

**NpJSC «Astana Medical University»**

UDC: 614.2:616.9(574.24)

IPC: C12N1/00, G16H50/00

**Onggarbek Aruzhan Ermekkyzy**

**ASSESSMENT OF LONG -TERM DYNAMICS OF HIGHLY INFECTIOUS  
DISEASE IN AKMOLA REGION**

**7M10128 – «Biological Safety»**

Project for the academic degree of Master of Public Health

Research Supervisor

d.m.s., leading Specialist. on biosafety  
NCE KSEK Ministry of Health of the  
Republic of Kazakhstan  
Akmola region, Professor,  
Tashmetov K.K.

Reviewer

PhD, Senior Researcher of the Research  
Institute of Preventive Medicine named  
after Academician E. Dalenov  
Doszhanova G.N.

Astana, 2025

## TABLE OF CONTENTS

REGULATORY REFERENCES.....	3
DEFINITIONS .....	4
DESIGNATIONS AND ABBREVIATIONS .....	5
LIST OF TABLES AND FIGURES.....	6
INTRODUCTION.....	8
1. ASSESSMENT OF GLOBAL AND REGIONAL DYNAMICS OF HIGHLY INFECTIOUS DISEASES: FOCUS ON THE AKMOLA REGION (literature review).....	11
1.1 Highly Infectious Diseases: Global Standards and Kazakhstan's Practice.....	11
1.2 International Response Experience to Highly Infectious Diseases .....	13
1.3 Spread of Highly Infectious Diseases in Akmola Region, Regulatory Framework, and Recommendations for Improved Monitoring .....	15
2. EPIDEMIOLOGICAL ANALYSIS OF HIDS IN AKMOLA REGION (2021– 2023) (Materials and Methods) .....	17
3. LONG-TERM DYNAMICS OF HID IN AKMOLA REGION (Research Results) .....	22
3.1 The dynamics of brucellosis incidence in 2021, 2022, 2023.....	22
3.2 The dynamics of Listeriosis incidence in 2021, 2022, 2023 .....	27
3.3 The dynamics of Tularemia incidence in 2021, 2022, 2023.....	31
3.4 The dynamics of TBE incidence in 2021, 2022, 2023 .....	34
3.5 The dynamics of Anthrax incidence in 2021, 2022, 2023.....	37
CONCLUSION .....	41
FINDINGS .....	43
PRACTICAL RECOMMENDATIONS.....	44
LIST OF REFERENCES .....	46
APPENDIX A .....	50
APPENDIX B .....	51
APPENDIX C .....	52

## REGULATORY REFERENCES

This project uses references for the following standards:

1. Code of the Republic of Kazakhstan about the health of the people and the healthcare system dated July 7, 2020 No. 360-VI 3RK (with footnote on 24.06.2021 and 30.12.2021).

2. Order of the Minister of Health of the Republic of Kazakhstan about approval of the list of diseases, the treatment of which is prohibited in the non-governmental healthcare sector dated October 14, 2009 No. 526 (with footnote on 17.08.2015).

3. Order of the Minister of Health of the Republic of Kazakhstan about approval of forms of accounting and reporting documentation in the sphere of sanitary and epidemiological welfare of the population dated August 20, 2021 No. RK MOH-84 (with footnote on 20.06.2024).

4. Order of the Minister of Health of the Republic of Kazakhstan about approval of the Sanitary Rules "Sanitary and Epidemiological Requirements for the Organization and Conduct of Sanitary and Anti-Epidemic, Sanitary and Preventive Measures to Prevent Particularly Dangerous Infectious Diseases" dated November 12, 2021 No. RK MOH-114 (with footnote on 21.04.2025).

5. Order of the Minister of Health of the Republic of Kazakhstan about approval of the Sanitary Rules "Sanitary and Epidemiological Requirements for the Organization and Conduct of Sanitary and Anti-Epidemic Measures to Prevent Infectious Diseases (Plague, Cholera)" dated November 17, 2021 No. RK MOH-116 (with footnote on 21.04.2025).

6. Order of the Minister of Health of the Republic of Kazakhstan about approval of the standard for the organization of medical care for infectious diseases in the Republic of Kazakhstan dated March 17, 2023 No. 40.

## DEFINITIONS

The following terms with their respective definitions were utilized in this project:

*Brucellosis* – A bacterial infection caused by *Brucella* species, primarily transmitted through contact with infected animals or consumption of contaminated animal products. It affects both humans and livestock, leading to fever, joint pain, and long-term complications.

*Listeriosis* – A serious bacterial infection caused by *Listeria monocytogenes*, primarily affecting individuals with weakened immune systems, pregnant women, and newborns. It is transmitted through contaminated food, such as dairy products and processed meats.

*Tularemia* – A zoonotic infectious disease caused by *Francisella tularensis*, which spreads through direct contact with infected animals, insect bites, contaminated food, or inhalation. It can cause fever, ulcers, and severe pneumonia.

*Tick-borne Encephalitis (TBE)* – A viral infection affecting the central nervous system, caused by the tick-borne encephalitis virus (TBEV). It is transmitted through tick bites or consumption of unpasteurized dairy products from infected animals, leading to neurological complications.

*Anthrax* – A bacterial disease caused by *Bacillus anthracis*, affecting livestock and wildlife but also transmissible to humans through direct contact, inhalation, or consumption of contaminated animal products. It presents in cutaneous, gastrointestinal, and inhalational forms, with the latter being the most severe.

*Zoonotic Diseases* – Infectious diseases that can be transmitted between animals and humans, often through direct contact, vectors, or contaminated food and water sources.

*Epidemiological Surveillance* – A systematic process of collecting, analyzing, and interpreting health data to detect, prevent, and control disease outbreaks within a population.

*Sanitary and Epidemiological Safety* – A set of regulations and measures aimed at preventing the spread of infectious diseases and ensuring public health through hygiene and disease control strategies.

*Veterinary Safety* – The implementation of regulations and measures to prevent, control, and eliminate infectious diseases in animals, ensuring the safety of animal products and public health.

*Highly infectious diseases (HID)* - Are diseases caused by pathogens—such as viruses, bacteria, or parasites—that can spread rapidly from person to person, animal to person, or through environmental sources, and often result in severe illness or death.

*Long-term dynamics* – Distribution of diseases in 3 years. In this case, distribution of HIDs from 2021 to 2023 years.

## DESIGNATIONS AND ABBREVIATIONS

AI	- Artificial Intelligence
B. anthracis	- Bacillus anthracis (Anthrax bacterium)
CDC	- Centers for Disease Control and Prevention
EFSA	- European Food Safety Authority
ECDC	- European Centre for Disease Prevention and Control
FAO	- Food and Agriculture Organization
F. tularensis	- Francisella tularensis (Tularemia bacterium)
GMP	- Good Manufacturing Practices
GIS	- Geographic Information System
HACCP	- Hazard Analysis and Critical Control Points
HID	- Highly Infectious Diseases
MOH	- Ministry of Health
OIE	- World Organisation for Animal Health
PCR	- Polymerase chain reaction
TBE	- Tick-Borne Encephalitis
TBEV	- Tick-Borne Encephalitis Virus
WHO	- World Health Organization

## LIST OF TABLES AND FIGURES

Figure 1	An example from a fragment of the database of registered HID in the Akmola region.....	16
Figure 2	Trends in HID Tested Samples Collected from Humans.....	17
Figure 3	Trends in HID Tested Samples Collected from Environment....	17
Figure 4	Trends in HID Tested Samples Using 4 Laboratory Techniques Collected from Humans.....	18
Figure 5	Trends in HID Tested Samples Using 4 Laboratory Techniques Collected from Environment.....	19
Figure 6	Number of Brucellosis Cases Among Humans in Akmola region in Akmola region by Year Based on Tested Sample.....	21
Figure 7	Brucellosis Levels in the Environment in Akmola region by Year Based on Tested Samples.....	22
Figure 8	Number of Brucellosis Cases Among Humans in Akmola region by Year Based on Bacteriological Studies.....	23
Figure 9	Brucellosis Level in the Environment in Akmola region by Year Based on Bacteriological Studies.....	24
Figure 10	Number of Brucellosis Cases Among Humans in Akmola region by Year Based on Serological Studies.....	25
Figure 11	Brucellosis Levels in the Environment in Akmola region by Year Based on Serological Studies.....	25
Figure 12	Number of Listeriosis Cases Among Humans in Akmola region by Year Based on Tested Samples.....	27
Figure 13	Listeriosis Levels in the Environment in Akmola region by Year Based on Tested Samples.....	27
Figure 14	Number of Listeriosis Cases Among Humans in Akmola region by Year Based on Bacteriological Studies.....	28
Figure 15	Listeriosis Level in the Environment in Akmola region by Year Based on Bacteriological Studies.....	29
Figure 16	Number of Listeriosis Cases Among Humans in Akmola region by Year Based on Serological Studies.....	30
Figure 17	Listeriosis Levels in the Environment in Akmola region by Year Based on Serological Studies.....	30
Figure 18	Number of Tularemia Cases Among Humans in Akmola region by Year Based on Tested Samples.....	32
Figure 19	Tularemia Levels in the Environment in Akmola region by Year Based on Tested Samples.....	32
Figure 20	Number of Tularemia Cases Among Humans in Akmola region by Year Based on Serological Studies.....	33
Figure 21	Tularemia Levels in the Environment in Akmola region by Year	

	Based on Serological Studies.....	34
Figure 22	Number of TBE Cases Among Humans in Akmola region by Year Based on Tested Samples.....	35
Figure 23	TBE Levels in the Environment in Akmola region by Year Based on Tested Samples.....	36
Figure 24	Number of TBE Cases Among Humans in Akmola region by Year Based on Serological Studies.....	37
Figure 25	TBE Levels in the Environment in Akmola region by Year Based on Serological Studies.....	37
Figure 26	Number of Anthrax Cases Among Humans in Akmola region by Year Based on Tested Samples.....	39
Figure 27	Anthrax Levels in the Environment in Akmola region by Year Based on Tested Samples.....	39
Figure 28	Number of Anthrax Cases Among Humans in Akmola region by Year Based on Bacteriological Studies.....	40
Figure 29	Anthrax Level in the Environment in Akmola region by Year Based on Bacteriological Studies.....	41

## INTRODUCTION

### **Relevance of the topic:**

Highly infectious diseases pose a serious threat to public health, bioeconomic security, and the sustainable development of regions. In the context of globalization, climate change, intensification of agriculture, and migration processes, there is an increase in epidemiological risks associated with infections such as tularemia, brucellosis, anthrax, tick-borne encephalitis, and listeriosis. In this regard, studying the mechanisms of their spread and improving systems for monitoring and prevention is of particular importance both globally and regionally.

Akmola Region is characterized by the presence of permanently unfavorable points for anthrax. In 2019, an anthrax outbreak was recorded in the region, with five people hospitalized, indicating a continued risk of recurring disease episodes [1]. Furthermore, the geographical and climatic conditions of the region contribute to the formation of stable natural foci of infections such as tularemia and tick-borne encephalitis. A high level of livestock farming and the presence of numerous small farms, often operating in violation of sanitary regulations, create favorable conditions for the circulation of pathogens such as brucellosis and listeriosis. Sporadic cases of listeriosis are recorded annually in the Republic of Kazakhstan [2].

An important feature is that the spread of HID in the region depends not only on natural factors but also on the level of epidemiological alertness, the functioning of surveillance bodies, the technical equipment of laboratories, and the awareness of the population. The relevance of the problem is heightened by the fact that Kazakhstan, as a participant in the International Health Regulations, is obliged to ensure an effective system for responding to infectious threats, especially considering potential cross-border risks. Of additional interest is the analysis of international experience in responding to HID, which can be adapted to Kazakhstani conditions. EU countries, the USA, and some Asian states have successfully implemented systems of geoinformation monitoring, mobile applications for self-registration and alerts, mass vaccination programs for animals and humans, and platforms for interagency data exchange. These approaches have proven effective when supported by appropriate regulatory and technical infrastructure.

Thus, research dedicated to analyzing the spread of highly infectious diseases in Akmola Region and international response experience is relevant and timely. It will help identify vulnerabilities in the regional epidemiological surveillance system, propose specific measures for its modernization, and contribute to the formation of a sustainable biosafety system at the regional level. The results obtained can be used not only in Akmola Region but also in other regions of Kazakhstan with similar conditions, and they may also serve as a foundation for developing programs to improve HID monitoring across the country.

**The aim of the research:**

Improving approaches to monitoring highly infectious diseases, considering the established trends of their distribution in the Akmola region.

**Object and subject of research:**

The object of the study was the highly infectious diseases of the Akmola region in 3 years.

Subject of the study: trends in the spread of highly infectious diseases.

Analysis period: 2021-2023

The database will be grouped by:

- Types of infectious diseases.
- By sources (external, internal);
- By laboratory tests (serological, biological, bacterial and genetic indicators).

**Research objectives:**

1. To study the world experience of monitoring infectious diseases abroad and effective preventive measures.
2. To analyze the dynamics of the spread of infectious diseases in the Akmola region with ranking of infection sources.
3. To develop recommendations for improving the system of monitoring and preventing infectious diseases.

**Research methods:**

The work used information-analytical, statistical (descriptive, correlation by external and internal sources, ranking, etc.), retrospective methods.

The statistical program for processing was Excel.

**Scientific novelty:**

Trends in the spread of highly infectious diseases in the Akmola region for the period 2021-2023 have been analyzed, considering both internal (humans) and external (rodents, ticks, pellets) sources of infection.

Promising areas of the surveillance strategy are identified, combining GIS mapping, automated PCR diagnostics and AI-based technologies to improve the early detection and control of infectious diseases.

**Practical significance:**

1. Proposals for improving approaches to monitoring and controlling infectious diseases in the Akmola region are substantiated.
2. To assess the effectiveness of early detection and response, it is recommended to integrate artificial intelligence into the diagnostics of infectious diseases, such as brucellosis and tuberculosis.
3. Strengthening the capacity of the Akmola region in monitoring, preventing and controlling diseases should be based on large-scale vaccination of animals with the participation of local health authorities in global warning systems, which provides early warning of infectious threats, helping to quickly respond to them.

**The main provisions submitted for defense:**

1. The trend in the field of controlling highly infections in the Akmola region demonstrates noticeable improvements in reducing such infections as brucellosis and tularemia; demonstrates an increase in listeriosis in serological studies, the stability of

detection of tick-borne encephalitis and anthrax, which requires stricter environmental supervision.

2. In order to improve the efficiency of monitoring and prevention of infectious diseases, improve the surveillance system for HID, it is recommended to widely implement automated PCR diagnostics with tools based on artificial intelligence, use geographic information systems to track outbreaks and predict the spread of diseases.

**Volume and structure of the project:**

The project was written on 49 pages of computer text, consisting of an introduction, a literature review, five chapters of the results of the author's own research, a conclusion, findings, practical recommendations and a list of used sources. The work was illustrated with 29 figures. The list of used literature includes 38 sources.

**Project approbation:**

The work was approved at an extended departmental meeting of the Department of Public Health and Epidemiology of the NpJSC "Astana Medical University" (protocol No. 9 dated 11.03.2025, Appendix A).

Main provisions and results of the master's project were published in the sourcebook "CDII International scientific and practical conference "Young researcher: challenges and prospects" (Moscow, 04/21/2025, Appendix B).

# **1. ASSESSMENT OF GLOBAL AND REGIONAL DYNAMICS OF HIGHLY INFECTIOUS DISEASES: FOCUS ON THE AKMOLA REGION (literature review)**

## **1.1 Highly Infectious Diseases: Global Standards and Kazakhstan's Practice**

Highly infectious diseases have accompanied humanity throughout history, causing large-scale epidemics and pandemics.

At the international level, the key document in the field of epidemiological regulation is International Health Regulations. In 1951, the WHO adopted the International Sanitary Regulations, which were renamed the International Health Regulations in 1969. At that time, the term "quarantine infections" appeared, referring to six diseases: plague, cholera, yellow fever, smallpox, typhus, and relapsing fever. The latter two were removed in 1970, and smallpox was eliminated in 1981 following its official eradication [3]. In 2005, the 58th World Health Assembly adopted a new version of the International Health Regulations, which came into force in 2007 [4]. Currently, there are no unified standards in global medicine regarding which infections should be classified as highly infectious diseases. The lists of such infections vary across different regions, may be supplemented with new diseases, or, conversely, have certain infections excluded [5]. At the same time, the term "quarantine infections" is no longer used in IHR-2005, rendering it outdated [3]. The modern international approach also introduced the concept of a "Public Health Emergency of International Concern (PHEIC)" an extraordinary event that poses a threat to other states and requires coordinated response measures [6]. It should be noted that each country independently forms its list of highly infectious diseases based on the epidemiological characteristics of its territory, natural and geographical conditions, the level of development of the healthcare system, and national biosafety priorities. This approach allows for consideration of regional specificity in pathogen circulation and the adaptation of sanitary-epidemiological surveillance, prevention, and response measures to real threats within a specific country. At the same time, despite the differences in national HID lists, most countries rely on WHO recommendations and the provisions of the International Health Regulations (2005) when developing their classifications, ensuring coordination in the global control of infectious diseases. For example, in tropical countries, dengue fever is a serious problem and often presents severe hemorrhagic, often fatal forms among the local population. In contrast, Europeans tend to experience it in a milder form, without hemorrhagic manifestations, and the disease cannot spread in European countries due to the absence of the vector. Meningococcal infection in Central African countries is characterized by widespread severe forms and high mortality (the so-called "African meningitis belt"), whereas in other regions, the disease shows lower prevalence of severe forms and therefore lower mortality [7]. Meanwhile Southeast Asia is predominantly characterized by a tropical climate and is currently facing significant environmental challenges due to global warming, rapid urbanization, deforestation,

water scarcity, and increasing levels of pollution. The factors influencing infectious diseases in the region have changed considerably in response to environmental transformations. Within WHO regions, South-East Asia accounts for 25% of the global cases of HIV and tuberculosis and has the second-highest malaria incidence worldwide. Additionally, widespread malnutrition in the region increases vulnerability to neglected tropical diseases (NTDs), including arboviral infections such as dengue, chikungunya, Japanese encephalitis, and pandemic influenza [8]. Appendix 2 of the IHR lists specific infections that must be reported to the WHO immediately: cholera, pneumonic plague, yellow fever, etc. It is important to note that the term "highly infectious diseases" has little official international status and is mainly used in CIS countries, including Kazakhstan [3]. Nevertheless, in local practice, terms such as "highly infectious," "quarantine," "emergency-causing," and "dangerous to others" are used. WHO, in turn, recommends classifying pathogens by biological risk groups (3–4) for laboratory work, rather than using generalized terms [3].

In Kazakhstan, according to the Law of minister of health of the Republic of Kazakhstan about 'About approval of the List of diseases, the treatment of which is prohibited in the non-governmental healthcare sector' the official list of HID includes HIV infection, AIDS, Crimean hemorrhagic fever, hemorrhagic fever with renal syndrome, leprosy, rabies, leptospirosis, listeriosis, tuberculosis, tularemia, brucellosis, anthrax, and foot-and-mouth disease. Infections are also classified as: quarantine, parasitic, airborne, acute infectious, etc. [9]. The main document regulating the prevention and control of HID in Kazakhstan is order of the minister of health of the Republic of Kazakhstan dated November 12, 2021 No. RK MOH-114, which approved the Sanitary Rules "Sanitary and Epidemiological Requirements for the Organization and Implementation of Sanitary and Anti-Epidemic, Sanitary and Preventive Measures to Prevent HID". This document details the mechanisms for carrying out measures to localize and prevent the spread of HID, establishes the procedure for quarantine measures, and regulates the actions of medical organizations in the event of outbreaks of HID. In addition, the Order of the minister of health dated November 17, 2021 No. KP MOH-116 is in effect, which specifies the sanitary rules for the prevention of HID such as plague and cholera. Both documents were updated in 2025. Also, within the framework of the Code of the Republic of Kazakhstan "About the health of the people and the healthcare system", general legal foundations for the functioning of the epidemiological service and sanitary supervision are established. Particular attention is paid to sanitary protection of borders, biological safety, mandatory registration and recording of cases of HID, as well as the actions of medical organizations in the event of epidemic threats on pages 91–96, 103, 109 of the Code. In addition, it is necessary to highlight, Order of the minister of health of the Republic of Kazakhstan dated March 17, 2023 No. 40, which approved "the Standard for the Organization of Medical Care for Infectious Diseases". The document regulates the algorithms for diagnosing, routing and treating patients with suspected HID, including requirements for infectious hospitals, isolation conditions and actions of medical personnel in an emergency

epidemiological situation. And finally, the Order of the minister of health of the Republic of Kazakhstan dated August 20, 2021 No. RK MOH-84, defining the forms of accounting and reporting documentation in the field of sanitary and epidemiological well-being. This document provides a unified standard for monitoring morbidity, includes forms of registration, reporting on laboratory and epidemiological measures, and also regulates the maintenance of an epidemiological card. Moreover, The National Scientific Center for HID named after M. Aikimbayev, located in Almaty, also plays an important role in the system of prevention and control of HID in Kazakhstan. This is the country's leading research organization, providing scientific and methodological support in the field of epidemiological surveillance of HID. The Center is engaged in the detection and monitoring of natural foci of HID, such as anthrax, tularemia, Crimean-Congo hemorrhagic fever and brucellosis. It carries out high-tech laboratory diagnostics using PCR, enzyme immunoassay and serological tests [10].

The causes of the spread of HID in Kazakhstan are diverse. The vast territory, climatic and biological diversity, and the large number of farm and wild animals create favorable conditions for the formation of natural foci of infections [10]. Tularemia, plague, anthrax, brucellosis, hemorrhagic fevers and listeriosis cover significant areas. For example, tularemia foci are registered in almost all regions of Kazakhstan, except for Turkestan and Mangystau regions; brucellosis is widespread; anthrax outbreaks periodically occur in various regions [11].

## **1.2 International Response Experience to Highly Infectious Diseases**

Tularemia. Endemic in Scandinavia and Eastern Europe. In 2019, 1,463 cases were reported in the EU/EEA, 817 of which were in Sweden [12]. In the USA, 200–300 cases are reported annually. International experience includes monitoring of natural foci, protecting the population from contact with vectors, public awareness campaigns, and laboratory confirmation. A recent systematic review covering human tularemia cases from 1993 to 2023 reported cases in 35 countries, with the majority originating from the United States, Turkey, and Spain [13].

Brucellosis. Widely spread in Mediterranean countries, Central Asia, and the Middle East [14]. Recent data on brucellosis indicates a significant number of human cases worldwide, with estimates suggesting at least 1.6 to 2.1 million new cases annually [15]. Key measures include animal vaccination (Rev.1, RB51 strains), sanitary control at slaughterhouses, monitoring of dairy products, and pasteurization. Additionally, serological screening of livestock workers and control of illegal animal trade are conducted [16].

Tick-borne encephalitis. The endemic region for tick-borne encephalitis extends from Alsace-Lorraine in the west to Vladivostok and northeastern parts of China in the east, and from Scandinavia down to Italy, Greece, and Crimea in the south. Additionally, TBE is endemic in northern Japan, where the virus has been repeatedly detected in blood samples from sentinel dogs, ticks, and rodent spleens

[17]. Approximately 5,000–10,000 TBE cases are reported from endemic countries each year [18].

Anthrax incidence varied widely between countries, ranging from 0.03 in Ghana to 1.4 in Georgia per 100,000 inhabitants. [19].

Listeriosis. A foodborne infection with high mortality among vulnerable groups (pregnant women, newborns, the elderly). In the EU — up to 2,770 cases annually, in the USA — around 1,600 [20, 21].

Artificial intelligence is increasingly being utilized in the monitoring, prevention, and control of infectious diseases. At the ESCMID 2024 conference, experts highlighted AI's role in enhancing infection prevention strategies. AI applications include surveillance, predictive analysis, antimicrobial stewardship, environmental monitoring, personalized patient care, and education and training. For instance, AI-driven facial recognition systems can monitor proper face mask usage within hospitals, while hand hygiene compliance is tracked using computer vision technologies. Additionally, AI-powered robots equipped with sensors can assess environmental conditions in real-time to optimize disinfection processes. Despite these advancements, challenges such as knowledge gaps and regulatory hurdles remain, necessitating collaborative efforts between healthcare professionals and AI specialists to fully realize AI's potential in infection control [22].

GIS has proven effective in monitoring infectious diseases, tracking environmental health, supporting emergency responses, and overseeing non-communicable diseases. It offers a tool for visualizing complex spatial information, detecting patterns, and guiding decisions based on evidence. The use of GIS goes beyond conventional limits, helping to create a comprehensive understanding of the complex relationships between health outcomes and environmental, socio-economic, and demographic factors [23]. In China, researchers used ArcGIS software to spatially analyze COVID-19 data from 2020 to 2022. Using global and local spatial autocorrelation (Moran index) methods, they identified clusters of high and low incidence and tracked the shifting epicenter of the epidemic. This allowed them to identify regions with the highest risk and tailor local responses [24]. HealthMap is a US-based web platform that aggregates data from news sources and social media to visualize infectious disease outbreaks around the world. The system successfully identified early signs of the 2014 Ebola outbreak in West Africa and the 2019 Wuhan pneumonia outbreak, which preceded the COVID-19 pandemic. HealthMap provides interactive maps to track the spread of diseases in real time [25]. In Jeddah, Saudi Arabia, a GIS application was developed for mapping and cluster modeling three diseases: diabetes, asthma, and hypertension. The system uses health center data and demographic information to identify spatial patterns and support healthcare decision-making [26]. In Europe, interactive maps have been developed, such as the European Interactive Geovisualization of Notifiable Diseases (ENDIG), which allow public health professionals to monitor the status of surveillance systems and the spread of diseases in different countries. Another example is the Zoonotic Infection Risk Map for the Twente-Achterhoek Region (ZIRTA), which is designed to inform general

practitioners about regional disease incidence like Hengelo for human infections with *Leptospira*, hantavirus, and tick-borne encephalitis virus [27].

### **1.3 Spread of Highly Infectious Diseases in Akmola Region, Regulatory Framework, and Recommendations for Improved Monitoring**

An analysis of the epidemiological situation in the Akmola region in recent years shows that the region is at risk of the spread of highly infectious diseases due to a combination of natural, social, and economic factors. In particular, the high level of rural livestock farming and the presence of numerous small farms, often operating in violation of sanitary standards, create favorable conditions for the circulation of pathogens such as brucellosis, anthrax, and listeriosis. For example, in 2014 and 2015, cases of brucellosis were registered in Ereimentau and Doroginka due to contact with unexamined cattle and small ruminants [28, 29]. In 2023, an outbreak of anthrax in the Zharkain district was also linked to violations in slaughter regulations and the distribution of meat from dead animals. As a result, 12 people were hospitalized with anthrax symptoms. In ten of them, the diagnosis was confirmed by laboratory tests [30]. In addition, the geographical and climatic features of the region (steppes, forest-steppes, water bodies) contribute to the formation of stable natural foci of such infections as tularemia and tick-borne encephalitis. In the Sandyktau district, for instance, two confirmed cases of tick-borne encephalitis were registered during the 2024 epidemic season, and the patients were unvaccinated [31, 32]. This highlights the importance of vaccination and serological prophylaxis for risk groups. Special attention should also be paid to listeriosis as a foodborne infection — in 2025, contamination of products with *Listeria monocytogenes* was detected at the Makinsk poultry farm, leading to a temporary suspension of the plant's operations and enhanced sanitary control [33]. Thus, both anthropogenic factors (low level of sanitary education, insufficient veterinary services) and natural factors (environmental conditions favoring vector and reservoir circulation) contribute to the sustainable existence and spread of HID in the region.

Considering the above, it is necessary to implement additional measures to improve the effectiveness of monitoring and prevention of HID in the Akmola region. First and foremost, GIS mapping of natural foci and cases of HID should be used — this technology allows visualization of disease spread in real time and forecasting of potential outbreaks based on geographic and seasonal data. Second, it is necessary to expand the use of digital healthcare tools in accordance with Chapter 7 of the Code “About the health of the people and the healthcare system”. This includes the development of mobile applications for self-diagnosis, risk notifications, registration of tick bites, and vaccination tracking. It is also important to implement educational programs for rural residents and agricultural workers aimed at improving sanitary literacy and awareness of HID symptoms and prevention. A third key area is vaccination (Rev.1, RB51), especially against brucellosis. International experience shows that mass vaccination of animals significantly reduces epidemic risks.

In conclusion, a comprehensive strategy that includes cartographic monitoring, digitization of the sanitary service, public education, and immunization can significantly enhance the Akmola region's resilience to the threats posed by HID. Given the stable presence of natural space and recurring outbreaks, the implementation of such approaches is not only relevant but also essential for ensuring the biological safety of the region.

## **2. EPIDEMIOLOGICAL ANALYSIS OF HIDS IN AKMOLA REGION (2021–2023) (Materials and Methods)**

The first part of this master's project utilized an elements of scoping review method to map existing literature and identify research gaps. The literature review encompassed scientific sources such as Scopus, PubMed, and Google Scholar, as well as official reports from WHO, CDC, and the European Parliament. These sources provided insights into the dissemination of highly infectious diseases abroad and various mitigation strategies. Comparative analysis was conducted to assess how global approaches to HID management align with those implemented in Kazakhstan. By integrating diverse data sources, the study aimed to comprehensively analyze the transmission trends of HID in the Akmola region over three years.

The second part of the study employed a statistical method to analyze primary epidemiological records. Data processing and visualization were conducted using Microsoft Excel. The research focused on the Akmola region, which features a continental climate with significant seasonal temperature variations. Population density, healthcare infrastructure, and socioeconomic factors were all considered in assessing disease dynamics.

Primary data were sourced from the Ministry of Healthcare of Kazakhstan, regional epidemiological bulletins, and hospital records covering 2021 to 2023 (Appendix C). The database included yearly incidence rates of highly infectious diseases, compiled from government-requested data and restricted-access health records. This dataset consisted of two main parts: samples from human or environment, indicating the number of samples analyzed for HID positivity. Specimens which were tested by laboratory tests for disease identification: Laboratory methods which were used:

- ❖ Bacteriological Method – Used for pathogen isolation and identification.
- ❖ Biological Method – Applied for in vivo and in vitro pathogen detection.
- ❖ Serological Method – Focused on detecting antibodies or antigens to assess population-level exposure.
- ❖ Genetic Method – Utilized PCR (Polymerase Chain Reaction) for detecting pathogen-specific genetic markers with high sensitivity and specificity.

Over the three-year period (2021, 2022, 2023), the number of recorded diseases ranged from 16 to 22 annually, with brucellosis, tularemia, and anthrax being the most prevalent. Another key focus of the study was separating infection sources. These included human carriers, environmental reservoirs, and disease vectors. As part of the research, both human subjects and environmental factors were analyzed, including:

- Rodents – Potential carriers of zoonotic pathogens.
- Mites – Vectors associated with disease transmission.
- Collected pellets – Environmental samples examined for infectious agents.

Epidemiological database on HID in Kazakhstan for the years 2021, 2022, and 2023 (Appendix C). They include information on the number of tested samples, laboratory identification methods (bacteriological, serological, genetic), and

confirmed cases for various infectious diseases. The data allows for trend analysis of disease incidence and the effectiveness of public health measures over three years. Additionally, the documents contain insights into environmental and vector-based transmission sources, contributing to a broader understanding of disease dynamics in the region (Figure 1).

№	Наименование возбудителя	Таблица 4. Лабораторный мониторинг за особо опасными инфекциями лаб ООИ + района Акимолской области за 2021г общая													Таблица 4. Лабораторный мониторинг за особо опасными инфекциями лаб ООИ + района Акимолской области за 2021г об																									
		Всего	из них поло ж	Исследовано проб					Всего	из них поло ж	Проведено исследований					Всего	из них поло ж	Проведено бактериологических исследований					Всего	из них поло ж	Проведено серологических исследований															
				% пол ож	от людей	из них поло	из веш	из них поло			% поло ж	от людей	из них поло ж	% из веш	из них поло ж			% поло ж	от людей	из них поло ж	% из веш	из них поло ж			% поло ж	от людей	из них поло ж	% из веш	из них поло ж											
1	Бруцеллез	2058	173	8	2034	169	8	24	4	17	4419	372	8	4383	368	8	36	4	11	1	28	1	3	5714	22	1	4	5454	6	0	0	4385	371	8	4606	4361	367	8	4	16
2	Сибирская язва	236	0	0	0	0	0	236	0	0	705	0	0	0	0	0	0	0	0	2	230	0	0	0	0	0	230	0	0	0	234	0	0	0	0	0	0	0	0	
3	Туляремия	680	25	4	72	12	0	608	13	2	2117	25	1	72	12	17	2045	13	1	3	867	0	0	0	0	0	867	0	0	0	766	25	3	2637	72	12	16	7	13	
4	Холера	3563	4наг	0.1	1962	0	0	1601	4	0.2	4191	4наг	0	1962	0	0	2229	4наг	0	4	1941	4	4	1766	175	0	0	1766	4	4	2123	0	0	1787	0	0	0	0	0	
5	Иерсиниоз	22	0	0	22	0	0	0	0	0	163	0	0	22	0	0	141	0	0	5	80	0	0	0	0	0	80	0	0	22	0	0	22	0	0	0	0	0		
6	Псевдотуберкулез	5	0	0	5	0	0	0	0	0	85	0	0	5	0	0	80	0	0	6	80	0	0	0	0	0	80	0	0	5	0	0	5	0	0	0	0	0		
7	Листериоз	1041	28	3	961	28	0	80	0	0	1041	28	3	961	28	3	80	0	0	7	108	0	0	28	0	0	80	0	0	933	28	3	300107	933	28	3	0	0		
8	Пастереллез	7	2	29	7	2	0	0	0	0	87	2	2	7	2	29	80	0	0	8	80	0	0	0	0	0	80	0	0	7	2	28	3714	7	2	28	6	0		
9	Леггосириоз	179	6	3	18	6	0	161	0	0	239	6	3	18	6	33	221	0	0	9	0	0	0	0	0	0	0	0	0	179	6	3	35109	18	6	161	0	0		
10	Эпидемический сыпной тиф	163	0	0	163	0	0	0	0	0	163	0	0	163	0	0	0	0	0	10	0	0	0	0	0	0	0	0	163	0	0	163	0	0	0	0	0	0		
11	Ку-лицироз	141	0	0	0	0	0	141	0	0	141	0	0	0	0	0	141	0	0	13	0	0	0	0	0	0	0	0	141	0	0	0	0	0	0	0	0	0		
12	Боррелиоз	71	0	0	16	0	0	55	0	0	71	0	0	16	0	0	55	0	0	14	0	0	0	0	0	0	0	0	16	0	0	16	0	0	0	0	0	0		
13	ККГЛ	80	0	0	0	0	0	80	0	0	80	0	0	0	0	0	80	0	0	16	0	0	0	0	0	0	0	0	80	0	0	0	0	0	0	0	0	0		
14	ВКЭ	334	6	2	87	6	0	247	0	0	334	6	2	87	6	7	247	0	0	20	0	0	0	0	0	0	0	0	302	6	1	98675	55	6	10	9	247	0		
15	ВЛК	2	0	0	0	0	0	2	0	0	2	0	0	0	0	0	2	0	0	22	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0		
16	ВОК	17	9	53	0	0	0	17	9	53	61	18	30	0	0	0	61	18	30	23	17	9	53	0	0	17	9	53	9411	7	4	16	666	0	0	24	4	16		

Figure 1 - An example from a fragment of the database of registered HIDs in the Akmola region

Overall, among the total percentage of HID incidence recorded between 2021 and 2023, the top five diseases—brucellosis, listeriosis, tularemia, tick-borne encephalitis, and anthrax—were selected and categorized based on the source of analysis (human or environment). Figure 2 illustrates the number of cases of these diseases found in humans in the Akmola region. While tularemia, brucellosis, and TBE showed a declining trend over time, the incidence of other diseases increased. This variation suggests potential changes in epidemiological patterns, surveillance efforts, or external environmental factors influencing disease spread.

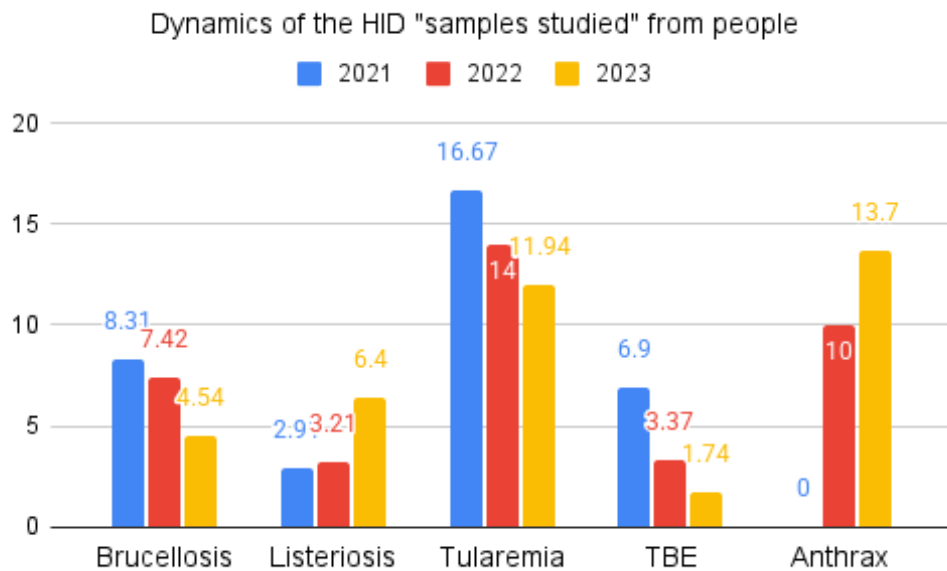


Figure 2 – Trends in HID Tested Samples Collected from Humans.

The next graph illustrates the number of incidences of the top five diseases in the Akmola region detected in environmental sources, including rodents, mites, and collected pellets. Overall, brucellosis had the highest incidence compared to other diseases. However, despite its prevalence, the number of brucellosis cases declined over the given period. Other HID categories showed little to no recorded incidence, except for anthrax, which was detected only once in 2023. Figure 3 provides a detailed representation of these trends.

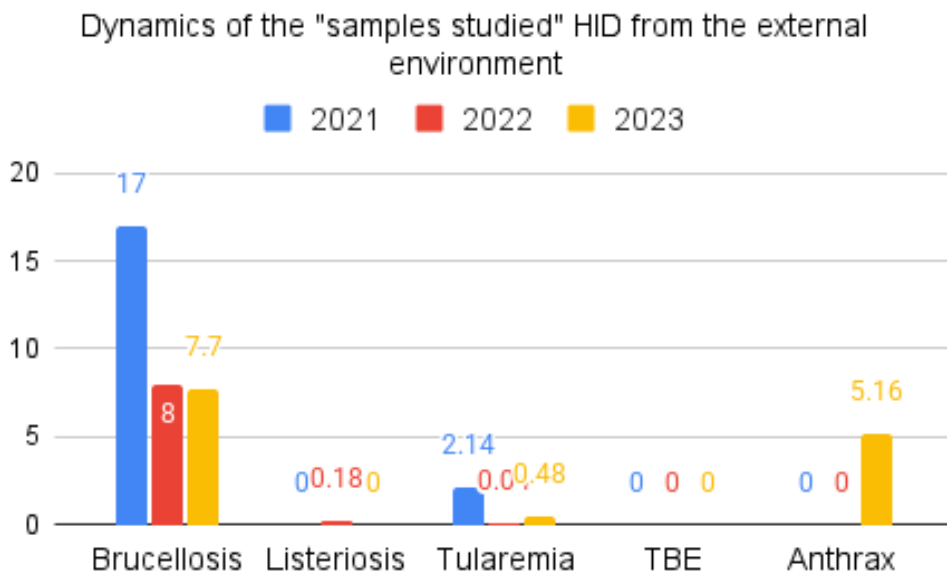


Figure 3 – Trends in HID Tested Samples Collected from Environment.

The next two graphs illustrate the number of incidences of the top five diseases in the Akmola region, tested using 4 identification methods: bacterial, biological,

serological, and genetic analysis. Samples were collected from both humans and environmental sources, including rodents, mites, and pellets. Figure 4 reveals that the downward trend observed as Figure 2 for brucellosis, anthrax, and tularemia persisted throughout the given period. This suggests a consistent decline in the detection of these diseases across different testing methods and sample sources.

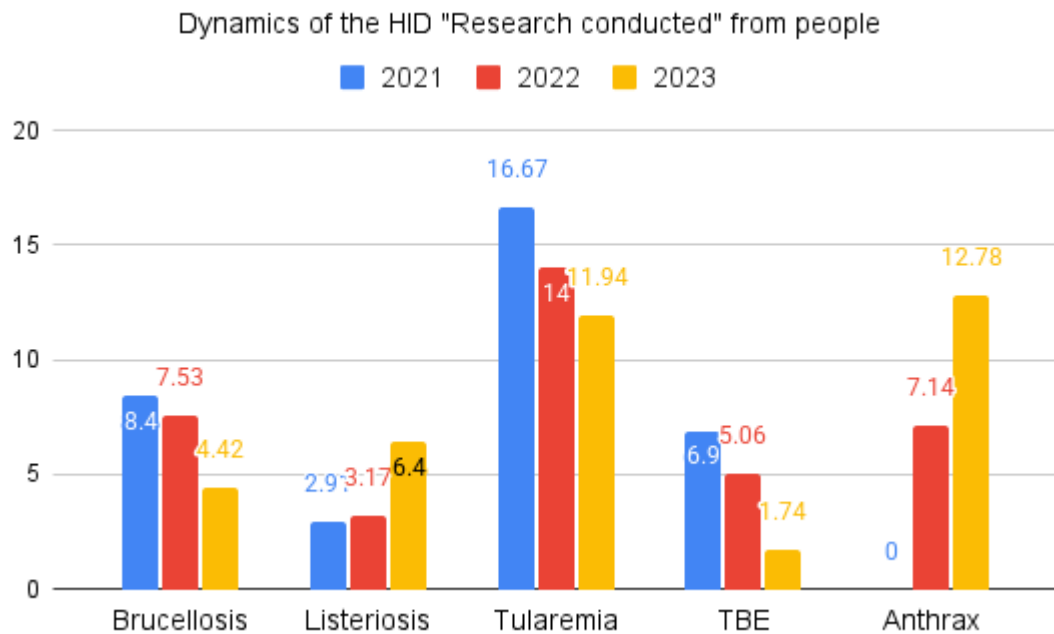


Figure 4 – Trends in HID Tested Samples Using 4 Laboratory Techniques Collected from Humans

The final graph presents the results of laboratory tests conducted on HID samples collected from environmental sources. Unlike the samples taken from humans, where brucellosis showed a declining trend, its incidence in environmental samples increased. However, anthrax was detected only once in 2023, like previous observations. Figure 5 provides a detailed representation of these findings.

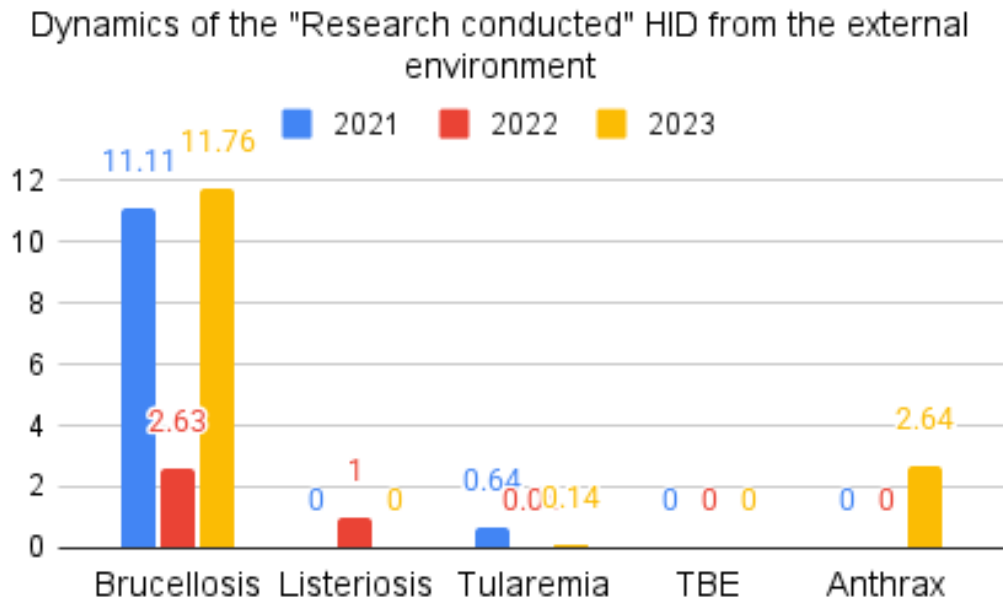


Figure 5– Trends in HID Tested Samples Using 4 Laboratory Techniques Collected from Environment

This study utilized a retrospective epidemiological analysis, along with statistical and analytical methods, to evaluate the three-year trends of infectious diseases. The research specifically focused on highly contagious diseases, including brucellosis, listeriosis, tularemia, TBE, and anthrax.

The study was approved by the local ethics committee of the Department of Public Health and Epidemiology of the NpJSC "Astana Medical University" protocol No. 9 dated 11.03.2025 (Appendix A).

### 3. LONG-TERM DYNAMICS OF HID IN AKMOLA REGION (Research Results)

#### 3.1 The dynamics of brucellosis incidence in 2021, 2022, 2023

Brucellosis is a highly infectious zoonotic disease caused by bacteria of the genus *Brucella*, which primarily affects livestock such as cattle, sheep, goats, and pigs. Humans contract the disease through direct contact with infected animals or by consuming unpasteurized dairy products and, less commonly, undercooked meat. The World Health Organization classifies brucellosis as a neglected zoonosis that poses a major threat to both animal and human health, particularly in low- and middle-income countries. The disease typically manifests in humans with undulant fever, fatigue, muscle pain, headaches, and night sweats. If not properly diagnosed and treated, brucellosis can progress to chronic forms with complications such as arthritis, endocarditis, and neurobrucellosis, leading to significant morbidity [34].

According to the database, in the period from 2021 to 2023, brucellosis monitoring among the population is carried out in the Akmola region, including both a general examination and bacteriological and serological studies. Data analysis shows a decrease in the incidence rate, which may be due to improved preventive measures and an increase in the level of sanitary control (Figure 6).

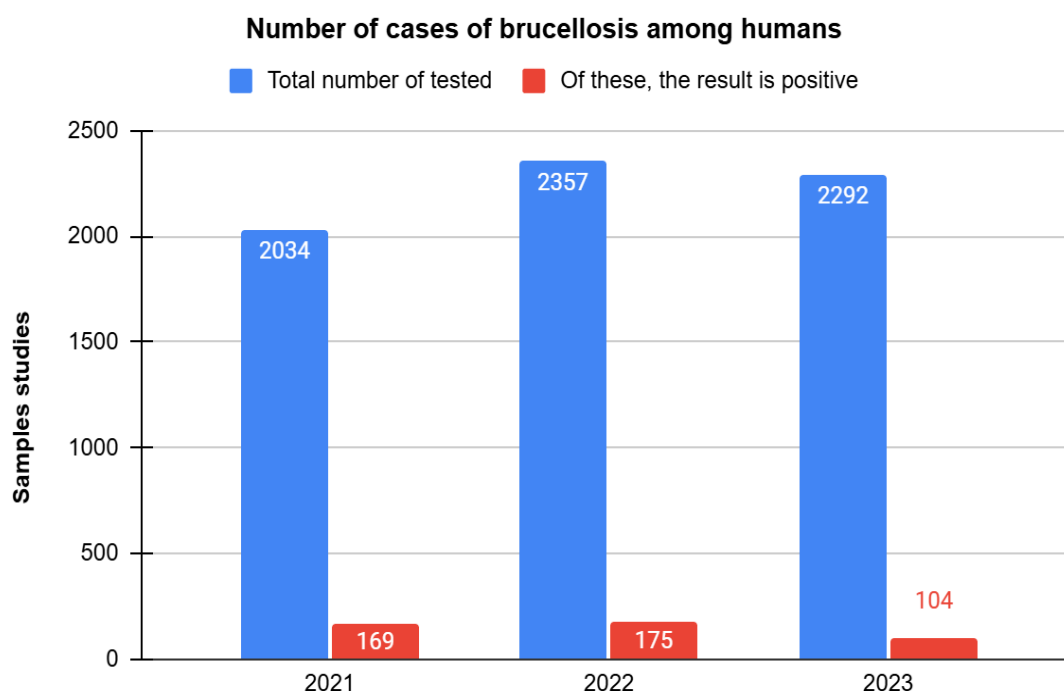


Figure 6 - Number of Brucellosis Cases Among Humans in Akmola region by Year Based on Tested Samples.

For the samples taken from the environment, in 2021, 24 tests were conducted, of which 4 were positive, which was 16.67%. In 2022, the number of cases decreased to 2 from 24 samples studied. However, the percentage of cases decreased to 8.3%,

which may indicate more active detection of infection among the population. In 2023, the volume of infections increased to 26 tests, the number of cases was 2, with the percentage of infected people being 7.69%. This trend demonstrates a gradual decrease in the prevalence of the infection (Figure 7).

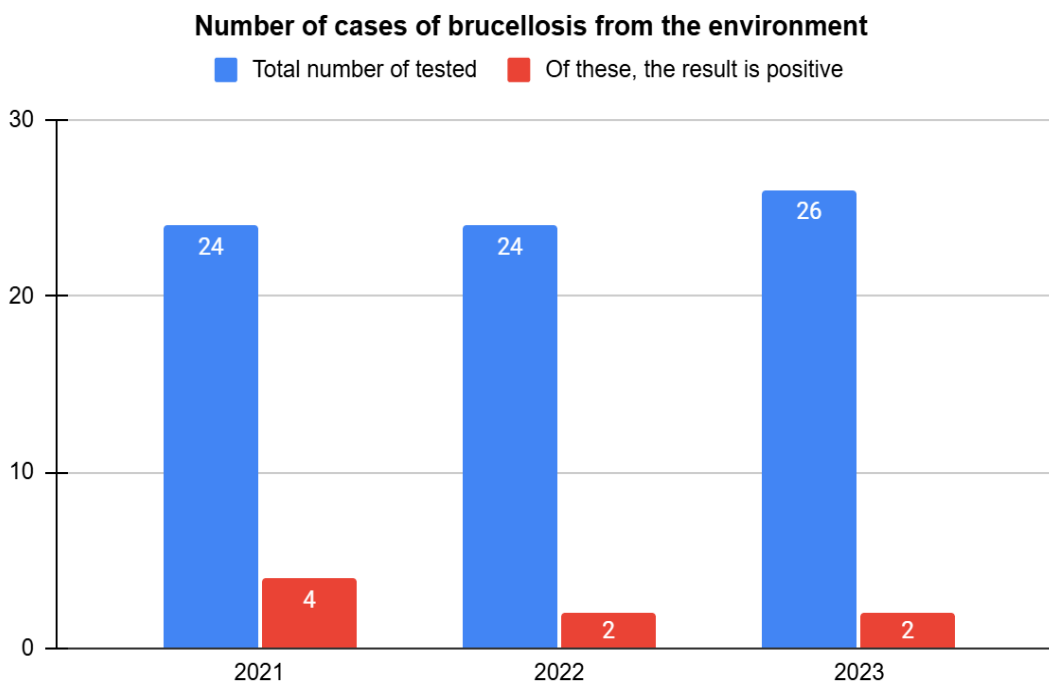


Figure 7 - Brucellosis Levels in the Environment in Akmola region by Year Based on Tested Samples.

For bacteriological testing, in 2021, 22 tests were conducted, of which 1 were positive, which was 4.54%. In 2022, the number of cases was 1, with the number of tested samples 44.. The percentage of cases decreased to 2.27%, which may indicate more active detection of infection among the population. In 2023, the volume of infections increased to 49 tests, the number of cases decreased to 0, with the percentage of infected people being 0%. This trend demonstrates a sharp decrease in the prevalence of the infection (Figure 8).

**Annual Number of Confirmed Human Brucellosis Cases Identified Through Bacteriological Analysis**

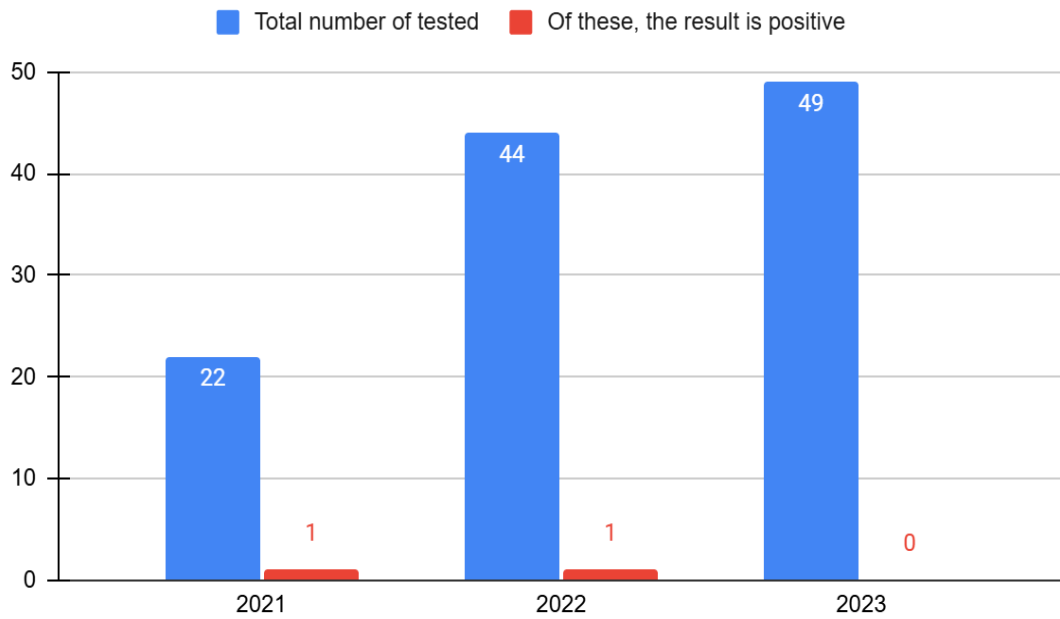


Figure 8 - Number of Brucellosis Cases Among Humans in Akmola region by Year Based on Bacteriological Studies.

Bacteriological studies have made it possible to detect the presence of Brucellosis in biological samples. In 2021, 6 bacteriological tests were performed, of which none of them was positive. In 2022, the volume of studies increased to 23, but the percentage of positive cases increased to 8.70% (2 cases). In 2023, 8 tests were performed, and the number of positive results was 2 (25%). These data indicate an increase in the circulation of the pathogen among the population (Figure 9).

### Annual Number of Confirmed Environment Brucellosis Cases Identified Through Bacteriological Analysis

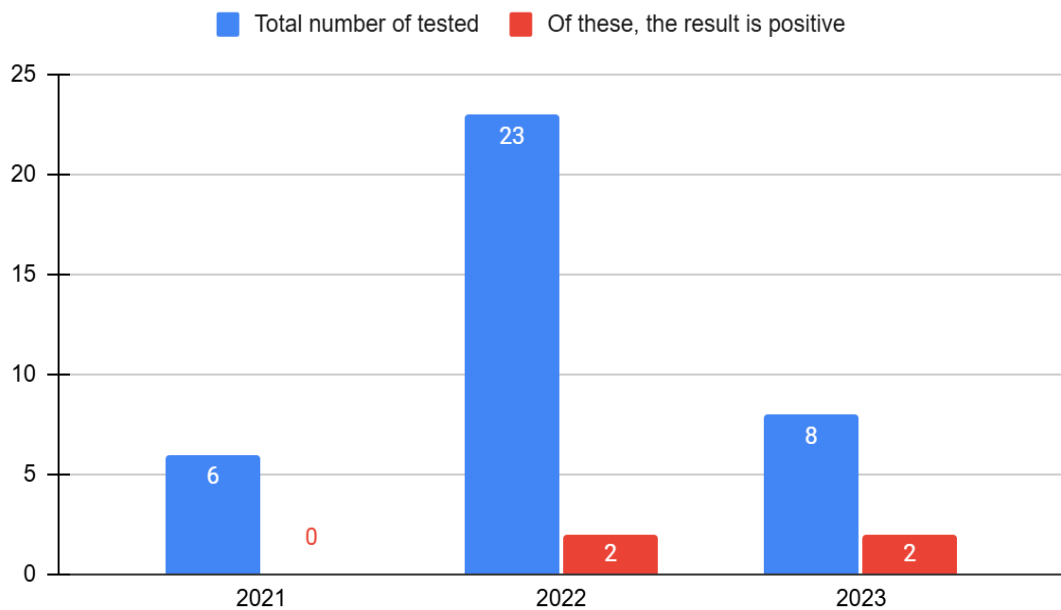


Figure 9 - Brucellosis Level in the Environment in Akmola region by Year Based on Bacteriological Studies.

Serological tests are aimed at detecting antibodies to Brucellosis and can determine the prevalence of the infection. In 2021, 4361 serological tests were performed, of which 367 (8.42%) were positive. In 2022, the volume of tests increased to 5162 and the number of positive cases decreased to 7.57%. However, in 2023, a significant decrease was recorded: out of 5963 tests, only 266 (4.46%) were positive. This indicates a decrease in the prevalence of infection among the population (Figure 10, 11).

### Annual Incidence of Human Brucellosis Determined Through Serological Testing

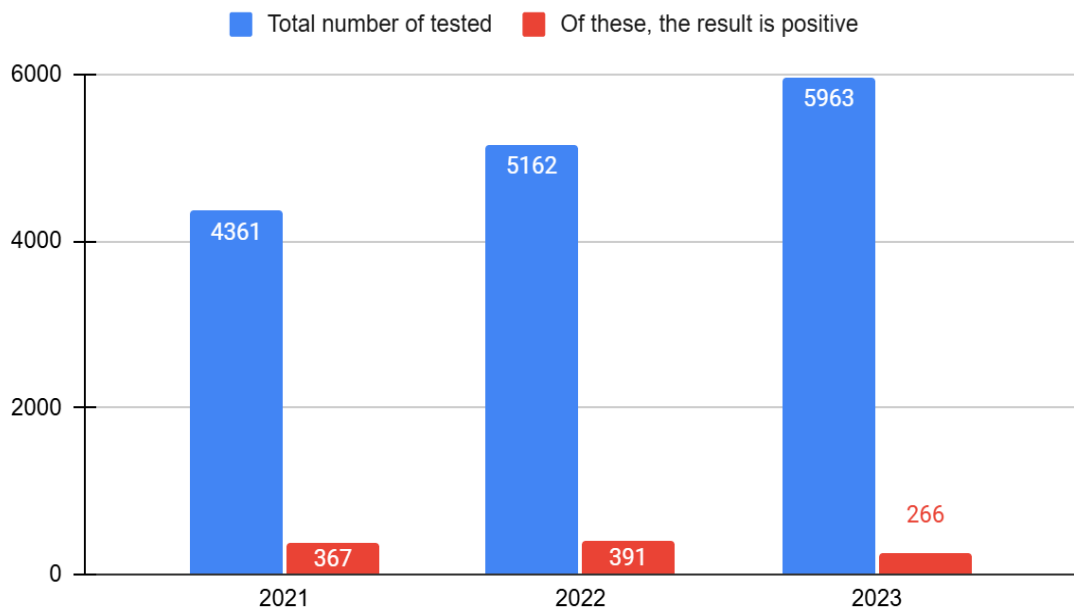


Figure 10 - Number of Brucellosis Cases Among Humans in Ak-mola region by Year Based on Serological Studies.

### Annual Incidence of Environment Brucellosis Determined Through Serological Testing

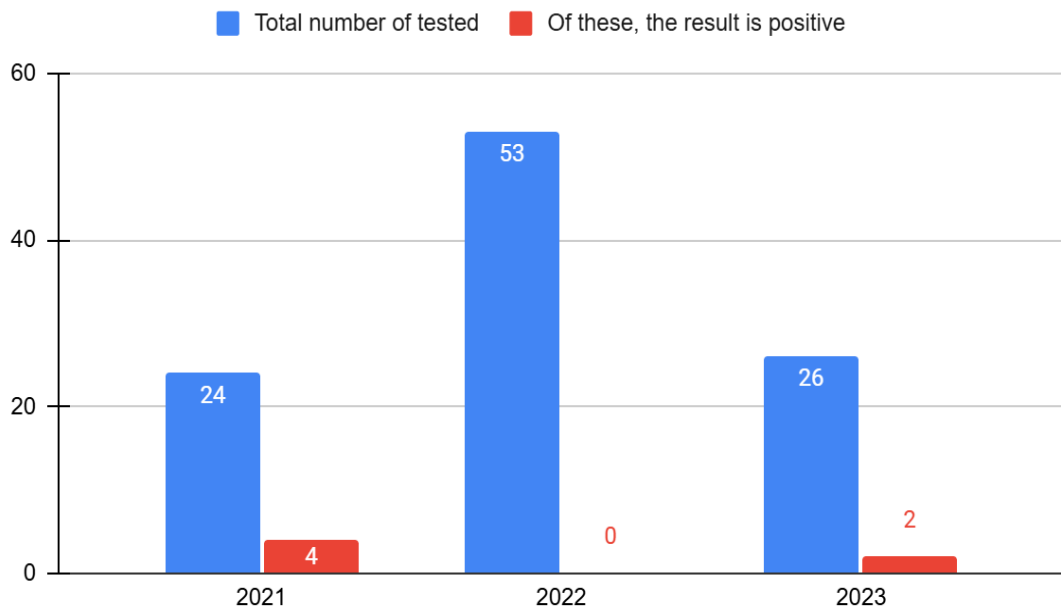


Figure 11 - Brucellosis Levels in the Environment in Ak-mola region by Year Based on Serological Studies.

The data show that the incidence of Brucellosis in the Akmola region has been declining over three years, despite a temporary increase in bacterial cases. A decrease in the proportion of positive bacteriological and serological tests in 2023 suggests that preventive measures such as vaccination and control of animal products are beginning to yield results. However, the persistence of infection cases indicates the need for continued monitoring and preventive measures to completely eradicate the disease.

### 3.2 The dynamics of Listeriosis incidence in 2021, 2022, 2023

Listeriosis, caused by the bacterium *Listeria monocytogenes*, is a serious foodborne illness that predominantly affects pregnant women, newborns, the elderly, and individuals with weakened immune systems. Despite its relatively low incidence compared to other foodborne diseases, listeriosis is associated with high hospitalization and mortality rates, making it a significant public health concern worldwide. According to the World Health Organization, the global incidence of listeriosis varies between 0.1 to 10 cases per million people annually, depending on the country and region. This variation is influenced by factors such as food safety practices, surveillance systems, and population demographics [35].

In 2021, 961 tests were conducted, of which 28 were positive (2.91%). In 2022, the testing volume more than doubled to 1151 tests, and 37 cases of infection were detected (3.21%). In 2023, the number of tests was 968, and 62 cases of infection were recorded (6.40%). These data indicate a rise of the level of pathogen circulation among the population, despite absence from environmental testing (Figure 12, 13).

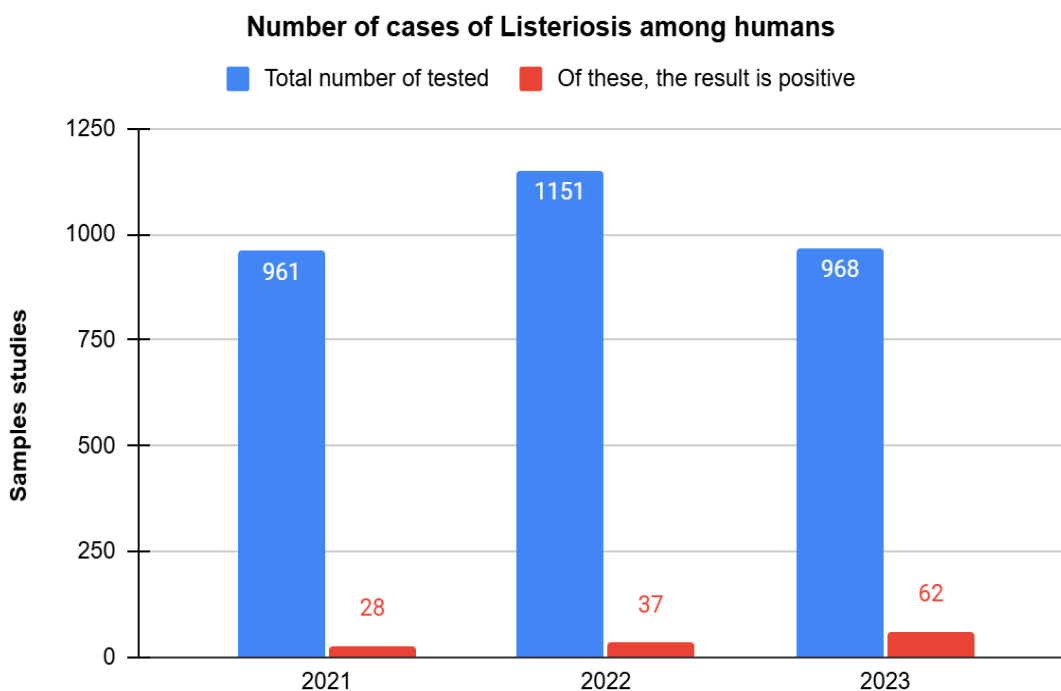


Figure 12 - Number of Listeriosis Cases Among Humans in Akmola region by Year Based on Tested Samples.

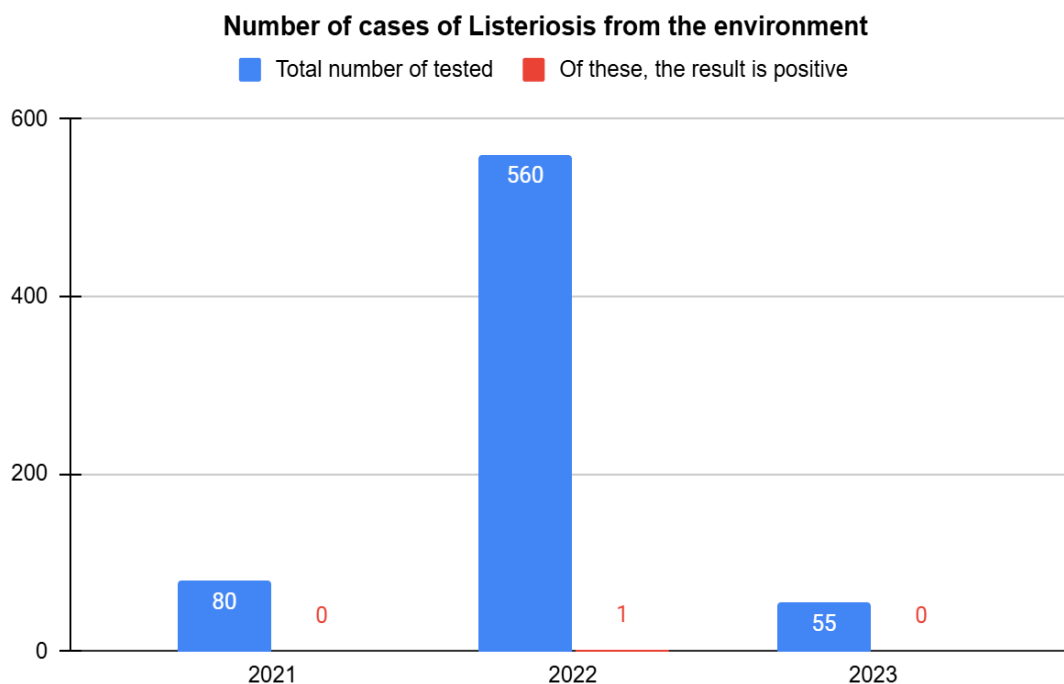


Figure 13 - Listeriosis Levels in the Environment in Akmola region by Year Based on Tested Samples.

The bacteriological method is the main method for detecting *Listeria monocytogenes* in biological materials. In 2021, 28 bacteriological tests were performed, none of which were positive. In 2022, the volume of studies increased to 235, but the number of positive cases increased to 2 (0.08%). In 2023, 154 tests were performed, and no positive case was detected. These data show a stable but extremely low incidence rate from bacteriological analysis (Figure 14, 15).

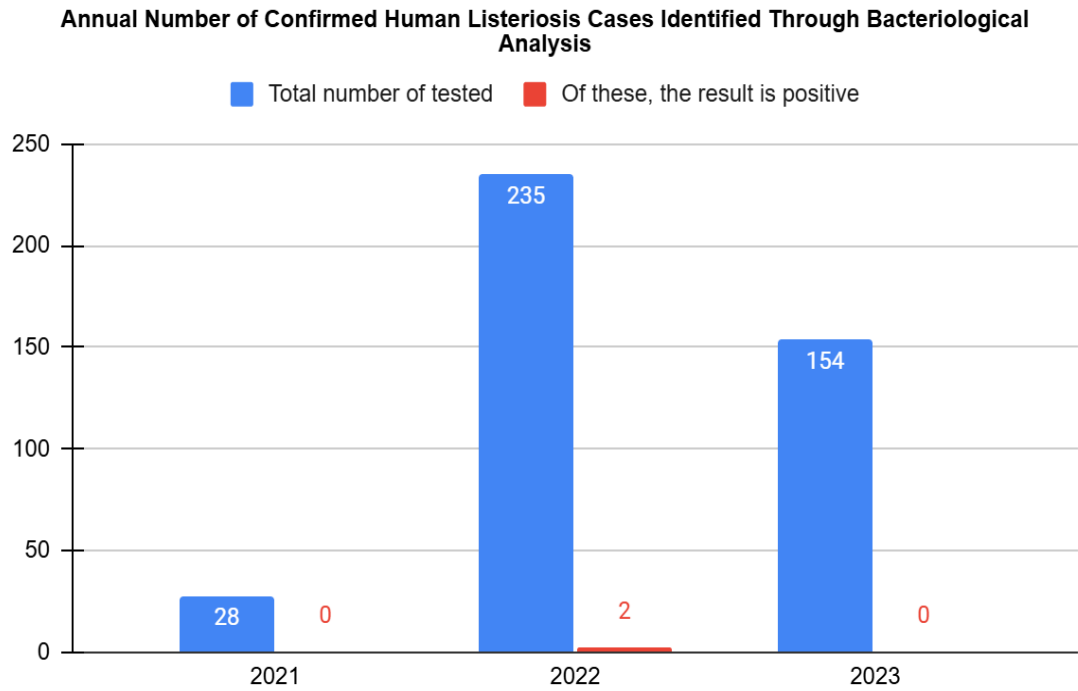


Figure 14 - Number of Listeriosis Cases Among Humans in Akmola region by Year Based on Bacteriological Studies.

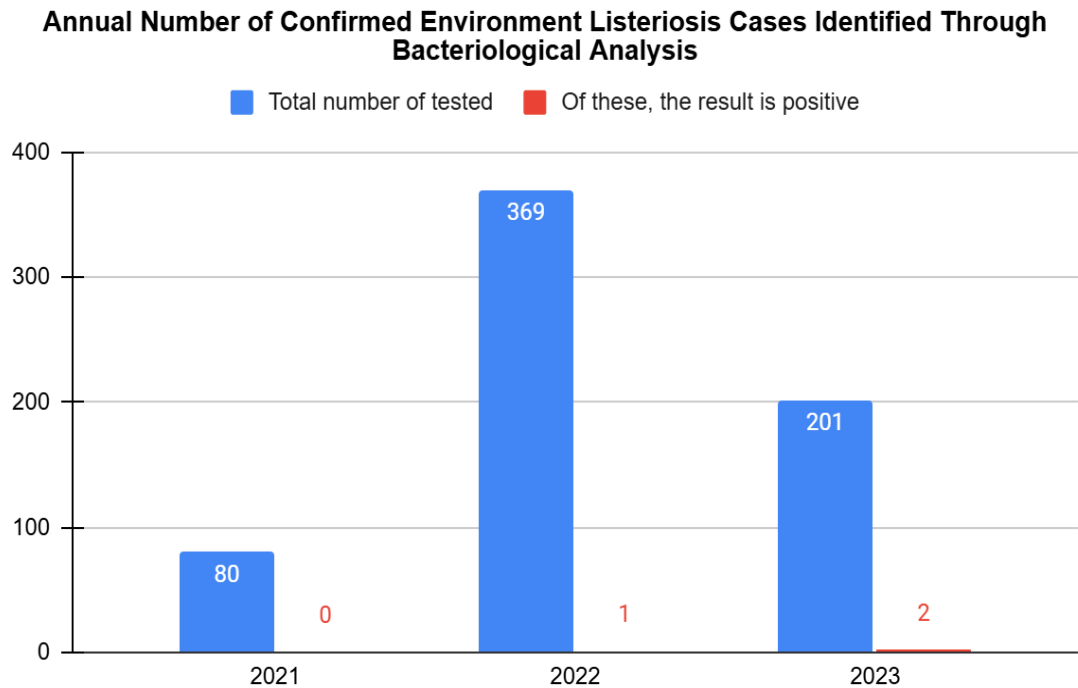


Figure 15 - Listeriosis Level in the Environment in Akmola region by Year Based on Bacteriological Studies.

Serological tests are designed to detect Listeriosis and allow us to determine the prevalence of infection in the population. In 2021, 3% positive results were detected, while in 2022 the percentage was almost the same. However, in 2023 the Listeriosis incidence increased to 7.62% (Figure 16, 17).

#### Annual Incidence of Human Listeriosis Determined Through Serological Testing

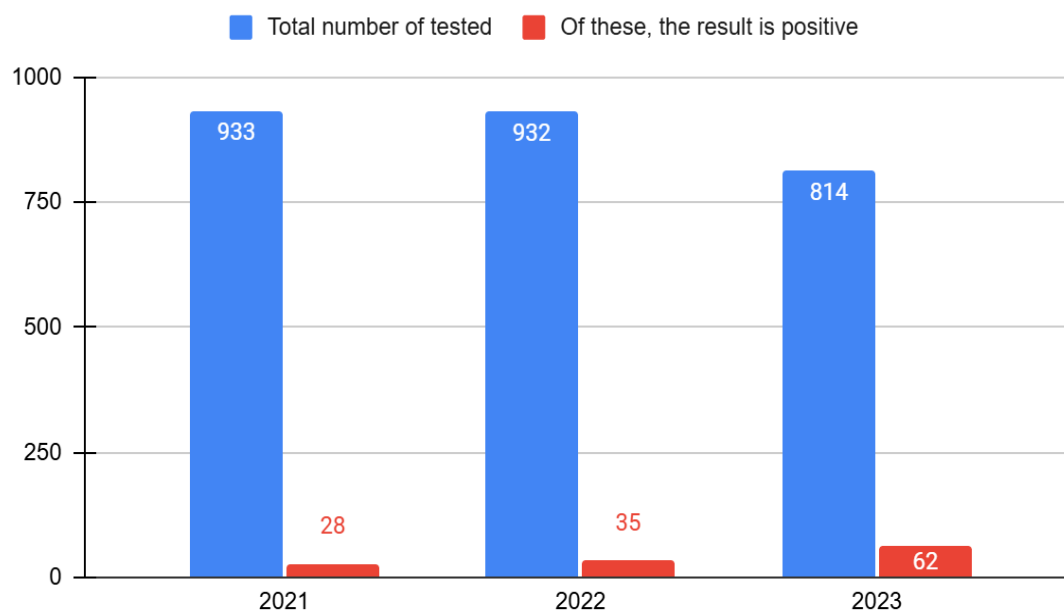


Figure 16 - Number of Listeriosis Cases Among Humans in Akmola region by Year Based on Serological Studies.

### Annual Incidence of Environment Listeriosis Determined Through Serological Testing

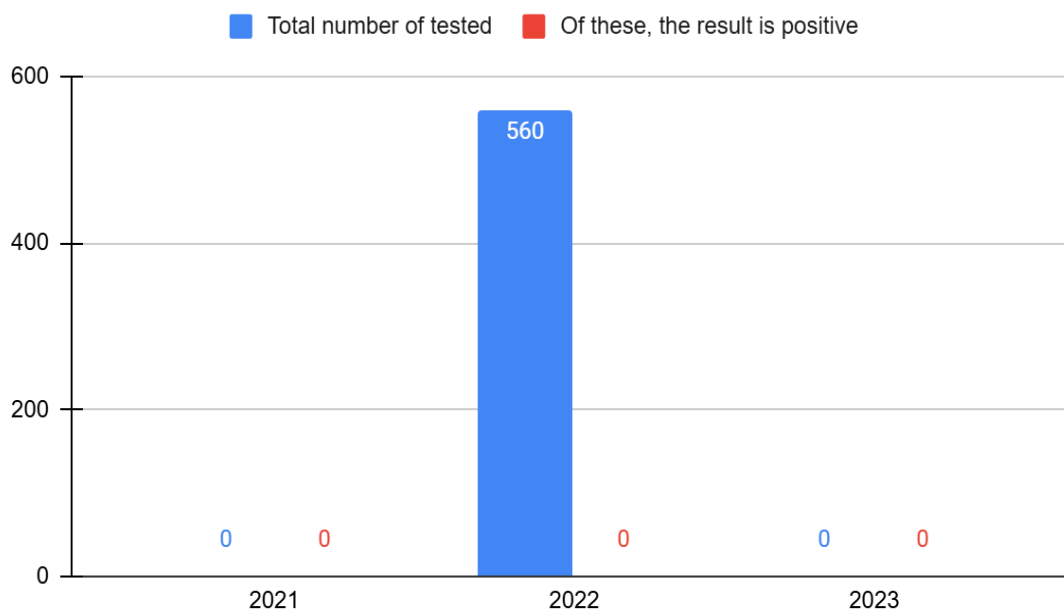


Figure 17 - Listeriosis Levels in the Environment in Akmola region by Year Based on Serological Studies.

The data from 2021 to 2023 indicate a gradual increase in Listeriosis cases based on serological testing, rising notably to 7.62% in 2023, which suggests an intensifying circulation of the pathogen among the population. Despite this, bacteriological testing continues to show extremely low positivity rates, highlighting its limited sensitivity in detecting *Listeria monocytogenes*. The disparity between testing methods emphasizes the importance of comprehensive surveillance strategies. Overall, the rising trend in serological positivity calls for increased public health attention and improved diagnostic monitoring.

### 3.3 The dynamics of Tularemia incidence in 2021, 2022, 2023

Tularemia, caused by the bacterium *Francisella tularensis*, is a zoonotic disease with varying incidence across different regions. Between 2021 and 2023, surveillance data indicate fluctuations in reported cases globally, influenced by factors such as environmental conditions, wildlife reservoirs, and public health interventions [36].

As shown in the primary database, in 2021, 72 tests for tularemia were conducted, but 12 positive cases were detected (16.67%). In 2022, testing volume decreased to 50 tests, and the infection level decreased to 14%. In 2023, 134 tests were conducted, but again cases of the disease decreased to 11.94% (Figure 18, 19).

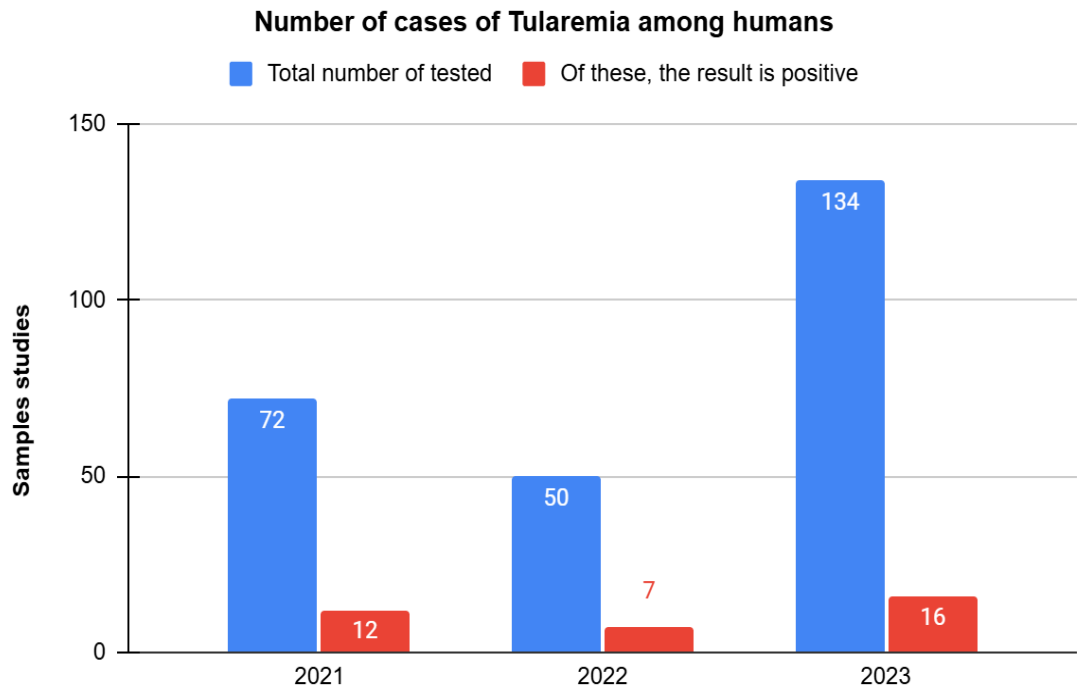


Figure 18 - Number of Tularemia Cases Among Humans in Ak-mola region by Year Based on Tested Samples.

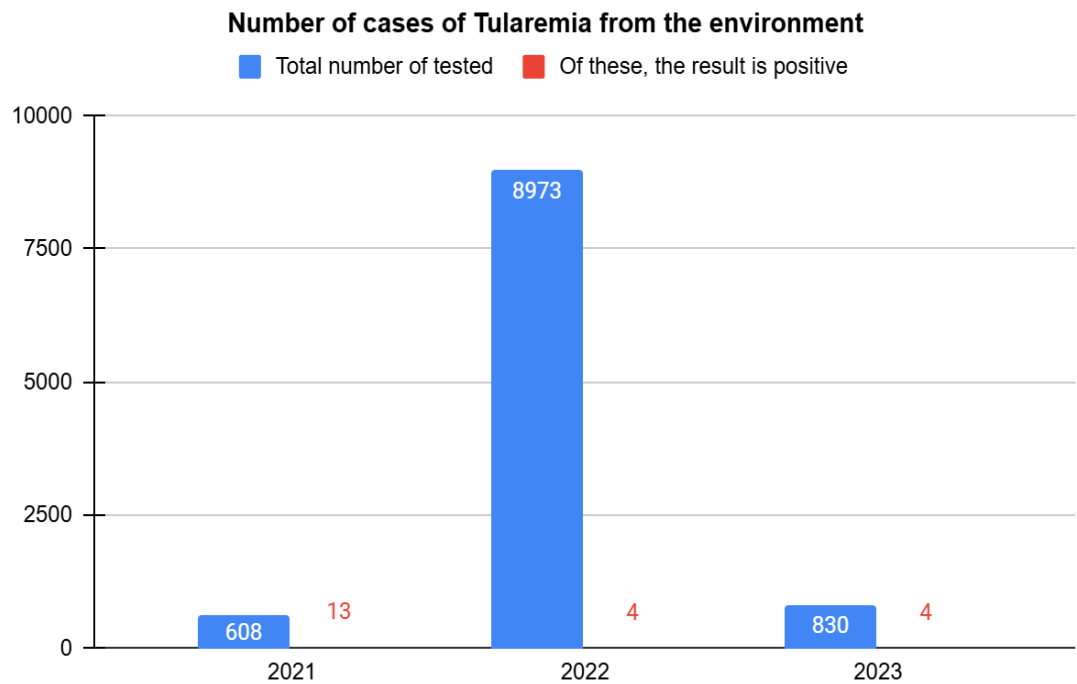


Figure 19 - Tularemia Levels in the Environment in Ak-mola region by Year Based on Tested Samples.

Monitoring serological studies, Tularemia showed the same patterns of positive results. This indicates the gradual decrease of Tularemia Levels (Figure 20, 21).

**Annual Incidence of Human Tularemia Determined Through Serological Testing**

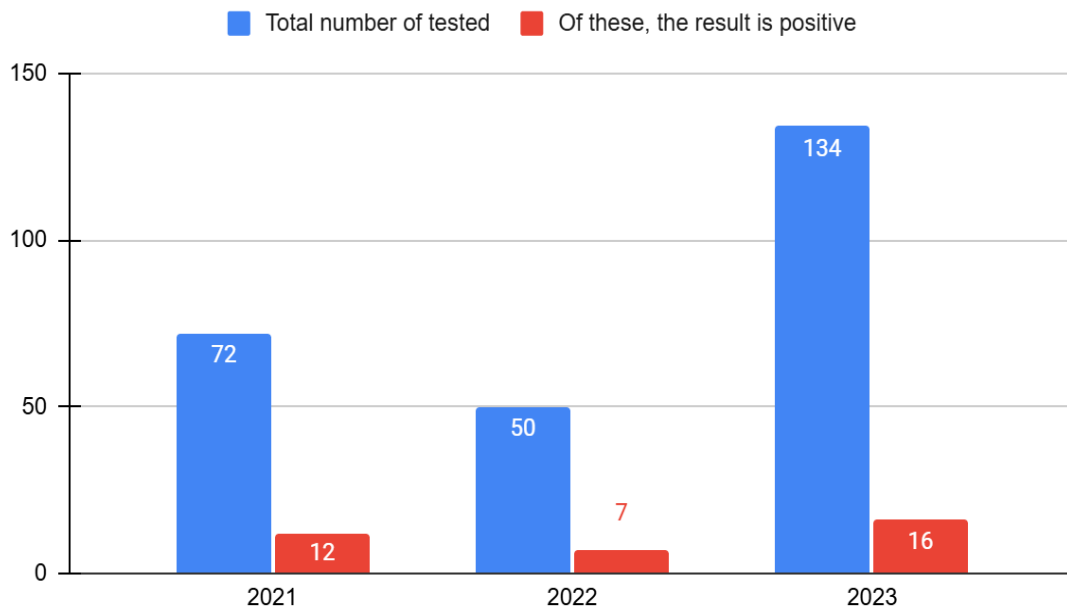


Figure 20

- Number of Tularemia Cases Among Humans in Akmola region by Year Based on Serological Studies

**Annual Incidence of Environment Tularemia Determined Through Serological Testing**

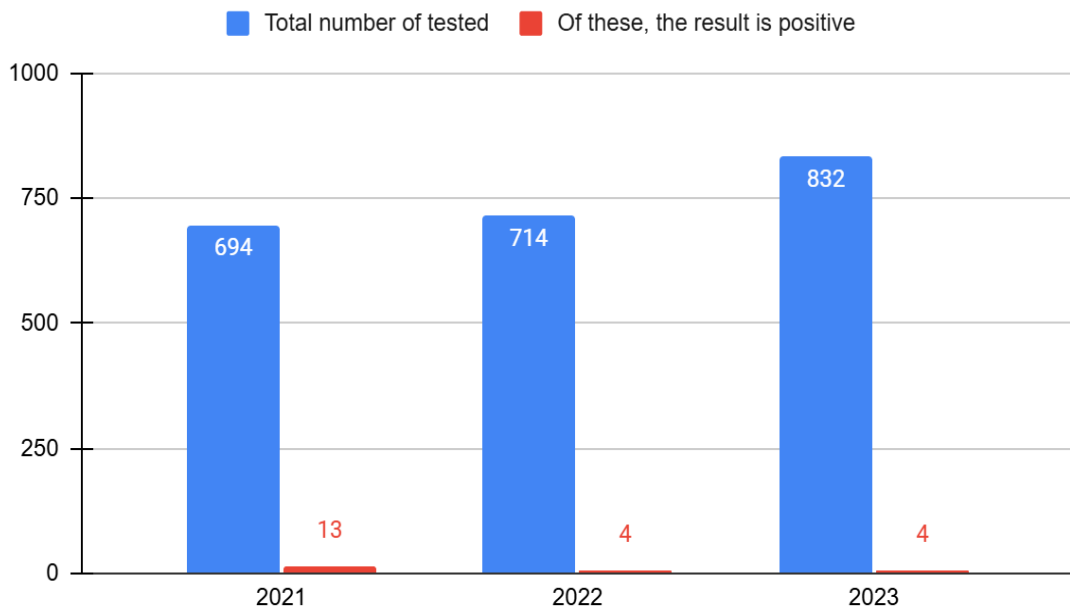


Figure 21 - Tularemia Levels in the Environment in Akmola region by Year Based on Serological Studies.

Tularemia has shown gradual decrease in the Akmola region in the last three years, which may indicate a decrease in prevalence of the infection. It is important to continue epidemiological surveillance and preventive measures, especially among risk groups such as hunters, farmers and veterinarians.

### 3.4 The dynamics of TBE incidence in 2021, 2022, 2023

Tick-borne encephalitis is a viral infection affecting the central nervous system, transmitted primarily through the bite of infected ticks (*Ixodes* species) and, less commonly, via consumption of unpasteurized dairy products from infected animals. The disease presents a seasonal pattern, with most cases occurring between late spring and early autumn [37].

According to the primary database, in 2021, 87 tests for TBE were conducted, and 6 positive cases were detected. In 2022, the testing volume more than doubled to 178 tests, and again 6 positive cases were detected. In 2023, the number of tests was 230, but decrease in disease level was recorded to 4 (Figure 22, 23).

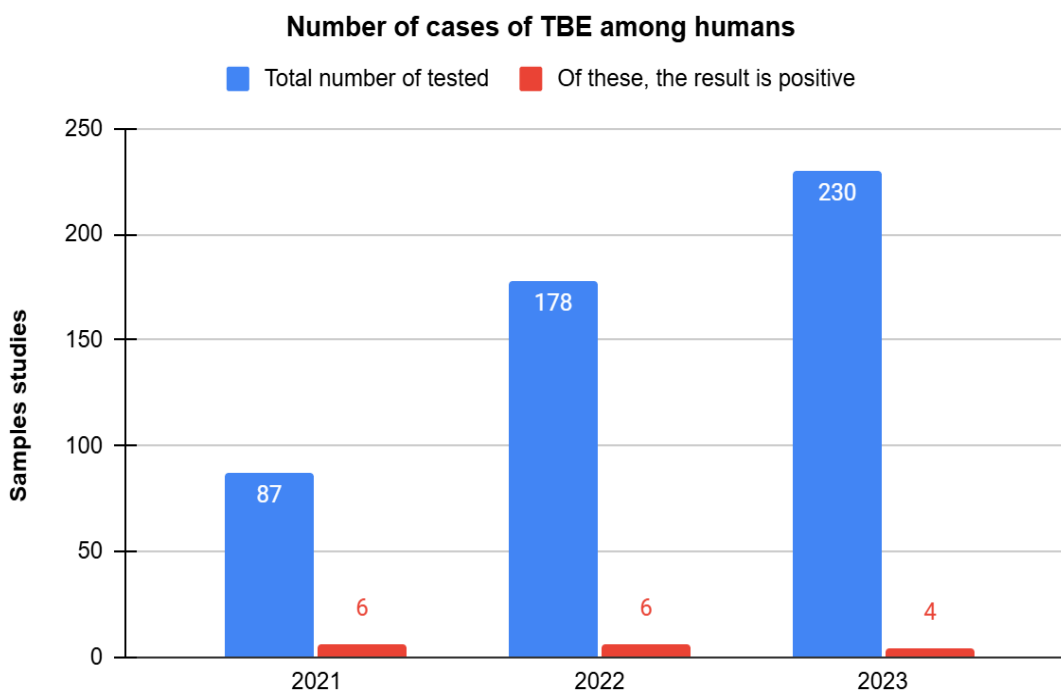


Figure 22 - Number of TBE Cases Among Humans in Akmola region by Year Based on Tested Samples.

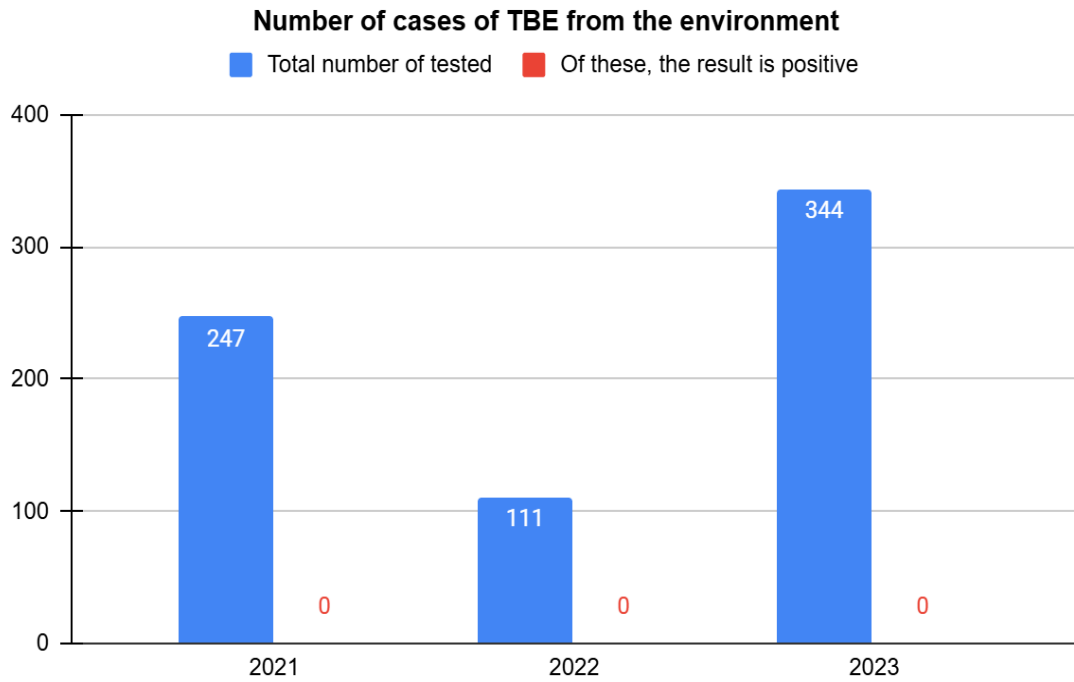


Figure 23 - TBE Levels in the Environment in Akmola region by Year Based on Tested Samples.

Laboratory tests for tick-borne encephalitis virus include serological tests to detect antibodies in patients' blood. Over three years of monitoring in Akmola region. The level of disease decreased from 10.91% to 1.74% (Figure 24)

### Annual Incidence of Human TBE Determined Through Serological Testing

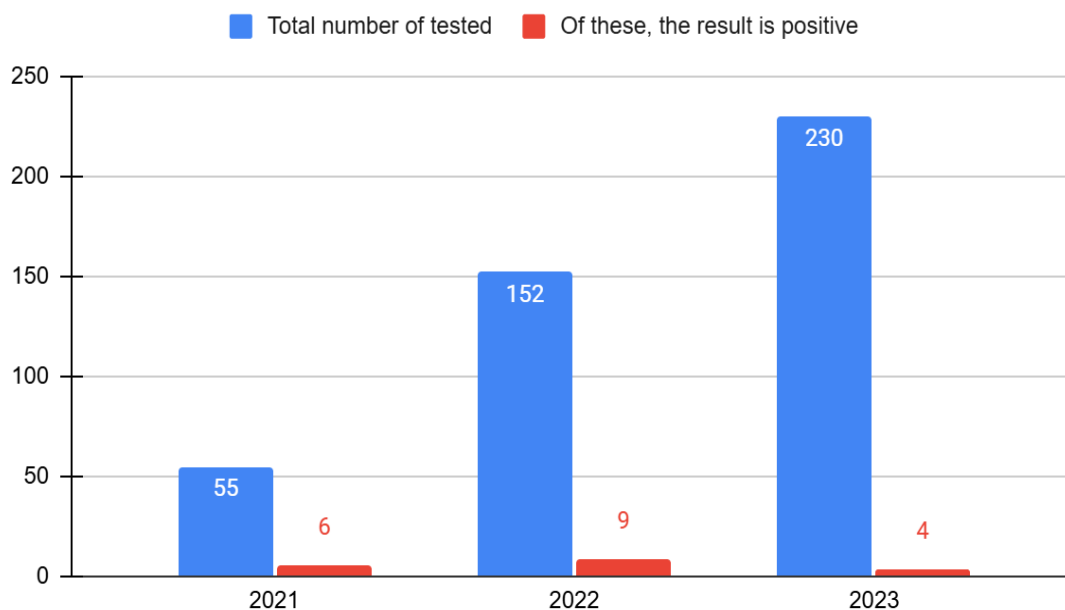


Figure 24 - Number of TBE Cases Among Humans in Akmola region by Year Based on Serological Studies.

### Annual Incidence of Environment TBE Determined Through Serological Testing

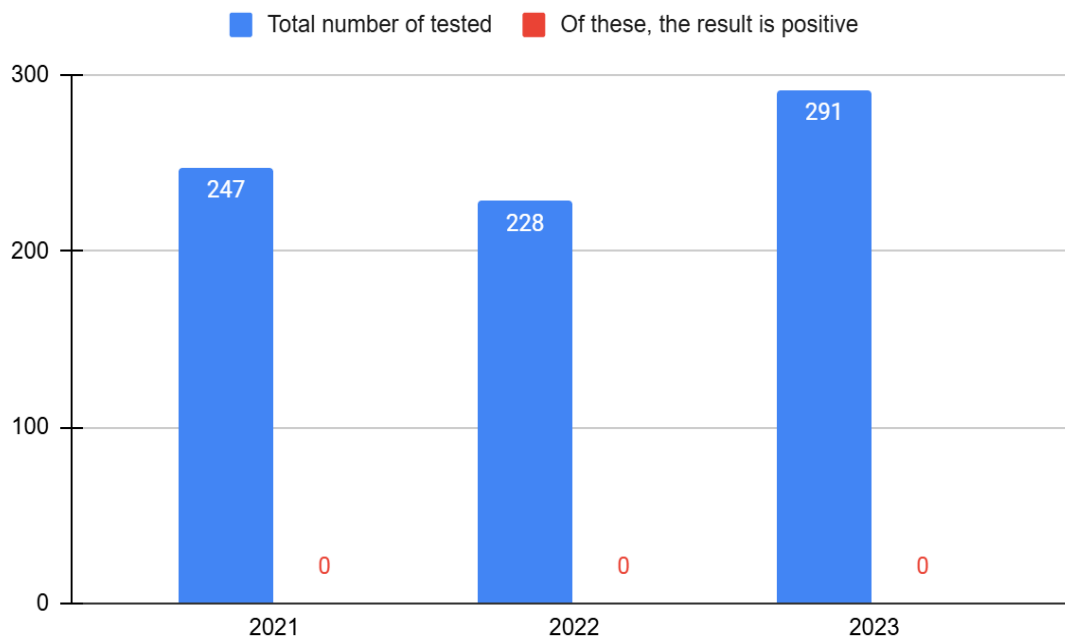


Figure 25 - TBE Levels in the Environment in Akmola region by Year Based on Serological Studies.

The decrease of registered cases of TBE in the region may indicate a low level of virus circulation among ticks and animal reservoirs. However, the risk of infection remains, especially during periods of tick activity (spring and summer). Prevention of the disease includes vaccination, use of repellents, wearing protective clothing and regular examinations for ticks after being outdoors. Epidemiological surveillance of viral tick-borne encephalitis should be continued to prevent possible outbreaks of infection.

### 3.5 The dynamics of Anthrax incidence in 2021, 2022, 2023

Anthrax, caused by the spore-forming bacterium *Bacillus anthracis*, remains a significant zoonotic threat, particularly in regions where veterinary surveillance and public health infrastructure are limited. The disease primarily affects livestock such as cattle, sheep, and goats, with human infections arising from contact with infected animals, animal products, or through the consumption of contaminated meat. While relatively rare in humans, anthrax is associated with high fatality rates when untreated, especially in its inhalational and gastrointestinal forms [38].

As stated in the official database, in 2021 no positive cases were detected among the samples tested. However, in 2023, 10 positive results were registered, which may indicate an increase in the activity of the pathogen (Figure 26, 27).

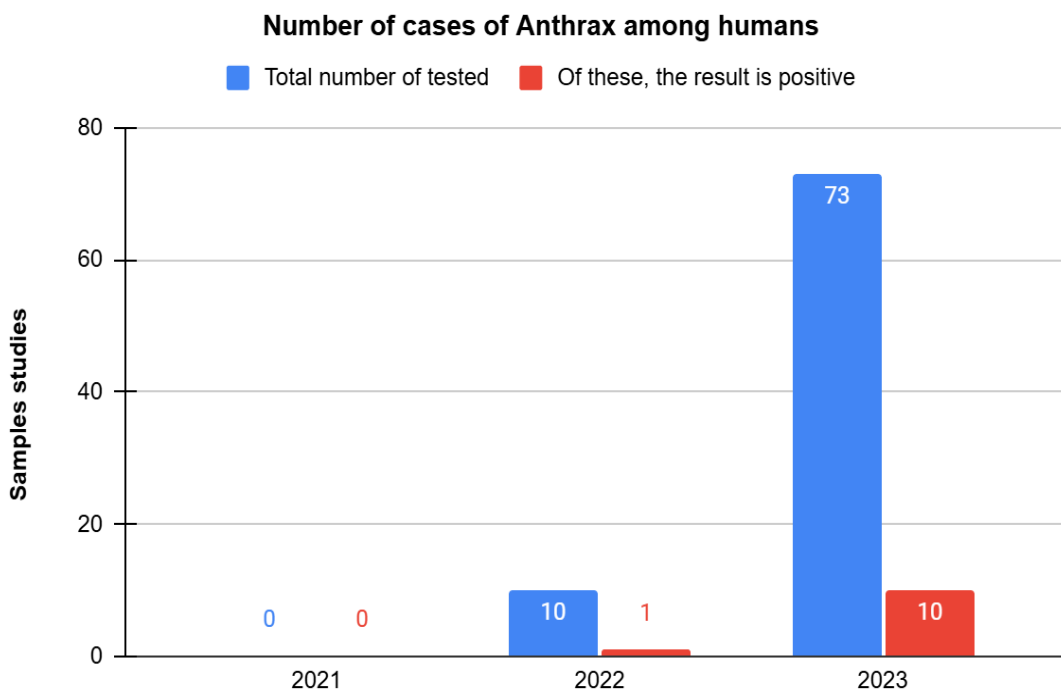


Figure 26 - Number of Anthrax Cases Among Humans in Akmola region by Year Based on Tested Samples.

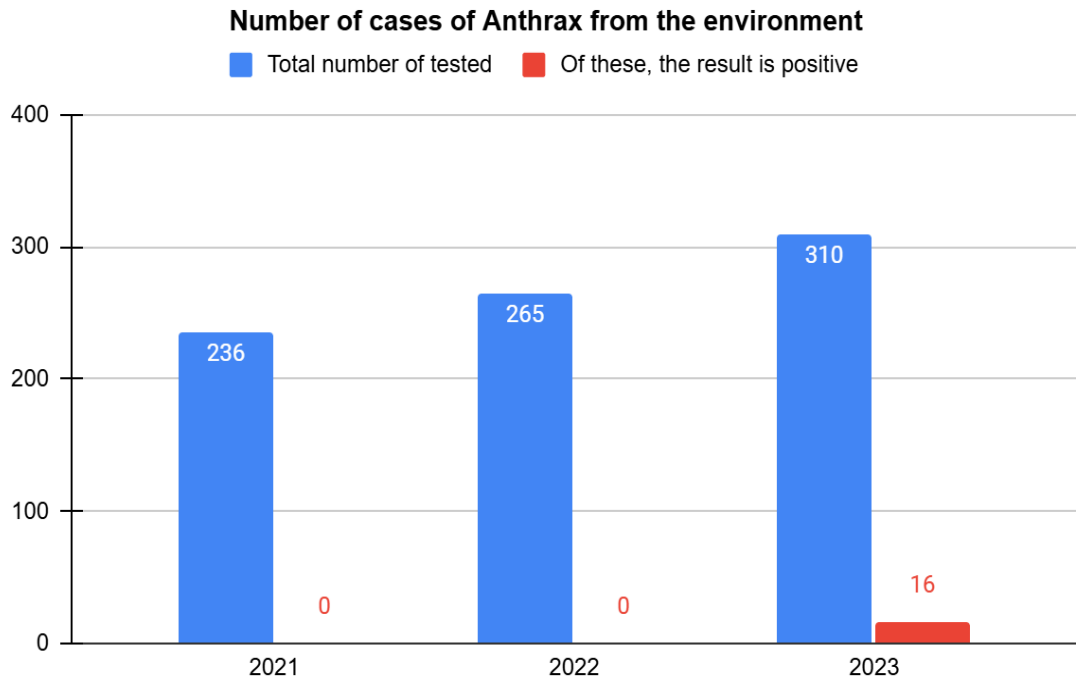
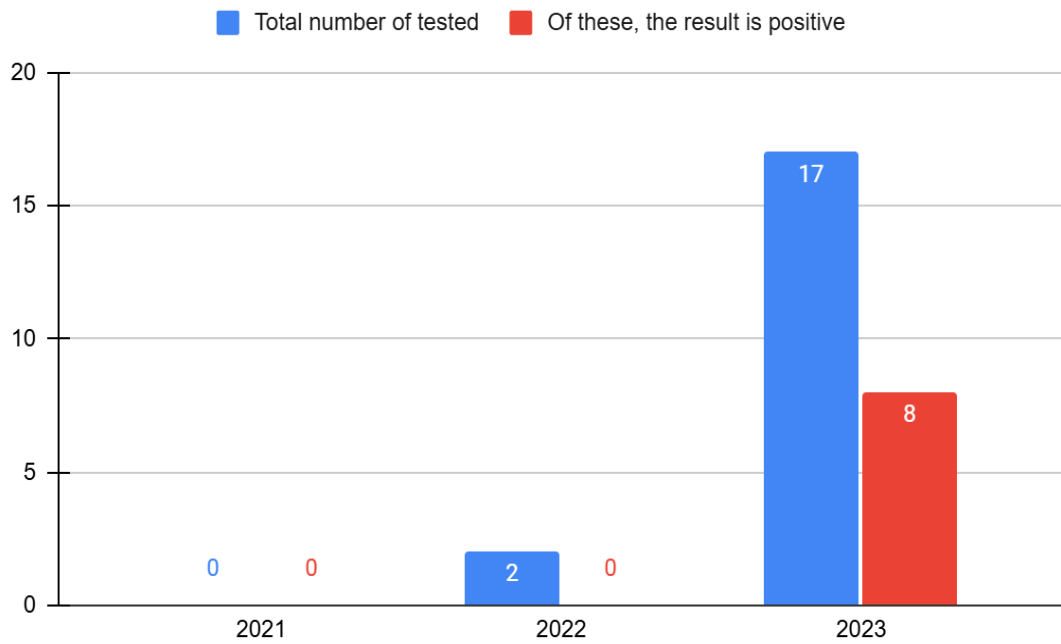


Figure 27 - Anthrax Levels in the Environment in Akmola region by Year Based on Tested Samples.

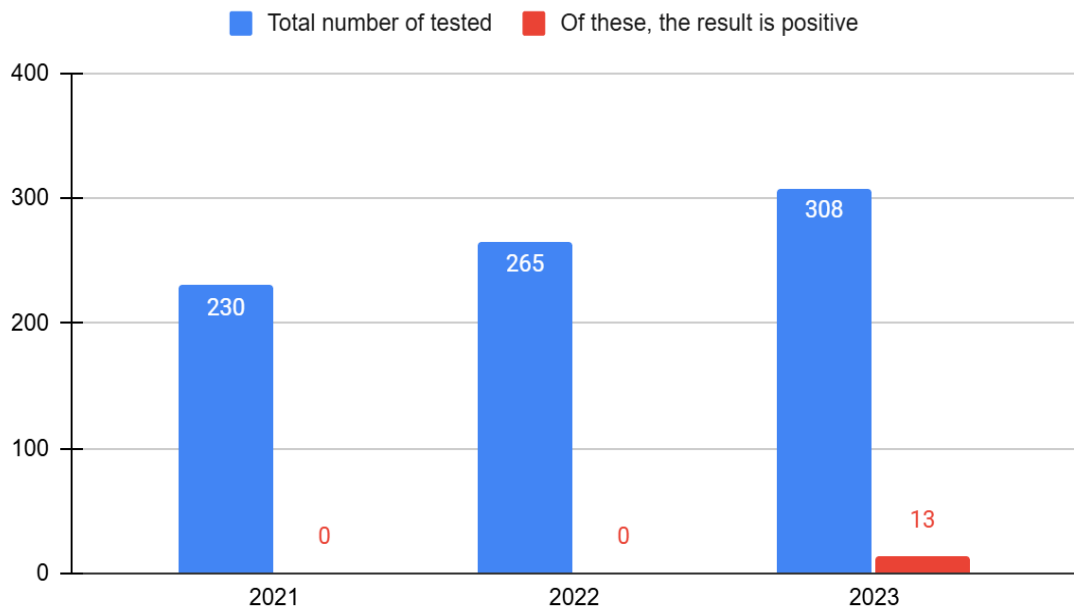
Bacteriological studies show that the pathogen was not detected in 2021 and 2022. In 2023, the testing volume increased significantly (18 samples), with 8 positive cases detected, indicating a possible worsening of the epidemiological situation (Figure 28, 29).

**Annual Number of Confirmed Human Anthrax Cases Identified Through Bacteriological Analysis**



**Figure 28 - Number of Anthrax Cases Among Humans in Ak-mola region by Year Based on Bacteriological Studies.**

**Annual Number of Confirmed Environment Anthrax Cases Identified Through Bacteriological Analysis**



**Figure 29 - Anthrax Level in the Environment in Ak-mola region by Year Based on Bacteriological Studies.**

Analysis of the dynamics of anthrax cases shows that in 2023, the number of positive bacteriological tests has increased, and the number of cases detected among the total number of samples tested has increased. This may indicate increased circulation of *Bacillus anthracis* in the region. To prevent further spread of the infection, enhanced veterinary control, monitoring of soil and farm animals, as well as strict surveillance of potential sources of infection are necessary.

## CONCLUSION

The results of this master's project demonstrate a comprehensive understanding of the long-term dynamics of HID in the Akmola region between 2021 and 2023. The analytical foundation of the project is based on epidemiological data obtained from the National Center for Sanitary and Epidemiological Expertise, the Ministry of Healthcare of Kazakhstan, regional epidemiological bulletins, and hospital records covering 2021 to 2023. The core database includes yearly incidence rates of HID, compiled from official and restricted-access health records. It consists of two primary components: (1) samples analyzed from human or environmental sources and (2) laboratory investigations. The laboratory testing methods used in this studied database include Bacteriological method, Biological method, Serological method and Genetic method. The study focuses on five major zoonotic diseases—brucellosis, listeriosis, tularemia, tick-borne encephalitis, and anthrax—and seeks to evaluate their trends, testing practices, and risk levels within the local population and environmental reservoirs. Statistical processing was performed using retrospective and descriptive methods in Microsoft Excel. The grouping of results allowed for cross-comparison and ranking of risk sources while identifying areas requiring improved disease control and prevention strategies.

The analysis of brucellosis data shows a clear downward trend across multiple diagnostic methods. In environmental samples, positivity rates decreased from 16.67% in 2021 (4 out of 24) to 7.69% in 2023 (2 out of 26). Bacteriological studies among humans revealed a drop from 4.54% in 2021 (1 out of 22) to 0% in 2023 (0 out of 49). However, in environmental bacteriological tests, positivity increased to 25% in 2023 (2 out of 8), compared to 0% in 2021. Serological testing in the population revealed a significant decline in positive cases—from 8.42% (367 out of 4361) in 2021 to 4.46% (266 out of 5963) in 2023. These results reflect a notable reduction in brucellosis prevalence due to preventive and sanitary measures, though pathogen circulation persists in the environment.

Listeriosis exhibited a contrasting trend. Bacteriological testing among humans yielded minimal positivity: 0% in both 2021 (0 out of 28) and 2023 (0 out of 154), and only 2 positive cases in 2022 (0.08% of 235). In contrast, serological results indicate growing infection rates, increasing from 3% in 2021 to 7.62% in 2023. This disparity underscores the low sensitivity of bacteriological diagnostics for *Listeria monocytogenes* and highlights the rising seroprevalence as a potential threat requiring attention in food safety policies.

Tularemia showed consistent decreases in infection rates. In 2021, 12 positive cases were detected from 72 tests (16.67%), decreasing to 14% in 2022 (7 out of 50), and to 11.94% in 2023 (16 out of 134). These patterns indicate a gradual decline in circulation of *Francisella tularensis*, likely due to effective environmental monitoring and control of wildlife vectors.

TBE incidence remained stable at 6 cases in both 2021 (6 out of 87, 6.90%) and 2022 (6 out of 178, 3.37%), followed by a decrease to 4 cases in 2023 (1.74% of

230 tests). This suggests progress in public education, vector control, and possibly a decrease in tick-host interactions in high-risk months.

Anthrax cases were absent in 2021 and 2022 but rose to 10 positive results in 2023, as identified from environmental samples. Additionally, bacteriological tests confirmed 8 positive findings out of 18 samples in 2023. These results signal a resurgence in *Bacillus anthracis* activity and the importance of enhanced environmental surveillance and vaccination in risk zones.

The study achieved its core objectives by analyzing trends in incidence, identifying contributing factors, and offering well-grounded recommendations for improving surveillance, diagnostics, and public health interventions. The research fully addressed all the stated objectives. A thorough review of international best practices provided a global context for understanding HID, and the comparison highlighted the strengths and gaps in Kazakhstan's current systems. The integration of retrospective epidemiological analysis, laboratory testing (bacteriological, serological, biological, genetic), and the use of regional health databases allowed for detailed tracking of disease prevalence and spread. Additionally, the research proposed practical and evidence-based strategies to enhance disease control in the region.

Building on this work, several recommendations were formulated to guide the implementation of improved HID prevention and response strategies. These include the expansion of geographic information systems for real-time outbreak tracking, deployment of automated PCR diagnostics, and incorporation of artificial intelligence for rapid, accurate analysis. The project also proposes increasing public health education and outreach and calls for improved coordination with global systems such as ProMED. In terms of environmental surveillance, systematic monitoring of zoonotic vectors like rodents and ticks must be intensified to mitigate re-emergence risks.

From a scientific and practical standpoint, this project contributes meaningfully to the field of public health in Kazakhstan. It provides an original assessment of HID dynamics in Akmola region using multi-source data and laboratory diagnostics. Unlike many studies focused on national trends, this research offers granular regional insights that are crucial for tailored policymaking. Compared to international benchmarks, the methodology used aligns with modern surveillance and analytical frameworks adopted by organizations such as WHO and ECDC. Thus, the level of this work is consistent with the best practices observed in global public health research.

In conclusion, this master's project fills an important gap in the understanding of HID epidemiology in Akmola and presents actionable strategies to strengthen the region's public health infrastructure. As HID remain a persistent global and regional threat, the findings of this study are timely, relevant, and critical for shaping more resilient and responsive healthcare systems. Future research should focus on expanding the temporal range of observation to 5–10 years and incorporating more advanced digital health tools, enabling Kazakhstan to take a leading role in regional infectious disease prevention and control.

## FINDINGS

The analysis of HID in the Akmola region from 2021 to 2023 revealed the following key findings:

1. Highly dangerous diseases remain a serious global health problem, with prevalence varying by region. To improve global monitoring and prevention, it is important to introduce innovative technologies for early diagnosis (such as GeneXpert), structured treatment programs, geographic information systems, mobile laboratories, PCR diagnostics and artificial intelligence, ensuring rapid response.

2. The latest trends in the field of highly dangerous infectious diseases in the Akmola region show noticeable improvements in the reduction of the following infections: brucellosis from 16.67% in 2021 to 7.69% in 2023, from 0% in the number of cases among people; listeriosis shows an increase in a serological study from 3% in 2021 to 7.62% in 2023, despite low results in a bacterial study; tularemia cases decreased from 16.67% in 2021 to 11.94% in 2023; Tick-borne encephalitis (TBE) remained stable and the number of cases decreased slightly in 2023; anthrax, previously absent, re-emerged in 2023, highlighting the need for stricter environmental surveillance.

3. To improve disease control in Akmola region, it is critical to strengthen surveillance systems using geographic information systems for outbreak mapping and automated PCR diagnostics for rapid on-site detection. Public education should focus on hygiene, vaccination, and zoonotic disease prevention, adapted to local languages and context.

4. Digital health tools and mobile apps that are effective in tracking symptoms and raising awareness of outbreaks in real time should strengthen Akmola region's capacity for disease monitoring, prevention, and control.

5. Integrating artificial intelligence into healthcare diagnostics can improve early and accurate detection of infectious diseases. Participation of authorized bodies in global alert systems such as Program for Monitoring Emerging Diseases facilitates early warning of infectious threats and rapid response by local health authorities.

## **PRACTICAL RECOMMENDATIONS**

To effectively mitigate the risks of HID in the Akmola region, several practical measures should be implemented.

### **I. Strengthening disease surveillance and early detection, including areas for application:**

#### *Geographic information systems:*

Implement GIS technology to improve disease surveillance by mapping outbreaks and predicting the spread of infectious diseases.

GIS tracks and visualizes human and animal health data, enabling targeted interventions.

Identifying areas and territories at higher risk of zoonotic disease outbreaks will enable health authorities to allocate resources more effectively.

GIS is critical for monitoring, providing spatial analysis that improves control measures.

#### *Automated PCR diagnostics:*

Automated PCR tools can identify pathogens in real time, helping to reduce response delays and provide accurate results.

#### *AI-based diagnostics:*

Integrating AI-based diagnostic tools into local health systems can significantly improve the speed and accuracy of diagnosis. For diseases such as tuberculosis and brucellosis, AI can analyze medical images, PCR results, and patient data to ensure early and accurate diagnosis.

AI tools have proven effective in improving diagnostic accuracy in global health systems.

### **II. Public Health Education and Outreach Organizations**

#### *Localized Education Programs:*

Launch targeted educational organizations focused on good hygiene practices, zoonotic disease prevention, and the importance of vaccination.

Materials should be adapted to the local context, including language, cultural norms, and specific regional health risks.

#### **Digital Health Solutions:**

Use mobile health (mHealth) applications to raise awareness of disease outbreaks, track symptoms, and guide preventive measures.

Real-time alerts for diseases such as brucellosis, tuberculosis, and tick-borne encephalitis can be sent to local populations, encouraging them to take appropriate action.

Digital tools can also provide information on vaccination schedules and health services, enabling greater community engagement.

### **III. Vaccination Programs for Zoonotic Diseases**

#### *Brucellosis Vaccination:*

Brucellosis, a zoonotic disease that affects both humans and livestock, can be controlled through animal vaccination.

Implementation of livestock vaccination programs, especially for cattle, sheep and goats, with vaccines such as RB51 (for cattle) and Rev-1 (for sheep and goats), is critical.

Vaccination of livestock reduces the risk of transmission of the virus to humans and is an effective strategy for controlling brucellosis outbreaks.

#### *Tuberculosis Control through Vaccination and Early Diagnosis:*

Tuberculosis, another major problem in Akmola, can be mitigated using the BCG vaccine in high-risk groups. Along with vaccination, early diagnosis using tools such as GeneXpert can lead to faster initiation of treatment.

GeneXpert is particularly valuable in regions with limited laboratory infrastructure, as it provides rapid results and supports more timely interventions.

### **IV. Implementation of ProMED and Global Health Networks**

#### *Integration of ProMED:*

Akmola can benefit from participation in ProMED, a global surveillance system that tracks and reports emerging infectious diseases.

ProMED provides early warning of outbreaks, giving local authorities valuable time to respond.

The system has proven effective in detecting diseases such as avian influenza and new strains of brucellosis.

By integrating ProMED into the regional health infrastructure, Akmola will help receive timely updates on infectious disease trends and prepare accordingly.

### **V. Improving Environmental Surveillance and Vector Control**

#### *Environmental Monitoring for Disease Detection:*

Strengthening environmental surveillance, especially for diseases such as anthrax, tularemia, and tick-borne encephalitis, will help track pathogens in wildlife and the environment.

This includes routine testing of animal and environmental samples to detect early signs of disease spread.

Akmola, with its vast agricultural landscape, can focus on monitoring water sources, animal populations, and vector control to reduce the risk of disease transmission.

Evidence from previous outbreaks has shown that environmental monitoring plays a key role in preventing diseases such as anthrax.

## LIST OF REFERENCES

1. Сибирская язва в Акмолинской области: пятеро человек госпитализированы [Электронный ресурс] // Zakon.kz. – 2019. – URL: <https://www.zakon.kz/proisshestviia/4982031-sibirskaya-yazva-v-akmolinskoy-oblasti.html>
2. Листерия – опасное инфекционное заболевание [Электронный ресурс] // Департамент санитарно-эпидемиологического контроля по Атырауской области. – 2023. – URL: <https://www.gov.kz/memleket/entities/departament-kkbtu-atyrau/press/article/details/135277>
3. Akhmetov I.K., Abdullina G.R., Sharipova G.R. Особо опасные инфекции: современные подходы к эпидемиологическому надзору и профилактике // Эпидемиология и Вакцинопрофилактика. – 2023. – Т. 22, № 2. – URL: <https://epidemiology-journal.ru/en/archive/article/41495>
4. World Health Organization. International Health Regulations. 3rd ed. Geneva: WHO; 2016. – 75 p. – URL: <https://iris.who.int/bitstream/handle/10665/246107/9789241580496-eng.pdf>
5. Особо опасные инфекции. Учебный курс [Электронный ресурс]. – URL: [https://www.feldsher.ru/obuchenie/kurs/kurs.php?COURSE\\_ID=7&CHAPTER\\_ID=0418&LESSON\\_PATH=394.418](https://www.feldsher.ru/obuchenie/kurs/kurs.php?COURSE_ID=7&CHAPTER_ID=0418&LESSON_PATH=394.418)
6. Public health emergencies and IHR emergency committees. WHO [Электронный ресурс]. – URL: <https://www.who.int/news-room/questions-and-answers/item/emergencies-international-health-regulations-and-emergency-committees#:~:text=A%20PHEIC%20is%20defined%20in...>
7. Особо опасная инфекция // Википедия [Электронный ресурс]. – URL: [https://ru.wikipedia.org/wiki/%D0%9E%D1%81%D0%BE%D0%B1%D0%BE\\_%D0%BE%D0%BF%D0%B0%D1%81%D0%BD%D0%B0%D1%8F\\_%D0%B8%D0%BD%D1%84%D0%B5%D0%BA%D1%86%D0%B8%D1%8F](https://ru.wikipedia.org/wiki/%D0%9E%D1%81%D0%BE%D0%B1%D0%BE_%D0%BE%D0%BF%D0%B0%D1%81%D0%BD%D0%B0%D1%8F_%D0%B8%D0%BD%D1%84%D0%B5%D0%BA%D1%86%D0%B8%D1%8F)
8. Population Dynamics and Infectious Diseases in Asia // ResearchGate [Электронный ресурс]. – URL: [https://www.researchgate.net/publication/235950011\\_Population\\_Dynamics\\_and\\_Infectious\\_Diseases\\_in\\_Asia](https://www.researchgate.net/publication/235950011_Population_Dynamics_and_Infectious_Diseases_in_Asia)
9. Приказ Министра здравоохранения Республики Казахстан от 14 октября 2009 года № 526. Зарегистрирован в Министерстве юстиции Республики Казахстан 5 ноября 2009 года № 5847. [Электронный ресурс]. – URL: <https://adilet.zan.kz/rus/docs/V090005847>
10. Национальный научный центр особо опасных инфекций имени М. Айкимбаева [Электронный ресурс]. – URL: <https://nscedi.kz/ru/rukovodstvo/>
11. Природные очаги каких особо опасных инфекций имеются в Казахстане // Inform.kz [Электронный ресурс]. – URL: [https://www.inform.kz/ru/prirodnye-ochagi-kakih-osobo-opasnyh-infekciy-imeyutsya-v-kazahstane\\_a4048735](https://www.inform.kz/ru/prirodnye-ochagi-kakih-osobo-opasnyh-infekciy-imeyutsya-v-kazahstane_a4048735)
12. ECDC. Tularemia. Annual Epidemiological Report for 2019. – Stockholm: European Centre for Disease Prevention and Control, 2021. – 12 p. – [Электронный ресурс]


- ресурс]. – Режим доступа: <https://www.ecdc.europa.eu/sites/default/files/documents/AER-tularaemia-2019.pdf>
13. Systematic Review: Clinical Features, Antimicrobial Treatment, and Outcomes of Human Tularemia, 1993–2023. <https://doi.org/10.1093/cid/ciad736>
14. Alsubaie M.S., Almutairi M.M., Almuzaini A.M. An Epidemiological Study of Brucellosis in Different Animal Species from the Al-Qassim Region, Saudi Arabia // *Veterinary World*. – 2023. – Vol. 16, No. 2. – P. 345–351.
15. Laine, C. G., Johnson, V. E., Scott, H., & Arenas-Gamboa, A. M. (2023). Global Estimate of Human Brucellosis Incidence. *Emerging Infectious Diseases*, 29(9), 1789-1797. <https://doi.org/10.3201/eid2909.230052>.
16. Food and Agriculture Organization of the United Nations (FAO). Brucellosis in Humans and Animals. – [Электронный ресурс]. – URL: <https://www.fao.org/4/a0083e/a0083e0a.htm>
17. Всемирная организация здравоохранения. Tick-borne encephalitis. Vaccine standardization. [Электронный ресурс]. — URL: <https://www.who.int/teams/health-product-policy-and-standards/standards-and-specifications/norms-and-standards/vaccine-standardization/tick-borne-encephalitis>
18. Centers for Disease Control and Prevention (CDC). Tick-borne encephalitis. Travel-associated infections and diseases. [Электронный ресурс]. — URL: <https://www.cdc.gov/yellow-book/hcp/travel-associated-infections-diseases/tick-borne-encephalitis.html>
19. Di Bari C., Fastl C., Devleeschauwer B. Global burden of anthrax: a systematic review // *Population Medicine*. – 2023. – Vol. 5, Supplement. – Article A262. – [Электронный ресурс]. – URL: <https://www.populationmedicine.eu/Global-burden-of-anthrax-a-systematic-review,163760,0,2.html>
20. European Centre for Disease Prevention and Control (ECDC). *Listeriosis*. In: *ECDC. Annual Epidemiological Report for 2022*. Stockholm: ECDC; 2024. – [Электронный ресурс]. – URL: [https://www.ecdc.europa.eu/sites/default/files/documents/LIST\\_AER\\_2022\\_Report.pdf](https://www.ecdc.europa.eu/sites/default/files/documents/LIST_AER_2022_Report.pdf)
21. Centers for Disease Control and Prevention (CDC). Listeria (Listeriosis) – About Listeria. CDC; 2024. [Электронный ресурс]. – URL: <https://www.cdc.gov/listeria/about/index.html#:~:text=Quick%20facts,people%20die%20from%20the%20infection>.
22. Pharmaceutical Technology. ESCMID 2024: Using AI in infection prevention and control. [Электронный ресурс]. — URL: <https://www.pharmaceutical-technology.com/analyst-comment/escmid-2024-using-ai-in-infection-prevention-and-control/>
23. Biu P.W., Nwasike C.N., Tula O.A., Ezeigweneme C.A., Gidiagba J.O. A review of GIS applications in public health surveillance // *World Journal of Advanced Research and Reviews*. – 2024. – Vol. 21, No. 1. – P. 30–39. – DOI: 10.30574/wjarr.2024.21.1.2684. – [Электронный ресурс]. – URL: [https://www.researchgate.net/publication/377265989\\_A\\_review\\_of\\_GIS\\_applications\\_in\\_public\\_health\\_surveillance](https://www.researchgate.net/publication/377265989_A_review_of_GIS_applications_in_public_health_surveillance)

24. Analysis and prediction of infectious diseases based on spatial visualization and machine learning // Scientific Reports [Электронный ресурс]. – URL: <https://www.nature.com/articles/s41598-024-80058-1>
25. Coronavirus Researchers Are Using High-Tech Methods to Predict Where the Virus Might Go Next // TIME [Электронный ресурс]. – URL: <https://time.com/5780683/coronavirus-ai/>
26. Murad, A.; Khashoggi, B.F. Using GIS for Disease Mapping and Clustering in Jeddah, Saudi Arabia // ISPRS International Journal of Geo-Information. – 2020. – Vol. 9, Issue 5. – Article 328. – DOI: <https://doi.org/10.3390/ijgi9050328>
27. Tjaden N., Geeraedts F., Kioko C.K., Riezebos-Brilman A., al Naiemi N., Blanford J., Beerlage-de Jong N. The power of interactive maps for communicating spatio-temporal data to health professionals // Geospatial Health [Электронный ресурс]. – 2024. – Vol. 19, No. 2. – DOI: 10.4081/gh.2024.1296
28. Косенов А. Бруцеллез подтвердился у двух жителей Акмолинской области. Tengrinews.kz; 30 мая 2014. [Электронный ресурс]. — URL: <https://tengrinews.kz/events/brutsellez-podtverdilsya-u-dvuh-jiteley-akmolinskoy-oblasti-256208/#:~:text=,%D0%B3%D0%BE%D0%B2%D0%BE%D1%80%D0%B8%D1%82%D1%81%CC%8C%D1%8F%20%D0%B2>
29. Косенов А. Акмолинские сельчане, заразившиеся бруцеллезом, требуют дезинфекции аула. Zakon.kz; 22 февраля 2018. [Электронный ресурс]. — URL: <https://www.zakon.kz/proisshestiia/4905242-akmolinskie-selchane-zarazivshiesya.html>
30. В селе Ушкарасу сибирской язвой заразились 10 человек. Khabar.kz; 31 августа 2023. [Электронный ресурс]. — URL: <https://khabar.kz/ru/news/obshchestvo/152399-v-sele-ushkarasu-sibirskoj-yazvoj-zarazilis-10-chelovek>
31. Два случая клещевого энцефалита зарегистрировано в Акмолинской области. Kazinform; 2023. [Электронный ресурс]. — URL: <https://www.inform.kz/ru/dva-sluchaya-kleshevogo-entsefalita-zaregistrovano-v-akmolinskoy-oblasti-316eb0>
32. Случай клещевого энцефалита зарегистрировали в Акмолинской области. Tengrinews.kz; 2024. [Электронный ресурс]. — URL: [https://tengrinews.kz/kazakhstan\\_news/sluchay-kleshevogo-entsefalita-zaregistrovali-akmolinskoy-537758](https://tengrinews.kz/kazakhstan_news/sluchay-kleshevogo-entsefalita-zaregistrovali-akmolinskoy-537758)
33. Listeria found in poultry meat at a Kazakh poultry farm. Kaztag.kz; 2024. [Electronic resource]. — URL: <https://kaztag.kz/en/news/listerii-obnaruzhili-v-myase-ptitsy-kazakhstanskoy-ptitsefabriki>
34. Brucellosis // World Health Organization (WHO) [Электронный ресурс]. — URL: <https://www.who.int/news-room/fact-sheets/detail/brucellosis>
35. Listeriosis (Listeria Infection): Causes, Symptoms & Treatment // Cleveland Clinic [Электронный ресурс]. — URL: <https://my.clevelandclinic.org/health/diseases/17721-listeriosis>

36. Tularemia // Centers for Disease Control and Prevention (CDC) [Электронный ресурс]. – URL: <https://www.cdc.gov/tularemia/about/index.html>
37. Tick-borne encephalitis (TBE) // NHS [Электронный ресурс]. – URL: <https://www.nhs.uk/conditions/tick-borne-encephalitis/>
38. Anthrax // Centers for Disease Control and Prevention (CDC) [Электронный ресурс]. – URL: <https://www.cdc.gov/anthrax/about/index.html>

## APPENDIX A

Conclusion on permission to conduct a study of the local ethics committee at Department of Public Health and Epidemiology of the NpJSC "Astana Medical University" protocol No. 9 dated 11.03.2025.



**«АСТАНА МЕДИЦИНА УНИВЕРСИТЕТИ» КеАҚ**  
Локальды Биоэтикалық комитет

**Решение ЛКБ НАО МУА №9**

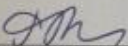
Внеочередное заседание № 4 Дата 11.03.2025 г.


Название протокола: Assessment of long-term dynamics of highly infectious disease in Akmola region/ Оценка многолетней динамики особо опасных инфекций в Акмолинской области					
Основной исследователь:		Онгарбек Аружан Ермаккызы, магистрант профильной магистратуры по специальности «Биологическая безопасность» НАО «Медицинский университет Астана»			
НАО «Медицинский университет Астана»					
Рассмотренные элементы		Приложены <input checked="" type="checkbox"/>	Не приложены		
Первичное рассмотрение					
Решение:		Одобрено			
№.	Голосование членов ЛЭК	решение			
		О	Рек	ПР	НР
1	Рахметова Венера Саметовна	√			
2	Камалбекова Гульнара Маратовна	√			
3	Жусупова Гульзира Кенжесевна	√			
4	Дербисалина Гульмира Аждадиновна	√			
5	Фурсов Роман Александрович	√			
6	Мукатова Ирина Юрьевна	√			
7	Базарова Анна Викентьевна				
8	Сливкина Наталья Владимировна	√			
9	Жусупова Гульнара Даргеровна	√			
10	Базарова Гульмира Сейловна	√			
11	Курмалаев Азамат Сайнович				
12	Долгов Алексей Алексеевич				
13	Шукирбекова Алма Боранбековна	√			
14	Мулдахметов Мейрам Сейтжанович	√			
15	Бураев Галымжан Бауыржанович	√			
16	Шарапатов Ержан Ақілдаулы	√			
17	Зулхажы Айгул Зулхажыевна	√			
18	Мажитова Жанна Сабитбековна	√			
19	Байғалиева Бахыт Мадениетовна	√			

Примечание: О - Одобрено; Рек - Одобрено с рекомендациями; ПР- Повторное рассмотрение; НР - Не рекомендовано

**Принятое решение:**  
Одобрить проведение исследования.

**Подпись:**

  
 \_\_\_\_\_  
 Председатель ЛКБ НАО МУА  
 д.м.н., проф. Рахметова В.С.

  
 \_\_\_\_\_  
 Секретарь ЛКБ НАО МУА  
 Оуезханова Г.Н.

## APPENDIX B

**ИНТЕРНАУКА**  
internauka.org

# СЕРТИФИКАТ участника

CDII Международной научно-практической конференции  
«Молодой исследователь: вызовы и перспективы»

Настоящий сертификат подтверждает участие в конференции  
и публикацию статьи в электронном сборнике трудов

***Onggarbek Aruzhan Ermekkyzy***

«ASSESSMENT OF LONG-TERM DYNAMICS OF HIGHLY INFECTIOUS  
DISEASE IN AKMOLA REGION»

Научный руководитель  
***Tashmetov Kasymzhan Kalizhanovich***

Генеральный директор  
Издательство «Интернаука»



И.С. Степанов



21.04.2025  
Москва

# APPENDIX C

Screenshots of the data provided for the study from Ministry of Healthcare of Kazakhstan, regional epidemiological bulletins, and hospital records covering 2021 to 2023

## 1. Database on Highly infectious diseases in 2021.

The screenshot shows an Excel spreadsheet with the following structure:

- Table 4. Laboratory control for highly infectious diseases in the Akmola region in 2021 (total)**
  - Investigation type:** Бактериологические исследования (Bacteriological investigations)
  - Columns:** Disease name, Total, Positive, Negative, and various percentages.
  - Rows:** Brucellosis, Salmonella spp., Typhoid fever, Cholera, Hepatitis, Poliovirus, Listeria, Pasteurella, Legionella, Enterococcus, E. coli, Borrelia, KKLZ, BKZ, BLK, BOK.
- Table 4. Laboratory control for highly infectious diseases in the Akmola region in 2021 (by district)**
  - Investigation type:** Серологические исследования (Serological investigations)
  - Columns:** Same as the first table.
  - Rows:** Same as the first table.

## 2. Database on Highly infectious diseases in 2022.

The screenshot shows an Excel spreadsheet with the following structure:

- Table 4. Laboratory control for highly infectious diseases in the Akmola region in 2022 (total)**
  - Investigation type:** Бактериологические исследования (Bacteriological investigations)
  - Columns:** Disease name, Total, Positive, Negative, and various percentages.
  - Rows:** Brucellosis, Salmonella spp., Typhoid fever, Cholera, Hepatitis, Poliovirus, Listeria, Pasteurella, Legionella, Enterococcus, E. coli, Borrelia, KKLZ, BKZ, BLK, BOK.
- Table 4. Laboratory control for highly infectious diseases in the Akmola region in 2022 (by district)**
  - Investigation type:** Серологические исследования (Serological investigations)
  - Columns:** Same as the first table.
  - Rows:** Same as the first table.

