REPUBLIC OF AZERBAIJAN

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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

CHARACTERISTICS OF OCULAR DISEASES IN CHILDREN BORN FROM CONSANGUINEOUS MARRIAGES IN AZERBAIJAN

Specialty: 3219.01 – "Eye diseases"

Field of Science: Medical Sciences

Applicant: **Ravana Mehman Hasanova**

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The work was performed at the National Ophthalmology Centre named after Academician Zarifa Aliyeva.

Scientific Supervisor: Corresponding Member of ANAS, Honored Scientist, Doctor of Medical Sciences, Professor **Elmar Mustafa Gasimov**

Official Opponents: Doctor of Medical Sciences, Associate Professor **Rana Boyukkishi Aghayeva**

Doctor of Medical Sciences, Associate Professor **Tural Pasha Galbinur**

Doctor of Philosophy in Medical Science **Vafa Ali Aslanova**

Dissertation council FD 1.03 of Supreme Attestation Commission under the President of the Republic of Azerbaijan operating at National Ophthalmology Centre named after Academician Zarifa Aliyeva

Chairman of the Dissertation Council:
Corresponding Member of ANAS, Honored Scientist, Doctor of Medical Sciences, Professor
Elmar Mustafa Gasimov

Scientific Secretary of the Dissertation Council:
Doctor of Medical Sciences, Associate Professor
Nazila Mammad Rustamova

Chairman of the Scientific Seminar:
Doctor of Medical Sciences
Nizami Aliniyaz Baghirov

GENERAL CHARACTERISTICS OF THE STUDY

Relevance of the Study. Hereditary eye diseases (HED) are considered one of the important problems of modern ophthalmology and the healthcare system. From an early age, these pathologies lead to reduced visual acuity and, in severe cases, blindness, which in turn negatively affects the physical, psychological and social development of children [1].

According to data from the World Health Organization (WHO), childhood blindness accounts for approximately 4% of total blindness worldwide. That is, 19 million children suffer from visual impairment of varying degrees, and approximately 1.4 million of them live with blindness[2,3]. At the same time, it is noted that about half of childhood blindness is due to preventable causes, i.e., treatable conditions[4]. This demonstrates the great importance of early diagnosis and preventive measures[5,6].

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Hereditary eye diseases arise as a result of genetic mutations and are transmitted by autosomal-dominant, autosomal-recessive, X-linked or mitochondrial inheritance mechanisms[7].

Scientific studies show that consanguineous marriage is one of the major risk factors in the spread of HED [8]. Worldwide, more than 20% of marriages are consanguineous, and the incidence of autosomal-recessive genetic diseases is significantly higher among children born from such marriages[9]. Consanguineous marriages increase the probability of both parents being carriers of the same mutant gene, resulting in an increased transmission of genetic diseases from generation to generation[10].

Children born from consanguineous marriages exhibit various congenital and hereditary pathologies of the visual organ; these pathologies may manifest either as isolated ocular diseases or as part of multisystem genetic syndromes. These pathologies can lead to a progressive impairment of visual function from early childhood, to disability, and in a number of cases to the development of irreversible blindness[11],[12].

In many countries, the wide prevalence of consanguineous marriages has provided a basis for extensive scientific research into

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the epidemiology, clinical features, and risk factors of hereditary diseases[13],[14]. Epidemiological studies show that in populations where consanguineous marriages are widespread, the incidence of autosomal-recessive genetic diseases, including HED, is significantly higher[15],[16]. For this reason, in the modern healthcare system, early diagnosis of hereditary diseases, the implementation of population screening programs, and the development of genetic counseling services are of particular importance[17].

Consanguineous marriages is considered one of the important factors that increases the risk of transmission of genetic diseases, including hereditary ocular pathologies, among future generations[18].

By Decision No. 213 of the Cabinet of Ministers dated 23 June 2020, the Rules on raising public awareness of the adverse consequences of consanguineous marriage were approved. Subsequently, under the law of 28 June 2024 amending the Family Code, marriage between certain degrees of kinship was prohibited, with the amendment entering into force on 1 July 2025.

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The purpose of these measures is to reduce the medical-genetic consequences of consanguineous marriage, including the risk of the spread of hereditary diseases. The principal aim of these legislative amendments is to prevent the possible medical and genetic consequences of consanguineous marriage, reduce the risk of the spread of hereditary and congenital diseases, and protect the health of future generations [19].

It should also be noted that the epidemiological and clinical characteristics of hereditary eye diseases observed in children born from consanguineous marriages in Azerbaijan still remain relevant and continue to be one of the priority scientific and practical issues requiring detailed study[20],[21].

Taking into account the above, the study of ocular diseases observed in children born from consanguineous marriages in Azerbaijan, the analysis of their clinical characteristics, identification of risk factors, and improvement of early diagnostic measures are of great scientific and practical importance. In this regard, the presented dissertation is devoted to one of the current problems in the field of ophthalmology.

Object and subject of the study. The present study analyses the examination results of 560 children examined at the Medical Expert Commission (MEC) operating under the Academician Zarifa Aliyeva National Ophthalmology Centre of the Republic of Azerbaijan during 2019–2023.

Aim of the study. Clinical and epidemiological analysis of hereditary eye diseases in children born from consanguineous

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marriages in Azerbaijan and development of a diagnostic screening algorithm.

Objectives of the study. To achieve the above-mentioned aim, the following objectives were set:

1. Analysis of epidemiological and clinical manifestations of hereditary eye diseases in Azerbaijan.

2. Study of the impact of the consanguineous marriage factor on the incidence and clinical course of hereditary eye diseases.

3. Quantitative assessment of the degree of visual function impairment in hereditary eye diseases and identification of the main factors influencing the development of blindness.

4. Analysis of treatment approaches applied for various hereditary eye pathologies.

5. Development of a screening algorithm for early diagnosis of hereditary eye diseases.

Study methods. The medical records and clinical data of patients were analysed retrospectively and prospectively. Based on family history, the demographic indicators of patients, the time of presentation and the clinical characteristics of hereditary eye diseases were studied. The incidence by age subgroup and sex, as well as the distribution by economic region, were assessed. Parametric and non-parametric statistical methods were used in the analysis of the collected data, and qualitative and quantitative indicators were statistically compared between groups.

Main provisions submitted for defense: As a result of the conducted research, the following conceptual approaches were obtained and presented in the form of provisions.

- Determination of epidemiological characteristics of children with hereditary eye diseases based on sex, age, and family history indicators;

- Determination of the nosological structure based on comparative and systemic analysis of clinical manifestations of hereditary eye diseases in children born from consanguineous marriages;

- Identification of the main risk factors influencing the development of blindness and low vision in hereditary eye diseases and assessment of their medical and social significance;

- Analysis of treatment approaches applied depending on the clinical form of pathology in children with hereditary eye diseases, taking into account family history;

- Development of an algorithm for prevention and early diagnosis of hereditary eye diseases.

Scientific novelty of the study:

1. The nosological structure of hereditary eye diseases among children born from consanguineous marriages in Azerbaijan was systematically studied, and the main factors causing blindness in children were identified.

2. The incidence of hereditary eye diseases among children born from consanguineous marriages by regions of the Republic of Azerbaijan was studied based on appeals to the Medical Expert Commission.

3. A staged screening algorithm aimed at early diagnosis of hereditary eye diseases in children was proposed.

Theoretical and practical significance of the study results:

The results of the study make a significant contribution to improving existing practices and enriching scientific knowledge in the field of ophthalmology and healthcare. These results, through the timely detection of diseases and appropriate treatment, create conditions for preserving visual function and reducing the level of disability.

The application of the diagnostic algorithm developed on the basis of this research, particularly in the examination of children born from consanguineous marriages, will increase the effectiveness of the work of physicians and healthcare institutions by ensuring early-stage disease detection and adequate clinical intervention.

Approbation of the dissertation:

The materials, main results, and main propositions of the dissertation were reported and discussed at the following scientific-practical conferences: 11th Conference of Young Ophthalmologists,

2017 (November 24, Azerbaijan, Lankaran), Scientific-Practical Conference "Modern Diagnosis and Treatment of Glaucoma", 2018 (March 15, Azerbaijan, Baku), 6th Regional Conference of the Azerbaijan Ophthalmologists Society, 2018 (October 26, Azerbaijan, Lankaran), 52nd International Congress of the Turkish Ophthalmology Association, 2018 (November 13-18, Turkey, Antalya), 12th Conference of Young Ophthalmologists, 2018 (November 30, Azerbaijan, Nakhchivan), 7th Regional Conference of the Azerbaijan Ophthalmologists Society, 2019 (October 25-26, Azerbaijan, Sheki), International Scientific-Practical Conference "Current Problems of Ophthalmology" dedicated to the 96th anniversary of Academician Zarifa Aliyeva, 2019 (April 29, Azerbaijan, Baku), International Scientific-Practical Conference "Current Problems of Ophthalmology" dedicated to the 99th anniversary of Academician Zarifa Aliyeva, 2022 (April 28, Azerbaijan, Baku), 8th Regional Conference of the Azerbaijan Ophthalmologists Society, 2022 (May 13, Azerbaijan, Ganja), 35th Annual Meeting of the Asia-Pacific Association of Cataract and Refractive Surgeons, 2023 (35th APACRS Annual Meeting, June 8-10, Singapore, e-poster), International Ophthalmology Conference dedicated to the 20th Anniversary of the Establishment of the Branch of Ophthalmology of the Republican Specialized Scientific-Practical Medical Centre of the Republic of Uzbekistan, 2023 (International Ophthalmological Congress, Dedicated To The 20th ANNIVERSARY OF THE FOUNDATION OF RSSPMCES IOC), (October 12-13, Samarkand, Uzbekistan), International Conference "Physiology of Vision and Occupational Pathologies: Fundamental and Applied Aspects" and 6th Congress of Azerbaijani Physiologists dedicated to the 100th anniversary of National Leader Heydar Aliyev and outstanding scientist Academician Zarifa Aliyeva, 2023 (October 30-31, Azerbaijan, Baku), 15th Azerbaijan Young Ophthalmologists Conference and I Forum of Azerbaijan Young Ophthalmologists – "YOC-2023" dedicated to the 100th anniversary of Academician Zarifa Aliyeva, 2023 (November 24-25, Azerbaijan, Baku), 12th Regional Conference of the Azerbaijan Ophthalmologists Society

dedicated to the 100th anniversary of Academician Zarifa Aliyeva, 2023 (December 8, Azerbaijan, Nakhchivan), 29th Winter Meeting of the European Society of Cataract and Refractive Surgeons (ESCRS), 2024 (February 28 – March 2, Athens, Greece, e-poster), World Ophthalmology Congress 2024 (World Ophthalmology Congress-2024) (August 16-19, Vancouver, Canada, e-poster), 2nd ASO&TROS Joint International Ophthalmology Symposium hosted by the Azerbaijan Ophthalmologists Society, 2024 (October 25-26, Sheki, Azerbaijan), XVI Azerbaijan Young Ophthalmologists Conference and II Forum of Azerbaijan Young Ophthalmologists dedicated to the 100th anniversary of Dr. Munavvar khanum Gasimova, 2025 (February 21, Baku, Azerbaijan).

Preliminary discussion – (April 08, 2026; protocol No. 2) was held at the scientific seminar of Dissertation Council FD 1.03 operating at the National Ophthalmology Centre named after Academician Zarifa Aliyeva (June 12, 2026; protocol No. 8). The work was approved at the Specialized Scientific Seminar (Baku, 2026).

Name of the organization where the dissertation was carried out:

The dissertation was carried out on the basis of the Medical Expert Commission of the National Ophthalmology Centre named after Academician Zarifa Aliyeva.

Publication of the main results of the dissertation: 25 scientific works on the dissertation topic have been published, including 3 articles in 10 local and foreign publications recommended by the Supreme Attestation Commission under the President of the Republic of Azerbaijan, 1 clinical protocol, and 11 theses.

Volume and structure of the dissertation:

The dissertation consists of 195 pages of computer text (237,406 characters) and includes an introduction (17,590 characters), literature review (60,931 characters), materials and methods chapter (22,250 characters), three chapters of original research (98,272 characters), conclusion, results, practical recommendations (35,581 characters),

and a bibliography of 211 references. The dissertation contains 29 figures and 59 tables.

MATERIALS AND METHODS OF THE STUDY

The study was carried out on the basis of the clinical materials of children examined at the Medical Expert Commission of the Academician Zarifa Aliyeva National Ophthalmology Centre during 2019–2023. In total, 7,592 children were examined, of whom 4,124 (54%) presented for the first time, and hereditary eye diseases were identified in 1,120 of them. Using simple random sampling and taking inclusion/exclusion criteria into account, 560 children (1,056 eyes) were included in the study. The age range was 0–15 years, with a mean age of 7.4±0.2 years.

Based on family history, patients were divided into two groups: children born from consanguineous marriages (n=409; 73%) and children with no history of consanguineous marriage (n=151; 27%); both groups were further divided into 0–5, 6–10 and 11–15-year age subgroups.

In accordance with the Law of the Republic of Azerbaijan of 7 July 2021, patients were grouped by the country's 13 economic regions (the Nakhchivan Autonomous Republic was not included in the study, as no cases were referred from there). The fact of consanguineous marriage in the anamnesis, the number of other affected children in the family, the presence of eye disease in the family line, birth order and the time of initial detection of the disease were recorded.

Ophthalmological examination methods

To diagnose hereditary eye diseases, all patients underwent comprehensive ophthalmological examination.

Visual acuity was determined taking into account the age characteristics of the children using Snellen and Sivtsev–Golovin optotypes, as well as with a chart projector (Huvitz CCP-3100, Huvitz Co., Korea). Refractive errors were assessed after cycloplegia by retinoscopy (Welch Allyn, Skaneateles Falls, NY, USA) and

automated refractometry (Tomey Auto Ref-Keratometer, Tomey Corporation, Japan).

The condition of the anterior segment of the eye was evaluated by biomicroscopy (TOMEY TSL-5000, Tomey Corporation, Japan). Fundus examination was performed by direct and indirect ophthalmoscopy using a fundus lens (OCULUS 90D, Oculus Inc., USA).

Intraocular pressure was measured mainly by non-contact applanation tonometry (PT-1000, TOMEY Corporation, Japan). In young children, a portable tonometer (Tono-Pen, Reichert Technologies, USA) was used.

Optical coherence tomography (Cirrus HD-OCT 5000, Carl Zeiss Meditec, Germany/USA) was applied for the assessment of retinal and optic nerve structure. Electrophysiological examination methods – electroretinography (ERG) and visual evoked potentials (VEP) – were performed using the ROLAND CONSULT Super Color Ganzfeld 0450 device (Roland Consult, Germany).

Ultrasound examination of the eye was performed using a B-scan ultrasound device (Ultrascan B-scan, Alcon, USA).

DIAGNOSTIC ALGORITHM FOR HEREDITARY EYE DISEASES IN CHILDREN

A staged diagnostic algorithm was developed for the early detection of hereditary eye diseases in children. The algorithm is based on collaboration between paediatricians, ophthalmologists and specialised experts. At the initial stage, the red reflex and visual function are assessed, and suspicious cases are referred for ophthalmological examination. At the next stage, clinical and instrumental examinations are performed and the disease is classified into aetiological groups. Treatment is carried out by surgical or conservative methods depending on the nature of the disease, and patients are enrolled in regular follow-up. The aim of the algorithm is early diagnosis and the reduction of preventable blindness.

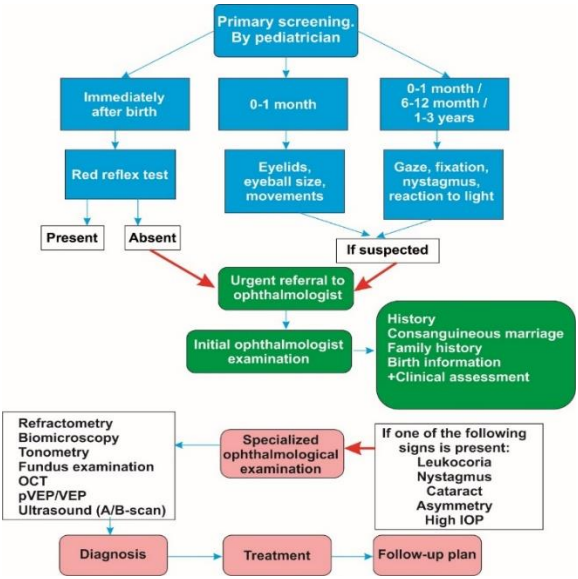

Figure 1. Scheme of the clinical-diagnostic algorithm for hereditary eye diseases in children

Statistical processing methods

The clinical and instrumental data obtained were systematised in Microsoft Excel 2010 and processed using modern medical-statistical methods. The mean value (M) and standard error (m) were calculated for quantitative indicators.

Student's t-test was applied for comparing quantitative indicators between two groups under normal distribution, while the Mann–Whitney U test was used in the absence of normal distribution or with a small sample size. Comparison of qualitative indicators and assessment of the relationship between groups were performed using Pearson's χ^2 test.

Relative indicators were expressed as percentages (%), and results were considered statistically significant at $p<0.05$. Results are presented comparatively in tables and figures.

RESULTS OF THE STUDY

General characteristics of children with hereditary eye diseases. The study of the epidemiological characteristics, clinical-statistical indicators and family history of hereditary pathologies of the visual organ is of great importance for the early detection and prevention of these diseases.

Since the pathological gene in autosomal-recessive hereditary diseases is not sex-linked, the incidence should theoretically be equal between boys and girls [22]. However, according to the results of the present study, the proportion of boys among children with HED was higher, at 62.9% (n=352), while the proportion of girls was 37.1% (n=208).

This difference is not genetic but is mainly explained by demographic factors: according to the State Statistical Committee of the Republic of Azerbaijan, more boys than girls have been born in recent years, which is consistent with the finding of this study.

The analysis showed that, across all years of observation, the highest proportion of diseases was recorded in the 6–10-year age subgroup (mean annual indicator 42.36%; $p < 0.05$) (Table 1). In this age group, the proportion of boys (65.2±3.1%; 230 cases) predominated, although the difference was not statistically significant ($p > 0.05$).

Table 1
Distribution of prevalence rates of hereditary diseases by age subgroups

Years of observation	0-5 years		6-10 years		11-15 years	
	Absolute number (n)	Proportion %	Absolute number(n)	Proportion %	Absolute numbe (n)	Proportion %
2019	19	20.88	45	49.45	27	29.67
2020	67	36.21	71	38.38	47	25.41
2021	31	40.79	30	39.48	15	19.73
2022	54	36.99	55	37.67	37	25.34

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2023	16	25.8	29	46.78	17	27.42
5-year indicator	187	33.39	230	41.07	143	25.54
Average annual indicator	37.4	32.1	46	42.36	28,6	25.51
$P\chi^2$	0.098		0.035*		0.545	
P_u	0.027*		0.002*		0.124	

Table 2

Analysis of disease indicators by sex and age subgroups based on differences between eyes

	Total examined patients (n=560)		Gender				Age group					
			Boys (n=352)		Girls (n=208)		0-5 years (n=187)		6-10 years (n=230)		11-15 years (n=143)	
	Absolute number		Absolute number		Absolute number		Absolute number		Absolute number		Absolute number	
	%	±	%	±	%	±	%	±	%	±	%	±
2 eye	501		324		177		163		206		132	
	88.1	1.3	91.2	1.5	84.1	2.5	87.2	2.4	89.6	2.0	92.3	2.2
1 eye	59		28		31		24		24		11	
	11.4	1.3	8.8	1.5	15.9	2.5	12.8	2.4	12.6	2.2	7.7	2.2
$P\chi^2$			<0.001*		<0.001*		<0.001*		<0.001*		<0.001*	
P_u			<0.001*		<0.001*		<0.001*		<0.001*		<0.001*	

Note: **Differences between group and sex indicators are statistically significant according to Pearson and Mann–Whitney tests (p<0.005).*

Analysis of the incidence of hereditary eye pathologies showed that the majority of cases were bilateral in nature: 89.5% (n=501) bilateral versus 10.5% (n=59) unilateral pathology (p<0.005).

By sex, the proportion of bilateral pathology was 91.2±1.5% (n=324) in boys and 84.1±2.5% (n=177) in girls, whereas unilateral pathology, conversely, was higher in girls (15.9±2.5%; n=31) than in boys (8.8±1.5%; n=28) (Table 2). By age subgroup, the highest number of both bilateral and unilateral pathologies was recorded in the 6–10-year age subgroup.

In the regional distribution of patients, the highest indicator was recorded in the Baku economic region (23.6%; n=132), with relatively high indicators observed in the Lankaran-Astara (11.8%; n=66) and

Mil-Mugan (10.4%; n=58) economic regions. The lowest indicator was recorded in the Eastern Zangazur economic region (0.9%; n=5).

Differences in the sex structure by region were identified: in the Baku economic region, boys accounted for 66.7% (n=88) and girls for 33.3% (n=44). In the Mil-Mugan economic region, the proportion of boys was higher (70.7%; n=41), while in the Lankaran-Astara economic region, the proportion of girls was the highest among all regions (47%; n=31).

Certain differences were observed in the distribution of patients among economic regions by age subgroup: in the 0–5-year group, Baku (26.2%) and Lankaran-Astara (16.5%); in the 6–10-year group, Baku (25.2%) and Mil-Mugan (10.4%); and in the 11–15-year group, Baku (17.5%) and Mil-Mugan (14.7%) predominated. These differences were not statistically significant ($p>0.05$).

To study the characteristics of children with hereditary eye diseases based on family history, patients were divided into two groups: Group A – children born from consanguineous marriages (n=409; 73%), Group B – children without a history of consanguineous marriage (n=151; 27%).

The analysis showed that the incidence of hereditary eye diseases was higher in Group A, and the difference between the groups was statistically significant ($p<0.005$).

Analysis of the sex structure showed that in Group A boys accounted for 64% and girls for 36%; in Group B, boys accounted for 59.6% and girls for 40.4%. The difference between groups by sex was not statistically significant ($p>0.05$).

Analysis by age subgroup showed that in both groups the highest proportion of diseases was observed in the 6–10-year age subgroup (40.6% in Group A, 42.4% in Group B).

Comparison of pathologies by eye showed that bilateral eye pathology accounted for 97.8% in Group A and 63.6% in Group B. The difference between the groups was statistically significant ($p<0.005$).

Analysis of clinical manifestation forms of hereditary eye diseases occurring in children based on family history

The results of the analysis showed that hereditary retinal dystrophies (HRD) occupied the leading place in the structure of diseases, accounting for 27% (n=151); the mean age in this group was 8.5±0.3 years (95% CI: 8.0–9.1). Congenital lens pathologies ranked second (20%; n=112; mean age 6.7±0.4 years, 95% CI: 5.9–7.5), and refractive errors and strabismus ranked third (15.4%; n=86; mean age 8.4±0.4 years, 95% CI: 7.7–9.2).

In addition, congenital optic-nerve pathologies were detected in 13% (n=73) of cases, with a mean age of 6.8±0.5 years (95% CI: 5.9–7.7) in this group. Oculocutaneous albinism was recorded in 9.6% (n=54) of cases (mean age 5.8±0.5 years, 95% CI: 4.7–6.9), and congenital developmental defects of the eyeball were observed in 7.5% (n=42) of cases (mean age 7.1±0.6 years, 95% CI: 5.9–8.3). Primary congenital glaucoma was recorded in 5.7% (n=32) of cases, with a mean age of 6.7±0.8 years (95% CI: 5.1–8.4). Among the pathologies studied, hereditary corneal dystrophies were the least common form (1.8%; n=10).

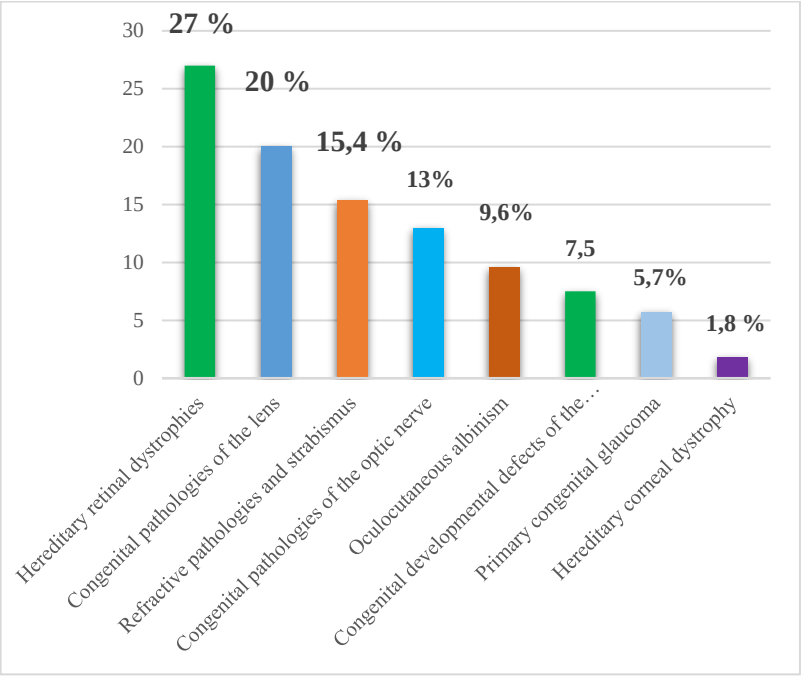

Figure 2. Clinical manifestation forms of hereditary eye diseases

A statistically significant difference was found in mean age between clinical forms (Kruskal–Wallis test, $p<0.05$), indicating that nosological forms differ in the age at which they are detected.

In the sex structure, hereditary retinal dystrophies (69.5%), congenital lens pathologies (64.3%) and oculocutaneous albinism (70.4%) predominated in boys, but the difference in the overall structure was not statistically significant ($\chi^2=13.634$; $p>0.05$).

Analysis by age subgroup showed that hereditary retinal dystrophies and refractive errors were mainly observed in the 6–10-year age subgroup, while congenital lens pathologies and oculocutaneous albinism were more common in the 0–5-year age subgroup ($p<0.005$).

Assessment by economic region showed that hereditary eye diseases were most frequently recorded in the Baku, Lankaran-Astara and Mil-Mugan economic regions.

Analysis of clinical forms of hereditary eye diseases in children born from consanguineous marriages

The 409 children examined accounted for 73% of all HED cases. In the nosological structure, hereditary retinal dystrophies occupied the leading place (32.8%; n=134), followed by congenital lens pathologies (16.7%; n=68) and congenital optic-nerve pathologies (15.1%; n=62). Refractive errors and strabismus were observed in 11.2% (n=46) of cases, and oculocutaneous albinism in 9.3% (n=38). Less common forms included congenital developmental defects of the eyeball (6.4%; n=26), primary congenital glaucoma (6.1%; n=25) and hereditary corneal dystrophies (2.4%; n=10).

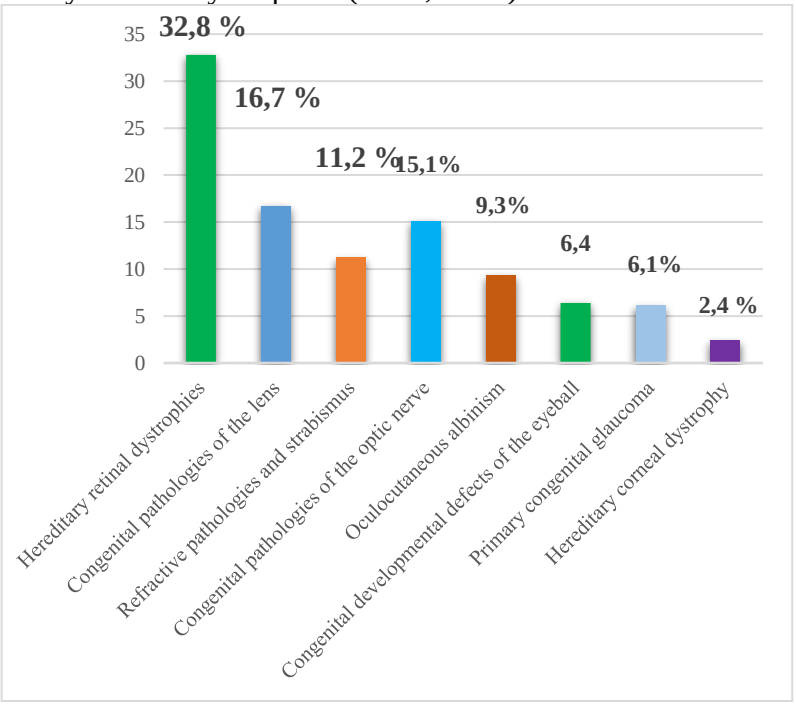

Figure 3. Clinical manifestation forms of hereditary eye diseases in children born to consanguineous marriage

The mean age of patients was 7.2±0.2 years (95% CI: 6.8–7.6). The highest mean age was observed in HRD (8.6±0.3; 95% CI: 8.0–9.2) and refractive errors (8.2±0.5; 95% CI: 7.2–9.2), while the earliest detection occurred in oculocutaneous albinism (5.7±0.6), hereditary corneal dystrophies (5.1±1.1) and congenital lens pathologies (6.3±0.5). Analysis of variance confirmed a statistically significant difference in age indicators between clinical forms (ANOVA: $F=5.824$; $p<0.001$).

Analysis by sex showed that HRD (69.4%), congenital lens pathologies (64.7%) and refractive errors/strabismus (63.0%) predominated in boys, whereas congenital lens pathologies and developmental defects of the eyeball were more common in girls; the difference was not statistically significant ($\chi^2=11.086$; $p=0.135$).

By age subgroup, congenital lens pathologies and oculocutaneous albinism predominated in the 0–5-year age subgroup, while HRD and refractive errors predominated in the 6–10-year age subgroup ($p<0.001$).

Analysis by eyes showed that hereditary retinal dystrophies, refractive errors, oculocutaneous albinism, and hereditary corneal dystrophies were mainly bilateral in character, and the difference was statistically significant ($\chi^2=32.185$; $p<0.001$).

Regionally, cases were mainly concentrated in the Baku, Lankaran-Astara and Mil-Mugan economic regions ($p=0.010$).

By degree of kinship, the majority of cases (87–90%) were associated with first-degree consanguineous marriage, with HRD (85.8%), congenital optic-nerve pathologies (95.2%) and congenital glaucoma (92.0%) predominating in this group.

Clinical manifestation of hereditary eye diseases in children without a history of consanguineous marriage

In this group, 151 children were examined, accounting for 27% of all HED cases. In the nosological structure, congenital lens pathologies occupied the leading place (29.1%; n=44), followed by refractive errors and strabismus (26.5%; n=40). Oculocutaneous albinism and congenital developmental defects of the eyeball had an equal share (10.6% each; n=16). Hereditary retinal dystrophies

(11.3%; n=17) and congenital optic-nerve pathologies (7.3%; n=11) were less common, and primary congenital glaucoma was rare (4.6%; n=7). Hereditary corneal dystrophies were not observed in this group.

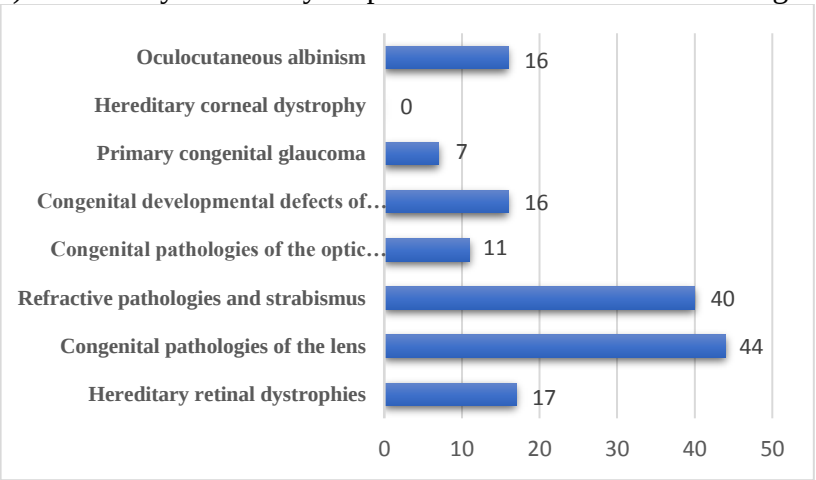

Figure 4. Distribution of clinical forms of hereditary eye diseases in children born to non-consanguineous parents

The mean age was 7.9 years. No statistically significant difference was found in age indicators between clinical forms (ANOVA: F=1.297; p=0.262), indicating that clinical presentation did not depend on age.

By sex, HRD (70.6%), congenital lens pathologies (63.6%), refractive errors and strabismus (57.5%) and oculocutaneous albinism (62.5%) predominated in boys, while congenital glaucoma (71.4%) and congenital optic-nerve pathologies (45.5%) predominated in girls, but the difference was not statistically significant (χ^2=4.270; p=0.640).

Analysis by age subgroups showed that, HRD (52.9%) and refractive errors/strabismus (47.5%) were mainly recorded in the 6–10-year subgroup, and congenital optic-nerve pathologies (54.5%) in the 11–15-year subgroup; the differences were not statistically significant (p>0.05).

By eye, 66.9% of cases were bilateral and 33.1% unilateral; HRD, refractive errors and oculocutaneous albinism were mainly bilateral ($p<0.05$).

No significant regional difference was found, although congenital lens pathologies were recorded with a relatively higher incidence in Baku (22.7%) and Central Aran (20.5%), and refractive errors in Lankaran-Astara and Mil-Mugan (15% each) economic regions.

Status of visual function in children born from consanguineous marriages Assessment of visual function in children showed that normal vision was preserved in only 2% of cases; low vision (66%) predominated mainly in refractive errors, HRD and congenital lens pathologies, while blindness (32%) predominated in developmental defects of the eyeball, congenital glaucoma and optic-nerve pathologies ($\chi^2=161.255$; $p<0.001$).

The mean visual acuity indicator was 0.074±0.059 (logMAR 1.45); the lowest functional results were recorded in congenital optic-nerve pathologies (logMAR 2.23), and the highest in the refractive-error group (logMAR 1.03) ($p<0.001$).

The recurrence rate of the disease within families was 62.9% for congenital optic-nerve pathologies and 54.5% for HRD ($\chi^2=18.474$; $p=0.010$).

Analysis of the disability structure showed a predominance of Group II disability (56%); Group I disability was mainly associated with optic-nerve pathologies and congenital glaucoma, while Group II disability was associated with HRD and congenital lens pathologies ($\chi^2=80.531$; $p<0.001$).

Visual function indicators in children born from non-consanguineous marriages were analyzed by various hereditary eye pathologies.

Normal vision was found in 16.9%, low vision in 60.9% (mainly refractive errors 97.5%, HRD 64.7%), and blindness in 22.2% (mainly optic-nerve pathologies 40.9%, developmental defects of the eyeball 43.8%) ($\chi^2=112.451$; $p<0.001$).

The mean visual acuity was 0.196±0.293 (logMAR 1.16); the best functional results were recorded in glaucoma (logMAR 0.51) and developmental defects of the eyeball (0.53), and the lowest in optic-nerve pathologies (0.82). The between-group difference was significant for visual acuity ($F=5.151$; $p<0.001$), but not significant for logMAR ($F=0.638$; $p=0.700$).

A family history of disability was more common in glaucoma (71.4%), albinism (87.5%) and lens pathologies (47.7%) ($\chi^2=38.242$; $p<0.001$).

In the disability structure, Group II disability predominated mainly in refractive errors (90.0%) and albinism (81.3%), while Group III disability predominated in glaucoma (100%), lens pathologies (63.6%) and developmental defects of the eyeball (68.8%) ($p<0.001$).

Analysis of Treatment Results

In children born from consanguineous marriages, specific treatment was not applied in the majority of cases of HRD (94.8%), optic-nerve pathologies (98.4%) and oculocutaneous albinism (100%) — related to the degenerative nature of these pathologies. Surgical intervention predominated in congenital lens pathologies (91.2%) and glaucoma (96.0%), while optical correction predominated in refractive errors and strabismus (69.6%). A statistically significant association was found between treatment type and pathology type ($\chi^2=549.117$; $df=14$; $p<0.001$).

In children with no history of consanguineous marriage, no treatment was applied for optic-nerve pathologies (100%); in HRD, no treatment was given in 64.7% of cases, optical correction in 29.4%, and surgical intervention in 5.9%. Surgical treatment predominated in lens pathologies (97.7%) and glaucoma (100%), optical correction predominated in refractive errors (97.5%), while no treatment was given in 75% of oculocutaneous albinism cases.

RESULTS

1. An epidemiological analysis conducted on a sample of 560 individuals formed during 2019–2023 showed that 73.0% (n=409) of

children with hereditary eye disease were born from consanguineous marriages (Group A), and 27.0% (n=151) had no history of consanguineous marriage (Group B) *(p<0.05).* Diseases were most frequently recorded in the 6–10 years age subgroup *(41.1%; n=230; p<0.05);* 89.5% of pathologies were bilateral *(p<0.001).* The highest regional rates were recorded in the Baku (23.6%), Lankaran-Astara (11.8%), and Mil-Mughan (10.4%) economic regions. In the nosological structure, hereditary retinal dystrophies (27.0%; n=151) and congenital pathologies of the lens (20.0%; n=112) occupied the leading positions.

2. In children born from consanguineous marriages, 87.0% of recorded cases occurred against a background of first-degree consanguinity *(p<0.05);* hereditary retinal dystrophies occupied the leading position in the nosological structure (32.8%; n=134). The highest frequency of diseases was recorded in the 6–10 years age subgroup *(40.6%; n=166; χ^2=10.334; p<0.05)*. The clinical course was mainly bilateral (97.8%; n=400), while unilateral cases accounted for 2.2% (n=9) *(p<0.001).* The factor of consanguineous marriage was statistically reliably associated with a high incidence of hereditary eye diseases, manifestation at an early age, and a severe bilateral clinical course (*p<0.05).*

3. Mean visual acuity in children born from consanguineous marriages (0.074±0.059) was statistically significantly lower compared to children without consanguineous marriage (0.196±0.293) *(p<0.05);* the frequency of blindness was recorded as 32.0% and 22.2%, respectively (p<0.05). The difference in the frequency of bilateral involvement showed even higher significance (p<0.005). The most severe vision loss in both groups was observed in congenital glaucoma (logMAR 2.48) and in optic nerve pathologies (logMAR 2.39); differences in comparison of visual function by nosological groups were highly statistically significant *(χ^2=161.255; p<0.001).* The risk of blindness in children born from consanguineous marriages was 1.5–1.7 times higher compared to the comparison group *(p<0.05).*

4. The dependence of treatment approaches on pathology type was confirmed with high statistical reliability *(χ^2=549.117, df=14 and*

$\chi^2=241.372$, df=12; p<0.001). In pathologies amenable to treatment, congenital pathologies of the lens (91.2–97.7%) and congenital glaucoma (96.0–100.0%) were managed with surgical intervention as the main therapeutic approach. In degenerative pathologies, the proportion of cases without treatment was high: 64.7–94.8% in hereditary retinal dystrophies and 98.4–100.0% in optic nerve pathologies. These results confirm the clinical prognostic significance of early diagnosis and the necessity of a rehabilitation-oriented approach in degenerative forms.

5. Based on the study, a four-stage diagnostic screening algorithm was developed, covering the following sequence: (I) assessment of the red reflex in the neonatal period; (II) identification of risk groups based on family history and clinical signs; (III) age-appropriate standard ophthalmologic examination; (IV) application of specialized ophthalmologic diagnostics in suspected cases.

PRACTICAL RECOMMENDATIONS

1. Taking into account the manifestation of hereditary eye diseases at early ages, it is considered necessary to organize systematic ophthalmologic examinations to ensure primary-stage diagnosis in children included in the risk group.
2. The implementation of the developed diagnostic algorithm in clinical practice can provide support to pediatricians and ophthalmologists in the process of early diagnosis and appropriate referral.
3. The assessment of children born from consanguineous marriages as a specific risk group and their early-stage ophthalmologic examination is considered appropriate.
4. The treatment approach should be individualized for each patient, and the therapy strategy should be optimized in accordance with changes in the clinical condition.
5. Long-term follow-up of children with hereditary eye pathologies should be ensured, and the results of regular monitoring should be recorded in a systematic manner.

6. Within the framework of preventive measures, it is important to expand awareness-raising activities among the population regarding genetic risk factors, especially the possible consequences of consanguineous marriages.

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LIST OF ABBREVIATIONS

CI	- Confidence interval
ERG	- Electroretinography
VEP	- Visual evoked potentials
HED	- Hereditary eye disease
ER	- Economic region
HRD	- Hereditary retinal dystrophy
MEC	- Medical expert commission
WHO	- World Health Organization

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