Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Predictors of One-Year Disease Inactivity in Pediatric Uveitis: A 25-Year Single-Center Retrospective Study from Tunisia

Houcem Hrizi[1]

houcem.hrizi@fmt.utm.tn

Tunis El Manar University

Arwa Mechergui[1]

Tunis El Manar University

Rawia Farhat[2]

Tunis El Manar University

Hela Jouini[1]

Tunis El Manar University

Mohamed Jrad[1]

Tunis El Manar University

Maha Hadj Ltaeif[1]

Tunis El Manar University

Leila Essaddam[1]

Tunis El Manar University

Zohra Fitouri[1]

Tunis El Manar University

Research Article

Keywords: Pediatric uveitis, juvenile idiopathic arthritis, antinuclear antibodies, immunosuppressive therapy, disease inactivity, prognostic factors.

Posted Date: August 18th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10707791/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Background

Pediatric uveitis is an uncommon but potentially sight-threatening inflammatory disease. Its chronic and often silent course may delay diagnosis and increase the risk of ocular complications. Identifying predictors of early disease control could help improve risk stratification and therapeutic decision-making.

Methods

We conducted a single-center retrospective study in the Department of Pediatrics D, Béchir Hamza Children's Hospital, Tunis, Tunisia, over a 25-year period from January 2000 to December 2024. Children aged < 18 years with ophthalmologist-confirmed uveitis and at least 12 months of follow-up were included. Epidemiological, clinical, laboratory, imaging, etiological, therapeutic, and outcome data were collected. The primary outcome was disease inactivity at one year, defined according to Standardization of Uveitis Nomenclature criteria. Factors associated with one-year inactivity were analyzed using univariate analysis and multivariable logistic regression.

Results

Fifty-five children were included in the descriptive analysis, and 47 had complete one-year follow-up data. The mean age at diagnosis was 8.0 ± 3.6 years, and the male-to-female ratio was 0.9. Bilateral uveitis was observed in 74.5% of patients. Anterior uveitis and panuveitis were the predominant anatomical forms, each accounting for 43.6% of cases. Idiopathic uveitis was the leading etiology (61.8%), followed by juvenile idiopathic arthritis-associated uveitis (18.2%). Topical corticosteroids, systemic corticosteroids, and conventional immunosuppressive therapy were used in 83.6%, 72.7%, and 69.1% of patients. Disease inactivity at one year was achieved in 76.6% of patients, whereas relapses and ocular complications occurred in 44.7% and 36.2%, respectively. In multivariable analysis, positive antinuclear antibodies (odds ratio [OR] 17.33, 95% confidence interval [CI] 1.94–154.64; p = 0.011), immunosuppressive therapy (OR 5.54, 95% CI 1.18–26.07; p = 0.030), and absence of vitreous abnormalities (OR 11.73, 95% CI 1.33–103.80; p = 0.027) were independently associated with one-year disease inactivity.

Conclusions

In this Tunisian pediatric cohort, uveitis was predominantly idiopathic, frequently bilateral, and often chronic. Most children achieved disease inactivity at one year, although relapses and ocular complications remained common. Antinuclear antibody positivity, immunosuppressive therapy, and absence of vitreous abnormalities may help identify children more likely to achieve early inflammatory control. Prospective multicenter studies are needed to validate these findings and optimize risk-adapted management strategies.

Introduction

Pediatric uveitis is an uncommon but potentially sight-threatening intraocular inflammatory disease and remains an important cause of visual morbidity in children. Compared with adult uveitis, pediatric uveitis is characterized by a higher frequency of chronic and insidious forms, delayed recognition, and a substantial risk of ocular complications, including cataract, glaucoma, macular edema, posterior synechiae, and irreversible loss of visual acuity [1, 2]. These features are partly related to the limited ability of young children to report visual symptoms and to the often silent course of anterior uveitis [3].

The etiological spectrum of pediatric uveitis is heterogeneous and varies according to age, geographic region, referral setting, and associated systemic diseases. Juvenile idiopathic arthritis remains the most common systemic inflammatory disease associated with chronic anterior uveitis in children, particularly in young patients with antinuclear antibody positivity [4, 5]. Other causes include Behçet disease, sarcoidosis, inflammatory bowel disease, infectious uveitis, and idiopathic forms [3, 6]. This etiological diversity makes diagnostic evaluation and therapeutic decision-making particularly challenging in pediatric practice.

Despite advances in therapeutic strategies, including topical corticosteroids, systemic corticosteroids, conventional immunosuppressants such as methotrexate, and biologic agents targeting tumor necrosis factor-α, the course of pediatric uveitis remains difficult to predict [1, 7, 8]. Achieving sustained disease inactivity is a major therapeutic goal, as persistent inflammation is strongly associated with ocular damage and poor visual outcomes [2, 9]. However, reliable prognostic factors that can help identify children more likely to achieve disease inactivity or remission remain insufficiently defined [10, 11].

Most available data on pediatric uveitis come from European, North American, or Asian cohorts, whereas evidence from North African and other resource-limited settings remains scarce. Differences in referral pathways, access to biologic therapies, ophthalmologic screening practices, and timing of treatment initiation may influence both disease presentation and outcomes [12]. Therefore, regional data are needed to better characterize pediatric uveitis and to guide individualized management strategies.

The aim of this study was to describe the epidemiological, clinical, etiological, therapeutic, and outcome profile of pediatric uveitis in a Tunisian tertiary pediatric center over a 25-year period, and to identify factors independently associated with disease inactivity at one year.

Methods

Study design and setting

We conducted a single-center retrospective analytical study in the Department of Pediatrics D, Béchir Hamza Children's Hospital, Tunis, Tunisia. The study covered a 25-year period, from January 2000 to December 2024. The department is a tertiary referral pediatric center involved in the diagnosis and management of children with systemic inflammatory diseases and chronic uveitis.

Study population

The study included children and adolescents aged less than 18 years who were followed for chronic uveitis during the study period. The diagnosis of uveitis was established by an ophthalmologist based on a complete ophthalmological examination, including slit-lamp examination and fundus assessment when feasible.

Patients were identified from medical records and outpatient follow-up files. Epidemiological, clinical, ophthalmological, laboratory, etiological, therapeutic, and outcome data were collected using a standardized data collection form.

Inclusion criteria

Patients were included if they met all the following criteria:

1. age below 18 years at diagnosis;
2. diagnosis of uveitis confirmed by an ophthalmologist;
3. follow-up in the Department of Pediatrics D or referral to the department for etiological assessment and systemic management;
4. availability of sufficient clinical, ophthalmological, biological, therapeutic, and follow-up data;
5. minimum follow-up duration of 12 months for the analysis of one-year outcome.

Exclusion criteria

Patients were excluded in the following situations:

1. ocular diseases other than uveitis;
2. pseudo-uveitis or masquerade syndromes, including intraocular tumors or malignant hematological disorders;
3. post-traumatic or postoperative endophthalmitis;
4. severe myopia or other ocular conditions that could interfere with the interpretation of inflammatory findings;
5. incomplete or unusable medical records;
6. follow-up duration shorter than 12 months;
7. patients lost to follow-up before one year;
8. patients transferred to another center before outcome assessment.

Ophthalmological assessment

All patients underwent a comprehensive ophthalmological examination. This included assessment of best-corrected visual acuity when feasible, slit-lamp examination of the anterior segment, grading of

anterior chamber inflammation, measurement of intraocular pressure, and fundus examination after pupillary dilation.

Additional ophthalmological investigations, including optical coherence tomography, fluorescein angiography, ocular ultrasound, and other ocular imaging modalities, were performed according to clinical indication.

Anterior chamber inflammation and uveitis activity were assessed according to the Standardization of Uveitis Nomenclature (SUN) Working Group criteria [13]. Uveitis activity was evaluated by the presence and intensity of inflammatory cells in the anterior chamber and/or by the presence of inflammatory signs in the vitreous, retina, choroid, or optic disc.

Anatomical classification of uveitis

Uveitis was classified anatomically according to the SUN Working Group classification [13].

Anterior uveitis was defined as inflammation predominantly involving the anterior chamber, including iritis and iridocyclitis.

Intermediate uveitis was defined as inflammation predominantly involving the vitreous cavity and/or the pars plana region, with vitritis, snowballs, or snowbanking when present.

Posterior uveitis was defined as inflammation predominantly involving the retina and/or choroid, including retinitis, choroiditis, chorioretinitis, retinal vasculitis, or papillitis.

Panuveitis was defined as inflammation involving the anterior chamber, vitreous, retina, and/or choroid, without a single predominant anatomical site.

Granulomatous and non-granulomatous uveitis

Uveitis was also classified according to its clinical inflammatory pattern.

Granulomatous uveitis was defined by the presence of large “mutton-fat” keratic precipitates and/or iris nodules, including Koeppe nodules at the pupillary margin or Busacca nodules on the iris stroma.

Non-granulomatous uveitis was defined by the presence of fine keratic precipitates or anterior chamber inflammation without granulomatous features.

Etiological classification

Etiologies were classified into three main groups: non-infectious immune-mediated uveitis, infectious uveitis, and idiopathic uveitis.

Non-infectious immune-mediated uveitis included juvenile idiopathic arthritis-associated uveitis, Behçet disease, sarcoidosis, inflammatory bowel disease-associated uveitis, and other systemic inflammatory diseases.

Infectious uveitis included viral, bacterial, and parasitic causes when supported by clinical, biological, serological, microbiological, or imaging findings.

Idiopathic uveitis was defined as uveitis without an identified infectious or systemic inflammatory cause after appropriate etiological assessment.

Juvenile idiopathic arthritis was classified according to the International League of Associations for Rheumatology classification criteria, second revision, Edmonton 2001 [14]. Behçet disease was diagnosed according to the International Study Group criteria for Behçet disease [15]. Sarcoidosis was diagnosed based on compatible clinical, radiological, biological, and/or histological findings, according to the ATS/ERS/WASOG statement on sarcoidosis [16].

Laboratory and etiological assessment

The etiological work-up was guided by clinical presentation, anatomical type of uveitis, associated systemic manifestations, and ophthalmological findings.

Laboratory investigations included complete blood count, erythrocyte sedimentation rate, C-reactive protein, liver and renal function tests, renal function tests, antinuclear antibodies, rheumatoid factor, angiotensin-converting enzyme, infectious serologies, tuberculin skin test and/or interferon-gamma release assay when available, and HLA typing when indicated.

Radiological investigations, including chest radiography, thoracic computed tomography, brain magnetic resonance imaging, abdominal ultrasound, and joint imaging, were performed according to clinical suspicion.

Treatment data

Therapeutic data included local corticosteroid therapy, cycloplegic agents, systemic corticosteroids, conventional immunosuppressive therapy, biologic therapy, anti-infectious treatment, and surgical or laser procedures when performed.

Conventional immunosuppressants included methotrexate, azathioprine, mycophenolate mofetil, and cyclophosphamide. Biologic therapy mainly included anti-tumor necrosis factor agents, particularly adalimumab.

Outcome definitions

The primary outcome was disease inactivity at one year.

Active uveitis was defined according to SUN criteria as the presence of active intraocular inflammation, including anterior chamber cells grade ≥ 1 + and/or active vitreous, retinal, choroidal, or optic disc inflammation [13].

Disease inactivity was defined as the absence of active intraocular inflammation at the one-year assessment. This included anterior chamber cells grade 0 and absence of active inflammatory signs in the vitreous or posterior segment. Disease inactivity could be achieved while the patient was still receiving topical or systemic anti-inflammatory or immunomodulatory treatment.

Complete remission was defined as absence of active intraocular inflammation for at least three months without any topical corticosteroid, systemic corticosteroid, immunosuppressive, or biologic therapy.

Partial remission was defined as complete absence of active ocular inflammation for at least three months while the patient was still receiving maintenance treatment, including low-dose topical corticosteroids and/or systemic immunosuppressive or biologic therapy.

Persistent inflammation was defined as ongoing active intraocular inflammation despite treatment.

Relapse was defined as recurrence of active inflammation after a period of inactivity, corresponding to an increase of at least two grades of inflammation or the reappearance of active inflammatory signs after previous control [13].

Recurrence was defined as a new episode of active inflammation occurring after at least three months of inactivity without treatment [13].

Ocular complications recorded during follow-up included cataract, glaucoma or ocular hypertension, posterior synechiae, band keratopathy, macular edema, retinal vasculitis, papillitis, vitreous hemorrhage, retinal detachment, optic atrophy, and persistent reduction in visual acuity.

Statistical analysis

Statistical analyses were performed using SPSS software version 25.0. Quantitative variables were expressed as mean ± standard deviation when normally distributed, or as median and interquartile range when distribution was non-normal. Qualitative variables were expressed as numbers and percentages.

Comparisons between groups were performed using the chi-square test or Fisher’s exact test for qualitative variables, and Student’s t-test or the Mann–Whitney U test for quantitative variables, as appropriate.

For the analysis of predictive factors, patients were divided into two groups according to disease status at one year: patients with disease inactivity and patients with persistent active inflammation. Variables associated with one-year disease inactivity in univariate analysis with a p-value ≤ 0.20 were entered into a multivariable logistic regression model. Results were expressed as odds ratios with 95% confidence intervals. In both univariate and multivariable analyses, statistical significance was defined as $p < 0.05$.

Ethical considerations

All data were collected retrospectively from medical records and were anonymized before analysis. The study was conducted in accordance with the principles of the Declaration of Helsinki. Given the retrospective design and the use of anonymized data, the requirement for individual informed consent was waived according to local institutional regulations.

Results

1. Study population

During the 25-year study period, 55 children diagnosed with uveitis were identified and included in the descriptive analysis. Of these, 47 patients had complete one-year follow-up data and were included in the outcome and predictive factor analyses, whereas eight patients were lost to follow-up before the one-year assessment.

The mean age at diagnosis was 8.0 ± 3.6 years. The male-to-female sex ratio was 0.9, indicating a slight female predominance.

2. Epidemiological and clinical findings

The study population was characterized by a slight female predominance and a mean age at diagnosis in school-aged children. Uveitis was most often diagnosed after ocular symptoms or routine ophthalmological examination, whereas systematic screening accounted for a minority of cases. A substantial proportion of children had asymptomatic “white-eye” uveitis, highlighting the silent presentation of pediatric uveitis.

Clinically, ocular redness and decreased visual acuity were the most frequent presenting symptoms. Extraocular manifestations were observed in more than one-third of patients and were mainly articular. Bilateral involvement was common. Anatomically, anterior uveitis and panuveitis were the predominant patterns, while intermediate and posterior uveitis were less frequent. Most cases were non-granulomatous. Initial visual impairment was variable, ranging from preserved visual acuity to severe visual loss at diagnosis. The main epidemiological and clinical characteristics are summarized in Table 1.

Table 1
Epidemiological and clinical characteristics of the study population (N = 55)

Characteristic	Result
Number of patients included in descriptive analysis	55
Mean age at diagnosis, years	8.0 ± 3.6
Male-to-female sex ratio	0.9
Known JIA before uveitis diagnosis	6/55
Mean interval between systemic disease onset and uveitis diagnosis	5.8 ± 6.5 months
Symptomatic uveitis at diagnosis	77.0%
Asymptomatic “white-eye” uveitis	23.0%
Systematic screening as mode of diagnosis	10.9%
Ocular redness	45.5%
Decreased visual acuity	36.4%
Blurred vision	16.4%
Ocular pain	12.7%
Photophobia	12.7%
Tearing	9.1%
Extraocular manifestations	38.2%
Articular involvement	21.8%
Bilateral uveitis	74.5%
Anterior uveitis	43.6%
Intermediate uveitis	9.1%
Posterior uveitis	3.6%
Panuveitis	43.6%
Granulomatous uveitis	34.5%
Non-granulomatous uveitis	65.5%
Mean initial visual acuity	4.5/10
Severe visual impairment at diagnosis, < 1/10	31.0%
Visual acuity > 5/10 at diagnosis	42.9%

3. Laboratory and imaging findings

Laboratory investigations showed limited systemic inflammatory activity in most patients. The erythrocyte sedimentation rate was elevated in 12.7% of cases, mainly among patients with oligoarticular juvenile idiopathic arthritis, idiopathic uveitis, or Behçet disease. C-reactive protein was positive in only one patient with oligoarticular juvenile idiopathic arthritis. Serum calcium and phosphate levels were normal in all patients. Angiotensin-converting enzyme was elevated in two patients, both of whom were diagnosed with sarcoidosis. Antinuclear antibodies were positive in 36.4% of the cohort and were particularly frequent in children with juvenile idiopathic arthritis-associated uveitis, being present in 80% of these patients. Rheumatoid factor was tested in 18 patients and was positive in four cases.

Ophthalmological imaging was performed according to clinical indication and helped characterize posterior segment involvement and disease extension. Fundus examination was abnormal in approximately half of the patients, with retinal vasculitis, optic disc edema, papillitis, and retinal lesions being the main findings. In nearly one quarter of patients, the fundus could not be assessed because of media opacity or severe anterior segment involvement. Fluorescein angiography was performed in selected patients and confirmed retinal vascular and optic disc inflammatory abnormalities, mainly vasculitis and papillitis. Optical coherence tomography was performed in 28 patients and was abnormal in most examined cases, showing optic disc edema, macular edema, or retinal lesions. B-scan ultrasonography was reserved for severe cases or when fundus visualization was limited; it identified retinal detachment and vitreous abnormalities in some patients.

4. Etiological profile

The etiological spectrum was dominated by idiopathic uveitis, which accounted for the majority of cases. Non-infectious immune-mediated uveitis represented the second main group and included juvenile idiopathic arthritis-associated uveitis, Behçet disease, sarcoidosis, and inflammatory bowel disease-associated uveitis. Infectious causes were uncommon and included Lyme disease and herpetic uveitis. Overall, idiopathic uveitis and JIA-associated uveitis were the two leading etiological categories. The etiological distribution of the study population is presented in Table 2.

Table 2
Etiological distribution of pediatric uveitis in the study population (N = 55)

Etiology	n/N	Percentage
Idiopathic uveitis	34/55	61.8%
Oligoarticular JIA-associated uveitis	9/55	16.4%
Unclassified JIA-associated uveitis	1/55	1.8%
Behçet disease	4/55	7.3%
Sarcoidosis	3/55	5.5%
Lyme disease	2/55	3.6%
Inflammatory bowel disease-associated uveitis	1/55	1.8%
Herpetic uveitis	1/55	1.8%
Total	55/55	100%

JIA: juvenile idiopathic arthritis.

5. Treatment patterns

Therapeutic management was tailored according to the anatomical type of uveitis, inflammatory activity, etiology, and presence of sight-threatening complications. Most patients received local corticosteroid therapy, frequently combined with systemic treatment in more severe or chronic forms. Systemic corticosteroids were used in nearly three-quarters of patients, mainly as induction therapy in active or severe inflammation.

Conventional immunosuppressive therapy was required in a substantial proportion of patients, reflecting the chronic and recurrent nature of pediatric uveitis in this cohort. Methotrexate was the main steroid-sparing agent used, particularly in juvenile idiopathic arthritis-associated uveitis and chronic non-infectious forms. Biologic therapy, mainly anti-TNF agents, was reserved for refractory or severe cases. Anti-infectious treatment was used only in patients with confirmed or strongly suspected infectious uveitis. The therapeutic approaches used in the study population are summarized in Table 3.

Table 3
Therapeutic characteristics of the study population (N = 55)

Treatment modality	Result
Topical corticosteroid therapy	83.6%
Systemic corticosteroid therapy	72.7%
Conventional immunosuppressive therapy	69.1%
Mean duration of immunosuppressive therapy	36.78 ± 21.48 months
Biologic therapy, anti-TNF agents	7.3%
Anti-infectious treatment	3.6%
Surgical or laser procedures	According to complications

Anti-TNF: anti-tumor necrosis factor.

6. One-year outcomes and ocular complications

At the one-year assessment, overall inflammatory control was achieved in most patients. According to the predefined outcome categories, complete remission off treatment was observed in a minority of children, whereas partial remission or treatment-maintained inactivity accounted for the majority of favorable outcomes. Overall, disease inactivity at one year, including complete remission, partial remission, and inactivity under treatment, was observed in 76.6% of patients.

Persistent inflammation at three months was observed in more than half of the cohort, reflecting the chronic and initially active nature of pediatric uveitis in this series. Relapses occurred in 44.7% of patients, with a mean delay of 4.5 months after initial inflammatory control and a mean relapse rate of 1.14 episodes per year. Relapses mainly involved anterior uveitis and panuveitis and were most frequently observed in idiopathic uveitis, followed by JIA-associated uveitis. Recurrence after treatment discontinuation was rare and occurred in only one patient with oligoarticular JIA-associated panuveitis.

Visual outcome was favorable in most patients. At one year, visual acuity remained stable or improved in 80.9% of children, whereas worsening was observed in a smaller proportion of cases.

Ocular complications at one year were recorded in 36.2% of patients. Idiopathic uveitis accounted for most complicated cases, followed by oligoarticular JIA-associated uveitis and Behçet disease. Complications were more frequent in panuveitis than in anterior uveitis. Cataract was the most common complication and occurred exclusively in idiopathic uveitis. Macular edema was observed in Behçet disease, idiopathic uveitis, and oligoarticular JIA-associated uveitis. Papillitis, retinal vasculitis, keratopathy, optic disc edema, optic neuropathy, and ocular hypertension were mainly observed in idiopathic uveitis, whereas ciliary body detachment was reported in one patient with Behçet-related panuveitis. The distribution of ocular complications according to etiology is shown in Fig. 1.

7. Predictive factors of one-year disease inactivity

7.1 Univariate analysis

To identify factors associated with one-year disease inactivity, univariate analyses were performed among the 47 patients with complete one-year follow-up. The variables assessed included demographic characteristics, anatomical subtype, inflammatory pattern, laboratory findings, vitreous involvement, initial ocular complications, and therapeutic modalities.

In univariate analysis, three variables were significantly associated with one-year disease inactivity: positive antinuclear antibodies, absence of vitreous abnormalities, and use of immunosuppressive therapy. Sex and duration of immunosuppressive therapy did not reach statistical significance but showed p-values below the predefined threshold for entry into the multivariable model. No other clinical, biological, anatomical, or therapeutic variable was significantly associated with disease inactivity at one year. These results are summarized in Table 4.

Table 4
Univariate analysis of factors associated with one-year disease inactivity, N = 47

Variable	p-value	Interpretation
Positive antinuclear antibodies	0.002	Significantly associated with disease inactivity
Absence of vitreous abnormalities	0.009	Significantly associated with disease inactivity
Immunosuppressive therapy	0.020	Significantly associated with disease inactivity
Sex	0.070	Candidate variable for multivariable analysis
Duration of immunosuppressive therapy	0.060	Candidate variable for multivariable analysis

ANA: antinuclear antibodies.

7.2 Multivariable analysis

Variables with a p-value ≤ 0.20 in univariate analysis were entered into the multivariable logistic regression model. After adjustment, three factors remained independently associated with one-year disease inactivity: positive antinuclear antibodies, use of immunosuppressive therapy, and absence of vitreous abnormalities.

Positive antinuclear antibodies showed the strongest association with disease inactivity. Immunosuppressive therapy was also independently associated with a favorable inflammatory outcome, supporting its role in achieving disease control. Absence of vitreous abnormalities was independently associated with inactivity, suggesting a better prognosis in patients without posterior segment or vitreous involvement. The results of the multivariable analysis are presented in Table 5.

Table 5
Multivariable analysis of independent factors associated with one-year disease inactivity, N = 47

Variable	OR	95% CI	p-value
Positive antinuclear antibodies	17.33	1.94–154.64	0.011
Immunosuppressive therapy	5.54	1.18–26.07	0.030
Absence of vitreous abnormalities	11.73	1.33–103.80	0.027

ANA: antinuclear antibodies; CI: confidence interval; OR: odds ratio.

Discussion

Principal findings

In this 25-year single-center retrospective study, we described the epidemiological, clinical, etiological, therapeutic, and outcome profile of pediatric uveitis in a tertiary pediatric center in Tunisia. Our cohort was characterized by a high frequency of bilateral disease and a predominance of anterior uveitis and panuveitis. Idiopathic uveitis was the leading etiological category, followed by juvenile idiopathic arthritis-associated uveitis, whereas infectious causes were uncommon.

Despite the chronic nature of the disease and the relatively high burden of ocular complications, most patients achieved inflammatory control at one year. Disease inactivity at one year was observed in 76.6% of patients with complete follow-up data. However, this favorable inflammatory outcome should be interpreted with caution, as many children achieved inactivity while still receiving maintenance therapy, and relapse remained frequent during follow-up. Therefore, one-year disease inactivity in this cohort reflects disease control rather than definitive cure.

The main contribution of this study is the identification of three independent factors associated with one-year disease inactivity: positive antinuclear antibodies, use of immunosuppressive therapy, and absence of vitreous abnormalities. The absence of vitreous involvement appears clinically consistent with a less extensive inflammatory phenotype and a better prognosis. In contrast, the associations with antinuclear antibody positivity and immunosuppressive therapy require more nuanced interpretation. ANA positivity may reflect a better-recognized clinical phenotype, particularly JIA-associated chronic anterior uveitis, leading to earlier screening and closer follow-up. Similarly, the association between immunosuppressive therapy and inactivity should be interpreted in light of indication bias, as these treatments were more likely to be prescribed in children with more severe, chronic, or corticosteroid-dependent disease.

Overall, these findings underline the importance of early diagnosis, repeated etiological assessment, close ophthalmological monitoring, and timely introduction of steroid-sparing therapy in children with

chronic uveitis. They also provide original data from a North African pediatric cohort, a population that remains underrepresented in the published literature.

2. Comparison with North American and European cohorts

Several features of our cohort are consistent with data reported from North American and European pediatric uveitis series, including the predominance of chronic disease, frequent bilateral involvement, and the major contribution of anterior uveitis. In a large North American retrospective cohort of 527 children with uveitis, Smith et al. reported a median age at diagnosis of 9.4 years, a slight female predominance, and anterior uveitis as the most frequent anatomical subtype. Idiopathic uveitis, JIA-associated uveitis, and pars planitis were the leading diagnoses in that cohort [17]. Similarly, bilateral and persistent forms were common, confirming that chronicity and bilateral disease are key characteristics of pediatric uveitis across different healthcare settings.

However, our etiological distribution differed from that reported in many North American and European cohorts. In our series, idiopathic uveitis was markedly predominant, whereas JIA-associated uveitis accounted for less than one fifth of cases. In contrast, several European population-based or rheumatology-linked cohorts reported a higher proportion of JIA-associated uveitis. In the Finnish population-based study by Siiskonen et al., JIA-associated uveitis represented the majority of pediatric uveitis cases, and anterior involvement was almost universal among children with JIA-associated disease [5]. This difference may reflect variations in referral pathways, screening practices for children with JIA, local epidemiology, and the type of center in which patients were recruited.

The relatively high proportion of panuveitis in our cohort also contrasts with many European JIA-focused cohorts, where chronic anterior uveitis predominates. This may be partly explained by the inclusion of all pediatric uveitis etiologies in our study, rather than only JIA-associated uveitis, and by the tertiary referral nature of our center, which may enrich the cohort with more severe or atypical cases. In North American tertiary cohorts, posterior uveitis and panuveitis have been associated with poorer visual prognosis and a higher risk of vision-threatening complications [17], supporting the clinical relevance of anatomical classification in prognostic assessment.

Outcome comparisons should be interpreted carefully because definitions differ across studies. In the recent Kaiser Permanente Northern California community cohort, Qian et al. evaluated drug-free remission in children with incident non-infectious uveitis and reported that approximately half of children with chronic non-infectious uveitis achieved drug-free remission at five years [10]. By contrast, our primary outcome was disease inactivity at one year, including inactivity achieved under ongoing treatment. Therefore, the 76.6% rate of one-year inactivity observed in our cohort reflects inflammatory control rather than drug-free remission and cannot be directly compared with long-term remission off treatment.

European long-term data also emphasize the importance of early screening and sustained follow-up. In the population-based Nordic JIA cohort, Rypdal et al. showed that uveitis may occur late during the

course of JIA and that ocular complications remain frequent despite long-term follow-up [18]. These findings support prolonged ophthalmological surveillance, particularly in children with JIA or other risk factors. In our cohort, the lower proportion of JIA-associated uveitis compared with Northern European studies may indicate differences in population structure and referral patterns, but it also highlights the need for repeated etiological reassessment in children initially classified as having idiopathic uveitis.

Overall, compared with North American and European cohorts, our study confirms the chronic and potentially severe nature of pediatric uveitis, while showing a higher proportion of idiopathic and panuveitic forms. These differences underline the influence of geographic setting, referral bias, access to systematic JIA screening, and therapeutic availability on the observed clinical spectrum of pediatric uveitis.

3. Comparison with MENA and North African data

Data on pediatric uveitis from North Africa and the broader Middle East and North Africa region remain relatively limited compared with European and North American cohorts. Nevertheless, available studies suggest marked regional heterogeneity in etiological distribution, anatomical patterns, infectious burden, and frequency of systemic inflammatory associations.

Our findings are partially consistent with previous Tunisian data. In an earlier referral-center study from Monastir, Tunisia, Khairallah et al. reported that idiopathic uveitis accounted for 50% of childhood-onset uveitis, whereas infectious causes represented 25% of cases, mainly toxoplasmosis. JIA-associated uveitis was uncommon, accounting for only 6.25% of cases [19]. In our cohort, idiopathic uveitis was also the leading category, but infectious uveitis was less frequent, while JIA-associated uveitis represented a higher proportion of cases. This difference may reflect changes over time in referral pathways, diagnostic work-up, infectious screening, and the pediatric rheumatology-based recruitment of our series.

Studies from the Gulf region also highlight the heterogeneity of pediatric uveitis in MENA countries. In a Saudi pediatric uveitis survey including 163 children, Hamade et al. reported that anterior non-granulomatous uveitis of undetermined etiology was the most frequent presentation, followed by intermediate uveitis, Vogt–Koyanagi–Harada disease, and JIA-associated uveitis; infectious causes were uncommon [20]. More recently, a tertiary referral-center study from Riyadh reported panuveitis as the most common anatomical form and VKH disease as the leading specific diagnosis, followed by JIA, sarcoidosis, and presumed tuberculous uveitis [21]. Compared with these Saudi data, our cohort shared a high proportion of panuveitis but differed by the absence of VKH disease and by the predominance of idiopathic uveitis.

Egyptian data further illustrate the influence of referral setting and local epidemiology. In a large tertiary pediatric eye hospital cohort, Abd El Latif et al. found that intermediate uveitis was the most common anatomical category, followed by panuveitis and posterior uveitis. JIA, toxoplasmosis, and VKH disease were the most common causes of anterior, posterior, and panuveitic involvement, respectively [22].

Another Egyptian multicenter referral study showed frequent bilateral disease and a substantial burden of ocular complications, particularly cataract, glaucoma, and cystoid macular edema [23]. More recently, a study from the Delta region reported a distinct etiological profile, with presumed trematode-induced uveitis as the leading cause, followed by JIA and undetermined forms [24]. These findings emphasize that infectious and environment-related causes may remain important in some North African settings, even when non-infectious uveitis predominates elsewhere.

Overall, comparison with MENA and North African data suggests that pediatric uveitis in this region cannot be considered a homogeneous entity. Geographic location, environmental exposure, infectious epidemiology, access to ophthalmological screening, availability of immunological and microbiological investigations, and referral patterns all influence the observed clinical spectrum. Our study adds data from a pediatric rheumatology-oriented Tunisian cohort, in which idiopathic and non-infectious immune-mediated forms predominated, infectious etiologies were uncommon, and panuveitis represented a substantial proportion of cases. These findings support the need for regional multicenter registries to better characterize pediatric uveitis across North Africa and the Middle East and to distinguish true epidemiological differences from referral and diagnostic biases.

4. Predominance of idiopathic uveitis and diagnostic reclassification over time

The predominance of idiopathic uveitis was one of the main features of our cohort. In our series, no specific infectious or systemic inflammatory cause was identified in 61.8% of patients after etiological assessment. This finding is consistent with previous Tunisian data, in which idiopathic uveitis was also the leading category, but it appears more pronounced than in several European or North American cohorts, where JIA-associated uveitis often represents a larger proportion of cases [17, 19]. In our setting, this high proportion of idiopathic forms may reflect both true isolated ocular inflammation and limitations related to retrospective classification over a long study period.

Idiopathic uveitis in childhood should not be regarded as a fixed diagnosis in all cases. Pediatric uveitis may precede the clinical expression of an underlying systemic inflammatory or autoinflammatory disease. Therefore, an initially well child with apparently isolated uveitis may later develop features allowing reclassification as JIA-associated uveitis, Behçet disease, sarcoidosis, inflammatory bowel disease-associated uveitis, TINU syndrome, Blau syndrome, or another immune-mediated condition [3, 25]. This is particularly relevant in children with bilateral, chronic, granulomatous, recurrent, posterior, or panuveitic disease.

Several factors may have contributed to the high idiopathic rate in our study. First, the study covered a 25-year period during which diagnostic tools, infectious screening, immunological testing, ophthalmological imaging, and access to specialized multidisciplinary care evolved considerably. Second, some systemic manifestations may have been absent at the time of initial ophthalmological diagnosis or may not have been documented in early medical records. Third, the etiological work-up was guided by clinical presentation, which may have led to under-recognition of pauci-symptomatic or delayed-onset systemic diseases. Finally, some children classified as idiopathic may have had

incomplete phenotypic expression at one year, requiring longer follow-up before a definitive etiological label can be assigned.

This issue has important clinical implications. Children with idiopathic uveitis should not be considered as having a definitive exclusion diagnosis after the initial assessment only. Instead, idiopathic status should prompt regular clinical reassessment, repeated screening for extraocular symptoms, and targeted biological or imaging investigations when new signs appear. This is especially important in recurrent or treatment-dependent disease, where the emergence of arthritis, oral or genital ulcers, skin lesions, gastrointestinal symptoms, renal abnormalities, or neurological signs may modify the final diagnosis and therapeutic strategy.

In our cohort, the predominance of idiopathic uveitis therefore highlights the need for long-term multidisciplinary follow-up involving pediatricians, rheumatologists, and ophthalmologists. It also supports the creation of regional pediatric uveitis registries with standardized baseline and longitudinal assessments, which would help distinguish truly idiopathic forms from cases awaiting later diagnostic reclassification.

5. One-year outcomes and ocular complications

In our cohort, disease inactivity at one year was achieved in 76.6% of patients with complete follow-up data. This finding suggests that inflammatory control can be obtained in a substantial proportion of children when regular ophthalmological monitoring and systemic pediatric management are available. However, this outcome should not be interpreted as definitive remission. In our study, one-year disease inactivity included complete remission, partial remission, and treatment-maintained inactivity. Therefore, many children achieved disease control while still receiving topical or systemic maintenance therapy. This distinction is clinically important, as pediatric uveitis often follows a chronic and treatment-dependent course rather than a rapidly self-limited evolution [1, 10].

The high relapse rate observed in our cohort further supports this interpretation. Relapses occurred in 44.7% of patients, with a mean delay of 4.5 months after initial inflammatory control and a mean relapse rate of 1.14 episodes per year. Relapses were mainly observed in anterior uveitis and panuveitis, and were most frequent in idiopathic and JIA-associated uveitis. This confirms that apparent early control does not exclude subsequent inflammatory reactivation and underlines the need for prolonged follow-up, even in children who achieve inactivity during the first year. In contrast, recurrence after treatment discontinuation was rare in our series, suggesting that most inflammatory reactivations occurred in the context of chronic or treatment-maintained disease rather than true drug-free remission.

Visual outcome was favorable in most patients, with stable or improved visual acuity in 80.9% of children at one year. This result is encouraging and may reflect the benefit of multidisciplinary follow-up and early therapeutic intensification in selected patients. Nevertheless, visual stability should be interpreted alongside the burden of ocular complications. In our cohort, 36.2% of children developed at least one ocular complication during the first year of follow-up. Complications were more frequent in panuveitis

than in anterior uveitis, highlighting the prognostic importance of anatomical extent and posterior segment involvement.

Cataract was the most frequent complication, mainly occurring in idiopathic uveitis and involving both anterior uveitis and panuveitis. This finding is consistent with the known impact of chronic anterior chamber inflammation and corticosteroid exposure in pediatric uveitis [2, 9]. Macular edema, papillitis, and retinal vasculitis were less frequent but clinically important because they reflect posterior segment involvement and may directly threaten visual prognosis. In our series, macular edema was observed in Behçet disease, idiopathic uveitis, and oligoarticular JIA-associated uveitis, whereas papillitis and retinal vasculitis were mainly associated with panuveitis or posterior uveitis.

Other complications, including keratopathy, optic disc edema, optic neuropathy, ocular hypertension, and ciliary body detachment, were less common but illustrate the wide spectrum of ocular damage that may occur in children with chronic uveitis. Keratopathy was observed in idiopathic anterior uveitis, whereas ocular hypertension and ciliary body detachment occurred in more severe panuveitic forms. These findings support the need for systematic screening not only for inflammatory activity, but also for structural complications that may progress silently in children.

Compared with studies evaluating long-term drug-free remission, our one-year outcome reflects an earlier and broader endpoint of inflammatory control. Qian et al. reported that drug-free remission may require several years in children with chronic non-infectious uveitis [10]. Therefore, the relatively high rate of one-year disease inactivity in our cohort should be interpreted as a short-term therapeutic success rather than a marker of permanent disease resolution. This reinforces the importance of maintaining close ophthalmological surveillance after the first year, especially in children with idiopathic disease, JIA-associated uveitis, panuveitis, or previous complications.

Overall, our findings confirm that pediatric uveitis carries a dual burden: persistent inflammatory activity requiring long-term treatment and cumulative structural ocular damage. Achieving inactivity at one year is an important therapeutic milestone, but it should be accompanied by continued monitoring for relapse, corticosteroid-related complications, macular involvement, and optic nerve damage.

6. Predictive factors of one-year disease inactivity

The identification of factors associated with one-year disease inactivity is clinically important because pediatric uveitis is often chronic, relapsing, and potentially sight-threatening. In our multivariable analysis, three variables remained independently associated with disease inactivity at one year: absence of vitreous abnormalities, ANA positivity, and use of immunosuppressive therapy. These factors probably reflect different dimensions of prognosis: anatomical extent of inflammation, clinical phenotype and screening pathway, and therapeutic intensification.

6.1 Absence of vitreous abnormalities

The association between absence of vitreous abnormalities and one-year disease inactivity is clinically coherent. Vitreous involvement usually reflects intermediate, posterior, or panuveitic disease rather than isolated anterior inflammation. These anatomical forms are generally more severe, more difficult to control, and more frequently associated with vision-threatening complications such as macular edema, retinal vasculitis, papillitis, and persistent visual impairment [2, 9, 17].

In our cohort, the absence of vitreous abnormalities was independently associated with disease inactivity, suggesting that children without vitreous or posterior segment involvement had a more favorable inflammatory course. This may reflect a lower baseline inflammatory burden, better response to treatment, and reduced risk of structural ocular damage. Conversely, vitreous inflammation may be a marker of more extensive intraocular disease, delayed diagnosis, or insufficient initial control, all of which can contribute to persistent activity at one year.

This finding supports the importance of careful posterior segment evaluation at baseline and during follow-up. Even in children presenting with apparently anterior uveitis, assessment of the vitreous, retina, macula, and optic disc remains essential, as subclinical posterior involvement may modify both prognosis and therapeutic strategy.

6.2 ANA positivity

ANA positivity was the strongest independent factor associated with one-year disease inactivity in our study. This result should be interpreted cautiously. ANA are well established as a risk marker for the development of chronic anterior uveitis in children with JIA, particularly in young patients with oligoarticular disease [4, 26]. However, their role as a prognostic marker of better inflammatory outcome is less clearly established.

In our cohort, ANA positivity may not represent a direct protective biological factor. A more plausible explanation is that ANA positivity identifies a better-recognized clinical phenotype, especially JIA-associated chronic anterior uveitis. Children with JIA and positive ANA are usually considered at high risk for uveitis and are therefore more likely to undergo systematic ophthalmological screening, closer follow-up, and earlier treatment adjustment [26]. Earlier detection may allow treatment before the development of severe ocular complications or extension toward the posterior segment.

This interpretation is supported by the fact that ANA-positive uveitis is often associated with chronic anterior involvement, a pattern that may be more amenable to regular screening and earlier therapeutic control than posterior or panuveitic forms. Therefore, the association between ANA positivity and one-year inactivity in our study may reflect the combined effect of earlier diagnosis, closer surveillance, and a more standardized management pathway rather than an intrinsically milder disease.

Nevertheless, this finding remains noteworthy because ANA are generally discussed as predictors of uveitis occurrence in JIA rather than predictors of subsequent inactivity. It should therefore be considered hypothesis-generating and interpreted with caution, especially given the limited sample size

and wide confidence interval observed in the multivariable model. Larger prospective studies are needed to determine whether ANA status has independent prognostic value beyond its role in risk stratification and screening.

6.3 Immunosuppressive therapy

The independent association between immunosuppressive therapy and one-year disease inactivity also requires careful interpretation. In pediatric uveitis, conventional immunosuppressants, particularly methotrexate, are commonly used as steroid-sparing agents in chronic, recurrent, severe, or corticosteroid-dependent disease [1, 4, 7, 26]. Biologic therapy, especially monoclonal anti-TNF agents such as adalimumab or infliximab, is recommended when systemic treatment is needed or when inflammation remains uncontrolled despite conventional therapy [8, 26].

At first glance, the association between immunosuppressive therapy and disease inactivity may suggest that early systemic immunomodulation improves inflammatory control. This interpretation is clinically plausible. By reducing persistent inflammation and limiting prolonged corticosteroid exposure, immunosuppressive therapy may help prevent structural ocular damage and improve the likelihood of achieving inactivity.

However, this result must also be interpreted in light of indication bias. In retrospective studies, immunosuppressants are not prescribed randomly; they are usually introduced in patients with more severe, chronic, relapsing, or steroid-dependent uveitis. Therefore, children receiving immunosuppressive therapy may have had a higher baseline risk of persistent inflammation. The fact that immunosuppressive therapy remained associated with inactivity after adjustment may suggest that therapeutic intensification contributed to disease control despite greater initial severity.

This finding reinforces the importance of timely steroid-sparing therapy in children with chronic or sight-threatening uveitis. It also highlights the need to avoid prolonged reliance on topical or systemic corticosteroids alone, particularly in patients with recurrent inflammation, bilateral disease, posterior segment involvement, or early complications. Nevertheless, because of the retrospective design of our study, this association should not be interpreted as proof of causality. Prospective studies using standardized treatment algorithms are needed to better define the optimal timing of immunosuppressive therapy and its impact on long-term remission, visual prognosis, and relapse prevention.

Overall, the three predictive factors identified in our study appear clinically complementary. Absence of vitreous abnormalities reflects lower anatomical severity, ANA positivity may reflect a phenotype benefiting from earlier recognition and closer surveillance, and immunosuppressive therapy may reflect the effect of therapeutic intensification in patients requiring systemic control. Together, these findings support a risk-adapted approach to pediatric uveitis, combining early anatomical assessment, systematic screening of high-risk children, and timely use of steroid-sparing therapy when indicated.

7. Strengths and limitations

This study has several strengths. First, it provides original data on pediatric uveitis from a North African tertiary pediatric center, a geographic area that remains underrepresented in the international literature. Second, the long study period allowed us to describe the spectrum of pediatric uveitis over 25 years and to capture different etiological, therapeutic, and outcome profiles. Third, our cohort was managed in a pediatric setting with multidisciplinary collaboration between pediatricians, ophthalmologists, and pediatric rheumatology specialists, which is particularly relevant for chronic non-infectious uveitis. Fourth, we analyzed not only descriptive epidemiological and clinical features, but also therapeutic patterns, one-year outcomes, ocular complications, and predictive factors of disease inactivity. Finally, the use of standardized SUN-based definitions for uveitis activity and inactivity strengthens the comparability of our findings.

However, several limitations should be acknowledged. The main limitation is the retrospective design, which exposes the study to missing data, incomplete documentation, and variability in the quality of medical records, especially during the earliest years of the study period. The single-center design may also limit the generalizability of our findings, as the cohort may reflect local referral pathways and the specific recruitment of a tertiary pediatric department. Referral bias is therefore possible, with overrepresentation of severe, chronic, recurrent, or systemic inflammatory forms.

Another important limitation is the relatively small sample size, particularly for subgroup analyses and multivariable modeling. Although three independent factors were associated with one-year disease inactivity, the confidence intervals were wide, indicating limited statistical precision. Therefore, the strength of these associations should be interpreted cautiously. The number of patients receiving biologic therapy was also low, which prevented meaningful evaluation of the specific impact of anti-TNF agents on one-year outcomes.

The 25-year study period is both a strength and a limitation. During this time, diagnostic tools, ophthalmological imaging, infectious and immunological investigations, screening practices for JIA-associated uveitis, and access to immunosuppressive and biologic therapies evolved considerably. This temporal heterogeneity may have influenced etiological classification, treatment decisions, and outcome assessment. Some patients classified as having idiopathic uveitis may also be reclassified during longer follow-up if systemic manifestations emerge later.

Therapeutic interpretation is also limited by indication bias. Immunosuppressive therapy was not randomly assigned, but was prescribed according to disease severity, chronicity, corticosteroid dependence, or relapse. Therefore, the association between immunosuppressive therapy and disease inactivity should not be interpreted as definitive proof of causality. It may reflect the benefit of therapeutic intensification, but also the clinical selection of patients requiring systemic treatment.

Finally, our primary endpoint was disease inactivity at one year, not long-term drug-free remission. This endpoint is clinically relevant because it reflects early inflammatory control, but it does not capture the full chronic course of pediatric uveitis, late relapses, cumulative ocular damage, or long-term visual prognosis. Longer prospective follow-up with standardized assessment of visual acuity, imaging

findings, treatment exposure, and corticosteroid-sparing strategies would be needed to better define long-term outcomes.

Despite these limitations, our study provides useful regional data and supports the need for prospective multicenter registries in North Africa and the MENA region. Such studies should use standardized diagnostic and outcome definitions, harmonized ophthalmological screening protocols, and structured therapeutic algorithms to validate prognostic factors and improve individualized management of pediatric uveitis.

8. Clinical implications and future directions

Our findings have several clinical implications for the management of pediatric uveitis. First, they support the need for early and systematic ophthalmological screening in children at risk, particularly those with JIA and ANA positivity. Although ANA positivity was associated with one-year disease inactivity in our cohort, this finding should not be interpreted as a marker of benign disease. Rather, it may identify a subgroup of children who benefit from earlier recognition, closer ophthalmological surveillance, and more standardized management pathways. This reinforces the importance of applying structured screening protocols in children with JIA and other systemic inflammatory diseases [26].

Second, our results emphasize the importance of complete baseline anatomical assessment. The absence of vitreous abnormalities was independently associated with disease inactivity, suggesting that posterior segment or vitreous involvement should be considered an important marker of disease severity. Careful examination of the vitreous, retina, macula, and optic disc, supported by ocular imaging when needed, should therefore be integrated into the initial evaluation and follow-up of all children with uveitis. Identifying posterior segment involvement early may help guide treatment intensity and follow-up frequency.

Third, the high proportion of idiopathic uveitis in our cohort highlights the need for repeated etiological reassessment over time. In children, an initially idiopathic uveitis may precede the clinical emergence of systemic inflammatory, autoinflammatory, infectious, or granulomatous disease. Therefore, idiopathic uveitis should be considered a dynamic diagnostic category rather than a definitive label. New systemic symptoms, relapses, treatment dependence, granulomatous features, or posterior segment involvement should prompt renewed clinical and laboratory evaluation.

Fourth, the association between immunosuppressive therapy and one-year disease inactivity supports the role of timely steroid-sparing treatment in children with chronic, severe, recurrent, or corticosteroid-dependent uveitis. In clinical practice, prolonged reliance on corticosteroids alone should be avoided, particularly in children at risk of ocular complications or treatment-related adverse effects. Conventional immunosuppressive agents, especially methotrexate, remain central in the management of chronic non-infectious pediatric uveitis, while biologic agents should be considered in refractory or sight-threatening forms according to current recommendations [8, 26].

From a broader perspective, our study underlines the need for a risk-adapted approach to pediatric uveitis. Children with anterior, ANA-positive disease and no vitreous involvement may have a more favorable probability of achieving inactivity, provided that screening and treatment are timely. Conversely, patients with vitreous abnormalities, panuveitis, posterior segment involvement, recurrent inflammation, or early ocular complications should be considered at higher risk and may require closer monitoring and earlier therapeutic escalation.

Future studies should aim to validate these findings in larger prospective cohorts. Multicenter studies from North Africa and the MENA region are particularly needed, as available data suggest substantial regional heterogeneity in etiological profiles, infectious burden, referral pathways, and access to biologic therapies [12, 19–24]. Standardized registries using harmonized SUN-based definitions, structured ophthalmological imaging protocols, and predefined treatment algorithms would allow better comparison across regions and help identify robust prognostic markers.

Long-term studies are also needed to distinguish short-term disease inactivity from sustained drug-free remission. As pediatric uveitis may relapse after apparent inflammatory control, future research should assess long-term visual prognosis, cumulative ocular damage, corticosteroid exposure, treatment duration, relapse patterns, and quality of life. Such data would help define optimal treatment duration and tapering strategies, particularly in children who achieve early inactivity but remain at risk of recurrence [10].

Overall, our findings support a multidisciplinary model of care involving pediatricians, pediatric rheumatologists, and ophthalmologists. Early diagnosis, repeated etiological reassessment, anatomical risk stratification, and timely use of steroid-sparing therapy may improve inflammatory control and help preserve long-term visual function in children with uveitis.

Conclusion

Pediatric uveitis remains a rare but potentially sight-threatening inflammatory disease, characterized by a chronic course, frequent bilateral involvement, and a substantial risk of ocular complications. In this 25-year single-center Tunisian cohort, idiopathic uveitis was the leading etiological category, followed by JIA-associated uveitis, while infectious causes were uncommon.

Most children achieved inflammatory control at one year, with disease inactivity observed in 76.6% of patients with complete follow-up data. However, relapse and ocular complications remained frequent, emphasizing that one-year inactivity should be interpreted as disease control rather than definitive cure. These findings underline the need for prolonged ophthalmological surveillance even after apparent inflammatory improvement.

Positive antinuclear antibodies, use of immunosuppressive therapy, and absence of vitreous abnormalities were independently associated with one-year disease inactivity. Absence of vitreous involvement appears to reflect a less extensive and more favorable anatomical phenotype. ANA

positivity may identify children who benefit from earlier recognition and closer screening, particularly in the context of JIA-associated uveitis. The association with immunosuppressive therapy supports the role of timely steroid-sparing treatment, although it should be interpreted cautiously because of potential indication bias.

Overall, our results support a risk-adapted and multidisciplinary approach to pediatric uveitis, combining early diagnosis, repeated etiological reassessment, careful evaluation of posterior segment involvement, and timely introduction of immunomodulatory therapy when indicated. Prospective multicenter studies, particularly from North Africa and the MENA region, are needed to validate these prognostic factors, harmonize management strategies, and improve long-term visual outcomes in children with uveitis.

Declarations

Ethics approval and consent to participate

The study was approved by the Ethics Committee of Children Hospital Béchir Hamza, University of Tunis El Manar, Tunis, Tunisia. Given the retrospective design of the study, the Ethics Committee waived the requirement for written informed consent. All procedures performed in this study involving human participants were conducted in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments.

Consent for publication:

Not applicable.

Competing interests:

The authors declare no competing interests.

Use of AI-assisted tools

During manuscript preparation, an AI-assisted language model was used to support English language editing, restructuring, and drafting assistance. The authors critically reviewed, revised, and approved all AI-assisted content and take full responsibility for the accuracy, integrity, and originality of the final manuscript.

Funding:

No specific funding was received.

Author Contribution

AM contributed to data collection, data curation, literature review, and drafting of the initial manuscript. HH conceived and designed the study, supervised data collection, contributed to data interpretation, and critically revised the manuscript. HJ, MHL and RF contributed to clinical data collection and verification. MJ and LE contributed to statistical analysis and interpretation of results. ZF supervised the study, contributed to interpretation of the findings, and critically revised the manuscript for important intellectual content. All authors read and approved the final manuscript.

Acknowledgements

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

References

1. - Kim L, Li A, Angeles-Han S, Yeh S, Shantha J. Update on the management of uveitis in children: an overview for the clinician. Expert Rev Ophthalmol. 2019;14(4–5):211–8.
2. - Rosenberg KD, Feuer WJ, Davis JL. Ocular complications of pediatric uveitis. Ophthalmology. 2004;111(12):2299–306.
3. - Tuğal-Tutkun İ. An Overview of Pediatric Uveitis. Turk Arch Pediatr. 2023;58(4):363–70.
4. - Sen ES, Ramanan AV. Juvenile idiopathic arthritis-associated uveitis. Clin Immunol. 2020;211:108322.
5. - Siiskonen M, Hirn I, Pesälä R, Ohtonen P, Hautala N. Encouraging visual outcomes in children with idiopathic and JIA associated uveitis: a population-based study. Pediatr Rheumatol Online J. 2023;21(1):56.
6. -Gentile P, Ragusa E, Bolletta E, De Simone L, Gozzi F, Cappella M, Fastiggi M, De Fanti A, Cimino L. Epidemiology of Pediatric Uveitis. Ocul Immunol Inflamm. 2023;31(10):2050–9.
7. - Modrzejewska M, Zdanowska O. Diagnosis and Treatment of Uveitis in Children: A Summary of the Latest Data from a 5-Year Literature Review (2018–2023). J Clin Med. 2024;13(11):3097.
8. -Gaggiano C, de-la-Torre A, Guerriero S, Costi S, Ragab G, Paroli MP, et al. Adalimumab monotherapy or combination therapy with methotrexate in paediatric uveitis: data from the AIDA network uveitis registry. Clin Exp Ophthalmol. 2025;53(6):619–26.
9. - Gautam Seth N, Kaur S, Yangzes S, Jugran D, Bansal R, Gupta V, Dogra MR, Suri D, Singh S, Singh R. Ophthalmic Complications in Pediatric Uveitis. Ocul Immunol Inflamm. 2021;29(7–8):1375–80.

10. - Qian Y, Xu RH, Rabbani JW, Tucker LY. Incidence and Predictors of Remission of Childhood Uveitis in a Large Community Cohort. Am J Ophthalmol. 2025;277:221–229. 2025;277:221–229.
11. - Yakovlev AA, Gaidar EV, Sorokina LS, Nikitina TN, Kalashnikova OV, Kostik MM. Uveitis associated with juvenile idiopathic arthritis and chronic idiopathic uveitis in children: A retrospective cohort study. World J Clin Pediatr. 2025;14(2):100336.
12. -Utz VM, Angeles-Han ST. Global perspectives on paediatric uveitis: bridging the divide in child-centered ocular care. Ocul Immunol Inflamm. 2025;33(10):2241–4.
13. Jabs DA, Nussenblatt RB, Rosenbaum JT, Standardization of Uveitis Nomenclature (SUN) Working Group. Standardization of uveitis nomenclature for reporting clinical data. Results of the First International Workshop. Am J Ophthalmol. 2005;140(3):509 – 16.
14. Petty RE, Southwood TR, Manners P, Baum J, Glass DN, Goldenberg J, He X, Maldonado-Cocco J, Orozco-Alcala J, Prieur AM, Suarez-Almazor ME, Woo P. International League of Associations for Rheumatology. International League of Associations for Rheumatology classification of juvenile idiopathic arthritis: second revision, Edmonton, 2001. J Rheumatol. 2004;31(2):390–2.
15. Criteria for diagnosis of Behçet's disease. International Study Group for Behçet's Disease. Lancet. 1990;335(8697):1078–80.
16. Statement on sarcoidosis. Joint Statement of the American Thoracic Society (ATS), the European Respiratory Society (ERS) and the World Association of Sarcoidosis and Other Granulomatous Disorders (WASOG) adopted by the ATS Board of Directors and by the ERS Executive Committee, February 1999. Am J Respir Crit Care Med. 1999;160(2):736–55.
17. Smith JA, Mackensen F, Sen HN, Leigh JF, Watkins AS, Pyatetsky D, Tessler HH, Nussenblatt RB, Rosenbaum JT, Reed GF, Vitale S, Smith JR, Goldstein DA. Epidemiology and course of disease in childhood uveitis. Ophthalmology. 2009;116(8):1544.
18. Rypdal V, Glerup M, Songstad NT, Bertelsen G, Christoffersen T, Arnstad ED, Aalto K, Berntson L, Fasth A, Herlin T, Ekelund M, Peltoniemi S, Toftedal P, Nielsen S, Leinonen S, Bangsgaard R, Nielsen R, Rygg M, Nordal E. Nordic Study Group of Pediatric Rheumatology. Uveitis in Juvenile Idiopathic Arthritis: 18-Year Outcome in the Population-based Nordic Cohort Study. Ophthalmology. 2021;128(4):598–608.
19. Khairallah M, Attia S, Zaouali S, Yahia SB, Kahloun R, Messaoud R, Zouid S, Jenzeri S. Pattern of childhood-onset uveitis in a referral center in Tunisia, North Africa. Ocul Immunol Inflamm. 2006;14(4):225–31.
20. Hamade IH, Al Shamsi HN, Al Dhibi H, Chacra CB, Abu El-Asrar AM, Tabbara KF. Uveitis survey in children. Br J Ophthalmol. 2009;93(5):569–72.
21. AlBloushi AF, AlTariqi SM, Alghofaili RS, Gikandi PW, Abu El-Asrar AM. Patterns and outcomes of pediatric uveitis in a university-based tertiary referral center in Riyadh, Saudi Arabia. Ocul Immunol Inflamm. 2025;33(4):654–61.
22. Abd El Latif E, Mousa R, Tawfeeq Mahdi M, Mahmoud Amin A, Mohammed Ahmed Ali M, Abdelhamid NE, Elmoddather M, Shamselden Yousef H, Hafez EHG, Salem SGT, Soliman AH.

Etiology of Pediatric Uveitis in a Tertiary Pediatric Eye Hospital in Egypt. Ocul Immunol Inflamm. 2023;31(10):1978–83.

23. Abd El Latif E, Fayez Goubran W, El Gemai EEDM, Habib AE, Abdelbaki AM, Ammar H, Seleet M. Pattern of Childhood Uveitis in Egypt. Ocul Immunol Inflamm. 2019;27(6):883–9.
24. Abdelmageed NH, Adi A, Abo El-Khair S, Shahin M, Mosa DM, Sabry D, El Nokrashy A. Demographic and Clinical Profile of Pediatric Uveitis in Delta Region, Egypt. Ocul Immunol Inflamm. 2024;32(9):2121–9.
25. Rahman N, Petrushkin H, Solebo AL. Paediatric autoimmune and autoinflammatory conditions associated with uveitis. Ther Adv Ophthalmol. 2020;12:2515841420966451.
26. Angeles-Han ST, Ringold S, Beukelman T, Lovell D, Cuello CA, Becker ML, et al. 2019 American College of Rheumatology/Arthritis Foundation guideline for the screening, monitoring, and treatment of juvenile idiopathic arthritis-associated uveitis. Arthritis Care Res (Hoboken). 2019;71(6):703–16.

Figures

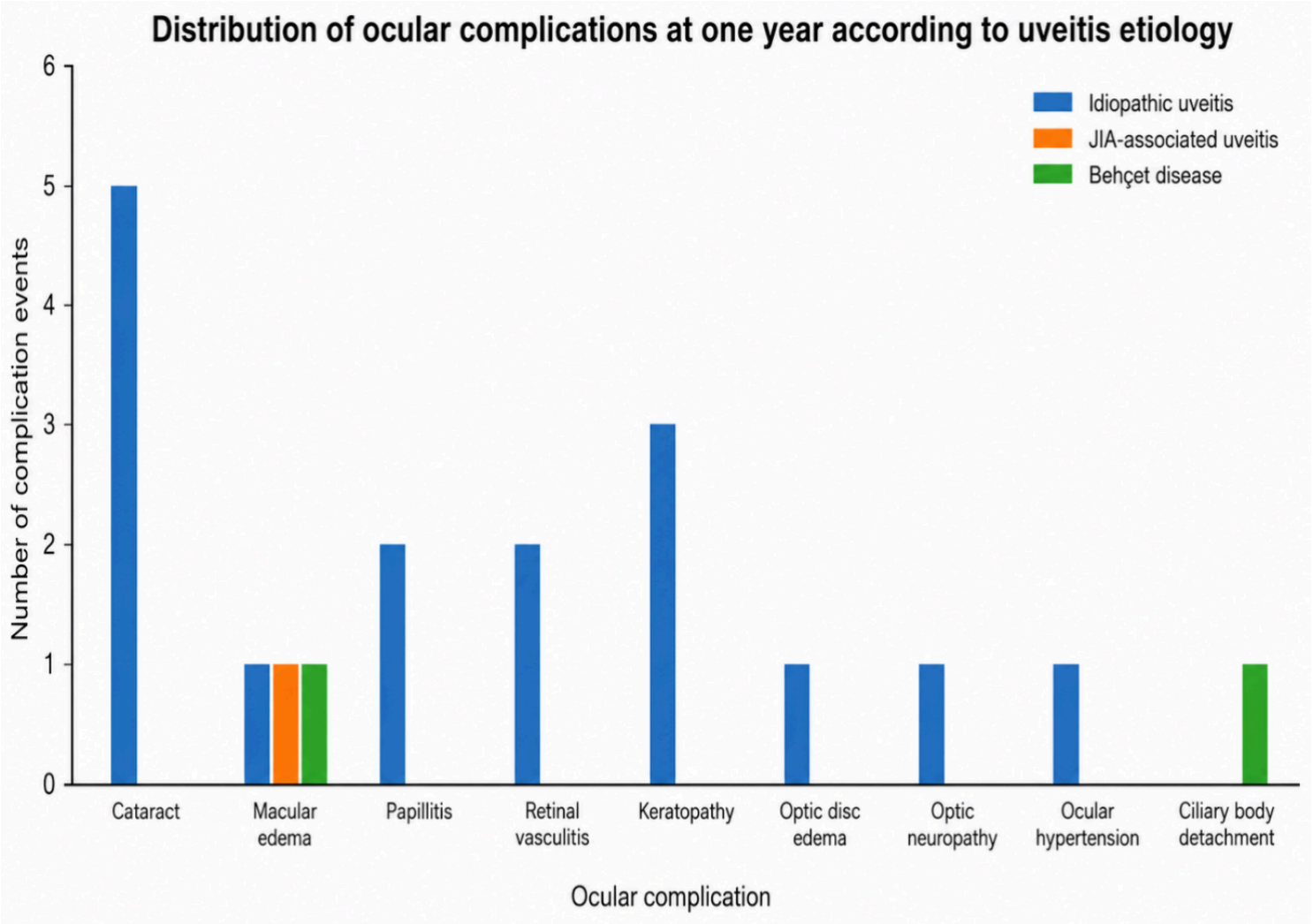


Figure 1

Distribution of ocular complications at one year according to uveitis etiology (N= 47)