. The use  
24  
25 of recommended PPE at all times minimizes the exposure to these hazards. All the welders in  
26  
27 three districts of eastern Nepal are not aware of the hazards. Many welders are still not aware  
28  
29 of the PPE and a much smaller proportion among them actually use PPE during welding. The  
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31 mask and sunglasses being used are not the recommended PPE - respirators and welding  
32  
33 goggles should be used instead.  
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41 Welders in the study area are not trained and have acquired their welding skills while working  
42  
43 on the job. There is no culture of occupational safety and health among the welders and their  
44  
45 employees. This study provides only a glance of the actual problems and risks involved in this  
46  
47 profession. **There is a gap between the knowledge the welders report on awareness of hazard  
48  
49 and PPE with the actual using of PPE at work by the same welders. This gap needs to be further  
50  
51 explored so that appropriate interventions can be planned to close this gap. With a high level of  
52  
53 awareness present in this group an intervention to increase the use of PPE is needed.**  
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3 Occupational health and safety needs to be promoted by the labour organizations in Nepal and  
4  
5 should be highlighted by the public health agencies which can make this a priority issue among  
6  
7  
8 our policy makers.  
9

### 10 11 **Acknowledgements**

12  
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14  
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16  
17 gave us their invaluable time. We are also thankful to association of Metal Workshops'  
18  
19 Association (GRILL BYABASAYI SANGH) which provided us the list of workshops and also an  
20  
21 important insight into the area and the work practices.  
22  
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25  
26 **Competing Interests:** none declared.  
27

28  
29 **Funding:** No funds were available.  
30

31  
32 **Data :** No additional data available.  
33

### 34 35 **Authors Contributions:**

36  
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38  
39 SS Budhathoki was responsible for conceptualizing the research, data collection, data analysis  
40  
41 and writing preliminary drafts.

42  
43  
44 SB Singh was instrumental in refining the research idea, questionnaire designing and review of  
45  
46 drafts.

47  
48  
49 Sagtani RA worked partly on the statistical analysis and reviewing and preparing the final draft  
50  
51 of the manuscript.

52  
53  
54 SR Niraula was responsible for study design, questionnaire designing and the statistical analysis.

55  
56  
57  
58 PK Pokharel was instrumental in supervision of all the aspects - refining the research idea,  
59  
60 approving the questionnaire and critical appraisal of preliminary drafts.

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Welders at work using only sunglasses and cotton mask during welding in Nepal  
90x67mm (300 x 300 DPI)

Review only

## STROBE STATEMENT FOR THE STUDY

Title : **Awareness of occupational hazards and use of safety measures among welders: a cross-sectional study from eastern Nepal.**

| Item No                          | Recommendation   | Main Document (page no.) |
|----------------------------------|--|--------------------------|
| <b>Title and abstract</b> [1]    | (a) Indicate the study's design with a commonly used term in the title or the abstract.  | addressed                |
|                                  | (b) Provide in the abstract an informative and balanced summary of what was done and what was found  | addressed                |
| <b>Introduction</b>              |  |                          |
| Background [2]                   | Explain the scientific background and rationale for the investigation being reported   | Pg-6                     |
| Objectives [3]                   | State specific objectives, including any pre specified hypotheses  | Pg-7                     |
| <b>Methods</b>                   |  |                          |
| Study design [4]                 | Present key elements of study design early in the paper  | Pg 7                     |
| Setting [5]                      | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection  | Pg 7                     |
| Participants [6]                 | Give the eligibility criteria, and the sources and methods of selection of participants  | Pg 7                     |
| Variables [7]                    | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable   | -                        |
| Data sources/<br>measurement [8] | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group                         | Pg 8                     |
| Bias [9]                         | Describe any efforts to address potential sources of bias  | -                        |
| Study size [10]                  | Explain how the study size was arrived at  | Pg 8                     |
| Quantitative variables [11]      | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why   | -                        |
| Statistical methods [12]         | (a) Describe all statistical methods, including those used to control for confounding  | Pg 9                     |
|                                  | (b) Describe any methods used to examine subgroups and interactions  | -                        |
|                                  | (c) Explain how missing data were addressed  | -                        |
|                                  | (d) If applicable, describe analytical methods taking account of sampling strategy   | Pg 8-9                   |
|                                  | (e) Describe any sensitivity analyses  | -                        |
| <b>Results</b>                   |  |                          |
| Participants [13]                | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed            | Pg 8                     |
|                                  | (b) Give reasons for non-participation at each stage   | -                        |
|                                  | (c) Consider use of a flow diagram   | -                        |
| Descriptive data [14]            | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders   | Pg 8-9                   |
|                                  | (b) Indicate number of participants with missing data for each variable of interest  | -                        |
| Outcome data [15]                | Report numbers of outcome events or summary measures   | Pg 9-10                  |
| Main results [16]                | (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | Pg 10-11                 |
|                                  | (b) Report category boundaries when continuous variables were categorized  | addressed                |
|                                  | (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period   | -                        |
| Other analyses [17]              | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses   | -                        |



|                          |      |  |          |
|--------------------------|------|--|----------|
| <b>Discussion</b>        |      |  |          |
| Key results              | [18] | Summarise key results with reference to study objectives   | Pg 15-18 |
| Limitations              | [19] | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias                 | Pg 18    |
| Interpretation           | [20] | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | Pg 15-19 |
| Generalisability         | [21] | Discuss the generalisability (external validity) of the study results  | Pg 18    |
| <b>Other information</b> |      |  |          |
| Funding                  | [22] | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based              | Pg 19    |

# BMJ Open

## Awareness of occupational hazards and use of safety measures among welders : a cross-sectional study from eastern Nepal.

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Manuscripts

## TITLE PAGE

**Title: Awareness of occupational hazards and use of safety measures among welders : a cross-sectional study from eastern Nepal.**

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## ABSTRACT

**Title: Awareness of occupational hazards and use of safety measures among welders : a cross-sectional study from eastern Nepal.**

### **Objective:**

Proper use of safety measures among welders are important ways of preventing and/or reducing a variety of health hazards, the welders are exposed to during welding. Knowledge of hazards, personal protective equipments (PPE) and use of PPE among the welders in Nepal is not known. We designed a study to assess the awareness of hazards, awareness of PPE and its use among welders; and to find the possible relation between awareness and use of PPE among welders of eastern Nepal.

### **Materials and Methods:**

A cross-sectional study, among 300 welders selected using simple random sampling from three districts of eastern Nepal, was conducted using a semi-structured questionnaire. Data regarding age, education level, duration of employment, awareness of hazards, safety measures and the actual use of safety measures were recorded.

### **Results:**

Overall, 272 (90.7%) welders were aware of at least one hazard of welding and similar proportion of welders were aware of at least one PPE. However, only 47.7% used one or more type of PPE. Education and duration of employment were both significantly associated with the awareness of hazard, awareness of PPE and the use of PPE. The welders who reported using PPE during welding were two times more likely to have been aware of the hazard (OR=2.52,

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3 95% CI 1.09-5.81) and five times more likely to have been aware of PPE compared to the  
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6 welders who did not report the use of PPE (OR=5.13, 95%CI 2.34-11.26).  
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### 8 **Conclusion:**

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11 The welders using the PPE are those who were aware of hazards and PPE. There is gap between  
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13 being aware of hazard or PPE (90%) and use of PPE (47%) at work. Further research is needed  
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15 for identifying the underlying factors leading to low utilisation of PPE despite of being  
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17 knowledgeable among the welders of eastern Nepal.  
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## 28 **ARTICLE SUMMARY**

### 29 **STRENGTHS OF THE STUDY**

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- 32 • Based on occupation health and safety which is a neglected area of research in Nepal.
  - 33 • Study methodology: Use of pre-tested questionnaire, scientific calculation of sample  
34 size, random sampling and calculation of odds ratios.
  - 35 • Makes an attempt to bridge the information gap on the awareness and practice of use  
36 PPE among welders in this part of the world.
  - 37 • The study highlights frequent use of sun glasses and cloth masks as personal protective  
38 equipment which is not recommended.  
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### 46 **LIMITATIONS OF THE STUDY**

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- 49 • The sample size of the current study is small which is reflected by width of confidence  
50 intervals.  
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  - 53 • The external validity of the study is limited in context of urban cities which has more  
54 workshops and more welders.  
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## SUMMARY BOX

Present state of scientific knowledge before the study was done.

- Occupational health and safety is a major concern in the South East Asian region which has a workforce of about 500 million people (2011).
- Welders of the South east Asian region are exposed to a wide range of occupational hazards and risks.

Need for the study

- The concept of occupational health and safety is relatively new which is exemplified by very few number of studies related to working conditions of the working population.
- In eastern region of Nepal, there is no organized occupational health service for welders and their adherence to safety measures is also unknown.

Results which were not known before

- There is a gap between knowledge and practice among welders in eastern Nepal.
- Awareness does not necessitate practice of protective equipment.
- Sun glasses and cloth masks are being used as personal protective equipment which is not recommended.

Policy and Practice implications

- Use and adherence to the occupational safety and health measures needs to stressed and enforced by the Ministry of Labor and Transport Management in Nepal.

## Introduction

Occupational Health aims at the promotion and maintenance of the highest degree of physical, mental and social wellbeing of workers in all occupations.<sup>1</sup> Welding, a skilled profession has been in use since the ancient times.<sup>2</sup> Welders join and cut metal parts using flame or electric arc and other sources of heat to melt and cut or to melt and fuse metal.<sup>3</sup>

Welding being a hazardous profession with a multiplicity of factors that can endanger the health of a welder, such as heat, burns, radiation (ultraviolet, visible and infrared), noise, fumes, gases, electrocution, and even the uncomfortable postures involved in the work; the high variability in chemical composition of welding fumes, which differs according to the work-piece, method employed, and surrounding environment; and the routes of entry through which these harmful agents access the body.<sup>4</sup> Some of the health effects of welding on health includes photo-keratitis or arc eye, metal fume fever, decrease in lung function, pneumoconiosis, asthma, photo-dermatitis and fertility abnormalities.<sup>5-11</sup>

Hazards arising from workplaces could impair the health and wellbeing of the workers, therefore it is necessary to anticipate, recognize, evaluate and control such hazards.<sup>12</sup> The use of Personal Protective Equipment (PPE) at all times is a good safe practice by welders to protect from exposure to the hazards and injuries during welding or cutting.<sup>13</sup>

Occupational Health and Safety (OSH) is not a old science however, the working conditions of workers in general and welders in particular is unsatisfactory in Nepal. The fact of low awareness of safety measures and the low frequency of their regular utilization are a matter of concern in Nepal. These may be due to various reasons like low level of education, lack of

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3 institutional training, age group structure and work experience along with non-adaptation of  
4 regulatory measures by concerned authorities on safety precautions.<sup>14</sup> Welders in our study  
5 area do not have organised occupational health services and to make matters worse there is  
6 lack of awareness regarding the importance of occupational safety at the workplace. The  
7 literature search showed that studies in Nepal have not tried to find the use of protective  
8 measures and the factors which facilitate their use. Thus, the current study was designed to  
9 assess awareness of occupational hazards and protective measures among welders working in  
10 three districts of eastern Nepal. We also tried to find the factors associated with awareness of  
11 occupational hazards and protective measures and use of protective measures, and possible  
12 relationship of awareness with the actual use of PPE. This study was envisioned to highlight the  
13 need for research in the area of occupational health which is a neglected issue in our country.  
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### 33 **Materials and Methods**

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35 A cross-sectional study was designed to be conducted among welders working in three districts  
36 of eastern Nepal namely Jhapa, Morang and Sunsari from the period of July 2010 to July 2011.  
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38 According to the available literature ( Isah et al )<sup>15</sup>, the most prevalent health complaints were  
39 arc eye injuries, followed by foreign bodies in the eyes, back/waist pain, metal fume fever,  
40 cuts/injuries from sharp metals etc. Among which, the least prevalent (37.7%) work related  
41 complaint was cut injuries from sharp metals .  
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50 Thus, Prevalence (p) = 37.7%

51 Compliment of prevalence (q) = 100-37.7 = 62.3%

52 Permissible Error (PE) at 15%, L = 15% of 37.7= 5.655  
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$$\begin{aligned}\text{Sample size (n)} &= (Z_{1-\alpha})^2 * pq/L^2 \\ &= (1.96)^2 * 37.7*62.3/ (5.655)^2 \\ &= 283 \text{ (Approx.)}\end{aligned}$$

Inflating the sample size by 5% we got the estimated sample size of 298. We planned to interview 300 grill workers, 100 from each district.

Average number of welders present per shop was three. (Results based on preliminary survey of 15 workshops of the study area). Taking 3 welders per shop, the number of workshops required for survey is =  $298/3 = 100$  Workshops i.e. number of work shop per district is =  $100/3 = 34$  shops per district. So, the workshops were selected through a simple random sampling from list of metal workshops provided by the Metal Workshops' Association (GRILL BYABASAYI SANGH) using computer generated random numbers.

Welders working in the workshops listed in the Metal Workshops' Association were included in the study. The workshop was visited with prior appointment from the workshop administration. The investigators conducted individual interviews of 45-90 minutes with the welders using a semi-structure questionnaire. The questionnaire comprised of open questions on age, level of education and duration of employment in years. These variables were divided into categories on the basis of literature review and to show their impact on knowledge and use of PPE during analysis. Questions on awareness of hazards of welding, awareness of PPE and use of PPE were structured. The welders were first asked to list the hazards of welding. Followed by which probing questions on specific hazards light/radiation, welding fumes, sharp metals, electric current, heat, noise, sparks, vibration and physical environment at work were asked as a yes/no answers were asked. Similarly for awareness and use of PPE, the welders were asked to list any

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3 PPE they were aware of and they used. This was again followed by yes/no option for welding  
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5 helmet/faceshield, protective gloves, welding goggles/eyeshield, respirators/masks, sturdy  
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7 footwear, apron, ear muffs and an open option for any other equipment they wore for their  
8  
9 protection. The welders were asked to show us the PPE they used during the welding.  
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11  
12 Data collected were entered, edited and coded in an Microsoft excel sheet . The data was then  
13  
14 exported to Statistical Package for Social Sciences (SPSS) version 11.5 for analysis. Bivariate  
15  
16 analysis for categorical data was done using chi square test ( $\chi^2$ ). The strength of association was  
17  
18 calculated using Odds Ratio (OR) using Epi Info™ 7. The probability of significance was set at  
19  
20 5%.  
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25  
26 The approval for the study was taken from the Institutional Ethical Review Board of B P Koirala  
27  
28 Institute of Health Sciences. Informed consent was taken from the participants ensuring  
29  
30 confidentiality and anonymity of the participants. Permission was sought from the welders to  
31  
32 use the picture for scientific publication.  
33  
34

### 35 36 **Results**

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38 The data was collected from a total of 300 welders who agreed to participate in the current  
39  
40 study. Since, the permission was taken from the Metal Workshop's association and the authors  
41  
42 have been working in this particular area with other programs of occupational safety and  
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44 health, all the workers gave a positive response leading to a response rate of 100%. All welders  
45  
46 were male with a mean age of 31.29 years with a standard deviation of 6.57 years. Almost half  
47  
48 (48%) of the welders were in the age group of 30-39 years. In total 93% of the welders in this  
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50 study were literate. There were 16.3% of welders working for more than 10 years. The mean  
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3 duration of employment in years of the welders in this study was 6.94 years (not shown in  
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6 table).

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8 The study showed that 90.7% of welders were aware of one or more hazards of welding.  
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10 Excessive brightness (90.7%) was the most common hazard identified by the welders working in  
11  
12 the area followed by sharp metals (86.7%), heat (83.7%), physical environment (83.3%),  
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14 electrical current (80.30%), noise (75.70%), welding fumes (51.70%), sparks (44.3%) and  
15  
16 vibration (17%) (not shown in table).  
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21 Table 1 shows that 90% of welders were aware of at least one kind of PPE while only 47.7% of  
22  
23 welders use at least one kind of PPE during work. While welding goggles/eye shields (86.7%)  
24  
25 were the most commonly reported PPE for use, the most commonly worn PPE was sturdy  
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27 footwear (40.7%)  
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31 Sun glasses were considered protective and was used as a personal protective device by 74.3%  
32  
33 of the 260 welders who reported being aware about the welding goggles/eye shields as a PPE.  
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35 None of the welders used welding masks while cotton mask was used by 45% of the 300  
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37 welders who reported to be aware of welding masks. The sunglasses and cotton masks are  
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39 however not included in the table, as they are not recommended PPE for welding.  
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44 The illustration of the sun glasses and cotton mask used by the welders in Nepal is depicted in  
45  
46 figure 1.  
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48  
49 There was a positive association between level of education and the awareness of hazards  
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51 among the welders ( $p < 0.001$ ). Compared to illiterate welders, the welders with primary  
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53 education were seven times more likely to be aware of hazards of welding (OR= 7.621, 95%CI  
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55 2.738-21.208 ), while the odds of awareness regarding welding was sixty times higher among  
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3 welders with secondary level of education than welders who were illiterate (OR= 60.5, 95%CI  
4 14.517-252.132) .  
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8 The duration of employment was seen to be negatively associated with the awareness of  
9 hazards among the welders ( $p = 0.01$ ) i.e. the chances of welders being aware of the hazards  
10 was 66 percent more for those welders working for more than five years compared to those  
11 who worked for 1 -5 years as shown in table 2.  
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14  
15 Table 3 entails that awareness regarding use of PPE was significantly associated with secondary  
16 level of education ( $p = 0.004$ ). The welders who had received secondary level of education were  
17 about five times (OR=4.93, 95%CI 1.50-16.23) more likely to being aware of PPE compared to  
18 illiterate welders.  
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29 There was a significant positive relation between reported use of PPE and secondary level of  
30 education ( $p < 0.001$ ). The welders who reported using PPE at work were two times more likely  
31 to have had attended secondary education or more (OR= 2.167, 95%CI 1.865-5.430).  
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38 Interestingly, the awareness regarding PPE did not find any significant association with duration  
39 of employment however, use of PPE by the welders was seen to be more among the welders  
40 who had been working for a longer duration of time ( $p < 0.001$ ). The welders who have been  
41 working for 11 years or more were almost four times more likely to using PPE at work  
42 compared to those who had work experience of 1 – 5 years (OR=3.98, 95%CI 1.99-7.97) as  
43 shown in table 4.  
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53 Table 5 shows that the odds of using PPE during welding was twice among welders who were  
54 aware of the health hazards associated with welding than those who were not aware (OR=  
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2.52, 95%CI 1.09-5.81). It was also seen that welders who knew about PPE were five times more likely to use them during welding compared to those who did not know about them (OR= 5.13, 95%CI 2.34-11.26).

All welders learned their welding skills working as an apprentice to an experienced welder. They had not had any formal training on welding, health and safety. The knowledge on hazards, PPE and use of PPE were all limited to self-learning on the job.

**Figure 1: Welders at work using only sunglasses and cotton mask during welding in Nepal**

(Separate JPEG file attached "Welder PPE PIC.jpg")

**Table 1: Distribution of welders according to Awareness and Use of PPE (n=300)**

| Awareness among welders     |                                |                      |
|-----------------------------|--------------------------------|----------------------|
| PPE types                   | Number of welders <sup>#</sup> | Percent <sup>#</sup> |
| At least one                | 270                            | 90.0                 |
| Welding goggles/ eye shield | 260                            | 86.7                 |
| Protective Gloves           | 255                            | 85.0                 |
| Sturdy footwear             | 244                            | 81.3                 |
| Welding helmet/Face shield  | 162                            | 54.0                 |
| Apron                       | 161                            | 53.7                 |
| Masks                       | 156                            | 52.0                 |
| Earmuffs                    | 59                             | 19.7                 |

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 Use Among the welders
 

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|                             |     |       |
|-----------------------------|-----|-------|
| At least one                | 143 | 47.7  |
| Sturdy footwear             | 122 | 40.7  |
| Protective Gloves           | 70  | 23.3  |
| Welding goggles/ eye shield | 54  | 18.0  |
| Apron                       | 50  | 16.67 |
| Welding helmet/Face shield  | 19  | 6.3   |
| Earmuffs                    | 16  | 5.3   |

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# Multiple responses recorded per welder

**Table 2: Factors associated with awareness of hazards among welders of eastern Nepal.**

| Variables              | Aware of Hazards |    | p value * | Unadjusted Odds Ratio |                |
|------------------------|------------------|----|-----------|-----------------------|----------------|
|                        | Yes              | No |           | OR                    | 95% CL         |
| Education              |                  |    |           |                       |                |
| Illiterate             | 10               | 11 | <0.001    | 1.00                  |                |
| Primary                | 87               | 14 |           | 7.62                  | 2.74 - 21.21   |
| Secondary and Above    | 165              | 3  |           | 60.50                 | 14.52 - 252.13 |
| Duration of Employment |                  |    |           |                       |                |
| 1-5 years              | 157              | 9  | 0.012     | 1.00                  |                |
| 6-10 years             | 73               | 12 |           | 0.34                  | 0.14 - 0.86    |
| 11 years and more      | 42               | 7  |           | 0.34                  | 0.12 - 0.97    |

\* Calculated using  $\chi^2$  at  $df=2$

**Table 3: Factors associated with awareness of PPE among welders of eastern Nepal.**

| Variables                     | Aware of PPE |    | p value * | Unadjusted Odds Ratio |              |
|-------------------------------|--------------|----|-----------|-----------------------|--------------|
|                               | Yes          | No |           | OR                    | 95% CL       |
| <b>Education</b>              |              |    |           |                       |              |
| Illiterate                    | 16           | 5  | 0.004     | 1.00                  |              |
| Primary                       | 96           | 15 |           | 2.00                  | 0.63 - 6.26  |
| Secondary and Above           | 158          | 10 |           | 4.93                  | 1.50 - 16.23 |
| <b>Duration of Employment</b> |              |    |           |                       |              |
| 1-5 years                     | 145          | 21 | 0.220     | 1.00                  |              |
| 6-10 years                    | 80           | 5  |           | 2.13                  | 0.84 - 6.38  |
| 11 years and more             | 45           | 4  |           | 1.62                  | 0.53 - 4.99  |

\* Calculated using  $\chi^2$  at  $df=2$

**Table 4: Factors associated with use of PPE at work among welders of eastern Nepal.**

| Variables                     | Use of PPE at Work |     | p value * | Unadjusted Odds Ratio |             |
|-------------------------------|--------------------|-----|-----------|-----------------------|-------------|
|                               | Yes                | No  |           | OR                    | 95% CL      |
| <b>Education</b>              |                    |     |           |                       |             |
| Illiterate                    | 9                  | 12  | <0.001    | 1.00                  |             |
| Primary                       | 30                 | 81  |           | 0.49                  | 0.18-1.29   |
| Secondary and Above           | 104                | 64  |           | 2.16                  | 0.86 -5.43  |
| <b>Duration of Employment</b> |                    |     |           |                       |             |
| 1-5 years                     | 64                 | 102 | <0.001    | 1.00                  |             |
| 6-10 years                    | 44                 | 41  |           | 1.71                  | 1.00 - 2.89 |
| 11 years and more             | 35                 | 14  |           | 3.98                  | 1.99 - 7.97 |

\* Calculated using  $\chi^2$  at  $df=2$

**Table 5: Association of awareness regarding hazards and PPE with use of PPE at work.**

| Awareness        | Use of PPE at Work |    | p value* | Unadjusted Odds Ratio |             |
|------------------|--------------------|----|----------|-----------------------|-------------|
|                  | Yes                | No |          | OR                    | 95% CL      |
| Aware of Hazard  |                    |    |          |                       |             |
| Not Aware        | 18                 | 10 | 0.046    | 1.00                  |             |
| Aware            | 223                | 49 |          | 2.52                  | 1.09 - 5.81 |
| Aware of PPE Use |                    |    |          |                       |             |
| Not Aware        | 15                 | 15 | <0.001   | 1.00                  |             |
| Aware            | 226                | 44 |          | 5.13                  | 2.34 -11.26 |

\*Calculated using  $\chi^2$  at  $df=1$

## Discussion

Almost half (48%) of the welders were in the category of 30-39 years, similar to the finding by Sabitu et al<sup>14</sup>, where majority (44.5 %) fall in the same category but differs with the study by Isah et al<sup>15</sup> in the same country where higher proportion of welders (40.3%) were in the 20-29 years category. Although 93% of the welders in the study had some schooling, only 90% of the welders had knowledge of one or more hazards of welding. Findings are similar to the study by Singh SB on jute mill workers of the same region.<sup>16</sup>

The working population in this profession has high turnover in this area with a very small number working for a longer duration in this profession. However, studies in Nigeria by Isah<sup>15</sup> shows 74.8% welders with experience of more than 10 years including 24.7% of welders with experience of more than 21 years. Similarly, a Canadian study by El-Zein et al<sup>17</sup> shows 81.8% welders working for 10 years and more with 22.8% of welders aged 30 years and above and



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3 were working for 20.33 years in this profession. The studies by Isah et al<sup>15</sup> and Sabitu et al<sup>14</sup> in  
4  
5 Nigeria which show there are welders in even in the above 60 years category. The reasons for  
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7 absence of welders above 49 in this study could be due to migration of skilled experienced  
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9 welders to other areas for better wages and opportunities.  
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14 This profession is regarded as the most hazardous profession and not all of the welders are  
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16 aware of all the hazards.<sup>18</sup> In our study, ninety percent of welders were aware of at least one  
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18 hazard of welding. The comparison with other studies showed inconsistent results. The study by  
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20 Isah EC et al<sup>15</sup> in Benin, Nigeria showed 91.6% of welders being aware of one or more hazard of  
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22 welding while another study in Kaduna, Nigeria by Sabitu K et al<sup>14</sup> showed 77.9% of awareness  
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24 of one or more hazards of welding in welders.  
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30 Excessive brightness was the most frequently identified hazard by the welders in our study.  
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32 Welding fumes which is regarded as the combination of highly toxic metals and their oxides<sup>19</sup>  
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34 was identified as a hazard by 51.7% of the welders. There are also 9.3% of welders who were  
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36 not aware of any specific hazard at their work. They could not think of any harmful factor in  
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38 welding.  
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43 In the study, 90.7% of welders were aware of welding goggles/eye shield to protect eyes. The  
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45 same the percentage of welders were aware of at least one PPE. Although 75% of the welders  
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47 identified noise as hazard at their working place only 19.7% were aware about earmuffs. The  
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49 utilisation of at least one PPE among the welders was 47.7%, as compared to the study by  
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51 Sabitu K et al (34.2%)<sup>14</sup> and the study by Isah EC et al<sup>15</sup> (35.9%) in Nigeria. The most commonly  
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53 used PPE was masks (45%), whereas the most common PPE worn were Welding goggles in both  
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3 Nigerian studies; 60.9% by Sabitu K et al<sup>14</sup> and 35.9% by Isah EC et al<sup>15</sup>. Welding goggles/ face  
4 shield use was seen among only 18% of the welders in the current study.  
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8  
9 It was found that a very high proportion of welders (74.3%) used the general sunglasses  
10 regularly at work. Sunglasses are not among the recommended PPE<sup>20</sup> to protect from welding  
11 radiation to the eye. The reason for provision of the sunglasses by the employer may be due to  
12 being cheaper, easy available and comfortable. The sunglasses used were also not certified for  
13 UV protection. The mask used by the welders in this study is also the commonly used cotton  
14 mask. This also does not meet the requirement<sup>21</sup> as a respirator for use during welding. It was  
15 also seen that more than half of the welders (52.3%) did not use any PPE during work.  
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28 Level of education had a significant relationship with awareness of hazard ( $p < 0.05$ ), awareness  
29 of PPE ( $p < 0.05$ ) and use of PPE ( $p < 0.05$ ) in this study. This showed that with increase in level of  
30 education among population, awareness and safety practices increased. Welders who have had  
31 higher level of education have the tendency to read news, get updates increases the awareness  
32 of hazards & PPE, and they tend to increase the practice of use of PPE as well. Sabitu et al<sup>14</sup> also  
33 showed that awareness increased significantly with increase in education level.  
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44 It was found that welders who were employed for a longer duration reported being less aware  
45 of the hazards of welding. It is maybe generally expected for the opposite to be true. The  
46 reason for such findings in this study could be due to welders working for longer duration failing  
47 to recognise the exposure as hazard after being exposed to them for many years. However this  
48 is just a possible explanation which needs to be further explored. However in terms of using  
49 PPE at work, the welders who have been working for longer duration report more use of PPE. It  
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3 is seen that welders who have been working for shorter duration are more aware of hazard but  
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5 use of PPE is lower. One possible reason for this may be younger people having the tendency of  
6  
7 having more risk taking behaviour. However this also needs to be explored further in future  
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9 studies.  
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12  
13 Awareness on hazard ( $p < 0.05$ ) and awareness on PPE ( $p < 0.05$ ) both when compared with the  
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15 use of PPE at work showed significant relationship. Thus, the current study shows that more  
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17 the people are aware of the hazard and equipment to protect from, the tendency to use those  
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19 equipment increases.  
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25 All welders learned welding through apprenticeship under an experienced welder for few years.  
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27 No welders in had any vocational training as compared to Sabitu et al<sup>14</sup> finding where 8.5% of  
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29 welders of Kaduna, Nigeria went to welding school. Learning by apprenticeship is a common  
30  
31 practice in welding here and also in data by Sabitu K et al<sup>14</sup> in Kaduna also show more than 90 %  
32  
33 welders learnt by apprenticeship. There is no vocational training course or welding school so far  
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35 for learning welding skills in this area.  
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41 The welders were also not trained or oriented regarding hazards and safety measures at work  
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43 including basic first aid at work. This is also one of the reasons they are not aware of many  
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45 hazards of the profession and about protective measures.  
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50 There are a few limitations of the study. Though, the sample size was calculated with a scientific  
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52 formula the width of the confidence intervals show that the sample size is inadequate. A study  
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54 with a larger sample size might provide a more accurate estimate of the study variables.  
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56 Generalizability of this study to the other parts of Nepal, predominantly to urban cities is  
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3 limited as these cities have more workshops, more welders and therefore, can have different  
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5 working conditions.  
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9 Welding is a hazardous profession which exposes the workers to various kinds of physical and  
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11 chemical hazards in absence of judicious and effective use of personal protective equipment.  
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14 The unwanted exposure can lead to variety of disease conditions among the welders. The use  
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16 of recommended PPE at all times minimizes the exposure to these hazards. All the welders in  
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18 three districts of eastern Nepal are not aware of the hazards. Many welders are still not aware  
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20 of the PPE and a much smaller proportion among them actually use PPE during welding. The  
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22 mask and sunglasses being used are not the recommended PPE - respirators and welding  
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24 goggles should be used instead.  
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30 Welders in the study area are not trained and have acquired their welding skills while working  
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32 on the job. There is no culture of occupational safety and health among the welders and their  
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34 employees. This study provides only a glance of the actual problems and risks involved in this  
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36 profession. There is a gap between the knowledge the welders report on awareness of hazard  
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38 and PPE with the actual using of PPE at work by the same welders. This gap needs to be further  
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40 explored so that appropriate interventions can be planned to close this gap. With a high level of  
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42 awareness present in this group an intervention to increase the use of PPE is needed.  
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45 Occupational health and safety needs to be promoted by the labour organizations in Nepal and  
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47 should be highlighted by the public health agencies which can make this a priority issue among  
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49 our policy makers.  
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## AUTHOR CONTRIBUTIONS

- SS Budhathoki developed the research idea, designed the questionnaire, collected data and wrote the preliminary drafts.
- SB Singh was responsible for streamlining the research idea, finalizing the questionnaire and critiquing the drafts.
- RA Sagtani was involved in organising data, writing and critiquing the drafts.
- SR Niraula was responsible for study designing and statistical analysis.
- PK Pokharel was involved and supervised the research idea, data measurement and appraisal of written drafts.

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## TITLE PAGE

**Title: Awareness of occupational hazards and use of safety measures among welders : a cross-sectional study from eastern Nepal.**

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## AUTHOR CONTRIBUTIONS

- SS Budhathoki developed the research idea, designed the questionnaire, collected data and wrote the preliminary drafts.
- SB Singh was responsible for streamlining the research idea, finalizing the questionnaire and critiquing the drafts.
- RA Sagtani was involved in organising data, writing and critiquing the drafts.
- SR Niraula was responsible for study designing and statistical analysis.
- PK Pokharel was involved and supervised the research idea, data measurement and appraisal of written drafts.

## ABSTRACT

**Title: Awareness of occupational hazards and use of safety measures among welders : a cross-sectional study from eastern Nepal.**

### **Objective:**

Proper use of safety measures among welders are important ways of preventing and/or reducing a variety of health hazards, the welders are exposed to during welding. Knowledge of hazards, personal protective equipments (PPE) and use of PPE among the welders in Nepal is not known. We designed a study to assess the awareness of hazards, awareness of PPE and its use among welders; and to find the possible relation between awareness and use of PPE among welders of eastern Nepal.

### **Materials and Methods:**

A cross-sectional study, among 300 welders selected using simple random sampling from three districts of eastern Nepal, was conducted using a semi-structured questionnaire. Data regarding age, education level, duration of employment, awareness of hazards, safety measures and the actual use of safety measures were recorded.

### **Results:**

Overall, 272 (90.7%) welders were aware of at least one hazard of welding and similar proportion of welders were aware of at least one PPE. However, only 47.7% used one or more type of PPE. Education and duration of employment were both significantly associated with the awareness of hazard, awareness of PPE and the use of PPE. The welders who reported using PPE during welding were two times more likely to have been aware of the hazard (OR=2.52,

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3 95% CI 1.09-5.81) and five times more likely to have been aware of PPE compared to the  
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6 welders who did not report the use of PPE (OR=5.13, 95%CI 2.34-11.26).  
7

### 8 **Conclusion:**

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11 The welders using the PPE are those who were aware of hazards and PPE. There is gap between  
12  
13 being aware of hazard or PPE (90%) and use of PPE (47%) at work. Further research is needed  
14  
15 for identifying the underlying factors leading to low utilisation of PPE despite of being  
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17 knowledgeable among the welders of eastern Nepal.  
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## 28 **ARTICLE SUMMARY**

### 29 **STRENGTHS OF THE STUDY**

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- Based on occupation health and safety which is a neglected area of research in Nepal.
  - Study methodology: Use of pre-tested questionnaire, scientific calculation of sample size, random sampling and calculation of odds ratios.
  - Makes an attempt to bridge the information gap on the awareness and practice of use PPE among welders in this part of the world.
  - The study highlights frequent use of sun glasses and cloth masks as personal protective equipment which is not recommended.

### 46 **LIMITATIONS OF THE STUDY**

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- The sample size of the current study is small which is reflected by width of confidence intervals.
  - The external validity of the study is limited in context of urban cities which has more workshops and more welders.

## SUMMARY BOX

Present state of scientific knowledge before the study was done.

- Occupational health and safety is a major concern in the South East Asian region which has a workforce of about 500 million people (2011).
- Welders of the South east Asian region are exposed to a wide range of occupational hazards and risks.

Need for the study

- The concept of occupational health and safety is relatively new which is exemplified by very few number of studies related to working conditions of the working population.
- In eastern region of Nepal, there is no organized occupational health service for welders and their adherence to safety measures is also unknown.

Results which were not known before

- There is a gap between knowledge and practice among welders in eastern Nepal.
- Awareness does not necessitate practice of protective equipment.
- Sun glasses and cloth masks are being used as personal protective equipment which is not recommended.

Policy and Practice implications

- Use and adherence to the occupational safety and health measures needs to stressed and enforced by the Ministry of Labor and Transport Management in Nepal.

## Introduction

Occupational Health aims at the promotion and maintenance of the highest degree of physical, mental and social wellbeing of workers in all occupations.<sup>1</sup> Welding, a skilled profession has been in use since the ancient times.<sup>2</sup> Welders join and cut metal parts using flame or electric arc and other sources of heat to melt and cut or to melt and fuse metal.<sup>3</sup>

Welding being a hazardous profession with a multiplicity of factors that can endanger the health of a welder, such as heat, burns, radiation (ultraviolet, visible and infrared), noise, fumes, gases, electrocution, and even the uncomfortable postures involved in the work; the high variability in chemical composition of welding fumes, which differs according to the work-piece, method employed, and surrounding environment; and the routes of entry through which these harmful agents access the body.<sup>4</sup> Some of the health effects of welding on health includes photo-keratitis or arc eye, metal fume fever, decrease in lung function, pneumoconiosis, asthma, photo-dermatitis and fertility abnormalities.<sup>5-11</sup>

Hazards arising from workplaces could impair the health and wellbeing of the workers, therefore it is necessary to anticipate, recognize, evaluate and control such hazards.<sup>12</sup> The use of Personal Protective Equipment (PPE) at all times is a good safe practice by welders to protect from exposure to the hazards and injuries during welding or cutting.<sup>13</sup>

Occupational Health and Safety (OSH) is not a old science however, the working conditions of workers in general and welders in particular is unsatisfactory in Nepal. **The fact of low awareness of safety measures and the low frequency of their regular utilization are a matter of concern in Nepal. These may be due to various reasons like low level of education, lack of**

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3 institutional training, age group structure and work experience along with non-adaptation of  
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5 regulatory measures by concerned authorities on safety precautions.<sup>14</sup> Welders in our study  
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8 area do not have organised occupational health services and to make matters worse there is  
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10 lack of awareness regarding the importance of occupational safety at the workplace. The  
11  
12 literature search showed that studies in Nepal have not tried to find the use of protective  
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14 measures and the factors which facilitate their use. Thus, the current study was designed to  
15  
16 assess awareness of occupational hazards and protective measures among welders working in  
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18 three districts of eastern Nepal. We also tried to find the factors associated with awareness of  
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20 occupational hazards and protective measures and use of protective measures, and possible  
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22 relationship of awareness with the actual use of PPE. This study was envisioned to highlight the  
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24 need for research in the area of occupational health which is a neglected issue in our country.  
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### 33 **Materials and Methods**

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35 A cross-sectional study was designed to be conducted among welders working in three districts  
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37 of eastern Nepal namely Jhapa, Morang and Sunsari from the period of July 2010 to July 2011.  
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39 According to the available literature ( Isah et al )<sup>15</sup>, the most prevalent health complaints were  
40  
41 arc eye injuries, followed by foreign bodies in the eyes, back/waist pain, metal fume fever,  
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43 cuts/injuries from sharp metals etc. Among which, the least prevalent (37.7%) work related  
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45 complaint was cut injuries from sharp metals .  
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50 Thus, Prevalence (p) = 37.7%

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52 Compliment of prevalence (q) = 100-37.7 = 62.3%

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55 Permissible Error (PE) at 15%, L = 15% of 37.7= 5.655  
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$$\begin{aligned}\text{Sample size (n)} &= (Z_{1-\alpha})^2 * pq/L^2 \\ &= (1.96)^2 * 37.7*62.3/ (5.655)^2 \\ &= 283 \text{ (Approx.)}\end{aligned}$$

Inflating the sample size by 5% we got the estimated sample size of 298. We planned to interview 300 grill workers, 100 from each district.

Average number of welders present per shop was three. (Results based on preliminary survey of 15 workshops of the study area). Taking 3 welders per shop, the number of workshops required for survey is =  $298/3 = 100$  Workshops i.e. number of work shop per district is =  $100/3 = 34$  shops per district. So, the workshops were selected through a simple random sampling from list of metal workshops provided by the Metal Workshops' Association (GRILL BYABASAYI SANGH) using computer generated random numbers.

Welders working in the workshops listed in the Metal Workshops' Association were included in the study. The workshop was visited with prior appointment from the workshop administration. The investigators conducted individual interviews of 45-90 minutes with the welders using a semi-structure questionnaire. The questionnaire comprised of open questions on age, level of education and duration of employment in years. These variables were divided into **categories on the basis of literature review and to show their impact on knowledge and use of PPE during analysis**. Questions on awareness of hazards of welding, awareness of PPE and use of PPE were structured. The welders were first asked to list the hazards of welding. Followed by which probing questions on specific hazards light/radiation, welding fumes, sharp metals, electric current, heat, noise, sparks, vibration and physical environment at work were asked as a yes/no answers were asked. Similarly for awareness and use of PPE, the welders were asked to list any



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3 PPE they were aware of and they used. This was again followed by yes/no option for welding  
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6 helmet/faceshield, protective gloves, welding goggles/eyeshield, respirators/masks, sturdy  
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9 footwear, apron, ear muffs and an open option for any other equipment they wore for their  
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11 protection. The welders were asked to show us the PPE they used during the welding.

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13 Data collected were entered, edited and coded in an Microsoft excel sheet . The data was then  
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16 exported to Statistical Package for Social Sciences (SPSS) version 11.5 for analysis. Bivariate  
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19 analysis for categorical data was done using chi square test ( $\chi^2$ ). The strength of association was  
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22 calculated using Odds Ratio (OR) using Epi Info™ 7. The probability of significance was set at  
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25 5%.

26  
27 The approval for the study was taken from the Institutional Ethical Review Board of B P Koirala  
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30 Institute of Health Sciences. Informed consent was taken from the participants ensuring  
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33 confidentiality and anonymity of the participants. Permission was sought from the welders to  
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36 use the picture for scientific publication.

## 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60

### Results

The data was collected from a total of 300 welders who agreed to participate in the current  
study. Since, the permission was taken from the Metal Workshop's association and the authors  
have been working in this particular area with other programs of occupational safety and  
health, all the workers gave a positive response leading to a response rate of 100%. All welders  
were male with a mean age of 31.29 years with a standard deviation of 6.57 years. Almost half  
(48%) of the welders were in the age group of 30-39 years. In total 93% of the welders in this  
study were literate. There were 16.3% of welders working for more than 10 years. The mean

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3 duration of employment in years of the welders in this study was 6.94 years (not shown in  
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6 table).

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8 The study showed that 90.7% of welders were aware of one or more hazards of welding.  
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10 Excessive brightness (90.7%) was the most common hazard identified by the welders working in  
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12 the area followed by sharp metals (86.7%), heat (83.7%), physical environment (83.3%),  
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14 electrical current (80.30%), noise (75.70%), welding fumes (51.70%), sparks (44.3%) and  
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16 vibration (17%) (not shown in table).  
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20  
21 Table 1 shows that 90% of welders were aware of at least one kind of PPE while only 47.7% of  
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23 welders use at least one kind of PPE during work. While welding goggles/eye shields (86.7%)  
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25 were the most commonly reported PPE for use, the most commonly worn PPE was sturdy  
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27 footwear (40.7%)  
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31 Sun glasses were considered protective and was used as a personal protective device by 74.3%  
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33 of the 260 welders who reported being aware about the welding goggles/eye shields as a PPE.  
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35 None of the welders used welding masks while cotton mask was used by 45% of the 300  
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37 welders who reported to be aware of welding masks. The sunglasses and cotton masks are  
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39 however not included in the table, as they are not recommended PPE for welding.  
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44 The illustration of the sun glasses and cotton mask used by the welders in Nepal is depicted in  
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46 figure 1.  
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49 There was a positive association between level of education and the awareness of hazards  
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51 among the welders ( $p < 0.001$ ). Compared to illiterate welders, the welders with primary  
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53 education were seven times more likely to be aware of hazards of welding (OR= 7.621, 95%CI  
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55 2.738-21.208 ), while the odds of awareness regarding welding was sixty times higher among  
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3 welders with secondary level of education than welders who were illiterate (OR= 60.5, 95%CI  
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5 14.517-252.132) .  
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8 The duration of employment was seen to be negatively associated with the awareness of  
9 hazards among the welders ( $p = 0.01$ ) i.e. the chances of welders being aware of the hazards  
10 was 66 percent more for those welders working for more than five years compared to those  
11 who worked for 1 -5 years as shown in table 2.  
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14 Table 3 entails that awareness regarding use of PPE was significantly associated with secondary  
15 level of education ( $p = 0.004$ ). The welders who had received secondary level of education were  
16 about five times (OR=4.93, 95%CI 1.50-16.23) more likely to being aware of PPE compared to  
17 illiterate welders.  
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19

20 There was a significant positive relation between reported use of PPE and secondary level of  
21 education ( $p < 0.001$ ). The welders who reported using PPE at work were two times more likely  
22 to have had attended secondary education or more (OR= 2.167, 95%CI 1.865-5.430).  
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25 Interestingly, the awareness regarding PPE did not find any significant association with duration  
26 of employment however, use of PPE by the welders was seen to be more among the welders  
27 who had been working for a longer duration of time ( $p < 0.001$ ). The welders who have been  
28 working for 11 years or more were almost four times more likely to using PPE at work  
29 compared to those who had work experience of 1 – 5 years (OR=3.98, 95%CI 1.99-7.97) as  
30 shown in table 4.  
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33 Table 5 shows that the odds of using PPE during welding was twice among welders who were  
34 aware of the health hazards associated with welding than those who were not aware (OR=  
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2.52, 95%CI 1.09-5.81). It was also seen that welders who knew about PPE were five times more likely to use them during welding compared to those who did not know about them (OR= 5.13, 95%CI 2.34-11.26).

All welders learned their welding skills working as an apprentice to an experienced welder. They had not had any formal training on welding, health and safety. The knowledge on hazards, PPE and use of PPE were all limited to self-learning on the job.

**Figure 1: Welders at work using only sunglasses and cotton mask during welding in Nepal**

(Separate JPEG file attached "Welder PPE PIC.jpg")

**Table 1: Distribution of welders according to Awareness and Use of PPE (n=300)**

| Awareness among welders     |                                |                      |
|-----------------------------|--------------------------------|----------------------|
| PPE types                   | Number of welders <sup>#</sup> | Percent <sup>#</sup> |
| At least one                | 270                            | 90.0                 |
| Welding goggles/ eye shield | 260                            | 86.7                 |
| Protective Gloves           | 255                            | 85.0                 |
| Sturdy footwear             | 244                            | 81.3                 |
| Welding helmet/Face shield  | 162                            | 54.0                 |
| Apron                       | 161                            | 53.7                 |
| Masks                       | 156                            | 52.0                 |
| Earmuffs                    | 59                             | 19.7                 |

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 Use Among the welders
 

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|                             |     |       |
|-----------------------------|-----|-------|
| At least one                | 143 | 47.7  |
| Sturdy footwear             | 122 | 40.7  |
| Protective Gloves           | 70  | 23.3  |
| Welding goggles/ eye shield | 54  | 18.0  |
| Apron                       | 50  | 16.67 |
| Welding helmet/Face shield  | 19  | 6.3   |
| Earmuffs                    | 16  | 5.3   |

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# Multiple responses recorded per welder

**Table 2: Factors associated with awareness of hazards among welders of eastern Nepal.**

| Variables              | Aware of Hazards |    | p value * | Unadjusted Odds Ratio |                |
|------------------------|------------------|----|-----------|-----------------------|----------------|
|                        | Yes              | No |           | OR                    | 95% CL         |
| Education              |                  |    |           |                       |                |
| Illiterate             | 10               | 11 | <0.001    | 1.00                  |                |
| Primary                | 87               | 14 |           | 7.62                  | 2.74 - 21.21   |
| Secondary and Above    | 165              | 3  |           | 60.50                 | 14.52 - 252.13 |
| Duration of Employment |                  |    |           |                       |                |
| 1-5 years              | 157              | 9  | 0.012     | 1.00                  |                |
| 6-10 years             | 73               | 12 |           | 0.34                  | 0.14 - 0.86    |
| 11 years and more      | 42               | 7  |           | 0.34                  | 0.12 - 0.97    |

\* Calculated using  $\chi^2$  at  $df=2$

**Table 3: Factors associated with awareness of PPE among welders of eastern Nepal.**

| Variables              | Aware of PPE |    | p value * | Unadjusted Odds Ratio |              |
|------------------------|--------------|----|-----------|-----------------------|--------------|
|                        | Yes          | No |           | OR                    | 95% CL       |
| Education              |              |    |           |                       |              |
| Illiterate             | 16           | 5  | 0.004     | 1.00                  |              |
| Primary                | 96           | 15 |           | 2.00                  | 0.63 - 6.26  |
| Secondary and Above    | 158          | 10 |           | 4.93                  | 1.50 - 16.23 |
| Duration of Employment |              |    |           |                       |              |
| 1-5 years              | 145          | 21 | 0.220     | 1.00                  |              |
| 6-10 years             | 80           | 5  |           | 2.13                  | 0.84 - 6.38  |
| 11 years and more      | 45           | 4  |           | 1.62                  | 0.53 - 4.99  |

\* Calculated using  $\chi^2$  at  $df=2$

**Table 4: Factors associated with use of PPE at work among welders of eastern Nepal.**

| Variables              | Use of PPE at Work |     | p value * | Unadjusted Odds Ratio |             |
|------------------------|--------------------|-----|-----------|-----------------------|-------------|
|                        | Yes                | No  |           | OR                    | 95% CL      |
| Education              |                    |     |           |                       |             |
| Illiterate             | 9                  | 12  | <0.001    | 1.00                  |             |
| Primary                | 30                 | 81  |           | 0.49                  | 0.18-1.29   |
| Secondary and Above    | 104                | 64  |           | 2.16                  | 0.86 -5.43  |
| Duration of Employment |                    |     |           |                       |             |
| 1-5 years              | 64                 | 102 | <0.001    | 1.00                  |             |
| 6-10 years             | 44                 | 41  |           | 1.71                  | 1.00 - 2.89 |
| 11 years and more      | 35                 | 14  |           | 3.98                  | 1.99 - 7.97 |

\* Calculated using  $\chi^2$  at  $df=2$

**Table 5: Association of awareness regarding hazards and PPE with use of PPE at work.**

| Awareness        | Use of PPE at Work |    | p value* | Unadjusted Odds Ratio |             |
|------------------|--------------------|----|----------|-----------------------|-------------|
|                  | Yes                | No |          | OR                    | 95% CL      |
| Aware of Hazard  |                    |    |          |                       |             |
| Not Aware        | 18                 | 10 | 0.046    | 1.00                  |             |
| Aware            | 223                | 49 |          | 2.52                  | 1.09 - 5.81 |
| Aware of PPE Use |                    |    |          |                       |             |
| Not Aware        | 15                 | 15 | <0.001   | 1.00                  |             |
| Aware            | 226                | 44 |          | 5.13                  | 2.34 -11.26 |

\*Calculated using  $\chi^2$  at  $df=1$

## Discussion

Almost half (48%) of the welders were in the category of 30-39 years, similar to the finding by Sabitu et al<sup>14</sup>, where majority (44.5 %) fall in the same category but differs with the study by Isah et al<sup>15</sup> in the same country where higher proportion of welders (40.3%) were in the 20-29 years category. Although 93% of the welders in the study had some schooling, only 90% of the welders had knowledge of one or more hazards of welding. Findings are similar to the study by Singh SB on jute mill workers of the same region.<sup>16</sup>

The working population in this profession has high turnover in this area with a very small number working for a longer duration in this profession. However, studies in Nigeria by Isah<sup>15</sup> shows 74.8% welders with experience of more than 10 years including 24.7% of welders with experience of more than 21 years. Similarly, a Canadian study by El-Zein et al<sup>17</sup> shows 81.8% welders working for 10 years and more with 22.8% of welders aged 30 years and above and

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3 were working for 20.33 years in this profession. The studies by Isah et al<sup>15</sup> and Sabitu et al<sup>14</sup> in  
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5 Nigeria which show there are welders in even in the above 60 years category. The reasons for  
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7 absence of welders above 49 in this study could be due to migration of skilled experienced  
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9 welders to other areas for better wages and opportunities.  
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14 This profession is regarded as the most hazardous profession and not all of the welders are  
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16 aware of all the hazards.<sup>18</sup> In our study, ninety percent of welders were aware of at least one  
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18 hazard of welding. The comparison with other studies showed inconsistent results. The study by  
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20 Isah EC et al<sup>15</sup> in Benin, Nigeria showed 91.6% of welders being aware of one or more hazard of  
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22 welding while another study in Kaduna, Nigeria by Sabitu K et al<sup>14</sup> showed 77.9% of awareness  
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24 of one or more hazards of welding in welders.  
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30 Excessive brightness was the most frequently identified hazard by the welders in our study.  
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32 Welding fumes which is regarded as the combination of highly toxic metals and their oxides<sup>19</sup>  
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34 was identified as a hazard by 51.7% of the welders. There are also 9.3% of welders who were  
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36 not aware of any specific hazard at their work. They could not think of any harmful factor in  
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38 welding.  
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43 In the study, 90.7% of welders were aware of welding goggles/eye shield to protect eyes. The  
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45 same the percentage of welders were aware of at least one PPE. Although 75% of the welders  
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47 identified noise as hazard at their working place only 19.7% were aware about earmuffs. The  
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49 utilisation of at least one PPE among the welders was 47.7%, as compared to the study by  
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51 Sabitu K et al (34.2%)<sup>14</sup> and the study by Isah EC et al<sup>15</sup> (35.9%) in Nigeria. The most commonly  
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53 used PPE was masks (45%), whereas the most common PPE worn were Welding goggles in both  
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3 Nigerian studies; 60.9% by Sabitu K et al<sup>14</sup> and 35.9% by Isah EC et al<sup>15</sup>. Welding goggles/ face  
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5 shield use was seen among only 18% of the welders in the current study.  
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9 It was found that a very high proportion of welders (74.3%) used the general sunglasses  
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11 regularly at work. Sunglasses are not among the recommended PPE<sup>20</sup> to protect from welding  
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13 radiation to the eye. The reason for provision of the sunglasses by the employer may be due to  
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15 being cheaper, easy available and comfortable. The sunglasses used were also not certified for  
16  
17 UV protection. The mask used by the welders in this study is also the commonly used cotton  
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19 mask. This also does not meet the requirement<sup>21</sup> as a respirator for use during welding. It was  
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21 also seen that more than half of the welders (52.3%) did not use any PPE during work.  
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28 Level of education had a significant relationship with awareness of hazard ( $p < 0.05$ ), awareness  
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30 of PPE ( $p < 0.05$ ) and use of PPE ( $p < 0.05$ ) in this study. This showed that with increase in level of  
31  
32 education among population, awareness and safety practices increased. Welders who have had  
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34 higher level of education have the tendency to read news, get updates increases the awareness  
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36 of hazards & PPE, and they tend to increase the practice of use of PPE as well. Sabitu et al<sup>14</sup> also  
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38 showed that awareness increased significantly with increase in education level.  
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44 It was found that welders who were employed for a longer duration reported being less aware  
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46 of the hazards of welding. It is maybe generally expected for the opposite to be true. The  
47  
48 reason for such findings in this study could be due to welders working for longer duration failing  
49  
50 to recognise the exposure as hazard after being exposed to them for many years. However this  
51  
52 is just a possible explanation which needs to be further explored. However in terms of using  
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54 PPE at work, the welders who have been working for longer duration report more use of PPE. It  
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3 is seen that welders who have been working for shorter duration are more aware of hazard but  
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5 use of PPE is lower. One possible reason for this may be younger people having the tendency of  
6  
7 having more risk taking behaviour. However this also needs to be explored further in future  
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9 studies.  
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13 Awareness on hazard ( $p < 0.05$ ) and awareness on PPE ( $p < 0.05$ ) both when compared with the  
14  
15 use of PPE at work showed significant relationship. Thus, the current study shows that more  
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17 the people are aware of the hazard and equipment to protect from, the tendency to use those  
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19 equipment increases.  
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25 All welders learned welding through apprenticeship under an experienced welder for few years.  
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27 No welders in had any vocational training as compared to Sabitu et al<sup>14</sup> finding where 8.5% of  
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29 welders of Kaduna, Nigeria went to welding school. Learning by apprenticeship is a common  
30  
31 practice in welding here and also in data by Sabitu K et al<sup>14</sup> in Kaduna also show more than 90 %  
32  
33 welders learnt by apprenticeship. There is no vocational training course or welding school so far  
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35 for learning welding skills in this area.  
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41 The welders were also not trained or oriented regarding hazards and safety measures at work  
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43 including basic first aid at work. This is also one of the reasons they are not aware of many  
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45 hazards of the profession and about protective measures.  
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50 There are a few limitations of the study. Though, the sample size was calculated with a scientific  
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52 formula the width of the confidence intervals show that the sample size is inadequate. A study  
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54 with a larger sample size might provide a more accurate estimate of the study variables.  
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56 Generalizability of this study to the other parts of Nepal, predominantly to urban cities is  
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3 limited as these cities have more workshops, more welders and therefore, can have different  
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5 working conditions.  
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9 Welding is a hazardous profession which exposes the workers to various kinds of physical and  
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11 chemical hazards in absence of judicious and effective use of personal protective equipment.  
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13 The unwanted exposure can lead to variety of disease conditions among the welders. The use  
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15 of recommended PPE at all times minimizes the exposure to these hazards. All the welders in  
16  
17 three districts of eastern Nepal are not aware of the hazards. Many welders are still not aware  
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19 of the PPE and a much smaller proportion among them actually use PPE during welding. The  
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21 mask and sunglasses being used are not the recommended PPE - respirators and welding  
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23 goggles should be used instead.  
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30 Welders in the study area are not trained and have acquired their welding skills while working  
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32 on the job. There is no culture of occupational safety and health among the welders and their  
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34 employees. This study provides only a glance of the actual problems and risks involved in this  
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36 profession. There is a gap between the knowledge the welders report on awareness of hazard  
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38 and PPE with the actual using of PPE at work by the same welders. This gap needs to be further  
39  
40 explored so that appropriate interventions can be planned to close this gap. With a high level of  
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42 awareness present in this group an intervention to increase the use of PPE is needed.  
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44 Occupational health and safety needs to be promoted by the labour organizations in Nepal and  
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46 should be highlighted by the public health agencies which can make this a priority issue among  
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48 our policy makers.  
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**Funding:** No funds were available.

**Data :** No additional data available.

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Welders at work using only sunglasses and cotton mask during welding in Nepal  
90x67mm (300 x 300 DPI)

Review only



## STROBE STATEMENT FOR THE STUDY

Title : **Awareness of occupational hazards and use of safety measures among welders: a cross-sectional study from eastern Nepal.**

| Item No                       | Recommendation   | Main Document (page no.) |
|-------------------------------|--|--------------------------|
| <b>Title and abstract</b> [1] | (a) Indicate the study's design with a commonly used term in the title or the abstract.  | addressed                |
|                               | (b) Provide in the abstract an informative and balanced summary of what was done and what was found  | addressed                |
| <b>Introduction</b>           |  |                          |
| Background [2]                | Explain the scientific background and rationale for the investigation being reported   | Pg-6                     |
| Objectives [3]                | State specific objectives, including any pre specified hypotheses  | Pg-7                     |
| <b>Methods</b>                |  |                          |
| Study design [4]              | Present key elements of study design early in the paper  | Pg 7                     |
| Setting [5]                   | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection  | Pg 7                     |
| Participants [6]              | Give the eligibility criteria, and the sources and methods of selection of participants  | Pg 7                     |
| Variables [7]                 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable   | -                        |
| Data sources/ measurement [8] | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group                         | Pg 8                     |
| Bias [9]                      | Describe any efforts to address potential sources of bias  | -                        |
| Study size [10]               | Explain how the study size was arrived at  | Pg 8                     |
| Quantitative variables [11]   | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why   | -                        |
| Statistical methods [12]      | (a) Describe all statistical methods, including those used to control for confounding  | Pg 9                     |
|                               | (b) Describe any methods used to examine subgroups and interactions  | -                        |
|                               | (c) Explain how missing data were addressed  | -                        |
|                               | (d) If applicable, describe analytical methods taking account of sampling strategy   | Pg 8-9                   |
|                               | (e) Describe any sensitivity analyses  | -                        |
| <b>Results</b>                |  |                          |
| Participants [13]             | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed            | Pg 8                     |
|                               | (b) Give reasons for non-participation at each stage   | -                        |
|                               | (c) Consider use of a flow diagram   | -                        |
| Descriptive data [14]         | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders   | Pg 8-9                   |
|                               | (b) Indicate number of participants with missing data for each variable of interest  | -                        |
| Outcome data [15]             | Report numbers of outcome events or summary measures   | Pg 9-10                  |
| Main results [16]             | (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | Pg 10-11                 |
|                               | (b) Report category boundaries when continuous variables were categorized  | addressed                |
|                               | (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period   | -                        |
| Other analyses [17]           | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses   | -                        |

|                          |      |  |          |
|--------------------------|------|--|----------|
| <b>Discussion</b>        |      |  |          |
| Key results              | [18] | Summarise key results with reference to study objectives   | Pg 15-18 |
| Limitations              | [19] | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias                 | Pg 18    |
| Interpretation           | [20] | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | Pg 15-19 |
| Generalisability         | [21] | Discuss the generalisability (external validity) of the study results  | Pg 18    |
| <b>Other information</b> |      |  |          |
| Funding                  | [22] | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based              | Pg 19    |