ISSN- O: 2458 - 868X, ISSN–P: 2458 – 8687
National Library of Medicine - ID: 101731606

International Journal of Medical Science and Innovative Research (IJMSIR)
IJMSIR : A Medical Publication Hub
Available Online at: www.ijmsir.com
Volume – 8, Issue – 1, January – 2023 , Page No. : 140 – 147

Effect of illumination over Postive fusional vergence

[1]Raisul Azam, Department of Optometry and Vision Science, Amity Medical School, Amity University Haryana.

[1]Sourav Karmakar, Department of Optometry and Vision Science, Amity Medical School, Amity University Haryana.

[1]Gaurav Kumar Bhardwaj, Department of Optometry and Vision Science, Amity Medical School, Amity University Haryana.

[1]Animesh Mondal, Department of Optometry and Vision Science, Amity Medical School, Amity University Haryana.

Corresponding Author: Raisul Azam, Department of Optometry and Vision Science, Amity Medical School, Amity University Haryana.

Citation this Article: Raisul Azam, Sourav Karmakar, Gaurav Kumar Bhardwaj, Animesh Mondal, "Effect of illumination over Postive fusional vergence", IJMSIR- January - 2023, Vol – 8, Issue - 1, P. No. 140 – 147.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: To compare the effect of change in illumination over positive fusional vergence for near.

Methods: This cross-sectional study consists of 34 participants aged between 21 to 25 years. This study was done within a period of 4 months at Optometry and Vision science clinic, Amity University Haryana. The participants undergone following ocular measurements; Positive fusional vergence, contrast sensitivity and pupil diameter. All measurements were assessed in three different illuminations modes: A, low Illumination- 50 Lux B, Medium Illumination -100 lux C, High Illumination-150 lux.

Results: The mean age of the participants in the study was 23.08 ± 1.40 (Range: 21-25) Years. Positive fusional was significantly changed under the different levels of illumination (P =<0.001, P =<0.001, P = <0.001 for Blur, Break, Recovery respectively). There was also significant change in the pupil diameter with different room illumination (P= <0.001, P<0.001 for OD and OS respectively). But there was no significant change in contrast sensitivity under three room illumination (P=0.368, P= 0.368, P=0.368 for OD, OS and OU respectively).

Conclusions: There is a statistically significant difference in positive fusional vergence and pupil diameter and no significant changes in contrast sensitivity for near under different level of illuminations. Moreover, under low illumination the positive fusional vergence seems to be higher.

Keywords: Negative Fusional Vergence, Positive Fusional vergence, Illumination.

Introduction

Illumination is an important aspect of workplace, as it can affect on working condition and performance of the worker. In different level of illumination ocular status may get affected and the proper level and position of illumination is needed for optimum functioning by workers.

Various sources of illumination have been proposed as the ideal standard for reading. Various studies and authority recommend various illumination levels for

different task in industries. Various researchers, appears to have differing opinions on the amount of light required for certain tasks. Indian Standard Code of Practice for Industrial Lighting have suggested that for Reading and writing it should be 300-400 lux and in 2011 National Electric Code of Indian standards they suggested for reading illuminance should be 300-700 lux and Central Building research institute of India suggests 200- 500 lux for task like reading. Recent evidence reveals that light levels and quality might have a major impact on behavior. (1)

We interpret binocular vision to mean more than just seeing with two eyes. We believe that combining two eyes and obtaining a single image is preferable to employing one eye at a time. Perhaps the phrase binocular single vision is more appropriate. It emphasizes the use of both eyes and the creation of a single image. The fact that binocular single vision can be achieved even when the eyes are not aligned (as in microtropia) illustrates that the occipital cortex is forgiving in terms of what it will take from homologous retinal areas to perceive single vision. Binocular single vision does not require central (foveal) fusion. It is sufficient to fuse the peripheral retinal regions. (2) Fusional amplitudes or vergences are the consequence of a reflex (motor response) to a sensory stimulation induced by pictures of the object of attention drifting off one fovea, resulting in disparity and requiring corrective movement of both eyes to preserve fusion and avoid diplopia. Good fusional amplitudes are required for binocular vision stability, and in the presence of vergence system anomalies, a wide range of symptoms are evoked, interfering with visual comfort and academic performance. Because the fusion reflex is necessary for sustaining heterophoria compensation, clinicians must understand what pro portion of total vergence amplitude is required to adjust for a deviation.(3) Positive Fusional vergence is determined by the maximal response to stimulation the examiner determines the amplitude by directly reading the maximal response end point starting from the position of rest and evoking maximal fusional convergence with either the prisms or the major amblyo scope; starting from the position of rest and evoking maximal.(4) The study of accommodation and convergence levels using a 3D object in two distinct illuminations revealed that accommo dation concentrates beyond the convergence in brighter lighting, whereas accommo dation and convergence were identical in position in darker illumination.(5) In low illumination, Wolska et al. found that convergence is more important than accommo dation.(6)

According to Okada Y et al., when there is a lot of light, the pupils become miotic and the degree of accommo dation and convergence decreases. When the pupils are mydriatic, the convergence and accommodation levels are directed beyond the plane of attention under low illumination, whereas in a brighter environment, they are focused within the plane of sight. (7)

Poor illumination has been linked to a variety of health problems, according to studies. visual problems, attention issues, and dietary deficits, as well as a deterioration in health and mood It's been proven that the right illumination can help to counteract these effects boost academic performance and solve challenges productivity brightness can have a significant impact on behaviour, as well as school and workplace performance. Visual faculties quickly deteriorate in the absence of enough light. Because focused vision, which is required for reading and writing, rapidly deteriorates as light levels decline, sight is worst at low illumination levels. Increased light brightness, in example, has been

demonstrated in tests to reduce unnecessary workload and hence boost productivity. (8)

This study aims to find effect of change in room illumination on subjects positive fusional vergence with considering change in contrast sensitivity and pupil diameter of subjects. The main objective of this study is to see changes in positive fusional vergence in change of room illumination for near.

Methods

Participants

Thirty-Four normal adults participated in the study (15 males and 19 females; mean age 23.08 ± 1.40 years). All the viewing observers had no history of ocular disease and had normal or corrected-to-normal visual acuity. After explaining the purpose of the study and any potential risks, all observers gave their informed consent.

Illumination Mode

This study was done in an ordinary room with white painted walls. Three 15-watt fluorescent bulbs were fitted on the ceiling. Each bulb could be controlled separately.

Three commonly used illumination modes were studied in this experiment: And it was measured with lux meter.

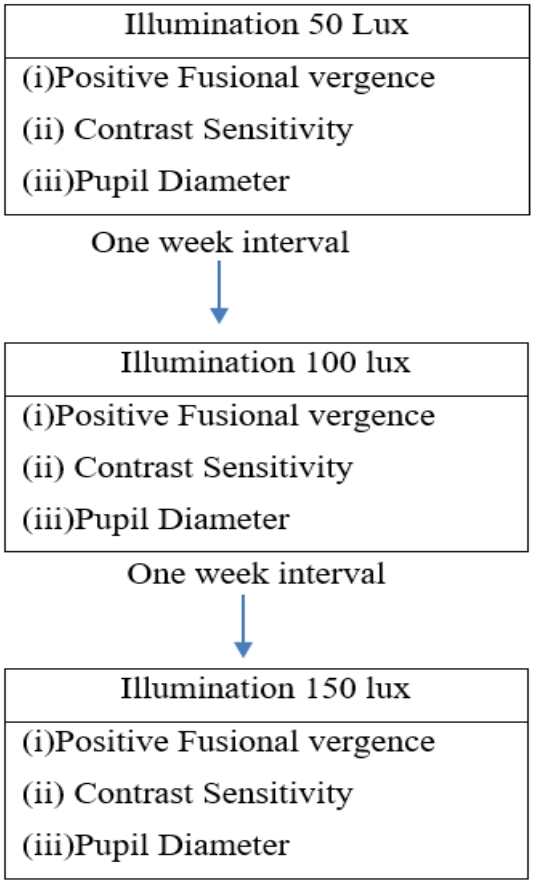
Mode A- The illumination at viewers position was 50 Lux. One fluorescent lamp was turned on.

Mode B- The illumination at viewers position was 100 Lux. Two fluorescent lamps were turned on. and Mode C- The illumination at viewers position was 150 Lux. Three fluorescent lamps were turned on.

Procedure

We assessed all the ocular status measures prior to the start of the experiment. The amount of positive fusional vergence was measured by using a prism bar under three different room illuminations (50 Lux, 100 Lux and 150 Lux based on the availability of illumination in the clinical set up). At first the positive fusional vergence was measured then contrast sensitivity was measured using log Mar Contrast sensitivity chart and pupil diameter was measured using a ruler. Each subject was examined in three illuminations in a gap of one week. In first week of examination the room illumination was 50 lux, positive fusional vergence, contrast sensitivity and pupil diameter were measured accordingly. Then after one week of interval same procedures were done in 100 lux. Then in third week of examination same procedures were done in 150 lux room illumination.

Figure 1: monstration of experimental sequence.



In Figure 1 the experimental sequence of our study is described how the data has been collected.

Statistical analysis

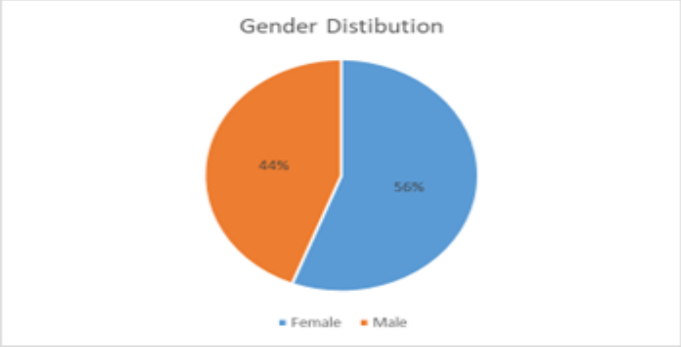
In establishing the patient's sample size, we assumed an expected proportion in population based on previous studies or pilot studies to be 0.021 and used fishers' law for calculating the sample size for a cross sectional quantitative study design. The required sample size is 34.

The number was rounded to 50 to make provision for any missing data. The descriptive statistic part was analyzed with Microsoft excel. Then with the help of SPSS we checked normality of data. On Shapiro wilk test the data was not normally distributed. Then Friedman test was applied to check comparison of positive fusional vergence, contrast sensitivity and pupil diameter in three different illuminations.

Results

In this study we included 50 participants in beginning, 5 of them were excluded from this study as they were coming into the exclusion criteria. And 11 participants haven't come for follow up visit i.e., in second and third week of experiments. 34 participants were only coming for follow-up in a interval of one week for three weeks till the data collection. The mean age group of participants was 23.088 ± 1.40059829 age. In this study there were 15 male (44%) And 19 females (56%). In figure 2 the gender distribution of this study is shown.

Figure 2: Showing Gender Distribution



A clinically significant result was there for three different levels of illumination. Friedman analysis shows significant influence of illumination on positive fusional vergence at near for blur (<0.001), break (<0.001) And recovery (<0.001). In figure 3 the box and whisker plot showing the comparison of blur in three different illuminations which shows higher the illumination lowers the prism dioptre for blur. Figure 4 in box and whisker plot shows the comparison of break point in three level of illumination which shows higher the illumination the break point in prism dioptre will be less. Figure 5 in box and whisker plot shows the comparison of recovery point in three level of illumination which shows higher the illumination the break point in prism dioptre will be less. Table 3 shows the significant change in recovery point.

Figure 3: Comparison of Blur Point in three different Illuminations.

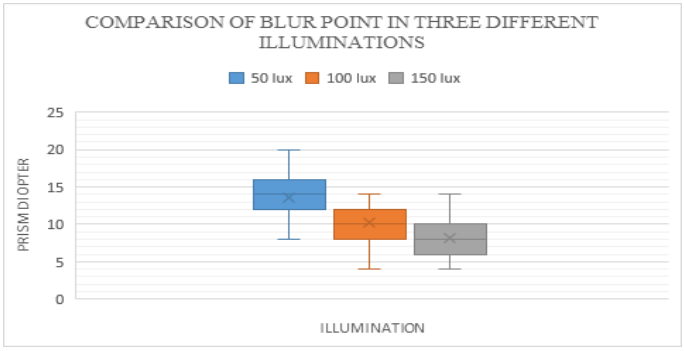


Figure 4: Comparison of Break Point in Three different illuminations.

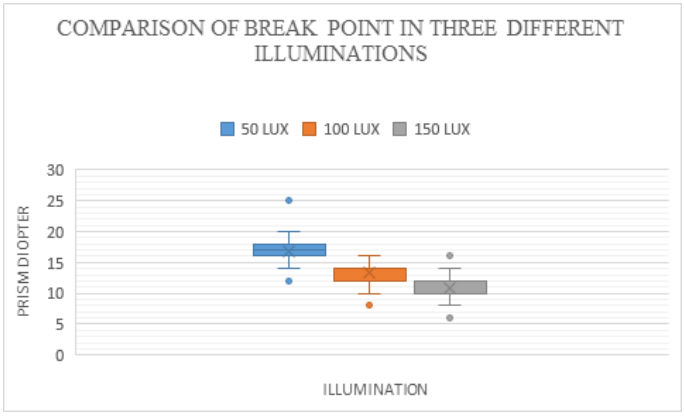


Figure 5: Comparison of Recovery Point in three different illuminations.

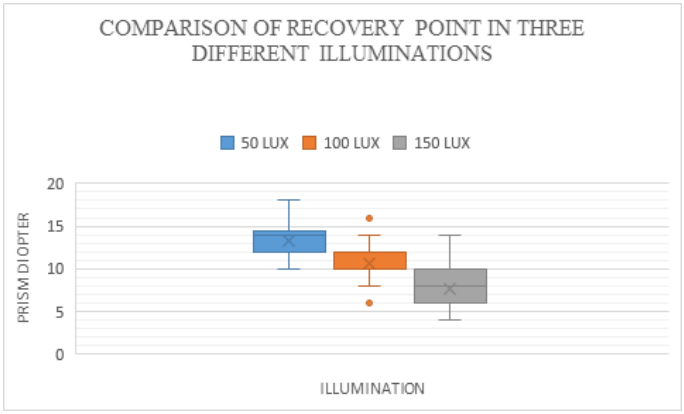


Table 1: Comparison of Positive Fusional Vergence in different illuminations.

	Illumination									
	High			Medium			Low			P Value
Positive fusional vergence	Mean Rank	Mean	S. D	Mean Rank	Mean	S. D	Mean Rank	Mean	S. D	
Blur	1.24	8.235294	2.188937	1.82	10.23529	2.297018	2.94	13.52941	2.513422	<0.001
Break	1.16	10.82353	2.262616	1.90	13.47059	1.862473	2.94	16.73529	2.403392	<0.001
Recovery	1.18	7.588235	2.731607	2.03	10.70588	2.139519	2.79	13.35294	2.186492	<0.001

Table 2: Comparison of Pupil diameter in different Illuminations.

	Illumination									
	High			Medium			Low			P Value
Pupil Diameter	Mean Rank	Mean	S. D	Mean Rank	Mean	S. D	Mean Rank	Mean	S. D	
OD	1.15	3.44	0.503	1.88	4.176	0.520	2.97	5.441	0.612	<0.001
OS	1.15	3.44	0.503	1.88	4.176	0.520	2.97	5.441	0.612	<0.001

In table 1 the comparison of positive fusional vergence with different level of illumination is shown, which shows there is a significant change in positive fusional vergence in all three parameters i.e., in blur break and recovery with change in room illumination.

In table 2 we can see the comparison of pupil diameter with change of room illumination in high, medium and low levels of illumination the pupil diameter of right and left eye shows there is a significant change.

In our study the was no significant change observed in comparison of contrast sensitivity and change in illumination. The changes were not significant as it was less than our p value. Contrast sensitivity was compared monocularly for both eyes and binocularly also. But there was significant result found as shown in table 4,5and 6.

We have compared pupil diameter of both eyes in different illumination, and Friedman test significant change in monocular pupil diameter with change of room illumination. Table 7 and 8 shows comparison of pupil diameter of OD and OS in three different illuminations. In both parameters we are getting significant change.

Discussion

In this study, we measured the subjects positive fusional vergence, contrast sensitivity and pupil diameter in three different room illumination. The blur, break, and recovery of positive fusional vergence, contrast sensitivity, pupil diameter was measured in three different room illumination and analyzed. There was no statistically significant difference in contrast sensitivity in three different room illumination. While Chan-Sik Kim, et al (9) they measured contrast sensitivity using an Arden Contrast Sensitivity System in an incandescent electric lamp, the influence of illumination on the contrast sensitivity function was investigated. The illumination intensities were set to 50,100,200,500, and 1,000 lux. In both monocular and binocular conditions,

the contrast sensitivity function was saturated at 500 lx light. However, frequency characteristics revealed that at 1,000 lx of illumination at high frequency, the CSF was increased considerably. The major goal of this research was to see if there is a relation between positive fusional vergence and illumination. Our results confirmed that the value of positive fusional vergence increases as the room illumination decreased. A similar Study by Chiranjib Majumder et al (10) supported our results they also find change in positive fusional vergence in different illumination while using visual display unit. Okada et al. (7) also confirmed our findings by measuring accom modative and convergence demand while seeing a 3D object under two lighting conditions. They discovered that under low-light conditions, accommodative and convergence demands were higher than in brighter conditions. As a result, low room illumination can result into more positive fusional vergence to be exerted, which might lead to asthenopia or visual tiredness symptoms after long periods of employment. According to Agnieszka Wolska (6) that convergence is affected by type of lighting but not with the symptoms of visual strain. The Direct-indirect lighting system had the greatest convergence reduction, which was considerably greater than the convergence changes for the Indirect lighting (p =.02) and Compound lighting (p =.005) lighting systems. (6) In a study by Jiang BC et al (5) they suggested that both vergence and accommodation tend to move toward new and individually characteristic resting postures when brightness is reduced, which are usually referred to as dark-vergence and dark-focus. Mononuclear focus tended to remain at the individual dark-focus at lower brightness levels, whereas binocular focus tended to correlate to the target distance. Vergence accommodation is the reason for these disparities. We can say that this variation is due to vergence accommodation, and that the best night myopia correction is based in part on the essential brightness level for fusional vergence activation. (11) Yuanyuan Chen their study concluded that the illumination mode, as well as 3D viewing, influences ocular condition. That could be explained by differences in luminance at the viewer's position, the direction of the light source, or the participants' familiar viewing environment. They show that front illumination is a good choice for seeing 3D displays. There is substantial evidence that environmental light influences ocular state, visual asthenopia, and visual cortex cell contrast modulation. Low brightness levels, such as those found in Mode A (total darkness), would result in poor viewing circumstances and noticeable changes. Source of Illumination can also have effect on other ocular parameters such as reading speed, visual performances. (12) Male Shiva Ram, in his study “Effect of Different Illumination Sources on Reading and Visual Performance” found that Reading rate was fastest in males under CFL, and in females under FLUO. There was no statistically significant difference between illumination and contrast acuity ($P > 0.47$) or Color vision ($P < 0.99$) in either male or female participants but both males ($P = 0.001$) and females ($P = 0.002$), there was a significant relationship between visual performance and lighting. Suggested suitable illuminations based on their visual comfort and reading experiences; the majority of male participants (85%) advised CFL, whereas the majority of female participants indicated FLUO (65 percent). (1) In a study by Chin-Chiuan Lin et al (13) they suggest that white light, 500 lux, and colour text were the better visual task setting parameters under similar and low screen brightness situations. Furthermore, the effect size reveals that the intensity of illumination has the biggest impact on short-term visual tasks and text colour. has the greatest

influence on long-term visual tasks. It is preferable to use blue as the font colour in low-luminance situations. Ayse Nihan Avci et al (14) they suggested the effects of different illuminance levels of LED lighting on users visual comfort and reading performance. Three illuminance levels were identified, 200 lux, 500 lux and 800 lux. 500 lux is best for a reading work, according to Turkish Standards TS EN 12464-1. In terms of the criteria of burning eye, the illuminance level of LED 500 lux was found to be visually more pleasant; on the other hand, the illuminance level of LED 200 lux was found to be visually more comfortable than the other illuminance levels. This study found that illuminance levels have a considerable impact on users' visual comfort, but that LED lighting illuminance levels do not affect all visual comfort criteria.

These data imply a link between illumination range type and visual performance in the clinical setting, and that poor illumination and intensity may contribute to poor visual performance. cause early onset of eye tiredness The present research may also increase patient understanding of the significance providing illumination, and to assist in the upkeep of a long-term partnership with optometrists and eye doctors' specialists. The importance of patient education cannot be overstated. concerning the significance of visual task criteria and given their importance in daily life, lighting in reading life. This study showed that there is a relation between the illumination and positive fusional vergence. Which can lead to various asthenopic symptoms if other ocular parameters are getting changed. In low illumination more convergence is needed that can lead to eye strain and headache after short span of reading or near work. In our study we included only participants age group 20 to 25 and only positive fusional vergence was considered. And sample size was taken less. For future direction we will suggest including more participants and to include more variable or parameters such as accommodation (NRA, PRA , Accommodative Facility, NPA) and vergence (Vergence Facility, NPC, PFV) . The limitation of this study is sample size is less and the age range of the participants in our study is 18-25 , it can be increased ill 35 only positive fusional vergence was considered in this study , other parameters should also be considered like accom modation parameters (Negative relative accom modation, positive relative accom modation, accom modative facility, near point of accom modation) convergence parameters (Positive fusional vergence , vergence facility , near point of convergence).

Conclusion

The result found in this study gives a relation between positive fusional vergence and change in room illumination. There is a statical significant change in positive fusional vergence for near with change of room illumination. In low illumination the value of positive fusional vergence is higher which can lead to eye strain and asthenopic symptom. This study also shows a significant change in pupil diameter and change of illumination.

Clinically these finding suggest that a relation between the positive fusional vergence and illumination. And improper illumination may lead to asthenopic symptoms and eyestrain or eye fatigue problems. This study plays an important role in awareness about the importance of illumination in work place or schools and colleges.it is important to educate patients about visual task standards and illumination in their day to day life.

References

1. Ram MS, Bhardwaj R. Effect of different illumination sources on reading and visual performance. J Ophthalmic Vis Res. 2018 Jan 1;13(1):44–9.

2. Evans BJW. Nature of Binocular Vision Anomalies. Pick well's Binocular Vision Anomalies. 2022;2–10.
3. Lança CC, Rowe FJ. Measurement of fusional vergence: a systematic review. Strabismus. 2019 Apr 3; 27 (2): 88–113.
4. Fusional vergence testing [Internet]. [cited 2022 May 28]. Available from: http:/ /p2. aao. org/ pols/ service layer/ search/ pols 2013.php?topic=3648
5. Jiang BC, Gish KW, Leibowitz HW. Effect of luminance on the relation between accommodation and convergence. Optom Vis Sci [Internet]. 1991 Mar 1 [cited 2022 May 29]; 68 (3): 220–5. Available from: https:// euro pepmc.org/article/med/2047085
6. Wolska A. Visual strain and lighting preferences of vdt users under different lighting systems. International Journal of Occupational Safety and Ergo nomics. 2003; 9 (4): 431–40.
7. Okada Y, Kojima T, Oohashi T, Miyao M. The effect of environmental illumination and screen brightness on accom modation and convergence. Dig Tech Pap. 2013; 44 (1):1078–81.
8. Abramson CI, Page MC, Zolna M, Howard W, Aquino IS, Nain S. A Preliminary Study of Illumination Levels in University and Elementary Classrooms in Campina Grande, Brazil. Journal of Social Sciences. 2007 Mar 1;3(3):155–8.
9. Effect of Illumination on Contrast Sensitivity | Journal of the Korean Ophthalmo logical Society; 729-732, 1987. | WPRIM [Internet]. [cited 2022 May 29]. Available from: https:// pesquisa. bvsalud. org/ portal/ resource/ pt/ wpr - 26402? lang=en
10. Majumder C, Sinathamby L. Effect of Illumination over Positive Fusional Vergence when Using VDU as Target. J Clin Exp Ophthalmol. 2017;08(03).
11. Jiang BC, Gish KW, Leibowitz HW. Effect of luminance on the relation between accommodation and convergence. Optom Vis Sci [Internet]. 1991 Mar 1 [cited 2021 Dec 14]; 68 (3):220–5. Available from: https:// euro pepmc.org/article/med/2047085
12. Chen Y, Wang Y, Yu X, Xu A, Jiang J, Chen H. Effect of Illumination on Ocular Status Modifications Induced by Short-Term 3D TV Viewing. Neural Plast. 2017;2017.
13. Lin CC, Huang KC. Effects of Lighting Color, Illumination Intensity, and Text Color on Visual Performance. International Journal of Applied Science and Engineering [Internet]. 2014 [cited 2021 Dec 14];12(3):193–202. Available from: https:// gigvvy. com/ journals/ ijase/ articles/ijase-201409-12-3-193
14. Avci AN, Memikoğlu İ. Effects of LED Lighting on Visual Comfort with Respect to the Reading Task. [cited 2021 Dec 14]; Available from: https:// www. research gate. net/ publication/ 320868090