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The Effects of Reading on Tear Stability in Soft Contact Lens Wearer

***Nur Aresya Ahmad Najmee & Fatin Hazirah Halim**

Department of Optometry, Faculty of Health Sciences, Universiti Teknologi MARA Cawangan Selangor, 42300 Bandar Puncak, Selangor, MALAYSIA

*Corresponding author: aresyanajmee@uitm.edu.my

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Abstract

This study aimed to determine the effects of reading on non-invasive tear break-up time (NIBUT) in soft contact lens wearers and establish the correlation between the Contact Lens Dry Eye Questionnaire-8 (CLDEQ-8) and the NIBUT before and after reading. The demographic questionnaire, Contact Lens Dry Eye Questionnaire-8 (CLDEQ-8), were completed by 18 soft contact lens wearer (36 eyes; 17 females and 1 male). The NIBUT was measured as a baseline using modified bowl perimetry before reading. The subjects were then instructed to read silently for 20 minutes a validated hard copy text. The NIBUT test was administered again following the reading task. This study enrolled a total of 18 contact lens wearers (36 eyes). The mean age of the participants was 22.89 ± 1.687 years, and the mean refractive power of their contact lenses ranged from Plano to -5.75D (1.44 ± 0.504D). Twenty-five eyes (55.6%) of contact lens wearers wore lenses less than -3.00D, while sixteen eyes (44.4%) wore lenses greater than -3.00D. The mean of pre-NIBUT and post-NIBUT were 6.43 secs (SD;1.250) and 3.22 secs (SD;0.964) respectively. The paired t-test revealed a significant difference between pre and post-NIBUT; $p < 0.001$. CLDEQ-8 had a negative poor correlation with pre-NIBUT ($r = -0.266$) and post-NIBUT ($r = -0.150$). The values of NIBUT decreased in soft contact lens wearers after a 20-minute near-reading task. Sustained 20 minutes of reading affects the tear stability, resulting in disruption of the tear film layer, which results in tear film instability as measured by CLDEQ-8 and NIBUT before and after reading. There was little correlation between CLDEQ-8 and NIBUT scores before and after reading.

Keywords: Contact lenses; non-invasive tear break up; reading, tear film stability

INTRODUCTION

Young adults used to interact more with printed media like books, magazines, and newspapers a few decades ago. Nowadays, digital media has largely replaced traditional printed materials, with 75% of Malaysians preferring e-books, 25% preferring physical books, and only 12.5% preferring print newspapers (Joeng,H. 2012). Despite this, a study discovered that young people read more books than older people (Zickuhr, K., & Rainie, L, 2014). Printed books have been widely used in schools, colleges, and universities until recently; however, today's lifestyle demands an increasing number of cognitive near-tasks, such as reading books for leisure or using electronic devices for work-related productivity. Increased cognitive demands necessitated increased concentration, which was associated with a decrease in blink rate and tear film stability (Wolkoff et al., 2005). Blinking patterns and quality were used to determine tear film stability. The predominance of blinking was in response to tear film stability and possibly ocular surface drying (Masakazu Hirota, Hiroshi Uozato, Takushi Kawamorita, Yuko Shibata, 2013). Nonetheless, when reading on a printed page, the blinking rate and tear break-up time were reduced more than when reading on an electronic device (Abusharha, 2017). This is due to a decrease in tear film thickness and a high meniscus, increasing tear film evaporation when the patient delays blinking. Blinking is essential for corneal wetting because it causes the tear film layer to reform (Doane, 1980). The action of the upper lid in order to spread thin tear film over the ocular surface causes the tear film stability to become more unstable during prolonged reading. The blinking rate and quality of the tear film are intertwined to spread the thin tear film over the ocular surface (Jansen et al., 2010). In both dry eyes and healthy people, prolonged reading causes ocular surface changes as aqueous tear secretion decreases (Karakus et al., 2018). The decreased blink rate and increased tear break-up caused by high concentration demand tasks resulted in ocular discomfort symptoms. These ocular symptoms due to tear stability are prominent with contact lenses, as the presence of a contact lens on the eyes can disrupt the stability of the tear film by disrupting the tear film structure (Craig & Downie, 2018). When no contact lenses were worn, tear break-up time was minimal, and there was a significant change in tear break-up time, particularly over the inferior cornea (Jansen et al., 2010).

Even though the nature of tear film was able to tolerate the contact lens's interaction with our eyes, the evaporation of the tear films is two times faster than those without a contact lens. Patients with dry eyes were typically associated with the distribution of lipid layer thickness. The physical engagement of the contact lens over the ocular surface also induced changes in the tear film layer. Pre-corneal tear film will be separated into the pre-lens tear film and post-lens tear film with the modification of inserting the contact lens into the eyes. The biophysical properties of tear film modification lead to the disappearance of mucin in pre-lens and the disappearance of the lipid layer in the post-lens tear film. The alteration in lipid, aqueous, and mucin components of the tears layer on soft lenses caused the impaired stability of the tear film, making it more vulnerable to disturbances and evaporation, particularly in subjects with dry eyes (Alonso-Caneiro et al., 2009). The lipid layer of the tear film and tear break-up time was related in which thicker lipid layer patterns provide longer tear break-up time. Nonetheless, contact lens wearers frequently experience tear film instability, often accompanied by ocular symptoms. Many clinical consequences exist, including contact lens-related dry eye symptoms, lens adherence, decreased tear exchange, contact lens dehydration, corneal desiccation, inflammatory events, and potentially sight-threatening events (Nichols & Sinnott, 2006).

The most frequent symptom reported related to tear film factors was dry eyes. The symptom occurred due to the thinning of the precorneal tear film raised from the surface tension of the tear film and hydrophobic regions on the lens surface, resulting in evaporation and de-wetting of the contact lens. In this condition, the lipid layers are thin, and the thinning time of the pre-lens tear film (PLTF) is 2.8 seconds faster than in non-dry eyes. Tear break-up time was minimal when there was no contact lens wear, and it was a significant change in the tear break-up time, especially over the inferior cornea (Jansen et al., 2010). With the addition of cognitive tasks such as prolonged reading, the dry eyes symptom was evident among the contact lens wearer. According to previous questionnaire studies, reading difficulty is one of the most common dry eye symptoms, lowering one's quality of life (Karakus et al., 2018). Visual symptoms associated with prolonged reading affect both dry eye patients and healthy individuals who have never been diagnosed with dry eye, as the tear film becomes more unstable and aqueous tear secretion decreases. The reduced blinking rate can also alter the pre-corneal tear film, resulting in thinning and instability of the pre-corneal tear film. Contact lenses on the eye may also contribute to the tear film alteration. Contact lenses can disrupt the normal structure of the tear film layer and the volume of tears, resulting in a decrease in the tear film's stability (Roshani S, 2011). Thus, this study will examine the effect of reading on the non-invasive tear break-up time (NIBUT) in soft contact lenses.

METHODOLOGY

This study is a cross-sectional study that used purposive sampling. The Research Ethics Committee of Universiti Teknologi Mara has approved this study: 600-TNCPI (5/1/6). Subjects were recruited based on the inclusion and exclusion criteria. There were eighteen subjects (36 eyes), with a mean age of 22.89 ± 1.687 years. All subjects were regular contact lens wearers who wore contact lenses for at least one year and more than four days per week. In this study, subjects were asked to refrain from wearing contact lenses for 12 hours before the assessments.

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Materials and Instruments

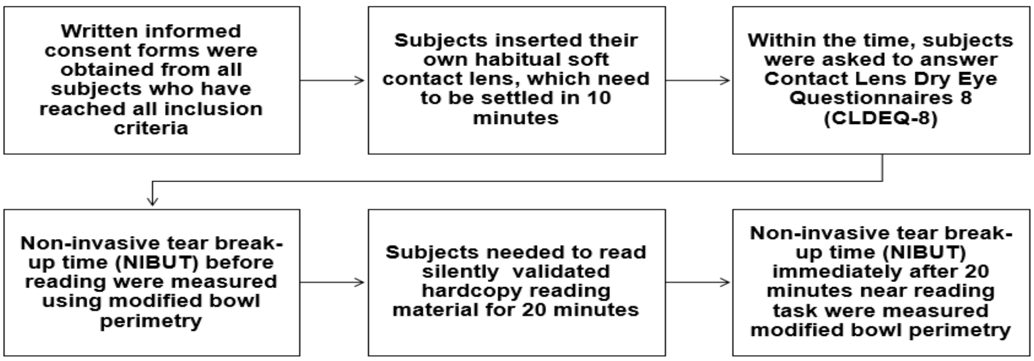
The Contact Lens Dry Eye Questionnaire 8 (CLDEQ-8), adapted from Chalmers et al., (2012) was used to assess dry eye symptoms (2012), which comprised eight questions to determine the frequency and severity of habitual ocular surface symptoms over a two-week recall period. The summation of CLDEQ-8 scores resulted in 37 scores for CLDEQ frequency questions regarding core symptoms on a scale of 0 (never) to 4 (constantly). The CLDEQ's intensity scale ranged from 0 to 5 (never have the symptom) (very intense). Meanwhile, the printed Bahasa Melayu newspaper was displayed and placed at a reading distance of 40 centimeters for the reading materials. The printed newspapers were 24 pages long and used the N12 font, which matched the standard newspaper's font and size for ease of use. The measurements were taken in a room (12-17 feet) lit uniformly at 1145 lux and had an ambient temperature of 73 to 75 degrees Fahrenheit.

The non-invasive tear break-up time was determined using a modified bowl perimetry instrument (NIBUT). The perimetry was an illuminated aspheric bowl. Internal illumination with a mean luminance of 50cd / m2 was used to present concentric and radial lines painted on the concave side of the bowl and a one-centimeter hole in the bowl's center using a near telescope (4x magnification). A telescope with a near-4x magnification project radial lines onto the participant's corneal surface. The examiner would determine the NIBUT by observing the pattern reflected from the cornea.

Study Procedure

The subjects' habitual soft contact lenses were inserted into each eye and allowed to settle for ten minutes. All subjects were required to complete the Contact Lens Dry Eye Questionnaires 8. (CLDEQ-8). Prior to the experiment, each subject needs to provide informed consent. The NIBUT measurements were taken twice; before (pre) and after reading (post). The reading task was conducted at a 40-cm distance. All measurements were made in an environment with relatively constant illumination and temperature.

The subject sat in a chair and rested his chin on the chin rest. The radial grid pattern on the cornea was observed using modified bowl perimetry. The time interval between the last blink and the first appearance of a discontinuity in the reflected mires' lines was measured. Subjects were allowed to blink for a few seconds during the *bleaching* period before the subsequent NIBUT measurement and permitted to blink whenever they felt uncomfortable to minimize the tearing reflex. Each subject had five measurements are taken (both eyes), and the mean of the five readings was used to determine the mean NIBUT(s). All participants received the tests in the same order, and the entire procedure took approximately 40 minutes per participant.



RESULTS

The NIBUT of these subjects was normally distributed (Shapiro-Wilk test: p=0.68). Table 1 summarizes the NIBUT before any reading task and NIBUT after 20 minutes near the reading task among soft contact lens wearers. A paired samples t-test with an α of 0.05 was used to compare the mean of non-invasive tear break-up time (in seconds) before any near reading task to non-invasive tear break-up time after 20 minutes of near reading task among soft contact lens wearers. The mean of pre-NIBUT and post-NIBUT were 6.43

secs (1.250) and 3.22 secs (0.964) respectively. There were significant different between pre-NIBUT and post-NIBUT (Paired t-test: 3.217 (0.960) dF = 35 and p < 0.005). The mean difference between NIBUT before and after 20 minutes of reading near the task is significantly different from zero (p<0.005, 95% CI 2.892, 3.542). We conclude that the mean of NIBUT after 20 minutes of reading near task is lower than NIBUT before reading near task. The mean difference of NIBUT before and after reading near task was between 2.892 and 3.542. It was concluded that the assumptions of normality and normality of difference scores were not violated after outputting and visually inspecting the relevant histograms. The NIBUTs of all subjects were normally distributed. The NIBUT before the reading task and after a 20-minute near reading task were summarised in Table 1. The mean of the measurements was compared using a paired t-test with a significance level of p<0.001. Pre- and post-NIBUT mean times were 6.43±1.250 and 3.22 ±0.964, respectively.

Table 1: Summary of NBUT measurement before and after reading.

Variables	Pre-NBUT Mean (SD)	Post-NBUT Mean (SD)	Mean of Score Difference (95% CI)	t-start (dif)	p-value
NBUT (sec)	6.43 ±1.25	3.22 ±0.96	3.217 ±0.96	20.10	0.001

Correlations between CLDEQ-8 and NIBUT

Pearson correlations showed a poor correlation between the total score CLDEQ-8 and NIBUT before and after 20-minutes near the reading task. Figures 1 and 2 showed correlations between the questionnaire and the distributions of non-invasive tear break-up time (NIBUT) measures before and after the reading task, respectively.

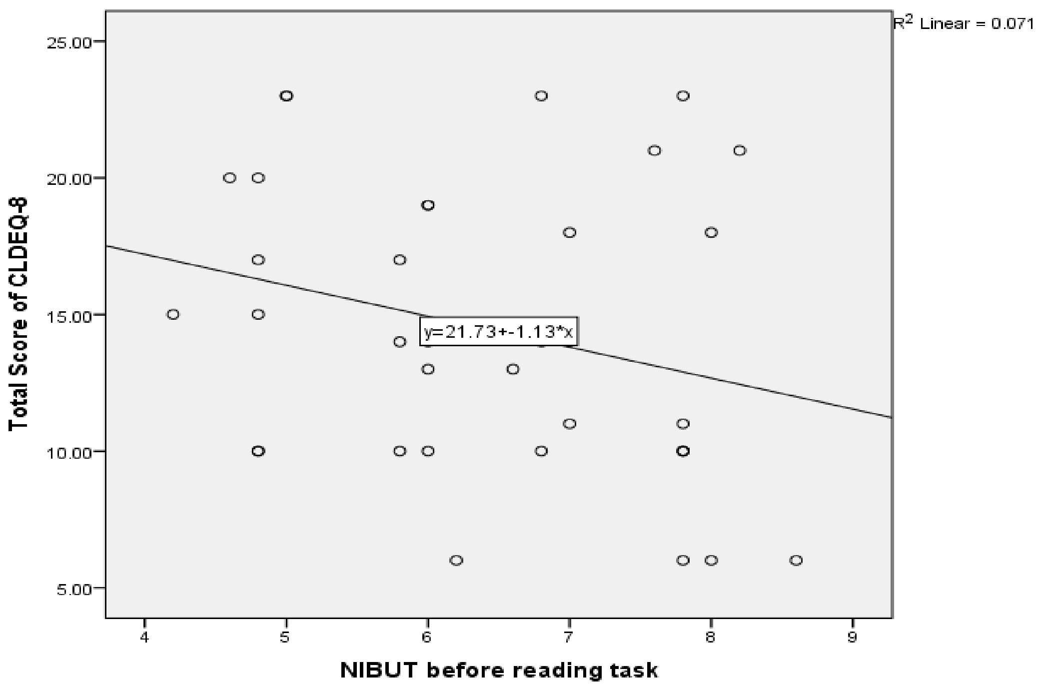


Figure 1: Correlation of CLDEQ-8 and non-invasive tear break-up time (NIBUT) before near reading task

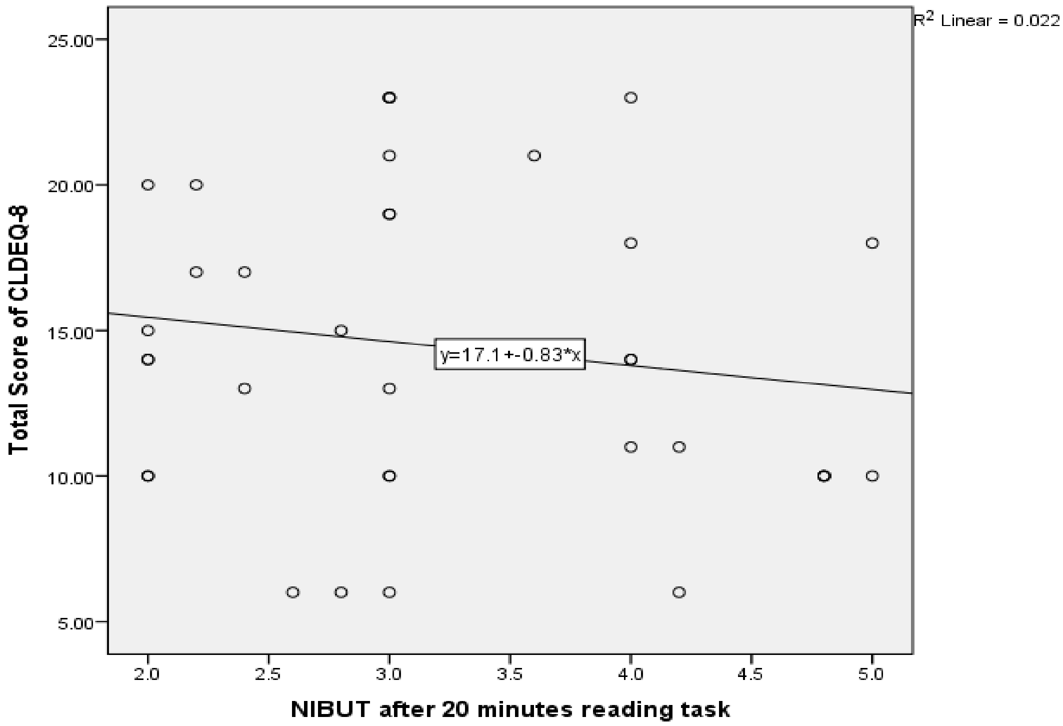


Figure 2: Correlation of CLDEQ-8 and non-invasive tear break-up time (NIBUT) after near reading task

DISCUSSION

The mean value for pre-and-post-NIBUT measurements in this study was 6.43 secs 1.25 and 3.22 secs 0.96, respectively. The NIBUT value decreased significantly after 20 minutes of prolonged reading with hardcopy printed text altered the pre-corneal tear film. According to Wolkoff et al., (2005), the alteration of the precorneal tear film occurred due to involuntary blinking. Additionally, reading has been shown to decrease the frequency and completeness of blinking (Dart, 2013; Marube 2009). The process occurred when the subject's gaze was fixed on the page while reading, resulting in incomplete blinks that take less time than complete blinks. Additionally, widening the exposed cornea affected the NIBUT value, resulting in increased water evaporation due to a pre-corneal tear film alteration (Wolkoff et al., 2005). As blinking frequency decreased during prolonged near visual or cognitive tasks, the pre-corneal tear film became thinner, resulting in its alteration. As a result of the unbalanced water loss, the precorneal tear film became dehydrated. During prolonged concentration near a task, the ocular surface enlarges, exposing a greater amount of ocular surface area to the environment via the evaporation process (Wolkoff et al., 2005; Smith et al.,2013). This resulted in inefficient tear redistribution, which caused increased water loss, ocular discomfort, and dry eyes (Palakuru et al.,2007). Moreover, the tear film thickness and the meniscus height were reduced as subjects were asked to delay each blink which eventually caused excessive tear film evaporation of the ocular surface.

Furthermore, Cardona et al., (2011) has confirmed that blinking affects the tear film integrity, which influences the type of visual task performed. Numerous studies established that highly demanding visual tasks such as reading and visual display terminal (VDT) use resulted in a significant decrease in blink rate, amplitude, and tear film stability. Additionally, Cardona et al. (2011) discovered a link between blinking rate and tear stability, which were significantly affected by near reading tasks. Thus, changes in the tear film's stability during reading may contribute to the onset of ocular discomfort symptoms. Even though the mean NIBUT after 20 minutes of sustained reading was significantly different, the actual state of tear film stability during reading was unknown. The NIBUT was measured immediately following the reading in this study, which corroborated with the study done by Cho et al., (1997). The palpebral fissure became smaller as the upper eyelids were lowered during reading. On the other hand, the eye is directed straight ahead during the NIBUT measurement. The experiment could be repeated with the subjects' reading material placed at eye level to prevent the subjects' eyelids from lowering during the reading, which marked the standardize the 'conditions' under which NIBUT is read and measured.

Meanwhile, results also showed a poor correlation between the CLDEQ-8 and the NIBUT measurements. The result may be influenced by the distinct selection of subjects who followed the inclusion and exclusion criteria where the moderate to the severe dry eye were eliminated from this study. According to previous research, 12 continuous hours of contact lens wear causes ocular discomfort and dryness, which becomes significantly worse after the eighth hour than during insertion (Papas et.al., 2015). However, subjects were permitted to insert their habitual contact lenses only immediately before the study started in this study. Thus, the poor correlation between the CLDEQ-8 and the NIBUT before and after reading could be explained by the fact that the total time required for each subject to complete the study is less than one hour. Additionally, the subjects in this study had low to moderate myopia, which may account for the negative correlation between CLDEQ-8 and NIBUT pre and post-reading. There were 20 eyes (55.6%) and 16 eyes (44.4%) that wore contact lenses with a power of less than or equal to -3.00D. A recent study established a strong correlation between TBUT and contact lens minus power; as the power of contact lenses increased, the TBUT decreased because the lenses were thicker, resulting in decreased oxygen permeability or hypoxia (Ammer, 2017). Nonetheless, this study also excluded individuals with severe myopia. There was no other study that adequately discussed the findings. The contact lens material and parameters were another possible explanation for the low correlations between CLDEQ-8 and NIBUT measurement. The water content of the contact lens also plays a role in lens dryness where numerous studies have briefly explained the significant correlation between tear break-up time and contact lens type (Rohit et al.,2013)

CONCLUSION

As a result, sustained reading for 20 minutes significantly affected the non-invasive tear break-up time (NIBUT) in soft contact lens wearers. However, the correlation between CLDEQ-8 and NIBUT was low before and after reading the printed text. Nearly all tasks requiring concentration, such as reading, decreased the tear film's and NIBUT's stability. One could argue that a potential limitation of the current study is that contact lens parameters were not excluded. It is possible for contact lens-related dry eye symptoms and tear break-up time caused by the type of contact lens material and fitting. In the future, this study can be improved by incorporating information about contact lens fitting, contact lens material types, and contact lens parameters. It is recommended that future research include several different approaches, such as the blinking rate during reading or other demanding task content, such as reading on electronic devices or watching movies. Additionally, it is recommended to use multiple measurement techniques to determine NIBUT to obtain a more robust, accurate, and precise result. Due to the low correlation between the CLDEQ-8 and the NIBUT before and after reading, alternative questionnaires such as the Ocular Surface Disease Index (OSDI) should be used to assess symptoms of ocular irritation and dry eye disease, as well as their effect on visual function.

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CONFLICT OF INTEREST

The author declares no conflict of interest in this study.

REFERENCES

[1] Jeong, H. (2012), "A comparison of the influence of electronic books and paper books on reading comprehension, eye fatigue, and perception", The Electronic Library, Vol. 30 No. 3, pp. 390-408.

[2] Zickuhr, K., & Rainie, L. (2014). Younger Americans' reading habits and technology use. *Pew Internet Group*.

[3] Wolkoff, P., Nøjgaard, J. K., Troiano, P., & Piccoli, B. (2005). Eye complaints in the office environment: Precorneal tear film integrity influenced by eye blinking efficiency. *Occupational and Environmental Medicine*, *62*(1), 4–12. https://doi.org/10.1136/oem.2004.016030

[4] Masakazu Hirota, Hiroshi Uozato, Takushi Kawamorita, Yuko Shibata, and S. Y. (2013). Effect of Incomplete Blinking on Tear. *Optometry and Vision Science*, *90*(7), 650–657.

[5] A Abusharha, A. (2017). Changes in blink rate and ocular symptoms during different reading tasks, 133–138.

[6] Doane, M. G. (1980). Interaction of eyelids and tears in corneal wetting and the dynamics of the normal human eyeblink. *American Journal of Ophthalmology*, *89*(4), 507–516.

[7] Jansen, M. E., Begley, C. G., Himebaugh, N. H., & Port, N. L. (2010). Effect of contact lens wear and a near task on tear film break-up. *Optometry and Vision Science*, *87*(5), 350–357.https://doi.org/10.1097/OPX.0b013e3181d951df

[8] Karakus, S., Agrawal, D., Hindman, H. B., Henrich, C., Ramulu, P. Y., & Akpek, E. K. (2018). Effects of Prolonged Reading on Dry Eye. *Ophthalmology*, 1–7. https://doi.org/10.1016/j.ophtha.2018.03.039

[9] Craig, J. P., & Downie, L. E. (2018). *Tears and Contact Lenses*. *Contact Lenses* (Sixth Edit). Elsevier Inc.

[10] Alonso-Caneiro, D., Iskander, D. R., & Collins, M. J. (2009). Tear film surface quality with soft contact lenses using dynamic-area high-speed videokeratoscopy. *Eye and Contact Lens*, *35*(5), 227–231.

[11] Nichols, J. J., & Sinnott, L. T. (2006). Tear film, contact lens, and patient-related factors associated with contact lens- related dry eye. *Investigative Ophthalmology and Visual Science*,*47*(4), 1319–1328.

[12] Roshani, S. (2011). The effect of ocular surface conditions on blink rate and completeness.*Master Thesis*, 1–115

[13] Chalmers, R. L. B. C., Moody, K., & Hickson-Curran, S. (2012). Contact lens dry eye Questionnaire-8 and overall opinion of contact lenses. *Optom Vis Sci*, *89*(10), 1435–1442.

[14] Dartt, D. A., & Willcox, M. D. P. (2013). Complexity of the tear film: Importance in homeostasis and dysfunction during disease. *Experimental Eye Research*, *117*, 1–3.

[15] Murube, J. (2009). Basal, reflex, and psycho-emotional tears. *Ocular Surface*, *7*(2), 60–66. https://doi.org/10.1016/S1542-0124(12)70296-3

[16] Palakuru, J. R., Wang, J., & Aquavella, J. V. (2007). Effect of blinking on tear dynamics. *Investigative Ophthalmology and Visual Science*, *48*(7), 3032–3037.

[17] Cardona, G., García, C., Serés, C., Vilaseca, M., & Gispets, J. (2011). Blink rate, blink amplitude, and tear film integrity during dynamic visual display terminal tasks. *Current Eye Research*, *36*(3), 190–197.

[18] Cho, P., Cheung, P., Leung, K., Ma, V., & Lee, V. (1997). Effect of reading on non-invasive tear break-up time and inter- blink interval. *Clinical and Experimental Optometry*, *80*(2), 62–68.

[19] Papas, E., Tilia, D., McNally, J., & de la Jara, P. L. (2015). Ocular discomfort responses after short periods of contact lens wear. *Optometry and Vision Science*, *92*(6), 665-670.

[20] Ammer, R. (2017). Effect of Contact Lens Wear on Tear Film Break up Time (TBUT) among Contact Lens Users. *Pakistan Journal of Ophtalmology*, *33*(3), 182–186.

[21] Ewen King-Smith, P., Reuter, K. S., Braun, R. J., Nichols, J. J., & Nichols, K. K. (2013). Tear film breakup and structure studied by simultaneous video recording of fluorescence and tear film lipid layer images. *Investigative Ophthalmology and Visual Science*, *54*(7), 4900–4909.

[22] Rohit, A., Willcox, M., & Stapleton, F. (2013). Tear lipid layer and contact lens comfort: A review. *Eye and Contact Lens*,*39*(3),247–253.