



Prevalence of non-strabismic binocular vision anomalies among welders

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Abstract

Aim: To find out the prevalence of Non-Strabismic Binocular Vision Anomalies among welders

Methods: A community-based Cross-sectional study was conducted in Butwal Sub Metropolitan city of Nepal among welders of age between 18 to 35 years from the date January 2021 to April 2022. A convenient sampling technique was used. All the Subjects were screened in the community to rule out exclusion criteria and inclusion criteria of the study. All the subjects who met the inclusion criteria underwent the NSBVA assessment at the community level. Descriptive and analytical analysis was done by SPSS.

Results: A total of 180 subjects were enrolled in the study. All the subjects were male.

The mean age and standard deviation of participants were 28.48 ± 5.858 .

The prevalence of NSBVA among welders was 33.33%.

Among the anomalies, Convergence insufficiency (13.3%) was more prevalent among welders followed by accommodative Insufficiency (6.7%), accommodative infacility (4.4%), accommodative excess (3.9%), convergence excess (2.8%), Basic esophoria (1.7%), and divergence excess (0.6%). Among the age group, 31 to 35 years had a higher proportion of NSBVA (18.33%) followed by 18 to 25 (7.78%) and 26 to 30 (7.22%). There was a mild correlation ($r=0.166$) between age and NABVA (Spearman correlation P value 0.026). There was a (Walcoxon rank sum test p-value 0.004) mild correlation between a Working experience ($r=0.303$) with NSBVA (spearman correlation p-value 0.0001). Total near-work exposure in dioptre per week and NSBVA was statistically significant (spearman correlation p-value 0.017) with mild correlation ($r=0.17$).

Conclusion: NSBVA is prevalent among welders among NSBVA convergence insufficiency is a common type of NSBVA seen among welders. NSBVA is prevalent among 31-35 years age group of welders than age 18 to 30 years. Age group, working experience and total near work have a positive correlation with the occurrence of NSBVA.

Keywords: NSBVA, welders, convergence insufficiency, accommodative excess, accommodative insufficiency, convergence excess, near work duration of work

Introduction

Welding is a growing industrial process, widely used for the permanent joining of metal parts^[1]. It is estimated that more than one million workers are employed as welders worldwide with more than three million performing welding intermittently as part of their work duties. According to International Labour Organization (ILO), 0.2 to 2 per cent of the total workforce is engaged in welding in typical industrialized countries^[2]. It can be referred to that the highly demanding visual task can manifest vision-related problems irrespective of the occupation^[3]. Welding is a visually intense task in terms of continuous near work which demands adequate near vision and associated visual skills. Good welders need to pay attention to details. For example, they need to clean grease or corrosion from parts and chip out holes, bubbles, and cracks prior to welding^[4]. Today in our changing environment and working pattern, the near and intermediate visual task have increased dramatically which needs lots of work to our external eye muscles which leads to eye fatigue. These also give rise to number of binocular anomalies in accommodation & convergence^[5, 6]. Failing to diagnose & treat these symptoms & signs give rise to strabismic problem^[7]. Decreased luminance, coupled with the high-contrast light source, would make eyestrain or visual fatigue a common facet of the welding trade. In addition, more permanent effects on visual function, such as acuities and color sensitivities, could also be expected^[8].

Welding is one of the most intense artificial sources of invisible and visible optic radiation, with ultraviolet B being the main actinic component^[9-12]. Gas and arc welding are the commonest types of welding^[13]. The main radiations in the iron industry that the workers are exposed to are ultraviolet and infrared radiations. Infrared radiation is absorbed by almost all structures of the eyes. The radiation of IR-A (770 to 1400 nm) is absorbed by the lenses and the wavelengths greater than 1400 nm (IR-C AND IR-B) are absorbed by the cornea^[16]. Visible light from welding processes is very bright and can overwhelm the ability of the iris of the eye to close sufficiently and rapidly enough to limit the brightness of the light reaching the retina. The result is that the light is temporarily blinding and fatiguing to the eye^[15]. Numerous studies have shown that the occupational and non-

occupational exposure to ultraviolet radiation of welding and workplace infrared cause eye and skin problems [17].

The state of simultaneous vision which is accomplished by the coordinated use of two eyes with the goal that separate and slightly different images emerging in each eye are appreciated as a single image by the process of fusion is expressed as binocular single vision [18]. Binocular vision anomalies mainly include strabismic and non-strabismic anomalies. Non-strabismic binocular vision anomalies are classified as accommodative and vergence anomalies. There are three different major types of accommodative anomalies, namely accommodative insufficiency, accommodative infacility and accommodative excess, and seven different types of vergence anomalies, namely convergence insufficiency, convergence excess, divergence insufficiency, divergence excess, basic esophoria, basic exophoria and Fusional vergence dysfunctions [19]. Binocular vision anomalies are the most common visual disorders which can be associated with symptoms such as headache, eyestrain, blurred vision while doing near tasks, etc. which are generally missed out unless a complete orthoptic and binocular vision examination is performed [20]. NSBVA mostly affects the binocularity, clarity and impair the comfort, visual performance and efficiency of patients particularly with difficulty in near vision [21-25]. The welders are continuously subjected to visual conditions that would appear to be conducive to eyestrain or visual impairment. It should be noted that most welders have vision loss due to welding and certainly experience discomfort with the working conditions, particularly on night shifts and under low ambient and focal luminance conditions [26]. As the welding involve intense continuous near work, welders may be expected to have non- strabismic binocular vision anomalies. Therefore, it is very important to explore the burden of non-strabismic binocular vision anomalies among the welders population.

Welders in developing countries like Nepal disproportionately suffer from occupational health problems. Butwal is one of the major industrial centre of Nepal and one such industry is related to welding which has served to meet the manufacturing and construction needs of the inhabitants of the city. Welding is a hazardous profession which can endanger the eye health of welders with heat, burns, radiations, fumes, gases, electrocution, etc. In addition, other factors such as poor working condition, longer hours at work, inadequate or poor safety precautions, age, welding duration, working distance, etc are possible risk factors associated with the occurrence of eye problems among the welders. Occupational safety measures are not well followed and adopted by welders in Nepal due to low awareness level, lower education level, lack of training and lack of resources [27].

No research works has been done on non-strabismic binocular vision anomalies among the welders in Butwal till date. Therefore, this study will help to explore the common non-strabismic binocular vision anomalies among the welders along with its associated risk factors. Information from the study will provide a database for the effective government policy formation on prevention of non-strabismic binocular vision anomalies in welder's population

Methods

A community-based cross-sectional analytical study was conducted among welders at their work station in Butwal, Sub metropolitan city of Rupandehi district of Nepal from Jan 2021 to April 2022. Different local welding workshop of Butwal was identified and community screening for binocular vision camp was conducted at their respective places. The research was approved by Institutional Review Committee Board of Lumbini eye institute and research centre, Bhairahawa, Nepal. A written consent was taken from all the welders before enrolling in the study.

Sample size calculation

$$\text{Sample size (n)} = Z^2 P(1-P)/d^2$$

Where;

P= expected prevalence of NSBVA=13.15% (angel Garcia Muniz *et al.*,2017) [28]

Z= statistic for a level of confidence (for the level of confidence of 95%, Z value is 1.96)

d= precision i.e. 0.05

Calculated sample size (n) =176

General Examination

A total of 230 welders of age 18 to 35 years were screened, only 180 welders were selected for the study based on purposive sampling.

Inclusion Criteria

- All the welders willing to participate in the study
- Corrected visual acuity better than or equal to 6/6 and N6, respectively, in both the eye for distance and near
- Normal anatomical and physiological condition of eye
- Presence of Binocular single vision

Exclusion Criteria

- One eyed
- Presence of cataract and other ocular diseases,
- Presence of strabismus, amblyopia and other ocular abnormalities
- Previous intraocular/strabismus surgery
- H/O previous ocular or head trauma
- History of systemic diseases

The study begins with detail history taking and detail eye examination which includes visual acuity, objective and subjective refraction, anterior and posterior examination.

Visual acuity was taken by Log MAR 4 meter chart for distance and reduced Log Mar for near, the external examination was performed by torch light, anterior segment evaluation was done hand-held Slit lamp and posterior segment was evaluated by Heine Direct ophthalmoscope. Subjective refraction was done followed by Objective static refraction was performed by Heine retinoscope. Refractive error was categorized by taking spherical equivalent and patient having refractive error $>-0.50D$ is myopia, $>+0.50D$ is hyperopia and $>0.50D$ of astigmatism^[41].

If a participants had significant refractive error for the first time (Myopia of $-0.50DS$ or more, hyperopia $+0.50DS$ or more, astigmatism $0.50DC$ or more and if there is change in refractive error of more than $0.50D$ (spherical or cylindrical power) during refraction, glasses were prescribed and binocular vision assessment was repeated after 2 weeks of adaptation to glasses.

Intraocular/strabismus surgery, ocular or head trauma or diabetes.

Non strabismic binocular vision assessment

After passing the general examination by the welders, they underwent binocular vision assessment at community level suggested by Jamel Rizwana Hussainden^[41] (Minimum battery test) i.e. NPC, Phoria measurement for distance and near, monocular accommodative facility and binocular facility are good sensitive and specificity for diagnosis of NSBVA at community level^[41].

Alternate cover test for distance and near was performed to illicit the phoria and phoria for distance and near was measured with prism bar cover test, NPC with red filter, NPA (M/O and B/O) were performed with push up method, accommodative facility (M/O and B/O) was evaluated by accommodative flipper and accommodative rock cards. Power of accommodative flipper was decided on the basis of amplitude of accommodation of the welders.

WFDT was done to check for the binocularity.

The diagnostic criteria was based on the criteria suggested by Scheiman and Wick^[30]

Near work calculation

Welders near work were assessed by asking hours spent at four activities 1. Welding hour 2. Reading for pleasure 3. Watching Television (TV) 4. Use of phone and playing games in phone hours per week.

To quantify the amount of time spent at near work, a formula was used which involved reading hours, watching TV, welding hours, hour spent playing video games or phone^[28]. The purpose of measuring near work was not just in time spent for near but also accommodative effort in dioptre required during each near activity

The dioptre hours (Dh) = $3 \times (\text{welding hour} + \text{reading hour}) + 2 \times (\text{use of phone in hour}) + 1 \times \text{watching television}$ ^[29] was used to calculate the near work exposure in dioptre.

Data Management

Data were collected in a clinical Performa and data entry was done in Microsoft excel 2007 and analysis was done with SPSS-V.20.0.Descriptive statistics were analysed. as the data does not follow the normality test hence; the non-parametric test was used. Spearman correlation, Walcoxon rank sum test odds ratio was used for association of age, working experience, total near work with NABVA. P- Value cut off of 0.05 for statistical significance.

Results

A Total of 230 welders of age 18 to 35 years were screened in different working station of welders where, 180 were included in our study because five of them had Foreign body in the eye, twenty five welders were above 35 of years, twenty welders were having cataract. The mean age of welders was 28.48 ± 5.858 .

Among the 180 welders, 33.33%(60) of welders had NSBVA whereas 66.7% (120) of welders had normal binocular vision show. Among the NSBVA convergence insufficiency (13.3%) was more prevalent among welders followed by accommodative Insufficiency (6.7%), accommodative in facility (4.4%), accommodative excess (3.9%), convergence excess (2.8%), Basic esophoria (1.7%), and divergence excess (0.6%). However, basic esophoria and divergence insufficiency was not seen among the welders.

Table 1: Prevalence of NSBVA among welders

NSBVA	Frequency	Percentage (%)
Convergence insufficiency	24	13.3
Accommodative insufficiency	12	6.7
Accommodative in facility	8	4.4
Accommodative excess	7	3.9
Convergence excess	5	2.8
Basic exophoria	3	1.7
Divergence excess	1	.6
Total	60	33.33%

Refractive error was categorised into myopia and hypermetropia by spherical equivalent. Prevalence of refractive error among 360 eyes of welders is shown in table1. It was found that 321 (89%) were emmetropia and 38(11 %) had refractive error either myopia or hypermetropia shown in table2. Among the emmetropia 5% (and refractive error group 28% and 5 % resp; had NSBVAs. Shown in figure2.

Table 2: Distribution of refractive error with normal binocular vision and NSBVA

Refractive error	Normal, N (%)	NSBVA (%)
Myopia	12 (3.3%)	8(2.22%)
Hypermetropia	7 (1.94%)	11(3.05%)
Emmetropia	222(61.1%)	101(28%)

Distribution of NSBVA in different age group is shown in table3.

Among the age group, 31 to 35 years had higher proportion of NSBVA (18.33%) followed by 18 to 25 (7.78%) and 26 to 30 (7.22%).

There was a significant difference in median age on NSBVA and Normal group (Walcoxon rank sum test, p value 0.0399).There was mild correlation ($r=0.166$) of age and NABVA (Spearman correlation P value 0.026). One year increase in age, Chance of NSBVA was 1.06 times higher in disease and chance of NSBVA was 2 times higher in >30 years than ≤ 30 years (logistic regression)

Table 3: Distribution of NSBVA in different age group

Age group	Normal binocular vision	NSBVA	Total
	Frequency (%)	Frequency (%)	
18-25	44(21.44)	14(7.78)	58
26-30	30(16.67)	13(7.22)	43
31-35	46(25.55)	33(18.33)	79
	120	60	180

Association of duration of welding in years (Working experience)with NSBVA was analysed. Relationship of NSBVA with duration of working experience in years shown in table4.

There was an association between duration of welding in years and NSBVA. (Walcoxon rank sum test p value 0.004) with a mild correlation between a Working experience ($r=0.303$) with NSBVA (spearman correlation p value 0.0001). It was 4.8 times more chance of NSBVA in working experience >10 years than working experience 0-5 years (logistic regression)

Table 4: Relationship of NSBVA with working experience

Working experience group (years)	Diagnosis of the patients		
	Normal Binocular Vision (%)	NSBVA (%)	Total (%)
0 to <5	53(44.17)	13 (21.67)	66 (36.67)
5 to <10	39(32.50)	14 (23.33)	53 (29.44)
≥ 10	28(23.33)	33 (55)	61 (33.89)
Total	120(100)	60(100)	180 (100)

There was a statistically significant (spearman correlation p value 0.017) with mild correlation ($r=0.17$) between total near work exposure in dioptr per week and NSBVA.

Discussion

Welders are exposed to visible light rays, Infrared (IR) and ultraviolet radiation (UV) that are emitted in various degrees by various welding machines. It has an adverse effect on body and eyes.³⁰ The long-term exposure with such radiation could have condition like pterygium, pinguecula, keratopathy, maculopathy, and eye irritation. Photokeratoconjunctivitis, chronic actinic keratopathy, photophthalmia, and corneal opacity, may cause

permanent and sight-threatening condition observed in welders' eye [31, 32]. Previous Studies have found that hazardous blue light can damage retina and cornea by inducing the phototoxicity and oxidative stress also can cause ocular fatigue, asthenopia, dry eye.³³ The wavelength of light produced from the LED devices is 400 to 490nm which falls on blue spectrum of light.

Our study is the first to report on prevalence of non-strabismic binocular vision among welders.

Prevalence of ocular disorder among welders was 59.9% (atekunda *et al*) [32]. Where pinguecula, pterygium, corneal opacity, pigmentary macular deposits was the common eye disorders occur among welders⁵. Current study showed 33.33% is the prevalence of NSBVA among welders whereas convergence insufficiency, accommodative infacility, accommodative insufficiency was the common non strabismic binocular vision anomalies found among welders.

Chirinjib *et al* study with mean age group of 22.58±1.48 had a prevalence of NSBVA 44%³⁴ and Gracia *et al* [35] with mean age of 22.90 ± 3.96 had 13.15% of NSBVA whereas the current study with mean age 28±5.598 had 33.33% of NSBVA, this could be because of different examination setting and population where convergence insufficiency (CI) was highly prevalent followed by accommodative insufficiency (AI) 6.7%. In the same accord, Chirinjib *et al* ⁷ found the prevalence of CI as 10% which is close to the current study. However, in contrast to the above studies Gracia *et al*³⁵ found a low prevalence of CI (3.43%) which could be because Gracia *et al* included only symptomatic clinical population whereas the current study included both symptomatic and Asymptomatic population.

Present study also found a positive correlation between age and NSBVA which was statistically significant. A few studies are available related to age and NSBVA in general population but no study had showed association between age and NSBVA in young adults but Duseket *et al*³⁸, Scheiman *et al*⁴⁰, Dwer *et al*³⁷, Wajuihian *et al*³⁶ showed CE is prevalent among young age group than older age group and that there is a higher prevalence of CI with increasing age. Also, a study done by Hussaindeen *et al* stated that with increase of age there is higher prevalence of NSBVA which is in alignment with the results of the current study which showed that prevalence of NSBVA is more among 31-35 age group (18%) as compared to that of 18 to 25 age group (7.78%).

The current study had also found a positive correlation between NSBVA and total accommodation utilized for all the near work performed in a day and week. Supporting to this result study done by Gur *et al*³⁹ found that the prevalence of NSBVA was more among VDU user who spent more than 5-6 hour/day at near. Moreover, present study also showed a positive correlation between working experience in years and NSBVA among welders.

Suggestions and Recommendations

From our study, it has been concluded that there is prevalence of NSBVAs among the welders. More researches should be done to find other various risk factors which are associated with the prevalence of NSBVAs in welders. Different research methodologies and comprehensive eye examination along with detailed orthoptic evaluation should be done to rule out the binocular vision status among the welders in various regions of Nepal.

Conclusion

NSBVA is prevalent among welders among the NSBVA convergence insufficiency is common type of NSBVA seen among welders. NSBVA is prevalent among 31-35 years age group of welders than age 18 to 30 years.

Age group, working experience and total near work has a positive correlation with occurrence of NSBV

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