

Impact of Climate Change on Eye Health in Visakhapatnam District Of Andhra Pradesh – A Case Study

Dr. Viswamithra P.¹, Hema Malini B²

¹ Associate Professor, Department of Ophthalmology, Andhra Medical College, Visakhapatnam,

² Professor Emeritus, Department of Geography, Andhra University, Visakhapatnam

Abstract: Eyes are the utmost significant organs in human life. Ocular deterioration is mainly caused by three elements namely oxygen, heat and solar radiation. Out of which, exposure to heat and radiation are more dangerous. Incidences of ocular diseases are on increase due to global warming and ozone depletion all over the world. The major causes for global warming and ozone depletion are concentration of greenhouse gases and Chloro Fluro Carbons in the atmosphere as a result of urban and industrial activities of man. These gases have a tendency to trap the outgoing radiation creating green house effect and destruct ozone molecules. As a consequence, harmful ultraviolet solar radiation (UVR) which is supposed to be filtered out by the ozone layer directly reaches the earth surface in larger quantities. Though, smaller amounts of UV radiation are essential for gaining Vitamin D, longer exposure to larger quantities of UV radiation harmful and cause health risks of skin, eye and immune system. In the present study, an attempt has been made to understand the trends in the incidence of eye related diseases i.e. cataracts, extra growths on the surface of the eye and carcinomas of the surface of the eye in the scenario of warming and high incidence of UV radiation that taking place in Visakhapatnam district. The study revealed a significant increase in the occurrence of these disorders in recent years, in all the age groups.

I. Introduction

Earth is the only planet in this entire universe, to have a suitable atmosphere to support life. It would not be an exaggeration to say that Earth's climate has shaped the history of mankind biologically, socially, culturally and geographically. Climate of the Earth and mankind are in a dynamic interrelationship. Earth receives energy from the sun and it emits back the same to the space. Any variation in this balance results in variations in climate. In the past also climatic variability occurred due to natural processes but it was gradual. At present, climate change become rapid due to the twin of activities of man namely urbanization and industrialization. The gases such as carbon dioxide, methane, nitrous oxide and Chloro Fluro Carbons emitted into the atmosphere in larger quantities by human activities and trapping the outgoing energy like glass panels of a greenhouse and responsible for global warming. Hence, these gases are known as greenhouse gases. The Concentration of these gases have increased in the atmosphere since 19th century (subhodh Sarma et al, 2006). This increase is by 29 percent, 150 percent and 29 percent of carbon dioxide, methane and nitrous oxide respectively (Intergovernmental Panel on Climate Change, 2001). Initially, the annual average concentration of CO₂ measured at Mauna Loa of 315 ppm in 1958 has increased to 338 ppm in 1980 (Jager, 1983). By 2006 the CO₂ concentration is ~ 380 ppm (Sarma and Rama Krishna, 2007). As a result, mean surface temperature globally risen by 0.4 to 0.8 °C (Oliver and Hidore, 2002). IPCC report (2001) s indicated that, the global average temperatures increased by 0.6 ± 0.2 °C since 1900. Some predictive models suggested that there will be increase of temperature of about 4 °C by 2100 (Dash and Hunt, 2007; Oliver and Hidore, 2002). In addition, concentration of Chloro Fluro Carbons gases is responsible for the depletion of ozone which enable the free entry of the UV radiation directly to reach the surface of the Earth. With the thinning of protective ozone layer, more UV radiation reaches the earth (Orval et al, 2007).

Exposure to high temperatures and intense Ultraviolet radiation together may responsible for the increase in the incidence of acute and chronic health effects on the skin, eye, and immune system of the body. The eye diseases include age-related cataract, Pterygium, ocular surface squamous neoplasia (OSSN), photokeratitis, corneal degenerative changes, dry eyes and photo conjunctivitis (which manifests as redness, grittiness, foreign body sensation of the eyes). Sometimes these eye diseases lead to blindness. The three diseases namely cataract, pterygium and ocular surface squamous neoplasia (OSSN) are directly attributed to the exposure to UV radiation. Solar radiation exposes the eye to UV radiation-B rays, UV- A radiation and visible rays. UV – B induces the formation cataracts in the eyes (Joan, 2011). Cataract is one of the major causes of blindness in the world. Pterygium is another eye related disease and its prevalence is attributed to

exposure to UV radiation and suspended particulate matter. Ocular surface squamous neoplasia (OSSN) also results from excess exposure to UV radiation particularly in the regions closer to equator. For the present study, the trends in the incidence of these three diseases in Visakhapatnam district were considered.

II. Study Area

Visakhapatnam district is one of the north coastal districts of Andhra Pradesh located and lies between 17° 1'18.16"N latitudes and 83°13'07.53"E longitudes. The district is bound in the northwest by Odisha State, in the northeast by Vizianagaram district, in the southwest by East Godavari district and in the east by Bay of Bengal. The district covers an area of 11,161 km² and exhibits heterogeneity in its physiographic characteristics. Based on the nature of physiography, the district can be broadly recognized as eastern coastal plains and western hilly area. The total population of the district is 3.83 million as per the 2001 Census out of about 3.25 million (~85%) people live in the Coastal plain while the Hilly area accounts for the remaining 0.58 million. Half of the district's population lives in rural and tribal areas and most of their earning is based on outdoor activities like farming, gathering and fishing, thus are exposing themselves to excessive sun. The district experiences semi arid climatic conditions in the coastal plains and dry sub humid climates in the hilly tract. The temperature of the district ranges from 18°C to 34°C throughout the year. In view of the above facts, a study was undertaken to assess the prevalence of eye related in the district of Visakhapatnam.

III. Data Collection And Analysis

Data on the incidence of ocular diseases namely cataract, pterygium and OSSN of Visakhapatnam district were collected from the records maintained by the Government Regional eye hospital, Department of Ophthalmology, Andhra medical College, Visakhapatnam, for a period of ten years (2002 to 2012). The data were analyzed and results discussed and represented in the form of graphs.

IV. Results And Discussion

The human eye is constantly exposed to sunlight and artificial lighting. However, exposure to the intense ambient solar radiation can pose a hazard particularly if the recipient is over 40 years of age (Joan, 2011). This radiation exposure can lead to impaired vision and transient or permanent blindness.

Cataract is "opacification or cloudiness of the lens inside the eye which obstructs the light rays and causing decrease in vision (Fig.1). Cataract is mostly responsible for visual impairment and blindness worldwide especially in middle age. Approximately 12 to 15 million people are becoming blind annually around the world, of which around 20 % may be due to exposure to sun (<http://www.who.int/uv/health/en>) induced cataract formation. Higher prevalence of cataract in India was observed among females (Sharma,1962). Epidemiological studies revealed that many workers including doctors are known to have developed premature cataracts while exposed to X-rays, Ultraviolet-A and Ultraviolet-B radiation and heat waves (Park and Park, 1977). But more incidence is due to UV-B radiation. Absorption of UV-B radiation leads to damage of tissues of cornea and lens of the eye (American optometric Association, 1993). Data on the incidence of cataracts in Visakhapatnam district were analyzed and graphically represented for the period between 2002 and 2012. (Fig.2). There were about 37 cases per 100 hospital based population, reported in the Regional eye hospital in Visakhapatnam in the year 2002-2003. Since then the cases were increased each year without any decline. By 2011-2012, the incidences reported were 51 per 100 population i.e. (51%). Pterygium is another ocular disease with the manifestation of triangular growth of the bulbar conjunctival tissue on white part of the eye that may extend onto the clear cornea where it can block the vision (Fig.3). Incidence of Pterygium has its geographical extent and occurs in between 37° N and 37° S latitudes (Fig.4). In these latitudes the prevalence rate of Pterygium is 2 percent to 29 percent. In India, its prevalence rate is 9.5 to 10.8 percent. It mostly occurs in the population who work in the sun and windy outdoors. And its prevalence is attributed to exposure to UV radiation and suspended particulate matter. This disorder can be cured surgically but sometime recurs. If not treated, it may lead to blindness. Incidence of Pterygium is increasing at alarming rates in Visakhapatnam district (Fig. 5). The analysis of data indicated that in the year 2002-2003 around 46 cases per 1000 hospital based population, were reported. Since then there is continuous rise in the incidence in each year. By 2011-2012 the cases of incidence were increased almost 5 times more than that of 2002-2003.

Ocular surface squamous neoplasia (OSSN) represents a rare spectrum of disease involving the conjunctiva and the cornea. Ocular surface squamous neoplasia (OSSN) comprises a wide spectrum of dysplastic changes in surface of the eye, e.g. the cornea and the conjunctiva causing "precancerous" lesions or invasive carcinoma of the ocular surface (Fig.6). World prevalence of OSSN varies between 0.03 and 1.9 per million population. OSSN incidence is high in the countries of located in the lower latitudes where excessive exposure to UV radiation is more common. UV-B radiation has shown to cause p53 gene mutation, which is associated with the incidence of OSSN (Mohamed, 2002). The rate of risk depends up on the type of UV rays, the intensity of exposure, total cumulative exposure and the amount of light absorption by the protective mantle

of the melanin. Out of UVA (320–400 nm), UVB (280–320 nm) and UVC (200– 280 nm), Ultraviolet- B (UVB) radiation is believed to be responsible for the incidence of various cutaneous and ocular surface cancers (Ng J et al, 2008). Histological evidence of solar injury, which is identified as a major contributory factor for conjunctival OSSN, has been reported in 50-100% cases of OSSN (Noopur et al, 2010). Apart from the exposure to UV radiation incidence of OSSN disease is associated with advanced age, male gender, fair skin, smoking, infection with human papilloma infection (HPV), immunosuppression and infection with human immunodeficiency virus (HIV) (Ruchi Mittal et al, 2013). The incidence of OSSN indicated changing trends with the upsurge of HIV infection (Karcioglu, 2009).

Figure 7 shows the increasing occurrence of Ocular Surface Squamous Neoplasia in the population of Visakhapatnam district. In Visakhapatnam district OSSN ocular diseases was a rare disease in the past, but at present its rate of incidence is increasing year by year in the study area. During 2002-2003 only one case recorded. However, since 2008-2009 the number of incidences has increased. During 2011-2012 around 22 cases per 10,000 hospital based population were reported.

V. Conclusions

The study of three eye diseases, the incidence of which are directly related with exposure to sun's radiation intensity are on increase on par with the warming of temperatures in Visakhapatnam district. Research on ocular hazards of sunlight is essential as it helpful for the improvement of visual health through implementing preventive medicine strategies.

REFERENCES

- [1.] American Optometric association, 1993: Statement on Ocular Ultraviolet Radiation Hazards In Sunlight A Cooperative Initiative of: The National Society to Prevent Blindness, The American Academy of Ophthalmology, Zpp.1-3
- [2.] Basti A, Macsai A MS 2003 : Ocular surface squamous neoplasia, a review. *Cornea*;22:687-704
- [3.] Dar, William D., 2007: Climate Change: Adding Uncertainty to Risk Prone Rain fed Agriculture in Africa and Asia. In Bahadur, Bir and Satyanarayana, B., eds Op.cit. PP. 315-228.
- [4.] Dash S.K., and J. C. R. Hunt J.C.R., 2007: Variability of climate change in India, *Current Science*, VOL. 93, NO. 6, Pp. 782-788
- [5.] Hansen J, Sato M, Ruedy R et al , 2006 : Global temperature change. *Proc Natl Acad Sci USA* 103:14288–14293 doi:10.1073/pnas.0606291103
- [6.] Intergovernmental Panel on Climate Change (IPCC), 2001: The Scientific Basis, ontribution of Working Group I to the Third Assessment Report of the Cambridge University Press, Cambridge, 2001a.
- [7.] Intergovernmental Panel on Climate Change (IPCC), 2007: Issues warning on Global warming, The Hindu news paper, P.13.
- [8.] Jager J., 1983: Climate and Energy Systems-A review of their interactions, John Wiley & Sons, New York, pp. 215-220.
- [9.] Joan E. Roberts, 2011: Ultraviolet Radiation as a Risk Factor for Cataract and Macular Degeneration, , *Eye & Contact Lens* Volume 37, Number 4, July 2011, DOI: 10.1097/ICL.0b013e31821cbcc9
- [10.] Karcioglu Z.A., Wagoner, M.D. , 2009: Demographics, etiology, and behavior of conjunctival squamous cell carcinoma in the 21st century. *Ophthalmology*;116:2045–6.
- [11.] Lee G.A., Hirst L.W., Sheehan, 1994: Knowledge of sunlight effects on the eyes and protective behaviours in the general community. *Ophthalmic Epidemiology*, Vol 1(2):67-84.
- [12.] Mahomed A., Chetty R., 2002: Human immunodeficiency virus infection, Bcl-2, p53 protein, and Ki-67 analysis in OSSN. *Arch Ophthalmol.*, 120:554-8
- [13.] Ng J, Coroneo M.T., Wakefield D., and Di Girolamo N., 2008: Ultraviolet radiation and the role of matrix metalloproteinases in the pathogenesis of ocular surface squamous neoplasia. *Invest Ophthalmol Vis Sci.*, 49:5295–306.
- [14.] Noopur Gupta , Shibal Bhartiya , Rajesh Sinha , Namrata Sharma, 2010: Ocular Surface Squamous Neoplasia : Major Review, *Kerala Journal of Ophthalmology*, Vol. XXII, No.2, Pp. 133-140
- [15.] Oliver, J.E., and Hidore J.J., 2002: *Climatology: An Atmospheric Science*, Pearson Education (Singapore) Pvt. Ltd. Indian Branch, Delhi, pp.1-410. P.297
- [16.] Orval M., Cullen A.P., De Gruijl F.R., 2007: The effects on human health from stratospheric ozone depletion and its interactions with climate change. *Photochem Photobiol Sci* 6:232–251
- [17.] Ruchi Mittal, Suryasnata Rath, and Geeta Kashyap Vemuganti, 2013: Ocular surface squamous neoplasia – Review of etio-pathogenesis and an update on clinico-pathological diagnosis, *Saudi Journal of Ophthalmology*, Volume 27, Issue 3 , Pp 177-186
- [19.] Sarma N.S., Sri Rama Krishna M. 2007: Green house warming by Carbon dioxide and its capture, storage and sequestration: An overview; in Proc of National conference on Global temperature rise : An Indian effort towards mitigation of CO₂ emissions, Andhra university, Visakhapatnam, pp.2-11.
- [20.] Schein O and Manoj B., 1997: Prevalence of dry eyes in the elderly, *American journal of Ophthalmology*, ;124:773-774
- [21.] Srinivasan J., 2006: Hottest decade: Early warning or false alarm? *Current Science*, Vol. 90, No. 3, 10 February 2006, Pp.273-274
- [22.] Subodh Sharma, Sumana Bhattacharya and Amit Garg 2006: Greenhouse gas emissions from India A perspective, *Current Science*, Vol. 90, No. 3, 10 February P. 326
- [23.] WHO – “Magnitude and causes of visual impairment”. WHO.int.2012-06-21. Retrived 2012-07-18
Young, 1992 : *J Natl Med Assoc.* Apr 1992; 84(4): 353–358.



Fig. 1. Showing eye affected with cataract

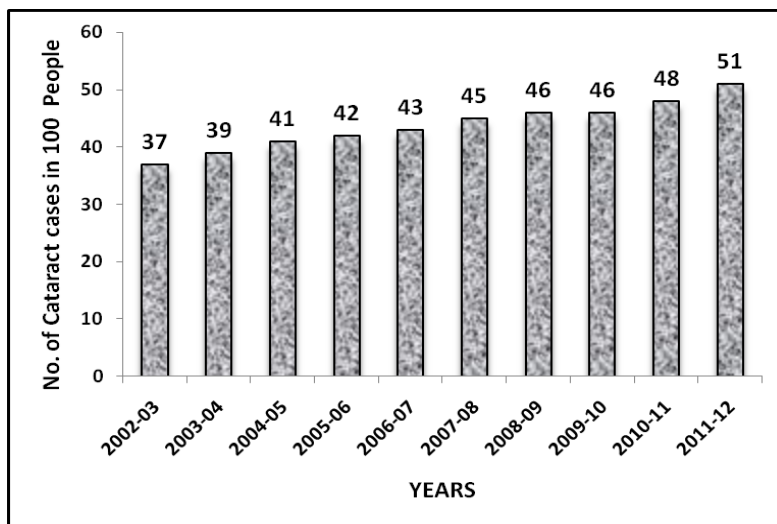


Fig.2. Trends in cataract incidence in Visakhapatnam district during 2002-2012



Fig.3. Eye affected with Pterygium disorder

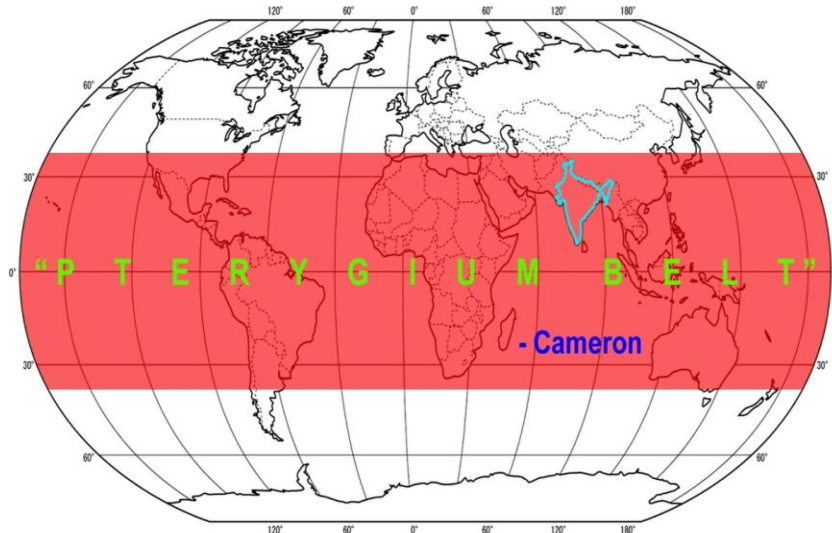


Fig.4. Geographic areas mostly affected with Pterygium in the world

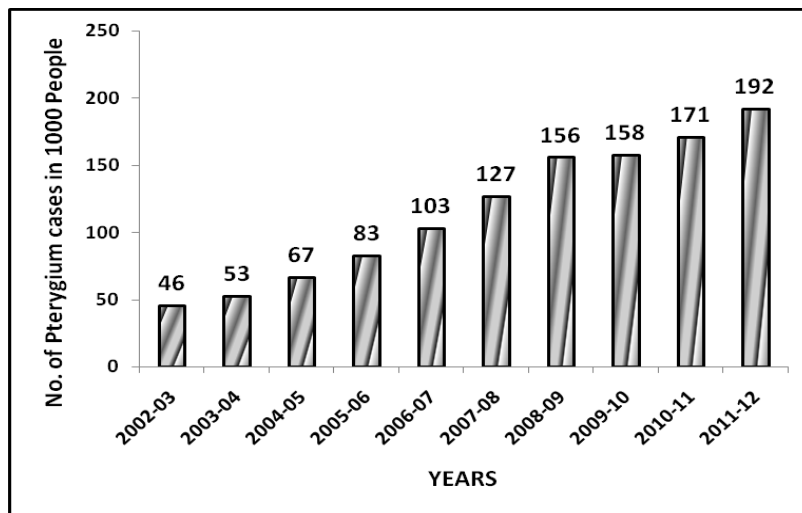


Figure 5. Trends in the incidence of Pterygium in Visakhapatnam district.



Fig. 6. Eye showing Ocular surface squamous neoplasia disorder

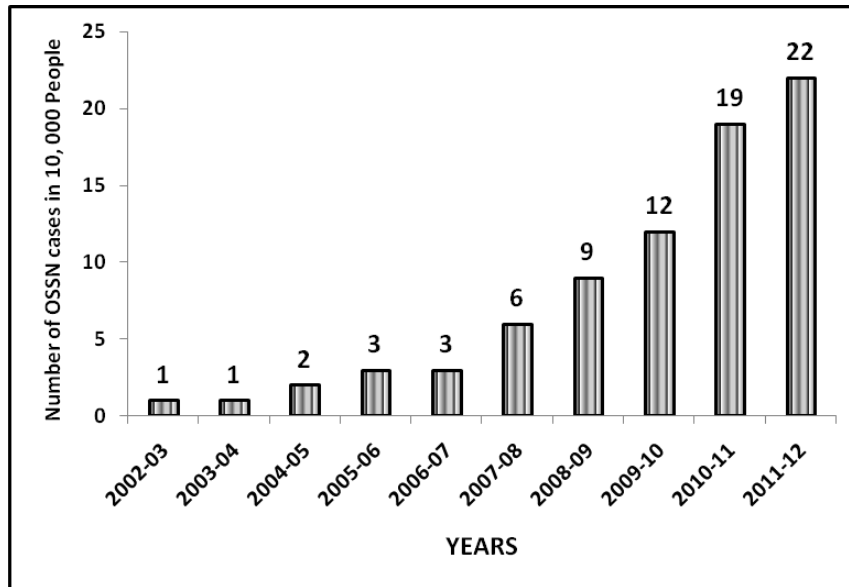


Fig.7. Trends in the incidence of OSSN in Visakhapatnam District