



Corneal Injuries Associated with Ocular Hazards in the Welding Industry: A Case Study of Nekede Mechanic Village Nekede, Imo State, Nigeria

Desmond Eberechukwu Ihekaire, Chinwe Stephanie Oji

Department of Optometry, Faculty of Health Sciences, Imo State University, Owerri, Nigeria

Email address:

ihekaide@gmail.com (D. E. Ihekaire), ojichinwe75@gmail.com (C. S. Oji)

To cite this article:

Desmond Eberechukwu Ihekaire, Chinwe Stephanie Oji. Corneal Injuries Associated with Ocular Hazards in the Welding Industry: A Case Study of Nekede Mechanic Village Nekede, Imo State, Nigeria. *International Journal of Ophthalmology & Visual Science*. Vol. 2, No. 2, 2017, pp. 37-54. doi: 10.11648/j.ijovs.20170202.12

Received: February 15, 2017; **Accepted:** March 30, 2017; **Published:** April 24, 2017

Abstract: This is a study of corneal injuries associated with ocular hazards in the welding industries in Nekede Mechanic Village Nekede Imo State. The data were collected from direct interview method and direct observation used to extract facts relating to the injuries and other factors that might predispose to them. The data were analyzed using frequency tables, bar charts and pie charts. A total number of 100 subjects were assessed with the ages of the subjects ranging between 18 and 35 years, selected at random and examined with the ophthalmoscope, penlight and a visual acuity chart, in their respective workshops. The study discovered about 48% of diverse cornea injuries: Pterygium, Pinguecula, Corneal opacity, Limbal changes and Photokeratitis. As shown on frequency distribution tables, pie charts and bar charts, 2% constantly used eye wear, 14% (often users), 41% (occasional users), 43% (never users). About 1.3% of the injuries occurred among regular users, 46.1% (occasional users), 38.1% (never users). This is a proof that the aforementioned injuries are products of non-compliance with the use of eye wear. Therefore, it is recommended that proper orientation and strict compliance should be emphasized on the use of protective eye wears in the welding industry.

Keywords: Corneal Injuries, Ocular Hazards, Welding Industry, Nekede, Mechanic Village, Imo State, Nigeria

1. Introduction

Industrialization is a desirable development since it ensures higher standard of living for the citizenry. In the industries there is bound to be risk or danger, which exists in various types and natures. The risks may be exposure to harmful chemicals, trauma, exposure to radiation, as well as foreign body infiltration; these are generally referred to as hazards and "ocular hazards" when the eye(s) and its related structures is/are affected.

Ocular hazards may be defined as those factors and conditions which pose a threat to the conservation and promotion of healthy, wholesome and comfortable vision. The factors and conditions include accident, injury or diseases which may manifest as a clinical vision anomalies.

According to [1], ocular hazards once described as the neglected disorder, has recently been highlighted as a major cause of visual morbidity. Annually, over 2.5 million people suffer an eye injuries, and globally more than half a million

blinding injuries occur every year. Worldwide, there are approximately 1.6 million people blind from eye injuries or hazards, 2.4 million bilaterally visually impaired and 1.9 million with unilateral vision loss, this being the commonest cause of unilateral blindness today.

The cornea is the most exposed to these hazards due to its location in the globe. Although, other ocular structures are also affected, but in a smaller or less frequent magnitude. Corneal injuries can be described as injuries to the cornea and can be particularly dangerous resulting in terrible repercussions bearing symptoms of blurred vision, eye pain or stinging and burning in the eye, swollen lids, light sensitivity among others [2].

There are numerous occupations in which ocular injuries pose special risk of which welding is one. Numerous hazards associated with these welding processes, ranging from high energy injuries (i.e. high temperature radiation) to flying metal chips and hot slags.

The eye is the body's window and about 90% of industrial

activities are dependent directly or indirectly on visual perception hence, influencing efficiency and output.

From the foregoing, it will be naïve to suggest putting a stop to industrialization; a better approach will be to seek a good understanding of the industrial environment in order to determine the attendant hazards and to devise means of avoiding or handling them when they occur.

Serious eye injuries involving the orbit or ocular structures of which the cornea is one are usually classified into those caused by blunt injuries, large sharp objects, small flying particles and burns. The type and extent of damage sustained by a traumatized eye depend on both the mechanism and force of injury. These mechanisms include:

- a) **Contusion Injury:** These may result from a variety of causes like flying blunt objects, falling objects, the employee falling, explosion or compressed air accident, and fluid under pressure escaping from burst pipes. The resultant ocular damage is due to a pressure wave traversing the fluid content of the eye. As the fluid is incompressible the blow will act as an explosive force in all directions from the centre outwards, resulting in the ocular contents being flung against their outer coat. The globe expands around the equator to take up a vertically oval shape. Any part of the eye may be affected.
- b) **Intraocular Foreign Bodies:** Foreign bodies that enter the eye may cause damage in two ways—they may cause structural damage to the intra-ocular con
- c) **Tents** as they enter and pass through the eye and—they may cause toxicity to the tissues as they degrade or oxidize, if not removed rapidly.
- d) **Perforating Injuries:** These carry a poorer prognosis than blunt injuries although the extent of damage depends on where and how far the object enters the eye. Wounds that are isolated to the cornea may not penetrate the anterior segment structures and if small, may seal itself with little visual morbidity especially if they are off the visual axis.
- e) **Burns:** Burns to the eye caused by strong acids or alkalis are amongst the most ocular emergencies. The outcome of any chemical burn depends on the concentration and ph of the offending agent and duration of exposure.

Alkalis in particular, cause severe injuries as they damage cells and penetrate the tissues rapidly. Acid injuries tend to be severe, as they remain confined to the ocular surface.

2. Background

The cornea is the anterior medium of the eyeball with the convex surface forming anterior one-sixth of the outer fibrous coat of the eyeball. Its refractive index is 1.337, refractive power of about 45 diopters with a radius of curvature of 7.8mm and 6.5mm antero-posteriorly. It measures about 12.5mm and 11.5mm in diameter and is composed of five concentric layers—epithelium, the underlying basement membrane, the bowman's layer, the

stroma (substantia propria), the descemets membrane (posterior elastic lamina) and the endothelium.

The cornea has its blood supply from the anterior ciliary vessels, which are in the subconjunctival tissue that overlaps it. The nervous supply is by the anterior ciliary nerves which are branches of ophthalmic division of the 5th cranial nerve. Except at the limbus, the cornea is usually avascular as this is necessary for optical clarity (transparency); its nourishment is via the permeation of tissue fluid through the stroma.

The cornea functions primarily by acting as a major refracting medium and protecting the intraocular contents. Cornea fulfills these duties by maintaining its transparency and replacement of its tissues, which is as a result of peculiar arrangement of corneal lamellae, avascularity and relative state of dehydration, which is maintained by barrier effects of epithelium and endothelium, and the active bicarbonate pump of the endothelium. Hence, any alteration to this unique cornea integrity would tend to compromise its normal transparent state. This alteration may manifest as—disease state and trauma or injury (radiation, penetrating and blunt injuries).

Therefore, minimum care needs to be taken to avoid injury as it is usually difficult to be replaced or repaired once damaged.

2.1. Definition and Classification of General Inflammatory Injuries of the Cornea

Inflammation of the cornea is regarded as keratitis. It could result from bacterial, fungal or viral infection, hypersensitivity to staphylococcal exotoxins, nutritional deficiencies in the precorneal tear film, mechanical and chemical radiation, trauma or interruption of the ophthalmic branch of the trigeminal nerve.

It is generally characterized by dullness and a loss of transparency of the cornea due to infiltrates, neovascularization, edema, and is accompanied by ciliary injection. The discomfort varies from a foreign body sensation to severe pain with lacrimation, photophobia, blepharospasm and an impairment of vision. In severe cases, ulcers and hypopyon (pus) appear, and the iris and ciliary body may become involved. Signs of keratitis may include:

- a) **Infiltration**, with dullness of surface and diminution of transparency, which may be followed by complete absorption of the infiltration, incomplete absorption leaving opacities, suppuration with formation of an ulcer and cicatrization (repair).
- b) **Limited or general vascularization**, an extension of the limbic vessel into the cornea between the epithelium and bowman's membrane produces pannus, whereas an extension of the scleral vessels into the stromal layers of the cornea produces interstitial vascularization.
- c) **Circumcorneal injection**
- d) **Complicating conjunctivitis** (often)
- e) **Congestion of neighboring deep parts** (iris and ciliary body) resulting in photophobia (pain on movement of the inflamed iris stimulated by exposure to light), and at times exudation into the anterior chamber.

Inflammation of the cornea (keratitis), may be classified into ulcers, superficial and deep keratitis. Ulcers are caused by—trauma, which is the most frequent cause, lacrimal sac infection, conjunctival inflammation, disturbance in the nutrition of the cornea, exposure of the cornea, infection during operation and acute infectious diseases.

If the ulcer is small and superficial, it will cleanse itself in the course of a few days. When it is deep, neighboring structures give evidence of inflammation; conjunctivitis, iris congestion, iritis and cyclitis. This process may spread to the interior of the eyes or perforation of the cornea.

Superficial keratitis is characterized by either multiple, small, flat epithelial dots resulting from bacterial infection, vitamin B₂ deficiency (riboflavin), virus infection, exposure to ultraviolet light, injury to the eye with aerosol or contact lens solutions.

Deep keratitis is essentially a cellular infiltration of deep layers of the cornea, without ulceration. It frequently occurs in childhood; it is chronic in its course and associated with uveal tract inflammation. The keratitis is merely a part of the uveitis, participation of the uveal tract being hidden during the style of opaque cornea.

2.2. Cornea Response to Injury

The cornea epithelium is maintained by a constant cycle of shedding of superficial cells and proliferation of cells in the basal layer. the primary function of the cornea epithelium is to form a barrier to invasion of the eye by pathogens and uptake of excess fluid by the stroma.

Accidental abrasion of the corneal epithelium demands a prompt healing response to recover the exposed basement membrane with cells. After abrasion, mitosis ceases and the cells at the wound edge retracts, thickens and lose their hemidesmosomal attachments to the basement membrane. The cells enlarge by amoeboid movement to cover the defect. After wound closure, mitosis resumes to restore the epithelium to its normal configuration.

Stromal wound healing involves the resynthesis and cross linking of collagen, alteration in proteoglycan synthesis and gradual remodeling leading to the restoration of tensile strength. Little or no mitosis occurs in the adult human corneal epithelium. For this reason, when endothelial cells are lost due to surgical trauma or disease or aging process, the defects are covered by the spreading of the cells adjacent to the wound to cover the wounded area.

When a single cell is lost as in aging, the cells immediately surrounding the defects spread to fill in the area left by the missing cells. Over time, this leads to the marked cell enlargement typical of the aged cornea.

When a large defect occurs as a result of a surgical insult or a decompensation episode in keratoconus, more extensive cell emigration occurs.

2.3. Assessment of Corneal Injuries/Diseases

The biomicroscope or slit lamp is an essential instrument for proper cornea examination, although the pen torch can be

used. The light is moved over the entire cornea while the course of the light reflection is being followed by the examiner, hence rough areas indicating epithelial defects are noticed. Examination of the cornea may be facilitated by instillation of a local anesthetic.

Flourescein staining can outline a superficial epithelial lesion that might otherwise be impossible to see. The patient history is very important in cornea disease evaluation as well as eliciting history of trauma. When examining the cornea, the following problems should be anticipated; epithelial staining, dystrophies, and pigment deposition [3].

2.4. Welding

The welding industry is an establishment engaged in the business of production of goods and services with the use of metallic, electrical and chemical materials.

Welding is the process of joining two similar metals by melting together, usually with additional filter rod of source sort to take up space.

A welder is a tradesman who specializes in welding materials together [4]. There are basically two types of welding: (1) Electrical welding, which is done with the use of welding arc, which has the prime function of converting electrical energy to heat energy, at a temperature of about 10,000F(5,500°C) by forming a mixture of ionized (charged) particles. (2) Gas welding, the most common type of gas welding is manual oxyacetylene welding in which flame temperature of about 5,500°F(3,300°C) is obtained by the controlled combustion of acetylene and oxygen.

2.5. Ocular Hazards in Welding

Hazards exist in various types and nature in industrial set-ups of which welding is one. The following eye hazards are associated with the welding process—hot slags, hot electrodes, fumes and gases, metal chips, visible light, sparks, ultraviolet radiation and infrared radiation.

2.6. Corneal Injuries Associated with Welding

2.6.1. Mechanical Injuries

- a) Retained extra ocular foreign bodies
- b) Blunt trauma (contusion injuries)
- c) Penetrating and perforating injuries
- d) Penetrating injuries with retained intraocular foreign bodies [5].

Extra ocular foreign bodies: these can be washed out by tears while some can be embedded in the epithelium or superficial stroma and rarely into the deep stroma. A cornea foreign body may be complicated by ulceration.

Pigmentation and or/opacity may be left behind by an iron or emery particles embedded in the cornea. The cornea shows marked vascular injection around the foreign body [6]. Ocular pain is experienced but difficult to localize, photophobia and also defective vision occurs when the foreign body is lodged in the centre of the cornea. Most foreign bodies are metallic, iron particles, and when they quickly oxidize in the tears, they result to inflammation of

the cornea and iris.

Contusion Injuries: these refer to closed-globe injuries resulting from blunt trauma. Damage may occur at the site of impact or at a distant site. Effects of contusion on the cornea are: (1) simple abrasions: this involves the loss of the surface of the cornea epithelium; it can be painful and discomfoting and can be diagnosed by fluorescein staining. These usually arise if the eyelids do not close properly with trauma induced conditions such as proptosis and ectropion. (2) Recurrent corneal erosions (recurrent keractalgia): these may sometimes follow simple abrasions; can also be as a result of incomplete healing of the cornea epithelium after a foreign body infiltration [7].

Patient usually gets recurrent attacks of acute pain and lacrimation on opening the eye in the morning. This occurs due to abnormally loose attachment of the epithelium to the underlying bowmans membrane; also there is alteration in the corneal normal curvature, resulting in temporary vision problems:

- a) Partial cornea tears (lamellar corneal laceration): these may also follow a blunt trauma. It presents more like a corneal abrasion but the trauma will be visible [8].
- b) Blood staining of the cornea: it may occur occasionally from the associated hyphema (presence of blood in the anterior chamber as a result of rupture of the vessels in the iris or ciliary body). Cornea becomes reddish brown or greenish in color and in later stages stimulates dislocation of the clear lens into the anterior chamber. It clears very slowly from the periphery towards the center; the whole process may take even more than two years [5].
- c) Deep corneal opacity: this is loss of transparency of the cornea due to scarring; it may result from edema of corneal stroma or occasionally from folds in the descemets membrane. Corneal opacity can be graded as nebula, macula and leucoma depending on the density. Nebula is when it is a faint opacity involving the bowmans layer and superficial stroma, macula when it is a semi-dense opacity involving half of the corneal stroma and leucoma when it is a dense white opacity involving more than half of the stroma. Corneal opacity produces loss of vision when it covers the pupillary area.
- d) Penetrating and perforating injuries: penetrating injuries are single full-thickness wound of the eyeball caused by a sharp object while perforating injuries refers to double full-thickness wounds (one entry and one exit) of the eyeball caused by a sharp object [9], these can cause serious damage to the eye (cornea) and so should be treated as serious emergencies.

Sometimes pyogenic organisms enter the eye during perforating injuries, multiply there and cause varying degrees of infection, depending upon the virulence and host defense mechanism. These include ring abscess of the cornea, sloughing epithelial surface of the cornea, endophthalmitis or panophthalmitis.

Penetrating injury to the cornea violates the globe of the

eye; this causes a ruptured globe.

Mechanical effects of penetrating or perforating injuries on the cornea can be divided into uncomplicated and complicated wounds:

- a) Uncomplicated wounds are not associated with prolapse of intraocular contents. Margins of such wounds swell up and lead to automatic sealing and restoration of the anterior chamber
- b) Complicated corneal wounds are associated with prolapse of the iris, sometimes lens matter and even vitreous.

A badly (severe) wounded eye, which refers to extensive corneo-scleral tears associated with prolapse of the uveal tissue may occur. Usually, there seems to be no chance of getting useful vision in these cases.

Retained intraocular foreign bodies: these may damage the ocular structures (cornea) when small hot foreign body from hammering or chipping hits the eye at great speed, penetrate the globe and actually seal their route of entry.

Mechanical effects of intraocular foreign body depend upon the size, velocity and type of foreign body. Foreign bodies greater than 2mm in size cause extensive damage. The lesions caused also depend upon the route of entry and the site up to which a foreign body has travelled; these include corneal perforation leading to decreased visual acuity. Foreign bodies also produce specific reactions especially when it has to do with changes produced by the alloy of copper in the eye. Copper ions from the alloy are dissociated electrolytically and deposited under the membranous structure of the eye. This can lead to Kayser-fleischer ring which is a golden brown ring which occurs due to deposition of copper under peripheral parts of the descemets membrane of the cornea.

2.6.2. Non-mechanical Injuries

These are subdivided into chemical, thermal, electrical and radiation injuries. But of relevance to this study thermal, electrical and radiation injuries will be discussed.

Thermal injuries: these are usually caused by fire, or hot fluids. The cornea is usually affected in severe cases but the main brunt of these injury lies on the lids.

Electrical injuries: the passage of strong electric currents may cause the cornea to develop punctate or diffuse interstitial opacities.

Radiation injuries: One of its most serious effects on the cornea is the loss of transparency. At very short wavelength in the ultraviolet and long wavelength in the infrared, essentially all of the incident optical radiation is absorbed in the cornea. Because of rapid re-growth, injury to this tissue by short UV radiation seldom lasts more than one or two days unless deeper tissues of the cornea are also affected. Thus, surface epithelium injuries are rarely permanent.

Photokeratitis, also called keratoconjunctivitis, arc eye or welders flash which is akin to sunburn of the cornea and conjunctiva not usually noticed until several hours after exposure can be produced by high doses of UV (UV-B, and UV-C:180-400nm) radiation to the cornea and conjunctiva;

common symptoms include pain, intense tears, eyelid twitching, discomfort from bright light and constricted pupils.

It occurs because the UV energy causes damage to or destruction of the epithelial cells. Injury to the epithelium is extremely painful as there are many nerve fibers located within the cells in the epithelial layer. However, it is usually temporary because the corneal epithelial layer is completely replaced in a day or two.

Corneal opacities can occur when there is near ultraviolet (UV-A: 315-400nm) and far infrared (IR-B and IR-C: 1.4-1000 μ m) radiation damage to the stroma causing an inversion of the entire cornea by blood vessels which turns the cornea milky [10].

Epithelial damage due to radiation injuries can lead to corneal edema wherein the corneal hydration becomes above 78 percent, which is the water content of a normal cornea, central thickness increases and transparency reduces leading to marked loss of vision, pain, discomfort and photophobia. Photo-ophthalmia, which refers to occurrence of multiple epithelial erosions due to the effect of ultraviolet rays especially from 311 to 29 μ occurs as seen in industrial welding. Exposure to UV rays after an interval of 4-5 years leads to desquamation of corneal epithelium causing multiple epithelial erosion.

UV-B and UV-C rays are absorbed by the corneal epithelium, which results in a reduction of the cell division in mild cases or in severe cases, in complete death of the epithelial cells. Corneal ulceration occurs in extreme cases.

Pterygium which manifests at the corneal periphery is also caused by UV radiation. The subconjunctival tissue undergoes elastic degeneration and proliferates as vascularised granulation tissue under the epithelium, which ultimately encroaches the cornea. The corneal epithelium, Bowman's layer and superficial stroma are destroyed [6].

2.7. Protective Eye Wears

Welders stand a very high risk of corneal injuries ranging from flying pieces of metals to exposure to the damaging effects of the ultra-violet radiations due to the nature of their job. The most effective treatment of all these ocular hazards facing the welders is prevention, of which eye protective wears in the form of protective goggles is the best. A good protective eye wear must satisfy the following requirements:

- a) Adequate protection against the particular hazard for which they are designed.
- b) Reasonable comfort when worn under designated conditions during welding; it should fit snugly and not interfere with the movement of the wearer.
- c) It should easily be disinfected and also easy to clean.
- d) It should be made non- inflammable or of slow burning materials.
- e) It should be clearly marked as safety wear, and the manufacturers and trademark intact.
- f) Provision should be made for those who require the use of corrective lenses to wear safety goggles over their regular prescription eye glasses.

Protective lenses are made of the following materials:

- a) Glass- heat toughened, chemically toughened and laminated.
 - b) Plastics- polymethyl methacrylate (PMMA), cellulose acetate.
 - c) Wire gauze
- Frames or lens holders may be made of metal or plastics.

2.8. Statement of the Problem

Cornea injuries /diseases have become a common problem in the welding industry, with the cornea being the first point of call during ocular hazard. In a clinical outreach at Mbaise in 2013, we saw a retired welder with a whitish cornea (leucoma) who confessed that he never liked wearing protective eye wear while welding. By the forgoing therefore, it is necessary to determine the nature and extent ocular hazards associated with the welding industry. It is also important to ascertain the reasons why some welders do not wear (or not like wearing) protection while they do their work since they are not immuned to the hazards therein. Could the aversion to protective eye wear be attributed to uncomfortable and inconveniencing fitting or ignorance of the need for protective eye wears among the welders?

2.9. Purpose of the Study

The study addressed the under-listed purposes:

- a) To determine the incidence of cornea injuries among a group of welders.
- b) To verify the nature/causes of such injuries.
- c) To verify if there is compliance to the use of eye protection.
- d) To determine the types of injuries suffered by this group.

2.10. Hypotheses

The null hypothesis states that "Welding does not pose any threat to vision", while the alternative hypothesis is "Welding poses threat to vision".

2.11. Significance of the Study

The significance of this research is to create awareness among, educate and enlighten those in the industry (and welders) on the need for protective eye wears, with emphasis on personal safety. It will serve as contribution to the history and development of preventive and environmental optometry as well as, industrial management in the country and in other nations. It will further enrich existing literature on occupational hazards and specifically, on ocular hazards associated with welding and help to provide useful information and guide in life diagnosis, treatment and management of corneal injuries.

3. Review of Related Literature

Following the delicate nature of the eye (cornea), several researchers have been out on its attendant injuries. Welding is

indispensable to numerous industrial and consumer products, as it plays a key role in building and maintaining equipment, tools and infrastructure that make our abundant lifestyle possible. If done properly, it is safe, productive and efficient; poor safety technique often translates to poor quality as well as posing hazard to operators and other people in the area he concluded. According to Lombardi et al. [11], welding and welding related tasks cause more eye injuries than any other occupation.

According to Kanski [9], trauma is the most common cause of unilateral cataract in the young, and sudden compression of the lens, with or without rupture of the lens can produce cataract. Contusion injuries may damage the anterior segment and may result in cornea abrasions, hyphema, and associated damage to the ciliary body, iris or lens. Contusion may also affect the innervations of the eye. He also pointed out that there is decreased sensitivity or anesthesia of the skin in the area of distribution of intra orbital nerve.

According to North [12] complications such as recurrent bleeding, uveitis and abnormal intraocular pressure may also occur. Whitcher et al [13] reported on corneal blindness that because of the difficulty of treating corneal blindness once it has occurred, public health prevention programs are the most cost-effective means of decreasing global burden of corneal injuries or blindness.

Trauma is often the most important cause of unilateral loss of vision in developing countries and that up to 5% of all bilateral blindness is a direct result of trauma. The implication is that well over half a million people in the world are blind as a result of eye injuries [14].

Thylefors [14] in his analysis of world literature on ocular injuries, revealed a global epidemic of ocular trauma with some 55 million eye injuries; 950 000 required hospitalization and 200 000 were open-angle injuries.

Chukwu, in his [15] study on the incidence of ocular hazards in the Port Harcourt refinery (NNPC) found a higher rate of ocular injuries; 118 cases of injuries from the various parts of the body were noted while ocular injuries were up to 20.3%. These hazards resulted from burns, fumes, foreign body, trauma, conjunctivitis and red eye.

Labric et al. [16] evaluated the ocular effect of dental curing light. It was found that the higher powered lamps showed potential to causing blue light mediated ocular damage at shorter distance, with damage occurring after cumulative viewing of only 6 seconds at the 30cm distance during 8 hour workday, both to the patients and the doctor.

A recent study of eye injuries showed that sports related injuries due to eye glasses were a common occurrence among young people under age 18 while fall injuries due to eye glasses occurred more among those aged 65 and above. Despite these, wearing eye glasses whether prescription or cosmetic has been found to provide significant eye protection against severe eye injuries [17].

Nakagawara [18] revealed that to workers who wore protective devices, this may be because they were wrong protectors. He however, cited instances to show almost three

out of five who suffered eye injury were not wearing eye protective devices at the time of the incidence.

According to Brophy et al. [19], center for injury research and policy, Columbus Children Hospital Ohio, USA, an estimated 2.4 million eye injuries occurred in the United States each year with nearly 35% of injuries among persons aged 17 years or less. Although, previous research had identified some of the characteristics of pediatric eye injuries, many studies focused only on a specific patient population or type of eye injury or relied on self-reported data.

According to Omoti et al. [20], a study on non-traumatic ocular findings in industrial technical workers in Delta State Nigeria, discovered that non-traumatic ocular disorders are common in the industrialized technical workers; the use of protective eye devices is low in the workers, and he suggested that measures to implement ocular safety should be undertaken in these industries. About 500 technical workers were screened, comprising 200 (40%) from the construction industry, 180(36%) from the rubber industry and 120(24%) from the oil mill. All the workers studied were males. Ocular disorders were seen in 664 (66.4%) of the eyes. The most common ocular disorder were pinguecula 215(21.55%), pterygium 86(8.6%) and chronic conjunctivitis 45(4.5%). There were also presbyopia, 97(9.75%) and 94(9.4%) refractive errors. None of the workers was blind from non-traumatic cases; only 36 workers wore any protective devices at work.

Waziri et al. [21] in evaluating ocular disorders in Nigeria suggested that exposure to irritant chemicals in the petroleum industry makes the technical workers more prone to allergic conjunctivitis, pterygium, cornea abrasions and foreign body in the cornea, especially without protection.

Occupational eye injuries are more common in younger men and comprise 70% of all the ocular injuries. Males have 2.2 to 5.5 times higher risk of sustaining eye injuries than females. According to NIOSH eye safety resources (2010) (NIOSH workplace safety and health), about 2000 Americans have job related eye injury that requires medical treatment. About one third of which is treated in hospital emergency departments, and more than 100 of these injuries result in one or more days lost work. The majority of these injuries results from small particles of objects.

Their static provided national estimates and rates of occupational injuries and illness treated in USA. Duke Elder and Macfaul [22] went on to classify various lens damages which can occur:

- a) Vossious ring opacity
- b) Sub epithelial disseminated opacities
- c) Traumatic shaped cataract
- d) Diffuse cataract
- e) Zonular cataract.

Sliney et al. [10] stated that ultraviolet radiations which extend between blue end of visible spectrum and low-energy x-rays, straddling the boundary between ionizing and non-ionizing radiation, which is conventionally set at 100mm are being used in daily industrial activities. These radiations, which produce tanning of the skin, is mostly completely

transmitted by the cornea and absorbed by the lens (UVA). UVB is partially absorbed while UVC, which is entirely absorbed by the ozone and is transmitted by the excimer laser, arc welding equipment and germicidal lamps is entirely absorbed by the cornea. The absorption of these may lead to photokeratitis, an acute superficial burn of the cornea surface, as well as photo conjunctivitis from over exposure of the tissue.

Walter [23] recorded that none of the victims of mine blast was wearing protective eye wear or clothing. He went further to say that such apathy is common and is to be reviewed seriously because occupational injuries although common, are preventable provided suitable precautions are taken.

Nakagawara [18] said that all protectors should meet a national standard institute. These are classified into six or otherwise called minimum requirement for eye protection:

- They should provide adequate protection against the particular hazard for which they are designed.
- They should fit well and not unduly interfering with movement of the wearer.
- They should be reasonably comfortable when worn under the designated control condition.
- They should be durable.
- They should be capable of being disinfected
- They should be easily cleaned.

Tituyal et al. [24] discovered that the frequency of ocular complaints among the industrial workers increased with age. The point prevalence of ocular morbidity stood at 746.03/1000 industrial workers. Refractive errors were commonest ocular condition (56%) followed by trachoma. The highest prevalence of morbidity was recorded among workers above 44 years.

Also, Okoye et al. [25] stated that eye injuries were commonly caused by metal chips, cement dust, fragment of woods, pieces of coal stones, and welders x-rays all of which could be prevented by wearing appropriate protective eye coverings. Contusion injury was the most common form of injury in their report.

Again, Omoti and Enock [26] in a bid to determine the ocular disorders in the petroleum industry in Warri, Nigeria concluded that exposure to irritant chemicals in the petroleum industry makes the technical workers more prone to allergic conjunctivitis, pterygium, corneal abrasion and foreign body on the cornea. They recommended that protective goggles should be provided for the technical workers.

Abiose and Otache [27] identified potential ocular hazards in two factory surveys as metal injury, radiation effect to the eye and chronic conjunctiva irritation from cotton fluff in the Atmosphere, foreign body injuries, and molten metal injury. They discovered that although protective devices were provided, they were not often worn and this failure resulted in the above mentioned six ocular accidents. They sued for proper training of health workers to treat such injuries as well as keeping of accident records. They observed that both the employee and the employer have roles to play in industrial safety.

YU [28] highlighted the need for provision of protection that are effective in protecting exposed welders as well as, education and safety training. He went further to state that maintenance and repair of machines and equipment may effectively reduce or eliminate the sources of such exposures for construction workers prone to multiple exposures.

Furthermore, Kagami et al. [29] in a study showed that pilots have a higher incidence of cataract when compared to the average population. His epidemiological study showed close link between cataract and exposure to sun; he went on to reveal that both UV and deep light have in some occupational hazard studies shown to be damaging the retina in laboratory studies.

Thylefors in [14] through their analysis of the world literature, brought to light a global epidemic of ocular trauma with some 5.5 million eye injuries occurring annually of which 150,000 cases required hospitalization and 20,000 were open globe injuries.

The Causes of Ocular Hazards

Different authorities classified causes of ocular hazards as follows:

According to Hotstetter [30]

- a) Large flying objects
- b) Small flying objects
- c) Dust and wind
- d) Splashing metal
- e) Gases, fumes and liquid
- f) Reflected glare
- g) Injurious radiant energy with moderate reduction of visible radiant energy
- h) Abrasive blasting.

According to Duke Elder and Macfaul [22]

Mechanical

- a) Contusion
- b) Incised wounds
- c) Retained foreign body
- d) Explosion
- e) Indirect effects of mechanical injury

Non –mechanical

- a) Thermal
- b) Ultrasonic
- c) Electrical
- d) Radiation
- e) Chemical
- f) Stress

According to Gulacsik, Auth and Silverstein [31]

- a) Impact industrial hazards
- b) Small missiles
- c) Air-borne contaminants
- d) Chemical
- e) Radiation

According to Fox (1973)

Mechanical

- a) Particles
- b) Dust
- c) Compression
- d) Hot solids

Non-mechanical

Chemical

- a) Thermal
- b) Electrical
- c) Radiation

Particles and dust are contusion injuries while compression and hot solids are perforating injuries.

Hazards can be principally classified into three groups:

- a) Flying particles
- b) Splashes of dust, acid and alkali
- c) Harmful rays {UV, infrared and glare}

In broad sense, ocular trauma can be divided into: (see figure 1)

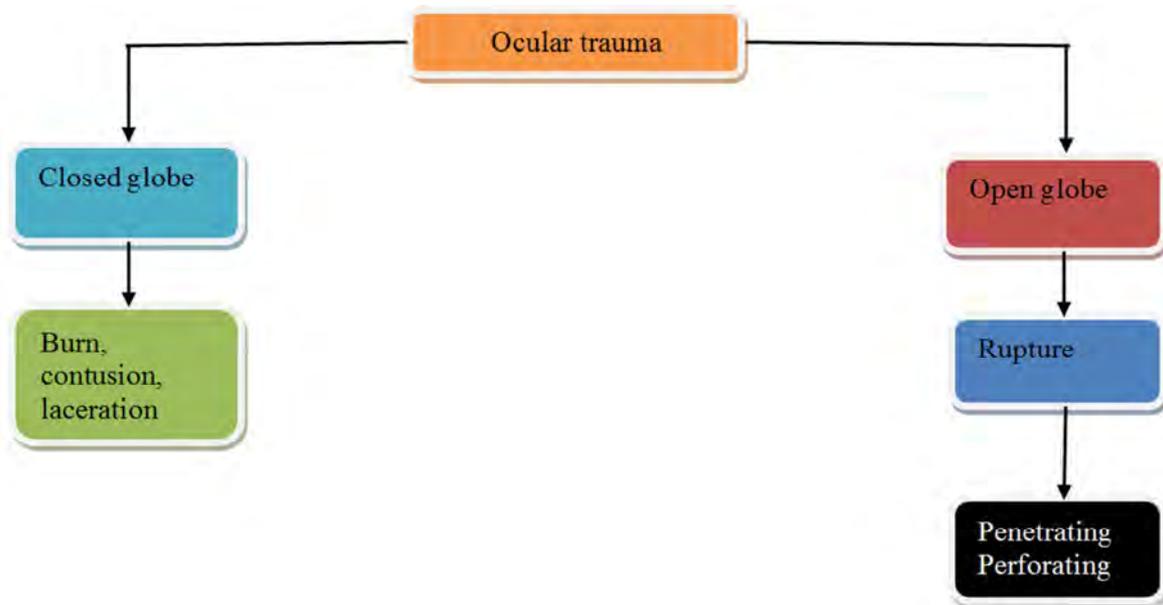


Figure 1. Divisions of Ocular Trauma.

Hendrix [32] stated in his talk, “once what we have come to recognize in considering persons for employment is the virtually important question of the state of their eye.” Basically, when we hire an individual, we attempt to utilize their natural gifts, whether it is brain or brawn, in jobs best fitted for them.

Smillie [33] indicated that over one million, four hundred thousand injuries occurred from occupational causes in United States of America. He also said that industrial accidents do not occur as a result of one thing, rather can be caused by both personal and mechanical factors.

Personal causes are:

- a) Improper attitude
- b) Lack of skill or knowledge
- c) Unnecessary exposure to danger
- d) Operating at unsafe speed, etc.

Mechanical causes are:

- a) Improper cover (guards) for immovable parts of the equipment
- b) Hazardous arrangement or procedure

Asogwa [34] agreed with the postulation, and short listed the major causes of injuries or accidents that are prevalent and non-prevalent in Nigeria.

Prevalent causes of accidents/injury are:

- a) Drunkenness
- b) Carelessness
- c) Physical handicap
- d) Effect of drugs

e) Illiteracy (inability to read, understand safety instructions)

f) Ill health

g) Faulty work technique and inadequate mastering of the work techniques.

Non prevalent causes of accidents/injury are:

- a) Poor living conditions
- b) Accidents proneness
- c) Alcoholism, drug addiction and bad social habit
- d) Inadequate job motivation

Asogwa [34] continued and highlighted that some of the immediate causes of accident /injury are:

- a) Unprotected equipment
- b) Explosion
- c) Fire
- d) Hot products

More importantly, the working environment can predispose one to accident/injury in industries. According to him, some factors that can lead to accidents/injuries are as follows:

- a) Cloudy environment, noxious gases or fumes/smokes
- b) Noise, bites from snakes, rats, bats etc
- c) Poor ventilation
- d) Slippery floors and poor illumination

Both Asogwa [34] and Smillie [33] never knew that other factors such as error of refraction could lead to accident/injury in an industry.

It was Dettmar in 1967 who mentioned that employee

upon vision screening discovered that they really needed vision correction, and even the supervisor understood that refractive error could lead to an accident and low productivity in the industry, though they vary from time to time.

Pigeon [35] felt industrial or occupational vision should be given more attention. The eye care specialist must first get his excellent basic knowledge of the topic in the optometry school. More participation in occupational vision program in industrial environment within convenient travelling from school like outreaches should be encouraged to alert the management on the prevention of injuries. Nakagawara [18] mentioned that there is need for eye care specialists in industries and the implementation of vision conservation program which is best done by the eye care specialists (optometrists).

Miller [36] said that the program during implementation will comprise the following services:

- a) Determination of job and work areas that should be identified as hazardous.
- b) Performing complete eye examination on these employees not meeting the minimum visual standard.
- c) Identification of occupational eye injuries and diseases.
- d) Educate the employees on the benefit of good visual performance.
- e) Regular survey of the welding environment to evaluate the employees and ensure that the employees have safety, comfortable and efficient visual performance.

4. Methods

4.1. Research Area

This research was carried out at Nekede mechanic village, Nekede, Imo state. The choice of this area was informed by its proximity to Imo State University Teaching Eye (Optometry) Clinic, where most of the clinical screenings were done.

4.2. Research Design

Descriptive versus analytical research design was adopted for this study. This is because the research was geared towards unveiling the various injuries to the cornea due to welding. The design went further to quantify them.

4.3. Study Population

A total of one hundred welders were used for the study, with their ages ranging from 18 to 55 years; all males. These welders came from different socio-cultural, socio-economic, and educational backgrounds. The sample population comprised 42 Electric welders (42%) and 57 Gas (57%) welders. Most of these welders were found to have one form of cornea injury or the other.

Out of the hundred welders examined, 85 (85%) revealed one type of corneal condition or the other. The remaining 15 showed neither objective nor reported corneal abnormality. 29 subjects out of 57 gas welders revealed different objective

corneal conditions, while 40 reported various corneal injuries.

Out of the 43 electric welders examined, 36 reported one form of corneal condition or the other while only 19 had objective corneal conditions. 7 of the electric welders reported no corneal condition and 24 had no objective corneal condition.

The subjects (welders) confessed to a common knowledge of the importance of the use of protective eye wear. They also knew that welding without protective eye wear is destructive to the eye. However, most of them either did not like using them or could not afford them.

4.4. Sample and Sample Technique

The study sample comprised of hundred welders randomly selected from different locations at Nekede mechanic village. Using uncontrolled direct observation and face to face interview method, the research went ahead as I collected data. The welders were directly met at their workplaces and asked the relevant questions (case history). Subsequently, those selected were referred to Imo State University Eye Clinic for comprehensive eye screening to identify any attendant hazard or trauma that resulted during the welding process. The technique used aided in obtaining a kind of subjective and objective results (signs and symptoms), thereby increasing the likelihood of validity and reliability of collected data.

4.5. Instruments for Data Collection

The following instruments were used in the research study:

- a) Illiterate and literate visual acuity charts (both far and near)
- b) Occluder
- c) Pen torch
- d) Ophthalmoscope
- e) Slit lamp biomicroscope

4.6. Procedure

The case history of the selected welders was taken utilizing objective and subjective methods of data collection. Visual acuities of the welders were taken with the snellen chart at distance 6m and near 40cm, consisting of both literate and illiterate charts; this test was done monocularly and binocularly and recorded. The pen torch was used for external examination for foreign bodies and presence of light perception and then the ophthalmoscope for internal examination. Finally, the slit lamp biomicroscope was used for further examination of the anterior and posterior segments of their eyes.

4.7. Administration of the Instruments and Field Work

The welders were met at their work place, where the essence and procedure of the study were explained to them. This boosted their interest and participation, especially as their identities would not be revealed. However, while some complied others did not; each was afraid to be examined first.

The latter group would always say that their eyes were delicate, and being their main source of living, would not play with it. Unfortunately, most of those who turned down the examination thought they were going to pay for it. The history of the samples were taken, consisting of their age, length of years on the job, exposure, the type of welding light used, how often they used their eye wear for work, any previous injury. Their corneas were also observed for any trauma, and their visual acuities taken.

4.8. Methods and Techniques of Data Analysis

The methods chosen and used for the explanation of the collected data are mean scores, pie charts, and bar charts. The data are presented in frequency tables, percentages and degrees. This technique aided in showing a distribution of the incident corneal conditions among two major welding types, the rate of the use of protective eye wear during welding compared to the prevalent injuries, and the rate of response of the welders to the injury.

5. Results and Discussion

Table 1. Age Distribution of Welder's Showing a Mean Age Distribution of 29.2.

AGE GROUP (YEARS)	CLASSMARK(X)	FREQUENCY(F)	FX
11-20	15.5	12	186.0
21-30	25.5	56	1428.0
31-40	35.5	17	603.5
41-50	45.5	13	591.5
51-60	55.5	2	111.0

EF=100
 EFX=2920
 Age distribution mean
 $X = EFX/EF$
 $= 2920/100$
 $= 29.2$

Table 2. Length of exposure of welders to welding light, ranging from 1 year to 30 years with a mean year of exposure of 10.15.

RANGE OF YRS OF EXPOSURE (YEARS)	CLASS MARK (X)	FREQUENCY (F)	FX
1-5	3	31	93
6-10	8	35	280
11-15	13	16	208
16-20	18	3	54
21-25	23	8	184
26-30	28	7	196
TOTAL		100	1015

EF=100
 EFX=1015
 Mean year of exposure
 $X = EFX/EF$
 $= 1015/100$
 $= 10.15$

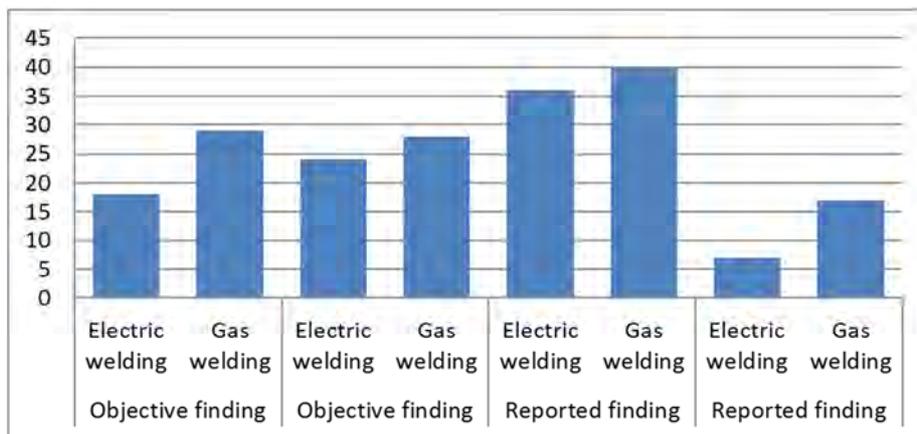


Figure 2a. Bar chart showing the distribution of findings among electric and gas welders.

Table 3. Frequency distribution of both objective and reported findings among welders.

RESULTS	objective			Reported		
	EW	GW	ALL	EW	GW	ALL
FINDINGS	19	29	48	36	40	76
NIL	24	28	52	7	17	24
TOTAL	43	57	100	43	57	100

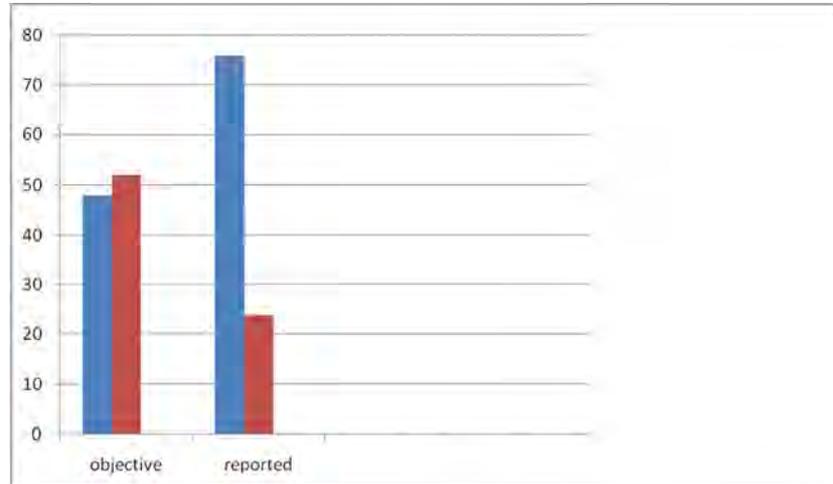


Figure 2b. Bar chart showing the distribution of objective and reported findings among all welders.

Table 4. Frequency distribution of objective corneal external abnormalities found in welders.

S/N	External Condition	Frequency	Percentages
1	Pterygium	19	21.8
2	Pinguecula	30	34.5
3	Corneal opacity	6	6.9
4	Poor VA	31	35.6
5	Limbal Changes	1	1.2
Total		87	100

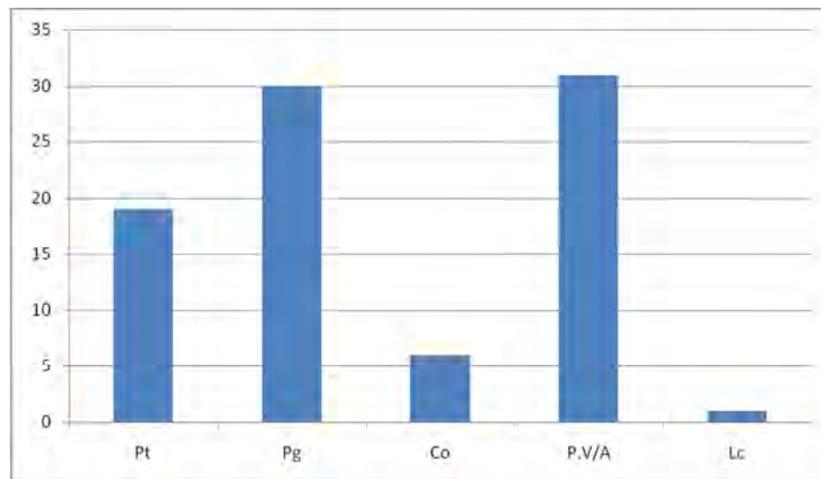


Figure 3. Bar chart showing the distribution of objective corneal external abnormalities found in welders.

Table 5. Frequency distribution of reported abnormalities (or symptoms) experienced by welders.

S/N	Reported abnormalities	Frequency	Percentages
1	Penetrating injury	17	20.2
2	Cloudiness of vision	27	32.1
3	Pains and tearing	13	16.6
4	Irritation	19	22.6
5	Itching	2	2.3
6	Photokeratitis	6	7.14
Total		84	100

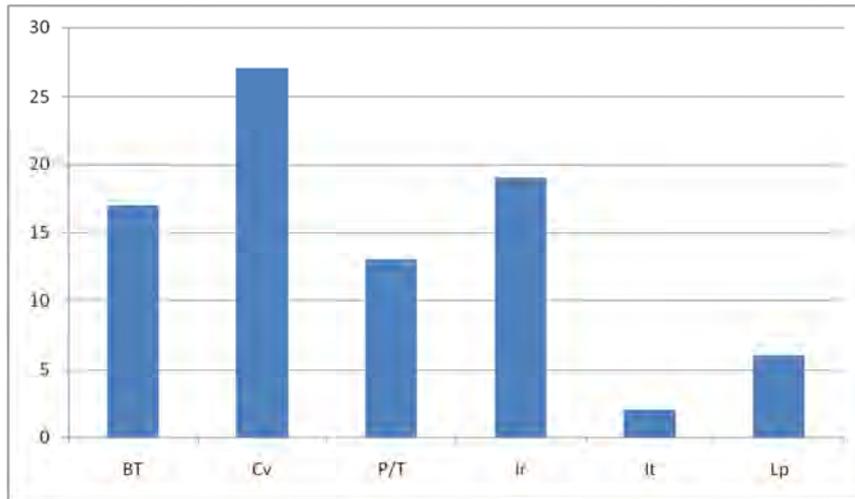


Figure 4. Bar chart showing the distribution of reported ocular abnormalities experienced by welders.

Table 6. Frequency distribution comparing the objective corneal abnormalities found in electric and gas welders.

S/N	Ocular conditions	Electric Welders		Gas welders	
		Frequency	percentage	frequency	Percentages
1	Pterygium	3	8.8	16	30.2
2	Pinguecula	16	47.1	14	26.4
3	Corneal opacity	2	5.9	4	7.5
4	Poor V.A	13	38.2	18	3.4
5	Limbal changes	0	0.00	1	1.9
Total		34	100	53	100

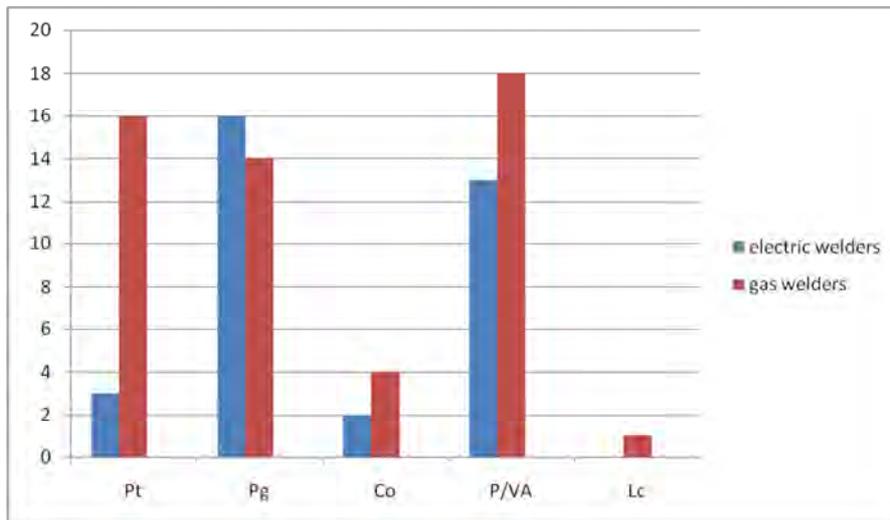


Figure 5. Bar chart showing the comparison of the objective corneal abnormalities between electric and gas welders.

Table 7. Frequency distribution comparing the reported corneal abnormalities found in electric and gas welders.

S/N	Ocular conditions	Electric welders		Gas welders	
		Frequency	Percentage	Frequency	Percentages
1	Penetrating injury	9	22.5	8	18.2
2	Cloudy vision	12	30	15	34.1
3	Pains/tearing	6	15	7	15.9
4	Irritation	11	27.5	8	18.2
5	Itching	1	2.5	1	2.3
6	photokeratitis	1	2.5	5	11.4
Total		34	100	53	100

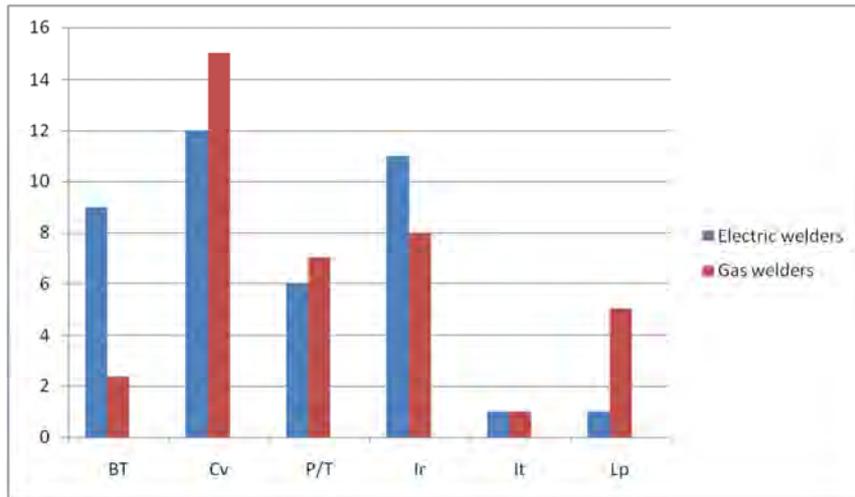
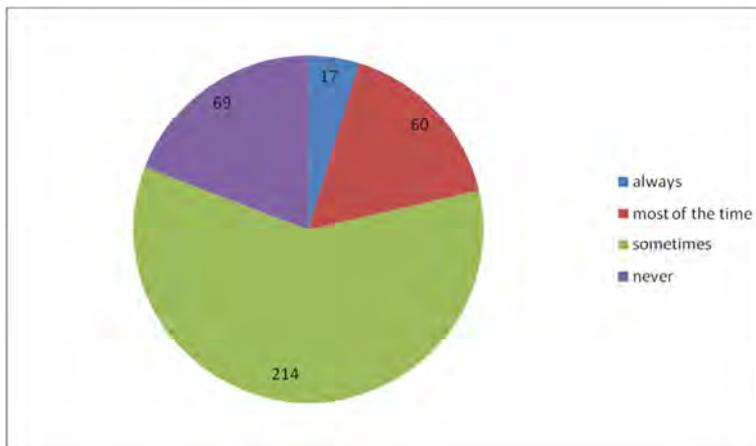


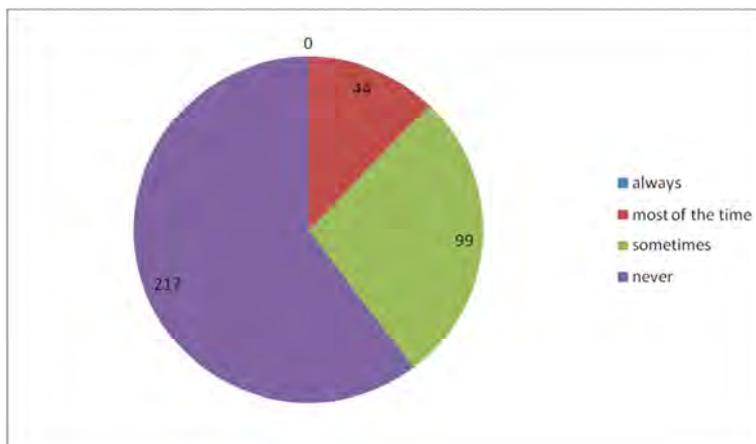
Figure 6. Bar chart showing the comparison between the reported corneal abnormalities found in electric welders and gas welders.

Table 8. Frequency distribution of the welder (electric and gas) according to use or non-use of protective eye wear.

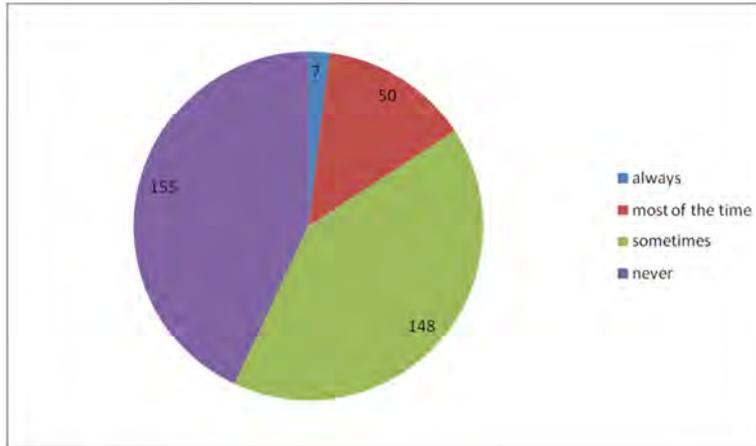
S/N	Use of protection	Electric welders			Gas welders			All welders		
		frequency	percentages	degree	frequency	percentages	degree	frequency	percentages	Degree
1	Always	2	4.8	17	0	0	0	2	2	7
2	Most of the time	7	16.7	60	7	12.1	44	14	14	50
3	Sometimes	25	59.5	214	16	27.6	99	41	41	148
4	Never	8	19.0	69	35	60.3	217	43	43	155
Total		42	100	360	58	100	360	10	100	360



(a) Electric welders



(b) Gas welders

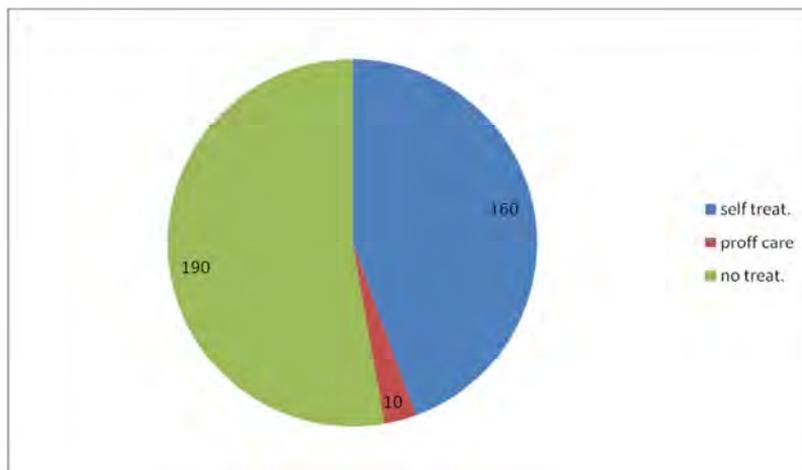


(c) All welders

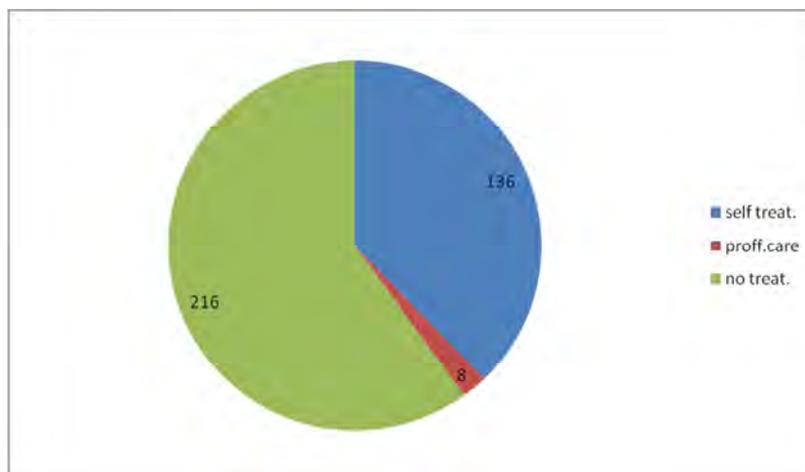
Figure 7. Pie chart showing the rate of the use of protective eye wear by electric, gas and all welders.

Table 9. Frequency distribution of the welder's response to injury.

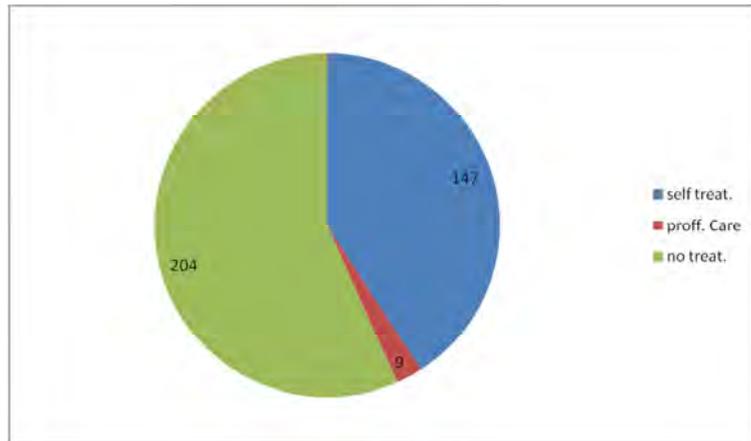
Response to injury	Electric welders			Gas welders			All welders		
	frequency	percentage	degree	frequency	percentage	degree	frequency	percentage	degree
Self treatment	16	44.4	160	17	37.8	136	33	40.7	147
Professional care	1	2.8	10	1	2.2	8	2	2.5	9
No treatment	19	52.8	190	27	60	216	46	56.8	204
Total	36	100	360	45	100	360	81	100	360



(a) Electric welders



(b) Gas welders

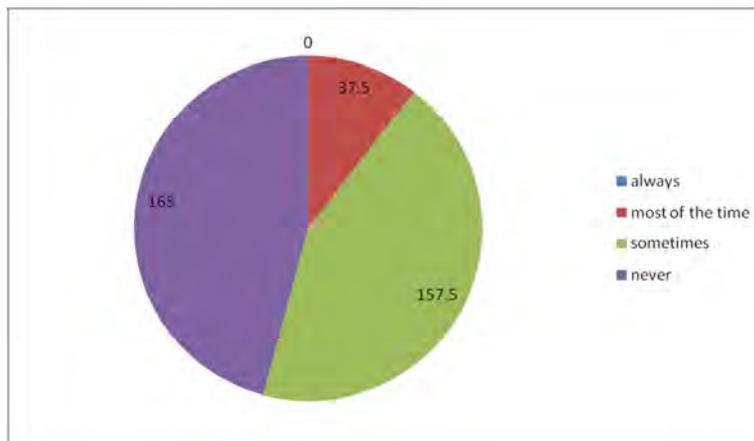


(c) All welders

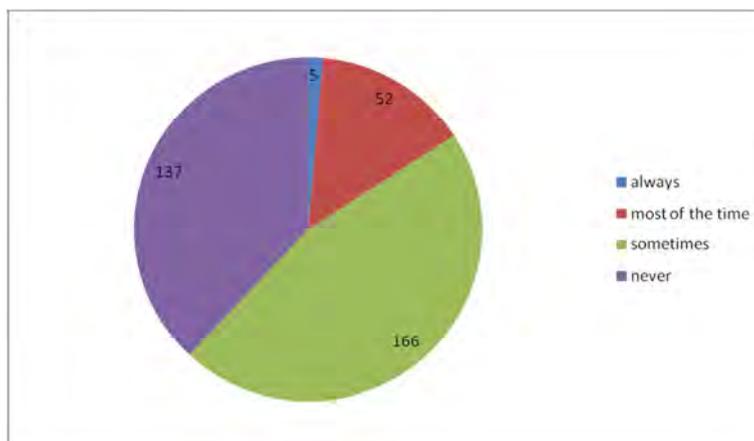
Figure 8. Pie chart representing the distribution of the welders' response to injury.

Table 10. Frequency distribution of objective and reported injury according to the rate of use of protective eye wear.

S/N	Use of protective wear	Reported			Objective		
		frequency	percentage	degree	frequency	percentage	Degree
1	Always	1	1.3	5	0	0	0
2	Most of the time	11	14.5	52	5	1.4	37.5
3	Sometimes	35	46.1	166	21	43.8	157.5
4	Never	29	38.1	137	22	45.8	165
Total		76	100	360	48	100	360



(a) Objective



(b) Reported

Figure 9. (a & b): Pie charts showing the rate of occurrence of injury; (a) objective (b) reported, with respect to the use of protective eye wear.

From the analysis of data done in chapter four, the majority of the welders were found within the age group of 21-30 years (mid class of 25.5) having the frequency of 56. This was followed by the age group of 31-40 years (mid class of 35.5) with a great margin, having the frequency of 17. Age group of 11-20 years (mid class of 45.5) came next the consecutive frequencies of 12 and 13, respectively. The age group of 51-60 years (mid class of 55.5) had the least frequency of 2. The mean age distribution of the welders were in their active age since welding is a high energy demanding work, and requires keen vision as well.

Thus, they tend to retire early from welding due to sagging strength and deteriorating vision.

The length of years of job exposure in welding revealed that 6-10 years (mid class of 8) of welding exposure has the highest frequency of 35, and is closely followed by 1-5 years exposure group, with frequency of 31. The remaining are 11-15 years exposure group, 21-25 years, 26-30 years, 16-20 years with frequency of 16, 8, 7 and 3 in that order. The mean years of job exposure is 10 years (Table 2). This is so because of the ocular hazards emanating from the process of welding without proper protection. A great number of (majority) of the welders never used protective eye wear while welding, hence early retirement due to diminishing vision or accidents, which denied them the ability of providing fine and neat work, and giving their best in service.

Among all the welders examined, 76% revealed reported cases of corneal condition while 24% revealed none. 48% of the welders revealed one form of corneal condition or the other, and 52% showed none (Table 3 and figures 2a and 2b). This corresponds with Lombardi et al.'s [11] finding that welding and welding related tasks cause more eye injuries than other occupations.

Table 4 and figure 3 show that reduced vision or poor visual acuity is the major objective corneal condition with a percentage frequency of 35.6%. Next is pinguecula, followed by pterygium with percentage frequencies of 34.5% and 21.8, respectively; corneal and limbal changes is the least with percentage frequencies of 6.9% and 1.2%, respectively.

Table 5 and figure 4 show the reported cases of corneal conditions among welders; cloudiness of vision (CV) has the highest percentage frequency of about 32.1%, followed by irritation (IR) 22.6%, penetrating injury or blunt (BT) 20.2%, pain and tearing (PT) 16.6%, photokeratitis or light perception (LP) 7.14% and itching 2.3%. These findings are because the majority of the welders never used their protective eye wears as required during welding, thereby exposing their eyes to ultraviolet radiation, smoke, flying objects/light objects, dust particles and other irritants in dirty work environments.

Table 6 and 7, and figures 5 and 6 shows the comparative occurrences of the corneal conditions among electric and gas welders to be 22.5% 18.2% respectively. Cloudiness of vision (30.0%, 34.1%) irritation (27.5%, 18.2%), pains in the eyes (15.0%, 15.9%), pinguecula 47.1%, 26.4%), pterygium (8.8%, 30.2%) and poor visual acuity (38.2%, 3.4%) all have

relatively high incidence in both methods of welding, but cumulatively higher in electric welders.

Electric welders have significantly lower incidence of pterygium (8.8%) than gas welders (30.2%). Corneal opacity (5.9%, 7.5%), limbal exchange (0.00%, 1.96%), itching (2.56%, 2.3%) and photokeratitis (1.00%;11.4%); all have relatively low incidence between both electric and gas welders. This findings supports Julie (2003) listing of eye irritation, photokeratitis (pain and tearing), cloudiness of vision, pterygium and others as frequent occurrence in unprotected welding.

The significantly higher incidence of pterygium among gas welders is as a result of the greater hazards- dust particles, gas fumes, etc. involved in gas welding which lead to poor visual acuity.

Table 2 and figure 6 show the distribution of the ocular anomalies according to the number of years of exposure to welding work. However, the number of years of exposure is directly proportional to the incidence of ocular abnormality. Job exposure groups 6-10, 1-5 and 11-5 have the highest number of welders 35, 31 and 16, respectively. Job exposure groups of 21-25, 26-30 and 16-20 have the least population of welders 8, 7 and 3 respectively. The above finding is so because 6-10 years has gained sufficient level of exposure since they are at the active stages of trade, doing most of the work in other to get established.

Beyond this age, they can afford to hire hands that do the actual welding jobs, who often weld without protection.

As shown in figure 7 (a-c, pie chart) and table 8, in the distribution of the use or non-use of protective eye wear among electric, gas and all welders, those who always used their protective eye wears while welding are represented as 17°, 0° and 7° respectively. For those who wore protective eye wear most of the time, 60° represents electric welders; 44°, gas welders; and 50° for all welders.

The use of protective eye wear occurred mostly, sometimes or occasionally among electric welders with 214°, followed by all welders 148° and then gas welders 99°, while 217° of the gas welders and 690 of the electric welders never used protection. A combination of the welders are represented by 155° that did not use protective eye wear. This low compliance to the use of eye wear especially among gas welders, explains the high incidence of corneal injuries (abnormalities) observed. Occasional users are equally susceptible as those who never used any.

In Table 9 and Figure 8 show that among the welders who experienced one form of eye injury or the other, 56.8% (204°) did not bother to treat the injury while 40.7% (147°) engaged in self-medication, and only 2.5% (9°) went for professional care. We compared response to injury among the electric and gas welders, and found that a greater number (216°) of the gas welders did not seek to manage injuries they sustained, only a few (8%) of them went for professional care. This gives credence to the higher number of avoidable corneal (eye) conditions among gas welders.

The distribution of the observed and reported injury

according to the rate of use of protective eye wear shows that both reported and objective finding had higher incidence with decreased rate of use of protective eye wear, (Table 10 and Figures 9a & b). This also helps to explain the high incidence of corneal (eye) abnormalities among welders.

6. Conclusion

From the foregoing, the incidence of corneal injuries among welders was 48%. The injuries include: pterygium, corneal opacity, limbal changes and photokeratitis. There was a low compliance to the use of protective eye wear; only 2% consistently used protective wear, 14% used it most often, 41% occasionally, while 43% never made use of it.

Compliance to the use of protective eye wear has significant influence on the occurrence of corneal injuries as the result showed that only 1.3% of the injury occurred among the “always” users, against the 46.1% and 38.1% of injuries observed among the “occasional” and “never” users, respectively.

Recommendation

Consistent use of eye protection as well as face protection, among welders should be encouraged. Enlightenment programs or awareness campaign should be embarked on as these means highlight the vulnerability of the eyes (cornea), the hazards of the job and the consequences of poor vision. Governments also have important roles to play in this direction. Every government in pursuing their policy of technological and industrial development of the country should support, by way of funding, providing facilities, and creating conducive environment, every program action geared towards safeguarding the drivers of this policy, among whom are welders and metal workers (fabricators).

Routine eye check-up should be made available in most of this industrial set-ups (welding) as part of the employee's benefit scheme. Employers of labour in this area should provide their workers with protective eye wears since non affordability could be a pathway to non-use. This will go a long way in the reduction of attendant hazards, and improve the efficiency of the welders and other industrial workers.

References

- [1] Coll, J. R. (1999). The Royal College of Surgeon of Edinburgh; 1999 Oct; 44(5): 317-23.
- [2] Yanoff M; Cameron D. (2011). Diseases of the visual system. In Goldman I. Schafer & A. I. Cecil. *Medicine* 24th ed. Philadelphia, Pa: Saunders Elsevier.
- [3] Grosvenor, T. (1996). Primary eye care optometry, 3rd edition. Boston: Butterworth-Heinemann.
- [4] Cary, H. B., & Scott, C. H. (2005). Modern welding technology, 246-249.
- [5] Khurana, A. K. (2007): Comprehensive Ophthalmology; 4th edition New Age International publishers, New Delhi, India. Chap 5 and 17.
- [6] Nathan, E. (2007): Optometry A-Z: 70-71; 73-83.
- [7] Dass, S. B. (2008). Recurrent corneal erosion syndrome. *Surv Ophthalmol*, 58(1), 3-15.
- [8] Gottschalk, M. (2007). Corneal Abrasion and Laceration. Retrieved from <http://www.columbusgeorgiaonline.com/corneal-abrasion/>
- [9] Kanski J. (1998). *Clinical ophthalmology* 3rd edition. Oxford, USA: Butterworth-Heinemann.
- [10] Sliney, D. H. (1994). Ocular hazards of light, pp 183-189. In: T W. Tibb.Hs.ed.
- [11] Lombardi, D. A., Pannala, R., Sorock, G. S., Wellman, H., Courtney, T. K., Verma, S., & Smith, G. S. (2005). Welding related occupational eye injuries: a narrative analysis. *Injury Prevention*, 11, 174-179. doi: 10.1136/ip.2004.007088.
- [12] North, R. (2003) Eye protection and ocular hazards, Washington DC. US department of health and services, centre for disease control and prevention 1997.
- [13] Whitcher, J. P. (2001). Corneal blindness: A global perspective. *Bulletin, World health Organization*, 79(3), 214-221.
- [14] Thylefors, B. (1992). Epidemiological patterns of ocular trauma. *Australian and New Zealand Journal of Ophthalmol*, 20, 95-98.
- [15] Chukwu G. (1999). Study on eye hazards in Portharcourt oil refinery, Rivers State. Vol 1, 30-32.
- [16] Labric D; Moe J; Prince R B; Young M E; Felix C M. Canadian Dental Association, 2011,77, 116.
- [17] Reesal, H. A. (1994). Epidemiological patterns of ocular trauma. *Australian and New Zealand Journal of Ophthalmology*, 20, 99-103.
- [18] Nakagawara, S. (1980). Prevention of injuries. *Industries Journal*, 57, 130-130-142.
- [19] Brophy, M., Zhou, J., Pattanaiks, W. P. (2006). Estimate of Eye injuries in the United States. *Centre for Injury Research and Policy Journal*, 6, 44.
- [20] Omoti, A., Omoti, C., & Mommoh, R. (2008). Ocular disorders in a petroleum industry in Nigeria. *Eye journal*, 18(7), 925-929.
- [21] Waziri et al. (2008). Ocular disorders in a petroleum industry in Nigeria. *West African Journal of Medicine*, 6(4), 27-28.
- [22] Duke-Elder, S., & Macfaul, P. A. (1972). System of Ophthalmology. London: Kimpton.
- [23] Walter, C. (1989). National occupational exposure survey. *American journal of Optometry*.
- [24] Tituyal, J., Paliwal, P., Sharman, A., & Tandon, R. (1998). Ocular Morbidity in a North Indian town. *Indian Journal of public health*, 42(2), 29-33.
- [25] Okoye, O., & Umeh, R. (2002). Eye health of industrial workers in the south-east Nigeria. *West African journal of medicine*, 21(2), 132-137.

- [26] Omoti, A., & Enock, M. (2009). Non traumatic ocular findings in industrial workers in Delta State, Nigeria. *Eye Journal*, 20(16), 214-215.
- [27] Abiose, A., & Otache, M. (1981). Ophthalmic needs of Nigerian factory workers. *Journal of Tropicmedical Hygiene*, 84(4), 160-162.
- [28] Yu, T. S. (2004). A case control study of eye injuries in workplace in Hongkong. *Journal of ophthalmology*, 11(1), 70-74.
- [29] Kagami, S., Bradshaw, S., Fukumoto, M., Tsukui, I., Aviat space enviros med. 2009 Sept; 80(9), 811-114.
- [30] Hotstetter, A. G. (Ed.) (1997). *Lasers in Urological Surgery*. Wiesbaden: Stringer.
- [31] Gulacsik, C., Auth, D. C., & Silverstein, F. E. (1979). Ophthalmic hazards associated with laser endoscopy. *Applied Optics*, 14(11), 1816-1823.
- [32] Hendrix, A. (1970), Industrial vision. *Journal of American Optometric Association*, 30(15), 601-607.
- [33] Smillie, W. G. (1997). Preventive medicine and public health. *Macmillan London journal of public health*, 6(4), 1-8.
- [34] Asogwa, S. E. (1985). Accidents in industry: a guide to occupational health practice in developing countries. *Epidemiology of industry*, 10, 236.
- [35] Pigeon, R T. (1964). Industrial vision. *Journal of American Optometric Association*, 35(9), 787-792.
- [36] Miller, C. (1999). Occupational vision programmes and identification. *Prevention of Ocular hazards*, 52, 240-243.