e-ISSN 2805-4356
p-ISSN 2805-4364

10.5281/zenodo.14879586 Vol. 7 Issue 09 Sept - 2024 Manuscript ID: #01787

Impact of different patterns of light on blink rate: A focus on occupational hazard

P. E. Ohwin[1], A. J. Money[2], O. O. Ofulue[3], E. O. Emurotu3, Z. B. Ovili-Odili[1], E. E. Cooke[2], and J. C. Odogwu[1]

[1]*Human Physiology Department, Faculty of Basic Medical Science, Delta State University Abraka. Nigeria.*
[2]*Dispensing Opticianry Department, Delta State College of Health Sciences, Ofuoma, Ughelli, Nigeria.*
[3]*Optometry Department, Faculty of Allied Health Sciences, Dennis Osadebe University, Asaba. Nigeria.*

**Corresponding Author: moneyjoy10@gmail.com; +234-8064029030.*

ABSTRACT:

Blinking is a protective function of the eye in keeping the ocular surface lubricated continuously. Current research evaluated the impact of different patterns of light on blink rate with a focus on occupational hazard. The study was carried out on subjects within Abraka and Agbor. The inclusion criteria include cyber or Information communication and technology (ICT) workers who spend long time on screen of smart devices, Television and Laptops, staffs of clubs and bars who works overnight and people in rural area who are less exposed to these light patterns. Data was collected using; A closed ended questionnaire, maximum blink interval and blink rate were determined using a stopwatch. The study recruited both sex; males (n=41, 51.3%) and females (n=39, 48.8%). The blink rate was recorded as the highest mean value (27.87) compared to that of maximum blink interval (MBI) mean (27.68). The blink rate of the individuals studied ranged from 9.00cm to 50.00cm. The average blink interval for those exposed to tonic light is 27.64 while MBI is 29.49. However, correlation with MBI has a negative (r-0.198) relationship with blink interval. The average blink interval for those exposed to rhythmic light is 25.28 while MBI is 27.13. However, correlation with MBI has a negative (r-0.175) relationship with blink intervals. The effect of tonic and rhythmic light on the studied groups showed that 71.4% exposed to tonic light pattern reported "No tearing on exposure to fan/AC" while 28.6% reported mildtearing.The descriptive statistics of the relationship between tonic light, MBI and blink rate showed a negative correlation (r=-0.198). This study has shown that light exposure arising from occupational and domestic activities can lead to an irregular blink rate which can result in inability to keep the ocular surface constantly lubricated, and obstructing homeostasis.

Keywords:

Maximum blink rate, Average blinks interval, light patterns, ocular surface, and lubrication

How to cite: Ohwin, P. E., Money, A. J., Ofulue, O. O., Emurotu, E. O., Ovili-Odili, Z. B., Cooke, E. E., & Odogwu, J. C. (2024). Impact of different patterns of light on blink rate: A focus on occupational hazard. *GPH-International Journal of Applied Science*, 7(09), 69-77. https://doi.org/10.5281/zenodo.14879586

INTRODUCTION

Background to study

Different types of light patterns are presented to our eyes every day. Each color has a different wavelength, much as the color spectrum. When we refer to visible light, we are referring to a variety of wavelengths that have different lengths. For instance, blue light has short wavelengths, while red light has long wavelengths. Each color may affect our eyes and eye care in a distinct way. When it comes to regulating our biological clocks, which determine when we should sleep and wake up, blue light is a particularly advantageous component of the light spectrum. Blue light therapy can even work as an antidepressant to help with seasonal affective disorder (SAD), a type of depression brought on by a lack of daylight.

Blue light toxicity and retinal stress from delayed melatonin production may contribute to conditions other than insomnia, such as high blood pressure, diabetes, and migraine headaches. Electrolytes imbalance can result from ocular surface exposure due to improper blinking rate affecting tear fluid stability (Ohwin, 2021).The tonic effect of light on the locomotor muscles is indicated by a change in stride length with changing light intensity (Van, 2016) and this effect has been reported to be associated to uneven illumination, which causes changes in posture (Rüfer, 2019).

Eye transmission is a common method by which humans acquire external information (Biswas *et al*., 2008). The interaction between the orbicularis oculi muscle, which closes the eyelid, and the levator palpebra superioris muscle, which lifts the palpebral, results in eye blinking, one of the primary physiological responses in humans. Blinking occurs when the eye closes because of the normally active levator palpebrae superioris muscle being inactive and the orbicularis oculi muscle contracting (Ashworth *et al*., 2020). Individuals' eyes naturally blink at a specific frequency and there are between 6 and 30 blinks per minute (Biswas *et al*., 2008). When working as opposed to when resting, the rate of eye blinking decreases (Rüfer, 2019). Lower eye blink rates are associated with higher focal distances with objects (Johnson, 2019). Increased interest induction from media viewing can lead to a decrease in eye blink rate, which can have pathological effects on the eyes. Ocular dryness is mentioned as one of the external symptoms of stable fatigue in study previouslyreported (Johnson, 2019), and a decreased eye blink rate has been shown to cause xerophthalmia (Rüfer, 2019). The symptoms of ocular dryness include irritation, burning sensation, and pink eye (also known as conjunctivitis), as well as visual disturbances, ocular discomfort, and ocular surface inflammation (Van, 2016).Therefore, the current study was designed to examine the impact of different light patterns on maximum blink interval and blink rate to increase the knowledge and awareness of impact oflight patterns in the environment on eye health.

MATERIALS AND METHODS

MATERIALS

The materials used were Stopwatch and Smart phone. Maximum blink interval and Blink interval were determined by asking the subject to fixate on the screen placed 40cm away from their eyes while being timed after the first subsequent blink and these were repeated three times for each subject and the average was recorded. Blink interval record was such that subject's blinks were counted per 60 seconds while maximum blink interval was time taken for individual to have a first blink.

STUDY DESIGN

Specifically, this research used a closed-ended questionnaire, which is a type of survey design that focuses on studying the sampling of individuals from a population and the techniques of survey data collection, such as questionnaire construction and methods for increasing the number and accuracy of responses to surveys. The focus of survey methodology is on tools and procedures that pose and seek answers to one or more open-ended questions. To collect the necessary information for the study, each correspondent was asked to fill out a questionnaire about their exposure to tonic light, rhythmic light, and the possible effects of each.

STUDY POPULATION AND DATA COLLECTION

The research was conducted on adults within the age range of 18-30 in the communities of Abraka (Ethiope East LGA) and Agbor (Ika South LGA).Participants were surveyed via mail-in, closed-ended questionnaires for this study. Two hundred (200) people answered the survey. For the same reason, extra care was taken to make sure the questions were clear before anyone answered them.

Those recruited were staff of ICT (cyber or informationand technology staff), staff working in clubs or/and bars that stay overnight while people in rural areas with minimal exposure to electricity and screen were recruited as control group. Study excluded visitors to the clubs and bars. Ethical consideration was provided by the Faculty of Basic Medical Sciences Research and Ethics Committee.Participants were only included in the study if they agreed to take part after being told of the study's nature and goals prior to data collection.

DATA ANALYSIS

The data collectedwas processed through SPSS (SPSS version 25). Graphs and frequency tables were used to display the data. Inferential statistics in this study made use of the Chi-square test with a 95% confidence interval, and a p value of less than 0.05 was considered to indicate statistical significance.

PRESENTATION OF RESULTS

Gender	Frequency (%)
Male	41(51.3%)
Female	39(48.8%)
Total	**80 (100%)**

Table 1: Gender analysis

Table 4.1 shows gender analysis of the subject. From the result, most of the subjects were males (n=41, 51.3%) while minorities were females (n=39, 48.8%).

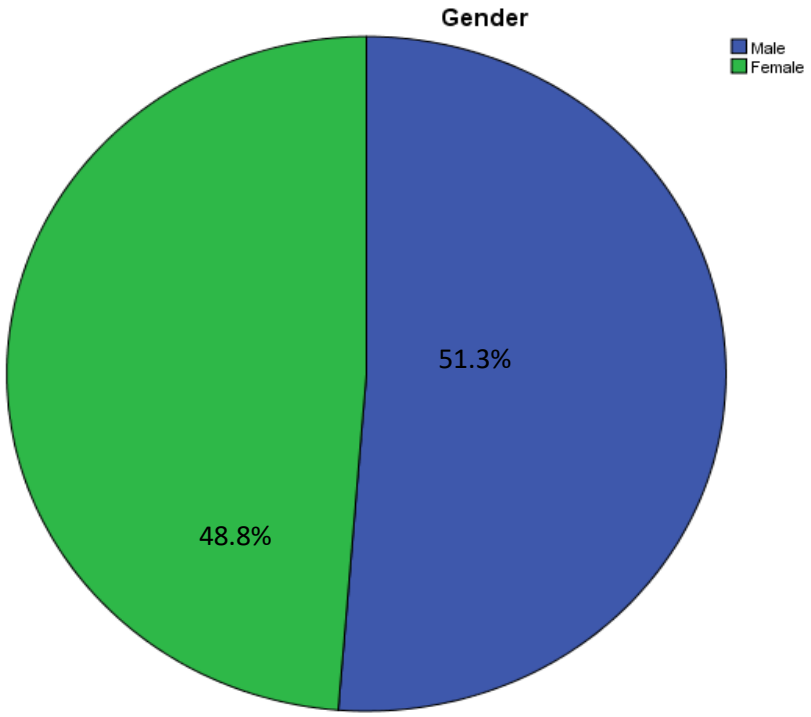

Figure 1: Gender Distribution of Respondents

The figure above showed that most of the study subjects were males (n=41, 51.3%) while minorities were females (n=39, 48.8%).

Table 2: Exposure distribution of Respondents

Light pattern	Frequency	Percentage (%)
Tonic	41	51.3
Rhythmic	24	30.0
Control	15	18.8

The table above showed that most of the subjects were the café staff exposed to tonic light pattern (51.3%), followed by rhythmic light pattern (30.0%) and control (18.8%).

Table 4: Descriptive statistics of the mean maximum blink interval and blink rate

Exposure		Minimum	Maximum	Mean ± Std Deviation
Tonic	Maximum blink interval(cm)	10.00	47.00	27.68±10.58
	Blink interval (cm)	11.00	50.00	27.87±11.61
Rhyhmic	Maximum blink interval	11.00	49.00	25.83±11.88
	Blink interval	9.00	44.00	23.08±10.07
Control	Maximum blink interval	11.00	37.00	24.27±7.35
	Blink interval	15.00	50.00	27.00±11.62

Table 4.4 shows the descriptive statistics of the mean maximum blink interval and blink interval of the study group. From the result, there was a statistically significant difference in the mean for maximum blink interval with that of blink rate for tonic light pattern. The blink rate recorded the highest mean value compared to that of maximum blink rate.
For rhythmic light pattern, there was also statistical difference in the mean of the maximum blink and blink interval as well as for control category.

Table 4.5: Descriptive statistics of the relationship between tonic light, MBI and blink rate

Parameters	Mean	SD	r-value
Tonic light	1.29	0.47	
MBI	29.43	11.63	-0.198
Blink interv	27.64	9.59	

Table 4.5 shows the descriptive statistics of the relationship between tonic light, MBI and blink rate. From the result, there was an effect on tonic light in comparison with MBI and blink, however, the effect was not positively related (r=-0.198).

Table 4.6: Descriptive statistics of the relationship between rhythmic light, MBI and blink rate

Parameters	Mean	SD	r-value
Rhythmic light	2.39	0.49	
MBI	27.13	11.24	-0.175
Blink rate	25.28	10.15	

Table 4.6 shows the descriptive statistics of the relationship between rhythmic light, MBI and blink rate. From the result, there was an effect on rhythmic light in comparison with BMI and blink, however, the effect was negatively related (r=-0.175).

Table 4.9: Descriptive statistics of the relationship between tonic light and rhythmic light on MBI and blink rate

Parameters	Mean	SD	r-value
Tonic light	1.39	0.49	
Rhythmic	2.55	0.66	-0.185
light	9.66	4.20	
MBI			
Blink rate	20.42	10.21	

Table 4.9 shows the descriptive statistics of the relationship between tonic light and rhythmic light in comparison with MBI and blink rate. From the result, there was an effect on tonic light and rhythmic light in comparison with BMI and blink, however, the effect was negatively related (r=-0.185).

Table10: Descriptive statistics of the relationship between tonic light, MBI, blink rate and gender

Parameters	Mean	SD	r-value
Gender	1.43	0.51	
Tonic light	1.29	0.47	-0.198
MBI	29.43	11.63	
Blink rate	27.64	9.59	

Blink rate

Table 4.10 shows the descriptive statistics of the relationship between tonic light, MBI, blink rate in comparison with gender. From the result, there was an effect of tonic light, MBI, tonic rate and blink rate in comparison with gender. However, the effect was negatively related (r=-0.198).

Table 11: Descriptive statistics of the relationship between rhythmic light, MBI, blink rate and gender

Parameters	Mean	SD	r-value
Gender	1.58	0.31	
Rhythmic	1.39	0.37	-0.177
light	23.50	9.30	
MBI	22.11	8.19	
Blink rate			

Table 4.11 shows the descriptive statistics of the relationship between rhythmic light, MBI, blink rate in comparison with gender. From the result, there was an effect of rhythmic light, MBI, tonic rate and blink rate in comparison with gender. However, the effect was negatively related (r=-0.177).

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

Discussion

The currentstudy investigated the impact of different patterns of light on blink rate with a focus on occupational hazard. This study reported that the negative effect of light on sleeping patternswas 23.75% while 52.5% did not have difficulty in sleeping. However, exposure to light was reported to cause repeated awakenings, interrupting the sleep cycle and reducing time spent in deeper, more restorative sleep stages by previous study (Stein*et al.,* 2014).

Present study showed that the average rate of blinking was significantly higher than the maximum rate of blinking. This report is likethe previous report on a wide variation in the blink rate among samples (9.0 50.0%). The orbicularis oculi muscle shortens when the eye is exposed to bright light or other stimuli. Electromyographic evaluation, as reported by Yates and Brown (1987), revealed that light intensity and distance from the eye influenced latency until blinking and contraction. However, a distance of less than 200 mm was reported to disturb test subjects. Patel *et al.* (2020) manually counted the number of times 16 subjects blinked before and during a video display unit game and found that subjects' blink rates decreased by an average of five times. Later, Tsubota and Nakamori (2016) compared the blinking rates of 104 office workers while they were at ease, reading a book, and reading text on a smartphone screen. The average number of times people blinked per minute was 22 when they were at rest, but only 10 and 7 when they were reading, respectively. Schlote*et al*.

(2019) discovered that while using a VDT, people tend to blink less frequently and exhibit unique blinking patterns.Studies have found that with the increased usage of smart phones, iPads, and laptops, there has been an increase in the development of dry eyes due to a decreased blink rate. Over time, the more someone engages with their devices the less they blink.The effect of tonic and rhythmic light on the studied groups showed that 71.4% reported that tonic light had no effect while 28.6% reported that tonic light had an effect. As the harmful effects of tonic light are gradually realized by the public, eye discomfort related to tonic light is becoming a more prevalent concern. The duration of times spent on smart phones and Tv showed that 78.6% spent 1-3hrs on smart phones and TV while 21.4% spend 4-6hrs on smart phones and TV. The descriptive statistics of the relationship between tonic light, MBI and blink rate showed that there was an effect on tonic light in comparison with MBI and blink, however, the effect was not positively related (r=-0.198). The findings of this study correspond with the report by Zhao *et al.* (2018) who studied the progress, effect and prevention of blue light on eyes.

Conclusion

The result from this study showed that exposure to rhythmic light affects the blink rate and some of the participants find sleeping very difficult and this was significant among age group 18 – 21. Also, this study has shown that light exposure arising from occupational and domestic activities can lead to irregular blink intervals of the eye which might be related to dry eye disease.

REFERENCE

Ashworth, J. L., Biswas, S., Wraith, E., & Lloyd, I. C. (2006). The ocular features of the mucopolysaccharidoses. Eye, J *Mac med,*20(5) :553-563.

Bim, J., Sunil Kumar, Y., Yoo, J., & Kwon, S. (2018). Change of blink rate in viewing virtual reality with hmd. *Med Symmetry,***10**(9): 400.

Biswas, S., Wraith, E., & Lloyd, I. C. (2006). Mucopolysaccharidoses and the eye. *Survey of ophthalmology*, 51(1), 1-17.

Biswas, S., Wraith, E., & Lloyd, I. C. (2006). Mucopolysaccharidoses and the eye. *Survey of ophthalmology*, **51**(1), 1-17.

Johnson, D. H., Bourne, W. M., & Campbell, R. J. (1982). The ultrastructure of Descemet's membrane: I. Changes with age in normal corneas. *Archives of ophthalmology*, **100**(12), 1942-1947.

Kim, J., Sunil Kumar, Y., Yoo, J., & Kwon, S. (2018). Change of blink rate in viewing virtual reality with hmd. *J D Symmetry*, **10**(9), 400.

Majo, F., Rochat, A., Nicolas, M., Jaoudé, G. A., &Barrandon, Y. (2008). Oligopotent stem cells are distributed throughout the mammalian ocular surface. *J health & Nature*, 456(7219), 250-254.

Mohammadi, N., Ehsani, M. R.&Bakhoda H. (2018). Impact of dryer eye disease/blink rate. *Food Biophys*.**13**, 240–249.

Muriel P. &Arauz, J. (2010). Tearing from exposure to dry air. *Fitoterapia*. **81** (5): 297–305.

Nair, C, L. (2011)"Diagnosis of dyr eye disease", Encyclopedia of Reagents for Organic Synthesis, *John Wiley & Sons, New York.* 50 (7) 45-673.

Ohwin P.E. (2021). Comparative study on variations in selected tears electrolytes among HIV patients. International J. Forensic Medical Investigation.; 6(1):36-44.

Parija, M., Bobby, Z &Kumar,V.S (2005).Tear film breakage and impact on blink rate. *Indian J PhysiolPharmacol*. 2005; 49(1): 95-98.

Parija, M., Bobby, Z &Kumar ,VS, (2005).Tear film breakage and impact on blink rate. *Indian J PhysiolPharmacol*. 2005; **49**(1): 95-98.

Porkka-Heiskanen, T. (2019) developmentental phase of tear film production. he .*Science.Pub.*276:1265–1268.

Porkka-Heiskanen, T. (2019) developmentental phase of tear film production. he .*Science.Pub.***276**:1265–1268.

Robert, R. Andreas., Meyer, and Claus, Vogelmeier.(2017) visuals stimulation of blinking : *Prospects Therapy*. *CHEST*.**110**:267-72.

Rüfer, F., Schröder, A., &Erb, C. (2005). White-to-white corneal diameter: normal values in healthy humans obtained with the Orbscan II topography system. Cornea, *J mack med*. 24(3), 259-261.

Stein, AN & Walker, M, P (2014). The role of sleep in emotional brain function. *Annu Rev Clin Psychol*. **10**:679-705.

Toorn, MV., Maria, P., Varies, S., Slebos, D., Bruin HG, &Abello N, (2012).. effects of computer . *Am j Physiol*. ;293:1156-62.

Van Buskirk, E. M. (1989). The anatomy of the limbus. Eye, *J Mac med* 3(2), 101-108. Ashworth, J. L., Biswas, S., Wraith, E., & Lloyd, I. C. (2006). The ocular features of the mucopolysaccharidoses. Eye, J *Mac med,***20**(5) :553-563.

Wang, Y., Liu, H., Hitchman, G. & Lei, X. (2013). Module number of default mode network: Blink rate & maximum blink interval. Brain *Res.***1596**:69–78.

Yates JR and Brown MW (1987). Prediction of the length of non-propagating fatigue cracks. Fatigue and fracture of engineering materials and structures. *International J. Fatigue*; 10 (3):187-201