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Research Article

Tobacco Smoking Impairs Tear Production among Male Students in Abia State University, Nigeria

Onu Nnenne Uwa[1]*, Onyekelu-Eze Amarachi Amanda[1], Timothy Christopher Okechukwu[1], Omaka Andrew Uma[1], Ezeigbo Amarachi C[1], Ndukuba Samuel Ononuju[1] and Obioma-Elemba Jacqueline Ezenwanyi[2]

[1]*Department of Optometry, Abia State University, Uturu, Nigeria*

[2]*Department of Optometry, Imo State University, Owerri, Nigeria*

***Corresponding Author:** Onu Nnenne Uwa, Department of Optometry, Abia State University, Uturu, Nigeria.

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Abstract

Significance: The results from this prospective study showed a significant effect of tobacco smoking on the tear quantity and quality which varied significantly when compared to non-smokers and that the tear stability of tobacco smokers varied with duration and intensity of smoking.

Purpose: This study evaluated the effect of tobacco-smoking on the tear stability of tobacco-smokers and non-smokers. **Methods:** The sample size was 64 participants (128 eyes): 34 tobacco-smokers (68 eyes) and 30 non-smokers (60 eyes) aged 18- 60 years within the environs of Abia State University Uturu, Nigeria. A questionnaire was designed to reveal the ages, type of smoke, frequency in smoking, number of sticks smoked per day, the duration of smoking in years and ocular irritations for the groups. Tear break up time tests and Schirmer's 1 test were conducted on both groups and their values recorded.

Results: The mean values for the Tear-break-up-time (TBUT) Right eye (OD) for tobacco-smokers 9.06 ± 2.17 and non-smokers 12.63 ± 2.84 ($P < 0.05$) while the mean values for the TBUT left eye (OS) for tobacco-smokers 10.03 ± 2.78 and non- smokers 13.27 ± 2.83 ($P < 0.05$). The mean Schirmer test values of non-smokers OD was 20.67 ± 6.65 while that of tobacco-smokers was 30.35 ± 7.51; for the OS of non-smokers it was 23.03 ± 6.23 while that of tobacco-smokers was 31.06 ± 7.03 ($P < 0.05$). There was a significant difference between the tear stability of tobacco-smokers and non-smokers. These varied with duration and intensity of smoking, whether frequently, moderately or rarely. The tests were done using analysis of variance (ANOVA) test, T-tests and the least square difference (LSD) test.

Conclusion: There was a significant difference in the tear film stability (quality and quantity) of tobacco smokers and non-smokers.

Keywords: *Tear-Production; Tobacco-Smoking; Tear Film; Tear Quality; Tear Quantity*

Introduction

The eyes are a very important organ to the body. One of the processes which keeps it healthy is the blinking action which bathes the tear film over the eyes [1]. The tear film is keeps the cornea and conjunctiva moist, provides oxygen to the epithelium, washes away debris and toxic substances away from the eyes, prevents infection due to antibacterial properties of the tears and facilitates the movement of the lids over the globe. [2,3]. These very important functions however may be either hindered or disrupted by certain behaviours such as constant computer use and smoking, and certain hazardous environmental exposures such as smoke, wind and dust.

Smoking which may be a factor affecting tear film disruption, is the inhalation of certain smoke which involves gaseous phases [4,5]. Of the different things smoked, tobacco, cocaine, heroin, and other forms of substances which may vary according to location is quite com-

mon [6,7]. Tobacco smoking, however, appears to be the commonest form of all the types of smoking done worldwide. This is done in different forms which could be with the use of cigars, electronically, snuffs or pipes, bidis, hookahs, bongs and shisha. [8,9]. This practice has an ancient history. Tobacco smoke can contain lots of heavy metals and toxic materials and possibly contain over 4000 compounds such as acetaldehyde, acetyl, acrolein, acrylonitrile, ammonia, benzene, butyraldehyde, cadmium, catechol, chromium, cresol, cresol, formaldehyde, hydrogen cyanide, hydroquinone, isoprene, lead, nickel, nitric oxide, phenol, toluene, coal tar, carbon monoxide, nicotine etc [10]. This practice has been associated with different health conditions such as respiratory problems and cardiovascular issues [5]. It has also been associated with ocular conditions such as cataract, age related macular degeneration, optic neuropathy, anterior ischemic optic neuropathy and dry eye syndrome, thereby making it a public health concern [11-16]. Studies existing have not separated and looked at the impact of different types of smoking on the tear film [17] while those that did worked on younger age groups [18].

Different tests are to access the tear quality and the tear quantity [19-22]. These access the healthiness of the tears. This study among university students who are tobacco smokers and non- smokers was done measuring the tear film quality and quantity of tears and comparing the results of the 2 groups.

Materials and Methods

This research was reviewed by an independent ethical review board and conforms with the principles and applicable guidelines for the protection of human subjects in biomedical research.

The study was a prospective research with 64 participants: 34 tobacco smokers and 30 non-smokers, aged 18-60 years. The participants were from the environs of Abia State University, Uturu. The research was carried out at Abia State University Optometry Clinic due to the proximity of the clinic to the people who serve as subjects.

The tear quantity and quality of all the study participants was measured using the Schirmer test strips and tear break-up tests. The tear quantity was measured using the Schirmer test strip for 5 minutes on each individual while the tear quality [23,24]. The baseline data taken was recorded and then for those who smoked for the day, they were allowed to smoke and then their tear quantity and quality tests were repeated and recorded but for the control group the data from them were used for comparison to those who smoked in different forms.

Ethical approval for the study was obtained from the University ethical board and the department of optometry committee on research. Written informed consent was obtained from all the study participants after a thorough explanation of the study to them.

Study participants were of both genders aged 18 - 60 years, who were not on any kind of medication like diuretics or antihistamine that could interfere with tear production, who did not have any ocular nor systemic pathologies that could interfere with the tear production and those who consented to being part of the study. The subjects in the control group were non-smokers, while those in the smoking group were either tobacco smokers or non-tobacco smokers.

The instruments and materials were used in the research work: questionnaires stop watch, cotton wool, fluorescein strip, Whatmann's filter paper, ophthalmoscope, normal saline and cobalt blue filter from the slit lamp. The questionnaire was used to collect data on age, gender, duration, intensity and visual complaints. A through case history was done to reveal the subjects post medication, a known pathological eye condition and also cross check data gotten from the questionnaire.

After selection and consenting, each participant filled the questionnaire, was stained with fluorescein strip the last blink and the first dry spot was recorded, the subject were allowed to rest after the tears break up time test was conducted.

After 15 minutes, the participants were tested for their tear quantity; they were asked to look up and the Whatmann's filter paper was inserted in the inferior conjunctival cul- de-sac the eyes were closed for five (5) minutes and the Whatmann's filter paper was removed and the amount of moisture was measured and recorded.

The data from this study was analyzed using Anova tests, T- tests and least square difference test on the SPSS 27 software.

Results

Tear quantity (Schirmer's) tests results

The mean values for the distribution of Schirmer's test values OD were: for non-smokers (N = 30) 20.67 ± 6.651 and for tobacco smokers (N = 34) 30.35 ± 7.511) whereas the mean values for the distribution of the Schirmer's test values OS were: for non-smokers (N = 30) 23.03 ± 6.228 and for tobacco smokers (N = 34) 31.06 ± 7.303.

Comparing the values for non-smokers and tobacco smokers, OD (P = .000) and OS (P = .000), there was significant difference between the Schirmer's values of non-smokers and tobacco smokers in both their OD and OS (Figure 1).

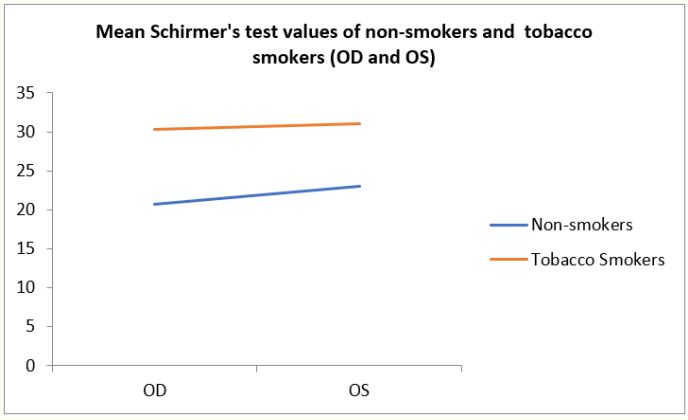

Figure 1: *Mean distribution of the Schirmer's test values of non-smokers and tobacco smokers (OD and OS).*

Tear quality (TBUT) results

The mean values for the distribution of TBUT test values OD were: for non-smokers (N = 30) 12.63 ± 2.883 and for tobacco smokers (N = 34) 9.06 ± 2.173 whereas the mean values for the distribution of the TBUT test values OS were: for non-smokers (N = 30) 13.27 ± 2.828 and for tobacco smokers (N = 34) 10.03 ± 2.276.

Comparing the values for non-smokers and tobacco smokers, OD (P = .000) and OS (P = .000), there was a significant difference between the tear quality (TBUT) values of non-smokers and tobacco smokers in both their OD and OS (Figure 2).

Tobacco smokers

The distribution of Schirmer's test values amongst tobacco smokers to their frequency in smoking (OD and OS) were OD: rarely (N = 5 33.40 ± 3.578), moderately (N = 15 32.73 ± 4.383) and frequently (N = 14 26.71 ± 9.707) while for OS: rarely (N = 5 34.00 ± 2.236), moderately (N = 15 33.53 ± 3.335) and frequently (N = 14 27.36 ± 9.834) (Figure 3).

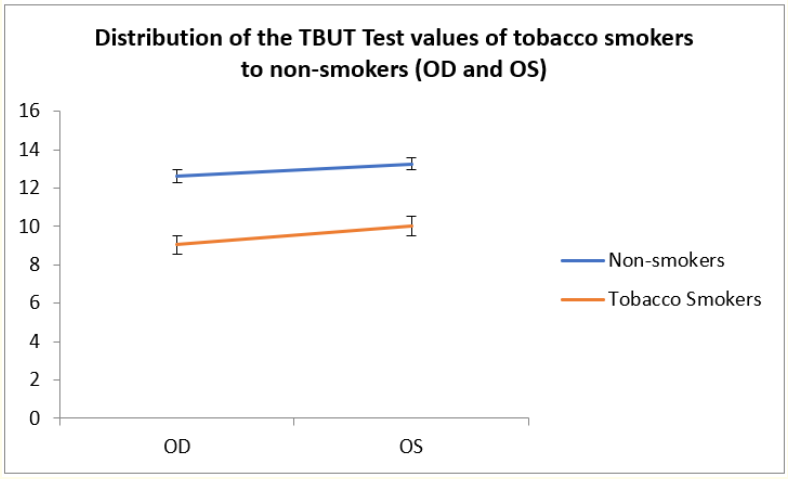

Figure 2: *The distribution of the TBUT values of Tobacco smokers to non-smokers (OD and OS).*

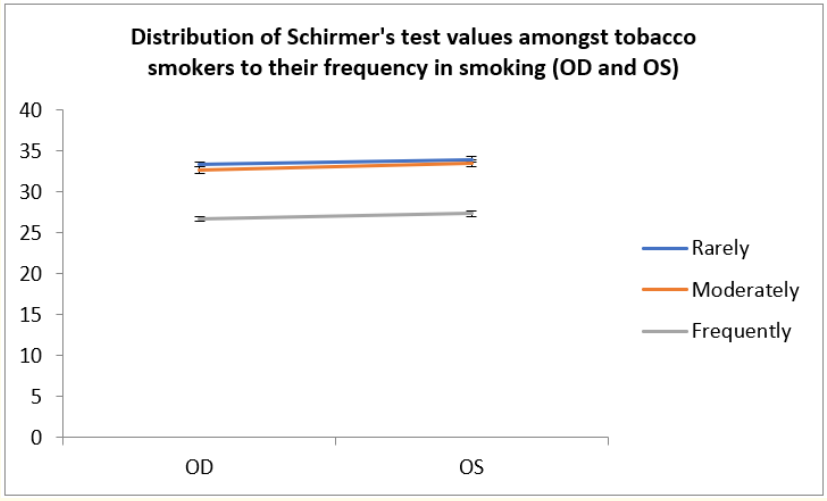

Figure 3: *The distribution of Schirmer's test values amongst tobacco smokers to their frequency in smoking (OD and OS).*

Comparing the Schirmer's test values amongst tobacco smokers to their frequency in smoking, OD (P = .056) there was no significant difference between the Schirmer's values of tobacco smokers and their frequency in smoking and OS (P = .041), there was a significant difference between the Schirmer's values of tobacco smokers and their frequency in smoking.

The LSD post analysis table below showed the differences (Table 1).

Dependent Variable	(I) Frequency	(J) Frequency	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
OD_TOB_SCHIRMER'S	Rarely	Moderately	.667	3.646	.856	-6.77	8.10
		Frequently	6.686	3.678	.079	-.82	14.19
	Moderately	Rarely	-.667	3.646	.856	-8.10	6.77
		Frequently	6.019*	2.623	.029	.67	11.37
	Frequently	Rarely	-6.686	3.678	.079	-14.19	.82
		Moderately	-6.019*	2.623	.029	-11.37	-.67
OS_TOB_SCHIRMER'S	Rarely	Moderately	.467	3.511	.895	-6.69	7.63
		Frequently	6.643	3.542	.070	-.58	13.87
	Moderately	Rarely	-.467	3.511	.895	-7.63	6.69
		Frequently	6.176*	2.527	.020	1.02	11.33
	Frequently	Rarely	-6.643	3.542	.070	-13.87	.58
		Moderately	-6.176*	2.527	.020	-11.33	-1.02
*. The mean difference is significant at the 0.05 level.							

Table 1: *Comparing the Schirmer's test values amongst tobacco smokers to their frequency in smoking (OD AND OS) using the LSD test.*

The result showed that the major difference laid between moderately and frequently in the right eye and moderately and frequently in the left eye. This showed that the effect occurred mainly between people that smoked moderately to frequently and there was no much effect on people that smoked rarely when compared with people that smoked moderately (Table 1).

The distribution of Schirmer's test values of tobacco smokers to the number of sticks taken per day was for OD: 1 - 5 (N = 19 30.63± 7.198), 6 - 10 (N = 15 30.00 ± 7.221) while for OS: 1 - 5 (N = 19 31.79± 7.223), 6 - 10 (N = 15 30.13 ± 7.549).

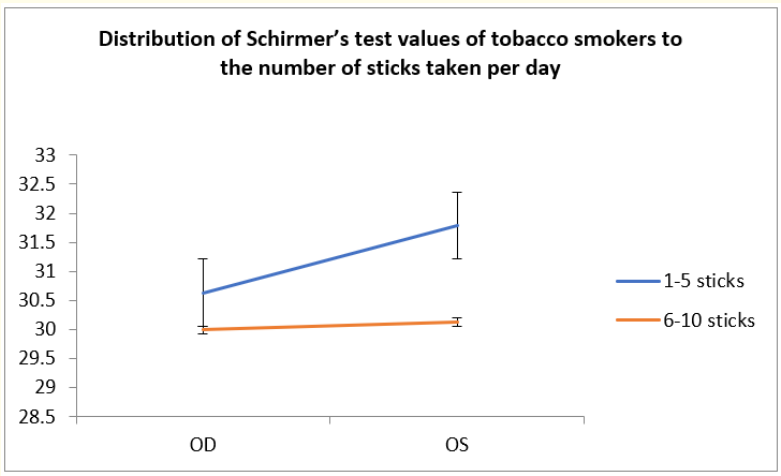

Figure 4: *The distribution of Schirmer's test values of tobacco smokers to the number of sticks taken per day.*

Comparing the Schirmer's test values of tobacco smokers to the number of sticks taken per day, OD (P = .812) OS (P = .520), there was no significant difference between the Schirmer's values of tobacco smokers and the number of sticks smoked per day on both eyes.

The Distribution of the Schirmer's test values of tobacco smokers against the duration of smoking in years were OD: 0-1 (N = 4, 33.00 ± 4.00), 1-5 ((N = 20, 31.75 ± 5.35) and >5 (N = 10, 26.50 ± 10.824) while for OS: 0-1 (N = 4, 33.75 ± 2.50), 1-5 (N = 20, 31.70 ± 6.594) and >5 (N = 10, 28.70 ± 9.557) (Figure 5).

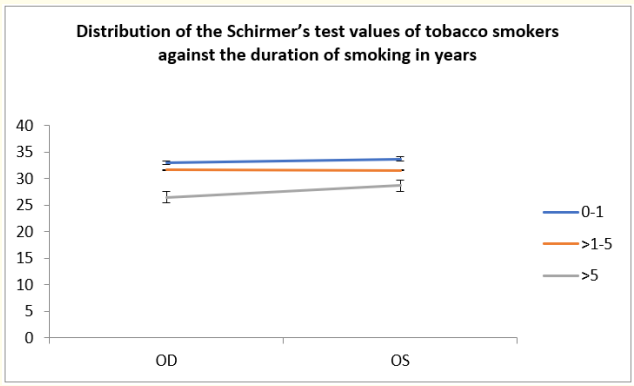

Figure 5: *Distribution of the Schirmer's test values of tobacco smokers against the duration of smoking in years.*

Comparing the Schirmer's test values of tobacco smokers against their duration of smoking in years, OD (P = .149) while OS (P = .432) there was no significant difference between the Schirmer's values of tobacco smokers and their duration of smoking in years in both OD and OS.

TBUT results for tobacco smokers

Distribution of TBUT amongst tobacco smokers to their frequency in smoking (OD and OS) was for OD: Rarely (N = 5, 10.40 ± 1.140), Moderately (N = 15, 9.47 ± 2.503) and Frequently (N = 14, 8.14 ± 1.748), while OS: Rarely (N = 5, 12.20 ± 2.775), Moderately (N = 15, 10.07 ± 2.374) and Frequently (N = 14, 9.21 ± 1.477) (Figure 6).

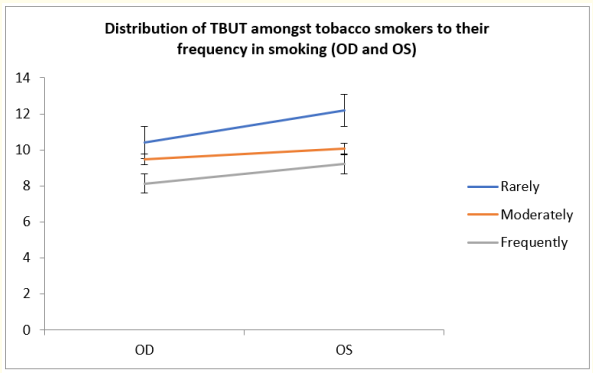

Figure 6: *Distribution of TBUT amongst tobacco smokers to their frequency in smoking (OD and OS).*

Comparing the TBUT amongst tobacco smokers to their frequency in smoking (OD and OS), OD (P = .082) while OS (P = .036). There was no significant difference between the TBUT values of tobacco smokers and their frequency in smoking in the right eye while for the left eye, there was a significant difference between the TBUT values of tobacco smokers and their frequency in smoking.

From the post analysis table above the result showed that the major difference laid between rarely and frequently in the right eye and rarely and frequently in the left eye. This showed that the effect occurred mainly in people that smoked frequently and there was no much effect on people that smoked moderately when compared with people that smoked rarely (Table 2).

Dependent Variable	(I) Frequency	(J) Frequency	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
OD_TBUT	Rarely	Moderately	.933	1.068	.389	-1.25	3.11
		Frequently	2.257*	1.078	.044	.06	4.46
	Moderately	Rarely	-.933	1.068	.389	-3.11	1.25
		Frequently	1.324	.769	.095	-.24	2.89
	Frequently	Rarely	-2.257*	1.078	.044	-4.46	-.06
		Moderately	-1.324	.769	.095	-2.89	.24
OS_TBUT	Rarely	Moderately	2.133	1.090	.059	-.09	4.36
		Frequently	2.986*	1.100	.011	.74	5.23
	Moderately	Rarely	-2.133	1.090	.059	-4.36	.09
		Frequently	.852	.784	.286	-.75	2.45
	Frequently	Rarely	-2.986*	1.100	.011	-5.23	-.74
		Moderately	-.852	.784	.286	-2.45	.75
*. The mean difference is significant at the 0.05 level.							

Table 2: *Comparing the TBUT amongst tobacco smokers to their frequency in smoking (OD and OS) using the LSD test.*

Distribution of the tear quality of tobacco smokers against the number of sticks taken per day was for OS: 1 - 5 (N = 19 10.37± 2.191), 6 - 10 (N = 15 9.60± 2.384) while for OD: 1 - 5 (N = 19 9.21± 1.718), 6 - 10 (N = 15 8.87± 2.696).

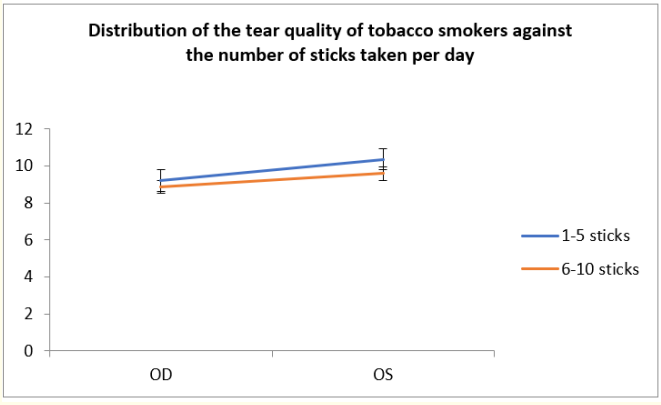

Figure 7: *Distribution of the tear quality of tobacco smokers against the number of sticks taken per day.*

Comparing the tear quality of tobacco smokers against the number of sticks taken per day OD (P = .654) while OS (P = .336). There was no significant difference between the TBUT values of tobacco smokers and the number of sticks smoked per day both in OD and OS.

Distribution of the TBUT test values of tobacco smokers against the duration of smoking in years were: OD: 0 - 1 year (10.25 ± 0.957), > 1 - 5 years (9.05 ± 2.417) and > 5 years (8.60 ± 1.955) while for OS: 0 - 1 year (11.50 ± 1.291), > 1 - 5 years (10.15 ± 2.739) and > 5 years (9.20 ± 0.919) (Figure 8).

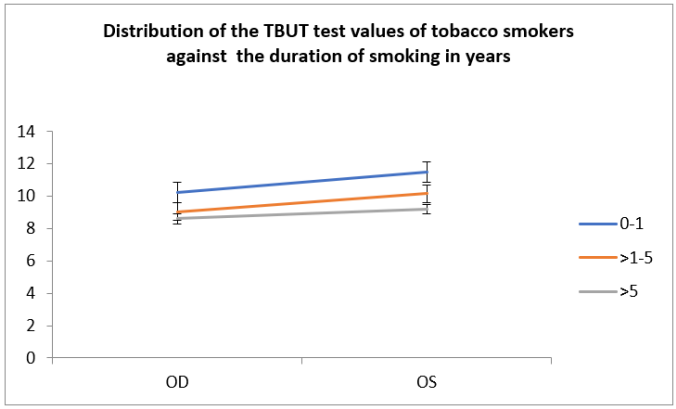

Figure 8: *Distribution of the Tbut test values of tobacco smokers against the duration of smoking in years.*

Comparing the TBUT test values of tobacco smokers against the duration of smoking in years, OD (P = .452) while OS (P = .222). There was no significant difference between the TBUT values of tobacco smokers and their duration of smoking in years in both OD and OS.

Discussion

Visual complaints by some of the patients were occasional itching, tearing, fuming, redness and foreign body sensation due to smoking. The tear quality and quantity of regular healthy tobacco smokers, non-tobacco smokers and non-smokers were assessed. The subjects in the smokers groups were grouped according to their age brackets, frequency in smoking, the number of sticks smoked per day and the duration for which they had been smoking in years. Schirmer's 1 test and tear break up time tests were conducted and their values were duly recorded.

There was a significant difference in the Schirmer's test values between tobacco smokers (OD = 30.35mm, OS = 31.06 mm, P (OD and OS) = 0.000 ($p < 0.05$) and non-smokers (OD = 20.67 mm, OS = 23.03 mm) (Figure 1). Tobacco Smokers produced more tears compared to non-smokers. This is similar to the study by Aktas., *et al.* (2017) who found that smokers had higher tear osmolality [25] whereas Thomas *et al,* found no significant difference between smokers and non-smokers [17]. However, this study did not separate the smokers into different categories of either tobacco or non-tobacco smokers [17].

There was a significant difference in the TBUT of tobacco smokers (OD = 9.06secs, OS = 10.03secs, P (OD and OS) = 0.000 ($p < .05$) and non-smokers (OD = 12.63 secs, OS = 13.27 secs) (Figure 2). The TBUT of tobacco smokers was lower compared to non-smokers. Aktas., *et al.* (2017), Yoon., *et al.* (2005), Thomas., *et al.* (2012), Md Isa *et al.,* and Mohidin and Jafar (2020) all found similar results in their studies [9,17,18,25,26].

Figure 3 compared the Schirmer's test values tobacco smokers against their frequency in smoking, the frequency was graded based on rarely, moderately or frequently. The Anova test statistics indicated the p values as .56 (p>.05) on OD and p = .41 (p < .05) on OS this indicated that there was slightly no significance difference on the OD and a significant difference in the OS of smokers. The LSD test was also conducted to determine where exactly the difference on the OD and OS was. The result showed that the major difference was between moderately and frequently in the right eye and moderately and frequently in the left eye (Table 1). This showed that the effect occurred mainly in people that smoked moderately to frequently and there was no much effect on people that smoked rarely. Matsumoto et al (2008) found that chronic smokers had changes in their "ocular surface health" [27].

The tear stability of tobacco smokers varied with the intensity and duration of smoking. Figure 4 showed there was no significant difference in the tear quantity of tobacco smokers compared to the number of sticks smoked per day (p value as .812 (p>.05) in OD and .520 (p>.05) in OS). Similar result has been found in other studies too [27,28]. These effects of smoking are in other ocular parameters too [28].

Analysis of the duration of smoking compared to the tear quantity showed there was no significant difference in both eyes (p:.149 (p>.05) in OD and .432 (p>.05) in OS (Figure 5). This result contrasts with other studies which show a direct relationship with smoking and the effect on the tear quantity [9,17,25-28].

The tear quality was also assessed and compared against the frequency, duration of smoking in years and the number of sticks smoked per day to note if the tear stability varies with the intensity and duration of smoking (Figure 6-8).

There was no significant difference in the tear quality of tobacco smokers based on their frequency of smoking on OD .082 (p>.05) but there was a significant difference in the tear quality of tobacco smokers based on their frequency of smoking on OS .036 (p<.05) (Figure 6). Other studies show that the 2 eyes are affected [12,15,26] whereas the results from this study showed difference in only one eye.

The LSD test showed that the major difference was between rarely and frequently in the right eye and rarely and frequently in the left eye. This showed that the effect occurred mainly in people that smoked frequently and there was no much effect on people that smoked moderately when compared with people that smoke rarely (Table 2). This is similar to results of studies on chronic smokers [27,28].

Analysis of the tear quality of tobacco smokers with respect to the number of sticks smoked per day, showed that there was no significant difference in the tear quality of tobacco smokers and the number of sticks smoked per day (p values:.336 (p>.05) on OD and .654 (p>.05) on OS) (Figure 7). Some studies had similar results [17] whereas others had contrasting results [29].

Analysis of the tear quality compared to their duration in smoking, showed there was no significant difference in the tear quality compared to the number of years smoked (p values were .452 (p > .05) in OD and .222 (p>.05) in OS) (Figure 8). The results are similar to some others [17] while the results contrasted some other studies [29].

Conclusion

The results from the study showed that there was significant effect of tobacco smoking on the tear quantity and quality which varied significantly when compared to non-smokers and that the tear stability of tobacco smokers varied with duration and intensity of smoking.

Limitations of the study was difficulty in finding smokers who only smoked tobacco, difficulty in convincing some of the participants to come to the optometry clinic for testing, apprehensiveness of having the Schirmer's Strip test inserted in their eyes and the control group contained non-smokers who often times came in contact with smoke from smokers, hence they were passive smokers.

Recommendations:

1. Practitioners should have a knowledge on the impact of tobacco smoking on the tear stability of smokers and advice their patients properly on the harmful effects of their addictive lifestyle.

2. Further care should be taken in protecting the eyes from other types of smoke/smoking as it also could affect the tear film stability.

Disclosures and Conflict of Interest

None to declare, and no funding was received for this work.

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