# Comparing the effectiveness of Schirmer's test I and Non-invasive tear break-up time (NITBUT) for the assessment of dry eye among University students: A case-control study

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## ABSTRACT

**Aim:** To compare the effectiveness of Schirmer's test I and non-invasive tear break-up time (NITBUT) for the assessment of dry eye among University of Buraimi students.

**Methods:** This prospective cross-sectional comparative study included 60 students from the University of Buraimi aged between 21-25 years and from three majors. Participants were selected using purposive sampling method. MacMonnies dry eye questionnaire was used to categorize the members as case group and control group. NITBUT followed by Schirmer's test-I was conducted for each participant's only one eye, which was randomly selected. Descriptive statistics was used to evaluate the results and means are used to compare the two tests.

**Results:** The mean of McMonnies Screening of the overall scores for all participants were 6.45 with an (SD) of 0.4472. The mean of Schirmer's test I is 25.4667 and (SD = 7.3904), while the Noninvasive TBUT was 5.0666 and (SD = 1.6020).

**Conclusions:** The study demonstrated a better sensitivity of the NITBUT test compared to Schirmer's test I. However, for borderline case group, there is an inverse correlation between questioners score and NITBUT values as the questioner's show borderline while measurements show the opposite.

*Keywords: NITBUT, Schirmer's test I, screening tool, effectiveness, McMonnies dry eye questionnaire*

## INTRODUCTION

### Background

Dry eye is one of the common causes which hampers the vision-related quality of life. It associates with symptoms of discomfort, visual disturbance, and tear film instability with acute damage to the ocular surface1. Accurate and timely diagnosis would be the management key.

The outer portion of the eye involves some structures, each of which has its particular function. 'The ocular surface, tear film, lacrimal glands, and eyelids.' Act as a functional unit to maintain the quality of the refractive surface of the eye; to provide protection for the eye against the environmental conditions. Dry eye is a condition of tear film abnormality. There are three layers of the tear film: an outer lipid layer, a thin aqueous layer in the middle and mucous layer. [9]

As it's a famous ophthalmological case, 73% of the patients and more show an expansion of this condition[2]. The population of > 40 years old have a significant percentage of Dry eye syndrome. Although it can affect any race, it is more prevalent in women. A daily life of computers users considers being one of the risk factor [1].

Various invasive and noninvasive methods are utilized in the assessment of the dry eye. Several techniques are used to evaluate tear film's quantity and quality. And it is a sufficient cognitive comprehension would be very helpful for clinical diagnosis[2].

Schirmer test I, tear break-up time (TBUT) are the most popular objective tests used for diagnosis of a dry eye condition. However, neither symptoms or signs always match with the results of these tests .[8]

'The McMonnies dry eye questionnaire is considered to be the 'gold standard' for the diagnosis of dry eye symptoms. This is the reason behind selecting this questionnaire for this study as it is considered to be earliest and most widely used screening for dry eye with a sensitivity ranging between 87% and 98% and a specificity of between 87% and 97%.'[9]

A dry eye questionnaire considers as a screening instrument with clinic procedure as it correlates with the sensitivity and specificity. This investigation helps to concerned with how the dry eye questionnaire responses should be considered to classify participants into dry eye, marginal dry eye, and non-dry eye groups.[11] The limitations of 'studies include different age distributions of the population, definitions of dry eye, and methodologies. Studies on the tests of tear function, including Schirmer's test I', tear breakup time test (TBUT) and the nature and circumstances of the environment or the clinic which require more proper preparations.

However, the gap between patient symptoms and the clinical observations exists. Hence, to identify the best assessment method. The proposed study compares the findings of the Schirmer's I and noninvasive TBUT and its associated patient symptoms.



## Literature Review

A study was done by Tung C et al. 1 to find out the relationships between tear meniscus dimensions and parameters of ocular surface disease in a various tear dysfunction conditions. Shows that Tear meniscus highly correlated with TBUT for all participants. They conclude that in tear dysfunction conditions lower tear volume has a strong relation with the 'corneal epithelial disease in ATD and Sjögren syndrome, conditions with lacrimal gland dysfunction. In contrast, higher tear volume' is correlated with corneal epithelial disease in MGD. Moreover, a study shows only 57% complain of having symptoms consistent with a diagnosis of DED. Where the TBUT(0.12), Schirmer test (0.09), corneal and conjunctival staining were the same. It was done by Benjamin D. Sullivan et al. 2 to estimate the relevance 'between 'signs and symptoms of dry eye disease (DED) in a clinic- based' population' concluding 'that no consistent correlation was found between the signs and symptoms of DED. Each type of measurement provides various information about the condition of the ocular surface. These results also proved that symptoms alone are insufficient for the diagnosis and management of DED and argue for an assent of clinical signs that better reflect all aspects of the disease. Furthermore, a study finds out that (75.6%) patients had abnormal result and(24.4%) had average TBUT. While (9.3 %) eyes with pterygium had Schirmer's test positive and (90.7 %) eyes had it negative. So they conclude that tear film breakup time test has better and accurate diagnostic value compared to Schirmer's test in determining tear film abnormality in patients with pterygium 3. These findings may support the ability to detect patients at risk for the corneal epithelial disease. In contrast, a study was done by Cihan Ünlü et al. 4 to compare the diagnostic values of the Schirmer's and tear film breakup time (TBUT) tests, and the Ocular Surface Disease Index (OSDI) in dry-eye syndrome approved that There was a significant opposite correlation between the OSDI and TBUT scores. On the other hand, they found that there is no significant relationship existed between the OSDI and Schirmer's test scores and the primary outcomes clarify 'that dry eye is a common issue among computer users. The OSDI questionnaire used together with the TBUT is easily performed and support the diagnosis of dry-eye syndrome'. However, Fermon S et al. 5 conducted a study about standardizing the Schirmer test I and tear break-up time involving a group of healthy people from a Mexican Ophthalmological Hospital they conclude that in Mexican people, the median of the Schirmer test and break-up time test is shorter than other reports. Among the study, there were no statistical significance in the difference between the genders results. The primary outcomes aim to set a new "normal standard" of the test to classify dry eye syndromes. 'Moreover, a study was done by Monica Alves et al. 6 states that the best collection of

diagnostic tests for DED was OSDI, TBUT and Schirmer test (sensitivity 100%, specificity 95% and accuracy 99.3%).And the outcomes shows that DED diagnostic test results present a wide range of variability among several conditions'. Vital staining's and TBUT correlated best with one another whereas the best test combination to identify DED was: OSDI/TBUT/ Schirmer. As the study aim 'was a 'compares signs, symptoms and predictive tools used to diagnose dry eye disease (DED) and ocular surface disorders in a different systemic well-defined and non-overlapping diseases.' A study done by B E Kurtul et al. 7 find out that TBUT scores and Schirmer-1 results of the study group were significantly lower than the control group. As the aim of the survey is To identify the effect of vitamin D deficiency on tear break-up time (TBUT) and Schirmer test scores and to estimate their relationship in non-Sjögren dry-eye patients. A study showed the prevalence of dry eye disease assessed by the tear osmolarity test was 27.7% and the primary outcomes were, the available standard diagnostic tests underestimate the presence of dry eye disease in people with type 2 diabetes. Moreover, they could not recognized tear hyperosmolarity from normal. Tear osmolarity could be considered as the best test for estimating of dry eye disease in people with type2 diabetes. As the following tests were also performed: Ocular Surface Disease Index (OSDI) questionnaire, Tear Film Breakup Time (TFBUT), Schirmer I test, Rose Bengal and Fluorescein staining. The outcomes of these tests were compared to the tear osmolarity measurement8. Another study was done by Naimah Ebrahim Khan 9 shows a strong positive relation respectively was found between the both eyes. As the aim is to establish normal values for Schirmer tear test and tear break-up time (TBUT) in a South African young adult Black population. The outcomes were. The mean values found in this study for the Schirmer test are the same to those that have been reported in the literature. However, values for TBUT differ from the values that have been previously reported, being higher in some instances and lower in others. These findings for dry eye diagnosis and also contact lens practice in South Africa. One more study was about effect of Duration of Diabetes on Schirmer's Test and Tear Film Break up Time 10. It stated that there is strong negative relation between duration of diabetes and TBUT value. There is a moderate negative relationship between length and Schirmer's value which is estimated to be statistically significant (p<0.001). Diabetes adversely affects the tear film

parameters. As the duration of diabetes increases, there is fall in both Schirmer's value and TBUT value.

## Rationale for the Study
Dry eye is one of the common causes which hampers the vision-related quality of life. Various invasive and noninvasive methods are used in the assessment of the dry eye. However, the gap between patient symptoms and the clinical observations exists. Hence to identify the best evaluation methods among the routine tests, the proposed study compares the findings of the Schirmer's I and noninvasive TBUT and its associated patient symptoms.

## Aim of Study
To compare the effectiveness of Schirmer's test I and noninvasive (NITBUT) for the assessment of dry eye among University of Buraimi students.

## MATERIALS AND METHODS
The examinations were conducted at the University of Buraimi's Optometry contact lens lab. The room temperature and level of illumination and instrument positioning are strictly kept under control to limit the confounding variables.

The McMonnies dry eye questionnaire with Scoring scheme that was disrupted among the participants with some modifying in questions according to the culture. Participants were randomly selected, with each person being informed by the procedures and signing written consent to participate. Questionnaires have been a standard tool in the dry eye diagnosis of dry eye; it is considered to be as screening tools. Surveys based on symptoms have been used to screen populations. Dry eye symptom questionnaires were a useful way to classify participants into groups.

The room temperature was 23 degrees, and there was four lights lamp with an intensity of 220 Volt and 26 Watts. The clinic is located on the third floor and supplied by all the instruments that were required for the research. After answering the questionnaire that classified them into case and control groups based on their score. A score of more than 20 considered as case group while less than 20 is the control group.

The measurements started by using Schirmers test strips (Optitech eye care) (Whatman filter paper no.41) which is 5mm x 35mm. In the lower fornix near the lateral canthus, the strips were placed away from the cornea and with eyes closed' it kept for 5

minutes for a randomly selected eye for each student in both groups. As the patients were directed to look forward and to blink frequently during the test.

Followed by Non-invasive TBUT using keratometry (Bausch & Lomb) to observe the interval between the last blink and the first appearances of the distorted keratometry mires.

The subject was asked to blink three times and then look straight forward, without blinking to take the average. The tear film was observed under the keratometry instrument and time between the last blink and first appearance of the first break in the tear film was recorded with a stopwatch. This procedure was repeated three times on one eye for each participant. A normal tear breakup time (TBUT) is between 15 and 45 seconds and less than 10 seconds is indicative of unstable tear film. Schirmer's result of 10-15 mm or more is regarded as normal tear production. A value of less than 5mm is considered to be suggestive of a dry eye.

## SAMPLE SIZE
Open Epi software was used to calculate the minimum sample size. Keeping the confidence interval (1-a) = 95% and absolute precision (d) of 0.08, the estimated sample size is calculated as 60. It involved 30 females in each group. A self-designed and validated questionnaire was used to classify them sort them into the groups. The survey collected patient responses on the grading of their symptoms such as itching, burning, watering and visual fluctuations using a Likert scale.

## INCLUSION CRITERIA
The study included all the participant with and without dry eye symptoms which are not undergoing any systemic or ocular treatment.

## EXCLUSION CRITERIA

Students are wearing contact lenses, previous ocular disorders, intraocular surgery, nasolacrimal duct obstruction, or who use topical ophthalmic or systemic medications were excluded from the study.

## Data Analysis
The questionnaire based responses identifying the association between case and control group was analyzed using chi – square test. Multiple regression analysis was used to analyze the most common dry eye symptoms. For each parametric value mean and the standard deviation was calculated. Microsoft Excel (2013) were used to store, analyze the data and to carry descriptive statistics.

## RESULTS

## DEMOGRAPHIC DETAILS

The population sample consisted of 60 participants from three majors (optometry, nursing, and engineering )resulting in 60 eyes were examined. The age of the participants ranged from 21 to 25 years, with a mean of 23 years and standard deviation (SD = 1.082).The optometry students were more than 50% of the sample population (figure 1). Schirmer's test I values (n= 60) have a total mean 25.4667 and (SD = 7.3904 ).While the Noninvasive TBUT were 5.0666 and (SD = 1.6020 ).
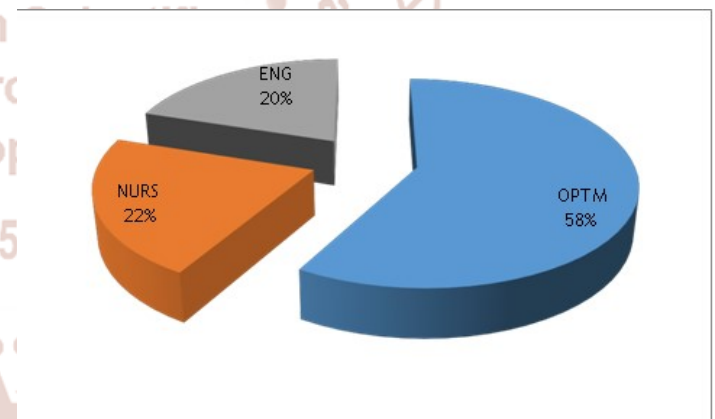


**Figure 1:** The number of participants according to majors

Table 1 shows that number of engineering students having moderate dry eye among the other majors. Hence the engineering students use the computers for long hours.

**Table 1**: Major wise comparison of Schirmer's test I and NITBUT among participants

|  | Schirmer's test I | Mean | NITBUT | Mean |
|---|---|---|---|---|
| **OPTM (n=35)** |  |  |  |  |
| **less than 5** | 1(2.9%) | 0.114 | 21(60%) | 1.93 |
| **5 to 10** | 3(8.8%) | 0.742 | 7(20%) | 1.295 |
| **more than 10** | 31(88.5%) | 26.5 | 7(20%) | 3.09 |
| **NURS (n=13)** |  |  |  |  |
| **less than 5** | 0 | 0 | 8(61.5%) | 2.06 |
| **Between 5-10** | 1(7.6%) | 0.692 | 5(38.4%) | 2.03 |
| **more than 10** | 12(92.3%) | 25.3 | 0 | 0 |
| **ENG ( n=12)** |  |  |  |  |
| **less than 5** | 3(25%) | 0.83 | 7(58.3%) | 2.04 |
| **Between 5-10** | 3(25%) | 1.5 | 5(41.6%) | 3.33 |
| **more than 10** | 7(58.3%) | 17.3 | 0 | 0 |

Table 2 show a McMonnies Screening Of 60 female subjects were involved in the study. Each group consists of 30 participants based on symptoms to screen the populations. The mean for the overall scores for all participants were 6.45 with an (SD) of 0.4472. The maximum score for all the participant was 16 and minimum was 0.

The noninvasive Tear breaks up test values for all the participants varies from 2 seconds to 20 seconds for the participants. The Schirmer's test I values was between 3mm to 35mm among the participants.

The number of participants having NITBUT values less than 5, were high compared to questioner's sore and Schirmer's I test values for (less than 5) as 36 cases were showing a dry eye. In contrast, it was low for (5-10) range. However, there is an inverse correlation between questioners score and NITBUT values as the questioner's show borderline while measurements show the opposite. According to the questionnaire, a score of over 20 is indicative of the dry eye, while a total score of between 10 and 20 is suggestive of borderline dry eye disease. On the other hand, the Schirmer test I and NITBUT values of (less than 5) consider as dry eye, (between 5-10) marginal dry eye, (between 11- 20) a borderline dry eye and (more than 20) as a normal condition.

**Table 2:** Descriptive details showing the questionnaire score, NITBUT and Schirmer's test I values for all the participants

|  | Q Score | NITBUT | Schirmer's test I |
|---|---|---|---|
| **Less than 5** | 15 (25%) | 36 (60%) | 3(5%) |
| **Between 5-10** | 38 (63.33%) | 17(28.3%) | 7 (11.6%) |
| **Between 11-15** | 6 (10%) | 5(8.33%) | 6 (10%) |
| **Between 16-20** | 1(1.66%) | 1(1.66%) | 0 |
| **More than 20** | 0 | 1(1.66%) | 44(73.33%) |

**DISCUSSION**

The purpose of this study was to compare effectiveness of Schirmer's test I and non- invasive (NITBUT) for the assessment of dry eye among University of Buraimi students. By identifying the comparing between the Schirmer's test, NITBUT used and the symptoms. However, the gap between patient symptoms and the clinical observations exists. As far as we searched the literature, this study was the first to compare between Schirmer's test I and NITBUT all the others compared between Schirmer test I or II and the invasive techniques. The study findings show that there is an inverse correlation between questioners score and NITBUT values as the questioner's grading reflects borderline dry eye, while measurements show the opposite. Also, the number of participants having NITBUT values less than 5, were high compared to questioner's sore. For the

convenient randomized sampling, participants aged 21-25 years were chosen for this study. The gender of participants in this study is different from the other selected studies that have shown both sexes for the assessment of tear values. The age of participants in this study is different from the range of the participants in other studies. Some researchers preferred to group members according to various age brackets; they have either included participants with a mean age of 55.8 ± 10.33 years old 8 or 48.8 years - ± 14.1 years from both genders 6. Hence the study can be explored with different age groups within Omani population.

A study identified TBUT is having good sensitivity compared to the Schirmer's test and considered to be an important diagnostic tool for detecting tear deficiency in eyes with pterygium 3. Similar results are also identified by a study done by Cihan Ünlü et al. 4.

However, a study done by Dr. Rashmi S et al. 10 found that Schirmer's test and rose bengal test have more diagnostic value in people with diabetes as compared to TBUT. This could be due to the different age group considered for the study. The advantage of having the same gender is an accurate way to compare between the Schirmer's test I and NITBUT for the assessment of dry eye. Hence dry eye disease affects women twice as often as men 12.

The study showed that the mean values obtained for NITBUT in the current study were marginally lower than Schirmer's test I that is given in table 1. However, there is an inverse correlation between questioners score and NITBUT values as the questioner's grading reflects borderline dry eye while measurements indicate the opposite that is shown in Table 2. In contrast, a study done by Khan Naimah Ebrahim 9 observed that Schirmer value for was marginally higher than the TBUT values.

A study done by Fermon S et al. used Benitez del Castillo questionnaire five while other studies 9 including ours used MacMonnies dry eye questionnaire with Scoring scheme as it is a useful screening tool for dry eye assessments.

Schirmer test I and NITBUT values of (less than 5) consider as dry eye and (more than 10) as a normal condition that has been widely accepted among the previous studies.5

The study showed that NITBUT has a better measurement on the population used than those found in the literature who depend on the using of invasive technique. The Schirmer and the non-invasive tear break up time are very easy to test, inexpensive and do not represent any risk for the patient. However, our study did not find the two test as reliable in the assessment of dry eye.

It might be interesting to perform further studies in different types of population that might support the result of this study. Future studies should involve a larger population sample including all the students from various primary and occupation. The age of the participants should be expanded and include all age groups among the students, those who are younger and older than those included in this study. Furthermore, factors such as contact lens wear, age, systemic diseases, gender, and environmental factors such as air conditioners, room illumination, and room temperature should be monitor accurately.

## CONCLUSION
The study demonstrated a better sensitivity of the NITBUT test compared to Schirmer's test I. Thus; it could be used as an initial screening tool to detect tear film instability in patients. However, the study identified the inverse relationship of TBUT reading with the Macmonnies questionnaire score. Using higher sample size and involving both genders can be helpful in further research.

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**APPENDICES (A):**

College of Health Sciences (Optometry)

Sequence Number :_____ Date:_____

Date of Birth: _____/_____/_____ Sex: M / F (Circle)

Dry eye occurs when there is in sufficient amount of tears in your eye necessary for maintaining moisture and proper surface nourishment. There are several for the lack of tears. The feeling of dry eyes, sometimes inconvenient as it is possible to be accompanied by the sense of burning or twitching in the eye. Many times we face such situations. For example, while exposure to air-conditioned or during TV watching continuously for several hours. Our study aims at understanding the diagnostic differences on patient symptom. We assure you that there is no harm associated with the procedures undertaken as those are practiced routinely in the optometric settings.

يحدث جفاف العين عند عدم وجود كمية كافية من الدموع في عينيك اللازمة للحفاظ على الرطوبة والتغذية. هنالك عدة أسباب لعدم وجود الدموع. الشعور بجفاف العين ،غير مريح في بعض الأحيان كما أنه من الممكن أن يكون مصحوب بشعور من الحرق أو الوخز في العين. وفي كثير من الأحيان نواجه مثل هذه الحالات. على سبيل المثال، أثناء التعرض لمكيف الهواء أو أثناء مشاهدة التلفاز بشكل مستمر لعدة ساعات. وتهدف الدراسة لدينا إلى فهم اختلاف وتنوع التشخيص فيما يتعلق بأعراض المريض. ونحن نؤكد لكم أنه لا يوجد ضرر مرتبط بممارسة الإجراءات المتخذة باعتبارها إجراءات روتينية متعلقة بإخصائي النظارات

Would you kindly answer the following questionnaire as I need it in my research project. Please read the instructions carefully and start answering the questions given. If you agree to participate in the study without any opposition. Please sign below.

أرجو التكرم بالإجابة على الاستبيان التالي وأنا في حاجة إليها في مشروع بحثي. الرجاء قراءة التعليمات بعناية والبدء في الإجابة على الأسئلة المحددة. إذا وافقت على المشاركة في الدراسة دون أي معارضة. الرجاء التوقيع في الأسفل.

Signature:_____

## MCMONNIES' DRY EYE QUESTIONNAIRE WITH SCORING SCHEME'

Please circle either : female/male. Age: less than 25years/25-45years/more than 45 years.

يرجى وضع دائرة إما : أناث/ذكور. العمر: أقل عن 25 سنه / 25-45 سنه / أكثر من 45 سنه.

Currently wearing : no contact lenses / hard contact lenses / soft contact lenses.

ترتدي حالياً: لا ترتدي العدسات اللاصقة / العدسات اللاصقة الصلبة / العدسات اللاصقة اللينة.

Please answer the following by underlining the responses most appropriate to you.

الرجاء أجب على الاتي من خلال تسليط الضوء على الاستجابات الأكثر ملاءمة لك.

1. Have you ever had drops prescribed or other treatment for dry eyes ?

Yes (2) / No(1) / Uncertain (0)

1.هل سبق لك ان استخدمت قطور أو علاج لجفاف العين؟

(نعم (2) / لا (1) / غير مؤكد (0)

2. Do you ever experience any of the following dry eye symptoms ?

1 Soreness(1) 2 Scratchiness (1) 3 Dryness (1) 4 Grittiness (1) 5 Burning

2.؟ هل سبق لك أن واجهت أي من أعراض جفاف العين التالية ؟

التقرح (1) 2 الخشونة (1) 3 جفاف (1) 4 رمل (1) 5 حرق 1

3. How often do your eyes have these symptoms?(underline)

Never (0) Sometimes (1) Often (2) Constantly (3)

3. أكد) ؟ ماهي غالبية شعورك بهذه الأعراض في عينيك ؟ (أكد

(أبدا (0) في بعض الأحيان (1) في كثير من الأحيان (2) باستمرار (3)

4. Are your eye usually sensitive to cigarette smoke , smog ,air conditioning , or central heating ? Yes (2) No (0) Sometimes (1)

4.؟هل عينك عادة حساسة لدخان السجائر، والدخان، وتكييف الهواء، أو التدفئة المركزية؟

(نعم (2) لا (0) في بعض الأحيان (1

5. Do your eyes become very red and irritated when swimming?

Not applicable (0) Yes (1) No (0) Sometimes (1)

هل تصبح عينيك حمراء جدا وتكون منزعج عند السباحة؟ .5

(لا ينطبق (0) نعم (1) لا (0) في بعض الأحيان (1

6. Do you take antihistamine tablets (1) or use antihistamine eye drops(1) ,diuretics (1) (Fluid tablet )

(هل تتناول أقراص مضادات الهيستامين (1) أو تستخدم مضادات الهيستامين كقطور للعين (1)، مدرات البول (1) (القرص السائل .6

7. Do you suffer from arthritis ? Yes (2) No (0) Uncertain (1)

(هل كنت تعاني من التهاب المفاصل؟ نعم (2) لا (0) غير مؤكد (1 .7

8. Do you experience dryness of the nose , mouth , throat ?

Never (0) sometimes (1) Often (2) Constantly (3)

هل واجهت جفاف الأنف والفم والحلق ؟.8

(أبدا (0) في بعض الأحيان (1) في كثير من الأحيان (2) باستمرار (3

9. Do you suffer from thyroid abnormality ?

Yes(2) No (0) Uncertain

هل تعاني من خلل الغدة الدرقية؟ نعم (2) لا (0) غير مؤكد .9

10. Are you known to sleep with your eyes partly open ?

Yes (2) No(0) Sometimes (1)

هل أنت معروف بنومك وعينيك مفتوحه جزئياً؟.10

(نعم (2) لا (0) في بعض الأحيان (1

11. Do you have eye irritation as you wake from sleep ?

Yes (2) No (0) Sometimes (1)

هل تهيج عينيك عندما تستيقظ من النوم؟ .11

(نعم (2) لا (0) في بعض الأحيان (1

Thank you for taking the time to complete the questionnaire.

.أشكركم على أخذ الوقت لاستكمال الاستبيان

Total score for answers 1 to 11: ☐

| Gender | Age | Score |
|---|---|---|
| Male or female | Under 25 | 0 |
| Male | 25-45 | 1 |
| Female | 25-45 | 3 |
| Male | Over 45 | 2 |
| Female | Over 45 | 6 |

A score of over 20 is indicative of dry eye , while a total score of between 10 and 20 is suggestive of borderline dry eye disease.

**Comments:**

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