

อาการแสดงทางตาในผู้ติดเชื้อเอชไอวีหรือผู้ป่วยโรคเอดส์ในจังหวัดมหาสารคาม

Ocular Manifestations in Patients with Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome in Maha Sarakham

พลอยทราย รุจกรกานต์^{1*}, ธานิตา วัฒนา¹, ปริญญ์ สิริไทร¹

Ploysai Rujkorakarn^{1*}, Thanita Hlowchitsieng¹, Parinya Srihatrai¹

Received: 22 January 2019; Revised: 15 March 2019; Accepted: 25 March 2019

บทคัดย่อ

ผู้ติดเชื้อเอชไอวีหรือผู้ป่วยโรคเอดส์อาจมีอาการทางตาได้หลายรูปแบบ การศึกษานี้ได้รายงานความชุกและประเมินปัจจัยเสี่ยงต่อการเกิดอาการแสดงทางตา โดยได้ทำการศึกษาที่จุดเวลาใดเวลาหนึ่งในผู้ป่วยที่มีผลการตรวจภูมิคุ้มกันเลือดต่อเชื้อเอชไอวีเป็นบวกที่เข้ารับการตรวจรักษา ณ คลินิกผู้ติดเชื้อเอชไอวีหรือผู้ป่วยโรคเอดส์ โรงพยาบาลสุทธาเวช ทำการศึกษาตั้งแต่เดือนกรกฎาคม พ.ศ. 2560 ถึงมิถุนายน พ.ศ. 2561 โดยรวบรวมข้อมูลจากเวชระเบียนผู้ป่วย การสัมภาษณ์ ผลการตรวจทางห้องปฏิบัติการ และการตรวจตาโดยจักษุแพทย์ พบว่าจากกลุ่มตัวอย่างทั้งสิ้น 58 ราย มี 57 รายที่ได้รับการรักษาด้วยยาต้านรีโทรไวรัส ความชุกของการตรวจพบทางตาทั้งสิ้น ร้อยละ 32.8 ได้แก่ ภาวะตาแห้ง (ร้อยละ 13.79) โรคของหลอดเลือดจอตา (ร้อยละ 6.9) รอยแผลเป็นที่จอตา (ร้อยละ 6.9) การอุดตันของรูม่านตา (ร้อยละ 3.45) และภาวะการอักเสบของม่านตาส่วนหน้าจากเชื้อไวรัสเฮอร์ปีส์ (ร้อยละ 1.72) พบสัดส่วนของอาการแสดงทางตาที่สูงขึ้นอย่างมีนัยสำคัญทางสถิติในผู้ป่วยเพศหญิง [AOR=8.4;95%CI=1.34-52.48; p=0.023]. เมื่อเปรียบเทียบกับการศึกษาอื่นพบว่ากลุ่มประชากรในการศึกษานี้มีอายุน้อยและระดับที่ลิมโฟไซต์ชนิดซีดี 4 มีค่าที่ค่อนข้างสูง ภาวะตาแห้งเป็นอาการแสดงทางตาที่พบได้บ่อยที่สุด และพบว่าเพศหญิงเป็นปัจจัยเสี่ยงต่ออาการแสดงทางตาต่างๆ

คำสำคัญ: เอชไอวี เอดส์ อาการแสดงทางตา ตาแห้ง

Abstract

HIV-infected patients or AIDS patients could present with various ocular manifestations. This cross-sectional study reports the prevalence and risk factors of ocular manifestations in human immunodeficiency virus (HIV)/ acquired immune deficiency syndrome (AIDS) patients, presented at the HIV/AIDS clinic, Suddhavej Hospital. The study was conducted from July 2017 to June 2018. Data was collected from medical records, patient interview, laboratory investigation and ocular examination. Of the 58 patients with HIV/AIDS, 57 were on antiretroviral therapy. The prevalence of ocular findings was 32.8%, which were dry eye disease (13.79%) followed by retinal microvasculopathy (6.9%), chorioretinal pigmented scar (6.9%), posterior synechiae (3.45%) and herpetic anterior uveitis (1.72%). The rate of ocular manifestation was significantly higher in female patients [AOR=8.4; 95%CI=1.34-52.48; P=0.023]. The subjects in the present study were in younger age group and the level of CD4+ T lymphocytes was quite high. Dry eye disease was the most common ocular manifestation. Female sex was shown to be the risk factor for all of ocular findings.

Keywords: HIV, AIDS, ocular manifestations, dry eye

¹ อาจารย์ ฝ้ายจักษุวิทยา โรงพยาบาลสุทธาเวช คณะแพทยศาสตร์ มหาวิทยาลัยมหาสารคาม ต.ตลาด อ.เมือง จ.มหาสารคาม 44000

¹ Lecturer, Faculty of Medicine, Suddhavej Hospital, Mahasarakham University, Mueang, Maha Sarakham 44000, Thailand

* Corresponding author: Srihatrai P. Tel.:+66865342777, Fax:+6643712991 e-mail: parinya@msu.ac.th

Introduction

Acquired Immune Deficiency Syndrome (AIDS) was first recognized as a new disease in 1981^{1,2}. This syndrome is caused by a human immunodeficiency virus (HIV) that attacks immune cells called CD4+ T lymphocyte cells. According to the Joint United Nations Programme on HIV/AIDS (UNAIDS), there were 36.7 million people worldwide living with HIV/AIDS in 2016, an estimated 450,000 people were in Thailand³. Even though approximately 6,400 people were newly infected in this country, the annual number of new HIV infections has declined from preceding years³. The high risk group included young women (aged 15–24 years), people who inject drugs, sex workers, transgender people, prisoners and men who have sex with men³. The incidence is rising among young people, which might be caused by their earlier sexually active status and easier way to connect to each other through social media.

HIV-associated disorders may involve any part of the eye from the adnexa and anterior to posterior segment, including orbit and the optic nerve⁴. Ocular manifestations of HIV/AIDS affect 50–75% of infected persons worldwide and may be divided into four categories: vasculopathy, unusual malignancies, neuro ophthalmologic abnormalities and opportunistic infections^{5,6}. Before the introduction of highly active antiretroviral therapy (HAART), cytomegalovirus (CMV) retinitis was the most common opportunistic ocular infection, affecting 37% of HIV-infected patients⁷. The incidence, visual morbidity and mortality of CMV retinitis and other HIV-associated retinopathies have decreased in the era of HAART⁸. Although the incidence of sight-threatening complications has decreased, there are still minor problems such as external ocular manifestations, which may disturb the quality of life and need some treatments^{9,10}.

According to the Thailand National Guidelines on HIV/AIDS treatment and prevention 2017, HIV infected cases could be able to have complete access to HAART. The data was analysed to determine the factors associated with HIV and ocular complications in this group of patients during the HAART era, and is the first report of its kind in this province.

Materials and Methods

A cross sectional study was conducted in Suddhavej Hospital from July 2017 to June 2018. The protocol was approved by the Mahasarakham University ethics committee for research involving human subjects (approval number 029/2018). All HIV-infected patients seen in HIV/AIDS clinic were included. All investigations were carried out in accordance with the tenets of the Declaration of Helsinki, and had been registered in the Thai Clinical Trials Registry (TCTR) system, clinicaltrials.in.th, (Study ID TCTR20180716002). All participants gave informed consent. Fifty-eight patients had complete data and attended ocular examination.

Data were collected from medical records, patient interviews, laboratory investigations and ocular examination performed by ophthalmologists. Both eyes of all participants were evaluated for best corrected visual acuity (BCVA) measured by Snellen chart, intraocular pressure measurement (via air puff tonometer), adnexal examination, anterior segment (slit lamp biomicroscope), dilated fundus examination using non-contact lens (20D Volk lens, Super Field® Volk lens).

Dry eye disease (DED) was diagnosed by using the Ocular Surface Disease Index (OSDI) questionnaire^{12,13}, defined as 13 points or more plus fluorescein staining of the ocular surface or fluorescein tear break up time of less than 10 seconds¹⁴. Herpetic anterior uveitis was diagnosed from clinical signs of anterior chamber cells with the presence of localized corneal scars or edema, decreased corneal sensation, geographically or diffusely distributed keratic precipitates, acutely elevated intraocular pressure or iris atrophy¹⁵. Retinal microvasculopathy was the most common HIV related ocular manifestation in a few studies^{16,17}. The cotton-wool spots, microaneurysms, retinal haemorrhages, telangiectatic vascular changes and areas of capillary nonperfusion might be revealed from the examination in these kind of patients^{10,18}.

Results were expressed as frequencies (%). Categorical variables were compared using Chi-squared test or Fisher's exact test. Association factors were determined by logistic regression analysis. The results were expressed as Odd Ratio (OR), 95% confidence

intervals (CI) and P-value. A $P < 0.05$ was considered statistically significant.

Results

Out of 74 patients in HIV/AIDS clinic, 59 patients agreed to be recruited and attended ocular examination. Of these, 1 patient was excluded because of incomplete data. A total of 58 patients were enrolled in the study. Data was collected and ocular examination was done by ophthalmologists. Fifty-two (89.7%) patients were male. The mean age of the patients was 25.6 ± 8.9 , range 19 - 57, and 72.4% of them were aged under 25 years old. The majority (71.1%) of patients were university students. Sexual transmission (93.1%) was the most common route of HIV infection. Forty nine (84.5%) homosexual patients were reported by the health status interview (Table 1).

The prevalence of ocular manifestation in females (66.7%) was higher than in males (19.2%) ($P = 0.026$). Ocular manifestations were commonly observed in the patients aged 25 years old or above (43.8%), ($P = 0.043$). Heterosexual orientation had ocular manifestation (43.8%) more than homosexual orientation (18.4%), ($P = 0.03$). By contrast, occurrence of ocular manifestations did not vary significantly across different occupational status, income, education status and route of infection (Table 1).

Only 1 of 58 patients was not on HAART and 54 patients have taken HAART less than five years. Duration of known HIV infection was less than 2 years in 50 (86.2%) patients. Eighty-three percent of patients had a recent CD4+ count of 200 cells/mm³ and above (Table 2). More than 95% of the patients had BCVA equal or better than 20/70 in each eye (Table 3).

Table 1 Distribution of socio-demographic characteristics and ocular manifestation of HIV/AIDS patients in Suddhavej Hospital

Socio-demographic characteristics	Ocular manifestation		P
	Presence, n (%)	Absence, n (%)	
Sex			
Male	10 (71.43)	42 (95.45)	0.026
Female	4 (28.57)	2 (4.55)	
Age (years), mean (SD)	31 (12.64)	23.91 (6.74)	0.009
Less than 25	7 (50.00)	35 (79.55)	0.043
25 or above	7 (50.00)	9 (20.45)	
Occupational status			
Employed	6 (42.86)	6 (13.64)	0.071
Unemployed	0 (0)	3 (6.82)	
University student	8 (57.14)	35 (79.55)	
Income (Thai Baht)			
Less than 10,000	9 (64.29)	35 (79.55)	0.434
10,000-20,000	4 (28.57)	7 (15.91)	
More than 20,000	1 (7.14)	2 (4.55)	
Education			
Below secondary	2 (14.29)	3 (6.82)	0.585
Secondary or above	12 (85.71)	41 (93.18)	
Route of infection			
Sexual intercourse	12 (85.71)	42 (97.67)	0.146
Mather to child transmission	2 (14.29)	2 (14.29)	
Sexual orientations			
Heterosexual	5 (35.71)	4 (9.09)	0.030
Homosexual	9 (64.29)	40 (90.91)	

Of 58 patients, 19 (32.8%) had ocular manifestations. The most frequent ocular manifestation in the present study was anterior segment manifestations which is DED (13.8%). Posterior segment manifestations were retinal microvasculopathy (6.9%) and chorioretinal pigmented scar (6.9%) (Table 4).

Table 2 Clinical profile of HIV/AIDS patients in Suddhavej Hospital

Clinical profile	n (%)
Current CD4+ cells (cells/mm ³)	
0-199	10 (17.24)
200-499	31 (53.45)
500 or above	17 (29.31)
Duration of HIV infection (months)	
Less than 13	34 (58.62)
13- 24	16 (27.59)
25-60	4 (6.90)
More than 60	4 (6.90)
Duration of antiretroviral therapy (years)	
5 or less	54 (93.10)
More than 5	4 (6.90)

HIV; human immunodeficiency virus.

Table 3 The visual status of HIV/AIDS patients in Suddhavej Hospital

Visual acuity	Right eye, n (%)	Left eye, n (%)
20/20-20/70	56 (96.55)	57 (98.28)
20/70-20/200	2 (3.45)	1 (1.72)

Table 4 Distribution of ocular manifestations of HIV/AIDS patients in Suddhavej Hospital

Ocular manifestations	n (%)
Anterior segment	
Dry eye disease	8 (13.79)
Herpetic anterior uveitis	1 (1.72)
Posterior synechiae	2 (3.45)
Posterior segment	
Retinal microvasculopathy	4 (6.90)
Chorioretinal pigmented scar	4 (6.90)
Total	19 (32.76)

In multiple logistic regression analysis, female patients were 8.4 times more likely to have ocular manifestation than male patients [AOR=8.4; 95% CI=1.34-52.48; $P=0.023$] (Table 5).

Table 5 Risk factors for ocular manifestation of HIV/AIDS patients in Suddhavej Hospital

Factor	Adjusted OR	95% CI	P
Sex			
Male	1		
Female	8.4	1.34 - 52.48	0.023

OR; odds ratio, CI; confidence interval.

Discussion

The overall prevalence of ocular manifestations in the present study was higher than in other studies, which were 17.5% in India¹⁹, 26.3% in China²⁰, and 25.7% in Ethiopia²¹. The prevalence was lower than the reports from Gondar University Hospital (60%)²² and TM Jafferji Hospital (70%)²³, that could be caused by these studies being carried out in tertiary care hospitals and about 90% of the patients were in WHO clinical staging of HIV/AIDS, stages III or IV, indicating mainly patients who were seriously ill and had low immune status. While more than half of patients in the present study were visiting HIV/AIDS clinic as outpatients with healthy condition, correlated with the study shown by Edathodu *et al* in 2009²⁴.

The most common ocular manifestation in this study was DED, which is consistent with the study

reported by Jimma in 2013 (11.3%)²⁵. Although it was not a serious sight-threatening problem, but it could impact the quality of life and need medical treatment^{9,10}. DED affects between 20% to 38.8% of HIV-positive hosts in the later stages of AIDS. Prevailing theories of its pathogenesis implicate HIV itself as the inflammatory mediator that destroys primary and accessory lacrimal glands. Direct infection and damage to the conjunctiva may also be involved.^{26,27}

Sight-threatening complications and posterior segment manifestations were not common in our patients. These might be caused by the posterior segment lesions such as cytomegalovirus (CMV) retinitis and HIV microangiopathy were strongly associated with CD4+ count less than 200 cells/mm³^{19,28-30}.

Female gender showed higher prevalence of dry eye compare to male as reported by Asiedu K *et al* in 2017³¹. In the present study, females showed significant negative influence to develop ocular manifestations in multivariate analysis, patients aged ≥ 25 and heterosexual contact were also predictive factors. However because of the lower number of patients in these groups, this result should be cautiously concluded. One limitation of this study is a small number of the population studied.

Conclusion

This study showed the prevalence of non-sight threatening anterior segment and adnexal ocular manifestations was higher than posterior ocular manifestations in HIV/AIDS patients with high CD4+ T lymphocytes count during the HAART era. The most common ocular manifestation was DED. We recommend that patients who have any eye symptoms, should get an eye examination in spite of high CD4+ cells count level.

Acknowledgements

This study was funded by a research grant from Mahasarakham University (MSU) Faculty of Medicine. We thank the participants for their time, and the HIV/AIDS Clinic at MSU Faculty of Medicine's Suddhavej Hospital for access to the resources used.

Authors' contributions: Srihatrai P: design, data collection, writing and final approval; Rujkorakarn P: design, data collection, writing the paper and analysis of data; Watha T: design, and data collection.

Foundations: This study was funded by a research grant from Mahasarakham University (MSU) Faculty of Medicine.

Conflicts of Interest: Rujkorakarn P, None; Watha T, None; Srihatrai P, None.

References

1. Gottlieb MS, Schroff R, Schanker HM, Weisman JD, Fan PT, Wolf RA, Saxon A. Pneumocystis carinii pneumonia and mucosal candidiasis in previously healthy homosexual men: evidence of a new acquired cellular immunodeficiency. *N Engl J Med* 1981;305(24):1425-31. (<https://www.ncbi.nlm.nih.gov/pubmed/6272109>)
2. Masur H, Michelis MA, Greene JB, Onorato I, Stouwe RA, Holzman RS, Wormser G, Brettman L, Lange M, Murray HW, Cunningham-Rundles S. An outbreak of community-acquired Pneumocystis carinii pneumonia: initial manifestation of cellular immune dysfunction. *N Engl J Med* 1981;305(24):1431-8. (<https://www.ncbi.nlm.nih.gov/pubmed/6975437>)
3. UNAIDS Joint United Nations Programme on HIV/AIDS (UNAIDS). UNAIDS 2017 report on the global AIDS epidemic. Switzerland, *UNAIDS Joint United Nations Programme on HIV/AIDS 2017*. Available from www.unaids.org/sites/default/files/media_asset/2017_data-book_en.pdf (Last accessed April 7, 2018).
4. Mehta R, Mehta P, Mohanty L, Bedi N, Punjabi S, Jain R, Nagar CK. Changing pattern of ophthalmic manifestation in AIDS patients in post HAART era. *Int J Adv Health Sci* 2014;1(5):15-22. (<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.683.9445&rep=rep1&type=pdf>)
5. Kestelyn PG, Cunningham ET. HIV/AIDS and blindness. *Bull World Health Organ* 2001;79(3):208-13. (<https://www.ncbi.nlm.nih.gov/pubmed/11285664>)

6. Vrabec TR. Posterior segment manifestations of HIV/AIDS. *Surv Ophthalmol* 2004;49(2):131-57. (<https://www.ncbi.nlm.nih.gov/pubmed/14998690>)
7. Jabs DA. Ocular manifestations of AIDS. *Curr Opin Ophthalmol* 1990;1(2):171-175. (https://journals.lww.com/co-ophthalmology/citation/1990/04000/ocular_manifestations_of_aids.16.aspx)
8. Goldberg DE, Smithen LM, Angelilli A, Freeman WR. HIV-associated retinopathy in the HAART era. *Retina* 2005;25(5):633-49. (<https://www.ncbi.nlm.nih.gov/pubmed/16077362>)
9. Jeng BH, Holland GN, Lowder CY, Deegan WF 3rd, Raizman MB, Meisler DM. Anterior segment and external ocular disorders associated with human immunodeficiency virus disease. *Surv Ophthalmol* 2007;52(4):329-68. (<https://www.ncbi.nlm.nih.gov/pubmed/17574062>)
10. Kim YS, Sun HJ, Kim TH, Kang KD, Lee SJ. Ocular manifestations of acquired immunodeficiency syndrome. *Korean J Ophthalmol* 2015;29(4):241-248. (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4520867/>)
11. Bureau of AIDS, TB and STIs. Thailand National Guidelines on HIV/AIDS Treatment and Prevention 2017. Thailand, *Bureau of AIDS, TB and STIs*. Available from www.silomclinic.in.th/file/Thailand_National_Guidelines_on_HIV_AIDS_Treatment_and_Prevention_2017.pdf (Last accessed April 24, 2018).
12. McGinnigle S, Naroo SA, Eperjesi F. Evaluation of dry eye. *Surv Ophthalmol* 2012;57(4):293-316. (<https://www.ncbi.nlm.nih.gov/pubmed/22726587>)
13. Chiffman RM, Christianson MD, Jacobsen G, Hirsch JD, Reis BL. Reliability and validity of the Ocular Surface Disease Index. *Arch Ophthalmol* 2000;118(5):615-21. (<https://www.ncbi.nlm.nih.gov/pubmed/10815152>)
14. Bron AJ. Diagnosis of dry eye. *Surv Ophthalmol* 2001;45 Suppl 2:S221-6. (<https://www.ncbi.nlm.nih.gov/pubmed/11587146>)
15. Cunningham ET. Diagnosing and treating herpetic anterior uveitis. *Ophthalmology* 2000;107(12):2129-30. ([https://www.aaojournal.org/article/S0161-6420\(00\)00287-6/fulltext](https://www.aaojournal.org/article/S0161-6420(00)00287-6/fulltext))
16. Abu EK, Abokyi S, Obiri-Yeboah D, Ephraim RK, Afedo D, Agyeman LD, Boadi-Kusi SB. Retinal microvasculopathy is common in HIV/AIDS patients: a cross-sectional study at the Cape Coast Teaching Hospital, Ghana. *J Ophthalmol* 2016;2016:8614095. (<https://www.hindawi.com/journals/joph/2016/8614095/>)
17. Martin-Odoom A, Bonney EY, Opoku DK. Ocular complications in HIV positive patients on antiretroviral therapy in Ghana. *BMC Ophthalmol* 2016;16:134. (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4973055/>)
18. Biswas J, Fogla R, Gopal L, Narayana KM, Banker AS, Kumarasamy N, Madhavan HN. Current approaches to diagnosis and management of ocular lesions in human immunodeficiency virus positive patients. *Indian J Ophthalmol* 2002;50(2):83-96. (<https://www.ncbi.nlm.nih.gov/pubmed/12194584>)
19. Pathai S, Deshpande A, Gilbert C, Lawn SD. Prevalence of HIV-associated ophthalmic disease among patients enrolling for antiretroviral treatment in India: A cross-sectional study. *BMC Infect Dis* 2009;9:158. (<https://www.ncbi.nlm.nih.gov/pubmed/19775470>)
20. Wang Z, Jia R, Ge S, He T, Zhang Y, Yang Y, Wang Y, Shi W, Ji Y, Ye F, Chen P, Lu J, Sun J, Xu X, Zhou Y, Gu P, Luo M, Lu H, Fan X. Ocular complications of human immunodeficiency viral infection in eastern China. *Am J Ophthalmol* 2012;153(2):363-369.e1. (<https://www.ncbi.nlm.nih.gov/pubmed/21982101>)
21. Amsalu A, Desta K, Nigussie D, Delelegne D. Ocular manifestation and their associated factors among HIV/AIDS patients receiving highly active antiretroviral therapy in Southern Ethiopia. *Int J Ophthalmol* 2017;10(5):776-781. (<https://www.ncbi.nlm.nih.gov/pubmed/28546937>)
22. Yared A, Asfawessen G, Azanaw M. Ocular manifestations of HIV/AIDS patients in Gondar university hospital, north west Ethiopia. *Ethiop J Health* 2006;20(3):166-169. (https://www.researchgate.net/publication/242512213_Ocular_manifestations_of_HI)

- VAIDS_patients_in_Gondar_University_Hospital_North_West_Ethiopia)
23. Sahoo S. HIV- and AIDS-related ocular manifestations in Tanzanian patients. *Malays J Med Sci* 2010;17(1):12–16. (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3216149/>)
 24. Edathodu J, Ali B, Alrajhi AA. CD4 validation for the World Health Organization classification and clinical staging of HIV/AIDS in a developing country. *Int J Infect Dis* 2009;13(2):243-6. (<https://www.ncbi.nlm.nih.gov/pubmed/18945632>)
 25. Bekele S, Gelaw Y, Tessema F. Ocular manifestation of HIV/AIDS and correlation with CD4+ cells count among adult HIV/AIDS patients in Jimma town, Ethiopia: a cross sectional study. *BMC Ophthalmol* 2013;13:20. (<https://www.ncbi.nlm.nih.gov/pubmed/23710936>)
 26. Acharya NR, Cunningham ET. Corneal, anterior segment, and adnexal manifestations of human immunodeficiency virus. *Int Ophthalmol Clin* 1998;38(4):161-77. (<https://www.ncbi.nlm.nih.gov/pubmed/10081732>)
 27. Biswas J, Sudharshan S. Anterior segment manifestations of human immunodeficiency virus/acquired immune deficiency syndrome. *Indian J Ophthalmol* 2008;56(5):363-75. (<https://www.ncbi.nlm.nih.gov/pubmed/18711264>)
 28. Gogri PY, Misra SL, Kothari RN, Bhandari AJ, Gidwani HV. Ophthalmic manifestations of HIV patients in a rural area of western Maharashtra, India. *Int Sch Res Notices* 2014;2014:347638. (<https://www.hindawi.com/journals/isrn/2014/347638/>)
 29. Kumar P, Vats DP, Mishra S, Makkar A, Banarji A, Patyal S, Gurunadh VS. CD4 counts: a strong indicator of retinal and ocular lesions in HIV disease. *Med J Armed Forces India* 2011;67(4):354–357. (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4920618/>)
 30. Chiotan C, Radu L, Serban R, Cornăcel C, Cioboată M, Anghelie A. Posterior segment ocular manifestations of HIV/AIDS patients. *J Med Life* 2014;7(3):399-402. (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4233448/>)
 31. Asiedu K, Kyei S, Boampong F, Ocansey S. Symptomatic Dry Eye and Its Associated Factors: A Study of University Undergraduate Students in Ghana. *Eye Contact Lens* 2017;43(4):262-266. (<https://www.ncbi.nlm.nih.gov/pubmed/26963438>)