PREVALENCE OF VIBRATION INDUCED OCCUPATIONAL HEALTH EVALUATION AMONGST WELDERS OF KOLKATA, WEST BENGAL

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ABSTRACT

Welding is the most common method of joining metals in industry today. Welding operation is one of the most critical operations of any manufacturing process. This study tried to assess occupational hazards of the welders of Kolkata, identify the early hidden cardiovascular amongst these welders and quantify their specific muscle damage profile. Arbitrarily 52 welders from manufacturing welding hub area of Kolkata and 40 non-welders 'workers were chosen for this study and some related physical, ocular and biochemical parameters were assessed in standardised procedure. Welders are mainly suffering from cardiac risk due to continuous exposed to excessive stress job profile. Moreover, they have severe ocular damage and blood vessel damage due to negligence of use of protective eye gear and gloves during welding time. Exposure to vibrating tools for prolonged time may lead to higher ANA titre. Awkward working posture leads to onset of musculo-skeletal disorders in near future. Proper preventive measure needs to be taken immediately for better productivity.

Key words: Welder, lipoprotein(a), C-R Protein, cardio-vascular risk, ocular pressure, Antinuclear antibody.

I. INTRODUCTION

Welding operation is the most critical operation of any manufacturing process, and quality of welding has direct impact on quality of final product. Joining technology is an integral part of the manufacturing process and effort has been spent to develop and demonstrate the suitability of various processes for application in both design and structural fabrication. Welding is the core of modern technology and it has gone through a complete evolution today, following the utmost precedence that machines have garnered in our lives. There is a rapid development in this industry and new methods are being discovered and added day by day. Welding is an ever-growing discipline which presents challenges and work opportunities for new generations of engineers [1].

In India, welding contributes significantly to the Gross Domestic Product (GDP) in several ways, such as welding intensive industries, auxiliary products, complementary goods, employment, and user industries. The Indian welding industry was dominated by low technology and very rare technological innovation. However, in recent years, the demand of automatic and semi-automatic welding production systems is rising. Simultaneously, low budgets and recession have marked the ongoing popularity of manual, economical techniques [2].

In welding process, different agents are produced which are hazardous to human health such as: Gases like acetylene, carbon monoxide, oxides of nitrogen, ozone, phosgene, tungsten; metals like arsenic, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, silver, tin, and zinc; and physical agents like electricity, hot environment, vibration, ultraviolet radiation, ionizing radiation, noise, and visible light. Welding "smoke" is a mixture of very fine particles (fumes) and gases. Many of the substances in welding smoke, such as chromium, nickel, arsenic, asbestos, carbon monoxide, cobalt, copper and so on can be extremely toxic. Welders experience a variety of chronic respiratory problems, including bronchitis, asthma, pneumonia, emphysema, decreased lung capacity and siderosis [3].The intense light associated with arc welding can cause damage to the retina of the eye, while infrared radiation may damage the cornea and result in the formation of cataracts. The "arc eye" or "welder's flash" is caused by the invisible ultraviolet light (UV) from the arc after even a brief exposure (less than one minute). The symptoms of arc eye usually occur many hours after exposure to UV light, and include a feeling of sand or grit in the eye, blurred vision, intense pain, tearing, burning, and headache. The arc can reflect off surrounding materials and burn co-workers working nearby. About half of welder's flash injuries occur in co-workers who are not welding. Welders and cutters who continually work around ultraviolet radiation without proper protection can suffer from permanent eye damage [4]. Welders have high chances of Hand-Arm Vibration Syndrome (HAVS) due to vibration damages that may occur in the fingers, hands and arms when working with vibrating tools or machinery. Vibration injuries are divided into three subgroups: neurological disorders, vascular and musculoskeletal. Hand-arm vibration syndrome (HAVS) is a disabling disease and is a recognized occupational injury. As of today, there are limited medical treatments for HAVS, however it can be prevented by taking precautions to protect oneself against high vibration exposure levels. HAVS comes as a result of injury to blood vessels, nerves, muscles, and joints caused by dangerous exposure to vibration from vibrating tools, such as drilling machines, angle grinders, needle, and chisel scalers. For acute health effect, working with vibrating tools can cause reduced feeling and numbness in the fingers. This can make operators less capable of doing precision jobs and handling the tools. If the tingling and numbness is felt for the entire time whilst using the tool and for a long time after, it might be an indication of dangerous exposure to vibrations. For chronic health effect, extensive exposure to vibrations over time will cause great risk of developing bloodless and numb fingers, also referred to as white fingers. This is why one or more fingers turn pale and look different from our normal skin [5].

The manual handling carried out by welders that are repeated regularly or involve twisting and turning into awkward postures can be particularly hazardous. Welding also comes with the risk of musculoskeletal disorders (MSDs). After reviewing several literature, it has been found that the main contributing factors to MSDs come from work conditions: awkward postures such as squatting, kneeling, or stooping due to the confined or tight locations, lifting heavy equipment or materials, keeping neck bent or keeping shoulders raised for a long time, the stress on neck from supporting the heavy weight of hard hat and welding mask. These conditions can lead to MSDs such as back, shoulder, neck, or knee problems. More than half of the injuries to welders involve the back, neck, shoulders, arms, and hands. The workplace should focus on preventing injuries to these parts of the body.

This unique attempt aims to justify the existing poor physical performance of welders of the Kolkata region and tries to find out the major causative factors for such hindrances. Again, after finding the said

probable factors, the experimenters would like to design a better remedial measure of physical conditioning, so that significant development in the performances would result at the end.

Under the above circumstances this study has been planned with the aims –

- To assess occupational hazards, welders of Kolkata are suffering from.
- To identify the early indicating hidden cardiovascular amongst these welders.
- To quantify the specific muscle damage profile of welders.

II. RESEARCH METHODOLOGY

Selection of the site and sample for the study

The study was a single-blind study conducted in the manufacturing welding hub of Kolkata. The sample comprised of 52 workers from the selected welding area. The selection criteria for the subjects were based on a questionnaire. The questionnaire covered standard demographic questions and occupational questions (years of exposure). Another 40 workers were randomly selected for the study as control group, who belonged to the same socioeconomic status but were not exposed to welding work.

Ethical Consideration

This study was performed following the ethical guidelines for biomedical research on human participants as directed by ICMR, Govt. of India and due permission was taken from the Institutional Ethical Committee (IEC) for research on human participants – of Hooghly Mohsin College.

All the following parameters were assessed between the two groups and tabulated in the following table.

Table 1: Assessment of physical parameter

Serial no	Parameters assessed	Testing Method
1.	Height (cm)	Anthropometric Rod
2.	Weight (Kg)	Weighting Machine
3.	BMI (kg/m2)	Online BMI Calculator
4.	Blood Pressure (mmHg)	Sphygmomanometer

Table 2: Assessment of Cardiac risk factors parameter

Serial no	Parameters assessed	Testing Method
1.	Lipoprotein(a)	ELISA Kit (ab212165)
2.	C-Reactive Protein (mg/L)	Human C Reactive Protein ELISA Kit (CRP) (ab99995)
3.	Antinuclear antibodies (ANA)	Immunofluorescence

Table 3: Assessment of ocular parameter

Serial no	Parameters assessed	Testing Method
1.	Intra Ocular Pressure (mmHg)	Non-contact Tonometer
2.	Fundus Fluorescein Angiogram	Fluorescein angiography

Moreover, a questionnaire, "Shoulder Pain And Disability Index (SPADI)" for detecting musculo-skeletal disorders was employed in this study to compliment the entire findings and to reciprocate their feelings, from quantitative point of view.

Structured cum schedule interview technique was adopted to elicit the information relating to socio economic background, health status, activity profile, time span frequency of performance, total days of performance in a year by performing the various task by the respondents using the PLIBEL questionnaire check list method.

Data was analyzed using software of Minitab 16. Descriptive statistics of socio-demographic variables were computed as mean, standard deviation. Student t-test was calculated with those data.

III. RESULTS AND DISCUSSION

There is approximately 20-30% of labour involved in different welding working area. The workers are routinely and repeatedly exposed to different chemicals, gases, fumes, light glare, vibration, and awkward postures. In this portion of this study, the observations were presented. The age range of both experimental & control group was 35 to 52 years. Both the welder and non-welder control group workers belong to same socio-economic group and had insignificant value of Height, Weight and Body Mass Index (BMI).

Table 4: Representation of Blood Pressure for exposed and control group.

Parameters	Exposed Group		Control Group		p- value (<0.05)
	Mean	S_D	***Mean***	S_D	
SBP (mmHg)	128.00	1.17	122.33	1.25	0.064#
DBP (mmHg)	72.6	2.02	81.66	1.36	**0.009***

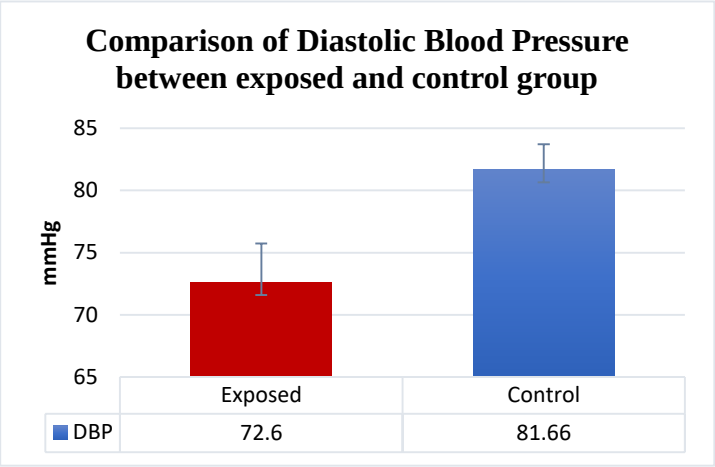
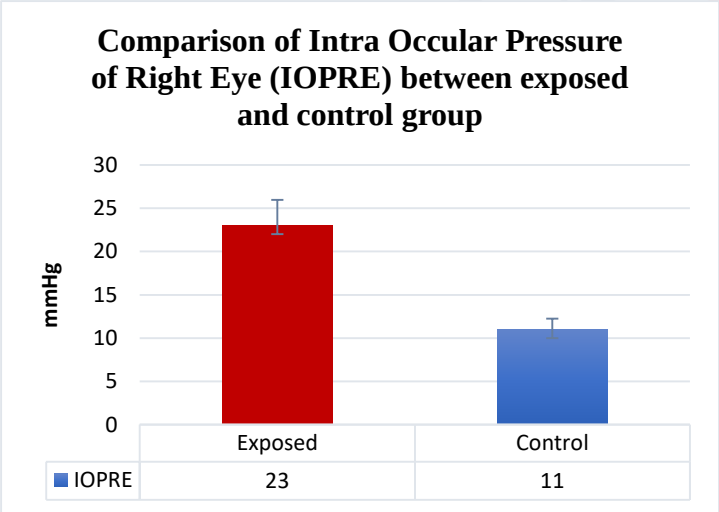
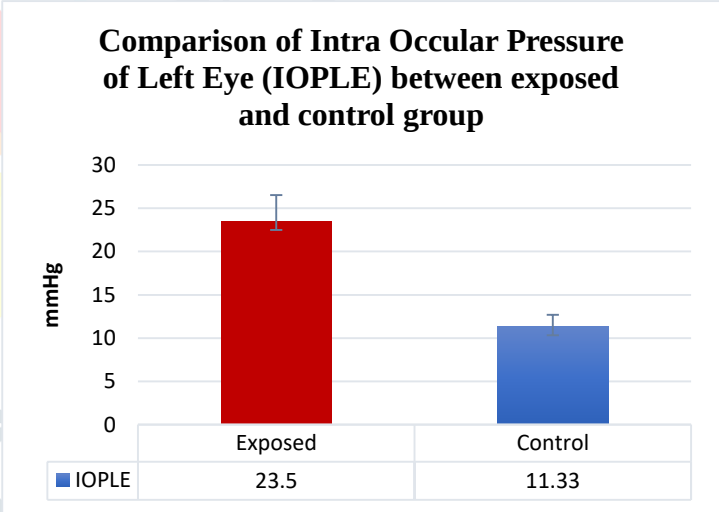
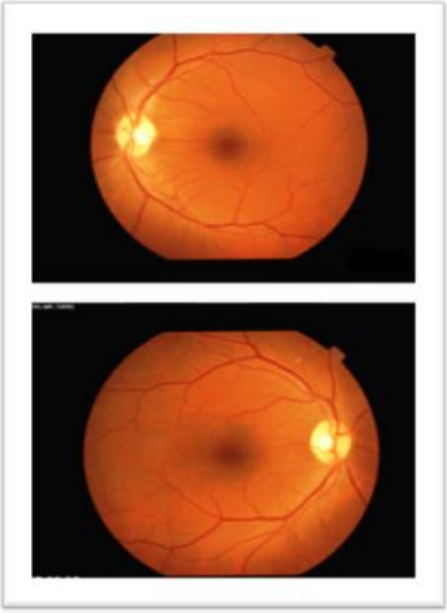


Table 5: Representation of Intraocular Pressure of eyes for exposed and control group.

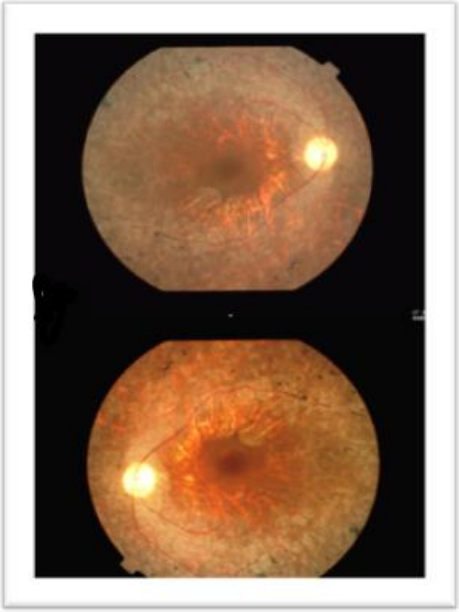
Parameters	Exposed Group		Control Group		p- value (<0.05)
	Mean	S_D	*Mean*	S_D	
IOPRE (mmHg)	23.00	2.97	11.000	1.265	**0.009***
IOPLE (mmHg)	23.50	3.02	11.33	1.366	**0.009***







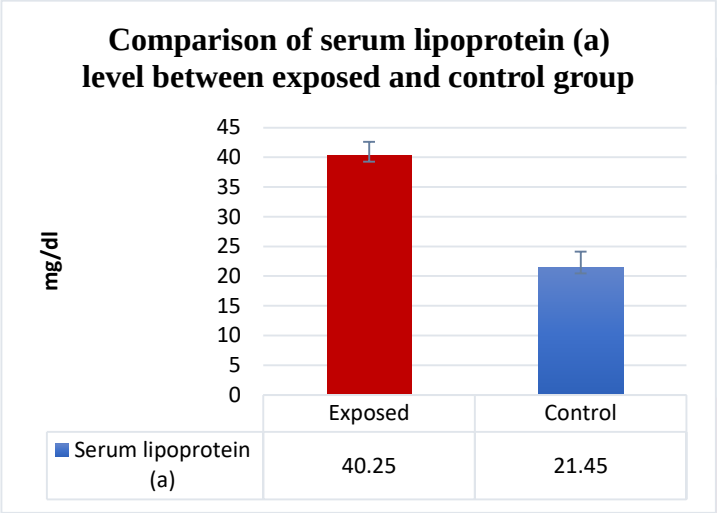
Fundus Fluorescein Angiogram of Normal eyes



Fundus Fluorescein Angiogram of Welder eyes

Table 6: Representation of Biochemical parameters of the exposed and control group.

Parameters	Exposed Group		Control Group		p- value (<0.05)
	Mean	S_D	***Mean***	S_D	
Serum lipoprotein (a) (mg/dl)	40.25	2.36	21.45	2.69	**0.001***
C-Reactive Protein (mg/L)	6.25	1.56	1.6	1.01	**0.004***



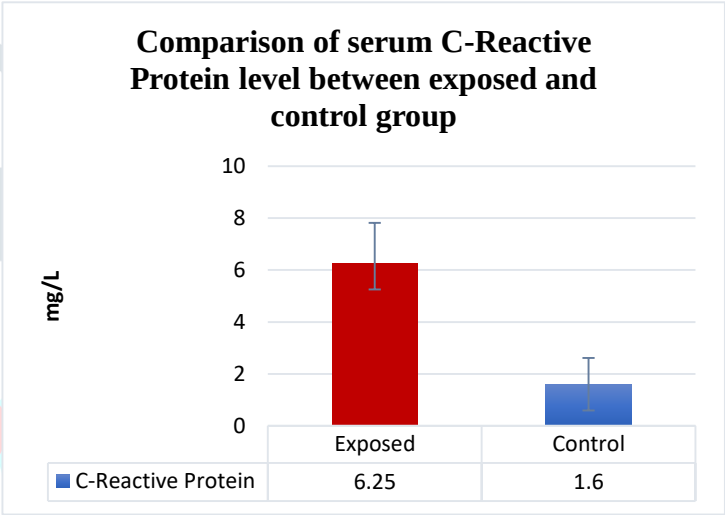
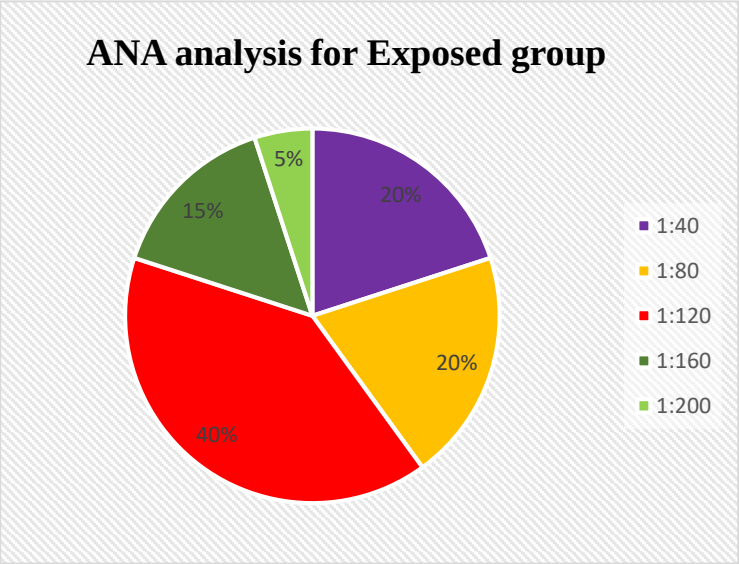


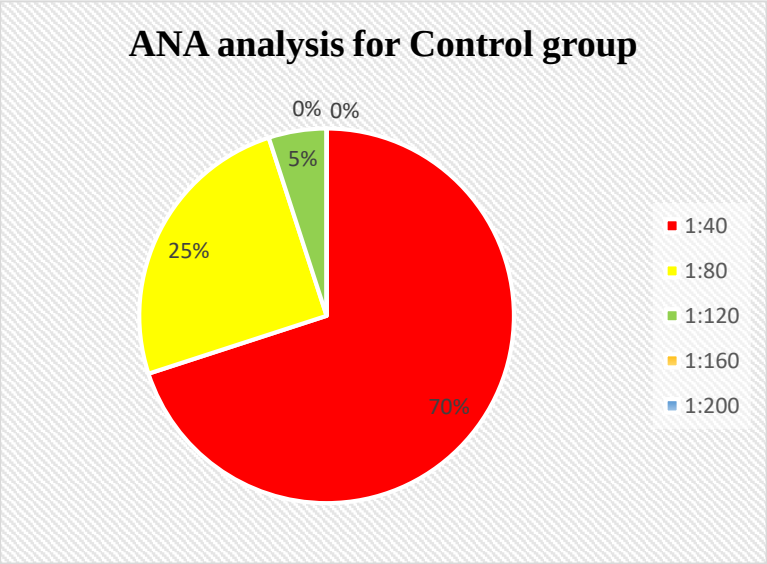
Table 7: Representation of Antinuclear Antibody (ANA) Titer of the exposed and control group.

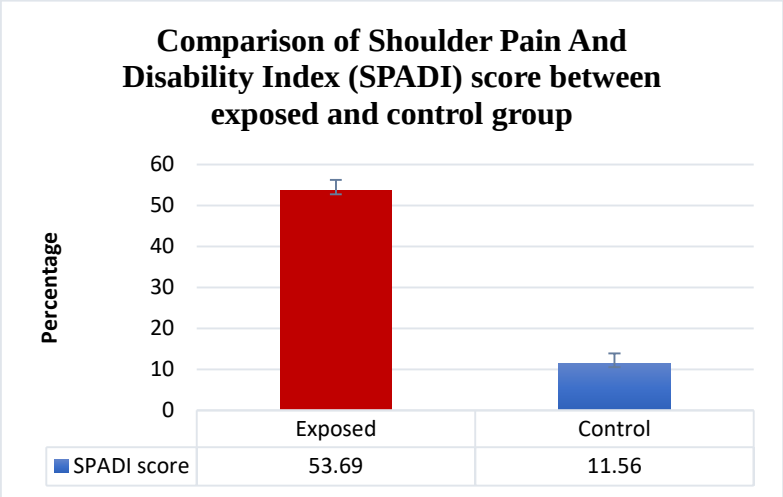
Subjects	Antinuclear Antibody Titer							
	1:40	**1:80**	**1:120**	**1:160**	**1:200**	**1:240**	**1:280**	**1:320**
Exposed	20%	20%	40%	15%	5%	0	0	0
Control	60%	35%	5%	0	0	0	0	0

Table 8: Representation of shoulder pain and disability index score (SPADI Score) of exposed and control group.

Parameters	Exposed Group		Control Group		p- value (<0.05)
	Mean	S_D	*Mean*	S_D	
SPADI Score	53.69	2.38	11.56	2.54	**0.002***







Welding is the most common method of joining metals in industry today. When welded, two pieces of similar metals are fused (melted) together. Once completed, the welded joint is as strong as or stronger than the pieces from which the joint is formed. General hazards of welding include impact, penetration, harmful dust, smoke, fumes, heat, vibration, and especially light radiation. The emerged data from the statistical analyses showed that the mean values with respect to height, weight, BMI, and Systolic Blood Pressure of both the groups resulted in statistically insignificant.

But, from the analysis, it was found that, their diastolic blood pressure was lower than normal and also significantly lower than their control counterpart. Low diastolic pressure indicates a low coronary artery pressure which means that heart is going to lack blood and oxygen (ischemia). Chronic, low-level ischemia may weaken the heart over time and potentially lead to heart failure [6]. It was found that Lp(a) and C-Reactive protein level of welders are significantly higher than control counterpart due to excessive stress, which leads them towards coronary heart failure. A high-sensitivity CRP and LP(a) level are major hidden cardiovascular risk factors.

For most welding processes, ultraviolet (UV) and visible radiations are the main components of optical emission, and the type and extent of optical damage depends on the energy absorbed, the wavelength of radiation and the duration of exposure. The eyes act as a filter and the rays are selectively absorbed by the different structures present in the eyes. UV radiation is absorbed by the cornea and lens, with the lens absorbing more of the radiation at wavelengths approaching 400 nm. This absorption causes chemical changes in the lens, leading to cataract formation [7]. From the ocular pressure analysis, it was found that, both eyes of welders have significantly higher eye pressure. Elevated level of intraocular pressure means Ocular Hypertension and it is one of the main risk factors for glaucoma. High pressure inside the eye is caused by an imbalance in the production and drainage of fluid in the eye (aqueous humour) and further it pushes towards complete blindness. Fundus Fluorescein Angiogram (FFA) image defines welders' retinal circulation with little vascular sheathing and occasional ocular uneasiness and is also an early indicator of retinal vascular damage in early age.

The hand-arm vibration syndrome (HAVS) causes changes in the sensation of the fingers which can lead to permanent numbness of fingers, muscle weakness and, in some cases, bouts of white finger. It is caused by working with vibrating tools. It is unusual to develop hand-arm vibration syndrome unless a person has an experience of using vibrating tools for at least five years. Antinuclear antibody titre analysis depicts welders' circulation damage due to repeated exposure to vibration induced tools. Taking regular breaks of at least 10 minutes away from the tool may be beneficial for preventing the progress of HAVS. Short bursts of work with short rest spells (work-rest cycle) are better than long periods of work without a break.

The welding workers often followed awkward posture during their work time. This repetition of awkward postures for long duration may lead to development of pain in different body parts. This pain affects their muscle, bones, and joints. Disorders or incapability that affects the body's movements is called Musculo-skeletal Disorders (MSD). When workers are exposed to MSD risk factors due to repetition and stress, they become susceptible to fatigue. SPADI score depicts pain in their body parts and disability due to continuous exposure to awkward posture and that ends in development of severe muscle fatigue in near future.

IV. CONCLUSION

From this study it may be concluded that, welders are suffering from low diastolic pressure, which is indicative of development of chronic and ischemic heart failure in near future, if precautions are not taken immediately. Additionally work-station design is found to be faulty and welders suffer from postural dysfunction and pain. More importantly lack of awareness about use of Personal Protective Equipment (PPE) enhances the damage in their ocular health profile. Welders need to break for at least 10 minutes, when they are exposed to vibration tools and also adopt work-rest cycle as they are suffering from cardiac risk. Moreover, excess use of UV rays occupationally damages their ocular environment silently. The employers & the employee federations should be concerned seriously and take steps for a healthier welding station in Kolkata.

V. ACKNOWLEDGEMENTS

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