BMJ open

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

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2013-004646
Article Type:	Research
Date Submitted by the Author:	09-Dec-2013
Complete List of Authors:	Budhathoki, Shyam; B.P.Koirala Institute of Health Sciences, School of Public Health and Community Medicine Singh, Suman; B.P.Koirala Institute of Health Sciences, School of Public Health and Community Medicine Sagtani, Reshu; B.P.Koirala Institute of Health Sciences, School of Public Health and Community Medicine Niraula, Surya; B.P.Koirala Institute of Health Sciences, School of Public Health and Community Medicine Pokharel, Paras; B.P.Koirala Institute of Health Sciences, School of Public Health and Community Medicine
Primary Subject Heading:	Occupational and environmental medicine
Secondary Subject Heading:	Public health
Keywords:	EPIDEMIOLOGY, Health & safety < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, OCCUPATIONAL & INDUSTRIAL MEDICINE

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

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

Conclusion:

The welders who are aware are more likely to protect themselves from harmful effects of welding. Thus, to ensure occupational safety and health of the welders more awareness campaigns and programmes can be designed.

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 prevalence of use and effect of awareness on use of 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

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 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.[1] Welding, a skilled profession has been in use since the ancient times.[2] 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.[3]

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.[4] 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.[5-11]

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.[12] 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.[13]

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

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 literature search showed that studies in Nepal have not tried to find the use of protective 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 descriptive 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)[15], 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

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

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

$= 283$ (Approx.)

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.

Ethical clearance was taken from the Institutional Ethical Review Board of BPKIHS. Face to face interviews were done with the study participants with the help of a pre-tested semi structured questionnaire at their respective welding workshop. All the welders working who gave informed consent were included in the study. Verbal consent was also taken from the employers. The information regarding their demographic characteristics, awareness of hazards, awareness and use of PPE was assessed. Confidentiality and anonymity was promised and maintained.

Data processing and analysis were done using Statistical Package for Social Sciences (SPSS) version 11.5

Results

A total of 300 welders who agreed to participate became the study respondents. 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 duration of employment in years of the welders in this study was 6.94 years.

The study showed that 90.7% of welders were aware of one or more hazards of welding. Excessive brightness (90.7%) was the most common hazard identified by the welders working in the area followed by sharp metals (86.7%), heat (83.7%), physical environment (83.3%), electrical current (80.30%), noise (75.70%), welding fumes (51.70%), sparks (44.3%) and vibration (17%).

Table 1 shows that 90% of welders were aware of at least one kind of PPE while only 47.7% of welders use at least one kind of PPE during work. Sun glasses were considered protective and was the most frequently used personal protective device (74.3%) by the welders of eastern Nepal. Welders with primary education were more aware of hazards of welding in comparison to the illiterate welders (OR= 7.621; CI= 2.738-21.208). The welders with secondary level or more education were sixty times more aware of the hazards of welding than the illiterate welders (OR= 60.5; CI= 14.517-252.132). The duration of employment was also seen to be negatively associated with the awareness of hazards among the welders ($p<0.05$) i.e. the welders who worked for six or more years were less likely to be aware of hazards related to welding compared to welders who worked for five or less years as shown in table 2.

Table 3 entails that awareness regarding use of PPE was significantly associated with education. The welders who received secondary or more education were almost five times more likely to be aware of PPE compared to welders who did not receive any formal education. However, the duration of employment could not find any statistical significance with awareness of PPE. The welders with higher education were two times more likely to use PPE compared to those

welders who did not go to school at all (OR= 2.167; CI= 1.865-5.430). The duration of occupation was associated with PPE use. The welders working for 6 to 10 years and those working for 11 years or more were more likely to use PPE compared to those who worked for five or less years shown in table 4. The welders who were aware of the hazards were more than two times more likely to use PPE compared to welders who were not aware (OR= 2.528; CI= 1.099-5.813). The odds of PPE use among welders who were aware of the PPE during welding was five times more compared to welders who has no idea about PPE (OR= 5.136; CI= 2.342-11.263) as shown in table 5.

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.

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

Awareness among welders		
PPE types	**Number of welders[#]**	**Percent[#]**
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
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
Duration of Employment					
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
Education					
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
Duration of Employment					
1-5 years	64	102		1.00	
6-10 years	44	41	0.00005	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[14], where majority (44.5 %) fall in the same category but differs with the study by Isah et al[15] 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.[16]

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[15] 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[17] 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[15] and Sabitu et al[14] 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.

This profession is regarded as the most hazardous profession and not all of the welders are aware of all the hazards.[18] In our study, ninety percent of welders were aware of at least one hazard of welding. The comparison with other studies showed inconsistent results. The study by Isah EC et al[15] in Benin, Nigeria showed 91.6% of welders being aware of one or more hazard of welding while another study in Kaduna, Nigeria by Sabitu K et al[14] showed 77,9% of awareness of one or more hazards of welding in welders.

Excessive brightness was the most frequently identified hazard by the welders in our study. Welding fumes which is regarded as the combination of highly toxic metals and their oxides[19] was identified as a hazard by 51.7% of the welders. There are also 9.3% of welders who were not aware of any specific hazard at their work. They could not think of any harmful factor in welding.

In the study, 90.7% of welders were aware of welding goggles/eye shield to protect eyes. The same the percentage of welders were aware of at least one PPE. Although 75% of the welders identified noise as hazard at their working place only 19.7% were aware about earmuffs. The utilisation of at least one PPE among the welders was 47.7%, as compared to the study by Sabitu K et al (34.2%) [14] and the study by Isah EC et al[15] (35.9%) in Nigeria. The most commonly used PPE was masks (45%), whereas the most common PPE worn were Welding goggles in both Nigerian studies; 60.9% by Sabitu K et al[14] and 35.9% by Isah EC et al[15]. Welding goggles/ face shield use was seen among only 18% of the welders in the current study.

It was found that a very high proportion of welders (74.3%) used the general sunglasses regularly at work. Sunglasses are not among the recommended PPE[20] to protect from welding

radiation to the eye. The reason for provision of the sunglasses by the employer may be due to being cheaper, easy available and comfortable. The sunglasses used were also not certified for UV protection. Mask used by the welders in this study is also the commonly used cotton mask. This also does not meet the requirement[21] as a respirator for use during welding. It was also seen that more than half of the welders (52.3%) did not use any PPE during work.

Level of education had a significant relationship with awareness of hazard (P<0.001), awareness of PPE (P<0.05) and use of PPE (P<0.001) in this study. This showed that with increase in education among population awareness and practices increased. Educated people have the tendency to read news, get updates increases the awareness of hazards & PPE, and they tend to increase the practice of use of PPE as well. Sabitu et al[14] also showed that awareness increased significantly with increase in education level.

Awareness on hazard (P<0.05) and awareness on PPE (P<0.001) both when compared with the use of PPE at work showed significant relationship. This shows that being aware has positive effect on practice. In this study we can see that more the people are aware of the hazard and aware of equipment to protect from it, more is the tendency to use those equipment increases.

All welders learned welding through apprenticeship under an experienced welder for few years. No welders in had any vocational training as compared to Sabitu et al[14] finding where 8.5% of welders of Kaduna, Nigeria went to welding school. Learning by apprenticeship is a common practice in welding here and also in data by Sabitu K et al[14] in Kaduna also show more than 90 % welders learnt by apprenticeship. There is no vocational training course or welding school so far for learning welding skills in this area.

The welders were also not trained or oriented regarding hazards and safety measures at work including basic first aid at work. This is also one of the reasons they are not aware of many hazards of the profession and about protective measures.

There are a few limitations of the study. Though, the sample size was calculated with a scientific formula the width of the confidence intervals show that the sample size is inadequate. A study with a larger sample size might provide a more accurate estimate of the study variables. Generalizability of this study to the other parts of Nepal, predominantly to urban cities is limited as these cities have more workshops, more welders and therefore, can have different working conditions.

Welding is a hazardous profession which exposes the workers to various kinds of physical and chemical hazards in absence of judicious and effective use of personal protective equipment. The unwanted exposure can lead to variety of disease conditions among the welders. The use of recommended PPE at all times minimizes the exposure to these hazards. All the welders in three districts of eastern Nepal are not aware of the hazards. Many welders are still not aware of the PPE and a much smaller proportion among them actually use PPE during welding. The mask and sunglasses being used are not the recommended PPE - respirators and welding goggles should be used instead.

Welders in the study area are not trained and have acquired their welding skills while working on the job. There is no culture of occupational safety and health among the welders and their employees. This study provides only a glance of the actual problems and risks involved in this profession. Awareness programs need to be organised for the employers and employees

regarding safety culture with special emphasis on harmful impacts on overall health of a worker. Occupational health and safety needs to be promoted by the labour organizations in Nepal and should be highlighted by the public health agencies which can make this a priority issue among our policy makers.

Acknowledgements

We express our gratitude to our study respondents who agree to participate in this study and gave us their invaluable time. We are also thankful to association of Metal Workshops' Association (GRILL BYABASAYI SANGH) which provided us the list of workshops and also an important insight into the area and the work practices.

Conflicting interests: none declared.

Funding: No funds were available.

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 STATEMEMENT 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.)
Title and abstract [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
Introduction		
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
Methods		
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	-
Results 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	-

Discussion		
Key results [18]	Summarise key results with reference to study objectives	Pg 14-16
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
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
Generalisability [21]	Discuss the generalisability (external validity) of the study results	Pg 17
Other information		
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

BMJ Open

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

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2013-004646.R1
Article Type:	Research
Date Submitted by the Author:	11-Apr-2014
Complete List of Authors:	Budhathoki, Shyam; B.P.Koirala Institute of Health Sciences, School of Public Health and Community Medicine Singh, Suman; B.P.Koirala Institute of Health Sciences, School of Public Health and Community Medicine Sagtani, Reshu; B.P.Koirala Institute of Health Sciences, School of Public Health and Community Medicine Niraula, Surya; B.P.Koirala Institute of Health Sciences, School of Public Health and Community Medicine Pokharel, Paras; B.P.Koirala Institute of Health Sciences, School of Public Health and Community Medicine
Primary Subject Heading:	Occupational and environmental medicine
Secondary Subject Heading:	Public health
Keywords:	EPIDEMIOLOGY, Health & safety < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, OCCUPATIONAL & INDUSTRIAL MEDICINE

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

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.[1] Welding, a skilled profession has been in use since the ancient times.[2] 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.[3]

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.[4] 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.[5-11]

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.[12] 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.[13]

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 literature search showed that studies in Nepal have not tried to find the use of protective

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

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

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

$= 283$ (Approx.)

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.

All welders working in the workshops listed in the Metal Workshops' Association were included in the study. The workshop was visited with prior appointment with 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 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 PPE they were aware of and they used. This was again followed by yes/no option for welding helmet/faceshield, protective gloves, welding goggles/eyeshield, respirators/masks, sturdy footwear, apron, ear muffs and an open option for any other equipment they wore for their protection. The welders were asked to show us the PPE they used during the welding.

Data collected were entered into an excel sheet and analysed using SPSS 11.5. Bivariate analysis for categorical data was done using chi square test (χ^2). The strength of association was calculated using Odds Ratio (OR). The probability of significance was set at 5% level of significance and 95% Confidence Interval. Data processing and analysis were done using Statistical Package for Social Sciences (SPSS) version 11.5

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

Results

The data was collected from a total of 300 welders who agreed to participate became the study respondents. The response rate was 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 duration of employment in years of the welders in this study was 6.94 years.

The study showed that 90.7% of welders were aware of one or more hazards of welding. Excessive brightness (90.7%) was the most common hazard identified by the welders working in the area followed by sharp metals (86.7%), heat (83.7%), physical environment (83.3%), electrical current (80.30%), noise (75.70%), welding fumes (51.70%), sparks (44.3%) and vibration (17%).

Table 1 shows that 90% of welders were aware of at least one kind of PPE while only 47.7% of welders use at least one kind of PPE during work. While welding goggles/eye shields (86.7%) were the most commonly reported PPE for use, the most commonly worn PPE was sturdy footwear (40.7%)

Sun glasses were considered protective and was used as a personal protective device by 74.3% of the 260 welders who reported being aware about the welding goggles/eye shields as a PPE. None of the welders used welding masks while cotton mask was used by 45% of the 300 welders in place of the welding masks they reported they were aware of. The sunglasses and cotton masks are however not included in the table, as they are not recommended PPE for welding. The illustration of the sun glasses and cotton mask used by the welders in Nepal is depicted in figure 1.

There was a positive association between level of education and the awareness of hazards among the welders ($p<0.05$). The welders who reported as being aware of the hazards of welding were seven times more likely to have had at least primary level education (OR= 7.621; CI= 2.738-21.208) and sixty times more likely more likely to have had secondary level or more education (OR= 60.5; CI=14.517-252.132) compared to those welders who did not report as being aware of the hazards of welding. The duration of employment was also seen to be negatively associated with the awareness of hazards among the welders ($p<0.05$) i.e. the welders who reported as being aware of the hazards were more likely to have been working for longer duration as shown in table 2.

Table 3 entails that awareness regarding use of PPE was significantly associated with level of education ($p<0.05$). The welders who reported as being aware of the PPE were five times more

likely to have received education up to secondary level or more compared to those welders who did not report as being aware of the PPE. This association was not found to be statistically significant.

There was a significant positive relation between welders who reported use of PPE and the welders who attended higher education (p<0,05). The welders who reported using PPE at work were two times more likely to have had attended secondary education or more (OR= 2.167; CI= 1.865-5.430). The reported use of PPE by the welders was seen to be more among the welders who had been working for a longer duration in years (p<0.05). The welders who reported using PPE at work were almost four times more likely to have been working for 11 years or more(OR=4.98; CI= 1.99-7.97) as shown in table 4.

Table 5 shows that odds of finding a welder who was aware of the hazards among the welders who reported using PPE during welding is twice the odds of finding a welder who was aware of hazards among those who did not report using PPE during welding (OR= 2.52; CI= 1.09-5.81). It was also seen that the odds of finding a welder who was aware of PPE for welding was among the welders who reported using a PPE is five times the odds of finding a welder who was aware of the PPE among the welders who did not report the use PPE during welding (OR= 5.13; 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)

PPE types	Number of welders[#]	Percent[#]
Awareness among welders		
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 χ^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		1.00	
Primary	96	15	0.004	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		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 χ^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		1.00	
Primary	30	81	0.000	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		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 χ^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 χ^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[14], where majority (44.5 %) fall in the same category but differs with the study by Isah et al[15] 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.[16]

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[15]

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[17] 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[15] and Sabitu et al[14] 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.

This profession is regarded as the most hazardous profession and not all of the welders are aware of all the hazards.[18] In our study, ninety percent of welders were aware of at least one hazard of welding. The comparison with other studies showed inconsistent results. The study by Isah EC et al[15] in Benin, Nigeria showed 91.6% of welders being aware of one or more hazard of welding while another study in Kaduna, Nigeria by Sabitu K et al[14] showed 77.9% of awareness of one or more hazards of welding in welders.

Excessive brightness was the most frequently identified hazard by the welders in our study. Welding fumes which is regarded as the combination of highly toxic metals and their oxides[19] was identified as a hazard by 51.7% of the welders. There are also 9.3% of welders who were not aware of any specific hazard at their work. They could not think of any harmful factor in welding.

In the study, 90.7% of welders were aware of welding goggles/eye shield to protect eyes. The same the percentage of welders were aware of at least one PPE. Although 75% of the welders identified noise as hazard at their working place only 19.7% were aware about earmuffs. The

utilisation of at least one PPE among the welders was 47.7%, as compared to the study by Sabitu K et al (34.2%) [14] and the study by Isah EC et al[15] (35.9%) in Nigeria. The most commonly used PPE was masks (45%), whereas the most common PPE worn were Welding goggles in both Nigerian studies; 60.9% by Sabitu K et al[14] and 35.9% by Isah EC et al[15]. Welding goggles/ face shield use was seen among only 18% of the welders in the current study.

It was found that a very high proportion of welders (74.3%) used the general sunglasses regularly at work. Sunglasses are not among the recommended PPE[20] to protect from welding radiation to the eye. The reason for provision of the sunglasses by the employer may be due to being cheaper, easy available and comfortable. The sunglasses used were also not certified for UV protection. The mask used by the welders in this study is also the commonly used cotton mask. This also does not meet the requirement[21] as a respirator for use during welding. It was also seen that more than half of the welders (52.3%) did not use any PPE during work.

Level of education had a significant relationship with awareness of hazard ($p<.05$), awareness of PPE ($p<0.05$) and use of PPE ($p<0.05$) in this study. This showed that with increase in level of education among population awareness and practices increased. Welders who have had higher level of education have the tendency to read news, get updates increases the awareness of hazards & PPE, and they tend to increase the practice of use of PPE as well. Sabitu et al[14] also showed that awareness increased significantly with increase in education level.

It was found that welders who were employed for a longer duration reported being less aware of the hazards of welding. It is maybe generally expected for the opposite to be true. The reason for such findings in this study could be due to welders working for longer duration failing

to recognise the exposure as hazard after being exposed to them for many years. However this is just a possible explanation which needs to be further explored. However in terms of using PPE at work, the welders who have been working for longer duration report more use of PPE. It is seen that welders who have been working for shorter duration are more aware of hazard but use of PPE is lower. One possible reason for this may be younger people having the tendency of having more risk taking behavior. However this also needs to be explored further in future studies.

Awareness on hazard ($p<0.05$) and awareness on PPE ($p<0.05$) both when compared with the use of PPE at work showed significant relationship. This shows that being aware has positive effect on practice. In this study we can see that more the people are aware of the hazard and aware of equipment to protect from it, more is the tendency to use those equipment increases.

All welders learned welding through apprenticeship under an experienced welder for few years. No welders in had any vocational training as compared to Sabitu et al[14] finding where 8.5% of welders of Kaduna, Nigeria went to welding school. Learning by apprenticeship is a common practice in welding here and also in data by Sabitu K et al[14] in Kaduna also show more than 90 % welders learnt by apprenticeship. There is no vocational training course or welding school so far for learning welding skills in this area.

The welders were also not trained or oriented regarding hazards and safety measures at work including basic first aid at work. This is also one of the reasons they are not aware of many hazards of the profession and about protective measures.

There are a few limitations of the study. Though, the sample size was calculated with a scientific formula the width of the confidence intervals show that the sample size is inadequate. A study with a larger sample size might provide a more accurate estimate of the study variables. Generalizability of this study to the other parts of Nepal, predominantly to urban cities is limited as these cities have more workshops, more welders and therefore, can have different working conditions.

Welding is a hazardous profession which exposes the workers to various kinds of physical and chemical hazards in absence of judicious and effective use of personal protective equipment. The unwanted exposure can lead to variety of disease conditions among the welders. The use of recommended PPE at all times minimizes the exposure to these hazards. All the welders in three districts of eastern Nepal are not aware of the hazards. Many welders are still not aware of the PPE and a much smaller proportion among them actually use PPE during welding. The mask and sunglasses being used are not the recommended PPE - respirators and welding goggles should be used instead.

Welders in the study area are not trained and have acquired their welding skills while working on the job. There is no culture of occupational safety and health among the welders and their employees. This study provides only a glance of the actual problems and risks involved in this profession. There is a gap between the knowledge the welders report on awareness of hazard and PPE with the actual using of PPE at work by the same welders. This gap needs to be further explored so that appropriate interventions can be planned to close this gap. With a high level of awareness present in this group an intervention to increase the use of PPE is needed.

Occupational health and safety needs to be promoted by the labour organizations in Nepal and should be highlighted by the public health agencies which can make this a priority issue among our policy makers.

Acknowledgements

We express our gratitude to our study respondents who agree to participate in this study and gave us their invaluable time. We are also thankful to association of Metal Workshops' Association (GRILL BYABASAYI SANGH) which provided us the list of workshops and also an important insight into the area and the work practices.

Competing Interests: none declared.

Funding: No funds were available.

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.

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

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

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.[1] Welding, a skilled profession has been in use since the ancient times.[2] 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.[3]

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.[4] 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.[5-11]

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.[12] 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.[13]

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

literature search showed that studies in Nepal have not tried to find the use of protective 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)[15], 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

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

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

$= 283$ (Approx.)

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.

All welders working in the workshops listed in the Metal Workshops' Association were included in the study. The workshop was visited with prior appointment with 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 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 PPE they were aware of and they used. This was again followed by yes/no option for welding helmet/faceshield, protective gloves, welding goggles/eyeshield, respirators/masks, sturdy footwear, apron, ear muffs and an open option for any other equipment they wore for their protection. The welders were asked to show us the PPE they used during the welding.

Data collected were entered into an excel sheet and analysed using SPSS 11.5. Bivariate analysis for categorical data was done using chi square test (χ^2). The strength of association was calculated using Odds Ratio (OR). The probability of significance was set at 5% level of significance and 95% Confidence Interval. Data processing and analysis were done using Statistical Package for Social Sciences (SPSS) version 11.5

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

Results

The data was collected from a total of 300 welders who agreed to participate became the study respondents. The response rate was 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 duration of employment in years of the welders in this study was 6.94 years.

The study showed that 90.7% of welders were aware of one or more hazards of welding. Excessive brightness (90.7%) was the most common hazard identified by the welders working in the area followed by sharp metals (86.7%), heat (83.7%), physical environment (83.3%), electrical current (80.30%), noise (75.70%), welding fumes (51.70%), sparks (44.3%) and vibration (17%).

Table 1 shows that 90% of welders were aware of at least one kind of PPE while only 47.7% of welders use at least one kind of PPE during work. While welding goggles/eye shields (86.7%) were the most commonly reported PPE for use, the most commonly worn PPE was sturdy footwear (40.7%)

Sun glasses were considered protective and was used as a personal protective device by 74.3% of the 260 welders who reported being aware about the welding goggles/eye shields as a PPE. None of the welders used welding masks while cotton mask was used by 45% of the 300 welders in place of the welding masks they reported they were aware of. The sunglasses and cotton masks are however not included in the table, as they are not recommended PPE for welding. The illustration of the sun glasses and cotton mask used by the welders in Nepal is depicted in figure 1.

There was a positive association between level of education and the awareness of hazards among the welders ($p<0.05$). The welders who reported as being aware of the hazards of welding were seven times more likely to have had at least primary level education (OR= 7.621; CI= 2.738-21.208) and sixty times more likely more likely to have had secondary level or more education (OR= 60.5; CI=14.517-252.132) compared to those welders who did not report as being aware of the hazards of welding. The duration of employment was also seen to be negatively associated with the awareness of hazards among the welders ($p<0.05$) i.e. the welders who reported as being aware of the hazards were more likely to have been working for longer duration as shown in table 2.

Table 3 entails that awareness regarding use of PPE was significantly associated with level of education ($p<0.05$). The welders who reported as being aware of the PPE were five times more

likely to have received education up to secondary level or more compared to those welders who did not report as being aware of the PPE. This association was not found to be statistically significant.

There was a significant positive relation between welders who reported use of PPE and the welders who attended higher education (p<0,05). The welders who reported using PPE at work were two times more likely to have had attended secondary education or more (OR= 2.167; CI= 1.865-5.430). The reported use of PPE by the welders was seen to be more among the welders who had been working for a longer duration in years (p<0.05). The welders who reported using PPE at work were almost four times more likely to have been working for 11 years or more(OR=4.98; CI= 1.99-7.97) as shown in table 4.

Table 5 shows that odds of finding a welder who was aware of the hazards among the welders who reported using PPE during welding is twice the odds of finding a welder who was aware of hazards among those who did not report using PPE during welding (OR= 2.52; CI= 1.09-5.81). It was also seen that the odds of finding a welder who was aware of PPE for welding was among the welders who reported using a PPE is five times the odds of finding a welder who was aware of the PPE among the welders who did not report the use PPE during welding (OR= 5.13; 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[#]**	**Percent[#]**
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 χ^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		1.00	
Primary	96	15	0.004	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		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 χ^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		1.00	
Primary	30	81	0.000	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		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 χ^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 χ^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[14], where majority (44.5 %) fall in the same category but differs with the study by Isah et al[15] 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.[16]

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[15]

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[17] 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[15] and Sabitu et al[14] 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.

This profession is regarded as the most hazardous profession and not all of the welders are aware of all the hazards.[18] In our study, ninety percent of welders were aware of at least one hazard of welding. The comparison with other studies showed inconsistent results. The study by Isah EC et al[15] in Benin, Nigeria showed 91.6% of welders being aware of one or more hazard of welding while another study in Kaduna, Nigeria by Sabitu K et al[14] showed 77.9% of awareness of one or more hazards of welding in welders.

Excessive brightness was the most frequently identified hazard by the welders in our study. Welding fumes which is regarded as the combination of highly toxic metals and their oxides[19] was identified as a hazard by 51.7% of the welders. There are also 9.3% of welders who were not aware of any specific hazard at their work. They could not think of any harmful factor in welding.

In the study, 90.7% of welders were aware of welding goggles/eye shield to protect eyes. The same the percentage of welders were aware of at least one PPE. Although 75% of the welders identified noise as hazard at their working place only 19.7% were aware about earmuffs. The

utilisation of at least one PPE among the welders was 47.7%, as compared to the study by Sabitu K et al (34.2%) [14] and the study by Isah EC et al[15] (35.9%) in Nigeria. The most commonly used PPE was masks (45%), whereas the most common PPE worn were Welding goggles in both Nigerian studies; 60.9% by Sabitu K et al[14] and 35.9% by Isah EC et al[15]. Welding goggles/ face shield use was seen among only 18% of the welders in the current study.

It was found that a very high proportion of welders (74.3%) used the general sunglasses regularly at work. Sunglasses are not among the recommended PPE[20] to protect from welding radiation to the eye. The reason for provision of the sunglasses by the employer may be due to being cheaper, easy available and comfortable. The sunglasses used were also not certified for UV protection. The mask used by the welders in this study is also the commonly used cotton mask. This also does not meet the requirement[21] as a respirator for use during welding. It was also seen that more than half of the welders (52.3%) did not use any PPE during work.

Level of education had a significant relationship with awareness of hazard ($p<.05$), awareness of PPE ($p<0.05$) and use of PPE ($p<0.05$) in this study. This showed that with increase in level of education among population awareness and practices increased. Welders who have had higher level of education have the tendency to read news, get updates increases the awareness of hazards & PPE, and they tend to increase the practice of use of PPE as well. Sabitu et al[14] also showed that awareness increased significantly with increase in education level.

It was found that welders who were employed for a longer duration reported being less aware of the hazards of welding. It is maybe generally expected for the opposite to be true. The reason for such findings in this study could be due to welders working for longer duration failing

to recognise the exposure as hazard after being exposed to them for many years. However this is just a possible explanation which needs to be further explored. However in terms of using PPE at work, the welders who have been working for longer duration report more use of PPE. It is seen that welders who have been working for shorter duration are more aware of hazard but use of PPE is lower. One possible reason for this may be younger people having the tendency of having more risk taking behavior. However this also needs to be explored further in future studies.

Awareness on hazard ($p<0.05$) and awareness on PPE ($p<0.05$) both when compared with the use of PPE at work showed significant relationship. This shows that being aware has positive effect on practice. In this study we can see that more the people are aware of the hazard and aware of equipment to protect from it, more is the tendency to use those equipment increases.

All welders learned welding through apprenticeship under an experienced welder for few years. No welders in had any vocational training as compared to Sabitu et al[14] finding where 8.5% of welders of Kaduna, Nigeria went to welding school. Learning by apprenticeship is a common practice in welding here and also in data by Sabitu K et al[14] in Kaduna also show more than 90 % welders learnt by apprenticeship. There is no vocational training course or welding school so far for learning welding skills in this area.

The welders were also not trained or oriented regarding hazards and safety measures at work including basic first aid at work. This is also one of the reasons they are not aware of many hazards of the profession and about protective measures.

There are a few limitations of the study. Though, the sample size was calculated with a scientific formula the width of the confidence intervals show that the sample size is inadequate. A study with a larger sample size might provide a more accurate estimate of the study variables. Generalizability of this study to the other parts of Nepal, predominantly to urban cities is limited as these cities have more workshops, more welders and therefore, can have different working conditions.

Welding is a hazardous profession which exposes the workers to various kinds of physical and chemical hazards in absence of judicious and effective use of personal protective equipment. The unwanted exposure can lead to variety of disease conditions among the welders. The use of recommended PPE at all times minimizes the exposure to these hazards. All the welders in three districts of eastern Nepal are not aware of the hazards. Many welders are still not aware of the PPE and a much smaller proportion among them actually use PPE during welding. The mask and sunglasses being used are not the recommended PPE - respirators and welding goggles should be used instead.

Welders in the study area are not trained and have acquired their welding skills while working on the job. There is no culture of occupational safety and health among the welders and their employees. This study provides only a glance of the actual problems and risks involved in this profession. There is a gap between the knowledge the welders report on awareness of hazard and PPE with the actual using of PPE at work by the same welders. This gap needs to be further explored so that appropriate interventions can be planned to close this gap. With a high level of awareness present in this group an intervention to increase the use of PPE is needed.

Occupational health and safety needs to be promoted by the labour organizations in Nepal and should be highlighted by the public health agencies which can make this a priority issue among our policy makers.

Acknowledgements

We express our gratitude to our study respondents who agree to participate in this study and gave us their invaluable time. We are also thankful to association of Metal Workshops' Association (GRILL BYABASAYI SANGH) which provided us the list of workshops and also an important insight into the area and the work practices.

Competing Interests: none declared.

Funding: No funds were available.

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

STROBE STATEMEMENT 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.)
Title and abstract [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
Introduction		
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
Methods		
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	-
Results 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	-

Discussion		
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
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Other information		
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.

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2013-004646.R2
Article Type:	Research
Date Submitted by the Author:	05-May-2014
Complete List of Authors:	Budhathoki, Shyam; B.P.Koirala Institute of Health Sciences, School of Public Health and Community Medicine Singh, Suman; B.P.Koirala Institute of Health Sciences, School of Public Health and Community Medicine Sagtani, Reshu; B.P.Koirala Institute of Health Sciences, School of Public Health and Community Medicine Niraula, Surya; B.P.Koirala Institute of Health Sciences, School of Public Health and Community Medicine Pokharel, Paras; B.P.Koirala Institute of Health Sciences, School of Public Health and Community Medicine
Primary Subject Heading:	Occupational and environmental medicine
Secondary Subject Heading:	Public health
Keywords:	EPIDEMIOLOGY, Health & safety < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, OCCUPATIONAL & INDUSTRIAL MEDICINE

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,

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

Conclusion:

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

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 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.[1] Welding, a skilled profession has been in use since the ancient times.[2] 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.[3]

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.[4] 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.[5-11]

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.[12] 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.[13]

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

institutional training, age group structure and work experience along with non-adaptation of regulatory measures by concerned authorities on safety precautions.[14] 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 literature search showed that studies in Nepal have not tried to find the use of protective 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 factors associated with awareness of occupational hazards and protective measures and use of protective measures, and 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 designed to be conducted among welders working in three districts of eastern Nepal namely Jhapa, Morang and Sunsari from the period of July 2010 to July 2011. According to the available literature (Isah et al)[15], 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 (37.7%) work related complaint was cut injuries from sharp metals .

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

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

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

= 283 (Approx.)

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

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

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

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

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

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

The study showed that 90.7% of welders were aware of one or more hazards of welding. Excessive brightness (90.7%) was the most common hazard identified by the welders working in the area followed by sharp metals (86.7%), heat (83.7%), physical environment (83.3%), electrical current (80.30%), noise (75.70%), welding fumes (51.70%), sparks (44.3%) and vibration (17%) (not shown in table).

Table 1 shows that 90% of welders were aware of at least one kind of PPE while only 47.7% of welders use at least one kind of PPE during work. While welding goggles/eye shields (86.7%) were the most commonly reported PPE for use, the most commonly worn PPE was sturdy footwear (40.7%)

Sun glasses were considered protective and was used as a personal protective device by 74.3% of the 260 welders who reported being aware about the welding goggles/eye shields as a PPE. None of the welders used welding masks while cotton mask was used by 45% of the 300 welders who reported to be aware of welding masks. The sunglasses and cotton masks are however not included in the table, as they are not recommended PPE for welding.

The illustration of the sun glasses and cotton mask used by the welders in Nepal is depicted in figure 1.

There was a positive association between level of education and the awareness of hazards among the welders ($p < 0.001$). Compared to illiterate welders, the welders with primary education were seven times more likely to be aware of hazards of welding (OR= 7.621, 95%CI 2.738-21.208), while the odds of awareness regarding welding was sixty times higher among

welders with secondary level of education than welders who were illiterate (OR= 60.5, 95%CI 14.517-252.132) .

The duration of employment was seen to be negatively associated with the awareness of hazards among the welders (p = 0.01) i.e. the chances of welders being aware of the hazards was 66 percent more for those welders working for more than five years compared to those who worked for 1 -5 years as shown in table 2.

Table 3 entails that awareness regarding use of PPE was significantly associated with secondary level of education (p = 0.004). The welders who had received secondary level of education were about five times (OR=4.93, 95%CI 1.50-16.23) more likely to being aware of PPE compared to illiterate welders.

There was a significant positive relation between reported use of PPE and secondary level of education (p <0.001). The welders who reported using PPE at work were two times more likely to have had attended secondary education or more (OR= 2.167, 95%CI 1.865-5.430).

Interestingly, the awareness regarding PPE did not find any significant association with duration of employment however, use of PPE by the welders was seen to be more among the welders who had been working for a longer duration of time (p<0.001). The welders who have been working for 11 years or more were almost four times more likely to using PPE at work compared to those who had work experience of 1 – 5 years (OR=3.98, 95%CI 1.99-7.97) as shown in table 4.

Table 5 shows that the odds of using PPE during welding was twice among welders who were aware of the health hazards associated with welding than those who were not aware (OR=

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 knew 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[#]**	**Percent[#]**
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	<0.001	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 χ^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		1.00	
Primary	96	15	0.004	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		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 χ^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		1.00	
Primary	30	81	<0.001	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		1.00	
6-10 years	44	41	<0.001	1.71	1.00 - 2.89
11 years and more	35	14		3.98	1.99 - 7.97

**Calculated using χ^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 χ^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[14], where majority (44.5 %) fall in the same category but differs with the study by Isah et al[15] 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.[16]

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[15] 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[17] 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[15] and Sabitu et al[14] 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.

This profession is regarded as the most hazardous profession and not all of the welders are aware of all the hazards.[18] In our study, ninety percent of welders were aware of at least one hazard of welding. The comparison with other studies showed inconsistent results. The study by Isah EC et al[15] in Benin, Nigeria showed 91.6% of welders being aware of one or more hazard of welding while another study in Kaduna, Nigeria by Sabitu K et al[14] showed 77.9% of awareness of one or more hazards of welding in welders.

Excessive brightness was the most frequently identified hazard by the welders in our study. Welding fumes which is regarded as the combination of highly toxic metals and their oxides[19] was identified as a hazard by 51.7% of the welders. There are also 9.3% of welders who were not aware of any specific hazard at their work. They could not think of any harmful factor in welding.

In the study, 90.7% of welders were aware of welding goggles/eye shield to protect eyes. The same the percentage of welders were aware of at least one PPE. Although 75% of the welders identified noise as hazard at their working place only 19.7% were aware about earmuffs. The utilisation of at least one PPE among the welders was 47.7%, as compared to the study by Sabitu K et al (34.2%) [14] and the study by Isah EC et al[15] (35.9%) in Nigeria. The most commonly used PPE was masks (45%), whereas the most common PPE worn were Welding goggles in both

Nigerian studies; 60.9% by Sabitu K et al[14] and 35.9% by Isah EC et al[15]. Welding goggles/ face shield use was seen among only 18% of the welders in the current study.

It was found that a very high proportion of welders (74.3%) used the general sunglasses regularly at work. Sunglasses are not among the recommended PPE[20] to protect from welding radiation to the eye. The reason for provision of the sunglasses by the employer may be due to being cheaper, easy available and comfortable. The sunglasses used were also not certified for UV protection. The mask used by the welders in this study is also the commonly used cotton mask. This also does not meet the requirement[21] as a respirator for use during welding. It was also seen that more than half of the welders (52.3%) did not use any PPE during work.

Level of education had a significant relationship with awareness of hazard ($p< 0.05$), awareness of PPE ($p<0.05$) and use of PPE ($p<0.05$) in this study. This showed that with increase in level of education among population, awareness and safety practices increased. Welders who have had higher level of education have the tendency to read news, get updates increases the awareness of hazards & PPE, and they tend to increase the practice of use of PPE as well. Sabitu et al[14] also showed that awareness increased significantly with increase in education level.

It was found that welders who were employed for a longer duration reported being less aware of the hazards of welding. It is maybe generally expected for the opposite to be true. The reason for such findings in this study could be due to welders working for longer duration failing to recognise the exposure as hazard after being exposed to them for many years. However this is just a possible explanation which needs to be further explored. However in terms of using PPE at work, the welders who have been working for longer duration report more use of PPE. It

is seen that welders who have been working for shorter duration are more aware of hazard but use of PPE is lower. One possible reason for this may be younger people having the tendency of having more risk taking behaviour. However this also needs to be explored further in future studies.

Awareness on hazard ($p<0.05$) and awareness on PPE ($p<0.05$) both when compared with the use of PPE at work showed significant relationship. Thus, the current study shows that more the people are aware of the hazard and equipment to protect from, the tendency to use those equipment increases.

All welders learned welding through apprenticeship under an experienced welder for few years. No welders in had any vocational training as compared to Sabitu et al[14] finding where 8.5% of welders of Kaduna, Nigeria went to welding school. Learning by apprenticeship is a common practice in welding here and also in data by Sabitu K et al[14] in Kaduna also show more than 90 % welders learnt by apprenticeship. There is no vocational training course or welding school so far for learning welding skills in this area.

The welders were also not trained or oriented regarding hazards and safety measures at work including basic first aid at work. This is also one of the reasons they are not aware of many hazards of the profession and about protective measures.

There are a few limitations of the study. Though, the sample size was calculated with a scientific formula the width of the confidence intervals show that the sample size is inadequate. A study with a larger sample size might provide a more accurate estimate of the study variables. Generalizability of this study to the other parts of Nepal, predominantly to urban cities is

limited as these cities have more workshops, more welders and therefore, can have different working conditions.

Welding is a hazardous profession which exposes the workers to various kinds of physical and chemical hazards in absence of judicious and effective use of personal protective equipment. The unwanted exposure can lead to variety of disease conditions among the welders. The use of recommended PPE at all times minimizes the exposure to these hazards. All the welders in three districts of eastern Nepal are not aware of the hazards. Many welders are still not aware of the PPE and a much smaller proportion among them actually use PPE during welding. The mask and sunglasses being used are not the recommended PPE - respirators and welding goggles should be used instead.

Welders in the study area are not trained and have acquired their welding skills while working on the job. There is no culture of occupational safety and health among the welders and their employees. This study provides only a glance of the actual problems and risks involved in this profession. There is a gap between the knowledge the welders report on awareness of hazard and PPE with the actual using of PPE at work by the same welders. This gap needs to be further explored so that appropriate interventions can be planned to close this gap. With a high level of awareness present in this group an intervention to increase the use of PPE is needed. Occupational health and safety needs to be promoted by the labour organizations in Nepal and should be highlighted by the public health agencies which can make this a priority issue among our policy makers.

Acknowledgements

We express our gratitude to our study respondents who agree to participate in this study and gave us their invaluable time. We are also thankful to association of Metal Workshops' Association (GRILL BYABASAYI SANGH) which provided us the list of workshops and also an important insight into the area and the work practices.

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.

Competing Interests: None.

Funding: No funds were available.

Data Sharing Statement: No additional data is available

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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,

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

Conclusion:

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

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 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.[1] Welding, a skilled profession has been in use since the ancient times.[2] 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.[3]

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.[4] 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.[5-11]

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.[12] 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.[13]

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

institutional training, age group structure and work experience along with non-adaptation of regulatory measures by concerned authorities on safety precautions.[14] 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 literature search showed that studies in Nepal have not tried to find the use of protective 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 factors associated with awareness of occupational hazards and protective measures and use of protective measures, and 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 designed to be conducted among welders working in three districts of eastern Nepal namely Jhapa, Morang and Sunsari from the period of July 2010 to July 2011. According to the available literature (Isah et al)[15], 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 (37.7%) work related complaint was cut injuries from sharp metals .

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

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

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

= 283 (Approx.)

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

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

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

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

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

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

The study showed that 90.7% of welders were aware of one or more hazards of welding. Excessive brightness (90.7%) was the most common hazard identified by the welders working in the area followed by sharp metals (86.7%), heat (83.7%), physical environment (83.3%), electrical current (80.30%), noise (75.70%), welding fumes (51.70%), sparks (44.3%) and vibration (17%) (not shown in table).

Table 1 shows that 90% of welders were aware of at least one kind of PPE while only 47.7% of welders use at least one kind of PPE during work. While welding goggles/eye shields (86.7%) were the most commonly reported PPE for use, the most commonly worn PPE was sturdy footwear (40.7%)

Sun glasses were considered protective and was used as a personal protective device by 74.3% of the 260 welders who reported being aware about the welding goggles/eye shields as a PPE. None of the welders used welding masks while cotton mask was used by 45% of the 300 welders who reported to be aware of welding masks. The sunglasses and cotton masks are however not included in the table, as they are not recommended PPE for welding.

The illustration of the sun glasses and cotton mask used by the welders in Nepal is depicted in figure 1.

There was a positive association between level of education and the awareness of hazards among the welders ($p < 0.001$). Compared to illiterate welders, the welders with primary education were seven times more likely to be aware of hazards of welding (OR= 7.621, 95%CI 2.738-21.208), while the odds of awareness regarding welding was sixty times higher among

welders with secondary level of education than welders who were illiterate (OR= 60.5, 95%CI 14.517-252.132) .

The duration of employment was seen to be negatively associated with the awareness of hazards among the welders (p = 0.01) i.e. the chances of welders being aware of the hazards was 66 percent more for those welders working for more than five years compared to those who worked for 1 -5 years as shown in table 2.

Table 3 entails that awareness regarding use of PPE was significantly associated with secondary level of education (p = 0.004). The welders who had received secondary level of education were about five times (OR=4.93, 95%CI 1.50-16.23) more likely to being aware of PPE compared to illiterate welders.

There was a significant positive relation between reported use of PPE and secondary level of education (p <0.001). The welders who reported using PPE at work were two times more likely to have had attended secondary education or more (OR= 2.167, 95%CI 1.865-5.430).

Interestingly, the awareness regarding PPE did not find any significant association with duration of employment however, use of PPE by the welders was seen to be more among the welders who had been working for a longer duration of time (p<0.001). The welders who have been working for 11 years or more were almost four times more likely to using PPE at work compared to those who had work experience of 1 – 5 years (OR=3.98, 95%CI 1.99-7.97) as shown in table 4.

Table 5 shows that the odds of using PPE during welding was twice among welders who were aware of the health hazards associated with welding than those who were not aware (OR=

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 knew 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[#]**	**Percent[#]**
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	<0.001	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 χ^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		1.00	
Primary	96	15	0.004	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		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 χ^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		1.00	
Primary	30	81	<0.001	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		1.00	
6-10 years	44	41	<0.001	1.71	1.00 - 2.89
11 years and more	35	14		3.98	1.99 - 7.97

**Calculated using χ^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 χ^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[14], where majority (44.5 %) fall in the same category but differs with the study by Isah et al[15] 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.[16]

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[15] 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[17] 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[15] and Sabitu et al[14] 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.

This profession is regarded as the most hazardous profession and not all of the welders are aware of all the hazards.[18] In our study, ninety percent of welders were aware of at least one hazard of welding. The comparison with other studies showed inconsistent results. The study by Isah EC et al[15] in Benin, Nigeria showed 91.6% of welders being aware of one or more hazard of welding while another study in Kaduna, Nigeria by Sabitu K et al[14] showed 77.9% of awareness of one or more hazards of welding in welders.

Excessive brightness was the most frequently identified hazard by the welders in our study. Welding fumes which is regarded as the combination of highly toxic metals and their oxides[19] was identified as a hazard by 51.7% of the welders. There are also 9.3% of welders who were not aware of any specific hazard at their work. They could not think of any harmful factor in welding.

In the study, 90.7% of welders were aware of welding goggles/eye shield to protect eyes. The same the percentage of welders were aware of at least one PPE. Although 75% of the welders identified noise as hazard at their working place only 19.7% were aware about earmuffs. The utilisation of at least one PPE among the welders was 47.7%, as compared to the study by Sabitu K et al (34.2%) [14] and the study by Isah EC et al[15] (35.9%) in Nigeria. The most commonly used PPE was masks (45%), whereas the most common PPE worn were Welding goggles in both

Nigerian studies; 60.9% by Sabitu K et al[14] and 35.9% by Isah EC et al[15]. Welding goggles/ face shield use was seen among only 18% of the welders in the current study.

It was found that a very high proportion of welders (74.3%) used the general sunglasses regularly at work. Sunglasses are not among the recommended PPE[20] to protect from welding radiation to the eye. The reason for provision of the sunglasses by the employer may be due to being cheaper, easy available and comfortable. The sunglasses used were also not certified for UV protection. The mask used by the welders in this study is also the commonly used cotton mask. This also does not meet the requirement[21] as a respirator for use during welding. It was also seen that more than half of the welders (52.3%) did not use any PPE during work.

Level of education had a significant relationship with awareness of hazard ($p< 0.05$), awareness of PPE ($p<0.05$) and use of PPE ($p<0.05$) in this study. This showed that with increase in level of education among population, awareness and safety practices increased. Welders who have had higher level of education have the tendency to read news, get updates increases the awareness of hazards & PPE, and they tend to increase the practice of use of PPE as well. Sabitu et al[14] also showed that awareness increased significantly with increase in education level.

It was found that welders who were employed for a longer duration reported being less aware of the hazards of welding. It is maybe generally expected for the opposite to be true. The reason for such findings in this study could be due to welders working for longer duration failing to recognise the exposure as hazard after being exposed to them for many years. However this is just a possible explanation which needs to be further explored. However in terms of using PPE at work, the welders who have been working for longer duration report more use of PPE. It

is seen that welders who have been working for shorter duration are more aware of hazard but use of PPE is lower. One possible reason for this may be younger people having the tendency of having more risk taking behaviour. However this also needs to be explored further in future studies.

Awareness on hazard ($p<0.05$) and awareness on PPE ($p<0.05$) both when compared with the use of PPE at work showed significant relationship. Thus, the current study shows that more the people are aware of the hazard and equipment to protect from, the tendency to use those equipment increases.

All welders learned welding through apprenticeship under an experienced welder for few years. No welders in had any vocational training as compared to Sabitu et al[14] finding where 8.5% of welders of Kaduna, Nigeria went to welding school. Learning by apprenticeship is a common practice in welding here and also in data by Sabitu K et al[14] in Kaduna also show more than 90 % welders learnt by apprenticeship. There is no vocational training course or welding school so far for learning welding skills in this area.

The welders were also not trained or oriented regarding hazards and safety measures at work including basic first aid at work. This is also one of the reasons they are not aware of many hazards of the profession and about protective measures.

There are a few limitations of the study. Though, the sample size was calculated with a scientific formula the width of the confidence intervals show that the sample size is inadequate. A study with a larger sample size might provide a more accurate estimate of the study variables. Generalizability of this study to the other parts of Nepal, predominantly to urban cities is

limited as these cities have more workshops, more welders and therefore, can have different working conditions.

Welding is a hazardous profession which exposes the workers to various kinds of physical and chemical hazards in absence of judicious and effective use of personal protective equipment. The unwanted exposure can lead to variety of disease conditions among the welders. The use of recommended PPE at all times minimizes the exposure to these hazards. All the welders in three districts of eastern Nepal are not aware of the hazards. Many welders are still not aware of the PPE and a much smaller proportion among them actually use PPE during welding. The mask and sunglasses being used are not the recommended PPE - respirators and welding goggles should be used instead.

Welders in the study area are not trained and have acquired their welding skills while working on the job. There is no culture of occupational safety and health among the welders and their employees. This study provides only a glance of the actual problems and risks involved in this profession. There is a gap between the knowledge the welders report on awareness of hazard and PPE with the actual using of PPE at work by the same welders. This gap needs to be further explored so that appropriate interventions can be planned to close this gap. With a high level of awareness present in this group an intervention to increase the use of PPE is needed. Occupational health and safety needs to be promoted by the labour organizations in Nepal and should be highlighted by the public health agencies which can make this a priority issue among our policy makers.

Acknowledgements

We express our gratitude to our study respondents who agree to participate in this study and gave us their invaluable time. We are also thankful to association of Metal Workshops' Association (GRILL BYABASAYI SANGH) which provided us the list of workshops and also an important insight into the area and the work practices.

Competing Interests: none declared.

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)

STROBE STATEMEMENT 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.)
Title and abstract [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
Introduction		
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
Methods		
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	-
Results 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	-

Discussion		
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
Other information		
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