Vol. 13, No. 2, December 2025 pp. 249-268

RESEARCH REPORTS

Epidemiology and Visual Impairment of Ocular Toxoplasmosis in the Maldives: A Descriptive and Analytical Study

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ABSTRACT *Ocular toxoplasmosis (OT) caused by the protozoon Toxoplasma gondii is the leading cause of permanent blindness in the Maldives.3 This study aims to describe the epidemiology of OT in the Maldives. This is a retrospective cross-sectional study comprising 60 participants, which utilized census sampling to identify patients diagnosed with OT, enlisted on HINAI, the database of the government tertiary hospital in the capital city of Maldives, Indira Gandhi Memorial Hospital (IGMH), as well as from VINAVI, the database of the universal health insurance scheme of Maldives, Aasandha between the years 2021 to 2024. The study demonstrates the association of the visual outcomes of OT based on age, gender, socioeconomic factors, contact with pets, comorbidities and clinical manifestations. Sociodemographic data was collected via phone interviews following verbal consent and the clinical data was extracted from the respective databases. Our findings revealed that severe visual impairment in OT was most commonly observed among lower income groups, elderly patients above the age of 55 years, equally distributed between both genders; male and female and in patients from southern Maldives compared to central and northern Maldives. In addition, severe visual impairment was observed in patients with chronicity of the disease for more than five years. Significant correlation was found between visual acuity and the location of lesion, type of scar and having an underlying comorbidity such as diabetes.*

Key Words: Epidemiology, Ocular toxoplasmosis, Toxoplasma gondii, Visual impairment

Introduction

Toxoplasma gondii is an obligate intracellular protozoon and one of the most common protozoan infections affecting the eye, transmitted either congenitally or through acquired infection. The life cycle of T. gondii consists of three key stages: the rapidly dividing tachyzoite responsible for acute disease, the slowly dividing bradyzoite within tissue cysts, and oocysts shed in the feces of infected felines that are the definitive hosts. Among domesticated pets, cats are the most common definitive host. Humans typically become infected through ingestion of undercooked meat harboring tissue cysts, contaminated water with oocysts, or by vertical transmission during pregnancy who most commonly acquire the infection by handling cat litter. While many individuals with T. gondii infection remain asymptomatic, approximately 2% of those infected develop ocular manifestations with an estimated 500 million people worldwide having been exposed and testing positive for antibodies (Sehu & Lee, 2012; Crick & Khaw, 2003).

ISSN 2308-5959/20251231

OT is the most common cause of posterior uveitis worldwide and typically presents as a necrotizing retinitis adjacent to a pigmented chorioretinal scar. The characteristic fundoscopic sign, often referred to as the "headlight-in-fog," results from active retinal lesions obscured by dense vitritis. Other manifestations may include satellite lesions, retinal vasculitis, and inflammatory ocular hypertension (Khandwala et al., 2020). Patients may experience floaters, blurred vision, or photophobia, often with unilateral acute or subacute onset. Severe visual impairment, such as vision of 20/200 or worse, has been reported in up to 24% of affected individuals (Khandwala et al., 2020).

In immunocompromised individuals, such as those with HIV, OT can have an atypical and fulminant presentation. These patients may present with multifocal lesions, minimal vitritis, or bilateral involvement. Evidence also shows that acquired disease reactivation may be more prevalent than congenital in such populations (Ryan, 2006; Zhang et al., 2022). Additionally, serological studies have suggested possible associations between T. gondii infection and diabetes mellitus (Lin et al., 2018).

Complications of OT include macular scarring, glaucoma, choroidal neovascularization, and retinal detachment. Vascular complications, such as retinal vasculitis and vitreoretinal traction, may also lead to significant vision loss (Park et al., 2013; Kalogeropoulos et al., 2022). According to Abu et al. (2015), the most disabling visual outcomes are related to involvement of the macula, optic nerve, or bilateral ocular involvement, often influenced by the virulence of the strain and host genetic factors.

Globally, the seroprevalence of T. gondii infection is estimated to be between 25% and 30%, with higher rates in Latin America, tropical Africa, and parts of South Asia (Goh et al., 2022). For instance, in Indian states such as Punjab and Kashmir, the prevalence has been reported to be 63% and 48%, respectively (Khan et al., 2017). In Bangladesh, T. gondii antibodies have been detected in livestock, suggesting zoonotic risk, with seroprevalence ranging from 12% in cattle to 40% in sheep. Similarly, OT seroprevalence is influenced by geographic, socioeconomic, and environmental factors. Contaminated drinking water, low income, poor hygiene, and pet ownership (particularly cats) have been implicated in various studies (Petersen et al., 2012; Gómez-Marín et al., 2021; Lin et al., 2018; Li et al., 2022).

OT disproportionately affects younger, economically productive populations. In the Maldives, a screening in Gn. Fuvahmulah in 2009 revealed OT-related effects in 3.03% of the population. Furthermore, it has been identified as a leading cause of permanent vision impairment in individuals aged 10 to 45, according to the Maldives Action Plan for Vision 2010 - 2020 (Center for community health and disease control & Ministry of health and family, 2010). However, despite its impact, data on the national prevalence and clinical profile of OT remains limited.

Therefore, our research aims to study the prevalence of ocular toxoplasmosis in the Maldives by defining the demographic and clinical characteristics of affected patients. We also assessed visual outcomes and explored associations with clinical and demographic variables to better understand the factors influencing prognosis in OT patients within the Maldivian population.

Objectives and hypothesis

Through our research, we aim to describe the demographics and clinical characteristics of patients diagnosed with OT at IGMH and cases retrieved from Aasandha database from 2021 to 2024. In addition, we seek to examine the associations between visual acuity and various demographic, socioeconomic, and clinical factors. These include age and gender predilection, household income, region of residence within the Maldives, type of drinking water, pet ownership, presence of comorbidities, and other relevant clinical features.

Methodology

Research design

This is a retrospective cross-sectional research design using data from January 2021 to December 2024 to assess the prevalence of OT in the Maldives. This research design identifies the clinical spectrum of the disease by descriptive analysis of visual acuity with factors such as the demographics and clinical characteristics noted in patients diagnosed with OT in the Department of Ophthalmology, IGMH and a subset of data from Aasandha portal from January 2021 to December 2024.

Sample, population or subjects

We used a census sampling method to select participants from our target population based on inclusion criteria of : (1) Patients diagnosed with OT in IGMH or within our subset of data from Aasandha during the study duration and (2) patients referred to IGMH with a diagnosis of OT. Patients were excluded from our study as per our exclusion criteria of : (1) Patients diagnosed with infectious eye diseases other than OT (2) Patients with incomplete medical records and (3) patients and guardians/parents who refused to give consent for participation. The total sample size following the application of both criteria was 60.

Data collection

For the purpose of data collection, we retrieved a list of diagnosed cases of OT in IGMH as well as from an available subset of data from Aasandha portal from January 2021 to December 2024, following which the data collection took place in 2 phases.

In phase 1, phone interviews were conducted to all the patients in our list, verbal consent and socio-demographic details were obtained. Section A and B of our research questionnaire was completed in the phase 1 of data collection. (11-Appendices ; Questionnaire).

In phase 2, relevant clinical data was obtained from the IGMH medical record's database HINAI as well as Aasandha portal. Section C of our research questionnaire was completed in the phase 2 of data collection. (11-Appendices ; Questionnaire).

Data management and data analysis

The raw data collected from the interviews with the participants and medical records were documented and entered in a google sheet accessible only by the research team during the period of data collection. The data was then cleaned and coded and exported into Statistical Package for Social Sciences (IBM SPSS

Statistics 30.0.0.0).

Descriptive analysis of the data in the form of frequency, percentage, mean, mode and median was carried out. Chi-Square analysis was carried out to determine any significant association between visual acuity and age and gender predilection, household income, region of Maldives, type of drinking/potable water, having pets, occupation comorbidities and clinical characteristics (Hypothesis 1).

Results

The final analysis comprised of 60 patients after the exclusion criteria and since data was taken from only one center across four years. However, because of missing data for certain variables, the sample size varies across analyses and does not always total to 60. For the 60 patients, chi-square analysis was conducted to examine associations between various demographic, clinical, and socioeconomic factors with visual acuity. Fisher exact was used due to small sample size in all variables.

Age distribution in OT patients

The participants were divided into four categories, 0-14 years (11.66%), 15-35 years (43.4%), 35-55 years (31.7%) and greater than 55 years (13.3%). The participants with visual impairment were categorized into moderate (visual acuity <6/18 - 6/60), severe (<6/60 - 3/60) and complete vision loss (<3/60-1/60). Most patients with moderate visual impairment were in the age group of 35-55 years with 78.94%. Alternatively, the majority of patients who presented with symptoms above the age of 55 had severe visual impairment with an occurrence of 25%. Patients who presented with symptoms at the age of 0-14 had no visual impairment (28.57%). Looking at the chi- square analysis, it yielded a p value of 0.507 with a degree of freedom of 6. This shows that there is no significant association between the age of presenting symptoms at presentation of symptoms and visual acuity (11. Appendices - Table 1 & 2)

Gender distribution and visual acuity in OT

The sample population had a slight predominance of female patients (56.7%) compared to males (43.3%). Males had a slightly lower proportion of no visual impairment (73.53%) compared to females (76.92%). The prevalence of moderate visual impairment was higher in males (17.65%) than in females (11.54%). The distribution of severe visual impairment was more or less similar between the two groups (8.82% in males and 11.54% in females). Chi- square analysis showed no significant relation between gender and visual impairment ($X2 = 0.498$, $df = 2$, $p = 0.826$) (11.Appendices - Table 1 & 2).

OT in different regions of Maldives

Residents at the time of diagnosis of the patients were categorized based on the region of their atoll; central, north, and south Maldives. Most patients were noted to be from central with a total of 50% compared to 23.3% and 26.7% in north and south atolls respectively. Patients from the central region had the highest proportion of no visual impairment (76.67%), followed by those from the north (78.57%) and the south (68.75%). Severe visual impairment was most common in the south (18.75%), compared to Central (6.67%) and northern (7.14%) regions.

Chi- square analysis showed no statistical significance between residence and visual impairment (X2 = 1.918, df = 4, p = 0.767).(11.Appendices - Table 1 & 2).

Household income and OT

Household income was categorized as lower income group ; < Maldivian Rufiyaa (MVR) 15000, middle income group; MVR 15000 - MVR 25000 and higher income group ; > MVR 25000. A higher proportion of individuals with higher income had no visual impairment (88.89% in the > MVR 25,000 group compared to 64.29% in the < MVR 15,000 group. Moderate and severe visual impairment were more prevalent in the lower income group, with the absence of severe impairment in the middle-income category. Chi-square analysis showed that there was no significance between visual acuity and average household income (X2 = 6.008, df = 4, p = 0.197) (11.Appendices - Table 1 & 2).

Association between the types of potable/drinking water and OT

Moreover, the type of drinking water consumed by the participants was categorized into collected rain water, bottled water, and mixed water (both rain and bottled water). 43.3% of the population consumed mixed water, while 35% only consumed rainwater and another 21.7% consumed exclusively bottled water. The majority of the people had no visual impairment regardless of their type of drinking water. Chi- square analysis showed that there was no significance between visual acuity and type of drinking water (X2 = 2.582, df = 4, p = 0.685) (11.Appendices - Table 1 & 2).

Association between pets and OT

Pet ownership was categorized into ownership of cats, other animals, and no pets. The majority of participants had no pets (71.7%) while only 21.7% had cats at home. Moderate visual impairment was highest among those with pets (cats: 76.92% and ; other animals: 74.42%). Chi square analysis revealed that there was no significance between visual acuity and pets (X2 = 3.332, df = 4, p = 0.467) (11. Appendices - Table 1 & 2).

Association between undercooked meat consumption and OT

Only 20% of the subjects consumed uncooked meat, while 80% consumed cooked meat only. On comparison of intake of undercooked meat with visual acuity, the majority of the people had no visual impairment irrespective of consuming undercooked meat. Chi-square analysis indicates that there was no significant correlation between visual acuity and intake of undercooked meat (X2 = 2.5, df = 2, p = 0.371) (11.Appendices - Table 1 & 2).

Distribution of the onset of symptoms in OT

In our study, we categorized the onset of symptoms as sudden and insidious. The majority of patients had sudden onset of symptoms which was 65%, while 31.6% of patients had insidious onset of symptoms. In comparison with visual acuity, the majority of patients who had sudden onset of symptoms had moderate visual impairment which was 84.61%. Whereas, 7.7% of patients with sudden onset of symptoms had severe visual impairment. Furthermore, patients who had insidious onset of symptoms had a significantly higher percentage of moderate visual loss i.e., at 57.9% and severe visual impairment was 15.78%. 7.7% and 26.31 % of patients reported no visual impairment with sudden onset of symptoms and insidious onset of symptoms, respectively. Chi- square analysis showed no significance between the onset of symptoms and visual acuity (X2 = 5.161, df = 2, p = 0.079).(11. Appendices - Table 1 & 2)

Distribution of the presenting symptoms in OT

Additionally, the presenting symptoms were sorted into three groups, 1) patients who presented with dark spots, 2) decreased vision and 3) others. Among these, decreased vision was the most common presentation at 58.3% and patients who presented with other symptoms were lesser in number. In comparison to visual acuity those patients who presented with dark spots severe visual impairment was 15.38% and the patients who presented with other symptoms with more moderate visual impairment was 91.6%. However, a greater number of participants who presented with dark spots had no documented visual impairment, representing 23.08% of the population. Performing the chi- square analysis showed that there is no significance between presenting symptoms and visual acuity (X2 = 3.35, df = 4, p = 0.539).(11.Appendices - Table 1 & 2)

Distribution of the duration of illness in OT

We also assessed the duration of ocular toxoplasmosis, categorizing participants into two groups: those who have the illness for less than 5 years (53.3%) and those with more than 5 years (31.6%). Moderate visual impairment was the most common in both groups, affecting 78.13% of participants with < 5 years of illness and 68.4% of those with > 5 years. However, severe visual impairment was more prevalent among patients with a duration of illness > 5 years (15.79%) compared to those with < 5 years. The chi- square analysis indicated that there was no significance between duration of illness and visual acuity (X2 = 1.379, df = 2, p = 0.497).(11.Appendices - Table 1 & 2)

Distribution of the laterality in OT

From our study sample, the unilateral eye was affected in 56 participants (93.4%). The remaining 4 (6.7%) of the participants were affected with OT in both eyes. Further comparison with laterality and its effect on visual acuity, revealed that in the right, left and bilateral eyes majority of the participants had moderate visual impairment representing 77.42%, 72% and 75%, respectively. Furthermore, severe visual impairment was highest in cases of bilateral OT (25%) and lowest in cases affected on the right eye. However, chi-square analysis revealed that there was no significant association ($X^2 = 4.474$, df = 4, p = 0.300) between laterality of disease and degree of visual impairment (11.Appendices - Table 1 & 2).

Fundoscopic findings in OT

Amid our 60 participants, fundoscopic/slit lamp findings tables were available for 54 participants. We classified the findings into presence of lesion (61.1%), retinal findings (9.3%), macula findings (14.8%), and anterior segment findings (18.5%). The presence of lesion was further categorized into inflammatory lesion, resolving lesion and chorioretinal/retinal scar. Among the 54 with the available findings, 57.6% had chorioretinal/retinal scar, active and resolving lesions were present in 24.2% and 18.2% of the participants, respectively. Subsequently, anterior segment findings were further classified into the presence of anterior chamber cells, anterior vitreous cells and pigments. Among the 10 participants with anterior segment findings, anterior chamber cells were found in 60% of participants and anterior vitreous cells were found in 30% of participants. Pigments were observed in the anterior chamber in 10% of participants (11.Appendices - Table 3).

Distribution of the type of lesion in OT

Moreover, upon further evaluation of the lesions identified in the fundoscopic findings and their impact of the visual acuity revealed that the majority of the cases with chorioretinal/retinal scars represented 62.5% of the participants, whereas, 84.2% (16) did not have any visual impairment. Furthermore, visual impairment was absent in all resolving lesions. Severe visual impairment was observed only in inflammatory lesions representing 18.75% of cases.

Chi-square analysis conducted to assess the association between the type of lesions and degree of visual impairment indicated no significant association between degree of visual impairment and the type of lesion ($X^2 = 6.727$, df = 4, p = 0.212) (11.Appendices - Table 1 & 2).

Association between comorbidities and OT

Furthermore, the majority of patients, 81.7%, had no comorbidities, while 18.3% had at least one comorbidity such as dyslipidemia, diabetes mellitus, hypertension, cardiovascular disease, and thyroid disease. A chi-square test indicated a statistically significant relationship between visual acuity and comorbidities (X2 = 5.172, df = 2, p = 0.042).(11.Appendices - Table 1 & 2).

OT complications

In the study sample, 65% of patients had no complications, while 35% experienced one or more complications. The most common complication observed was iridocyclitis, affecting 6.7% of patients. Other complications included unilateral blindness, cataracts, and epiretinal membranes, with less common complications such as macular holes, neovascularization, posterior synechiae, retinal detachment, snowball opacities, vitreous cells, and vitreous opacity. There was no statistically significant relationship between the lesion status and the occurrence of complications (X2 = 2.858, df = 2, p = 0.28) (11.Appendices - Table 1 & 2).

Laboratory parameters in OT

Lastly, Toxoplasma IgG and IgM indices revealed that: 58.3% had chronic infection, 12.5% presented with acute infection, and 9.2% showed no evidence of infection meaning that IgG and IgM levels were negative for these patients . A significant relationship was not found between visual acuity and Toxoplasma serological values (X2 = 6.4, df = 4, p = 0.153) (11.Appendices - Table 1 & 2)

In phase 2, relevant clinical data was obtained from the IGMH medical record's database HINAI as well as Aasandha portal. Section C of our research questionnaire was completed in the phase 2 of data collection. (11-Appendices ; Questionnaire).

Discussion

In our study, elderly patients (>55 years) were noted to have a higher percentage of severe visual impairment which aligns with observations by De-La-Torre et al., (2025), suggesting poorer visual outcomes in older patients. However, the lack of statistical significance in our study suggests that age may not be a definitive factor in poorer visual outcomes due to OT in Maldives.

Visual impairment was fairly distributed between male and females. The difference is likely attributable to the larger number of female participants in the sample. Although no statistical significance was noted, our findings align with the findings of Lyons et al., (2023), which suggests that both males and females have similar visual acuity outcomes following OT.

In addition, the regional variations observed in our study where patients from the southern region had a higher proportion of severe visual impairment compared to patients from other regions of Maldives. Our findings align with the findings of Sittivarakul et al., (2024), which demonstrated poorer visual outcomes in southern Thailand compared to central Thailand indicating that regional differences may influence visual outcomes.

In our study, 17.86% of the participants who had an average monthly income of less than MVR 15000 were noted to have severe visual impairment, while the percentage was less in participants with an income above MVR 15000. This is supported by a study done in Quindio, Colombia to identify the sociodemographic, clinical and environmental factors associated with recurrences in OT, which found that a larger size of lesions were observed in low socioeconomic groups leading to poor visual outcomes (Velasco-Velásquez et al., 2020).

A study conducted within Southern Brazil revealed that a T. gondii epidemic affecting 426 individuals was traced to a contaminated drinking water cistern, indicating an association between the drinking water source and toxoplasmosis (Mareze et al., 2019). However, in our study, the type of drinking water did not show any statistically significant association with degree of visual impairment in the majority of the participants diagnosed with OT irrespective of the type of water they drank before the diagnosis. However, we hypothesize that drinking water might have an association because some islands of Maldives rely on rainwater harvesting and stray cats are predominantly present all over the Maldives.

Additionally, in our sample, the majority of the participants did not have any pets. The majority of the participants had moderate visual impairment irrespective of having pets or not. However, we hypothesize that though the participants did not have pet cats, there might have been an indirect association with stray cats. There is a strong association between toxoplasmosis and having pet cats at home (Lin et al., 2018). Another study done in pet cats and their owners in northeastern China revealed that the seroprevalence of T. gondii infection are widespread in pet cats and their owners in Jilin province, northeastern China (Li et al., 2022).

Furthermore, in a case study done to find associations between OT and raw meat consumption, it was found that all participants had a highly suggestive temporal relationship between eating undercooked meat and developing systemic and ocular toxoplasmosis (Kohler et al., 2022). This contrasts with our findings where there was no statistically significant association between intake of raw or undercooked meat and visual acuity. This disparity could be due to the small sample size of our study. In our study, the absence of significant association between OT and consumption of undercooked meat might be due to very limited livestock farming in Maldives. Majority of the meat is imported into Maldives in a frozen condition primarily from countries such as Australia, India and United Arab Emirates. Freezing the meat kills the larval stages in the meat.

In our study, we found that decreased vision was the most common clinical presentation in OT in the majority of the patients, which was 58.3% that is in line with similar findings in studies performed by Gomez-Marrin et al., (2021) and Park et al., (2013). Although, there was limited research to support the relation between age at presentation and visual acuity, there are studies that suggest that older patients have poorer visual outcomes (De-La-Torre et al., 2025). Another study conducted in the Uveitis Clinic at the University Department of Ophthalmology, Charité Campus Virchow Klinikum, Berlin, Germany showed that OT patients over 35 years tend to present a lower baseline visual acuity than younger ones, both before and after therapy (Eraghi et al., 2024).

Most patients with OT are asymptomatic and are diagnosed at routine checkups according to Kanski et al., (2019). However, in our research the majority of the participants presented with sudden onset of symptoms of OT which correlates with Stokkermans & Havens, (2023)

demonstrating sudden onset of symptoms. Although, it is evident that longer duration of OT can lead to worsening of vision as stated by Park et al., (2013), our study demonstrates that there was no significance between duration of illness and visual acuity.

Our study demonstrates slight unilateral predominance of OT which aligns with the observations in recent studies by Arruda et al., (2021), de-la-Torre et al., (2025) and Sittivarakul et al., (2024). According to our data, the majority of cases of both unilateral and bilateral manifestation resulted in a moderate visual impairment. This suggests that the degree of visual impairment in patients is more likely affected by the factors related to the lesion; size, number and location (Arruda et al., 2021).

Additionally, visual impairment was observed in 25% of our participants, with the majority of them having moderate visual impairment. This aligns with similar findings by de-la-Torre et al., (2025), reporting that while the predominant portion of the population maintain their functional vision, a subset of patients develop debilitating visual defects. Additionally, they also report the possible factors associated with functionally limiting visual impairment to be age less than 16 years or greater than 50 years and bilateral involvement.

In our research, we found a predominant percentage of the patients are affiliated to have inactive disease while the remaining had active lesions. This corresponds to the findings reported by de-la-Torre et al., (2025) that displays the most common stage of OT to be observed is the inactive stage. Although moderate visual impairment was predominantly observed in both inactive and active disease, our study did not find a statistical association between the status of the lesion and degree of visual impairment. This finding further supports the assertion that the visual impairment is likely to be affected by the lesion characteristics (Arruda et al., 2021).

Fundoscopic findings revealed chorioretinal/retinal scar to be the most predominant finding, whereas chorioretinitis was the predominant retinal finding. Meanwhile, macular scar was the sole macular finding noted and was seen in 14% of participants. This aligns with the study by Kalogeropoulos et al., 2021, which mentions that retinochoroiditis is the most prevalent feature of active intraocular inflammation in patients with ocular toxoplasmosis and more than 70% of the patients included in this study are found to have both an active lesion and an older retinal scar on their first ophthalmological examination.

Additional assessment of the fundoscopic findings revealed that while the majority of cases with inflammatory and resolving lesions as well as chorioretinal/ retinal scar did not exhibit any visual impairment, a minor subset of cases with inflammatory lesions exhibited severe visual impairment. This implies that the severity of visual impairment is affected by the location of lesion, the immunological status of the participant and the visual acuity before disease manifestation, rather than the stage of lesion (Sittivarakul et al., 2024). Our study shows no significant statistical association between the type of lesion and visual impairment. However, further research with a larger sample size might be needed to ascertain the lesion factors associated with poor visual outcomes, in order to prevent debilitating visual impairment.

Noticeably, participants with macular scarring had a significantly worse visual outcome with the majority of the cases exhibiting moderate and severe visual impairment in contrast to cases with chorioretinal scars in which the majority of cases exhibited no visual impairment. These findings are consistent with those of Sittivarakul et al., (2024c) that indicate macular scarring and vitreous opacities as well as other complications as detriments to poor visual outcomes. A study in Brazil with 262 individuals found that macular lesions were significantly associated with poor visual outcomes (Arruda et al., 2021). Macular involvement often leads to decreased visual acuity, while peripheral lesions typically result in minimal visual impairment (Duraffour et al., 2020). Our research demonstrated a significant association between presence, type of scarring and visual impairment. Hence, these findings emphasize the involvement of macula as a key contributor to deterioration of vision and highlights the need for intervention to prevent macular damage in OT patients.

In addition, the impact of systemic comorbidities on visual outcomes in OT remains underexplored. Further research is needed to elucidate any potential associations. However, studies have been done to relate the role of immune status in OT progression and visual prognosis. A recent study revealed that immunocompromised patients were more likely to have larger retinitis lesions and experienced worse final visual acuity compared to immunocompetent patients (Sittivarakul et al., 2024). Our study revealed that there is a significant association between systemic comorbidities and visual outcomes in OT.

Moreover, complications like cataract, retinal detachment are frequently observed in ocular toxoplasmosis and can substantially impair visual function (Scherrer et al., 2006). A study of 262 Brazilian patients found that if an eye develops complications, it is more likely to have severely reduced vision compared to the eyes without complications (Arruda et al., 2021). However, our study did not reveal any significant association between the two variables probably as a result of smaller sample size.

In ocular toxoplasmosis, serological tests measuring IgG and IgM antibodies are primarily used to diagnose and differentiate between past and recent infections. While serological testing is crucial for diagnosing ocular toxoplasmosis, antibody titers alone do not reliably predict visual outcomes.

Limitations of the Study

One of the main limitations of our research was the small sample size. Additionally, the lack of sufficient data on each participant in HINAI and VINAVI portal made it more challenging to conduct a comprehensive analysis. These limitations prevented us from reaching certain conclusions, emphasizing the need for future studies with larger sample sizes and more detailed participants information.

Conclusion

Our study highlights the epidemiology and visual outcomes of OT in Maldives. Severe visual impairment due to OT is most commonly found in elderly patients from the southern region of Maldives with low-socio economic conditions. Proper control measures must be undertaken to prevent the ocular toxoplasmosis in Maldives with early diagnosis and intervention.

Acknowledgments

We would like to acknowledge Dr. P. Shaik Sayed Ali (Corresponding author, Assistant Professor, School of Medicine, Fathimath Rifa Moosa (Co-Corresponding author, Batch 4, School of Medicine, The Maldives National University) IGMH Ophthalmology Department and The Maldives National University School of Medicine for their continuous support in facilitating the necessary resources for data collection. Their assistance has been vital in enabling the smooth progression of our research.

Furthermore, we would like to extend our heartfelt gratitude to IGMH medical records department in providing the required data for this study. Their support has been indispensable in the successful completion of this study.

Ethical considerations

The necessary ethical guidelines were followed throughout the research process and the confidentiality and anonymity of the participants were maintained. Informed verbal consent was taken prior to the study and each participant was acquainted with the process of the research along with voluntary participation and choice to withdraw consent. For participants under the age of 18, consent was taken from the parent/guardian. Each participant was given a unique identifier code to maintain anonymity. The information obtained was compiled into a google sheet with no personal identification details included and was only accessible by the research team. The necessary ethical guidelines of The Maldives National University were adhered to throughout the research process and approval was obtained from The Maldives National University (MNU) Ethics Committee, National Healthcare Academy of Indira Gandhi Memorial Hospital and the National Health Research Council, Maldives.

Conflicts of interest

The authors declare no conflicts of interest.

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Appendices

Table 1. Distribution of the demographic and clinical factors

	Sample Population (n=60)	
Characteristic	**n**	**Valid %**
Age (yrs)		
15-35	24	40
35-55	23	38.3
>55	13	21.7
Gender		
Male	26	43.3
Female	34	56.7
Residence at diagnosis		

Central	30	50
North	14	23.3
South	15	26.7
Occupation		
Manual Jobs	10	16.7
Service Jobs	17	28.3
Professional Jobs	8	13.3
Unemployed	25	41.7
Type of drinking water		
Rain Water	21	35
Bottled Water	13	21.7
Mixed*	26	43.3
Pets		
Cats	13	21.7
Others	4	6.7
None	43	71.7
Income		
< MVR 15000	28	46.7
MVR 15000 - MVR 25000	14	23.3
> MVR 25000	18	30
Intake of raw/uncooked meat		
No	48	80
Yes	12	20
Onset of Illness		
Insidious	39	67.2
Sudden	19	32.8
Age at Presentation (yrs)		
0-14	7	11.7
15-35	26	43.3
35-54	19	31.7
>55	8	13.3
Duration (yrs)		
≤5	32	62.7
6+	19	37.3
Presenting Symptoms		
Dark Spots	13	21.7

Decreased Vision	35	58.3
Others*	12	20
Laterality		
Bilateral	4	6.7
Right Eye	31	51.7
Left Eye	25	41.7
Visual Acuity		
No visual impairment (>6/18)	45	75
Moderate (<6/18 – 6/60)	9	15
Severe (<6/60 - 3/60)	3	5
Blindness (<3/60 - 1/60)	3	5
Status of Lesion		
Active	20	33.3
Inactive	40	66.7
Location of Lesion		
Macula	12	27.3
Retina	32	72.7
Toxo IgG and IgM		
No Evidence of infection[1]	7	29.2
Acute Infection[2]	3	12.5
Chronic Intermediate[3]	14	58.3
Comorbidities		
Comorbidities*	11	18.3
No Comorbidities	49	81.7
Complications		
None	39	65
1 or more complications	21	35
- Blindness	3	5
- Cataract	3	5
- Epiretinal Membrane	3	5
- Iridocyclitis	4	6.7
- Macular hole	1	1.7
- Neovascularization	1	1.7
- Posterior synechia	1	1.7
- Retinal Detachment	1	1.7
- Snowball opacities	1	1.7

- Vitreous cells	1	1.7
- Vitreous Opacity	2	3.3

Mixed* includes participants who reported drinking water from multiple sources; rain water, bottled water, distilled water.
Others* include foreign body sensation, redness, pain, photophobia, swelling, tearing, itching and peripheral vision loss
Comorbidities* include dyslipidemia, Diabetes mellitus, hypertension, cardiovascular disease and thyroid disease.

[1]= IgG negative, IgM negative

[2]= IgG Equivocal, IgM positive

[3]= IgG Equivocal, IgM Equivocal

Table 2. Demonstration of statistical analysis chi-square between visual acuity and variables

Variables	Total	**Visual Acuity**			**X2**	**p value**	**df value**
		No Visual Impairment	**Moderate VI**	**Severe VI**			
	n=60	**n**	**n**	**n**			
Age (Years)					6.415	0.175	4
15-35	24	16	6	2			
36-55	23	20	2	1			
>55	13	9	1	3			
Gender					0.498	0.826	2
Male	34	25	6	3			
Female	26	20	3	3			
Residence at Diagnosis (Region of Maldives)					1.918	0.767	4
Central	30	23	5	2			
North	14	11	2	1			
South	16	11	2	3			
Occupation					0.58	1	6
Manual Jobs	10	8	1	1			
Professional Jobs	8	6	1	1			
Service Jobs	17	12	3	2			
Unemployed	25	19	4	2			
Type of Drinking Water					2.582	0.685	4
Rain Water	21	15	3	3			
Bottled Water	13	10	3	0			
Mixed	26	20	3	3			
Pets					3.332	0.467	4
Cats	13	3	10	0			

Others	43	5	32	6			
None	4	1	3	0			
Average Household Income (MVR)					6.008	0.197	4
< MVR 15000	28	18	5	5			
MVR 15000 - MVR 25000	14	11	3	0			
>MVR 25000	18	16	1	1			
Intake of Raw/Undercooked Meat					2.5	0.371	2
Yes	12	9	3	0			
No	48	36	6	6			
Onset					5.161	0.079	2
Sudden	39	3	33	3			
Insidious	19	5	11	3			
Age of Presentation (Years)					5.034	0.507	6
0-14	7	2	4	1			
15-35	26	4	20	2			
35-55	19	3	15	1			
>55	8	0	6	2			
Presenting Symptoms					3.135	0.539	4
Dark Spots	13	3	8	2			
Decreased Vision	35	5	26	4			
Others	12	1	11	0			
Duration (Years)					1.379	0.497	2
< 5 Years	32	5	25	2			
> 5 Years	19	3	13	3			
Laterality					4.474	0.3	4
Bilateral Eyes	4	0	3	1			
Left Eye	25	3	18	4			
Right Eye	31	6	24	1			
Status of lesion					1.883	0.415	2
Active	20	4	13	3			
Inactive	40	5	32	3			
Lesion Type					6.727	0.212	4
Inflammatory Lesion	16	10	3	3			
Resolving Lesion	6	6	0	0			
CR/Retinal Scar	19	16	3	0			

Toxo IgG and IgM Serologies					6.4	0.153	4
No evidence of infection	7	3	3	1			
Acute infection	3	3	0	0			
Chronic intermediate	14	12	2	0			
Complications					2.858	0.28	2
Complications	21	3	14	4			
No Complications	39	6	31	2			
Scar					10.708	0.022	4
CR Scar	17	15	2	0			
Macular Scar	7	2	3	2			
No scar	36	28	4	4			
Location of lesion					10.922	0.002	2
Macula	12	4	5	3			
Retina	32	2	29	1			
Comorbidities					5.172	0.042	2
Comorbidities	11	0	8	3			
No Comorbidities	49	9	37	3			

* *p value <0.005*

Table 3. Distribution of the fundoscopic findings

Fundoscopic/ Slit Lamp Findings	**n**	**%**
Lesion (n = 33)		
Active lesion	8	24.2
Resolving lesion	6	18.2
CR Scar / retinal scar	19	57.6
Retina (n = 5)		
Chorioretinitis	4	80
Active Retinitis	1	20
Macula (n = 8)		
Macular Scar	8	100
Anterior segment (n = 10)		
Anterior chamber cells	6	60
AVF cells	3	30
Pigments	1	10

Figure 1.Description of impairment of visual acuity

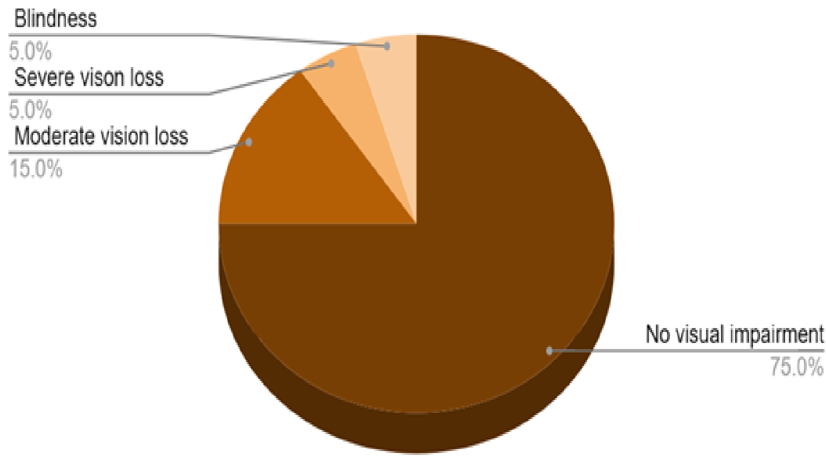

Figure 2. Chi-square analysis of location of lesion and visual acuity