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PARASITIC DISEASES IN CHILDREN

Monograph

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This monograph presents information related to improving the system for combating parasitic diseases among children based on the example of the Samarkand region within the framework of the program on epidemiology, microbiology, infectious and parasitic diseases. The monograph contains not only data on these scientific topics but also conclusions of modern scientific research based on scientific studies. It is recommended to use this monograph as an additional source of information for doctors and students during practical and lecture sessions on epidemiology, microbiology, infectious and parasitic diseases.

The author shares the results of her research, which may be of interest to doctors of relevant specialties – pediatricians, infectious disease specialists, microbiologists, and rehabilitologists – as well as for use in the activities of medical polyclinics and healthcare institutions.

The monograph was approved and recommended for publication by the Scientific Council of Samarkand State Medical University by protocol No. ___ dated “__” _____ 2026.

CONTENTS

LIST OF SYMBOLS AND TERMS

AlAT – Alanine aminotransferase

AsAT – Aspartate aminotransferase

AT – Antibody

WHO – World Health Organization

PHC – Primary Health Care Institution

ELISA – Enzyme-Linked Immunosorbent Assay

CIS – Commonwealth of Independent States

PPE – Preschool Educational Institution

AIDS – Acquired Immunodeficiency Syndrome

PCR – Polymerase Chain Reaction

MH – Ministry of Health

ESR – Erythrocyte Sedimentation Rate

IgM – Immunoglobulins of class M

IgG – Immunoglobulins of class G

IgE – Immunoglobulins of class E

PHCIs – Primary Health Care Institution

INTRODUCTION

Parasitic diseases are widespread throughout the world and are considered one of the urgent problems in the field of the healthcare system.
According to the data of the World Health Organization, "...almost five billion people of the world's population are infected with parasitic diseases."[1]
Parasitic diseases are considered common not only in developing countries or those with poor sanitation and medical systems, but at present, cases of these diseases are also being frequently recorded in developed countries.
Furthermore, the diagnosis, effective treatment, and determination of the epidemiological characteristics of these diseases are considered important issues.
It has been recognized that, regardless of the region, the main risk group for these diseases consists of school-aged and adolescent children.
In some countries considered endemic regions, the preventive use of antihelminthic drugs among these groups is part of national policy.
In this regard, improving the system of combating parasitic diseases in children, developing modern methods for the early diagnosis of parasitic diseases, and improving treatment and preventive measures remain priority directions of practical medicine.

Across the world, a number of scientific studies are being carried out in order to achieve high effectiveness of measures aimed at improving the quality of medical services provided to patients with parasitic diseases.
In this context, identifying the sources and causes of infection and transmission of parasitic diseases to humans; determining the nosological structure of parasitic diseases; substantiating the influence of parasitic diseases on the human body; improving preventive measures among the population, especially among organized communities; conducting mass deworming among the

population and evaluating its effectiveness; improving measures for the early diagnosis, prevention, and epidemiological control of the disease — all of these are of particular significance.
In our country, special attention is paid to developing the provision of medical services and adapting them to the requirements of world standards, as well as to research aimed at improving the application of modern technologies in the diagnosis, treatment, and prevention of infectious diseases, including parasitic diseases.

World Health Organization. Report of the third global meeting of the partners for parasite control. Deworming for Health and Development Geneva, 29–30 November 2020.

In this regard, tasks such as "…improving state management in the healthcare system, transforming the primary level into a system that detects and treats diseases at an early stage, accelerating the process of digitalization, determining the near- and long-term prospects of the sector's development, increasing the volume and fundamentally improving the quality of medical services, supporting competition and the private sector, enhancing the knowledge of medical workers, and developing education and science"[2] have been defined. Based on this, identifying the leading risk factors that contribute to the spread of parasitic diseases among children and improving the system of combating parasitic diseases are of particular importance.

In many countries of the world, the level of morbidity from parasitic diseases remains high, and therefore they continue to be an urgent problem in the pathology of infectious diseases (Osipova S.O., 2021).
The prevalence and degree of infection of parasitic diseases are indicators of the climatic and living conditions of society (Kumar et al., 2014).

The World Health Organization recommends conducting mass deworming among children living in endemic regions to prevent soil-transmitted helminths (A. Montresor et al., 2015).
Before carrying out mass deworming, it is necessary to determine the helminth species that are widespread in the given area, to identify the resistance of these helminths to medications, to determine among which layers of the population they are widely spread, and to identify the factors influencing the prevalence and degree of infection of helminths (P. Hotez et al., 2016).

The factors influencing the prevalence and degree of infection of parasitic diseases include demographic processes; the host/parasite genome affecting the parasite's adaptation to the host organism; the host organism's immunity; the virulence of the parasite; environmental conditions; and the distribution of the parasite (Ulrich and Schmid-Hempel, 2015).
In mass deworming, if personal hygiene rules are not followed, it does not affect the spread of helminthiases (D.A. Bundy et al., 2009; Khanum et al., 2010; A. Duflo et al., 2016).

[2] Resolution of the President of the Republic of Uzbekistan No. PQ-5124 dated May 25, 2021, "On Additional Measures for the Comprehensive Development of the Healthcare Sector."

In the Republic of Uzbekistan as well, in recent years, mass deworming has been widely introduced among school students and pupils of preschool educational institutions.

Nevertheless, nearly 300,000 new cases are registered in the country every year (Akhmedova M.D. et al., 2020).

For this reason, conducting scientific research aimed at identifying the factors influencing the prevalence of parasitic diseases and improving mass deworming is of great relevance in the Republic of Uzbekistan.

CHAPTER I. REVIEW OF LITERATURE. EPIDEMIOLOGICAL ANALYSIS OF THE DYNAMICS AND NOSOLOGICAL STRUCTURE OF PARASITIC DISEASES WORLDWIDE

§1.1. The Degree of Study of Factors Affecting the Level of Parasitic Disease Infection

At present, helminthiases have been recorded among people living in all climatic regions of the world; they even occur beyond the Arctic Circle (Kol Half Island, Taimyr, Yamal). The highest incidence of infection corresponds to countries located south of the Sahara in Africa, as well as to countries in Western and Eastern Asia [Kim B.J., Song K.S., 2014].

The life activities of helminths are very diverse, but their main stages depend on general living conditions. Accordingly, the diseases caused by helminths are classified as geohelminthiases, biohelminthiases, and contact helminthiases [Abdiev T.A., Suvonkulov U.T., 2016; Abdiev T.A., Saidakhmedova D.B., 2016; Abdiev F.T., Makhmudova L.B., 2010; Arzybaev M.A., Isaev M.A., 2015; Vakhobov T.A., Saidakhmedova D.B., 2013; Glamazdin I.I., Arkhipov I.A., 2013; Davis N.A., Belotserkovets V.G., 2015; Talabov M.S., 2012; Abdel Hamid M.M., Eljack I.A., 2015; Croke K., 2014].

Globally, approximately 2 billion people are infected with soil-transmitted helminthiases, i.e., geohelminthiases, which accounts for 24.0% of the world’s population. Such infections are widespread in tropical and subtropical countries, including the southern part of Africa considered the Sahara, as well as in countries in the Americas, China, and East Asia [Arkhipov I.A., Glamazdin I.I., 2014; Aslanova M.M., 2017; Tadzhiev B.M., Daminova M.N., 2019; Bethony J., Brooker S., 2006; Bundy D.A.P., Kremer M., 2009; Faria C.P., Zanini G.M., 2017; Healthcare Triage, 2015; Kruger M., Badenhorst C.J., 1996].

Human helminths are a group of parasites whose impact is felt most strongly by the poorest individuals in the world. According to global estimates, approximately 1.5 billion people are infected with at least one nematode [Aslanova M.M., Kuznetsova K.Yu., 2016; Sanad M.M., Al-Furaeihi L.M., 2006].

Similarly, the number of people infected with schistosomiasis and onchocerciasis worldwide is approximately 250 million and 30 million, respectively [Kosik-Bogacka D.I., Baranowska-Bosiacka I., 2010].

The prevalence of helminthiases among the population is influenced by environmental, socio-economic factors, customs, and the level of urbanization [Begaidarova R.Kh., Kultanov Zh., 2014; Varlamova A.I., Arkhipov I.A., 2017; Arkhipov I.A., Khalikov S.S., 2019; Gitsu G.A., Dudarev V.G., 2017; Daminova M.N., Rasulova Z.D., 2020; Dzhuraeva D.M., 2021; Sevbo D.P., Trusov S.N., 2010].

Approximately 67 million preschool-aged children and 568 million school-aged children live in regions with high levels of parasitic infection and are in need of treatment against parasites.

In foreign countries, helminthiases are most frequently recorded in countries located between 45 degrees north and south of the equator, including Algeria, Egypt, Italy, Spain, India, Romania, southern states of the USA, Argentina, and others. Analysis of published scientific studies shows that helminthiases are rarely recorded among the populations of France, Poland, Austria, the Czech Republic, and Slovakia [Dzhuraeva Z.B., 2017; Drachkov A.A., Lobanov Yu.F., 2018; Dudarev V.G., 2017; Ermakova L.A., Tverdokhlebova T.I., 2015;

Hicks J.H., Kremer M., 2015; Hotez P.J., Molyneux D.H., 2007; Jourdan P.M., Montresor A., 2017; Kabatereine N., Tukahebwa E., 2001; Koroma M.M., Williams R.A., 1996; Kremer M., Glennerster R., 2011; Kremer M., Holla A., 2009; Mettrick D.F., Jackson D.J., 1979; Miazek N., Michaels I., 2015; Miguel E., Kremer M., 2004].

In the Russian Federation, in 2005, 693 patients with helminthiases were identified, including 369 children under 14 years of age; the incidence rate per 100,000 population was 0.5, and for children under 14 it was 1.7. In 2006, 654 patients with helminthiases were recorded, including 384 children under 14, and the incidence rate increased from 0.5 to 1.8.

In the Southern Federal District, the highest incidence rates per 100,000 population were: Chechen Republic (18.9), Republic of Dagestan (6.3), Volgograd Region (1.2); in the Siberian Federal District: Tuva Republic (5.2), Khakassia (2.2), Altai (1.0) [Abramov I.A., Chernyavskaya O.P., 2020; Zagnei E.V., Nesterova Yu.V., 2014; Zotova Yu.A., Tivanova E.V., 2019; Kandrychyn S.V., 2017; Karavyanskaya T.N., Golobokova E.V., 2019; Kirilyuk A.A., 2020; Litvinov V.A., Khairnasov M.R., 2019].

In the Republic of Dagestan, the incidence rate of helminthiases per 100,000 population increased from 18.7 to 78.1 during the period from 1990 to 2013 [Aslanova M.M., Kuznetsova K.Yu., 2016; Bekish V.Ya., Zorina V.V., 2015; Berulava K.R., Adoeva E.Ya., 2019; Bobyreva N.S., Korneeva Ya.A., 2016; Bozhenova I.V., 2017; Islamova Zh.I., Mukhamatkhanova R.F., 2017; Islamova Zh.I., Yusupova S.M., 2021; Latypov R., 2011]. Helminthiases such as enterobiasis, ascariasis, trematodiasis, trichocephalosis, and hymenolepiasis have the greatest significance in the European part of Russia. At the same time, enterobiasis accounts for 89% and ascariasis for 6.8%.

Although nearly every person suffers from a parasitic disease at some point in their life, the highest incidence is observed among children [Arakelyan R.S., 2014; Arakelyan R.S., Kurganova M.V., 2014; Arakelyan R.S., Okunskaya E.I., 2019; Vasechkina L.I., Tyurina L.P., 2013; Erofeeva V.V., Pukhlyanko V.P., 2013; Kartashova A.Yu., Matsakov O.K., 2016; Malakhova A.Yu., Safarova A.Ya., 2013; Mirzoeva M.R., Khudoydodova S.G., 2019; Miropolskaya N.Yu., Ivanova I.B., 2014; Morozov E.N., 2016; Novozhilov K.A., Berebnev B.N., 2015; Novozhilov K.A., 2015]. The prevalence of enterobiasis among different population groups ranges from 10% to 35%, while school-aged and young children account for 90–95% of all cases of the disease.

The annual incidence of ascariasis ranges from 0.85 to 0.90–1 per 1,000 population. Among those infected with ascariasis, children predominate numerically (65.1%). A similar situation is observed in Moldova and Belarus [Bekish V.Ya., Zorina V.V., 2015; Kozlovsky A.A., 2016; Pashinskaya E.S., Pobyarzhin V.V., 2017; Pashinskaya E.S., Pobyarzhin V.V., 2018; Novozhilov K.A., Chernikova E.A., 2014; Mirzoeva Z.A., 2015].

In Armenia, helminthiases are most often recorded in the semi-desert zones. In Azerbaijan and Georgia, a significant prevalence of helminthiases has been identified among children's groups [Kostoeva P.A., 2019; Pechkurov D., 2011].

Helminthiases are widespread in the Central Asian republics. In Kyrgyzstan (Osh region), the prevalence of helminthiases among children aged 4–7 years is 8.7% [54; pp. 200–202]. In Turkmenistan (Ashgabat and Chardzhou), the prevalence of helminthiases in children's institutions reaches up to 30%.

In Tajikistan, helminthiases are almost equally widespread in the lowland regions (6.8%) and in the mountainous and foothill areas (5.2%). Higher prevalence (13.2–22.3%) is observed in the mountainous valleys of Northern Tajikistan. In Dushanbe, the prevalence of helminthiases among school-aged children ranges from 19% to 26.9% [Pechkurov D., 2015; Mukhitdinov Sh.T., Dzhuraeva F.R., 2017; Ortikova M.M., Mirzoeva Z.A., 2015; Raimkulov K.M., Narbekov O.N., 2019].
Initial data on the prevalence of helminthiases among the population of the Republic of Uzbekistan date back to the 1920s. According to these data, the prevalence of helminth infections among children in various regions of the republic ranged from 7% to 28.6% (Tashkent, old Bukhara, Kogon, Samarkand, Andijan, Namangan). Under the leadership of K.I. Skryabin, the 35th All-Union Helminthological Expedition to Central Asia examined 2,517 people from Tashkent, Samarkand, Andijan, Kokand, and other stations of the Central Asian Railway. Among those examined, pinworm infections were detected in 6.4% of cases, with children accounting for 12.1% of the examined population [Abdiev T.A., Suvonkulov U.T., 2014; Abdiev T.A., Mukhitdinov Sh.T., 2011; Madreimov A.M., Utepbergenova U.D., 2021; Masharipova R.T., Alieva P.R., 2020; Mukhitdinov Sh.T., 2011].

In 2015, out of 7,706,546 people examined in the republic, 265,766 (3.4%) were diagnosed with enterobiasis and 49,724 (0.6%) with hymenolepiasis. The relative weight of hymenolepiasis in the structure of helminthiases was 18.7%.

Among the population of Tashkent city, the prevalence of hymenolepiasis was 0.002%. Across the regions of the republic, pinworm invasion was recorded as 0.01% in the population of Khorezm region and 2.6% in Jizzakh, Surkhandarya, and Fergana regions.

In Namangan region, the prevalence of hymenolepiasis ranged from 0.8% to 1.3%, while in other regions and the Republic of Karakalpakstan, it ranged from 0.01% to 0.5%. In Samarkand region, this indicator was recorded at 0.6%. The actual prevalence of helminthiases is undoubtedly higher than the official data [Abdiev T.A., Egamberdiev O.A., 2013; Ahmedova M.D., Karimova M.T., 2020; Giyasov Kh.Z., Islamova Zh.I., 2011; Daminova M.N., Rasulova Z.D., 2020].

The widespread occurrence of hymenolepiasis in the Republic of Uzbekistan is associated with dry and hot climatic conditions and high population density. It is known that the source of infection is humans. The segments of the tapeworm body released from the host contain mature eggs, which are excreted with the patient’s feces and contaminate various objects in the environment. Hymenolepiasis is most commonly transmitted through door handles, toilets, basins, toys, objects, and contaminated hands, as well as via flies and cockroaches to food products, through which it infects healthy individuals.

In hymenolepiasis, auto-invasion occurs in the patient’s intestines. Eggs in the intestine can develop into mature tapeworms. According to the literature, hymenolepiasis occurs more frequently in young children and can be asymptomatic in up to 30% of cases. In other instances, hymenolepiasis manifests in two forms: subclinical and overt clinical. The subclinical form occurs twice as often as the overt clinical form and leads to chronic hymenolepiasis. The subclinical form is characterized by subtle symptoms: occasional abdominal pain after meals, disturbances in taste perception on the tongue, epileptic-like seizures, memory loss after seizures, appearance of vitiligo-like (white patch) spots on certain areas of the skin, eczema, dermatitis, and neurodermatitis. Nutritional supply to the hair is impaired, leading to focal hair loss and loss of eyebrows. In the subclinical form, symptoms such as sudden weight loss, paleness of the face, fatigue, weakness, and reduced work capacity are observed.

Overt Clinical Form: Abdominal pain of varying intensity lasting from a few minutes to several hours (in the abdomen, near the navel, in the intestines), bloating, diarrhea, often with mucus. Nausea, vomiting, loss of appetite, and salivation are observed. Neurological changes may occur, including irritability, restlessness, nervousness, memory and cognitive decline, headache, dizziness, and in some cases, the development of seizures. In cases of hymenolepiasis, the patient's immune system is weakened, reducing resistance to other diseases.

According to the literature, mixed parasitic invasions or co-infections—pinworm combined with other helminths—are reported in 17.3% of cases [Karimova M.T., Bebutova R.G. 2014; Bekish V.Ya., Zorina V.V. 2015; Lin R.J., Chen C.Y. 2014; Saidakhmedova D.B., Egamberdiev O.A. 2013; Saidakhmedova D.B., Suvonkulov U.T. 2015].

Co-infection of pinworms with other helminths can exacerbate the above symptoms and lead to severe complications in children. Several authors report the widespread prevalence of hymenolepiasis in the republic [Abdiev T.A., Suvonkulov U.T. 2014; Daminova M.N., Rasulova Z.D. 2020].

Hymenolepiasis is widely distributed in the southern regions, which researchers attribute to the positive effect of warm and humid climates on the development of pinworms; the high population density and numbers in southern areas; and the physiological conditions of the gastrointestinal tract. Dietary habits in hot and cold regions also play a role [Ershov I.B., Osigniug L.M. 2014; Zakhidova N.A. 2020; Ismoilova A.K., Daminova M.N. 2019; Mingbaeva Sh.N., Shoabdullaeva N.Sh. 2011; Kumar H., Jain K. 2014; Kvalsvig J.D. 2003; Sataeva T.P., Kutya S.A. 2018; Safarova A.Ya., Trusov S.N. 2013].

Previously, pinworm infections were not widespread in rural areas, being considered an “urban parasite.” Currently, however, in Uzbekistan, helminthiases are spreading in rural areas as well, at a rate of 7.9% [Muratkhodjaeva A.V. 2012; Pechkurov D. 2015; Narzikulov R.M. 2018]. Some researchers, however, note the opposite: pinworm infections are recorded in all cities and rural areas of Uzbekistan, particularly among children, where prevalence rates are high [Ortikova M.M., Norkulova G.S. 2017].

Epidemiological surveillance of helminthiases is the monitoring of the epidemic process of a particular disease in a specific region in a dynamic and comprehensive manner for the purpose of rationalizing preventive and anti-epidemic measures and increasing their effectiveness.

According to John Last, epidemiological surveillance is the regular and continuous collection, comparison, and analysis of data for taking specific measures, with timely dissemination of information among relevant stakeholders [Ahuja A., Baird S. 2015; Aiken A.M., Davey C. 2015; Mohammad M.A., Hegazi M.A. 2004; Mumtaz S., Siddiqui H. 2009].

The formation of an epidemiological diagnosis and the development of rational measures to manage the epidemic process in modern conditions cannot be carried out without an effective system for collecting, processing, and analyzing data of various types and volumes. Surveillance is intended to address the following tasks [Baird S., Hamory J. 2016; Kosik-Bogacka D.I., Kolasa A. 2012]:

- To assess the scope, distribution, and socio-economic significance of helminthiases;
- To determine the trends in the epidemic process of helminthiases over a certain period and evaluate their dynamics;
- To identify regions based on the level of actual and potential epidemic problems of helminthiases;
- To identify population groups at high risk of disease based on climate, social, household, age, and other characteristics;
- To determine the causes and conditions that explain the observed features of the epidemic manifestation of helminthiases;
- To identify a sufficient system of measures, plan their sequence, and schedule their implementation;
- To monitor and evaluate the scope, quality, and effectiveness of preventive and anti-epidemic measures, and to rationalize their adjustment;
- To develop periodic forecasts of the epidemic situation.

Epidemiological statistical indicators are divided into quantitative (characterizing the intensity, rate, rhythm, and duration of the epidemic process) and qualitative indicators (characterizing relationships and interactions within the epidemic process).

Quantitative indicators of the epidemic process include: intensity of morbidity; dynamics of morbidity throughout the year; annual distribution of morbidity intensity and dynamics, including the intensity of seasonal peaks; and foci (time of occurrence, number of foci occurring simultaneously, dynamics of foci emergence over time, and the distribution of foci affecting single or multiple cases of disease) [Bleakley H. 2007; Hunter M.M., Wang A. 2007].

Qualitative indicators of the epidemic process are calculated based on the distribution of patients: by regions (depending on research objectives – globally, within a country, or its specific regions: republic, province, district, city, or even within a single locality); between urban and rural populations; across different age groups; by gender; by occupational groups (number of patients grouped by occupation or workplace; among children attending organized groups versus those not attending; across different household, ethnic, and other population groups) [Brooker S., Jardim-Botelho A. 2007; James E. Wright, Marleen Werkman 2018].

The surveillance of helminthiases is carried out according to specially developed, targeted, integrated programs that include independent but interrelated sections corresponding to the areas of activity: informational and analytical; medical diagnostics; and management [Bundy D.A.P., de Silva N. 2017; Hotez P., Bundy D. 2006; Hotez P.J., Alvarado M. 2014].

Informational and analytical activities are the main components of helminthiasis surveillance. During this activity, all forms of infestation are taken into account and recorded, and the dynamics of morbidity are monitored. In each case, the amount of necessary information is determined by the specific features of the epidemiology of geohelminthiases, as well as the real capabilities of the anti-epidemic system to support the required information in a given location and under specific temporal conditions [Clemens M., Sandefur J. 2015].

The characteristics of helminthiasis epidemiology provide the data set necessary for a comprehensive study of the epidemiological situation. The most important task of informational and analytical activity is to ensure the completeness and reliability of the recorded data [Aslanova M.M., Zhnakina Zh.V. 2016; F. Makamu, M. Azam 2017].

Epidemiological diagnosis involves assessing the current situation in a particular region and its causes among certain population groups during the period under study. Traditionally, epidemiological indicators based on statistical data are applied. Epidemiological diagnosis is carried out using operational and retrospective epidemiological analysis. Operational epidemiological analysis involves studying morbidity within a short period. It allows for identifying the causes and conditions of current morbidity, as well as determining the individual characteristics of the epidemic process based on its probable nature. Based on the results of this analysis, an epidemiological diagnosis is formed. Epidemiological diagnosis is the assessment and study of the process and its causes within a specific group of the population at a particular point in time [Dadaev S., Abdurakhmanova S. 2013; F. Makamu, M. Azam 2014].

Based on the analysis, it can be concluded that socio-economic analysis is also of great importance, as it allows for the assessment of economic and social damage caused by a particular disease, namely an infestation.

Retrospective epidemiological analysis is the study of morbidity over a past period to justify long-term planning of anti-epidemic measures. Such analysis allows identifying the mechanisms of epidemic development and the most important and stable conditions in its manifestation. Its results serve as preliminary confirmatory data for long-term planning of anti-epidemic measures. Additionally, it is used to forecast morbidity levels and to evaluate the quality and effectiveness of previously implemented preventive measures.

Retrospective epidemiological analysis includes the following stages:
Stage I. Preparation of the program: identifying the objectives and tasks to be solved and determining practical and scientific research directions accordingly.
Stage II. Collection and primary processing (grouping) of information.
Stage III. Consolidation of data into grouped tables.
Stage IV. Study of the data according to relevant aspects.
Stage V. Conducting an epidemiological diagnosis.

The surveillance component responsible for identifying the situation and developing direct tactical actions for the anti-epidemic service is designated as monitoring. Improving the information support of epidemic monitoring aims to bring the recorded level of helminthiases closer to accuracy. The second component of helminthiasis surveillance is therapeutic and diagnostic activity. This involves the continuous development and improvement of clinical diagnostic, therapeutic, and health assistance systems for the population: improving the laboratory diagnostic system for helminthiases and enhancing its quality (standardizing laboratory diagnostic methods); expanding the possibilities for diagnosis and treatment of infected individuals (developing standards for identifying cases and standard treatment regimens for infected persons); and expanding the system of therapeutic measures [Dadaev S., Abdurakhmanova S. 2013; Dr. Vivian Awelch P 2017; Dupas P. 2014].

A large number of studies have been conducted on the epidemiological characteristics of parasitic diseases. In 2013, Khalafli Kh.N. and co-authors conducted a major study in Azerbaijan, examining the prevalence of parasitic diseases in the population. The study identified 12 types of parasitic diseases, among which intestinal giardiasis accounted for a large share – 14.3%, with children making up to 29.7% of cases.

When analyzing the age of children, those aged 3–7 years were the majority (24.4–29.8%), and among children who did not observe personal hygiene, the rate increased to 37.7%. The researchers established the modern helminthofauna of the population, identifying 21 types of parasites: 13 nematodes, 5 cestodes, and 3 trematodes. However, the largest shares were enterobiasis – 28.6%, trichocephalosis – 9.3%, ascariasis – 7.5%, hymenolepiasis – 45%, and trichostrongyloidosis – 2.7%.

The researchers associated the high prevalence of helminthiases and giardiasis in Baku city with the process of hyper-urbanization – a sharp increase in population, deterioration of living conditions, worsening sanitary and hygienic conditions, and age-related behavioral patterns among children.

Kozlovsky A.A. (2016) studied the prevalence of helminthiases among children in the Gomel region. According to his findings, 90.4% of all recorded cases of enterobiasis in the Gomel region were children under 17 years of age, 79.3% were ascariasis, and 55.5% were trichocephalosis. Most of these cases involved preschool and school-aged children. The researcher noted that the issue of polyinvasion—infestation with two or more helminths—was predominant among children. Among schoolchildren, this accounted for 74% of cases. Mixed infections such as enterobiasis + giardiasis, enterobiasis + ascariasis, ascariasis + trichocephalosis, and enterobiasis + giardiasis + toxocariasis were recorded. Kozlovsky associated polyinvasion not with poor living conditions or late diagnosis but with a symbiotic effect, where one infection reduces immunity and increases susceptibility to a second infection.

In his research, Kozlovsky A.A. also identified risk groups for helminth infections among children: children from large families, children from socially disadvantaged families, children attending organized groups (schools, preschools), frequently ill children, children simultaneously exhibiting seven or more dysregenerative stigmata, infants under one year on artificial feeding, children with delayed mental and physical development (as they have lower personal hygiene skills), children who play frequently with animals, and children who have contact with soil or sand.

According to the literature, the source of enterobiasis infection is exclusively a person infected with pinworms. Female pinworms lay eggs on the patient's skin, which mature in 4–6 hours and become infective. These eggs can get onto the patient's bedding and underwear, as well as into homes and service establishments, and are spread by flies, cockroaches, and rats. When ingested with food, pinworm eggs can enter the mouth and nose via dust. Patients with enterobiasis often experience autoinfection. Pinworms parasitize the lower part of the small intestine, the cecum, and the initial portion of the colon. Female pinworms actively migrate to the rectum, lay eggs around it, and die. The total life cycle of pinworms in the human body does not exceed 3–4 weeks.

Enterobiasis resembles a minor harmless helminth, but it can damage the intestinal mucosa and, in some cases, penetrate the intestinal wall down to the muscular layer, resulting in pinpoint bleeding and erosions. The metabolic products released by helminths sensitize the body, causing allergic reactions, bedwetting (enuresis) in children, and potentially convulsive syndromes. Female pinworms can carry bacteria from the intestines to the female genital organs. Scratching around the rectum can lead to irritation, secondary bacterial infections of the skin, and dermatitis, complicating the course of the disease.

Frequently, children with disturbed intestinal function experience porridge-like diarrhea, sometimes with mucous tenesmus. Additionally, children may feel pain around the navel, ranging from mild to severe, sometimes requiring surgical intervention. Appetite decreases, children develop a craving for sweets, and pinworms release intermediate metabolites, which can affect the adrenal glands, leading to pale skin, localized depigmentation, and signs of vitamin and micronutrient deficiency. This manifests as dull hair, hair loss, brittle nails, white spots on the skin, and cheilitis at the corners of the lips. Children may also develop bad habits, such as nail-biting and putting hands or objects in their mouths. As reported in the literature, even a minor helminth infection can delay both the mental and physical development of a child.

At the beginning of 2019, approximately 3.2 million people in Ethiopia were displaced to various locations, with 61% due to internal conflicts in the country, 17% due to natural disasters (droughts and floods), and 17% due to stress factors [Berger A. 2015].

Accordingly, implementing measures to control infectious diseases in areas of internal instability was also challenging. Among infectious diseases, soil-transmitted helminths occupy a leading position among those that sharply increase under adverse conditions [Hall A, Nguyen Bao L 2006; Brooker S., Kabatereine N.B. 2008; Bundy D A P, Appleby L 2017; Del Ozzo-Magana B.R., Lazo-Longer A. 2012].

Gosa Ebrahim Geleto and co-authors (2022) studied the prevalence of parasitic infections under these adverse conditions in Ethiopia. Among the observed children under 5 years of age, 73% (295) were carriers of a single type of parasite, of which 67.4% were soil-transmitted helminths. Specifically, 90%

(245) were A. lumbricoides, 12% (33) T. trichiura, 5% (13) hookworm, and 0.3% (1) S. mansoni. Additionally, mixed infections were observed in 6.1% (18) of cases. Coinfection of A. lumbricoides and T. trichiura occurred in 4.4% (13), and coinfection of A. lumbricoides and hookworms in 1.7% (5) of cases.

When studying the reasons for the high prevalence of soil-transmitted helminths, the authors found that 52.8% (214) of respondents had to travel more than 500 meters to reach a nearby water source, 56.5% (229) of participants had to wait an additional 30 minutes to collect water even after reaching the source, and 62.0% (251) received less than 5 liters of water per day. Furthermore, only 29.4% (119) used water purification tablets, while the remaining population relied on untreated drinking water. Similarly, 66.7% (270) of participants had no toilets in their households, and a large portion of the population disposed of waste in nearby open areas. Among the observed population, 84.9% (186) experienced malnutrition.

Of the population, 27.4% (111) had stunted growth, and 25% (101) of these were in severe stages of growth retardation. Additionally, 29.1% (118) suffered from extreme underweight.

A distinctive feature of parasitic diseases is the long-term survival of helminths in the patient’s body, which occurs with repeated infections, i.e., reinfections. The prolonged course of many parasitic diseases leads to delays in the physical and mental development of children, as well as reduced work capacity and social activity [Varlamova A.I., Arkhipov I.A. 2020; Suvonkulov U.T., Abdiev T.A. 2015; Talabov M.S. 2011; Trunova O.A. 2018; Tuygunov M.M., Lukmanov M.I. 2013; Abdul Latif Jameel 2011; Horton J. 2003; Barda B., Zepherine H. 2013].

A critical factor in acquiring helminthiasis is the number of parasites in the human body, which varies significantly depending on the type of helminth. Beyond direct pathological effects, widespread parasitic infections in the population contribute to the frequent occurrence and severe course of other infectious diseases. The extensive pathological impact of nearly all human parasitic pathogens leads to allergization and reduced immunological reactivity [Tverdokhlebova T.I., Kovalev E.V. 2017; Trunov V.A., Belonogova Yu.V. 2018; Abdul Latif Jameel 2012; Khan M.Y. 1979].

Typically, helminthiases are not considered fatal diseases, yet they are widespread among children [Uniting to Combat Neglected Tropical Diseases 2014; Abu-Madi M.A., Lewis S.W. 2011]. At the same time, chronic helminth infections have been linked with various infectious diseases, including bladder cancer (S. haematobium), anemia (hookworms), and asthma (A. lumbricoides) [Khan M.Y. 1979; Givewell Combination deworming 2015; Alderman H., Konde-Lule J. 2006]. Children remain highly susceptible to infections with a high prevalence and intensity [Anuar T.S., Salleh F.M. 2014; Kim B.J., Song K.S. 2014].

Moreover, children with parasitic infections often experience delays in mental and physical development and face nutritional deficiencies [Kosik-Bogacka D.I., Baranowska-Bosiacka I. 2010; Assefa L.M., Crellen T. 2014; Awasthi S., Pande V.K. 2000].

Kozlovsky A.A. (2016) emphasized that in the acute phase of parasitic infection, the leading pathogenetic factor is the sensitization of the organism, meaning that the body is primed for allergic reactions due to repeated exposure to the helminth. All these processes promote the development of inflammation and create optimal conditions for larval development.

Ascaris, considered a geohelminth, is widespread in Russia but also occurs in the Republic of Uzbekistan, and it possesses specific pathogenicity. Male and female Ascaris parasitize the human intestine, serving as the only source of infection. A mature female lays up to 245,000 eggs per day, which can be excreted outside. Infection occurs through the consumption of mature eggs. Vegetables have high epidemiological significance because soil particles adhere to their surfaces.

Currently, the most hazardous areas for the spread of ascariasis are gardens and vegetables, as sometimes human feces are used as fertilizer without proper sanitation. After a person consumes mature eggs, larvae emerge in the small intestine, penetrate the intestinal wall into capillaries, and then migrate via the bloodstream to the liver and lungs. Beyond the intestine, liver, and lungs, Ascaris larvae have been found in the brain, eyes, and other organs. They rapidly feed on plasma and erythrocytes. In the lungs, the larvae actively enter the alveoli and bronchi, moving along the ciliated epithelium of the small and large bronchi to the pharynx, from where they are swallowed back into the intestines.

During the larval migration, the disease manifests with allergic symptoms, which appear as the body responds with sensitization to the metabolic and degradation products of the larvae. Eosinophilic infiltrates form in the intestinal wall and lungs. Toxic-allergic reactions may also occur when adult Ascaris localizes in the intestine. The active movement of larvae causes mechanical effects as a second group of pathogenic influences. Pulmonary hemorrhage and hemoptysis are associated with bleeding from perforation sites caused by larvae. Ascaris does not attach to the intestine but presses against the intestinal wall with its posterior end. Consequently, it can migrate along the highly mobile intestinal tract, moving upward and downward, and even reach the stomach, esophagus, and respiratory tract. Migration of Ascaris to the liver and other organs manifests in severe cases.

A mature helminth can damage the intestinal wall with its sharp posterior end or, in some cases, cause mechanical intestinal obstruction by clustering. Toxic effects of products released by helminths on nerve endings may also contribute to spastic intestinal obstruction. Migration of Ascaris to other organs can transport bacterial infections, leading to purulent complications such as abscesses and cholangitis.

The literature review shows that helminthiases worldwide, including intestinal helminthiases, remain relevant. Studies have comprehensively documented the negative effects of intestinal helminthiases on the human body. However, comparative studies evaluating the prevalence of intestinal helminthiases and the factors contributing to their spread, depending on the degree of infection, have not yet been conducted globally, including in the Republic of Uzbekistan.

§1.2. Global Studies on the Effectiveness of Mass Deworming

The WHO recommends mass deworming in endemic areas to prevent reinfection with soil-transmitted helminths and schistosomiasis [Ozier O. 2014; Ozler B. 2015; Parajuli RP, Fujiwara T. 2014; Zuberbier T. 2011], because the expenses incurred for diagnosing helminths are much higher than the costs required for treatment. Mass deworming of children has been described as the most cost-effective strategy for improving school attendance among children in helminth-endemic areas. Although deworming costs only 0.50 US dollars per child, 276 million US dollars are spent annually on all children to implement WHO recommendations [GiveWell. 2016; Gosa Ebrahim Geleto. 2022; Hall A, Horton S. 2008; Pittet D., Sax H. 2004; Pullan RL, Smith JL. 2014].

According to the Cochrane review conducted in 2015, mass deworming does not improve children's health or their academic performance at school [Dhaliwal I, Duflo E. 2012; Quihui L., Valencia M.E. 2006; Sadaga G.A., Kassem H.H. 2007; Savioli L., Montresor A. 2002; Schapiro L. 1919; Kapczuk P., Kosik-Bogacka D. 2018].
Among children over the age of three who lag behind their peers in growth, mass deworming does not result in an increase in height. However, when mass deworming is carried out together with micronutrient-rich healthy nutrition and adherence to personal hygiene rules, the level of effectiveness may increase [Okyay P., Ertug S. 2004].
To enhance the effectiveness of mass deworming, it is first necessary to determine which types of helminths are prevalent in a given area and to select the drugs that effectively target each specific type of helminth. A difficult educational environment negatively affects learning. At the same time, continuous monitoring must be planned.
Finally, when analyzing mass deworming, its indirect effects must be taken into account: treated children have a positive effect on untreated children because the helminth load decreases. Indirect effects reduce the effectiveness of individually randomized studies; therefore, cluster-based research is considered more appropriate for assessing the effectiveness of mass deworming [GiveWell. 2016; Gosa Ebrahim Geleto. 2022; Hall A, Horton S. 2008; Simeon D.T., Grantham-McGregor S.M. 1995; Spakulová M., Orosová M. 2011; Speich B., Knopp S. 2010].
F. Makamu, M. Azam, and H. Kazianga (2016) studied the effectiveness of mass deworming in schistosomiasis and concluded that mass deworming for schistosomiasis may improve children's body weight but does not affect their height (the level of reliability is low) and has almost no effect on children's cognitive functions or school performance.

Bundy D. A. P., Appleby L. and others (2017), in their review, discussed the article by Croke K. and co-authors (2014) concerning the effect of deworming on children's body weight. Overall, mass deworming increases a child's body weight by an average of 0.13 kg. If mass deworming conducted twice a year costs 0.60 US dollars per child [GiveWell. 2016; Gosa Ebrahim Geleto. 2022; Hall A, Horton S. 2008], Croke et al. (2016) calculated that an increase of 1 kg in body weight costs 4.48 US dollars. For comparison, Galloway R. and co-authors (2009) studied a school feeding program, according to which an increase of 1 kg in a child's body weight costs 182 US dollars. Accordingly, every dollar spent on deworming increases body weight 40.62 times more effectively than school feeding.

It is known that soil-transmitted helminths — including hookworm, roundworm, and whipworm — are transmitted through soil when personal hygiene rules are not followed, and as a result of open defecation, their eggs enter the external environment and spread through the soil. Schistosomiasis, on the other hand, is also transmitted through contaminated freshwater. School-age children are particularly susceptible to such infections [Croke K., Hicks J. H. 2016; Staudacher O., Heimer J. 2014; Steinmann P., Usubalieva J. 2010; Taylor-Robinson D. C., Maayan N. 2015; Watkins W. E., Cruz J. R., Pollitt E. 1996; Weisbrod B. A., Andreano R. L. 1973; WHO (World Health Organization) 2015].

In treating infected individuals, the helminths die within their bodies, thereby preventing further spread. Bundy and others (1990) studied this program in South India and Montserrat, where children aged 2 to 15 years were treated with albendazole four times over a 16-month period. The researchers found that the prevalence of soil-transmitted helminth infections significantly decreased both among the target groups and among individuals aged 16–25 years.

In the literature, numerous studies have been presented examining the impact of mass deworming (MD) on education and the labor market. Among these, we will consider three studies conducted at different times and under different conditions. The first program was launched in 1910 by the Rockefeller Sanitary Commission (RSC), which was aimed at reducing the prevalence of hookworm infection in the southern United States. A mobile clinic was organized, in which local doctors from endemic regions were trained in treatment and preventive measures, and infected individuals were treated. Ten years after the implementation of the program, it was found that the number of infected individuals in endemic areas had decreased by 30% [Bleakley H. 2007; World Health Organization, Geneva 2011; Winiski A. 2021].

The second program was conducted from 1998 to 2001 in rural areas of Kenya. Before the study, it was found that 90% of school-aged children were infected with helminths. A non-governmental organization supplied schools in these areas with deworming medicines, and mass deworming was carried out twice a year against soil-transmitted helminths and once a year against schistosomiasis. In addition, informational materials on the prevention of helminth infections were distributed. The third study was conducted from 2000 to 2003 in Uganda. The initial rate of helminth infection among children aged 5–10 in the area was 60% [Koroma M.M., Williams R.A. 1996]. Mass deworming was carried out together with the addition of multivitamins to food.

When the results of these studies were analyzed, it was found that the mass deworming conducted between 1910 and 1920 increased school attendance among children by 20% and improved academic performance by 13%. At the same time, the rate of helminth infection among adults living in areas where deworming was implemented also significantly decreased.

Miguel E. and Kremer M. (2004, 2014) conducted mass deworming among school students located in rural areas of Kenya between 1998 and 1999, during which students took albendazole twice a year; in addition, some schools annually administered praziquantel to treat infections caused by schistosomiasis. The authors found that the level of helminth infection significantly decreased among treated, untreated, and treating school students, as well as among students of schools located near those schools. The authors determined that among untreated students attending the treating schools, the proportion of moderate and severe infections decreased by 18%, and among students attending schools located 3 km away from the treating schools, the proportion decreased by 22%.

Ozier (2014) studied this randomized program conducted in Kenya, but focused on children aged from birth to two years living around the schools where the program was implemented. These children were untreated but could benefit from the positive social externalities that arose in the community as a result of mass deworming in the schools. Indeed, ten years after the program, Ozier found that the average increase in test scores for these children was equal to 0.2 standard deviation units. According to the hypothesis that these children primarily benefited from the reduced spread of helminth infections, the effect was twice as high among those children who had an older sibling attending one of the treated schools.

Croke (2014) studied the effect of mass deworming on English literacy and numeracy levels in a long-term study conducted in Uganda. According to the obtained results, among children in villages where mass deworming was carried out, cognitive levels were significantly higher compared to children who were not treated.

Bobonis G. J., Miguel E., and Puri-Sharma C. (2006), on the contrary, obtained a result with a low level of statistical significance regarding the increase in the effectiveness of deworming and improvement in school performance among children in India through adding iron supplements to food in addition to deworming. According to the authors, this situation is related to the low prevalence of helminth infections in the area and the small number of treated individuals. Taken together, these studies provide strong evidence that in endemic areas, especially in regions with a high infection burden, mass treatment has major positive epidemiological external benefits. Such external benefits are important to consider both in decision-making related to public financing and from the perspective of economic efficiency.

Bleakley (2007) studied the 1940 census data of the United States in order to compare information collected before and after the implementation of mass deworming programs in the U.S. According to the obtained data, adults who lived in areas where deworming was regularly conducted during their childhood had higher levels of education and better labor market achievements compared to adults who did not live in dewormed areas. The author found that the wages of adults who received deworming were 43% higher than those who did not.

In Kenya, it was also found that children who underwent deworming achieved better outcomes in the labor market when they became adults. Baird and co-authors (2016) studied men and women separately and found that women who had received frequent deworming treatments were able to work in agriculture during the day and still switch to non-agricultural work at the end of the day without fatigue. Men who had received treatment worked 17% more hours per week and were more likely to engage in higher-paying entrepreneurial activities compared to those who had not received treatment.

Baird and co-authors (2016) compared the costs of deworming with the benefits gained from the increased productivity following deworming and calculated the profit for the state. According to the obtained data, the annual internal rate of return after deworming ranged from 32% to 51%. At the same time, deworming increases the labor force, which, in turn, leads to an increase in government revenue through taxes.

According to the literature review, the effectiveness of mass deworming has been studied in foreign countries, and most of these studies were conducted in the 20th century. In the modern stage, no data were found in the literature on its effectiveness. The available literature provides information mainly on the effectiveness of mass deworming against soil-transmitted helminths. The effectiveness of mass deworming against intestinal parasitoses — especially contagious helminths characteristic of the Republic of Uzbekistan — as well as comparative studies assessing its effectiveness based on the level of parasitic infection in the region, have not yet been investigated.

II CHAPTER. MATERIALS AND METHODS FOR IMPROVING THE CHILDREN'S PARASITE CONTROL SYSTEM THROUGH ASSESSMENT OF THE PREVALENCE OF PARASITIC DISEASES IN THE REGION

§2.1. Object of the study:

Official data on parasitic disease incidence for the years under study from the Sanitary-Epidemiological Safety and Public Health Committee; official data obtained from the Samarkand Regional Department of the Sanitary-Epidemiological Safety and Public Health Committee on the number of children aged 2–7 years living in Samarkand region who do not attend preschool educational institutions (non-enrolled children) and those who do attend preschool educational institutions (enrolled children); official information on centralized sewage service and access to clean drinking water in the districts of Samarkand region; questionnaires collected from 2,975 schoolchildren aged 7–14 years living in certain districts of Samarkand region, their parents (n=192), and the school pedagogical staff (n=322).

As the subject of the study, stool samples from 860 schoolchildren and both stool and blood serum samples from 57 schoolchildren were collected.

Study design. The planned study was a "case-control" design. In developing the research system, we proceeded from the objectives of the study and the specific tasks to be addressed during the research. The main part of the study was conducted at the clinic of the L.M. Isaev Research Institute of Microbiology, Virology, Infectious and Parasitic Diseases, under the Samarkand State Medical University of the Ministry of Health of the Republic of Uzbekistan.

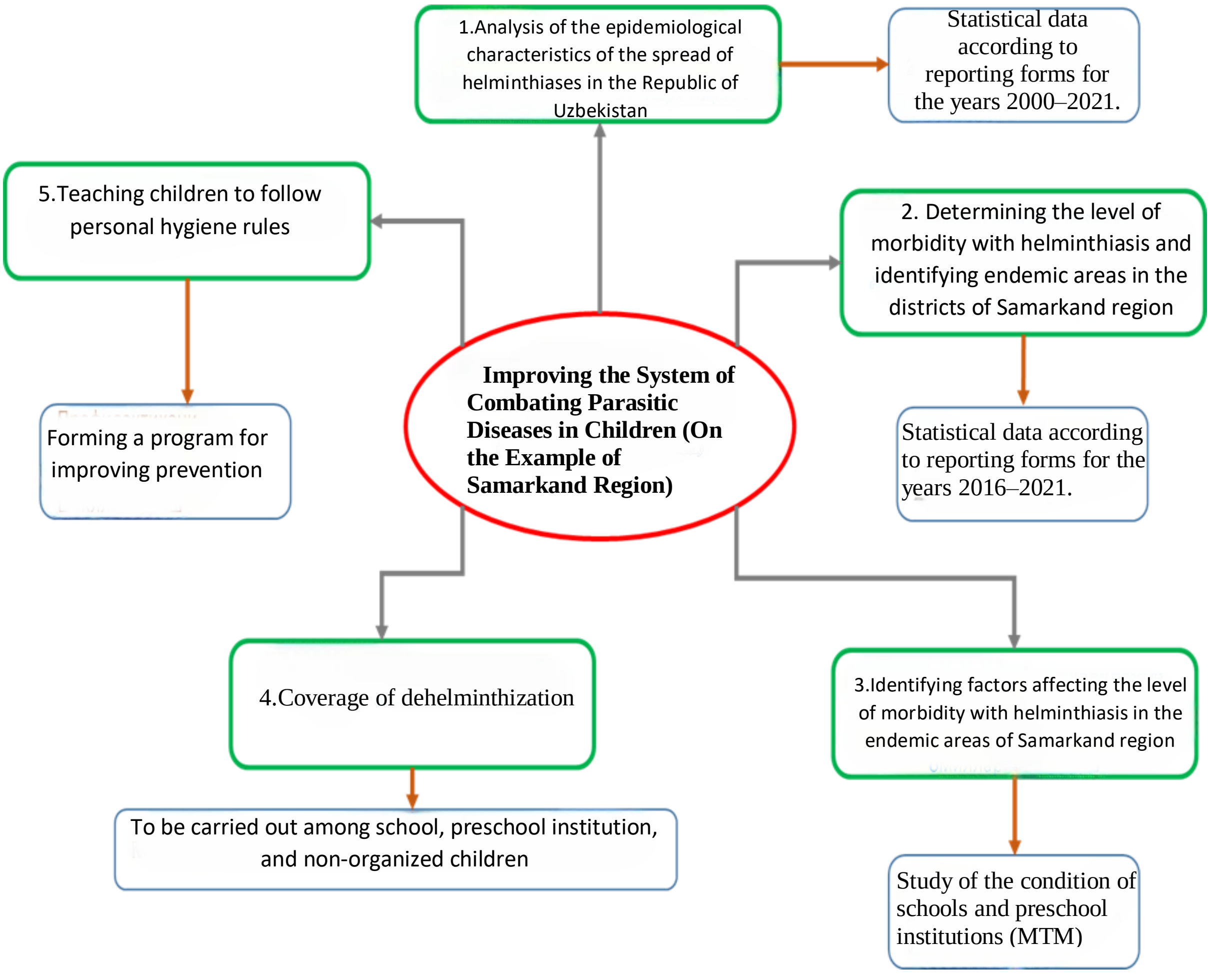


Figure 2.1. Design of the Study

Since the first task of the study was to retrospectively analyze the dynamics and nosological composition of parasitic diseases in Samarkand region during 2011–2021, official data on the incidence of parasitic diseases during the studied years were obtained from the Sanitary-Epidemiological Wellbeing and Public Health Committee of the Republic of Uzbekistan and were retrospectively analyzed. That is, the intensity, dynamics, composition, and territorial distribution of parasitic diseases among the population of the republic were determined, and the time, groups, and areas with the highest risk of morbidity were identified.

In order to determine the factors influencing the level of parasitic disease incidence in the endemic areas of Samarkand region, the epidemiological situation of the selected regions was comparatively analyzed using a mathematical model (population density, area size, availability of clean drinking water, degree of utilization of centralized sewerage services, the proportion of non-organized children in the regions, the sanitary condition of schools, and the level of coverage by deworming).

For this purpose, official data were obtained from the Samarkand Regional Department of the Sanitary-Epidemiological Wellbeing and Public Health Committee of the Republic of Uzbekistan regarding the proportion of children aged 2 to 7 years living in Samarkand region who do not attend preschool educational institutions (the number of non-organized children), the provision of centralized sewerage services and clean drinking water in the districts of Samarkand region, as well as official data on the condition of waste disposal sites, toilets, and clean drinking water supply in the three studied schools within the districts. The obtained data were statistically processed and retrospectively analyzed. Based on the obtained results, the risk factors influencing the development of parasitic diseases were identified.

The next task of the study was to assess the awareness level of schoolchildren, parents, and school teaching staff about helminth infections. For this purpose, one school was selected from each of the districts identified through the mathematical model, and a survey was conducted among children aged 7 to 14 years in these three schools based on a questionnaire developed by us. An operational analysis of the epidemiological examination was also conducted.

Table 2.1

QUESTIONNAIRE FOR SCHOOL STUDENTS

(*Mark only one of the answers in each question*)

1	Do you know that worms can exist in the human body?	Yes	No
2	Do you wash your hands with soap before eating?	Yes	No
3	Do you wash your hands with soap after playing with domestic animals?	Yes	No
4	Do you wash fruits and vegetables before eating them?	Yes	No
5	Do you drink unboiled water?	Yes	No
6	Have you ever seen worms in your stool?	Yes	No
7	Do you sometimes feel pain around your navel?	Yes	No
8	Do you experience hair or eyelash loss?	Yes	No
9	Do you have a habit of biting your nails?	Yes	No
10	Do you have white spots on your skin?	Yes	No

Along with school students, a survey was also conducted among parents and school teaching staff in order to determine their level of awareness about parasitic diseases. A separate questionnaire was developed specifically for parents and teachers.

QUESTIONNAIRE FOR PARENTS AND TEACHERS

(*Mark only one of the answers in each question*)

Table 2.2

1	Do you know that worms can exist in the human body?	Yes	No
2	Worms are transmitted to the human body through dirty hands.	Yes	No
3	Worms are transmitted through unboiled water.	Yes	No
4	Worms are transmitted through poorly washed fruits, vegetables, and greens.	Yes	No
5	Worms are excreted into the external environment through the feces of infected individuals.	Yes	No
6	Insects such as flies and cockroaches spread worm eggs.	Yes	No
7	Intestinal helminths are transmitted through household contact.	Yes	No
8	Intestinal helminths are transmitted through household contact.	Yes	No
9	When infected with intestinal helminths, children tend to bite their nails and frequently put their hands in their mouths.	Yes	No
10	Intestinal helminths are infectious diseases.	Yes	No

Based on the percentage distribution of the responses obtained from the questionnaire, the level of awareness of school students, their parents, and teachers about parasitic diseases in the studied regions was analyzed using statistical methods.

In order to improve and implement the algorithm for mass deworming (dehelminthization) among school students—one of the main objectives of the study—students from schools located in these areas were first examined parasitologically. For this purpose, the fecal samples of 300 students aged 7 to 14 from schools located in hyperendemic areas, 280 students from mesoendemic areas, and 280 students from hypoendemic areas were examined three times using the coproovoscopy method to identify parasitic infections.

In the first stage of the study, a total of 2,975 children participated. However, most of them did not fully take part until the end of the study: some failed to bring their test results 14 days after the mass deworming, while others did not submit their test results six months later. Therefore, this part of the research included only those children who participated in all stages of the study—specifically, 860 students mentioned above.Each student received three 10 ml vials containing Turdiev's preservative, and they were instructed to collect stool samples over three consecutive days. For younger students, the procedure was explained to their parents. The coproovoscopy test results were analyzed and compared among students from different regions using an operational analysis method. At the same time, mass deworming was conducted among these students according to established procedures. One week later, all students' stool samples were re-examined using the coproovoscopy method to assess the effectiveness of the mass deworming.

There are various methods for detecting parasitic diseases, such as coproovoscopy, ELISA, and PCR techniques. In order to study the significance of these methods in accurately diagnosing parasitic infections, 57 students from upper grades whose parents had given consent to participate in the study were selected. Along with the previously conducted coproovoscopy method, 5 ml of blood was taken from these students to test for IgM antibodies against giardiasis using the ELISA method. Additionally, their stool samples were collected in separate sterile containers to detect parasite DNA using the PCR method. The obtained results were comparatively analyzed using statistical methods.

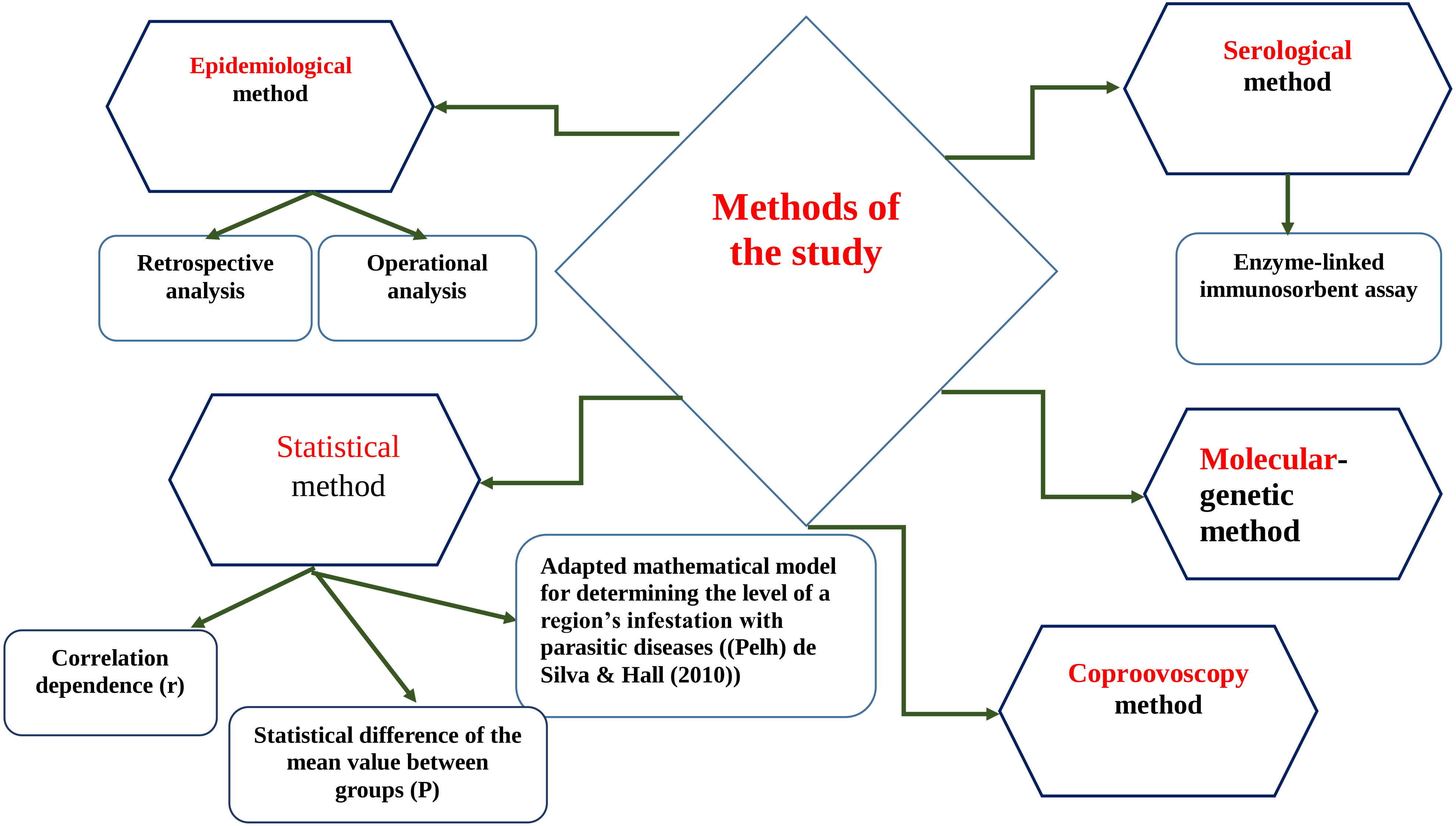

Methods of the study
Epidemiological method
Retrospective analysis
Operational analysis
Serological method
Enzyme-linked immunosorbent assay
Statistical method
Correlation dependence (r)
Statistical difference of the mean value between groups (P)
Adapted mathematical model for determining the level of a region's infestation with parasitic diseases ((Pelh) de Silva & Hall (2010))
Molecular-genetic method
Coproovoscopy method

Figure 2.2. Research Methods

§2.2. Research Methods

§2.2.1. Retrospective Epidemiological Analysis

A retrospective epidemiological analysis of the dynamics and nosological composition of parasitic diseases by district in Samarkand region was conducted for the years 2011–2021.

§2.2.2. Parasitological Method. Method of Stool Preservation

During stool examination, the samples were delivered to the laboratory while still warm (no more than 24 hours old). In cases where long-term storage or transportation of the material was required, stool preservation was recommended to prevent the deformation of helminth eggs caused by unfavorable environmental conditions.

For this purpose, Barbagallo's solution or synthetic detergent solutions such as "Lotos" and "Extra" were recommended. The ratio of stool to solution should be 1:10.

Detection of helminth eggs in stool by the enrichment method

Process: The stool is diluted in a flotation solution whose specific gravity is higher (more than 1.1) than that of helminth eggs. As a result, the eggs rise to the surface and form a film. The film is collected and examined under a microscope.

Reagents: The flotation solution according to Kalantaryan is prepared as follows: 1 kg of sodium nitrate ($NaNO_3$) is dissolved in 1 liter of distilled water. The solution is boiled until a film appears on the surface and is poured into dry glass containers without filtration. The specific gravity of the solution should be 1.38.

Special equipment: Beakers or special glass containers with a capacity of 100 ml and glass rods.

Detection procedure: 5 g of stool is thoroughly mixed with the flotation solution in a beaker. During mixing, the flotation solution is gradually added up to 100 ml. After mixing, large particles that rise to the surface are removed using a glass rod or folded paper. A cover glass is placed on top of the container filled with the saline solution. The cover glass should touch the solution. If the solution is insufficient, more is added to fill it. Then it is left to stand for 20–30 minutes, after which the cover glass is placed (with the wet or stained surface facing up) on a microscope slide and examined under a microscope. To prevent the preparation from drying out, 2–3 drops of 50% glycerin solution are added.

Working with stool samples in the laboratory. It is advisable to collect stool in glass or plastic containers, and a label indicating the subject's surname, first name, patronymic, age, and place of residence must be attached to them. The stool sample should fill not less than one-fourth of the container's volume, since a small portion dries quickly and the eggs may sometimes become deformed. In addition, repeated examinations by other methods may be required.

Stool samples sent to the laboratory must be examined on the same day they are delivered; if this is not possible, they should be kept cold until the next morning. After the examinations are completed, the containers must be boiled and disinfected by keeping them for 5 hours in 5% phenol or lysol solutions, or in 2% cresol solution.

If it is necessary to store the material for several days, preservatives should be used. When recording the test results, the names of the helminths are indicated according to the modern nomenclature (Latin names). The proper functioning of fume hood ventilation systems in laboratories must be regularly monitored.

§2.2.3. Serological Method. Enzyme-Linked Immunosorbent Assay Method

Immunofluorescence and enzyme-linked immunosorbent assay methods are currently the main laboratory diagnostic techniques used to detect Giardia infection in humans. This method allows the detection of antibodies against these pathogens in blood serum. The method has high sensitivity (66.3–98.9%) and specificity (92.6%). In our study, we used the diagnostic kit produced by "Vector-Best" in Moscow and Novosibirsk (D-3552). This kit is designed to detect immunoglobulins A, M, and G against Giardia in blood serum, which allows determination of the degree of invasion and the effectiveness of antihelminthic therapy. The presence of IgG indicates chronic giardiasis or the beginning of the recovery stage of acute giardiasis. If only IgM is detected, it indicates an acute giardiasis infection.

Using the ELISA method, 57 students were tested for the presence of IgM immunoglobulins specific to giardiasis. The results were evaluated according to the manufacturer's instructions.

The ELISA method is a laboratory technique used for the qualitative or quantitative detection of substances at low or very low concentrations. This method makes it possible to identify biologically active substances in the human body such as hormones, enzymes, neuropeptides, immune system products, and others, as well as foreign antigens and antibodies. Biogenic amines — melatonin, adrenaline, noradrenaline, dopamine, metanephrine, normetanephrine, serotonin, tryptophan — can be detected in blood serum, plasma, and urine, while histamine can also be detected in stool.

The ELISA method has several advantages: it is highly sensitive, specific, accurate, rapid, standardized (the reaction is automatically evaluated), does not require special laboratory conditions, needs only micro-volumes of material, and can be performed using existing local or imported laboratory equipment.

The enzyme-linked immunosorbent assay is based on the specific binding of an antibody to an antigen. If one of the components is conjugated with an enzyme, a colored product is formed as a result of the reaction with a corresponding chromogenic substrate. Using an ELISA analyzer, the compound or substance being sought in the material is detected spectrophotometrically.

The sensitivity of the ELISA method and the reliability of the technique are determined by the kinetic and thermodynamic properties of the antigen-antibody reaction, the ratio of reagents, the activity of the enzyme, and the parameters of the detection method.

The subjects of ELISA research are low-molecular and high-molecular compounds, viruses, and bacteria. To prevent errors outside the laboratory during ELISA, it is necessary to: follow the conditions for sample collection and preparation; adhere to sample storage conditions; comply with the transportation and storage conditions of test systems; carry out incoming quality control of test systems; and determine the quality of test systems (sensitivity, specificity using control materials, reproducibility).

Basic recommendations for preparing blood samples for ELISA.

The instruments and laboratory glassware used for analysis must be clean and dry. For the study, blood is most often taken from the patient's cubital vein (on an empty stomach). Blood samples should be collected using needles with a large diameter to avoid damaging erythrocytes, as hemolysis of erythrocytes can lead to false-positive results. From the moment of collection, the blood sample should be stored for no longer than 24 hours at a temperature of +2º to +8ºC.

The serum should be stored at +2º to +8ºC for 5 to 7 days, as longer storage can cause bacterial growth and result in false-positive outcomes. For longer storage, the serum may be frozen at −20ºC for up to 20 days, since prolonged freezing can affect the structure and stability of some components of the sample. Serum should not be repeatedly frozen and thawed, as repeated thawing leads to the destruction of antigens and antibodies and changes in the composition of the samples. Serum should not be stored in a self-defrosting freezer.

The ELISA method consists of three stages: 1 Recognition of the test compound by a specific antigen, leading to the formation of an immune complex. 2 Binding of the conjugate with the immune complex or with free binding sites 3Conversion of the enzyme label into a detectable signal.

§2.2.4. Molecular Genetic Method. Polymerase Chain Reaction (PCR)

The feces of 57 senior school students from a hyperendemic area who consented to participate in the study were examined by PCR to detect the DNA of intestinal parasites.

This test kit is designed to identify the DNA of intestinal parasites.

The polymerase chain reaction (PCR) is an experimental method in molecular biology that allows a significant amplification of specific nucleic acid (DNA) fragments present at low concentrations in a biological sample. The PCR method is based on repeatedly doubling a specific segment of DNA under artificial (in vitro) conditions using enzymes. As a result, a sufficient amount of DNA is produced for visual detection.

In addition to simply increasing the number of DNA copies (a process called amplification), PCR enables numerous other manipulations with genetic material—such as detecting mutations and combining DNA fragments—and is widely used in biological and medical practice, for example, for diagnosing diseases (hereditary and infectious), determining paternity, cloning genes, detecting mutations, and isolating new genes.

Specificity and application. PCR is a molecular diagnostic method that has become the "gold standard" for a number of infections, has stood the test of time, and has proven clinical effectiveness. The PCR method makes it possible to determine the presence of a pathogen even if only a few DNA molecules of the pathogen are present

in the sample.
PCR makes it possible to diagnose the presence of pathogens that grow for a long time without resorting to time-consuming microbiological methods. The specificity of PCR reaches 100%.

Carrying out PCR. In the simplest case, the following components are required for PCR: a DNA template containing the portion of DNA to be amplified; two primers complementing the ends of the desired fragment; thermostable DNA polymerase; deoxynucleotide triphosphates (A, G, C, T); Mg^{2+} ions required for the operation of the polymerase; buffer solution. PCR is carried out in a polymerase amplifier — a device that ensures the periodic cooling and heating of test tubes, usually with an accuracy of at least 0.1°C. To prevent the evaporation of the reaction mixture, a high-boiling oil, such as vaseline, is added to the test tube. The addition of special enzymes can increase the efficiency of the PCR reaction.

Course of the reaction. Usually, 20–35 cycles are carried out in PCR, each consisting of three stages. The double-stranded DNA template is heated to 94–96°C (or 98°C if an especially thermostable polymerase is used) for 0.5–2 minutes to separate the DNA strands. This stage is called denaturation — the hydrogen bonds between the two strands are broken. Sometimes, before the first cycle, the reaction mixture is preheated for 2–5 minutes to completely denature the template and primers. When the strands are separated, the temperature is lowered to allow the primers to bind to the single-stranded template. This stage is called annealing. The annealing temperature depends on the primers and is usually chosen 4–5°C below the melting point. The duration of this stage is 0.5–2 minutes.
DNA polymerase replicates the template strand using the primer. This is the elongation stage. The elongation temperature depends on the polymerase. The most frequently used polymerases are most active at 72°C. The elongation time depends on both the type of DNA polymerase and the length of the amplified fragment.

For successful analysis, it is important to correctly collect the material from the patient and prepare it properly. It is known that in laboratory diagnostics, most errors (up to 70%) occur at the sample preparation stage. In the INVITRO laboratory, vacuum systems are currently used for blood collection, which, on the one hand, cause minimal injury to the patient, and on the other hand, make it possible to obtain the material without contact. This prevents contamination of the material and ensures the objectivity of the PCR analysis.

§2.2.5. Statistical Method

The numerical materials of the research were processed using the *Microsoft Excel 2003 (XP)* software through the method of variational statistics. In this process, using both parametric and non-parametric variational statistics, the following were calculated: the arithmetic mean (M), standard deviation, standard error of the mean (m), and relative values (degree, %). The statistical significance of the observed shifts in the mean quantitative values between research groups was determined using the Student's *t*-test by calculating the probability of error (P). Quantitative changes with a reliability level of $p<0.05$ were considered statistically significant.

To determine the correlation relationship between the studied groups, correlation-regression analysis (Pearson's correlation coefficient) was carried out using a medical statistical calculator (https://medstatistic.ru/calculators).

To identify the statistically significant difference in qualitative indicators between groups, the *odds ratio (OR)* was determined, and its 95% maximum and minimum confidence interval (CI) was examined. In cases where the odds ratio was up to 5, statistical significance was evaluated using the four-field table method with Fisher's exact test; when the odds ratio was between 5 and 10, it was evaluated using the χ^2 test with Yates' correction; and when above 10, using the χ^2 test without correction.

To study the structure of intestinal parasitic diseases, the following statistical formula was used:

The structure of intestinal parasitic diseases (%) = occurrence of a single parasitic disease * 100 / total number of all detected parasitic diseases.

Formation of hypotheses about risk factors

Based on the data describing the forms of morbidity obtained from descriptive epidemiological studies, assumptions and hypotheses are formed about the causes of the existing situation, that is, about the cause-and-effect relationships between morbidity (outcome) and the factor that caused this morbidity. The formation of hypotheses about risk factors consisting of certain elements of natural and social conditions that determine the observed forms of morbidity is considered the final goal of descriptive epidemiology.

Hypotheses are formed on the basis of knowledge about a particular disease by applying the methods of formal logic. The methods of formal logic include the following: the method of difference (differentiation); similarity; concomitant variations; agreement. From this set of factors, alternative assumptions based on other methods of hypothesis formulation are consistently excluded.

Initially, risk factors that are convenient to substantiate and study are excluded. As a result, a hypothesis is formed about the effect of the residual risk factor. Hypotheses are formed on the basis of certain observed forms of morbidity and compared with scientific data; hypotheses are formed on the basis of scientific data and compared with certain observed forms of morbidity. After that, the hypothesis is tested by analytical studies. It is not always possible to clearly distinguish between the stages of hypothesis formulation and verification.

§2.3. Natural-Geographical and Socio-Demographic Characteristics of the Samarkand Region

Samarkand Region is one of the regions of the Republic of Uzbekistan. It was established on January 15, 1938. The region is located in the central part of the country, within the middle course basin of the Zarafshan River. Its borders adjoin Navoi Region to the west and northwest, Jizzakh Region to the north and northeast, Kashkadarya Region to the south, and Tajikistan to the southeast.

The central part of the region consists of a beautiful oasis, which occupies the area between the Zarafshan and Turkestan mountain ranges, stretching from east to west. The main irrigated lands of the region are located in this very area.

As of 2023, the population exceeds 4.2 million. In this regard, Samarkand Region ranks first in the republic, accounting for 11.4 percent of the country’s total population. The inhabitants are mainly Uzbeks, but there are also representatives of Tajik, Russian, Persian, Ukrainian, Azerbaijani, Armenian, Korean, Belarusian, Tatar, Meskhetian Turk, Jewish, Romani, and other nationalities.

The territory of the region covers 16.88 thousand square kilometers. In terms of the number of rural districts, Samarkand Region ranks first among the Republic of Karakalpakstan and other regions. There are 16 such districts in this region: Bulungur, Jomboy, Ishtikhon, Kattakurgan, Narpay, Nurobod, Oqdaryo, Payariq, Pastdargom, Paxtachi, Samarkand, Toyloq, Urgut, and Qushrabot districts. There are two cities — Samarkand and Kattakurgan.

Samarkand Region is situated on the western edge of the Pamir-Alay mountains, in the middle part of the Zarafshan River. Its relief mainly stretches along plains, surrounded by branches of the Turkestan mountain range to the north (Nurata mountain with an elevation of 2169 m, Oktoğ 2003 m) and by the Zarafshan mountain range to the south, encompassing the Zarafshan River valley. The valley descends from east to west — from 750–800 meters to 350 meters. The valley consists of sloping plains and foothills.

Climate: The climate is continental and arid. Cloudy days are rare. Winters in the plains are mild. The average temperature in January is -2°C in the north and -5°C in the mountains. Summers are hot, with an average July temperature of 26°–28°C. The average annual precipitation ranges from 282 to 460 mm. The vegetation period lasts 325–335 days. As altitude increases, the temperature gradually decreases. The climatic conditions and irrigation system of the Samarkand Region allow for the cultivation of cotton, tobacco, tea, and fruit trees such as peaches, apricots, plums, grapes, figs, and pomegranates, as well as grain crops like wheat, millet, and barley.

The main river is the Zarafshan. Within the region, its length is 193 km. Other waterways used for irrigation include the Dargom, Narpay (54 km), Right Bank (64 km), Left Bank (169.3 km), Central Main (39.5 km), Zarafshan, and Old Anhor canals, as well as the Kattakurgan Reservoir.

The soil is predominantly gray-brown (bo’z) soil. In the plains and up to an altitude of 500 meters, there are light gray soils; in irrigated lands, meadow-gray soils; at altitudes of 1500–1700 meters, dark gray soils; and in desert areas, sandy, takyr (hard clay), and brownish-gray soils are widespread.

The main river of the valley, the Zarafshan, originates from glaciers and is fed by snow and glacier meltwater. Therefore, the river’s water regime is quite stable, ensuring the continuous operation of hydroelectric power stations throughout the year and preventing floods. To use the water efficiently, the Kattakurgan Reservoir was built in the middle course of the Zarafshan, and the Quyimozor Reservoir in its lower course. Through the Old Anhor Canal, the waters of the Zarafshan also reach the Kashkadarya Region. In terms of water use efficiency, no river in Central Asia can match the Zarafshan — about 90 percent of its waters are used for irrigation. The region’s groundwater flows close to the surface; although it contains relatively few salts, it is not suitable for drinking.

CHAPTER III. ASSESSING THE PREVALENCE OF PARASITIC DISEASES IN THE REGION

§3.1. Results of the retrospective epidemiological analysis of the dynamics and nosological composition of parasitic diseases in the Samarkand Region from 2011 to 2021

The analysis of the overall incidence of parasitic diseases in the Samarkand Region from 2011 to 2021 shows that, during this period, the average incidence per 100,000 population was 363.4, fluctuating from 160.3 (in 2020) to 474 (in 2014).

However, it should be noted that the 2020 figure represents an unusually “low” value. In 2020, due to the COVID-19 pandemic, priorities in the healthcare sector shifted, which led to a significant decrease in population visits for other diseases, including parasitic infections, as well as a reduction in the diagnosis and identification of these diseases. For this reason, the incidence of intestinal parasitic diseases in 2020 (160.3) was recorded 2.3 times lower than the average value (363.4). Since this represents an anomalous deviation in the long-term dynamics of intestinal parasitic disease incidence in the region, it is methodologically appropriate to exclude the 2020 data from further analyses—especially in studies related to disease intensity—to avoid bias. When the 2020 figure is excluded from the series covering 2011–2021, the average incidence per 100,000 population rises to 373.1 (see Figure 3.1).

According to the analysis, during the period from 2011 to 2021, in all years except 2018 (281.0), the incidence of parasitic diseases was above the average value (373.1), whereas between 2016 and 2021, it was below the average. Thus, the long-term dynamics of parasitic disease incidence in the Samarkand Region can be divided into two periods: one characterized by high incidence intensity and another by relative decline.

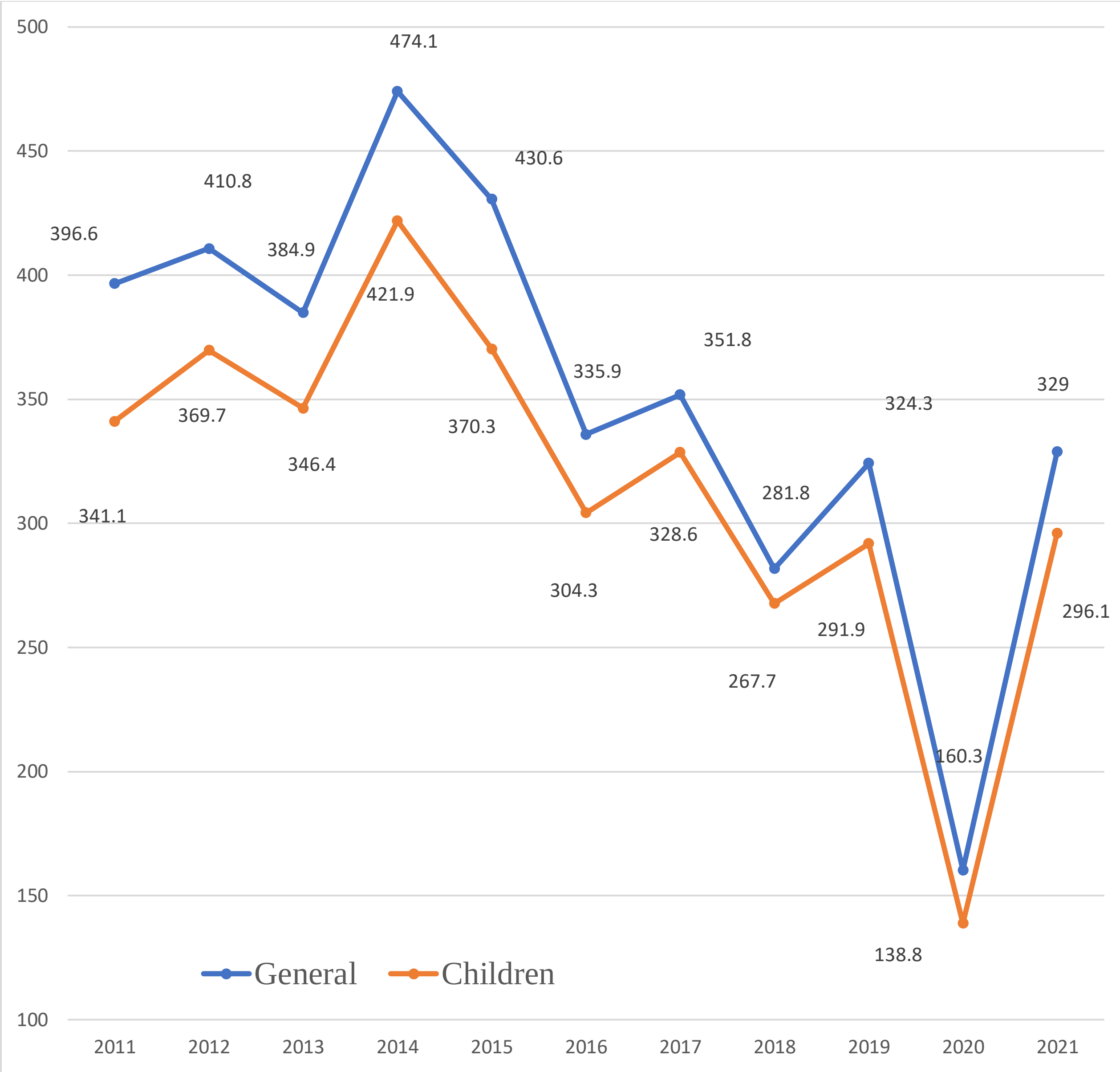


Figure 3.1. Dynamics of parasitic disease incidence in the Samarkand Region from 2011 to 2021 (incidence per 100,000 population)

During the period of high incidence (2011–2015), the level of morbidity was 1.1 times higher than the average indicator, and no declining trend in morbidity was observed during this period. Specifically, the incidence at the beginning of the observed years (2011) was 396.6, while by the end of the period (2015) it had reached 430.6 (see Figure 3.1). This indicates that factors determining the intensity of intestinal parasitic diseases consistently affected the population throughout these years.

During the period of relative decline (2016–2020), morbidity was recorded as 1.18 times lower (2017) and 1.4 times lower (2018) than the average indicator. Compared to 2011, the incidence decreased by 1.18 times in 2016 and by 1.2 times by 2021.

When analyzing parasitic disease incidence among children in Samarkand Region, it was found that from 2011 to 2021, children accounted for an average of 89.6% of total cases. From 2017 to 2021, the share of children in overall morbidity increased, reaching 90.0% in 2021 (see Figure 3.1).

Examining the trend of intestinal parasitic disease incidence over the studied years, the morbidity level showed a wave-like pattern, rising and falling. Between 2015 and 2020, the trend of morbidity decreased, but by 2021, the incidence rose again. Using Excel to forecast the trend for the next two years indicated that the incidence of parasitic diseases is likely to increase, with a 72.0% confidence interval ($R^2 = 0.82$) (see Figure 3.2).

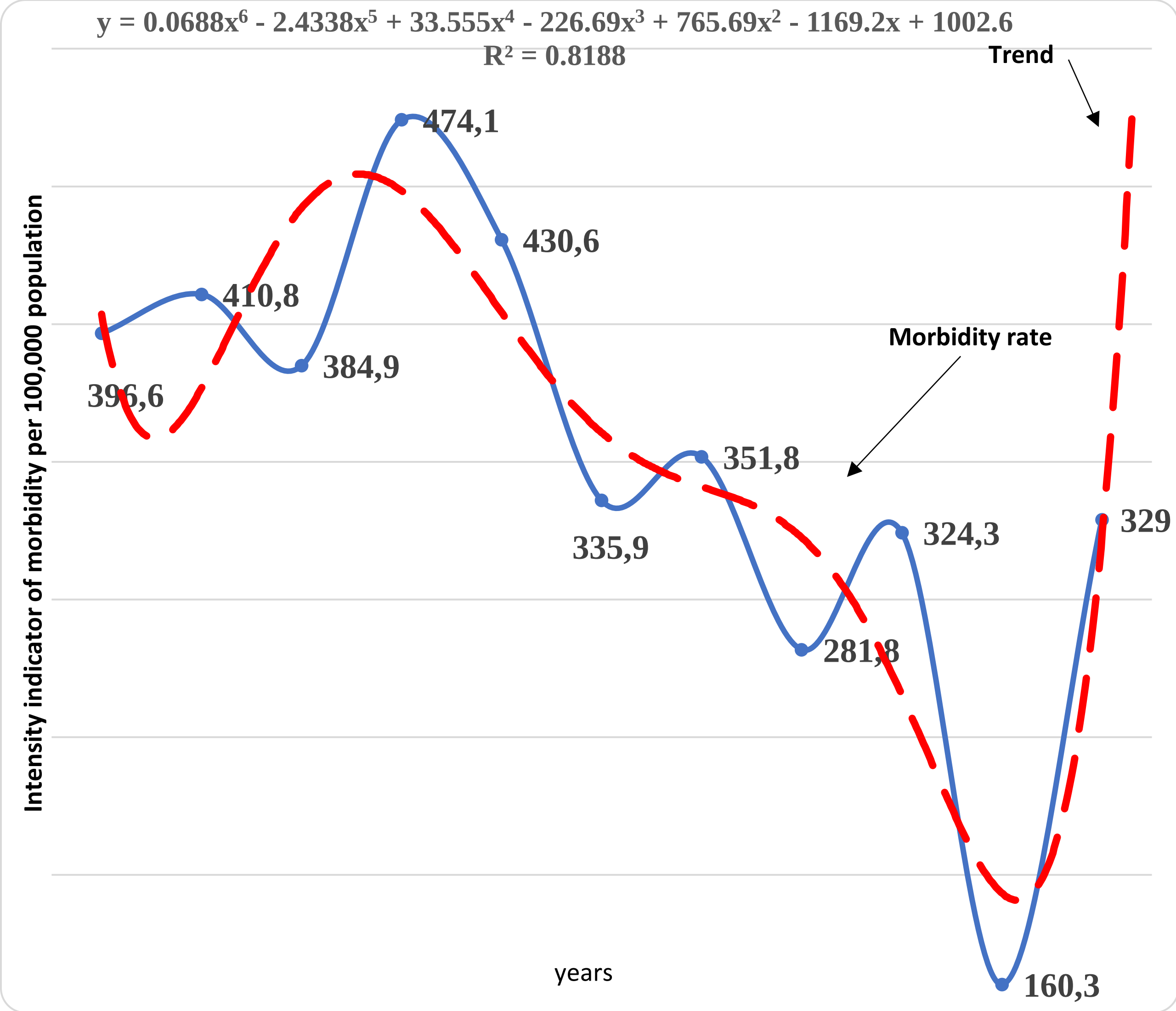


Figure 3.2. Trend of intestinal parasitic disease incidence in Samarkand Region from 2011 to 2021 (intensity indicator per 100,000 population)

In the next stage, we analyzed the compositional structure of parasitic diseases identified in Samarkand Region over the years. For this, we used the following statistical formula:

Structure of parasitic diseases (%) = Number of cases of a specific parasite × 100 / Total number of identified parasitic diseases

According to the results, over the past 11 years, enterobiasis occupied the leading position among identified intestinal parasites, averaging 60.3% between 2011 and

2021. During the studied years, its incidence ranged from 53.7% to 63.2%. The next most common was giardiasis, averaging 24.03%, fluctuating between 21.2% and 25.5% during the studied period. Among intestinal parasites identified in Samarkand Region, hymenolepiasis ranked third, with an average of 15.0%, observed within the range of 9.9–18.3% over the last 10 years.

Among the identified intestinal parasites in Samarkand Region, very low percentages were observed for teniarinchiasis (0.28%), echinococcosis (0.33%), and ascaridosis (average 0.02% per year). The incidence of these identified intestinal parasites did not show statistically significant changes over the years (see Figure 3.3).

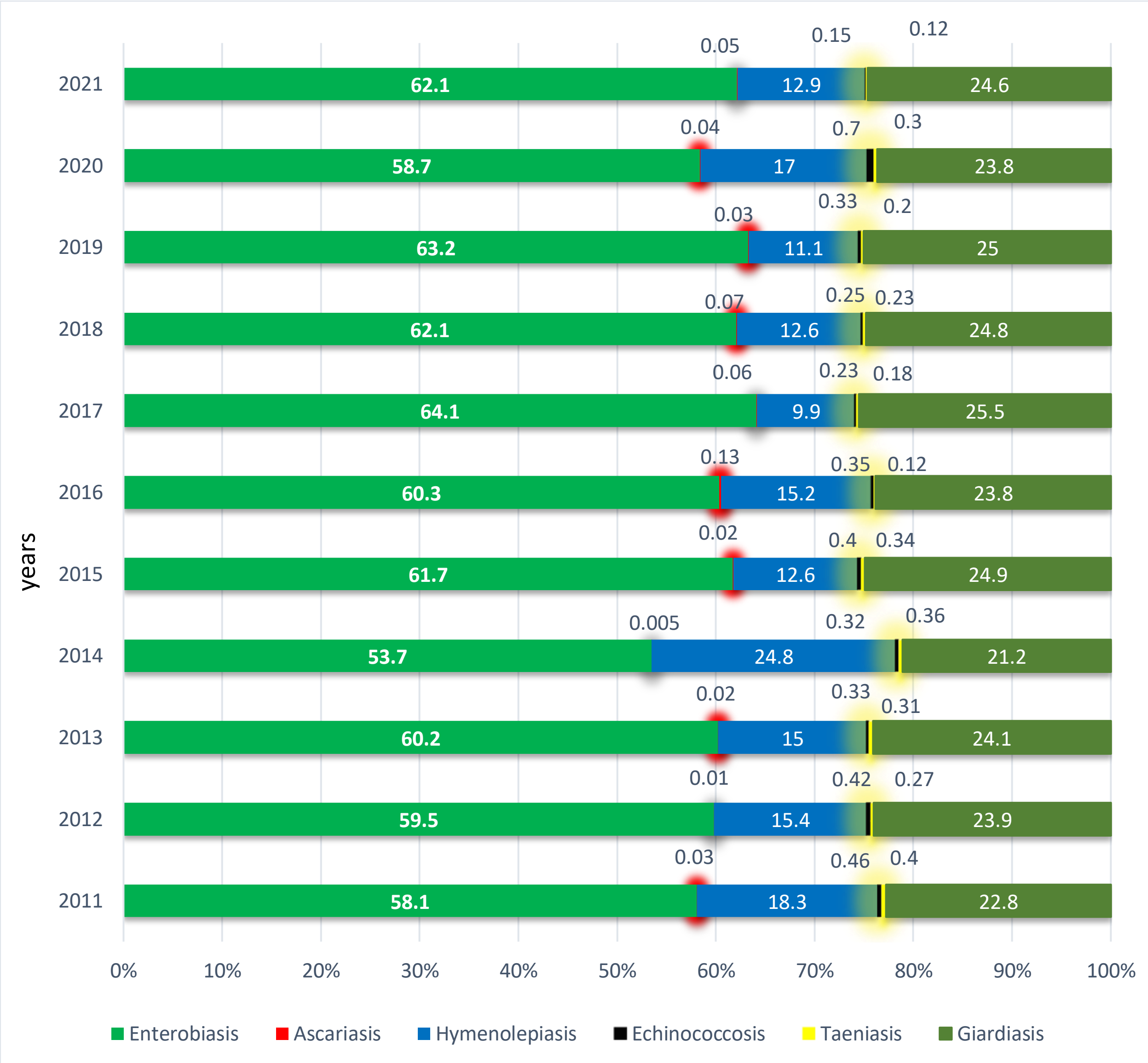
To determine the level of parasitic disease prevalence in the districts of Samarkand Region, we examined the mathematical model for calculating the prevalence of parasitic diseases in a specific area proposed by de Silva & Hall (2010) (P_{alh}).

$$\mathbf{P_{alh} = a + t + h - (a \times t + a \times h + t \times h) + (a \times t \times h) / 1.06}$$

Where:

- **a** = prevalence rate of ascariasis (%)
- **t** = prevalence rate of trichocephalosis (%)
- **h** = prevalence rate of hookworm infection (%)

[3] WHO Library Cataloguing Publication Date: Helminth control in school age children a guide for managers of control programmes -2hd ed. 2012.-76p.



3.3-Figure. Structural composition of parasitic diseases in Samarkand region (relative to all parasitic diseases identified in Samarkand region)

We adapted the mathematical calculation model for the prevalence of intestinal parasitic diseases in a given area, proposed by de Silva & Hall (2010) (Palh), for

Samarkand region, taking into account the leading intestinal parasitic diseases, and developed an adapted version of this mathematical model.

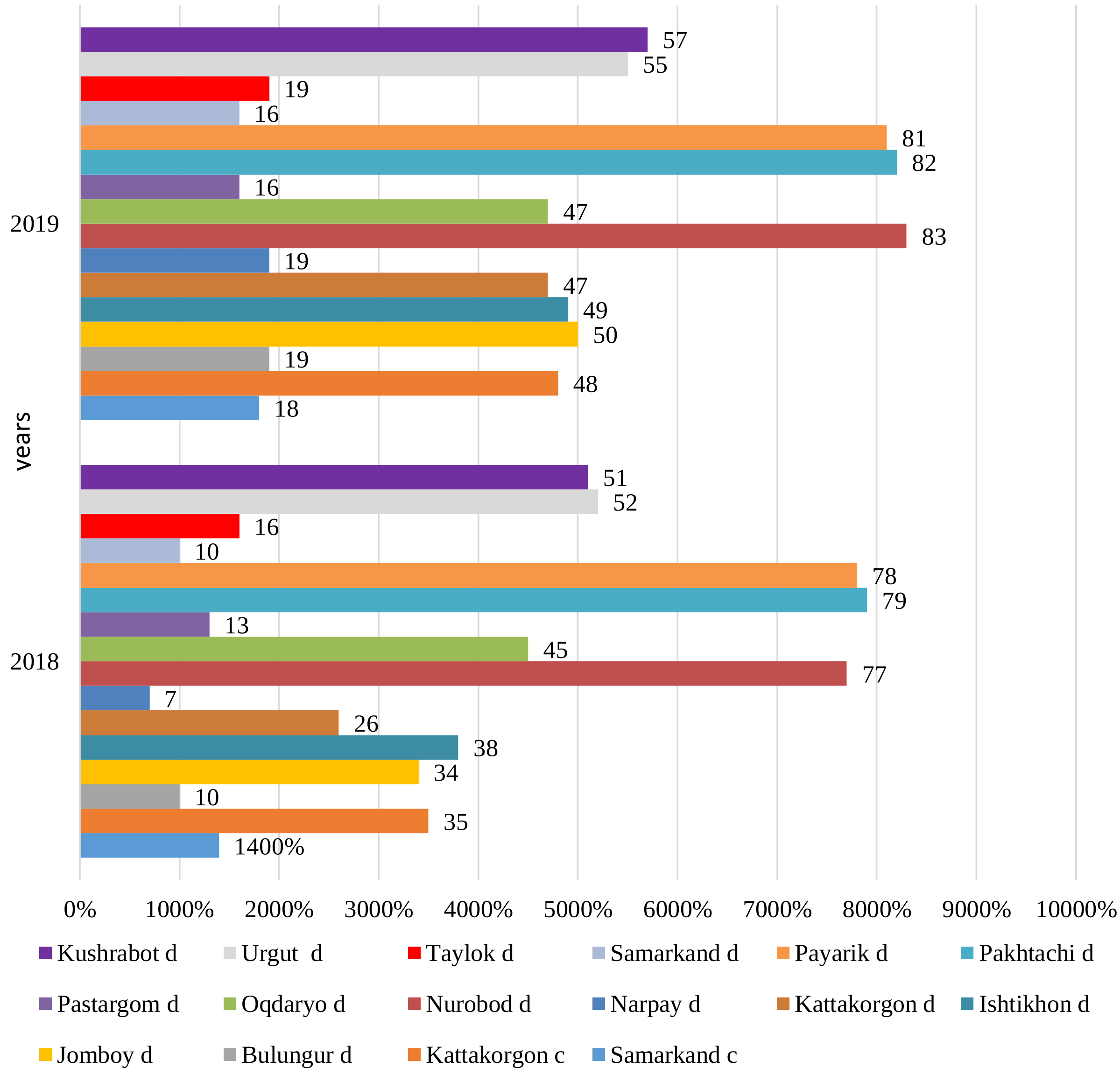
$$\mathbf{Pelh = e + l + h - (e \times l + e \times h + l \times h) + e \times l \times h / 1.06}$$

Where:

e = prevalence of enterobiasis (%)

l = prevalence of giardiasis (%)

h = prevalence of hymenolepiasis (%)



3.4-Figure. Assessment of the prevalence of parasitic diseases in the districts of Samarkand region using the mathematical calculation model (Pelh) (2018 and 2019) (%)

Using this mathematical model, we separately evaluated the degree of parasitic disease prevalence in all districts of Samarkand region for 2018 and 2019, taking into account the leading parasitic infections observed. Areas with a parasitic disease prevalence of ≥50% were considered hyperendemic; areas with ≥20% but <50% were considered mesoendemic; and areas with <20% were considered hypoendemic. As shown in Figure 3.4, in the districts of Pakhtachi, Payariq, Nurabad, Urgut, and Qo‘shrabot, the prevalence of parasitic diseases was ≥50%, and therefore these areas were classified as hyperendemic. In the districts of Jomboy, Ishtikhon, Kattaqo‘rg‘on, Oqdaryo, Pastdarg‘om, as well as Kattaqo‘rg‘on city, the prevalence ranged between ≥20% and <50%, and these districts were classified as mesoendemic. In the districts of Narpay, Bulung‘ur, Toyloq, Samarkand, and Samarkand city, the prevalence was <20%, so these areas were classified as hypoendemic. Based on these data, a map of the districts of Samarkand region was created showing the prevalence of enterobiasis, hymenolepiasis, and giardiasis infections (see Figure 3.5). On this map, areas colored red are hyperendemic, yellow indicates mesoendemic areas, and green indicates hypoendemic areas.

From the map, it is evident that districts with large areas located on the periphery of the region had a high prevalence of parasitic diseases; districts of medium size in the central part of the region were mesoendemic; and smaller districts were classified as hypoendemic.

Based on the above, it can be concluded that over the period 2011–2021 in Samarkand region, the prevalence of parasitic diseases showed two distinct periods – a period of high intensity of infection and a period of relative decline. The trend of disease dynamics had a wave-like character, and in the following years, the prevalence is projected to increase with a confidence interval of 75.0%.

In the structure of identified intestinal parasites, enterobiasis, hymenolepiasis, and giardiasis occupied the leading positions. When assessing the prevalence of intestinal parasitic infections in the districts of Samarkand region using the developed mathematical model, it was found that the degree of parasitic disease prevalence was unevenly distributed among the districts.

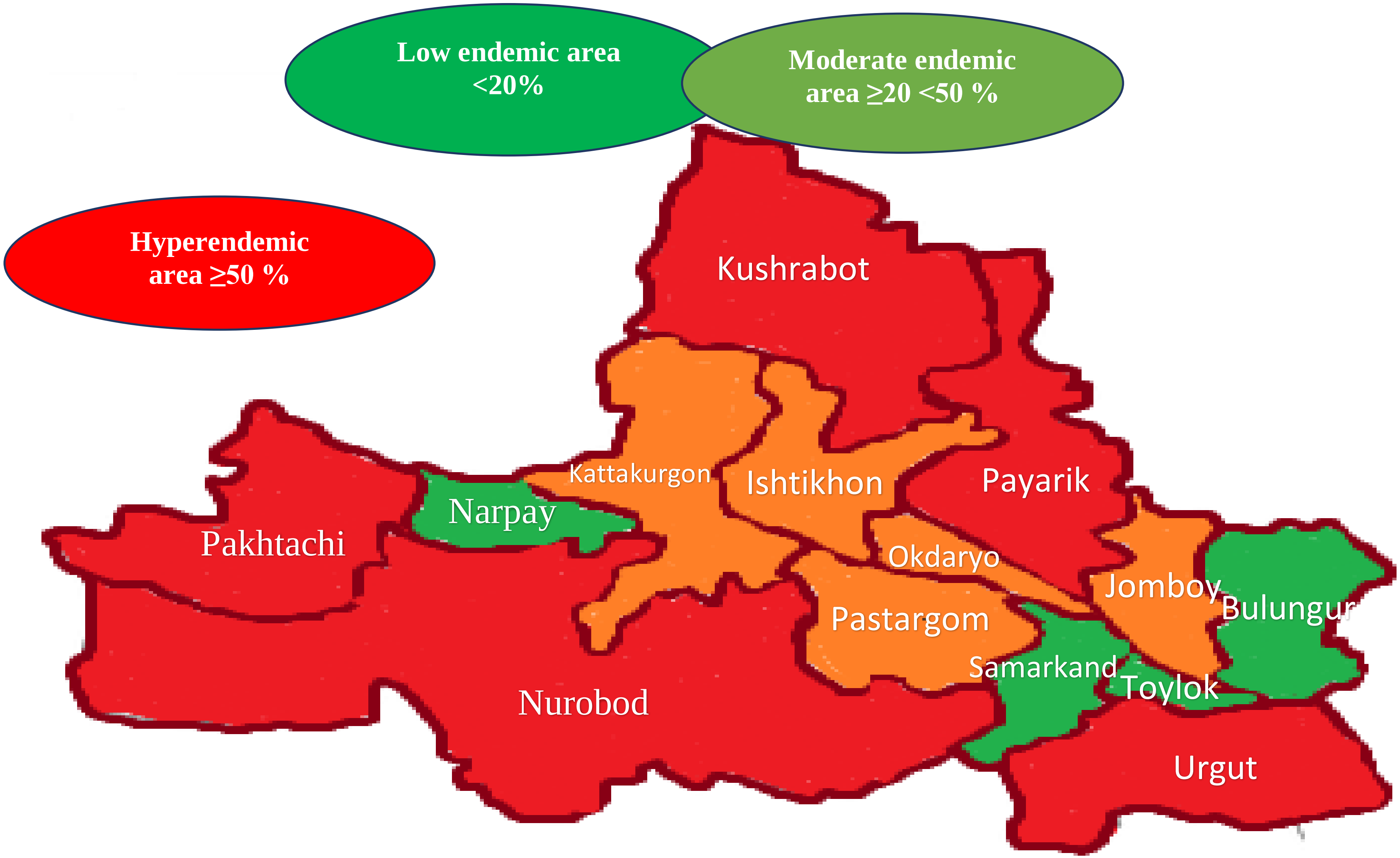
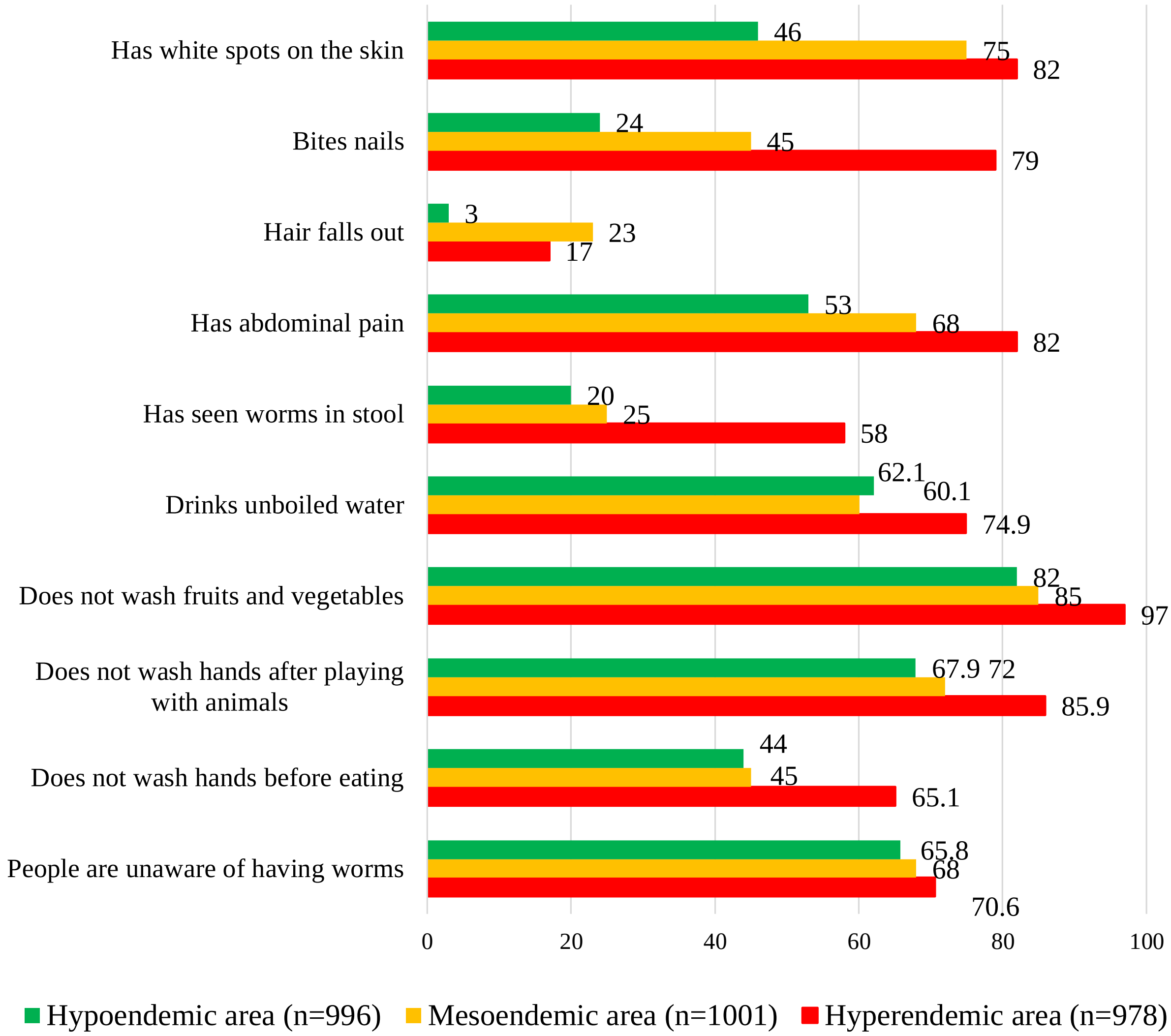


Figure 3.5. Map of Samarkand region districts showing the prevalence of enterobiasis, hymenolepiasis, and giardiasis infections

§3.2. Assessment of Schoolchildren's, Parents', and School Staff's Awareness of Helminthiasis

In the next stage of the study, in order to identify the reasons for the uneven distribution of parasitic diseases in the districts of Samarkand region, we comparatively analyzed the factors influencing the degree of infestation in each area. For this purpose, we selected one school located in each of the hyperendemic, mesoendemic, and hypoendemic areas identified using the previously developed mathematical model. A questionnaire, developed by researchers and approved by the Scientific Council of Samarkand Medical University, was conducted to assess the level of awareness about parasitic diseases among students aged 7 to 14, their parents, and the teaching staff of these schools. Based on the analysis of the survey results, regardless of the level of infestation in the area, on average 70% of the participating students did not know that worms can be transmitted to humans from the external environment. As shown in Figure 3.6, 65.1% (637) of students in the hyperendemic area and 44.0% (438) in the hypoendemic area did not wash their hands before eating (OR = 2.380; 95% CI = 1.985–2.85), and 85.9% (840) of students in the hyperendemic area and 67.9% (676) in the hypoendemic area did not wash their hands after playing with animals (OR = 2.88; 95% CI = 2.3–3.6). However, the difference between these two indicators was not statistically significant ($P > 0.05$). A statistically significant difference (Yates-corrected $\chi^2 < 0.001$) was observed in the consumption of unwashed fruits: 97.0% (949) of students in the hyperendemic area consumed fruits without washing, compared to 82.0% (817) in the hypoendemic area (OR = 7.7; 95% CI = 4.8–10.7). Regardless of the area, on average 65.7% of children drank unboiled water (OR = 1.8; 95% CI = 1.5–2.2) ($P > 0.05$). When students were asked whether they had ever seen worms in their feces, analysis of the responses showed that 567 students in the hyperendemic area and 199 students in the hypoendemic area answered "Yes" (OR = 5.5; 95% CI = 4.5–6.8), meaning that a statistically significant proportion of children in the hyperendemic area had observed worms in their feces (Yates-corrected $\chi^2 < 0.05$).



3.6-Figure. Analysis of the survey results (%) conducted among the schoolchildren under observation

Analysis of the responses to questions about the prevalence of the main clinical signs of parasitic diseases among schoolchildren showed that 82.0% (802) of students living in hyperendemic areas and 53.0% (528) of those in hypoendemic areas reported experiencing abdominal pain (OR = 4.0; 95% CI = 3.3–4.9) ($P > 0.05$). Hair loss was observed in 17.0% (166) and 3.0% (30) of students, respectively (OR = 6.5; 95% CI = 4.4–9.8) (Yates-corrected $\chi^2 < 0.05$); nail-biting habit was present in 79.0% (773) and 24.0% (239) of students, respectively (OR = 11.9; 95% CI = 9.7–14.8) ($\chi^2 < 0.001$); and white spots on the skin were found in 82.0% (802) of students in hyperendemic areas and 46.0% (458) in hypoendemic areas (OR = 5.4; 95% CI = 4.4–6.6) (Yates-corrected $\chi^2 < 0.05$).

These data indicate that children in hyperendemic areas had a statistically significantly higher prevalence of key clinical signs of parasitic diseases, such as nail-biting and hair loss, compared to children in hypoendemic areas. However, the symptom of abdominal pain, which is commonly observed in parasitic diseases, did not differ significantly between the groups.

At the next stage, we comparatively analyzed the survey results among the parents of these students across regions. As shown in Figure 3.7, regardless of the region, on average 80.1% of parents were unaware that worms cause diseases in humans. Without statistical significance, an average of 36.6% of parents did not know that diseases could be transmitted through dirty hands (OR = 1.9; 95% CI = 0.8–4.4), 84.2% did not know that poorly washed fruits can transmit diseases (OR = 2.7; 95% CI = 1.1–6.7), and 72.7% were unaware that flies can carry helminth eggs (OR = 2.37; 95% CI = 1.2–5.3) ($P > 0.05$). Additionally, only 19.9% (16) of parents in hyperendemic areas and 36.8% (23) in hypoendemic areas knew that parasitic diseases could be transmitted through household contact (OR = 2.36; 95% CI = 1.1–5.0), and this indicator did not differ significantly between the groups ($P > 0.05$).

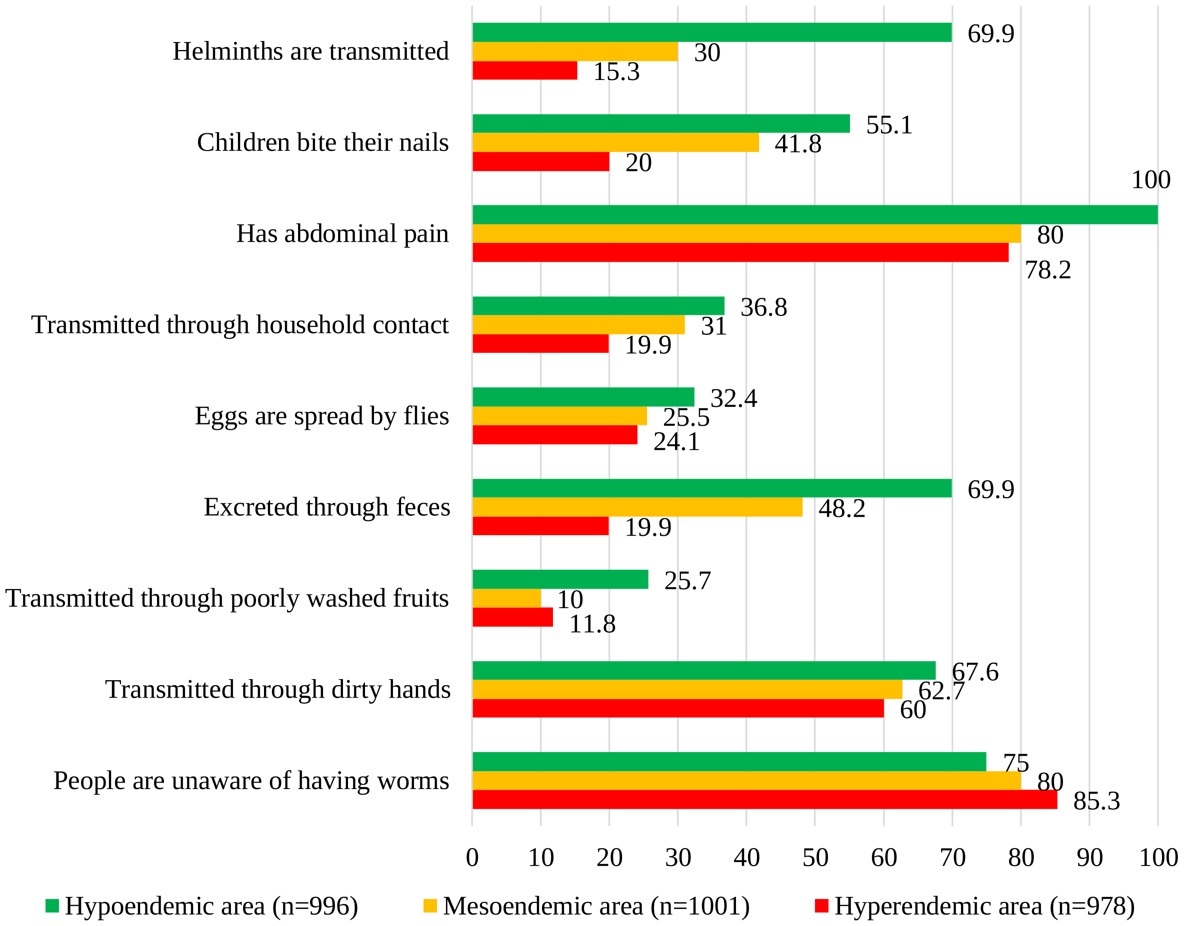
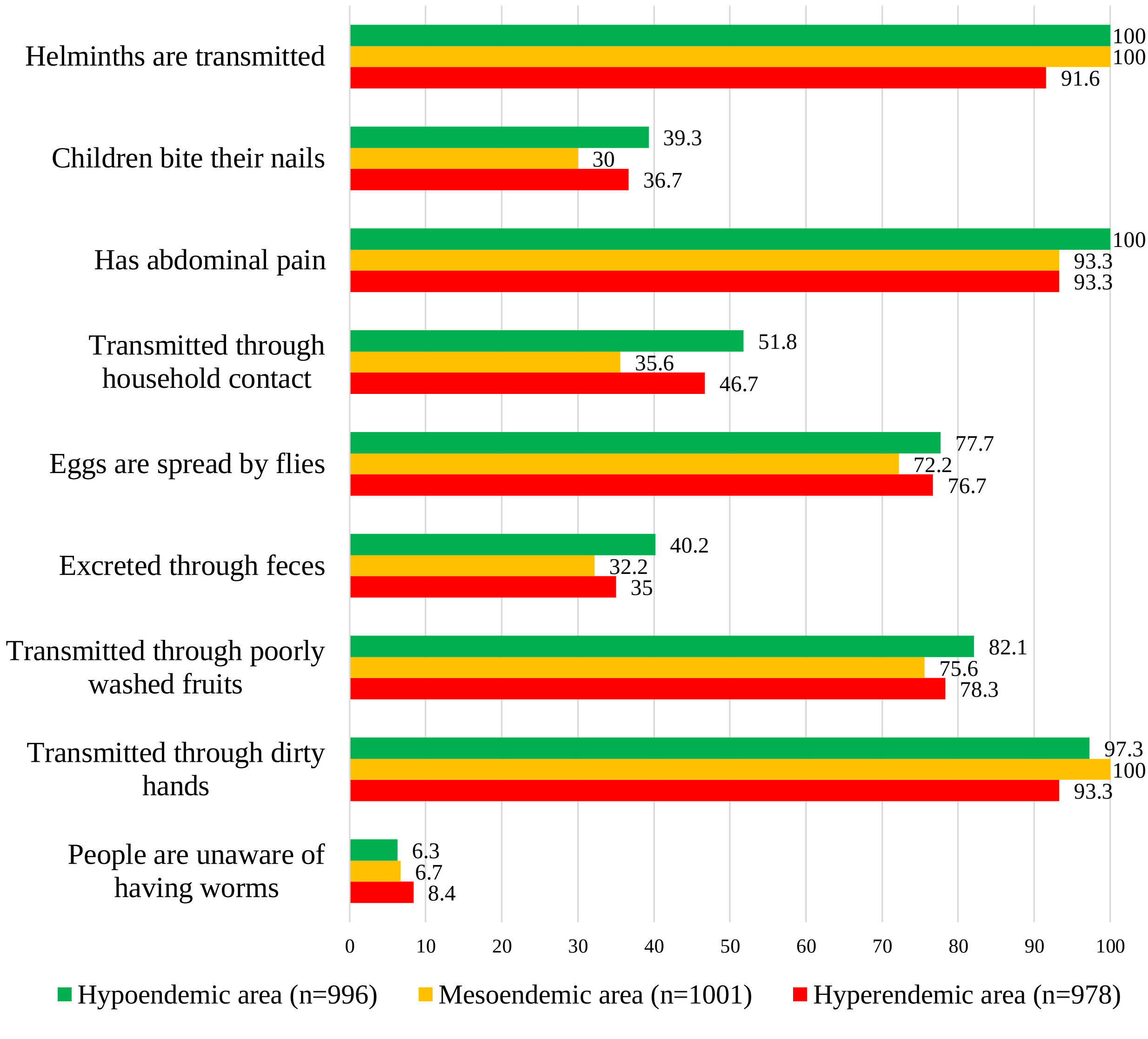


Figure 3.7. Analysis of survey results conducted among parents (%)

With statistically significant differences, 69.9% (43) of parents living in hypoendemic areas knew that worms are excreted in the feces of infected children, while only 19.9% (16) of parents in hyperendemic areas were aware of this (OR = 9.0; 95% CI = 4.2–19.5) (Yates-corrected $\chi^2 < 0.001$).

Analysis of parents’ knowledge regarding the main clinical signs characteristic of parasitic diseases showed that all parents in hypoendemic areas (62) were aware that intestinal helminths cause abdominal pain (in hyperendemic areas – 63) (OR = 16.5; 95% CI = 2.1–127.5) ($\chi^2 < 0.001$), 55.1% (34) knew that children develop the habit of nail-biting when infected with intestinal helminths (in hyperendemic areas – 16) (OR = 5.1; 95% CI = 2.3–10.2) (Yates-corrected $\chi^2 < 0.05$), and 69.9% understood that parasitic diseases are contagious (OR = 12.8; 95% CI = 5.7–29.0) — all significantly higher than parents in hyperendemic areas.

Analysis of the questionnaire results among teachers working in these schools (Figure 3.8) showed that, regardless of the region, on average 92.9% of teachers answered "Yes" to the question of whether worms can cause diseases in the human body.



3.8-figure. Analysis of the survey results conducted among the observed teachers (%)

Regardless of the region, on average, 96.9% of teachers know that infectious diseases are transmitted through dirty hands, 78.7% know they can be transmitted through poorly washed fruits, 75.5% know that flies spread helminth eggs, and 97.2% know that helminths can be transmitted from person to person. At the same time, all teachers are aware of some key clinical signs of parasitic diseases: on average, 95.5% know that abdominal pain occurs, and 35.3% know that children infected with helminths may develop the habit of nail-biting. However, regardless of the region, 64.2% of teachers do not know that helminth eggs are excreted into the external environment through feces, and 55.5% do not know that helminth eggs can be transmitted from person to person via household-contact routes.

A strong negative correlation (r = -0.992) was identified between the level of parasitic disease prevalence in the region and the awareness of parasitic diseases among schoolchildren and their parents. In other words, low awareness of parasitic diseases among parents and children increased the level of parasitic disease prevalence.

Based on the above, it can be concluded that factors affecting the prevalence of parasitic diseases in a region are associated with the low level of awareness about parasitic diseases among children living in the area and their parents. In hyperendemic regions, 71.0% of children and 85.0% of parents lack knowledge about parasitic diseases, and as a result, nearly 90.0% of children do not follow personal hygiene rules.

§3.3. Identification of the Leading Risk Factors Contributing to the Spread of Parasitic Diseases (Enterobiasis, Hymenolepiasis, Giardiasis) among Children in the Samarkand Region

In the next phase of the study, we examined factors contributing to the spread of parasitic diseases in the regions by assessing schools located in the areas identified through the mathematical model. These factors included the level of access to clean drinking water in schools, as well as the condition of school toilets and waste disposal facilities. As shown in Figure 3.9, 68.8% of schools in hypoendemic areas had access to clean drinking water, whereas in hyperendemic areas, this figure was only 33.4%.

A strong negative correlation (r = -0.995) was found between the prevalence of parasitic diseases in the region and the level of access to clean drinking water. That is, as access to clean drinking water decreased, the prevalence of intestinal parasitic diseases increased.

In hyperendemic areas, an average of 66.0% of school toilets were in unsatisfactory condition, compared to 51.0% in mesoendemic areas and 24.0% in hypoendemic areas. A strong positive correlation (r = 0.980) was observed between the unsatisfactory condition of school toilets and the prevalence of parasitic diseases, indicating that the worse the toilet conditions, the higher the prevalence of parasitic infections.

Similarly, a strong positive correlation (r = 1.000) was identified between the sanitary-hygienic condition of school waste disposal facilities and the prevalence of parasitic diseases. In hyperendemic areas, an average of 69.0% of school waste facilities were in unsatisfactory condition, compared to 45.0% in mesoendemic areas and only 23.0% in hypoendemic areas.

As a factor contributing to the spread of parasitic diseases in the regions, official data were analyzed from the Samarkand Regional Department of the Sanitary-Epidemiological Welfare and Public Health Committee regarding the level of use of the centralized sewage system in Samarkand region. As of 2020, only 13.8% of the region used this service, including 88.5% in Samarkand city, 29.2% in Kattaqorgon city, 0.9% in Oqdaryo district, and 11.7% in Bulungur district.

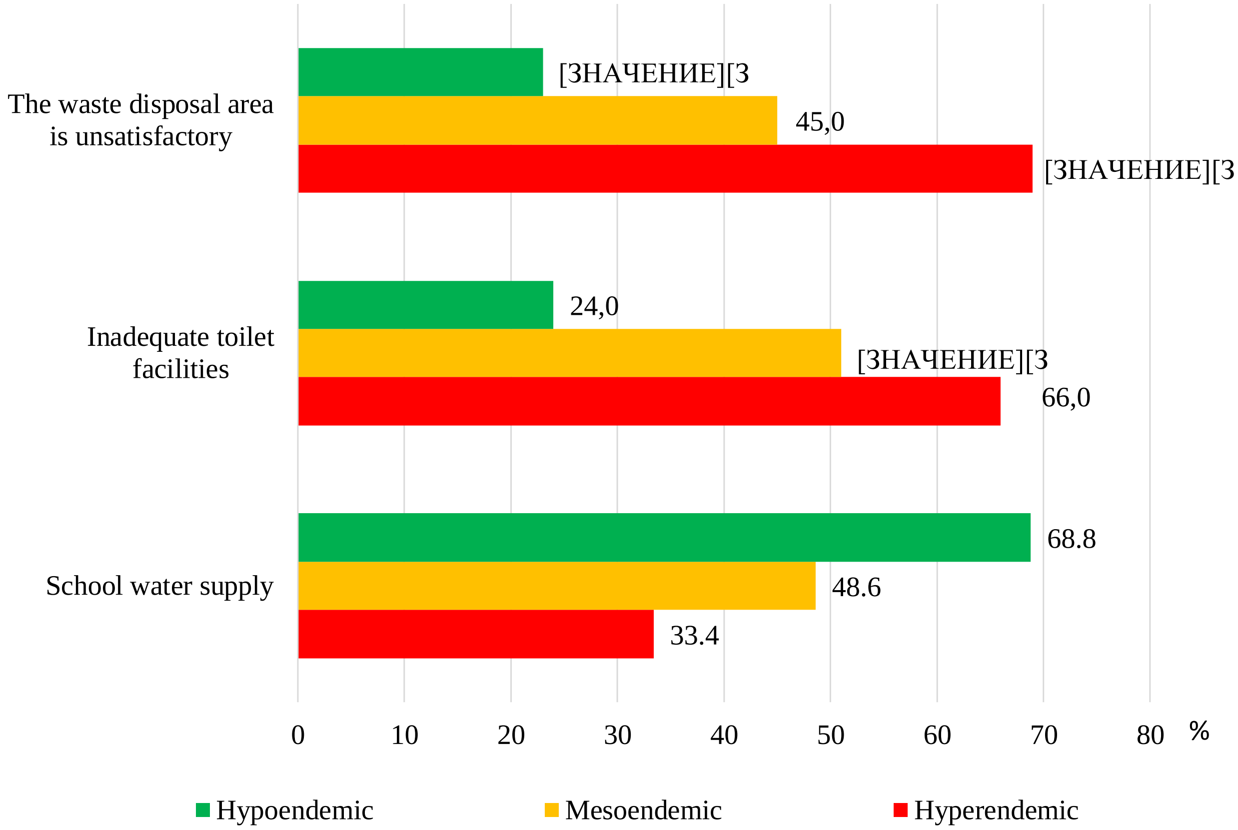


Figure 3.9. Analysis of Inspection Results Conducted in Schools in the Studied Areas (%)

When the official data obtained from the Samarkand Regional Department of the Sanitary-Epidemiological Welfare and Public Health Committee regarding the level of access to clean drinking water in the districts of Samarkand region were comparatively analyzed in the areas identified using the mathematical model, it was found that in hyperendemic areas for intestinal parasitic infections, the average level of access to clean drinking water was 31.2%. In mesoendemic areas, this figure was on average 55.3%, and in hypoendemic areas, 81.5%. A strong negative correlation was observed between the level of access to clean drinking water and the prevalence of intestinal parasitic infections (r = -0.89). In areas with lower access to clean drinking water, the prevalence of intestinal parasitic diseases was higher.

In the next stage of the study, as a factor influencing the spread of parasitic diseases, we comparatively analyzed the proportion of unorganized children (children not attending kindergartens) aged 2 to 7 years living in the regions. This information was also obtained from the official records of the Samarkand Regional Department of the Sanitary-Epidemiological Welfare and Public Health Committee. According to the analysis, in districts with a parasitic disease prevalence above 50.0%—Pakhachi (46.0%), Payariq (44.0%), Nurabad (40.0%), Urgut (45.0%), and Qoshrobot (41.0%)—the average proportion of unorganized children was 43.2%. In districts with a prevalence below 20.0%—Narpay (32.0%), Bulungur (24.0%), Tayloq (24.0%), and Samarkand city (20.0%)—this value averaged 25.0%. A moderate positive correlation was observed between the prevalence of intestinal parasitic infections and the proportion of unorganized children aged 2 to 7 years living in the area ($r = 0.74$). An increase in the proportion of unorganized children leads to an increase in the prevalence of parasitic diseases in the region.

Based on the above, it can be concluded that factors influencing the prevalence of parasitic diseases in the regions include the low level of access to clean drinking water in schools, unsatisfactory sanitary-hygienic conditions of school toilets and waste disposal, low utilization of centralized sewage services by the population, and a proportion of unorganized children aged 2 to 7 years exceeding 44.0%.

CHAPTER IV. IMPROVING AND IMPLEMENTING THE MASS DEWORMING ALGORITHM AMONG SCHOOL STUDENTS

To comparatively study the existing methods for diagnosing parasitic diseases, 57 fifth-grade students from the previously studied school in the hyperendemic area, whose parents consented to their participation in the study, were selected. To detect intestinal helminth infections in these students, stool samples were collected for triple coproscopy, and additional stool samples were taken for PCR to identify parasite DNA. Additionally, 5 ml of blood was collected for ELISA testing to detect anti-Giardia IgM antibodies (Table 4.1)

Table 4.1

Detection Rates (%) of Enterobiasis, Hymenolepiasis, and Giardiasis by Different Diagnostic Methods

Result / Diagnostic Method	Pinworm eggs (absolute number)	Hymenolepis eggs (absolute number)	Giardia cysts (absolute number)	Negative (absolute number)
Coproovoscopy Method (n=57)	28	10	15	4
PCR (n=57)	19	11	17	10
ELISA (n=57)	-	-	36	21
OR	2,4	1,8	3,6* 4,96** 4,65***	
P	>0,05	>0,05	>0,05* <0,001** <0,001***	

Note – * – Statistically significant difference between coproscopical and PCR methods
** – Statistically significant difference between coproscopical and ELISA methods
*** – Statistically significant difference between PCR and ELISA methods

According to the analysis of results obtained by the threefold coproscopical examination method, among 57 patients, 49.1% (28) were found to have pinworm eggs, 17.5% (10) had dwarf tapeworm eggs, and 26.3% (15) had Giardia cysts. Only 7.0% (4) of students' stool samples showed no helminth eggs.

When stool samples were examined using the PCR method, pinworm eggs were detected in 33.3% (19), dwarf tapeworm eggs in 19.3% (11), and Giardia cysts in 29.8% (17) of cases, while 17.6% (10) of students' stool samples showed no intestinal helminths.

When IgM antibodies against Giardia were tested in students' blood serum, 63.2% (36) of the 57 students tested positive. As presented in Table 4.1, the detection rate of pinworm eggs using PCR and coproscopical methods was similar, and the odds ratio (OR=2.4; 95% CI=1.0–5.3) was not statistically significant (P>0.05). The detection rate of dwarf tapeworm eggs was also nearly the same between PCR and coproscopical methods (OR=1.8; 95% CI=0.9–7.6), and no statistically significant difference was observed (P>0.05). The detection rate of Giardia cysts in stool samples by coproscopical method was close to that obtained by PCR (OR=3.6; 95% CI=3.4–9.6), with no statistically significant difference (P>0.05). When comparing the coproscopical method results with the detection of IgM antibodies against Giardia in blood serum using ELISA, the probability of detecting Giardia cysts by ELISA was five times higher than by coproscopical method (OR=4.96; 95% CI=2.2–10.6). The probability of detecting Giardia cysts by ELISA was also five times higher than by PCR (OR=4.65; 95% CI=3.1–12.4), and the difference between groups was statistically significant (Yates-corrected χ^2=14.192, P<0.001).

As can be seen, the ELISA method shows hyperdiagnosis of IgM antibodies against Giardia with a fivefold probability ratio. In other cases, the effectiveness of PCR and coproscopical methods is almost the same. Therefore, in practice, it is recommended to use the PCR method to resolve controversial cases of intestinal parasites and to prevent hyperdiagnosis, while in routine cases, the coproscopical method is recommended.

Stool samples from 300 students aged 7 to 14 in a school located in a hyperendemic area were examined using the coproscopical method. According to the results, 47.0% (141) of students had pinworm eggs, 14.3% (43) had Giardia cysts, 8.0% (24) had dwarf tapeworm eggs, 0.7% (2) had beef tapeworm eggs, and 28.7% (86) of students had two or more types of helminth eggs or Giardia cysts simultaneously, indicating mixed parasitic infection (see Table 4.2).

In the mesoendemic area, stool samples from 280 students were examined by coproscopical method. The results showed enterobiasis in 26.1% (73), hymenolepiasis in 3.9% (11), giardiasis in 8.9% (25), and mixed parasitic infection in 17.5% (49). In the hypoendemic area, the coproscopical examination of stool samples from 280 students showed enterobiasis in 11.1% (31), hymenolepiasis in 2.5% (7), giardiasis in 5.0% (14), and mixed parasitic infection in 7.1% (20).

Based on the results, it can be concluded that mixed parasitic infections were observed in 28.7% of children aged 7 to 14 in the hyperendemic area, 17.5% in the mesoendemic area, and 7.1% in the hypoendemic area.

Mass deworming was carried out in the areas identified using our “Mathematical Model for Assessing the Level of Parasitic Infection in the Region.” Albendazole tablets (400 mg) were prescribed for two consecutive days. Fourteen days after deworming, students’ stool samples were re-examined using the coproscopical method for intestinal parasites. The results were comparatively analyzed for the specified regions.

Table 4.2

Comparative Analysis of Coproscopical Results After Mass Deworming (%)

Result / Region	Hyperendemic region(n=300)					Mesoendemic region(n=280)					Hypoendemic region(n=280)				
	Before deworming	14 Days after	6 months after	OR	P	Before deworming	14 Days after	6 months after	OR	P	Before deworming	14 Days after	6 months after	OR	P
Pinworm eggs (%)	47,0	24,3	52,7	2,1	>0,05	26,1	8,6	9,6	3,7	>0,05	11,1	1,0	1,8	11,8	<0,001
Roundworm eggs (%)	8,0	8,7	10,3	2,6	>0,05	3,9	3,6	5,0	1,2	>0,05	7	7	8,6	1,8	>0,05
Giardia cysts (%)	14,3	13,7	14,7	0,85	>0,05	8,9	7,5	6,8	1,9	>0,05	5,0	3,2	2,9	2,1	>0,05
Beef tapeworm (%)	0,7	0,7	0,7	0,45	>0,05	-	-	-	-	-	-	-	-	-	-

Mixed (%)	28,7	28,7	35	1,7	>0,05	17,5	14,6	15,0	0,56	>0,05	7,1	4,6	4,6	0,78	>0,05
Negative result	30,0	53,3	21,6	2,8	>0,05	61,1	80,3	78,6	0,89	>0,05	81,4	88,8	86,7	2,2	>0,05

As presented in Table 4.2, mass deworming positively affected the detection rate of enterobiasis among students, regardless of the region. In hyperendemic areas, the detection rate decreased from 47.0% to 24.3%; in mesoendemic areas, from 26.1% to 8.6%; and in hypoendemic areas, from 11.1% to 1.0%.

The difference between pre- and post-treatment results in hyper- and mesoendemic areas was not statistically significant ($p>0.05$), whereas in hypoendemic areas, the change reached statistical significance ($p=0.092$). The detection rate of Giardia cysts did not change significantly after treatment in any region ($p=0.070$), although a slight decrease was observed in all groups. Similar trends were seen for Hymenolepis and Taenia eggs, indicating that the deworming had no effect on these helminth eggs. Consequently, the values of mixed parasitosis were also not significantly affected.

To assess the effectiveness of mass deworming, the stool of the monitored children was examined by coproovoscopy six months after deworming.

The results showed that in hyperendemic areas, the detection rate of Enterobius eggs increased compared to pre-deworming values. In hypo- and mesoendemic areas, the detection rate of Enterobius slightly increased six months after mass deworming but remained considerably lower than the initial values.

Regarding Hymenolepis eggs, no significant effect of mass deworming was observed. In all monitored children, the detection rate six months later increased compared to the initial values, but this difference was not statistically significant.

When the detection dynamics of Giardia cysts were analyzed in the monitored groups, no significant effect of mass deworming was observed, and six months later, its value also remained essentially unchanged.

In hyperendemic areas, the detection rate of Taenia eggs neither decreased nor increased. Consequently, the detection rate of mixed parasitoses also changed minimally, although a slight upward trend was observed over time.

Based on these results, due to the scientifically justified low effectiveness of once-yearly mass deworming in hyper- and mesoendemic areas, the procedure for mass deworming was optimized according to the degree of parasitic infection.

Accordingly, in hyperendemic areas, mass deworming among schoolchildren involved administering Albendazole tablets, 400 mg, once daily for 2 days, with a repeat course of 400 mg once daily for 2 days after 14 days. The study showed that 14 days after mass deworming in hyperendemic areas, the detection rate of Enterobius eggs did not significantly decrease. Since medications affect the helminths but not their eggs, and new worms can emerge from eggs within 14 days, repeating deworming after 14 days was recommended.

In mesoendemic areas, a noticeable positive effect was observed 14 days after mass deworming; however, six months later, the value slightly increased again. Therefore, schoolchildren in these areas were advised to take Albendazole 400 mg once daily for 2 days, with a repeat course of the same regimen after 6 months.

In hypoendemic areas, since a single round of mass deworming showed statistically significant effectiveness among children, it was recommended that schoolchildren in these areas receive Albendazole tablets, 400 mg, once daily for 2 days, once a year.

Regardless of the region, given the significant prevalence of mixed parasitoses among schoolchildren and the limited effectiveness of the mass deworming conducted, a treatment approach based on etiology was proposed. Accordingly, children diagnosed with intestinal giardiasis were prescribed Albendazole 400 mg once daily for 5 days. For those diagnosed with teniarinchiasis or hymenolepiasis, treatment was carried out according to standard protocols: in meso- and hypoendemic areas, children were given Albendazole 400 mg once daily for 2 days on day 1, followed from day 3 by Fenasal tablets administered twice daily for 5 days (dosages by age: adults and children over 12 years — 2.0 g/day; under 5 years — 0.5 g; 5–9 years — 1.0 g; 9–12 years — 1.5 g), with a 5-day break, then repeated for another 5 days.

For schoolchildren in hyperendemic areas, on day 1 they received Albendazole 400 mg once daily for 2 days, followed from day 3 by age-adjusted doses of Fenasal twice daily for 5 days, a 5-day break, Albendazole for 2 days on days 13–14, and a second 5-day course of Fenasal starting on day 15.

Taking into account the level of parasitic infection in different areas, it was recommended to conduct mass deworming twice a year in hyperendemic areas (Albendazole for 2 days, followed by a 14-day break, then 2 more days), twice a year in mesoendemic areas (Albendazole for 2 days), and once a year in hypoendemic areas (Albendazole for 2 days).

Based on the data obtained, an improved algorithm for mass deworming was developed.

Assessment of the Degree of Parasitic Infection in a Region Using a Mathematical Calculation Model

In a hyperendemic area, Albendazole 400 mg is administered for 2 consecutive days twice a year, with a 14-day interval between the two

In a mesoendemic area, Albendazole 400 mg is administered for 2 consecutive days, twice a year.

In a hypoendemic area, Albendazole 400 mg is administered for 2 consecutive days, once a year.

Considering that mixed parasitosis occurs in an average of 25.0% of children aged 7–14, it is recommended to examine their stool using the coproscopical method before conducting mass deworming and, based on the analysis results, provide treatment according to the standard protocol.

In cases of diagnosed intestinal giardiasis – Albendazole 400 mg, single dose, for 5 days starting from day 1.

For taeniasis and hymenolepiasis: In meso- and hypoendemic areas, on the first day, Albendazole up to 400 mg, single dose, for 2 days was prescribed. From the 3rd day, Fenasal tablets were administered twice daily for 5 days, followed by a 5-day break, after which another 5-day course was given. In the hyperendemic area, on the first day, Albendazole up to 400 mg, single dose, for 2 days was prescribed; from the 3rd day, Fenasal was administered twice daily for 5 days, followed by a 5-day break, on the 13th and 14th days Albendazole was given for 2 days, and from the 15th day, the second 5-day course of Fenasal was prescribed.

Figure 4.1. Improved Algorithm for Mass Deworming

Chapter V. Improving the Organization of Mass Preventive Activities Against Helminthiases

During the study, it was found that even in hypoendemic areas, the negative outcomes after mass deworming did not exceed 90.0%. In other regions, this indicator also did not reach 90.0%. In our view, this situation is associated with risk factors identified during the study, namely: low awareness among schoolchildren and their parents about parasitic diseases, non-compliance with personal hygiene rules, unsatisfactory conditions of school toilets and waste disposal facilities, lack of access to clean drinking water, and a proportion of unorganized children in the district exceeding 40.0%.

Based on the obtained results, the following recommendations were developed to improve the organization of mass preventive activities against helminthiases:

1. Based on the improved mass deworming algorithm developed by us, mass deworming should be carried out not only among schoolchildren but also among preschool institution attendees and unorganized children raised at home. That is, all children over 2 years of age must be covered by mass deworming according to the level of parasitic disease prevalence.
2. Based on the questionnaire conducted by us, it was found that, regardless of the level of parasitic disease prevalence in the area, more than 80.0% of schoolchildren are not aware of parasitic diseases, their main clinical signs, or the preventive measures. Therefore, regardless of the endemicity of the area, it is necessary to conduct open lessons every month among schoolchildren and large groups of preschool children on observing personal hygiene rules and preventing parasitic diseases. Additionally, every three months, booklets explaining preventive measures against parasitic diseases should be distributed, and films and video clips on the topic should be shown, with these films periodically broadcast on the “Bolajon” television channel.

Children should be taught to wash fruits and vegetables before consumption, wash their hands after playing with animals, and wash their hands after coming home from playing outside. They should be taught to wash hands not only with plain water but also with soap. In other words, practical skills for observing personal hygiene among children over 2 years old should be developed to the level of automatic habit.

Schoolchildren should also be familiarized with the main clinical signs of parasitic diseases that are widespread in the Republic of Uzbekistan and be taught to inform their parents or the school doctor if such signs appear.

3. According to the results of the questionnaire conducted by us, taking into account that nearly 90.0% of the teaching staff working at the studied school possess knowledge and skills regarding parasitic diseases, their transmission routes, main clinical signs, and preventive measures, the open lessons on parasitic disease prevention conducted among schoolchildren can be carried out not only by medical staff with specialized knowledge but also by the teaching staff themselves working at these schools.
4. A similar questionnaire should be conducted among staff of preschool educational institutions. If the staff demonstrate a low level of knowledge, it is necessary for them to conduct training sessions together with local doctors, nurses, and employees of the Sanitary-Epidemiological Safety and Public Health Committee, preparing them to work with children. The methodologist of the preschool institution, in cooperation with doctors, should prepare lessons for children on the topic “What are parasitic diseases? How to fight them?” in an accessible, simple, and playful format. These lessons should be conducted every three months, and among preschool children, practical skills for observing personal hygiene rules should be developed to the level of automatic habit.
5. Based on the analysis of the questionnaire, it was found that on average 75.0% of the parents of the schoolchildren being studied do not possess knowledge or skills regarding the prevention of parasitic diseases. Therefore, it is

recommended that the teachers working at these schools conduct open "Parasitic Disease Prevention Measures" days for parents once every three months.

For the parents of preschool children and parents of unsupervised children being raised at home, it is recommended that local doctors, nurses, and employees of the Sanitary-Epidemiological Safety and Public Health Committee conduct these sessions once every three months.

For parents, we provide the following generalized recommendations:

- Teach parents to wash fruits and vegetables properly. Fresh fruits and vegetables should be thoroughly washed under running water using a brush. In hyperendemic areas, especially where safe drinking water is not available, fruits, vegetables, and greens should be washed in boiled water. Greens should also be thoroughly washed under running water, and if they are not thermally treated, they should be soaked for 10 minutes in a 3% vinegar solution or a 10% plain salt solution, then rinsed with water.
- In areas without safe drinking water, it is recommended to use water that has been filtered or boiled. In hyperendemic areas, avoid swimming in unknown open water bodies, especially stagnant water, and encourage washing fruits and vegetables in boiled water whenever possible.
- In areas without centralized sewage services, teach people not to use fresh or unprocessed human or animal feces as fertilizer.
- To prevent parasitic diseases transmitted through meat, do not consume meat that has not passed veterinary-sanitary inspection. Meat should be cut into pieces no thicker than 2.5–3 cm and cooked for at least 3 hours. This thermal treatment protects against cattle or pig tapeworms. Fish should not be consumed raw, and fish roe prepared under unknown conditions should also be avoided.
- Train children, especially unsupervised children, to undergo parasitic disease testing every six months.

- Pets at home, particularly puppies and kittens, should be examined by a veterinarian and dewormed every six months.

Conclusion

Currently, helminthiases are recorded among people living in all climatic zones of the world, even beyond the Arctic Circle (Kol Peninsula, Taimyr, Yamal). The highest prevalence of infection is observed in countries south of the Sahara in Africa as well as in countries of Western and Eastern Asia [[164; pp. 65-66]]. According to global estimates, approximately 1.5 billion people are infected with at least one nematode [16; pp. 32-35, 193; pp. 1756-1758]. Similarly, the number of people infected with schistosomiasis and onchocerciasis worldwide is approximately 250 million and 30 million, respectively [159; pp. 1356-1359]. The prevalence of helminthiases among populations depends on environmental, socio-economic factors, customs, and the degree of urbanization [18; pp. 107-113, 26; pp. 87-89, 27; pp. 56-63, 30; pp. 44-45, 36; pp. 347-349, 37; pp. 73-75, 189; pp. 228-236]. Among 67 million preschool-aged children and 568 million school-aged children living in areas with a high prevalence of parasitic infections, treatment against parasites is necessary. In foreign countries, helminthiases are most prevalent in countries located between 45 degrees north and south of the equator (Algeria, Egypt, Italy, Spain, India, Romania, southern states of the USA, Argentina, etc.). Analysis of published scientific research shows that helminthiases are rarely recorded among populations in France, Poland, Austria, the Czech Republic, and Slovakia.

Helminthiases are widespread in the Central Asian republics. In Kyrgyzstan (Oshgan), the prevalence of helminthiases among children aged 4–7 years is 8.7% [54; pp. 200-202]. In Turkmenistan (Ashgabat and Chardzhou), helminthiasis prevalence in children’s institutions reaches up to 30%.

In Tajikistan, helminthiases are almost equally common in the lowland regions (6.8%) and in mountainous and foothill regions (5.2%). A higher prevalence (13.2–22.3%) is observed in the mountain valleys of Northern Tajikistan. In Dushanbe, the prevalence among schoolchildren is 19–26.9% [70; pp. 92-94, 71; pp. 30-32, 79; pp. 43-49, 83; pp. 39-43].

Preliminary data on the prevalence of helminthiases among the population of Uzbekistan date back to the 1920s. According to these data, the prevalence of helminthiasis among children in various regions of the republic ranged from 7% to 28.6% (Tashkent, old Bukhara, Kokand, Samarkand, Andijan, Namangan). Under the leadership of K.I. Skryabin, the 35th Union Helminthological Expedition to Central Asia examined 2,517 residents of Tashkent, Samarkand, Andijan, Kokand, and other stations along the Central Asian Railway. Among them, 6.4% were found to have Ascaris infections, and children accounted for 12.1% of those examined [2; pp. 6-10, 3; pp. 7-8, 61; pp. 234-235, 63; pp. 70-73, 69; pp. 93-95].

A distinctive feature of parasitic diseases is the long-term survival of helminths in the human body, which often occurs with repeated infections, i.e., reinfections. The chronic course of many parasitic diseases leads to delays in the physical and mental development of children and reduces their working capacity and social activity.

The WHO recommends mass deworming in endemic areas to prevent reinfection with soil-transmitted helminths and schistosomiasis (WHO, 2011), because the costs of diagnosing helminths are considerably higher than the costs of treatment. Mass deworming of children in endemic areas is described as the most cost-effective strategy to improve school attendance.

A review of the literature widely addresses the effectiveness of mass deworming, reporting its positive effects on children’s body weight gain, improvement of school performance, and even higher knowledge and skills in adulthood, leading to higher-paying jobs in the labor market (Croke, 2014). However, all these studies pertain to geohelminthiases, and there is no information on the effectiveness of mass deworming for contact helminthiases and other parasitic diseases common in the Republic of Uzbekistan.

Accordingly, the purpose of the study was to identify the epidemiological characteristics of parasitic diseases in the Samarkand region and to improve preventive measures against them.

To achieve the purpose of the study, the following tasks were defined: to conduct a retrospective epidemiological analysis of the dynamics of parasitic diseases in the Samarkand region from 2011 to 2021; to determine the nosological structure of parasitic diseases observed in the Samarkand region from 2011 to 2021; to identify the leading risk factors that lead to the spread of parasitic diseases (enterobiasis, hymenolepiasis, giardiasis) among children in the Samarkand region; to assess the level of awareness about helminthiases among school students, parents, and school pedagogical staff; to improve and implement the algorithm of mass deworming against helminthiases among schoolchildren. The main part of the research was carried out at the clinic of the L.M. Isaev Scientific Research Institute of Medical Parasitology of the Ministry of Health of the Republic of Uzbekistan. As the object of the study, the following were used: data from the Republican Committee for Sanitary-Epidemiological Wellbeing and Public Health on the incidence of parasitic diseases during the studied years; data obtained from the Samarkand Regional Department of the Committee for Sanitary-Epidemiological Wellbeing and Public Health on the number of organized and unorganized children aged 2–7 years living in the Samarkand region; information on the availability of centralized sewage service and clean drinking water in the districts of the Samarkand region; and questionnaires obtained from 2,975 schoolchildren aged 7–14 years living in some districts of the Samarkand region, from 192 parents (mother or father) of these students, and from 322 school pedagogical teachers.

The subject of the study consisted of feces, blood, and blood serum samples obtained from the study participants.

The level of parasitic infection in the Samarkand region was divided into zones using a mathematical calculation model ((Pelh) de Silva & Hall, 2010). One school was selected from each of these zones, and a survey was conducted among children aged 7 to 14 years from these three schools based on a questionnaire developed by us.

Along with school students, in order to determine the level of awareness about helminthiases among parents and school pedagogical staff, separate questionnaires were also developed and used to conduct surveys among parents and teachers.

At the first stage of the study, the dynamics of the overall incidence of intestinal parasitic diseases in the Samarkand region during the period of 2011–2021 were analyzed.

According to the obtained data, two periods were distinguished in the long-term dynamics of parasitic diseases in the Samarkand region — a period of high intensity of morbidity and a period of relative decline. When studying the trend of parasitic disease incidence dynamics in the Samarkand region over the studied years, it was found that the morbidity rate had a wave-like pattern, periodically increasing and decreasing; however, in recent years, the morbidity rate has shown a tendency to increase, with an 81.0% confidence interval ($R^2 = 0.81$).

The analysis of the dynamics of the overall incidence of parasitic diseases in the Samarkand region during 2011–2021 showed that during this period, the average incidence rate was 363.4 per 100,000 population, fluctuating between 160.3 in 2020 and 474 in 2014. However, it should be noted that the 2020 figure represents an exceptionally low outlier. That year, due to the COVID-19 pandemic, the priorities in the healthcare sector shifted, resulting in a noticeable decline in the number of people seeking medical care for other diseases, including parasitic infections. Consequently, both the diagnosis and detection of parasitic diseases decreased. For this reason, the incidence rate of intestinal parasitic diseases in 2020 (160.3) was 2.3 times lower than the average rate (363.4). Since this figure represents a deviation from the regular trend of intestinal parasitic disease dynamics in the region, and in order to avoid methodological errors, it was deemed appropriate to exclude the 2020 incidence rate from further analyses, particularly those related to disease intensity.

After excluding the 2020 figure, the average incidence rate of parasitic diseases in the Samarkand region for the period 2011–2021 was 373.1 per 100,000 population.

According to the analysis results, during 2011–2021, except for 2018 (281.0), in all other years the incidence of parasitic diseases was higher than the average rate (373.1), while during 2016–2021, it was observed to be below the average rate.

Thus, the long-term dynamics of parasitic disease incidence in the Samarkand region can be divided into two periods: a period of high intensity of incidence and a period of relative decline.

When analyzing the structural composition of parasitic diseases identified in the Samarkand region over the years, it was found that over the past 11 years, enterobiasis occupied the leading position (ranging from 53.7% to 63.2%), followed by giardiasis (average 24.03%), and the third place was held by hymenolepiasis (average 15.0%). Other parasitic infections occurred at very low percentages: taeniasis – 0.28%; echinococcosis – 0.33%; and lastly, ascariasis (average per year 0.02%). The incidence rates of these intestinal parasites did not change significantly over the years.

Comparing these results with literature data, in 2015, out of 7,706,546 people examined nationwide, 265,766 individuals (3.4%) were diagnosed with enterobiasis, and 49,724 individuals (0.6%) with hymenolepiasis. Within the composition of parasitic diseases, the relative burden of hymenolepiasis was 18.7%. Among the population of Tashkent city, the incidence of hymenolepiasis was 0.002%; in Khorezm region – 0.01%; in Jizzakh, Surkhandarya, and Fergana regions – 2.6%. In Namangan region, the incidence ranged from 0.8% to 1.3%, while in other regions and the

Republic of Karakalpakstan, it ranged from 0.01% to 0.5%. In Samarkand region, this indicator was recorded at 0.6%.

In the literature, it is often noted (17.3%) that mixed parasite infections, or mixed invasions, occur, where pinworms coexist with other helminths [117; 9–24].

A large number of studies have been conducted on the epidemiological characteristics of parasitic diseases. For example, in 2013, H. N. Khalafli and co-authors studied the contemporary helminth fauna of the Azerbaijani population, identifying 21 different parasites: 13 nematodes, 5 cestodes, and 3 trematodes.

However, the largest shares were enterobiasis – 28.6%, trichocephalosis – 9.3%, ascariasis – 7.5%, hymenolepiasis – 45%, and trichostrongyliasis – 2.7%.

The researchers associated the high prevalence of the listed helminthiases and giardiasis in Baku city with the process of hyper-urbanization – a sharp increase in population, deterioration in living conditions, worsening sanitary-hygienic conditions, and age-related behavior among children.

The values identified in the study and those reported in the literature do not provide sufficient information. Therefore, we examined the mathematical calculation model (($P_a lh$)) proposed by de Silva & Hall (2010) for estimating the prevalence of parasitic infections in a specific area. This model was originally designed for African countries with a high prevalence of geohelminthiases.

We adapted this mathematical model for Samarkand region, taking into account the leading parasitic diseases prevalent there.

Using this mathematical model, we separately assessed the prevalence of leading parasitic diseases in all districts of Samarkand region based on data from 2018 and 2019. Areas with a parasitic infection prevalence of ≥50% were classified as hyperendemic; those with ≥20% but <50% as mesoendemic; and those with <20% as hypoendemic. In the districts of Pakhtachi, Payariq, Nurobod, Urgut, and Qo‘shrabot, the prevalence of intestinal parasitic infections was ≥50%, so these areas were designated as hyperendemic.

In the districts of Jomboy, Ishtikhon, Kattaqo‘rg‘on, Oqdaryo, Pastdarg‘om, and in Kattaqo‘rg‘on city, the prevalence ranged from ≥20% to <50%, so these areas were classified as mesoendemic. In the districts of Narpay, Bulung‘ur, Tayloq, Samarkand, and in Samarkand city, the prevalence was <20%, and therefore these areas were designated as hypoendemic.

In the review of the studied literature, we did not find data examining the epidemiological characteristics of helminthiases through assessment of regional parasitic disease prevalence. However, the literature did show that many factors contribute to the increase in parasitic infection prevalence. In particular, Kozlovsky A.A. (2016) studied the prevalence of helminth infections among children in the Gomel region. The researcher identified polyinvasion as the leading problem, meaning infection with two or more helminths. Among schoolchildren, this condition accounted for 74%. Mixed infections recorded during childhood included enterobiasis + giardiasis, enterobiasis + ascariasis, ascariasis + trichocephalosis, and enterobiasis + giardiasis + toxocariasis. The researcher associated the polyinvasion phenomenon not only with poor living conditions or delayed diagnosis, but with a symbiotic effect, in which one infection reduces immunity, thereby increasing susceptibility to a second infection.

Kozlovsky A.A. also identified risk groups for helminth infections among children: children from large families, children from socially disadvantaged families, children attending organized groups (schools, preschools), frequently ill children, children simultaneously exhibiting seven or more dysembryogenesis stigmas, artificially fed children under one year old, and children with delayed mental and physical development, as these children generally have poor personal hygiene skills. Additional risk factors included children who play frequently with animals or have contact with soil and sand.

Gosa Ebrahim Geleto and co-authors (2022), when studying the reasons for the high prevalence of soil-transmitted helminths in Ethiopia, found that it was associated with low access to clean drinking water, water scarcity (using less than 5 liters per day), lack of toilets, large open areas around residences filled with waste, and insufficient food intake.

Other researchers have also concluded that the prevalence of helminth infections among populations depends on environmental factors, socio-economic conditions, cultural practices, and the degree of urbanization (Parajuli RP, 2014; Faria CP, 2017).

In the next stage of our study, we used a mathematical model to examine the factors influencing the prevalence of parasitic diseases in identified high-risk areas. According to the data, in hyperendemic regions, the prevalence of parasitic diseases was significantly influenced by the low level of awareness about parasitic infections among children and their parents, inadequate provision of clean drinking water in schools, unsatisfactory sanitary and hygienic conditions of school waste disposal sites and toilets (accumulated waste, large numbers of flies), low usage of centralized sewerage systems, poor access to clean drinking water, and a high proportion of unorganized children aged 2 to 7 years (over 44%). The prevalence of these factors in hyperendemic regions was statistically significantly higher than in hypoendemic areas. Specifically, the lower the access to clean drinking water in a region, the higher the prevalence of parasitic infections, demonstrating a strong negative correlation between these two indicators. A similar relationship was observed with the use of centralized sewerage systems: there was a strong negative correlation between the prevalence of parasitic diseases in a region and the population's usage of sewerage services.

The higher the proportion of children aged 2–7 living in the area who do not attend kindergarten and are raised at home, the higher the prevalence of parasitic diseases in that area, indicating a strong positive correlation. This reflects that medical examinations among unorganized children are not being conducted at the expected level.

In the study, we investigated the contemporary helminth fauna of parasitic diseases depending on the prevalence of parasitic infections in the region.

In a hyperendemic area, stool samples of 300 schoolchildren aged 7–14 from a selected school were examined using the coproovoscopic method. According to the results, 47.0% (141) of the students had pinworm eggs, 14.3% (43) had Giardia cysts, 8.0% (24) had hookworm eggs, 0.7% (2) had Taenia saginata eggs, and 28.7% (86) of the students' stool samples contained two or more types of helminth eggs or Giardia cysts simultaneously, indicating mixed parasitic infections.

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In a mesoendemic area, coproovoscopic examination of stool samples from 280 schoolchildren revealed that 26.1% (73) had enterobiasis, 3.9% (11) had hymenolepiasis, 8.9% (25) had giardiasis, and 17.5% (49) had mixed parasitic infections.

In a hypoendemic area, coproovoscopic examination of stool samples from 280 schoolchildren yielded the following results: 11.1% (31) for pinworm, 2.5% (7) for hymenolepiasis, 5.0% (14) for giardiasis, and 7.1% (20) for mixed parasitic infections. According to Kozlovsky A.A. (2016), the problem of polyinvasion among schoolchildren was 74%, including mixed infections such as enterobiasis + giardiasis, enterobiasis + ascariasis, ascariasis + trichocephalosis, and enterobiasis + giardiasis + toxocariasis.

The discrepancy between the obtained data and literature data was attributed to the sensitivity level of modern helminth detection methods. A comparative analysis of modern diagnostic methods was conducted among 57 children under observation. Fifty-seven fifth-grade students were selected, and for the detection of intestinal helminths, stool samples were collected for triple coproovoscopic examination and PCR, and 5 ml of blood was taken for ELISA testing of anti-Giardia IgM. According to the analysis of the results from the triple coproovoscopic examinations, 49.1% of the 57 children had pinworm eggs, 17.5% had hookworm eggs, 26.3% had Giardia cysts, and only 7.0% of the students' stool samples were negative for helminth eggs.

When stool samples were tested using the PCR method, pinworm eggs were detected in 33.3% of cases, hookworm eggs in 19.3%, and Giardia cysts in 29.8%, while intestinal helminths were not detected in 17.6% of the students' stool samples. Testing the students' blood serum for anti-Giardia IgM revealed positive results in 63.2% of the 57 students.

The detection rate of pinworm eggs using PCR and coproovoscopy was similar, and the odds ratio was statistically insignificant ($P>0.05$). The detection rate of hookworm eggs was also nearly identical between PCR and coproovoscopy methods ($P>0.05$).

For Giardia cysts, the detection rate in stool samples using coproovoscopy was close to the value detected by PCR ($P>0.05$). Comparing the results obtained by coproovoscopy and ELISA (IgM antibodies against Giardia) showed that the probability of detecting Giardia cysts by ELISA was five times higher than by coproovoscopy, and also five times higher than by PCR, with the difference between groups being statistically significant ($P<0.001$).

Thus, it is evident that ELISA testing for anti-Giardia IgM exhibits a fivefold likelihood of overdiagnosis. In other cases, the effectiveness of PCR and coproovoscopy methods is nearly the same. Therefore, it is recommended to use PCR for resolving ambiguous intestinal parasite cases and preventing overdiagnosis, while in routine situations, the coproovoscopy method is sufficient.

Analysis of the literature shows abundant information regarding the requirements for mass deworming, its effectiveness, and measures to increase its efficacy. For example, according to the 2015 Cochrane review, mass deworming does not improve children's health or school performance (DC Taylor-Robinson, 2015), and among children over three years old who are lagging behind peers in growth, mass deworming does not increase height. Conversely, F Makamu, M Azam, and H Kazianga (2016) demonstrated that mass deworming used for schistosomiasis improves children's body weight but has no effect on height and almost no effect on cognitive function or school performance. Historical mass deworming between 1910–1920 increased school attendance by 20% and academic performance by 13%.

Croke (2014) studied the effect of mass deworming (MD) on English language proficiency and numeracy skills in Uganda over many years. The results showed that children in villages who received MD had significantly higher cognitive abilities compared to those who did not receive treatment. Bleakley (2007) noted that adults who had grown up in areas where mass deworming was routinely conducted had higher awareness levels and better labor market outcomes compared to adults from areas without mass deworming. He also reported that their wages were 43% higher.

Baird et al. (2016) found that women who received multiple rounds of mass deworming during childhood were able to work in agriculture throughout the day and transition to non-agricultural work at the end of the day without fatigue. Men who received the treatment worked 17% more per week than untreated men and engaged more frequently in entrepreneurial activities that provided higher income.

The literature also indicates that the effectiveness of mass deworming increases when implemented alongside micronutrient supplementation, healthy nutrition, and adherence to personal hygiene practices (A. Montresor, D. Addiss, M. Albonico, et al., 2015). Bobonis, Miguel, and Puri-Sharma (2006) also found that adding iron to deworming interventions improved their effectiveness.

The authors also discussed the indirect effects of mass deworming, noting that treated children positively affect untreated children because the overall helminth burden decreases (Givewell, 2016). Bundy et al. (1990) reported that treating children aged 2–15 years four times with albendazole over 16 months led to a significant reduction in soil-transmitted helminth infection levels both in the targeted groups and among individuals aged 16–25 years.

Miguel and Kremer (2004) found a significant reduction in helminth infection levels among treated children, untreated children, children attending treated schools, and children from nearby schools.

The authors reported that the proportion of moderate and heavy infections among untreated children attending treated schools decreased by 18%, while children from schools located 3 km away from treated schools experienced a 22% reduction. Ozier (2014) observed that even children aged zero to two years living near treated schools showed a reduction in infection levels due to positive community-wide external effects resulting from mass deworming.

According to the literature review, the effectiveness of mass deworming has been studied in foreign countries, and most of these studies were conducted in the 20th century. Information on its effectiveness in the modern period is not clearly established in the literature. Existing studies primarily report on the effectiveness of mass deworming against soil-transmitted helminths.

The effectiveness of mass deworming against intestinal parasites, particularly contact helminths specific to the Republic of Uzbekistan, and a comparative assessment of its effectiveness based on the regional prevalence of parasitic infections have not yet been studied.

Accordingly, in the next phase of the study, mass deworming was carried out in the areas identified using the mathematical model we developed to assess the "degree of parasitic infection in the region." Albendazole tablets, 400 mg, were administered for two days. Fourteen days after the deworming, the students' stool samples were re-examined for intestinal parasites using the coproscopy method. Regardless of the region, the deworming positively affected the detection rate of enterobiasis among students. In hyperendemic areas, the detection rate decreased from 47.0% to 24.3%; in mesoendemic areas, from 26.1% to 8.6%; and in hypoendemic areas, from 11.1% to 1.0%.

The differences between pre- and post-treatment results in hyperendemic and mesoendemic areas were not statistically significant ($p>0.05$), but in hypoendemic areas, this change was statistically significant ($p=0.092$). The detection rate of Giardia cysts did not change significantly after treatment across all regions ($p=0.070$), although a slight decrease was observed in all groups. Similar trends were observed for the detection of hookworm and beef tapeworm eggs; the deworming had no effect on these helminth eggs. Consequently, the values for mixed parasitoses were also not significantly affected.

To determine the effectiveness of mass deworming, the stool of the children under observation was examined using the coproscopy method six months after the deworming.

According to the results, among children in hyperendemic areas, the detection rate of pinworm eggs increased compared to the pre-deworming level. In hypo- and mesoendemic areas, the detection rate of pinworm also slightly increased six months after the mass deworming, but remained considerably lower than the initial value.

For hookworm eggs, no effect of the mass deworming was observed; in fact, six months later, the values in all observed children slightly increased compared to the initial level, though this difference was not statistically significant.

When analyzing the dynamics of Giardia cyst detection in the observed groups, no significant effect of the mass deworming was noted, and six months later, the values remained largely unchanged.

In hyperendemic areas, the detection rate of beef tapeworms neither decreased nor increased. Consequently, the detection rate of mixed parasitic infections also changed minimally, though it showed a slight upward trend over time.

Based on these results, considering the low effectiveness of annual mass deworming in hyper- and mesoendemic areas, the program was improved according to the degree of parasitic infection. In hyperendemic areas, mass deworming for schoolchildren was adjusted to administer Albendazole tablets 400 mg for 2 consecutive days once, followed by a repeat dose of 400 mg for 2 consecutive days after 14 days.

The study also showed that in hyperendemic areas, six days after deworming, the detection rate of pinworm eggs did not decrease significantly. It is known that medications affect the helminths themselves but not the eggs; helminths can emerge from eggs around 14 days later. Considering this, it was recommended to repeat the deworming after 14 days.

In mesoendemic areas, a significant positive effect was observed 14 days after mass deworming, but six months later, its value slightly increased. Therefore, it was recommended that schoolchildren living in these areas be prescribed Albendazole tablets 400 mg for 2 days, and the same scheme be repeated six months later.

In hypoendemic areas, a statistically significant effect was observed after a single mass deworming. Therefore, it was recommended that schoolchildren in these areas receive Albendazole tablets 400 mg for 2 days once a year.

Regardless of the regions, considering that mixed parasitic infections among schoolchildren were present at significant levels and that mass deworming showed no effect, an etiology-based treatment approach was proposed. Accordingly, children diagnosed with intestinal giardiasis were prescribed Albendazole tablets 400 mg for 5 days; children diagnosed with teniarinhoz and hymenolepiasis were treated according to the standard: in meso- and hypoendemic areas, on the first day Albendazole 400 mg for 2 days was given; from the third day, Fenasal tablets (adults and children over 12 years: 2.0 g per day, children under 5 years: 0.5 g, 5–9 years: 1.0 g, 9–12 years: 1.5 g) were given twice daily for 5 days, followed by a 5-day break and then again for 5 days. For schoolchildren living in hyperendemic areas, on the first day Albendazole 400 mg tablets were given for 2 days; from the third day, Fenasal was given twice daily for 5 days in age-dependent doses; after a 5-day break, Albendazole was given on the 13th and 14th days for 2 days, and from the 15th day, Fenasal was given again for 5 days.

Considering the level of infection in the regions, it was recommended to conduct mass deworming twice a year in hyperendemic areas (Albendazole for 2 days, repeated for 2 days after a 14-day break), twice a year in mesoendemic areas (Albendazole for 2 days), and once a year in hypoendemic areas (Albendazole for 2 days).

Based on the data obtained above, an improved algorithm for mass deworming was developed.

During the study, it was found that even in hypoendemic areas, negative outcomes after mass deworming did not exceed 90.0%. In the remaining regions, this indicator also did not reach 90.0%. In our opinion, this situation was associated with the risk factors identified during the study, namely: low awareness of parasitic diseases among schoolchildren and their parents, non-compliance with personal hygiene rules, unsatisfactory conditions of school toilets and waste collection facilities, lack of access to clean drinking water, and more than 40.0% of children in the district being unorganized. Based on the obtained results, proposals were developed to improve the organization of mass preventive activities against helminthiases:

1. Conduct mass deworming not only among schoolchildren but also among children in preschool institutions and unorganized children being raised at home. That is, all children over 2 years old should be covered by mass deworming according to the degree of parasitic infection.
2. Regardless of the endemicity of the area, conduct open lessons every month among schoolchildren and large groups of preschool children on compliance with personal hygiene rules and prevention of parasitic diseases; distribute booklets describing preventive measures once every three months; show films and video clips, periodically broadcasting these films on the “Bolajon” television channel.
3. Open lessons on preventive measures against parasitic diseases conducted among schoolchildren should be delivered not by medical staff with special knowledge, but by the pedagogical staff actively working in these schools.
4. Among preschool staff, neighborhood doctors, nurses, and employees of the Sanitation-Epidemiological Safety and Public Health Committee should jointly conduct sessions and prepare staff to work with children. Every three months,

preschool children should be trained until compliance with personal hygiene rules becomes automatic.

5. Pedagogical staff working in schools should hold open days once every three months for parents on the topic “Preventive Measures Against Parasitic Diseases.”

SUMMARY

1. Over the past decade, the incidence of parasitic diseases in Samarkand region has shown a wave-like pattern, not tending to decrease, with a trend toward increase.
2. Between 2011–2021, enterobiasis (average 10,056.4 cases), hymenolepiasis (average 2,296.7 cases), and giardiasis (average 4,007.1 cases) have remained the leading parasitic diseases in Samarkand region, while ascariasis (average 6.6 cases), echinococcosis (average 46.1 cases), and teniarinhoz (average 43.8 cases) have been observed at low levels.
3. Regardless of the level of parasitic disease prevalence in the districts of Samarkand region, more than 70% of schoolchildren and over 50% of parents lack awareness about the routes of transmission, main clinical signs, and preventive measures of parasitic diseases. In contrast, the pedagogical staff of these schools have understanding about parasitic diseases at a level of 90.0%.
4. The risk factors leading to a high level of parasitic disease detection in hyperendemic areas include: 69.0% of schools in the area having waste collection facilities that do not meet sanitary standards (waste not removed on time, accumulation in places), 87.1% of the region lacking access to centralized sewerage services, 67% of schools not supplied with clean drinking water resulting in 66.0% of school toilets being in unsatisfactory condition (not cleaned on time, presence of flies, lack of water supply), and an average of 44.0% of 2–7-year-old children in hyperendemic areas belonging to unorganized groups.
5. Considering the level of parasitic disease prevalence in the region and the fact that parasitic infections are mixed in an average of 25.0% of cases, an improved

algorithm for mass deworming among schoolchildren was developed and implemented.

PRACTICAL RECOMMENDATIONS

1. For resolving controversial cases of intestinal parasites and preventing overdiagnosis, the use of PCR is recommended, while in routine cases, the coproovoscopy method should be used.
2. All children over 2 years of age should be included in mass deworming according to the level of parasitic disease prevalence.
3. In preschool institutions, the methodologist, together with doctors, should organize activities in a playful format titled “What are parasitic diseases? How to fight them?” that are easily accessible to children, not overly complex, conducted every 3 months, and ensure that preschool children develop automatic habits of following personal hygiene rules.
4. In schools, pedagogical staff should conduct open-door days for parents on the topic of “Preventive Measures Against Parasitic Diseases” once every 3 months.

For parents of preschool children and unorganized children at home, these sessions should be conducted once every 3 months by local doctors, nurses, and staff from the Sanitation-Epidemiology and Public Health Committee.

5. Considering that mixed parasitic infections occur in an average of 25% of children aged 7–14, feces should be examined using the coproovoscopy method before mass deworming, treatment should be recommended based on the analysis results, and to determine the effectiveness of mass deworming, feces of monitored children should be re-examined using the coproovoscopy method 6 months after the deworming.
6. During mass deworming, medications should be administered and supervised by the school doctor for schoolchildren, by the preschool nurse for preschool children, and by home-visiting nurses for unorganized children.

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