Sensitivity and specificity of McMonnies Questionnaire in diagnosing dry eye syndrome among patients aged 40 years and above in Uganda

Atto G[1], Twinamasiko A[1], Arunga S[1,2]

[1]Department of Ophthalmology, Mbarara University of Science and Technology, Uganda
[2]International Centre for Eye Health, London School of Hygiene & Tropical Medicine, UK

Corresponding author: Dr Gladys Atto, Department of Ophthalmology, Mbarara University of Science and Technology, Uganda. Email: attoglad@gmail.com

ABSTRACT

Objective: To evaluate the sensitivity and specificity of McMonnies Questionnaire (MQ) as a screening tool for Dry Eye Syndrome (DES) among patients aged 40 years and above attending Ruharo Eye Centre (REC).
Design: This was a cross-sectional hospital-based study.
Methods: The study was conducted during the months of September to December 2017. Both males (76) and females (91) who were aged 40 years and above using convenient sampling were included. All participants were screened for DES using McMonnies Questionnaire after which assessment for the signs of DES using Schirmer I, TBUT and Rose Bengal tests were done. We entered data into Excel and exported into Stata 13.0 for analysis.
Results: A total of 167 patients were enrolled, 91 (54.49%) were females. The female to male ratio was 1.2:1. The median age of the patients was 63 years (IQR: 54-72, range: 40-94). The median Schirmer I, TBUT and MQ scores were 14 mm (IQR: 5-22, range: 1-35), 6.67 seconds (IQR: 3.33-17, range: 1-34.33) and 12 (IQR: 9-17 range of 2-27). The prevalence of DES was 68%. The sensitivity and specificity of McMonnies Questionnaire in diagnosing DES were 81.6% (95% CI, 73.2 - 88.2) and 39.6% (95% CI, 26.5 - 54) respectively.
Conclusion: The McMonnies Questionnaire had a high sensitivity (81.3%)but low specificity (36.9%) in diagnosing DES. Therefore, when such a test is negative, it is good for ruling out DES but not suitable for identifying people at risk of the disease.

Key words: Dry eye syndrome, Sensitivity and specificity, McMonnies Questionnaire, Uganda

INTRODUCTION

The international Dry Eye Workshop 2007 (DEWS) defined Dry Eye Syndrome (DES) as a multifactorial disease of the tear and ocular surface that results in symptoms of discomfort, visual disturbance, and tear film instability with potential damage to the ocular surface. It is accompanied by increased osmolarity of the tear film and inflammation of the ocular surface[1]. DES is very common, affecting especially those older than 40 years with prevalence estimates ranging from approximately 10-30% of the population in the United States to 27.5% in rural Indonesia and 18.4% in India[2–4].

A variety of diagnostic tests are in common clinical usage such as TBUT, Schirmer, tear osmolarity, ocular surface stains but there is no consensus as to which combination of tests should be used to define the disease either in the clinic or for the purposes of a research protocol[5]. Practitioners sometimes make use of dry eye questionnaires to identify patients at risk for dry eyes[6]. The McMonnies Questionnaire is among the earliest and most widely used screening instruments for DES and it was found to be a useful tool in detecting the presence of dry eye disease and those at risk of developing the disease[6].

MATERIALS AND METHODS

This was a cross-sectional hospital-based study carried out in Ruharo Eye Center (REC), South-western Uganda. Approvals were sought from the Faculty Research Committee and Institutional Ethical Review Committee of Mbarara University of Science and Technology and REC. Informed consent was obtained from all the participants. Participants were also informed that participation in the study was voluntary and that refusal to participate would not affect their routine care at the hospital.

Convenient sampling was used. A sample size of 167 patients was determined using Buderer's formula[7].Since the test was required to be more sensitive than specific, the sensitivity formula was used to determine the sample size. Therefore, using the formula below, the anticipated sensitivity SN = 0.98, absolute precision = 0.03 with 95% confidence level (two-tailed), expected prevalence = 0.18 from hospital-based study[2].

Sample size (n) based on sensitivity.

$$\frac{Z^2 1 - \alpha/2 \times SN \times (1-SN).}{L^2 \times Prevalence}$$

Data collection period lasted for a total of 4 months of non-consecutive days from September to December 2017. We included all patients aged 40 years and above who consented to the study and excluded patients with symptoms requiring acute eye care and those who had undergone eye surgery in the past 3 months.

Demographic details including, age, sex was recorded. All patients were symptomatically screened for dry eye using McMonnies Questionnaire (MQ) modified by Nichols etal8. The MQ grades patients' symptoms with scores ranging from 0-409 and classifies patients as: normal (<10), marginal dry eye (10-20) and pathological dry eye (>20). All patients (dry eye and no dry eye) were then subjected to clinical examination and clinical dry eye tests.

Clinical examination

Visual acuity assessment was done using tumbling Snellen E- chart at 6meters.Slit lamp examination of anterior segment was done to assess conjunctival hyperemia, presence of mucus filament, thickening of the lid margin and telangiectasia. Meibomian gland dysfunction was assessed by performing gland expression with digital pressure to the central lower lid to indicate whether the orifices are plugged or open. A normal secretion was clear while an abnormal secretion would be cloudy meibum or more viscous, granular, or toothpaste-like material on expression or absence of expressible material.

The Schirmer 1 test (without anaesthesia) was performed by placing the filter strips which were 5x35 mm (Devine Meditech) in the inferior temporal fornix with the eyes closed. The test result was considered positive if the length of wetting obtained was ≤ 10 mm in 5minutes.

Tear Break Up Time (TBUT) test was recorded with the patient on a slit lamp after corneal staining using fluorescein strips (Ophtechnics limited) 1 mg/ml staining. The strips were initially wetted with normal saline before being gently dabbed on the lower aspect of the bulbar conjunctiva. The patients were asked to blink several times and then look straight at a target; the time taken for the first dry spot to appear was recorded, and an average of three readings was taken as TBUT. The test was considered positive if the average TBUT was ≤ 10seconds.

Ocular surface evaluation on a slit lamp was done using Rose Bengal strips (Devine Meditech) 1.5mg/ml staining placed for 2min in the lower outer conjunctional cul-de-sac after wetting using normal saline. The Oxford grading scheme was used to score ocular surface damage10. The grading chart is made up of five panels, each of which represents typical gradations of stain on either cornea or conjunctivaas 0, I, II, III, IV and V depending on number of dots per panel. Minimum being grade 0 and maximum score V11.

Both eyes of patients were examined, however, for purposes of analysis, only the more severely affected eye was considered.

Since no single test is considered a "gold standard", a composite score was formed using Schirmer I test and TBUT to act as the gold standard. A score of "one" was assigned to a positive test and a score of "zero" to a negative test and summation of the scores were taken as the composite score. A composite score of one and above was taken as DES, for example, if the TBUT and Schirmer I scores were zero and one respectively, the result would be interpreted as positive; if both scored one, the result would still be positive but negative if both scores were "zero" as shown in Table 1.

Table 1

	Schirmer I	TBUT	Composite score	Diagnosis
Patient 1	1	1	2	DES
Patient 2	0	0	0	No DES
Patient 3	1	0	1	DES

Analysis

The data set was entered into Microsoft Excel and exported into STATA version 13.0 for analysis. The prevalence of DES among patients aged 40 years and above presenting at REC was expressed as a proportion of patients diagnosed with DES out of all the patients enrolled in the study, and the respective confidence intervals were provided.

Sensitivity was calculated using STATA as the proportion of true cases (people with DES) correctly categorized as having the disease by the MQ, and specificity as the proportion of true non-cases (healthy people) correctly categorized as being healthy.

The McNemar's test was used to test if there was a statistically significant difference between MQ and the composite score with a P-value of <0.05 being significant.

RESULTS

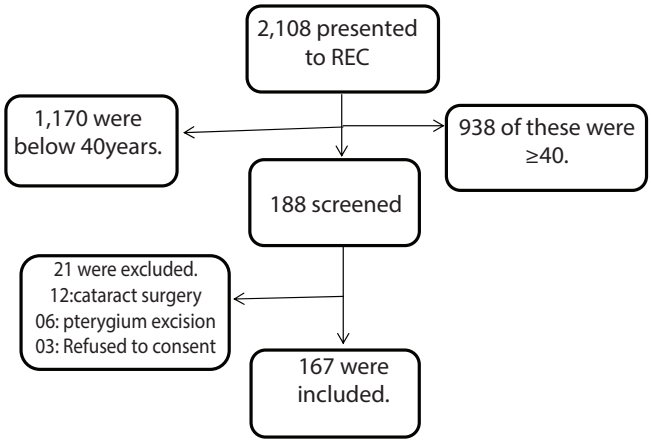

Figure 1: Flow chart

Table 2: Baseline characteristics and examination findings(n=167)

Variable	Description	Frequency	Percentage
Sex	Male	76	45.5
	Female	91	54.6
Age (years)	40-50	30	18.0
	51-60	44	26.4
	61-70	47	28.1
	>70	46	27.5
Examination findings			
Eyelids	Normal	164	98.2
	Retracted	0	0
	Ectropion	1	0.6
	Entropion	2	1.2
	Lagophthalmos	0	0
Eyelid margin	Normal	160	95.8
	Erythema	1	0.6
	Abnormal Deposits	1	0.6
	Keratinized	5	3.0
Meibomian gland orifices	Plugged	11	6.6
	Open	156	93.4
Eyelashes	Normal	164	98.2
	Trichiasis	3	1.8
	Distichiasis	0	0
Conjunctival hyperaemia	Absent	92	55.1
	Mild	57	34.1
	Moderate	18	10.8
	Severe	0	0
Pannus	Present	165	98.8
	Absent	2	1.2
Mucus filament	Present	35	21.0
	Absent	132	79.0

Prevalence of Dry Eye Syndrome (DES)

The McMonnies Questionnaire diagnosed the highest number of patients, 74.9% as having DES followed by the composite score with 68%. The 68% prevalence of DES as determined by the composite score was higher than that obtained by the individual tests as shown in Figure 2. The proportion of females and males who had DES was 70% and 66% respectively.

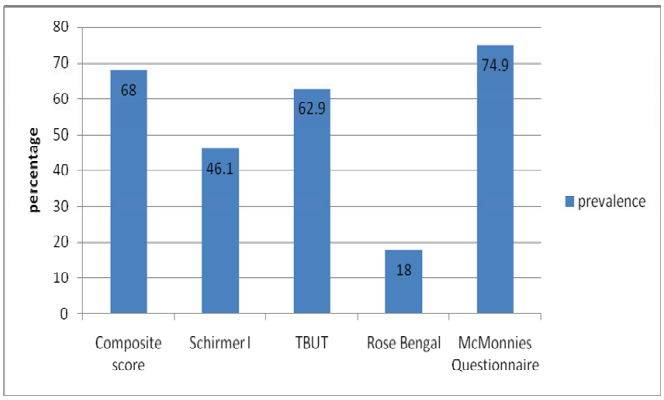

Figure 2: The prevalence of DES as determined by MQ and the different clinical tests (n=167)

Sensitivity and specificity of McMonnies Questionnaire in diagnosing DES

The sensitivity and specificity of McMonnies Questionnaire in diagnosing DES were 81.6% (95% CI,73.2 - 88.2) and 39.6% (95% CI,26.5 - 54) respectively. A positive predictive value of 73.4% and a negative predictive value of 50% were found as shown in Table 3.

Table 3: Two by Two

	Composite score positive	Composite score negative
MQ positive	93a	32b
MQ negative	21c	21d

Sensitivity= a/(a+c) x 100
Specificity= d/(d+b) x 100
Positive predictive value=a/a+b
Negative predictive value=d/c+d
McNemar's test X2= (b-c)2/(b+c) p>0.05
Accuracy=a+d/a+b+c+d X 100

Table 4: Sensitivity and specificity of McMonnies Questionnaire in diagnosing DES

Validity indices	Score	95% CI
Sensitivity	81.6%	73.2% - 88.2%
Specificity	39.6%	26.5% - 54%
Positive Predictive Value	73.4%	65.8% - 81.8%
Negative Predictive Value	50%	34.2% - 65.8%
Likelihood ratio (+)	1.35	1.07 - 1.71
Likelihood ratio (-)	0.465	0.279 - 0.774

DISCUSSION

This study found the sensitivity and specificity of McMonnies Questionnaire (MQ) in diagnosing DES to be 81.6% and 39.6% respectively. Previous studies using this questionnaire revealed varying values of sensitivity and specificity ranging from (34%–98%) and (36%–97%) respectively which might partly be explained by the difference in the experimental population [8,9,12,13]. McMonnies *et al*[13], for instance, studied a group of 50 women with Sjögren syndrome who had severe DES while our study included all patients aged 40 years and above, irrespective of their diagnosis. Furthermore, different scoring methods of the MQ have been used since its development.

In our study, we adopted the modified scoring system developed by Nichols and associates[8] which could possibly explain why the two findings were similar (82% and 36%) in contrast to the weighted algorithm based on clinical experience used by McMonnies *et al*[13] whose sensitivity and specificity estimates were higher (92% and 93% respectively) but one cannot rule out the possibility of selection bias since they assessed efficacy based on the data from the same sample of patients from whom the cutoff values for diagnosis were derived and not from an independent sample of new patients.

We thought of looking at age and gender stratifications of sensitivity and specificity by MQ, but we did not feel that these comparisons would be necessarily fair because the scoring algorithm for the McMonnies Index automatically weights women higher than men, and older individuals higher than younger individuals.

The prevalence of DES determined by MQ was 75% (125), quite higher than that of Schirmer and TBUT alone (46.1% and 62.9% respectively) which might probably reflects its poor correlation with other dry eye clinical tests as reported in other studies[14,15]. The overall prevalence of patients with DES in our population was as determined by the composite score was68%, similar to the 58.4% obtained from an Indian-based hospital study but higher than the 37.6% reported in the 40-49 year age group obtained from a population based study in Indonesia4. The high prevalence in our setting may be partly explained by the fact that our study utilized a composite score of Schirmer and TBUT that would be expected to capture more cases of DES than would be the case if individual tests were used. Considering that our data collection took place in a dry season, we might have probably overestimated the prevalence since dry conditions are known to exacerbate symptoms of dry eye nevertheless, the result still reflects how common DES is among this age group, a finding quite in agreement with many other studies even if their prevalence values were not as high as that obtained in our study[16,17].

The authors of this study chose TBUT and Schirmer tests for composite gold standard because they proved to be highly sensitive in most studies[10,18,19].

In conclusion, MQ had a high sensitivity but low specificity for diagnosing DES; when such a test is negative, it is good for ruling out DES but not suitable for identifying people at risk for the disease. An ideal screening test should have both a high sensitivity and specificity. We therefore recommend further studies with a larger sample size to further evaluate the screening properties of the questionnaire.

Availability of data and materials: The datasets used during the study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests.

Funding: We would like to acknowledge Sight savers International, Uganda for funding this study. All data were anonymized after extraction from clinical notes.

REFERENCES

1. Torricelli AAM, Novaes P, Matsuda M, Alves MR, Monteiro MLR. 2007 Report of the Internationl Dry Eye Workshop (DEWS). Vol 74.; 2011. doi:10.1590/S0004-27492011000500016.
2. Sahai A, Malik P. Dry eye: Prevalence and attributable risk factors in a hospital-based population. *Indian J Ophthalmol.* 2005;**53**(2):87-91. doi:10.4103/0301-4738.16170.
3. C Stephen Foster, MD, FACS, FACR, FAAO F. Dry Eye Disease (Keratoconjunctivitis Sicca) Clinical presentation: History. Accessed January 10, 2021. https://emedicine.medscape.com/article/1210417-clinical.
4. Lee AJ, Lee J, Saw SM, *et al*. Prevalence and risk factors associated with dry eye symptoms:

A population based study in Indonesia. *Br J Ophthalmol.* 2002;**86**(12):1347-51. doi:10.1136/bjo.86.12.1347.
5. Nichols K, Weibel K. The epidemiology of dry eye disease. *Ocul Surf Disord.* 2013;**5**(2):27-27. doi:10.5005/jp/books/12072_4.
6. Erickson PM, Stapleton F, Giannakopoulos DE. Reliability of the McMonnies Dry Eye Questionnaire. *Investig Ophthalmol Vis Sci.* 2002;**43**(13):3068.
7. Buderer NM. Statistical methodology: I. Incorporating the prevalence of disease into the sample size calculation for sensitivity and specificity. *Acad Emerg* Med. 1996;**3**(9):895-900.
8. Nichols KK, Nichols JJ, Mitchell GL. The reliability and validity of mcmonnies dry eye index. Cornea. 2004;23(4):365-371. doi:10.1097/00003226-200405000-00010.
9. Charles W. McMonnies AH. Patient history in screening for dry eye conditions. *J AM Optom Assoc.* 1987;**58**(4):296-301.
10. Schiffman RM, Christianson MD, Jacobsen G, Hirsch JD, Reis BL. Reliability and validity of the ocular surface disease index. *Arch Ophthalmol.* 2000;**118**(5):615-621. doi:10.1001/archopht.118.5.615.
11. Bron AJ, Evans VE, Smith JA. Grading of corneal and conjunctival staining in the context of other dry eye tests. Cornea. 2003;**22**(7):640-650. doi:10.1097/00003226-200310000-00008.
12. Nichols JJ, Mitchell GL, Nichols KK, Chalmers R, Begley C. The performance of the contact lens dry eye questionnaire as a screening survey for contact lens-related dry eye. *Cornea.* 2002;**21**(5):469-475. doi:10.1097/00003226-200207000-00007
13. McMonnies C, Ho A, Wakefield D. Optimum classification of dry eye using questionnaire responses. *J Am Optom Assoc.* 1998;**117**(2):835-837.
14. Hay EM, Thomas E, Pal B, Hajeer A, Chambers H, Silman AJ. Weak association between subjective symptoms of and objective testing for dry eyes and dry mouth: Results from a population based study. *Ann Rheum Dis.* 1998;**57**(1):20-24. doi:10.1136/ard.57.1.20.
15. Schein OD, Munuz B, Tielsch JM, Bandeen-Roche K, West S. Prevalence of dry eye among the elderly. *Am J Ophthalmol.* 1997;**124**(6):723-728. doi:10.1016/S0002-9394(14)71688-5.
16. Liu NN, Liu L, Li J, Sun YZ. Prevalence of and risk factors for dry eye symptom in mainland China: A systematic review and meta-analysis. *J Ophthalmol.* 2014;**2014**. doi:10.1155/2014/748654.
17. Moss SE, Klein R, Klein BEK. Long-term incidence of dry eye in an older population. *Optom Vis Sci.* 2008;**85**(8):668-674. doi:10.1097/OPX.0b013e318181a947.
18. Fuentes-Páez G, Herreras JM, Cordero Y, Almaraz A, González MJ, Calonge M. Lack of concordance between dry eye syndrome questionnaires and diagnostic tests. *Arch la Soc Española Oftalmol* (English Ed. 2011;**86**(1):3-7. doi:10.1016/s2173-5794(11)70002-0.
19. Bjerrum KB. Test and symptoms in keratoconjunctivitis sicca and their correlation. *Acta Ophthalmol Scand.* 1996;**74**(5):436-441. doi:10.1111/j.1600-0420.1996.tb00595.x.