

ANNOTATION

of the dissertation work by Ismailova Inara Kamal kyzy on “Epidemiological features and quality of life of patients with age-related macular degeneration in a metropolitan setting”, submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy (PhD) in the specialty 8D10101 – “Public Health”

Relevance of the Research

According to World Health Organization (WHO), approximately 2.2 billion people worldwide are affected by visual impairment. At least 1 billion of them, nearly half, have vision problems that could have been prevented or can still be corrected. This group includes individuals with moderate or severe distance vision impairment or blindness caused by uncorrected refractive errors and presbyopia, cataract, age-related macular degeneration (AMD), glaucoma, and diabetic retinopathy [1, 2].

According to global statistics, among individuals with visual impairment, age-related macular degeneration (AMD) is one of the leading causes of irreversible vision loss in the second half of life in developed countries [1–4]. The prevalence of AMD ranks third after uncorrected refractive errors and presbyopia and cataract, surpassing glaucoma and diabetic retinopathy. At the same time, AMD accounts for 8% of all cases of blindness due to ocular pathology [4, 5].

According to 2020 data, the contribution of age-related macular degeneration (AMD) to global visual impairment has increased significantly over the 30-year period (1990–2020) and reaches 69.8% of cases leading to blindness among individuals aged 50 years and older. In the WHO European Region, which includes the Republic of Kazakhstan, the share of AMD in global visual impairment in 2020 is 62.5%, having increased by 21.8% in cases leading to blindness among individuals aged 50 years and older over the period from 1990 to 2020 [5, 6].

The age-standardized prevalence of age-related macular degeneration (AMD) in 2020, leading to moderate and severe visual impairment globally, was 3.39 (UI 2.75–4.12). An increase of 10.6% (UI 8.7–12.6) was observed over the period from 1990 to 2020 among adults aged 50 years and older. In the regions of Central and Eastern Europe and Central Asia, including the Republic of Kazakhstan, the prevalence of AMD increased by 1.57 (UI 1.26–1.95) and by 4.8% (UI 3.1–6.5) [5, 6].

With the growing demand for prevention and treatment, ophthalmological services are unable to fully meet the needs of the population [7]. However, given that the reduction in the prevalence of preventable blindness (14.4%) was more substantial than the reduction in moderate and severe visual impairment (1.6%), it can be concluded that resources aimed at addressing these conditions should be primarily focused on reducing the level of blindness [8].

According to researchers, the projected number of people with AMD in 2020 was expected to reach 196 million (95% UI 140–261), and by 2040 this figure is projected to increase to 288 million (UI 205–399) [9].

Aggregated indicators indicate an increase in the incidence of age-related macular degeneration (AMD), associated with rising life expectancy in economically developed countries and an increasing proportion of the older population, which, according to World Health Organization (WHO) data, may account for up to one-third of the total population by 2050 [1, 4, 10, 11].

Evidence suggests that among individuals aged 40 to 79 years, the prevalence of late AMD among Asians was comparable to that reported in Caucasian populations, while early signs of AMD were less common among Asians. In this regard, further research is required to determine whether specific phenotypes or subtypes of AMD, such as polypoidal choroidal vasculopathy, are more prevalent in Asian populations [12]. More detailed socio-demographic analysis during data collection is also needed to identify at-risk groups and to accurately assess progress in the provision of ophthalmological services [8, 13].

The demographic dependency ratio, reflecting the burden on society and the economy from the non-working population, is 40.8% [14].

The population ageing index (the number of individuals aged over 65 per 100 children under 15) in the Republic of Kazakhstan has been gradually increasing; in 2017–2021 it ranged from 25.9 to 26.6 per 100 children, rising to 28.2 in 2022 [14, 15].

Pathologies associated with age-related macular degeneration (AMD) can be classified as neovascular or non-exudative. Since the majority of patients with AMD currently present with the non-exudative form, which remains incurable, the development of therapeutic and preventive measures specifically targeting non-exudative AMD is of particular importance [16–18].

At present, preventive medicine is one of the rapidly developing areas in healthcare. One of the key forms of primary prevention is the early identification of disease risk factors [19].

Without monitoring the effectiveness of investments through clinical data and data on service provision dynamics, it is not possible to assess the efficiency of such investments, nor to determine an optimal budget allocation strategy [20, 21].

Therefore, in order to assess healthcare financing for the treatment of AMD, a primary and essential step is the implementation and expansion of a centralized patient database at the primary healthcare level [21]. Only this approach ensures comprehensive collection, systematization, and analysis of all necessary medical and demographic data be ensured, forming the basis for the allocation of funds for AMD treatment and the further development of effective financial strategies in managing funding flows for ophthalmological services [22, 23].

Thus, improving organizational mechanisms for the timely detection, treatment, and prevention of socially significant diseases remains an important task for practical healthcare [24, 25].

The high prevalence of age-related macular degeneration (AMD), its progression to severe forms, and the early loss of work capacity among the population worldwide necessitate the early identification, at the preclinical stage, of risk groups for the development and progression of this disease in order to ensure timely initiation of treatment [26, 27]. Screening studies represent a methodological

approach used for large-scale population assessment aimed at identifying a specific disease (or group of diseases) or risk factors [27–29].

Given the challenges associated with the treatment of AMD, increased attention in healthcare should be directed toward the prevention of progressive AMD. The identification of causal, modifiable risk factors for progressive AMD is crucial for the implementation of preventive interventions [30–33].

To create conditions for improving vision-related quality of life (VRQoL), additional knowledge is required regarding the impact of AMD on daily life. Therefore, it is important to investigate how individuals with AMD perceive their everyday life and how physical activity, in combination with social interaction, can be structured to foster a supportive community, enabling individuals to maintain health and well-being despite vision loss [23, 34, 35].

Thus, studying the epidemiology of AMD will make it possible to identify patterns in its prevalence and to forecast disease incidence. Based on these data, key approaches to patient registration and the assessment of VRQoL can be developed, which, in turn, will contribute to the design of effective preventive measures.

Aim of the study

To develop risk prediction and approaches to improving the prevention of age-related macular degeneration based on the analysis of epidemiological features and the assessment of quality of life.

Objectives of the study

1. To study the theoretical and methodological foundations of the epidemiology of age-related macular degeneration (AMD) and to analyze the epidemiological situation of AMD globally and in the Republic of Kazakhstan.

2. To analyze the quality of life of patients with AMD in the Republic of Kazakhstan.

3. To develop a database for the epidemiological registration of patients and individuals at risk of AMD at the primary healthcare level.

4. To conduct risk prediction for the development of AMD at the early stages of the disease and to identify key risk factors with an assessment of their impact.

5. To develop a comprehensive functional model for improving the quality of life of key stakeholders involved in AMD management.

6. Based on the scientific findings, to substantiate and develop recommendations for optimizing preventive measures for the treatment of AMD and the progression of disease complications at the primary healthcare level.

Materials and Methods

Bibliographic search, information and analytical analysis, cross-sectional studies, sociological survey/questionnaire, statistical analysis, analysis of existing information systems, database structure development, development of a database interface (prototype), collection of clinical and anamnestic data, statistical and mathematical modeling, calculation of trigger risk factors, data collection and integration to meet the needs of key stakeholders in AMD management across medical, social, and psychological domains, systems analysis, SWOT analysis,

model development, synthesis of the results obtained, analysis of current practice, and development of recommendations.

Overall Study Design

Study Components	Materials and Methods	Research Materials	Scope/Findings
Study of the theoretical and methodological foundations of the epidemiology of age-related macular degeneration (AMD) and analysis of the global epidemiological situation of AMD	Bibliographic search, information and analytical analysis	including Elsevier, Google Scholar, PubMed, and other online resources using the keywords “age-related macular degeneration”, “epidemiology of AMD”, “global prevalence of AMD”, “risk factors for AMD”, and “economic burden of AMD”, as well as the review of World Health Organization (WHO) reports, international ophthalmological organizations’ data, and national statistical data from various countries on incidence, prevalence, and demographic indicators associated with AMD	A total of 280 scientific articles, reviews, monographs, and dissertations published between 2010 and 2025 were analyzed using database sources, including clinical guidelines and protocols of ophthalmological associations worldwide; of these, 225 were in English, 21 in Russian, and 2 in Ukrainian.
Analysis of the quality of life of patients with age-related macular degeneration (AMD)	Cross-sectional study, sociological survey/questionnaire, and subsequent statistical analysis	NEI VFQ-39 questionnaire, patients’ medical records, and patients’ informed consent forms	A total of 562 patients with a confirmed diagnosis of age-related macular degeneration (AMD) were invited to participate. The number of completed and analyzed questionnaires amounted to 458.
Development of a database for the epidemiological registration of patients and individuals at risk of age-related macular degeneration (AMD) at the primary healthcare level	Analysis of existing information systems, development of the database structure, and creation of a database interface (prototype)	Regulatory and legal framework of the Republic of Kazakhstan, technical specifications, and design documentation for the database structure and interface	Database
Development of a method for predicting the risk of age-related macular degeneration	Cross-sectional study, collection of clinical and anamnestic data,	De-identified patient medical data (in compliance with confidentiality	455 (100%) aged over 30 years; analysis of risk factors, development of a predictive model, and

(AMD) at the early stages of the disease and identification of trigger risk factors with an assessment of their impact	statistical and mathematical modeling, and calculation of trigger risk factors	requirements), results of ophthalmological examinations, questionnaire data on risk factors, and software for statistical analysis (SPSS, R, Python)	description of a risk scale
Development of a comprehensive functional model for improving the quality of life of key stakeholders involved in the management of age-related macular degeneration (AMD)	Data collection and integration to meet the needs of key stakeholders across medical, social, and psychological aspects, systems analysis, SWOT analysis, and model development	Diagrams and description of the developed model	Comprehensive functional model for improving the quality of life of key stakeholders involved in the management of age-related macular degeneration (AMD)
Synthesis of the study results and development of recommendations	Synthesis of the results of the completed tasks, analysis of current practice, and development of recommendations	Summarized results of the completed tasks, current clinical protocol of the Republic of Kazakhstan and international recommendations on the prevention of age-related macular degeneration (AMD), data on the economic burden of AMD, and regulatory legal acts	Based on the study findings, recommendations were developed and substantiated to optimize preventive measures for AMD and its complications at the primary healthcare and national healthcare system levels.

Object of the study

- scientific publications in the Web of Science, Scopus, Elsevier, Google Scholar, PubMed databases, and other online resources, as well as regulatory legal acts of the Republic of Kazakhstan, WHO reports, international recommendations on the prevention of age-related macular degeneration (AMD), and data on the economic burden of AMD;

- patients with a confirmed diagnosis of AMD, de-identified patient medical data, results of ophthalmological examinations, and questionnaire data on risk factors;

- technical specifications and design documentation related to the structure and interface of the database.

Subject of the study

- epidemiological features of AMD in the Republic of Kazakhstan;

- quality of life of patients with AMD in the Republic of Kazakhstan;

- a method for predicting the risk of AMD development at early stages of the

disease and the identification of trigger risk factors with an assessment of their impact.

Key provisions submitted for defense

1. The study demonstrates that both in the Republic of Kazakhstan and in many countries worldwide, there remains a lack of data on the prevalence, structure, trends, and socio-economic consequences of age-related macular degeneration (AMD), as well as the absence of unified mechanisms for its epidemiological monitoring.

2. The absence of a unified national database for the epidemiological registration of patients at the primary healthcare level makes it impossible to assess the prevalence of AMD and to forecast local and regional expenditures aimed at preventive and therapeutic measures. SWOT analysis has demonstrated the high feasibility and significant potential for the implementation of such a database.

3. The quality of life of patients with AMD depends on the stage of the disease and deteriorates as the disease progresses. The developed comprehensive functional model for improving the quality of life of key stakeholders involved in AMD management proposes a new conceptual framework for the interaction of different components of medical care (diagnosis, treatment, rehabilitation, and psychosocial support) and social support, aimed at improving the quality of life of all stakeholders. The model may serve as a theoretical basis for the development of new patient management standards oriented toward the needs of all participants in the process.

4. The developed method for predicting the risk of AMD enables the identification of risk groups and key trigger risk factors. The established correlations between the main indicators demonstrate their predominant role in the pathogenesis of AMD. In addition, the method provides a practical opportunity for earlier detection and increased effectiveness of disease prevention.

Description of the main research findings

The analysis of the epidemiological situation of age-related macular degeneration (AMD) worldwide indicates that this disease represents one of the most significant and steadily increasing global burdens on healthcare systems. With increasing life expectancy and overall population ageing, the burden of disease is shifting toward non-communicable and age-related conditions, among which AMD is one of the leading causes of irreversible vision loss.

In ophthalmological practice, patient-reported outcome measures (PROMs) are widely used to assess vision-related quality of life. These instruments allow for the quantitative evaluation of patients' subjective perception of visual limitations and their impact on daily functioning.

A review of the literature revealed significant challenges related to data collection. In some regions and countries, there is an acute lack of reliable information, which considerably complicates an adequate understanding of the epidemiology of the disease and the development of effective strategies for its prevention and treatment. Data aggregated at the regional level may distort the actual picture by masking substantial differences between individual countries. To address this issue, greater socio-demographic granularity in data collection is required, which would allow for the identification of at-risk groups and more accurate

monitoring of progress in the provision of high-quality ophthalmological services. In the Republic of Kazakhstan, there is a pressing need for data on the epidemiology of age-related macular degeneration (AMD), the number of patients, and the volume of funding allocated to its diagnosis, treatment, and prevention.

Thus, the identification and scientific substantiation of a comprehensive functional approach in the context of insufficient epidemiological data on AMD in the Republic of Kazakhstan form the theoretical and methodological basis for the development of a national system for the registration and analysis of this pathology.

The results of the study involving 458 patients with age-related macular degeneration (AMD) from three cities of the Republic of Kazakhstan showed that quality of life, assessed using the NEI VFQ-39 questionnaire, is statistically significantly associated with disease stage, age, visual acuity, disease duration, and place of residence. The mean overall NEI VFQ-39 score was 58.0 ± 23.8 , which is lower than corresponding values reported in Europe, the United States, and China (data from international studies were used for contextual comparison rather than formal inter-sample analysis).

The study demonstrated that quality of life significantly decreases with increasing age and more advanced stages of AMD. The greatest decline in scores was observed in the subscales “general health” (a difference of 92.9 points), “social functioning” (77.1 points), and “near activities” (73.0 points).

Factors such as sex, race, level of education, and social support did not have a statistically significant impact on quality of life.

The study results expand the theoretical and methodological foundations of AMD epidemiology and supplement existing data on the prevalence and risk factors of the disease in the Republic of Kazakhstan.

The development of a database (DB) will enable epidemiological monitoring and analysis to assess the prevalence of age-related macular degeneration (AMD), identify trends in disease incidence, and evaluate risk factors. Based on up-to-date data, it will be possible to accurately estimate the need for ophthalmological personnel, diagnostic equipment, and pharmaceuticals, thereby enabling efficient allocation of healthcare resources. The DB will also support monitoring of the effectiveness of various treatment methods and facilitate the development of individualized management plans. A centralized DB will serve as a valuable resource for scientific research and will enable healthcare authorities to make evidence-based decisions in the field of AMD prevention and treatment.

The developed DB includes key sections for data collection: demographic information, diagnostic data, medical history and risk factors, information on treatment and follow-up, as well as social and economic aspects. To ensure confidentiality, a unique anonymized patient identifier is used.

The conducted SWOT analysis demonstrates that the implementation of the DB is both feasible and strategically necessary.

The developed database for the epidemiological registration of patients and individuals at risk of age-related macular degeneration (AMD) at the primary healthcare level standardizes forms of epidemiological data recording and the

allocation of targeted financial resources for the diagnosis, treatment, and prevention of AMD.

For the development of an early-stage AMD risk prediction method, a questionnaire was designed based on a validated Asian AMD risk scale. The conducted studies demonstrated that existing questionnaires are not suitable for use in the Republic of Kazakhstan due to linguistic and cultural differences.

A total of 455 patients from ophthalmological clinics in Almaty, Shymkent, and Astana participated in the study. Based on questionnaire data, patients were stratified into three risk groups: low (3.5%), moderate (70.8%), and high (27.5%).

Logistic regression analysis showed that all studied factors were statistically significantly associated with the risk of AMD development. The strongest associations were identified with age, race, history of cataract surgery, and refractive errors.

The main risk factors associated with an increased likelihood of developing age-related macular degeneration (AMD) include: age (each additional year increases the odds by 1.15 times), race (odds are higher among Asians by 1.09 times), sex (odds are higher in women by 1.11 times), smoking (increases the odds by 1.10 times), family history (the presence of AMD in relatives increases the odds by 1.6 times), and body mass index (BMI) (each unit increase raises the odds by 1.09 times).

Comorbid conditions such as arterial hypertension, myocardial infarction, hypercholesterolemia, and atherosclerosis also significantly increase the odds of developing AMD. Ophthalmological conditions, including a history of cataract surgery and refractive errors, increase the odds by 10% and 11%, respectively. A statistically significant association was also found with light iris color (odds increased by 1.01 times).

These findings confirm the multifactorial nature of AMD and may be used to inform preventive measures in the Republic of Kazakhstan.

A systematization of various concepts of quality of life has been conducted. Contemporary methodology defines quality of life through four key domains: emotional state, social functioning, daily activities, and leisure organization.

The key stakeholders of the comprehensive functional model (CFM) include patients with AMD, their caregivers, individuals at risk, healthcare professionals, and social service workers. The model is aimed at addressing the needs of all these groups.

For patients with AMD, factors related to visual impairment are of particular importance, as they affect functional capacity and daily activities. Rehabilitation and psychological support are considered essential components of management.

For caregivers of patients with age-related macular degeneration (AMD), who are often family members, the focus is placed on reducing caregiver burden, providing support services, and ensuring access to community resources. Caregivers' quality of life depends on their emotional state, social activity, financial situation, and other factors.

For individuals at risk of AMD, the importance of screening, early detection of the disease, and increased awareness is emphasized. As for healthcare and social

service personnel, the comprehensive functional model (CFM) is intended to reduce their physical and emotional burden, ensure access to modern treatment methods, and support continuous professional development.

The development of the CFM is justified by the fact that existing approaches to prevention and rehabilitation often do not take into account all factors affecting quality of life. The implementation of the CFM will help optimize resources, improve treatment effectiveness, reduce costs, and enable early intervention. The practical application of the model will contribute to savings in public resources by reducing the burden on social support systems and lowering healthcare expenditures.

Overall, the CFM represents a comprehensive approach to assessing and monitoring the impact of AMD on quality of life, enabling the development of processes aimed at overcoming functional limitations and improving interaction among all stakeholders involved in the prevention and management of AMD.

Thus, the implementation and practical application of the developed database for the epidemiological registration of patients and individuals at risk of age-related macular degeneration (AMD) at the primary healthcare level, as well as the comprehensive functional model for improving quality of life, provide the foundation for the development of a national concept of epidemiological monitoring of AMD.

Practical recommendations have been developed for implementation both at the level of the state healthcare system and at the primary healthcare level:

At the level of the state healthcare system:

- Development and implementation of a regulatory and legal framework to optimize preventive measures aimed at preventing the development and progression of age-related macular degeneration (AMD) at the primary healthcare level.
- Introduction of amendments to treatment protocols: development and approval of clinical protocols for referral of individuals at risk of AMD to an ophthalmologist.
- Implementation of a nationwide system for early detection and monitoring of AMD.
- Establishment of a registry of patients with AMD and individuals at risk of the disease.
- Development and implementation of individualized prevention programs and risk factor management strategies for AMD.
- Integration of AMD prevention into screening programs, chronic non-communicable disease management programs, and the development of educational technologies for students of higher and secondary specialized educational institutions.
- Development of a regulatory and legal framework to ensure a patient-centered approach, interdisciplinary and intersectoral collaboration based on a comprehensive functional model for improving the quality of life of key stakeholders involved in AMD management.
- Development and implementation of personalized rehabilitation and social adaptation programs for patients with AMD.

- Use of regional and national media resources (mass media, social networks) to raise public awareness of AMD prevention.

At the primary healthcare level:

a) In accordance with the identified risk factors for the early stages of age-related macular degeneration (AMD) and trigger risk factors, it is necessary to integrate AMD prevention into general screening programs and chronic disease management programs, specifically:

1) During screening of patients aged over 50 years, administer the developed Asian AMD risk scale questionnaire. Information on family history of AMD, smoking status, dietary habits, as well as assessment of body mass index and other parameters, will allow for the identification of early manifestations of AMD;

2) Screening for risk factors. General practitioners (family physicians, therapists) should identify and manage arterial hypertension, hypercholesterolemia, atherosclerosis, and obesity, as these conditions are statistically significantly associated with an increased risk of AMD;

3) Targeted lifestyle counseling. Each patient in the risk group should be provided with specific recommendations on smoking cessation, dietary modification (increased intake of vegetables, fruits, and omega-3 fatty acids), and physical activity. The direct relationship between these factors and eye health should be clearly explained;

4) Awareness of early symptoms of AMD. Primary healthcare providers should inform patients about the importance of vision self-monitoring and the need for immediate consultation with an ophthalmologist in case of visual distortions, blurring, or decreased central vision;

5) Training and professional development of primary healthcare personnel:

6) Conducting specialized training programs. To develop and implement training programs for general practitioners, family physicians, and paramedical staff on early diagnosis of age-related macular degeneration (AMD), assessment of risk factors, and patient referral pathways to ophthalmologists. Particular attention should be given to methods for identifying early signs of AMD based on medical history and basic examination techniques;

7) Use of digital tools. To train personnel in the use of the developed electronic database for the epidemiological registration of AMD. Emphasis should be placed on the accuracy of data entry, which is critical for subsequent analysis and planning at regional and national levels.

b) Expansion of access to diagnostics and monitoring:

1) Provision Of Basic Equipment. At The Primary Healthcare Level, It Is Recommended To Ensure The Availability Of Basic Tools For Assessing Visual Acuity (E.G., Sivtsev Or Snellen Charts) And The Amsler Grid;

2) Organization Of Consultations Using Telemedicine. In Regions With Limited Access To Ophthalmologists, Consideration Should Be Given To Implementing Consultations Based On Digital Retinal Images Obtained At The Primary Healthcare Level For Screening And Remote Monitoring Purposes;

3) Public awareness and educational activities:

4) Development and dissemination of informational materials. To develop accessible brochures, posters, and online resources on age-related macular degeneration (AMD), its risk factors, symptoms, and preventive measures. The materials should be tailored to different age groups and take into account ethnic characteristics;

5) Organization of public lectures and awareness campaigns. To organize regular awareness campaigns within the primary healthcare system, local communities, and senior centers aimed at increasing awareness of AMD and the importance of regular ophthalmological examinations.

Justification of scientific novelty

A lack of systematized data on the epidemiology of age-related macular degeneration (AMD) and the absence of a comprehensive approach in the Republic of Kazakhstan has been identified, indicating the need to establish a national system for the registration and analysis of the disease.

The results of the quality-of-life assessment showed that AMD in patients in the Republic of Kazakhstan leads to a decrease in quality of life and is determined by age, disease stage, and place of residence. It was established that NEI VFQ-39 scores in patients in the Republic of Kazakhstan are lower than those reported in Europe, the United States, Canada, and China.

A method for predicting the risk and identifying trigger risk factors for the development of AMD at early stages of the disease has been developed for the population of the Republic of Kazakhstan. The strongest correlations were observed between demographic characteristics, family history of AMD (the presence of AMD in relatives increases the odds by 1.6 times; $p < 0.05$), personal medical history, and ocular status. Age (each additional year increases the odds by 1.15 times; $p < 0.05$), race (odds are higher among Asians by 1.09 times; $p < 0.05$), history of cataract surgery, and refractive errors increase the odds by 10% and 11%, respectively, and represent key factors in the pathogenesis of AMD. A statistically significant association was also identified with light iris color ($p < 0.05$), with an increase in odds of 1.01 times.

A prototype database for the epidemiological registration of patients and individuals at risk of age-related macular degeneration (AMD) at the primary healthcare level has been developed (certificate of copyright registration for the invention dated 20 July 2023, No. 120683).

A SWOT analysis was conducted, demonstrating the high feasibility and significant potential for the implementation of the database, the introduction of which represents a key element in the modernization of the healthcare system and in the effective control of AMD.

A comprehensive functional model for improving the quality of life of key stakeholders involved in AMD has been developed, based on a holistic approach to assessing and monitoring the impact of the disease on quality of life, identifying key functional limitations, and developing processes to overcome them. The application of this comprehensive approach is aimed at more efficient use of healthcare and social service resources, as well as improving interaction among physicians, social workers, patients, and their families.

Practical significance of the obtained results

The study enables the implementation of its findings into clinical practice to improve the effectiveness of diagnosis, risk prediction, and monitoring, with the aim of enhancing the quality of life of patients with age-related macular degeneration (AMD) in the following areas:

- The study findings substantiate the need to develop a national database and epidemiological surveillance programs for the management of patients with AMD, aimed at prevention, effective healthcare planning, and optimal allocation of funding for the diagnosis, treatment, and prevention of AMD.

- Resource optimization – the implementation of the database facilitates planning of healthcare expenditures, allocation of resources, and timely identification of individuals at risk, which is of critical importance for the healthcare system of the Republic of Kazakhstan.

- The practical application of the risk prediction method provides ophthalmologists with a tool for the objective assessment of individual disease risk. This enables the timely identification of individuals at high risk of disease development or progression, even before the onset of pronounced clinical symptoms. It also allows for the implementation of more intensive monitoring and initiation of treatment at an early stage. Timely risk prediction will improve the effectiveness of prevention and reduce the number of cases of late-stage AMD.

- The use of the validated NEI VFQ-39 questionnaire in clinical practice will allow for the objective assessment of the impact of treatment and rehabilitation interventions not only on clinical outcomes but also on patients' subjective perception of their condition.

- The implementation of a comprehensive functional model for improving the quality of life of key stakeholders involved in AMD management will enable the use of an algorithm and strategy for integrated patient management, involving all key stakeholders. The integration of diagnostic, therapeutic, rehabilitative, and psychosocial components will standardize approaches to treatment and patient support, ensuring continuity and comprehensiveness of care while addressing not only medical but also psychological and social needs of all stakeholders.

The study materials may be used in scientific and educational processes, as well as for the organization of professional training of medical specialists in public health and ophthalmology at all levels.

Author's contribution

All main sections of the dissertation were completed by the author. The author developed a method for predicting the risk and identifying trigger risk factors for the development of age-related macular degeneration (AMD) at the early stages of the disease for the population of the Republic of Kazakhstan. The author also developed a prototype database for the epidemiological registration of patients and individuals at risk of AMD at the primary healthcare level, as well as a comprehensive functional model for improving the quality of life of key stakeholders involved in AMD management.

Conclusions

The findings of the conducted research made it possible to formulate the following conclusions:

1) According to global statistics, age-related macular degeneration (AMD) is one of the leading causes of irreversible vision loss in the second half of life in developed countries. AMD ranks third in prevalence and accounts for 8% of all cases of blindness due to ocular pathology. The proportion of patients with AMD who have lost vision is 17.7%. Given the global population ageing, a significant increase in the number of people with AMD is expected in the coming decades. In the Republic of Kazakhstan, there are no official epidemiological data on the prevalence, structure, and trends of AMD, which complicates the assessment of the problem.

2) The analysis of quality of life demonstrated that its decline in patients with AMD is significantly correlated with place of residence, age, disease stage, visual acuity, and disease duration. A decrease in quality of life among patients with AMD in the Republic of Kazakhstan was established based on the mean overall NEI VFQ score of 58.0 ± 23.8 .

3) The developed database for the epidemiological registration of patients with AMD (electronic form) at the primary healthcare level consists of 15 key input parameters. The database is convenient for local use in specialized clinics, as well as for regional patient registration. The conducted SWOT analysis demonstrated the high feasibility and significant potential for the implementation of the database as a key element in the modernization of the healthcare system and the effective control of AMD.

4) The study results confirmed the multifactorial nature of age-related macular degeneration (AMD). Most of the examined characteristics are statistically significant predictors of AMD, including demographic factors (sex – odds are 1.11 times higher in women than in men ($p \leq 0.05$); age – each additional year increases the odds by 1.15 times; race – odds are higher among Asians by 1.09 times; family history – increases the odds by 1.6 times ($p \leq 0.05$)). Comorbid conditions also increase the likelihood of AMD development (body mass index (BMI) – 1.09 times; smoking – 1.10 times ($p \leq 0.05$); arterial hypertension – 1.09 times ($p \leq 0.05$); myocardial infarction – 1.09 times ($p \leq 0.05$); hypercholesterolemia – 1.10 times ($p \leq 0.05$); atherosclerosis – 1.08 times ($p \leq 0.05$)), as well as ophthalmological conditions (history of cataract surgery – 10% increase; refractive errors – 11% increase ($p \leq 0.05$)). A statistically significant association was also identified with light iris color, increasing the odds by 1.01 times ($p \leq 0.05$). Statistical evaluation and internal validation were performed. The developed Asian AMD risk scale is recommended for practical application.

5) The developed comprehensive functional model for improving quality of life reflects the interaction between key stakeholders and the surrounding environment.

The implementation of the comprehensive functional model (CFM) will enable the development of a more efficient, cost-effective, and patient-centered system of care. It will help optimize processes within healthcare and social systems and will

be aimed at improving the quality of life of all stakeholders involved in AMD management, while reducing the burden on public resources.

Based on the study findings, recommendations have been developed and substantiated for optimizing interdisciplinary preventive measures for the prevention of age-related macular degeneration (AMD) and the progression of its complications at the primary healthcare level (14 items) and at the national healthcare system level (9 items). These include the implementation of a database for epidemiological registration, screening of risk factors and targeted patient counseling, training of primary healthcare personnel, the use of telemedicine, and the implementation of public awareness and educational activities.

Approbation and implementation of research results

The main results of the dissertation were presented at the following conferences:

1. All-Ukrainian scientific and practical conference (with the possibility of remote participation) “Current Issues in Ophthalmology”, 21–22 September 2022, Odesa (Ukraine).

2. Apsattarov Readings: “New Vectors in the Science of the Century: Questions, Hypotheses, Answers”, 2020, Almaty.

Publications related to the dissertation

Two articles related to the dissertation topic have been published, including two scientific publications in journals indexed in the Scopus database:

1. Ismayilova I., Turdaliyeva B., Aldasheva N., Veselovskaya N. Assessing the quality of life in age-related macular degeneration patients: A cross-sectional study in Kazakhstan // *Acta Bio Medica: Atenei Parmensis*. – 2022. – Vol. 93 (6). – P. e2022299. DOI: 10.23750/abm.v93i6.13580.

2. Ismayilova I., Korol A., Aldasheva N. Development and Validation of the Asian AMD Age-Related Macular Degeneration Risk Scale // *Salud, Ciencia y Tecnología* – 2025. – Vol. 5. – P. 544. DOI: 10.56294/saludcyt2025537.

One article was published in journals recommended by the Committee for Quality Assurance in Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan.

1. Ismayilova I., Turdaliyeva B., Aldasheva N., Veselovskaya N. On the issue of epidemiological assessment of the prevalence of age-related macular degeneration under modern conditions // *Life and Health Sciences*. – 2020. – Vol. 1. – pp. 123–129.

Implementation of research results

1. Implementation Act No. 3 of the research results “Asian AMD Risk Scale” (“AARS”) at LLP “Kazakh Order of the Badge of Honour Research Institute of Eye Diseases”, March 2025.

2. Act of implementation of scientific achievements: “Database for the epidemiological registration of patients with age-related macular degeneration (electronic form)” into healthcare practice at the Municipal Non-Commercial Enterprise “Kyiv City Clinical Hospital No. 1”, Kyiv, Ukraine, 2023.

3. Act of implementation of scientific achievements “Asian AMD Risk Scale” (“AARS”) at the Vision Correction Center “Perfect Vision”, Almaty, Republic of Kazakhstan, 2024.

4. Act of implementation of scientific achievements “Database for the epidemiological registration of patients with AMD (electronic form)” at the Vision Correction Center “Perfect Vision”, Almaty, Republic of Kazakhstan, 2024 (Appendix A).

Three intellectual property certificates have been obtained:

1. Certificate No. 119838 dated June 19, 2023 – “Asian AMD Risk Scale” (AARS).

2. Certificate No. 120683 dated July 20, 2023 – “Database for Epidemiological Registration of Patients with Age-Related Macular Degeneration (Electronic Program Format)”.

3. Certificate No. 136150 dated May 14, 2025 – “Comprehensive Functional Model for Improving the Quality of Life of Key Stakeholders in Age-Related Macular Degeneration (AMD)” (Appendix B).

Scope and structure of the dissertation. The dissertation comprises 181 pages and includes the following sections: regulatory references, definitions, list of abbreviations and symbols, introduction, literature review, materials and methods, results of original research, conclusion, references, and appendices. The dissertation contains 21 tables and 20 figures.