

## Research Article

# Seasonal Variation in Tear Secretion and Tear-Film Stability among Adults in Enugu, Nigeria: A Longitudinal Study

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### Abstract

**Aim:** To investigate the variation in tear-film secretion and function between rainy and dry seasons among healthy adults in Enugu, Nigeria.

**Methods:** This was a population-based, longitudinal study involving a cohort of 31 healthy adult Nigerians residing in Enugu in 2018. The objective tests for tear secretion (Schirmer's test) and function (tear-film break-up time, TBUT) were conducted on the 62 eyes of the participants in January and July, the peaks of dry (D) and rainy (R) seasons, after obtaining their socio-demographic information. Their palpebral fissure height (PFH) and length, (PFL) were also obtained. Data was analysed using SPSS version 21. The level of significance was at  $p < 0.05$ .

**Results:** The participants comprised of more females, 20 (64.5%) than males, with a mean age of  $33.7 \pm 9.6$  SD years. They were mainly civil servants with tertiary education. The mean TBUT -R was  $30.0 \pm 18.3$  seconds and D,  $15.6 \pm 9.5$ . The mean Schirmer's test-R was  $25.2 \pm 10.1$  mm and D,  $22.1 \pm 11.2$  mm. There was significant difference between these means in rainy and dry seasons. ( $p = 0.000$  TBUT,  $p = 0.04$  Schirmer's test). When TBUT and Schirmer's test in both seasons were correlated with PFH and PFL, only TBUT -R and PFH showed a significantly positive correlation ( $r = 0.54$ ,  $p = 0.002$ ).

**Conclusion:** A significant seasonal variation in tear-film secretion and function exists among adults in Enugu. The higher the PFH, the less the break-up of the tear-film during rainy season. These findings have great implications in the management of dry eyes. The use of therapeutic lubricant gels to prolong the TBUT time in dry seasons may therefore be preferred.

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**Keywords:** Dry eyes; Enugu; Nigeria; Schirmer's test; Seasonal variation; TBUT

### Introduction

It has been documented that the secretion and function of the pre-corneal tear-film is associated with both intrinsic and extrinsic factors, ranging from advancing age [1-4], female gender [1-3], weather and environmental factors such as humidity, temperature and wind [4-6], use of some medications as anti-depressant and anti-histamine [7], and activities that promote infrequent blinking such as working on a computer [8], among others.

These factors are quite challenging in the diagnosis and management of Dry Eye Disease, (DED), a clinical condition resulting from deranged tear-film. DED is of public health importance, a chronic disease of the ocular surface with bothersome symptoms, necessitating frequent hospital visits and use of eye lubricants, which greatly impacts on patients' quality of life [9-11].

Understanding the influence of these extrinsic factors on the secretion and function of the pre-corneal tear-film would be of great help to the clinician to proffer differing management protocols, especially by modifying them to suit the individual patient with DED or other ocular surface disease.

Fewer studies have investigated the seasonal influence on the tear-film and invariably on DED [5,6]. In the US, symptoms of DED were exacerbated in the dry, cold, and windy environment of winter among patients from the Greater Boston Area [6], and in Miami [5], during winter and spring.

In Enugu, DED is of public health importance, with a prevalence of 19.2% [3]. To the best knowledge of the researchers, no similar study has been done. This study therefore sought to investigate the seasonal influence on the tear-film secretion and function and its possible association with the anthropometric characteristics of healthy subjects. The findings would assist the clinicians to make informed decision on the management of ocular surface diseases in the study area and elsewhere with similar settings.

### Methods

#### Background

Enugu is the capital of Enugu State, one of the 36 states of the Federal Republic of Nigeria. It is one of the 5 states that make up the south-east geo-political zone. It is sub-divided into 17 Local Government Areas (LGAs), of these, Enugu-North, Enugu-East, and Enugu-South LGAs form Enugu urban.

Enugu is located in the tropical rainforest climatic region, with two seasons of the year, rainy (May to October) and dry (November to April) seasons. The population is predominantly Ibos, with civil service, farming and trading as their major occupations.

## Eligibility

Healthy adult Nigerians without ocular symptoms, who had resided in Enugu continuously for, more than one year and voluntarily gave an informed consent to participation.

## Ethics

Prior to the start of the study, ethics clearance compliant with 1964 Helsinki Declaration, was obtained from University of Nigeria Teaching Hospital's Medical and Health Research Ethics Committee (Institutional Review Board).

## Study period

The study was conducted in 2018, January for the dry season and July for rainy season.

## Study design

This was a population-based, longitudinal survey involving a cohort of 31 healthy Nigerian adults residing in Enugu.

## Study procedure

Information on their socio-demographic characteristics as well as their Palpebral Fissure Height (PFH), and Palpebral Fissure Length (PFL) were obtained. Assessment of tear secretion was done using the Schirmer's test and the Tear film Break-Up Time (TBUT) was used to assess tear function. These tests were administered on all participants under the same room temperature conditions, 25-27°C, between 8.00 am (08 hours GMT) and 11.00 am (11 hours GMT). Firstly, TBUT was performed on both eyes. In order to minimize reflex tearing and ocular surface changes secondary to TBUT testing, a 10-minutes interval was observed, and then the Schirmer's test was administered on both eyes.

To obtain the TBUT, a pre-cut fluorescein strip impregnated with 2% sodium fluorescein (Ophthalmic Technology Pvt. Ltd., India), wetted with a drop of sterile water was inserted into the inferior conjunctival fornix and removed after 1 minute. The participant was then instructed to blink and hold the eyes open. The broad beam of cobalt blue light of the slit-lamp biomicroscope was used to examine the tear-film for areas of dryness, which appears as dark spots on the cornea. A stop watch was activated when the participant stopped blinking, and deactivated when the first random dark spot appeared around the central cornea. The time interval between the last blink and the appearance of the first dark spot was noted as the TBUT. This was done three times on each eye and the average reading was documented.

To obtain the Schirmer's test result, a 5 mm by 35 mm No. 41 Whatman's filter paper (Ophthalmic Technology Pvt. Ltd., India) was used. The filter paper was folded 5 mm from the zero end and inserted into the inferior conjunctival fornix midway between the outer and the middle third of the lower lid, without prior instillation of topical anesthetic drops. The participant was then instructed to blink and close the eyes. The paper was removed after 5 minutes, and the amount of wetting from the folded end was measured.

Using a transparent plastic millimetre rule (China Arts Hangzhou Import and Export Inc., Hangzhou, China), with the participant and the observer seated in a well-lit room, and their eyes at the same horizontal level, the PFH was measured as the distance between the upper

and lower lid margins at the pupillary midline, the PFL as the distance between the medial and lateral canthi.

## Data management

Data were cleaned, edited, coded and analysed using the Statistical Package for Social Sciences (SPSS) software for windows, version 21.0 (SPSS Inc, Chicago, Illinois, USA). Data were subsequently categorised by socio-demographic variables and subjected to descriptive statistical evaluation to yield frequencies, percentages, and proportions. Student T-test was used to compare the mean values of TBUT and Schirmer's during the two seasons. Pearson correlation was used to ascertain the relationship between TBUT and Schirmer's test in both seasons and PFH, and PFL. The level of significance was at p-value of < 0.05.

## Results

The participants comprised of more females, 20 (64.5%) than males, 11 (35.5%) with a mean age of  $33.7 \pm 9.6$  SD years and a range of 20 to 50. They were mainly civil servants with tertiary education. The socio-demographic characteristics of participants are as shown in table 1.

Variables	N (%)
<b>Age</b>	
20 - 30	11 (35.5)
31 - 40	11 (35.5)
41 - 50	9 (29.0)
<b>Gender</b>	
Male	11 (35.5)
Female	20 (64.5)
<b>Educational status</b>	
Primary	4 (12.9)
Secondary	8 (25.8)
Tertiary	19 (61.3)
<b>Marital status</b>	
Single	14 (45.2)
Married	17 (54.8)
<b>Occupational status</b>	
Unemployed	1 (3.2)
Civil services	21 (67.8)
Others	9 (29.0)
<b>Near-work related occupation</b>	
Yes	22 (71.0)
No	9 (29.0)

Table 1: Socio-demographic characteristics of the participants; N = 31.

The mean PFH was  $34.5 \pm 2.8$  SD mm (range 29 to 40 mm) and PFL,  $10.8 \pm 1.2$  SD mm (range 9 to 14 mm). The mean TBUT during rainy season was  $30.0 \pm 18.3$  seconds (8.0 to 80.0), and in dry season,  $15.6 \pm 9.5$ s (3.0 to 35.0). The mean Schirmer's test result in rainy season was  $25.2 \pm 10.1$  mm (5.0 to 35.0) and in dry season,  $22.1 \pm 11.2$  mm (4.0 to 35).

There was a statistically significant difference between these means in rainy and dry seasons. ( $p=0.000$  TBUT,  $P=0.04$  Schirmer's test) (Table 2).

Variables	Mean	MD	95% CI	SEM	T	p
<b>TBUT (seconds)</b>		14.5 ± 18.0	7.6 - 21.3	3.3	4.3	0.000*
Rainy	30.0 ± 18.3					
Dry	15.6 ± 9.5					
<b>Schirmer's (mm)</b>		3.1 ± 8.2	0.02 - 6.2	1.5	2.06	0.04*
Rainy	25.2 ± 10.0					
Dry	22.0 ± 11.2					

**Table 2:** Seasonal variations of TBUT and Schirmer's test; N = 62 eyes.

\*significant, MD = Mean Difference, CI = Confidence Interval, SEM = Standard Error Mean.

When TBUT and Schirmer's test in both seasons were correlated with PFH, and PFL, only TBUT in rainy season and PFH showed a significantly positive correlation ( $r = 0.54$ ,  $p = 0.002$ ), as shown in table 3; which implies that the higher the values for the PFH, the higher the time for the tear-film break-up, the less likely the occurrence of DED during the rainy season.

Variables	PFH	p-value
TBUT - R	0.54	0.00*
TBUT - D	0.06	0.73
Schirmer's test - R	0.22	0.23
Schirmer's test - D	0.18	0.34

**Table 3:** Pearson correlation between PFH, TBUT and Schirmer's test.

## Discussion

The participants comprised of more females, 20 (64.5%) than males, 11 (35.5%) with a mean age of  $33.7 \pm 9.6$  SD years. They were mainly civil servants with tertiary education. The two closely related US studies [5,6] did not report on the socio-demography of the participants. Further discussion on this is therefore precluded. Future studies should report on the socio-demographic profile of participants for comparison among studies.

In this study, a significant seasonal variation was observed in tear-film secretion and function (evaporation), as evidenced by the lower mean values of Schirmer's test and TBUT respectively during the dry season. Similar observations were made in the US studies [5,6] where symptoms of DED were exacerbated in the dry, cold, and windy environment of winter among patients from the Greater Boston Area [6], and in Miami [5], during winter and spring. Even though, the present study was on healthy participants, the obvious seasonal influence on the tear-film as well as the US findings suggests that possible environmental manipulation would positively impact on the management of DED. The use of therapeutic lubricant gels to prolong the TBUT time in dry seasons may therefore be preferred.

In this study, when TBUT and Schirmer's test in both seasons were correlated with PFH, and PFL, only TBUT in rainy season and PFH showed a significantly positive correlation. A Swedish study [12] that investigated the effect of vertical gaze position on ocular tear film stability on healthy volunteers observed that the higher the PFH the less stable the tear-film, but it did not indicate any seasonal influence. On the contrary, the present study found that the higher the PFH, the more stable the tear-film during rainy season. The slow rate of evaporation

of tear-film during rainy season in the study area may explain this observation. Clinicians should therefore be guided on the management protocols of ocular surface disease for the different seasons.

Further studies should be designed to explore more on the relationship between the tear-film and these palpebral characteristics to allow for more elaborate comparisons.

## Conclusion

A significant seasonal variation in tear-film secretion and function exists among adults in Enugu. The higher the PFH, the less the break-up of the tear-film during rainy season. These findings have great implications in the management of dry eyes in the study environment. The use of therapeutic lubricant gels to prolong the TBUT time in dry seasons is therefore preferred.

## Competing Interest

The authors declare no real or potential competing interests in this work.

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