

Epidemiology of Eye Diseases Among 3000 Patients in Western Sudan Amid Armed Conflict, 2023-2026

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ABSTRACT

Background: Understanding the epidemiology of eye disease improves public health, resource allocation, prevention, and quality of life. The present study aimed to characterize the epidemiology of eye diseases in a cohort of 3000 patients in Western Sudan during the armed conflict from 2023 to 2026.

Methodology: This study was conducted as a prospective descriptive analysis at Dr. Khalil Ophthalmology Center in El-Obeid City, North Kordofan State, Sudan, from July 1, 2023, to January 2026. The overall sample size for the specified timeframe was 3,000 patients.

Results: The most common eye diseases identified were surface eye diseases, followed by anterior segment and refractive errors (AS&RE), posterior segment and neuroophthalmological diseases (PSN), appendage diseases, and orbit and uveal tract (OUT), with prevalence rates of 40.2%, 38%, 15%, 6.4%, and 4.7%, respectively. Surface eye diseases comprised 78% of conjunctival diseases and 22% of corneal diseases. Of the appendages, 86.5% involved eyelid diseases, while 13.5% pertained to the lacrimal drainage system (LDS). PSN included 68.3% glaucoma, 23.2% retinal diseases, and 8.5% neuro-ophthalmological diseases. AS&RE diseases encompassed Lens (64.8%), Refractive Error (RE) (22.5%), and Anterior Chamber (AC) (0.3%). OUT consisted of 29.6% orbit cases and 70.4% uvea cases.

Conclusion: The prevalence of eye disease in Sudan is significantly elevated relative to other regions, influenced by various factors, notably the persistent armed conflict, poverty, and the deterioration of the health system. Cataracts, conjunctivitis, and refractive errors are common conditions.

Keywords

Eye disease, Ophthalmic disease, Cataracts, Conjunctivitis, Refractive errors, Sudan.

Introduction

Over 1 billion individuals worldwide are blind or visually impaired due to preventable or correctable causes. Ophthalmic treatments

are increasingly being evaluated for their effects on quality of life, which is a measure of physical, emotional, and social well-being. Vision impairment appears to impact quality of life significantly. Prompt cataract surgery and anti-vascular endothelial growth factor therapy for common retinal illnesses can enhance the quality of life for millions of individuals worldwide [1].

Vision impairment causes vary widely across and within countries. The availability and cost of eye care services and public understanding of vision-related diseases and how to prevent and treat them are key variables [2]. Unoperated cataracts cause more vision damage in low- and middle-income countries than in high-income countries [3,4]. Glaucoma and age-related macular degeneration (AMD) are more common in high-income countries [5].

On a global scale, refractive errors, cataracts, diabetic retinopathy, and ARMD are the most common causes of impaired or lost vision [6].

The Sudan war has and will continue to damage eye health through direct injuries, infectious disease spread, disrupted services, and socioeconomic deterioration, increasing preventable blindness and prolonged disability. We urgently need rapid, well-coordinated emergency eye-care interventions and the restoration of preventative public-health initiatives to reduce unnecessary vision loss and limit long-term effects [7-11].

In Sudan, eye diseases are influenced by a combination of infectious, nutritional, occupational, and chronic factors. Numerous causes of visual impairment are preventable or treatable; however, advancement necessitates coordinated efforts to enhance services, bolster workforce capacity, integrate eye care into primary health services, focus on high-burden areas, and refine surveillance. Such initiatives require data on the epidemiology of eye diseases in the country. This study aims to characterize the epidemiology of eye diseases in a cohort of 3000 patients in Western Sudan during the armed conflict from 2023 to 2026.

Materials and Methods

This was a prospective descriptive study conducted in Dr. Khalil Ophthalmology Center, in El-Obeid City, North Kordofan State, Sudan, from 1 July 2023 to January 2026. The overall sample size for the specified timeframe was 3,000 patients.

Inclusion and exclusion criteria: All individuals presenting at the center with ophthalmic complaints were included, irrespective of age, sex, or other demographic factors. Patients with eye trauma were excluded from the study, as they were directed to a different hospital that specialized in trauma management.

For all patients who arrived, we conducted a comprehensive history taking and thorough examination using a slit lamp to assess surface eye diseases and the anterior segments. This procedure was complemented by applanation tonometry for intraocular pressure evaluation, along with a 90D lens and ophthalmoscope for examining the retina and posterior segments. In certain cases involving the posterior segments, we employed A-scan and OCT. Additionally, MRI and CT scans were utilized for specific neuro-ophthalmological cases. We also performed the Schirmer test for dry eye assessment and used fluorescein dye to evaluate corneal ulcers. Additionally, an autorefractometer was employed to assess refractive errors.

Results

This study investigated 3,000 patients ranging from 4 months to 94 years, with an average age of 46 years. The majority of patients were aged 41–60 years, followed by those aged 19–40 years and over 70 years, with respective representations of 668 out of 3000 (22.2%), 623 (20.8%), and 587 (19.6%).

A total of 1429 (47.6%) males and 1571 (52.4%) females were included in the study. The majority of males were aged 8 years or younger, comprising 325 out of 1429 (22.7%), while the majority of females were aged between 41 and 60 years, totaling 364 out of 1571 (23.2%). The majority of patients were from urban areas, totaling 2208 (73.6%), while the remaining 792 (26.4%) were from rural areas, as shown in Table 1, Figure 1.

Table 1: Distribution of the patients by demographic features.

Variable	Males n=1429	Females n=1571	Total n=3000
Age			
≤8 years	325	255	580
19-40	263	360	623
41-60	304	364	668
61-70	262	280	542
71+	275	312	587
Residence			
Urban	1052	1156	2208
Rural	377	415	792

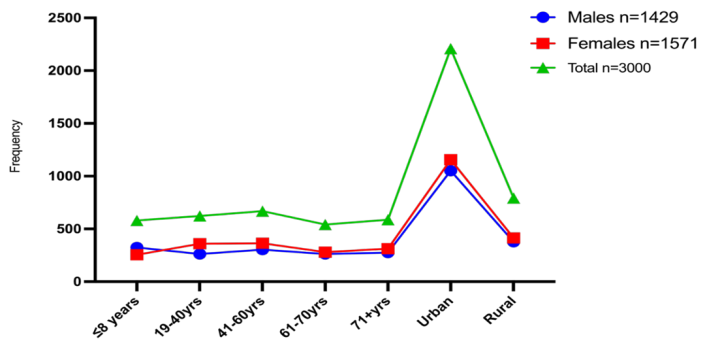


Figure 1: Description of the patients by demographic characters.

Table 2 and Figure 2 provide a comprehensive overview of the primary categories of eye diseases. The most common eye diseases identified included surface eye diseases, followed by anterior segments and refractive error diseases (AS&RE), posterior segments and neuroophthalmological diseases (PSN), appendage diseases, and orbit and uveal tract (OUT), with prevalence rates of 1207 out of 3000 (40.2%), 1141 (38%), 448 (15%), 192 (6.4%), and 142 (4.7%), respectively. A total of 1207 cases were analyzed, revealing that 944 (78%) were attributed to conjunctival diseases, while 263 (22%) were identified as corneal diseases. Of the appendages, 166 out of 192 cases (86.5%) were related to eyelid diseases, while 26 out of 192 cases (13.5%) involved the lacrimal drainage system (LDS). The PSN comprised 306 out of 448 cases (68.3%) related to glaucoma, 104 out of 448 cases (23.2%)

concerning retinal diseases, and 38 out of 448 cases (8.5%) associated with neuroophthalmological diseases. The AS&RE diseases comprised Lens 739 out of 1141 cases, accounting for 64.8%; Refractive Error (RE) 257 out of 1141 cases, representing 22.5%; and Anterior Chamber (AC) 3 out of 1141 cases, which is 0.3%. OUT consisted of 42 out of 142 cases (29.6%) involving the orbit and 100 out of 142 cases (70.4%) involving the uvea.

Table 2: Prevalence rates of overall Eye diseases.

Variable	Males	Females	Total
Surface Eye Diseases	606	601	1207
Concal diseases	144	119	263
Conjunctival diseases	462	482	944
Appendages	109	83	192
Eyelid	95	71	166
LDS	14	12	26
Neuroophthalmological diseases	214	234	448
Retina	48	56	104
Neuroophthalmological	17	21	38
Glaucoma	149	157	306
AS&RE	504	637	1141
Lens	340	399	739
RE	89	168	257
AC	1	2	3
OUT	74	68	142
Orbit	17	25	42
Uvea	57	43	100

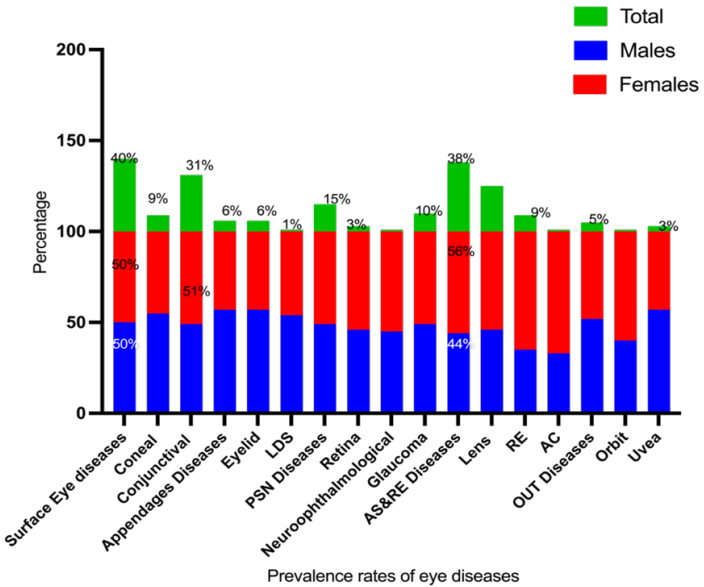


Figure 2: Proportions of prevalence rates of overall Eye diseases.

Table 3 and Figure 3 summarize the surface eye disorders. Corneal opacity was the most common corneal illness, followed by corneal foreign body (CFB) and ulcer, which accounted for 132/263 (50.2%), 53 (20.2%), and 51 (19.4%), respectively. Vernal keratoconjunctivitis (VKC) was the most frequent conjunctival disease, followed by dry eye, vitamin A deficiency (VAD), pterygium, conjunctivitis, and subconjunctival hemorrhage (SCH),

accounting for 429/944 (45.4%), 271 (28.7%), 94 (7.8%), 73 (7.7%), 52 (5.5%), and 17 (1.8%), respectively. Corneal disorders were quite similar between the sexes.

VKC was more prevalent in males than in females. The relative risk (RR) and 95% confidence interval (95% CI) of VKC among males were 1.3699 (1.1483 to 1.6342), $P = 0.0005$.

Females were more likely to have eye dryness than males, with an RR (95% CI) of 1.5310 (1.2097 to 1.9377), $P = 0.0004$.

VAD was more prevalent in men, with an RR (95% CI) of 1.4841 (0.9923 to 2.2197), $P = 0.0545$.

Table 3: Distribution of the patients by surface eye diseases (Corneal, Conjunctival).

Variable	Males n=1429	Females n=1571	Total n=3000
Corneal Diseases			
None	1285	1452	2737
Corneal opacity	69	63	132
Corneal ulcer	28	23	51
CFB	28	25	53
Corneal tear	4	3	7
Keratoconus	2	2	4
Chemical burn	6	2	8
Corneal graft	3	1	4
Limbal dermoid	4	0	4
Conjunctival Diseases			
none	967	1089	2056
VKC	238	191	429
Eye dryness	101	170	271
SCH	6	11	17
Pterygium	34	39	73
Pingicula	6	2	8
VAD	54	40	94
Conjunctivitis	23	29	52

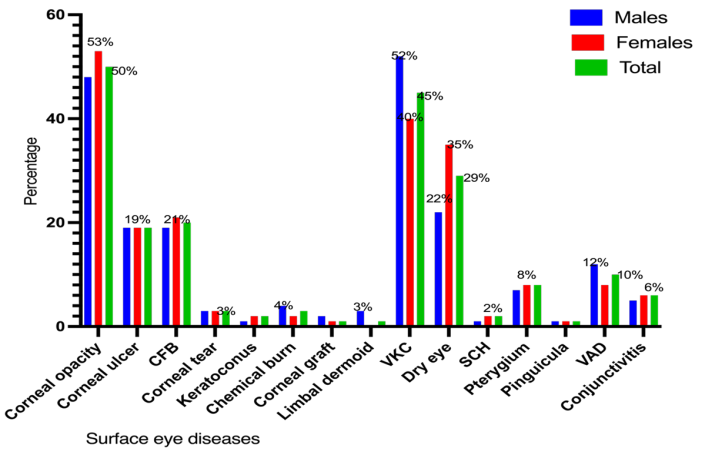


Figure 3: Proportions of Corneal and Conjunctival Diseases.

Table 4 and Figure 4 show the distribution of patients by eyelid and

lacrimal drainage system (LDS). The most common eyelid ailment was dermatitis, followed by chalazion, trichiasis, ptosis, and both cut-wound lid (CWL) and molluscum contagiosum (MC), which accounted for 132/166 (79.5%), 21 (12.7%), 5 (3%), 3 (2%), and 2 (1%). Of the 132 instances with dermatitis, 78 (59%) were males, and 54 (41%) were females. In terms of LDS, the most prevalent condition was congenital nasolacrimal duct obstruction (CNLDO), followed by chronic dacryocystitis, lacrimal gland tumor (LGT), and lacrimal gland swelling (LGS), which accounted for 15/26 (57.7%), 6 (23%), 3 (11.5%), and 2 (7.7%), respectively.

Table 4: Distribution of the patients by eyelid and the LDS.

Variable	Males n=1429	Females n=1571	Total n=3000
Eyelid n=166			
None	1334	1500	2834
Chalazion	9	12	21
Dermatitis	78	54	132
Ptosis	2	1	3
Trichiasis	3	2	5
MC	1	1	2
Blepharitis	0	1	1
CWL	2	0	2
Lacrimal drainage system (LDS) n=26			
None	1415	1559	2974
chronic dacryocystitis	4	2	6
CNLDO	9	6	15
LGT	0	3	3
LGS	1	1	2

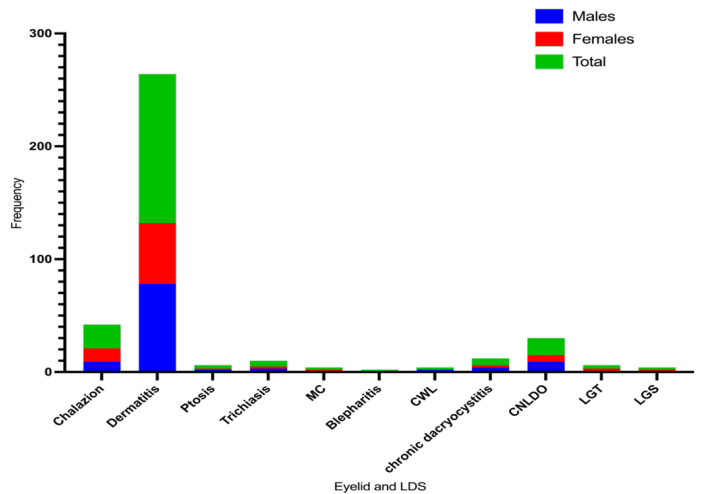


Figure 4: Proportions of Eyelid and LDS disorders.

Table 5 and Figure 5 show the patient distribution by posterior segments and neuro-ophthalmological illnesses (retina, neuro-ophthalmological, and glaucoma). Out of 104 retinal disorders, 44.2% were diabetic retinopathy (DR), 20.2% were retinal detachment (RD), and 12.5% were retinal degeneration. Females accounted for all cases of Retinopathy of Prematurity (ROP) (3/104, 2.9%) and Retinoblastoma (RB) (3/104, 2.9%).

Neuroophthalmological abnormalities were found in 38 cases: 11/38 (29%) Herpes Zoster Ophthalmicus (HZO), 11/38 (29%) Facial nerve palsy (FVP), 6/38 (15.8%) papillitis, 5/38 (13.2%) 6th nerve palsy (6thNP), and 4/38 (10.5%) Idiopathic intracranial hypertension (IICH). HZO was frequent among females, accounting for 8/11 (72.7%). FVP was more common among males (7/11, 63.6%). Glaucoma was generally similar in both men and women.

Table 5: Distribution of the patients by Posterior segments and neuroophthalmological diseases (Retina, Neuroophthalmological, and glaucoma).

Variable	Males n=1429	Females n=1571	Total n=3000
Retinal Diseases n=104			
none	1381	1515	2896
Diabetic retinopathy (DR)	24	22	46
Retinal detachment (RD)	10	11	21
ARMD	1	1	2
Macular hole	2	4	6
Macular oedema	1	2	3
Retinal degeneration	5	8	13
Optic atrophy	2	1	3
Retinitis pigmentosa	3	1	4
ROP	0	3	3
Retinoblastoma (RB)	0	3	3
Neuroophthalmological n=38			
None	1412	1550	2962
3rd n palsy (3rdNP)	0	1	1
6th nerve palsy (6thNP)	3	2	5
HZO	3	8	11
Facial nerve palsy (FVP)	7	4	11
IICH	1	3	4
Papillitis	3	3	6
Glaucoma n=306			
None	1280	1414	2694
Glaucoma	149	157	306

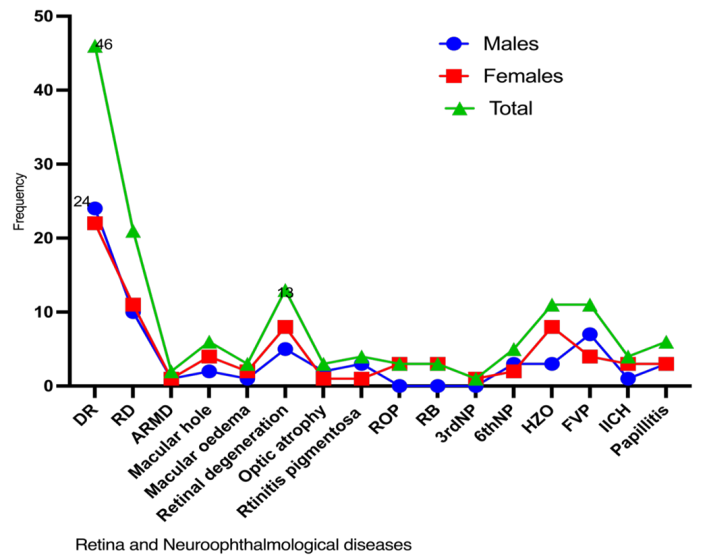


Figure 5: Proportions of Retina and Neuroophthalmological Diseases.

Table 6 and Figure 6 show the distribution of patients based on anterior segments and refractive error disorders (lens, refractive errors, and anterior chamber). The most common lens-related condition was cataract, followed by pseudophakia, intumescent cataract, posterior capsule opacification (PCO), and aphakia, which accounted for 458/739 (62%), 244/739 (33%), 19/739 (2.6%), 9/739 (1.2%), and 8/739 (1.1%), respectively. Out of 458 cataract cases, 255/1571 (16.2%) were females, while 203/1429 (14.2%) were males. The risk of cataracts in females, RR (95% CI) = 1.1426 (0.9641 to 1.3542), P = 0.1240. Aphakia was most prevalent in boys (7/8, 87.5%). The risk of aphakia among males is 7.6956 (95% CI) (0.9479 to 62.4740), P = 0.0561, and z statistic = 1.910.

Myopia was the most common refractive error problem, followed by presbyopia and hypermetropia, which accounted for 110/257 (42.8%), 96 (37.4%), and 51 (19.8%), respectively. Females had a higher prevalence of myopia (76/1571, 4.8%) than males (34/1429, 2.4%). The risk of myopia in females, RR (95% CI) = 2.0332 (1.3657 to 3.0272), P = 0.0005.

Females had a higher prevalence of presbyopia (63/1571, 4%) than males (33/1429, 2.3%). The risk of presbyopia in females is 1.7365 (95% CI) (1.1467 to 2.6299), P = 0.0092.

Table 6: Distribution of the patients by Anterior segments and refractive errors diseases (Lens, refractive errors, Anterior chamber).

Variable	Males n=1429	Females n=1571	Total n=3000
Lens n=739			
None	1089	1172	2261
Cataract	203	255	458
Pseudophakia	118	126	244
Aphakia	7	1	8
PCO	3	6	9
Dislocated lens	1	0	1
Intumescent cataract	8	11	19
Refractive Errors (RE) n=257			
None	1340	1400	2740
Myopia	34	76	110
Hypermetropia	22	29	51
Presbyopia	33	63	96
Anterior Chamber (AC) n=3			
None	1428	1569	2997
Hyphema	1	2	3

Table 7 and Figure 7 show the distribution of patients by orbit and uveal tract. The most common complications were uveitis (11/35; 31.4%) and endophthalmitis (6/35; 17%). Phthisis bulbi was more common in females (4/5, 80%) than in males (1/5, 20%). All instances of thyroid eye disease (TED) were found in females, 5/5 (100%). Of the 100 Uvea patients, 87% were anterior uveitis, whereas 13% were posterior uveitis. Males had a higher incidence of anterior uveitis (49/1429, 3.4%) than females (38/1571, 2.4%). The risk of anterior uveitis in males is 1.4176 (95% CI) (0.9337 to 2.1523), P = 0.1014.

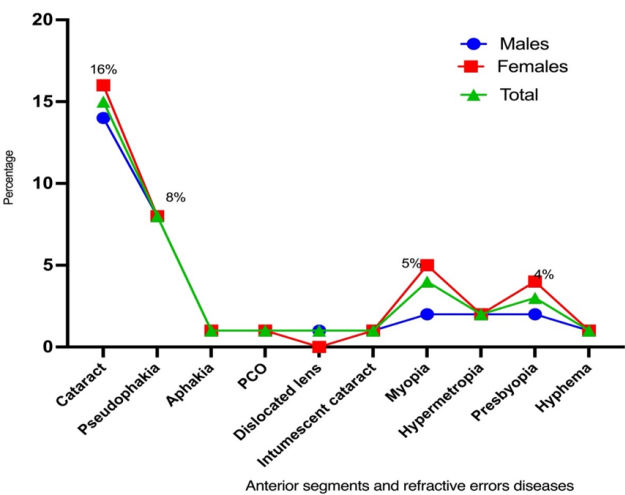


Figure 6: Description of Anterior segments and refractive errors diseases by gender.

Table 7: Distribution of the patients by Orbit and uveal tract (Orbital and Uveal tract diseases).

Variable	Males n=1429	Females n=1571	Total n=3000
Orbit n=35			
None	1419	1546	2965
Endophthalmitis	3	3	6
Squint	5	6	11
Phthisis bulbi	1	4	5
Microphthalmia	0	1	1
Nystagmus	1	4	5
Thyroid eye disease (TED)	0	5	5
Orbital cellulitis	0	2	2
Uvea n=100			
None	1372	1528	2900
Anterior uveitis	49	38	87
Posterior uveitis	8	5	13

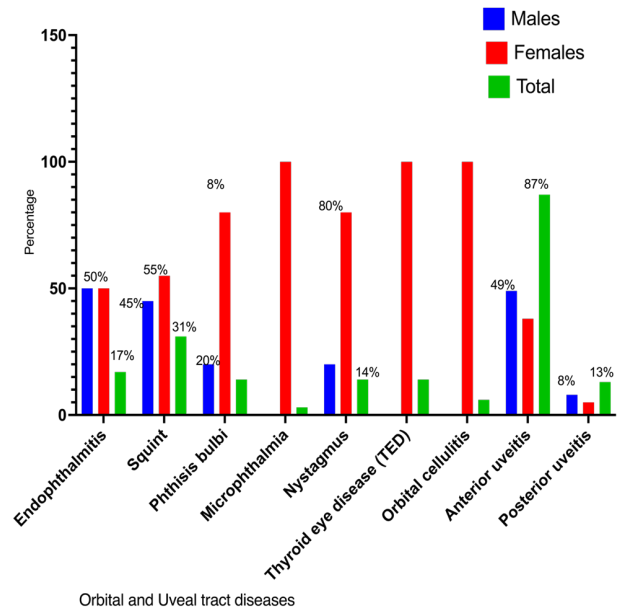


Figure 7: Description of the patients by Orbit and the uveal tract.

Discussion

Ophthalmic diseases in Sudan constitute a substantial public health burden, profoundly influenced by persistent armed conflict and socio-economic conditions. Ongoing initiatives are essential to enhance access to ophthalmic care, elevate awareness, and fortify the healthcare infrastructure to properly tackle this pressing concern. These require the availability of data concerning the epidemiology of eye diseases in the country to formulate appropriate strategies.

The results of the current study indicate that surface eye diseases constitute a significant portion of ophthalmic diseases in Sudan, accounting for over forty percent of all such conditions. The most common surface eye diseases in this study were conjunctival diseases, representing more than 31%, and corneal diseases were approximately 9%. Conjunctival disorders, especially conjunctivitis, are widespread globally, impacting more than 2% of the general population. Allergic conjunctivitis is the predominant kind, affecting 10% to 40% of individuals. Infectious conjunctivitis constitutes 35% of ocular cases in general practice, with an incidence rate of 13–14 per 1,000 individuals [12,13]. Corneal diseases represent a significant contributor to global blindness, impacting millions, with an estimated 6 to 8 million individuals affected by corneal pathologies resulting in blindness. A study indicates a 3.7% prevalence of corneal opacity in specific populations and a prevalence of corneal abnormalities reaching 49% in elderly populations. Primary factors encompass infection, trauma, and age-associated degeneration [14].

Eyelid diseases were observed in approximately 5.5% of the studied population, with a higher prevalence among males. Eyelid diseases are common, impacting as many as 78% of patients in ophthalmology clinics, with prevalence rising notably with age. Prevalent conditions encompass dermatochalasis (up to 61.8%), blepharitis (up to 32%), and blepharoptosis (up to 25%), frequently associated with chronic issues such as dry eye and Meibomian Gland Dysfunction (MGD) [15].

The prevalence of the lacrimal drainage system was 0.9% in the present study. About 6% to 20% of neonates have this disease. Congenital nasolacrimal duct obstruction usually resolves spontaneously, with 70% of children improving by 3 months and 90% by 1 year. One study found abnormal lacrimal drainage in 20% of healthy newborns in their first year. About 90% of infants with congenital nasolacrimal duct blockage resolve spontaneously by 6 months [16].

The prevalence of retinal diseases in this study was around 3.5%. The prevalence of retinal diseases, which cause visual impairment worldwide, ranges from 5.35 to 21 percent in adults aged 40 and up, with the risk increasing dramatically with age. Diabetic retinopathy, hypertensive retinopathy, and age-related macular degeneration (AMD) are important causes [17].

The prevalence of neuro-ophthalmological diseases in this study

was about 1.3%, which is very low compared to reports elsewhere. A study of 843 patients found 89 (4.8%) with neuro-ophthalmic multimorbidity. Thyroid eye disease (6.4%), Horner's syndrome (5.3%), pituitary macroadenoma (5.3%), and trochlear nerve palsy (5.3%) were the most prevalent subsequent diagnoses. The most common symptoms and examination findings of neuro-ophthalmic multimorbidity were chronic visual loss, proptosis, optic nerve pallor, incongruent strabismus, ophthalmoparesis, and lid lag/retraction [18].

The findings of the present study showed that the prevalence of glaucoma was 10.2%, which is very low compared to reports elsewhere. A previous study reported that overall glaucoma prevalence was 2.8% (n=2093, 95% CI, 2.6–3.2), with 2.7% of cases having an IOP of 21 mmHg or below (n=2046, 95%, 2.5–3.1). They found unilateral glaucoma in 1,464 of 2,093 patients (69.9%). The frequency of glaucoma in men (3.4%) was higher than in women (2.1%; $P<0.001$). Glaucoma prevalence increased considerably with age ($P<0.001$), with rates of 1.5%, 2.3%, 3.2%, 4.5%, 6.2%, and 13.2% for individuals under 40, 40–49 years, 50–59 years, 60–69 years, 70–79 years, and 80 years or more. The frequency of glaucoma suspects was estimated at 7.2% (n=5,378, 95% CI, 6.9–7.6). For additional investigation, normal and glaucoma eyes were included, with the exclusion of glaucoma suspicion [19]. Glaucoma is the second greatest cause of irreversible blindness after cataracts, making it a public health issue. Approximately 57.5 million people worldwide have primary open-angle glaucoma. Glaucoma risk increases for individuals over 60, family relatives of people with the disease, steroid users, diabetics, those with extreme myopia, hypertension, central cornea thickness less than 5 mm, and eye injury. The 2020 forecast is 76 million glaucoma cases, rising to 111.8 million by 2040 [20].

The prevalence of lens diseases in this study was over 24%, with cataracts representing about 62%. Lens disorders, notably cataracts, are common with aging. About 94 million people worldwide have cataracts, which impair vision. Prevalence exceeds 95% in those over 80. Nuclear sclerosis cataracts are most common (65.2%), followed by cortical (24.6%) and posterior subcapsular (43.4%) [21].

The prevalence of refractive error in the current study was 8.6%. One to two billion people worldwide have refractive defects (myopia, hyperopia, and astigmatism), with over 88 million having uncorrected distance vision problems. It can reach 80% in East Asia and increases with age, with younger people having the highest myopia [22]. Research indicates a prevalence range of 1.2% to 42% among youngsters, with rates markedly increasing related to lifestyle factors. The prevalence is elevated in East Asia (70–80%) and moderate in Western nations (25–40%). The overall prevalence of refractive errors has been reported at varying rates between 6% and 45% across multiple studies [23].

The findings of the present study showed that the prevalence of the orbit and uveal tract was 4.7%. Orbit and uveal tract diseases range from inflammatory, immune-mediated diseases

to uncommon cancers. Uveitis (uveal tract inflammation) affects 57–115 per 100,000 people in wealthy nations, although primary orbital malignancies are rare, affecting 2–10 per million [24]. Multivariate analysis showed that chronic inflammation, recurring inflammation, and poor visual acuity at presentation were risk factors for uveitis [25].

In conclusion, the prevalence of eye disease in Sudan is significantly elevated relative to other regions, influenced by various factors, notably the persistent armed conflict, poverty, and the deterioration of the health system. Cataracts, conjunctivitis, and refractive errors are common conditions.

The elevated prevalence of eye disease in Sudan, worsened by persistent armed conflict, requires a coordinated approach to enhance healthcare systems, raise public awareness, and execute targeted interventions to effectively tackle this significant public health concern.

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