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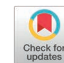

The effect of chronic giardiasis on cognitive functions and allergopathology in the pediatric population

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Abstract
Introduction: Giardiasis remains one of the most urgent parasitic infections in pediatric practice worldwide. The purpose of this retrospective cohort study was a comprehensive assessment of the clinical manifestations, risk factors, and long-term outcomes of giardiasis treatment in children.
Methods: The data of 500 patients aged 6-17 years were analyzed, formed into two groups comparable in basic parameters: the main group (250 children with verified giardiasis) and the control group (250 children without diagnosed invasion).
Results: The results of the study demonstrate that children with giardiasis before treatment had a significantly higher incidence of not only gastrointestinal symptoms, but also systemic manifestations. Asthenic syndrome was reported in 79.2% of patients, allergodermatoses in 49.6% versus 27.2%, and complaints of decreased concentration in 66.8% of children. A clear dependence of the risk of infection on social conditions was established: the main group was significantly dominated by children living in rural areas (58.0% versus 32.0%), using non-centralized water supply sources (52.8% versus 22.0%) and having contact with farm animals (47.2% versus 18.0%). Evaluation of long-term results 6, 12, and 24 months after successful eradication therapy showed rapid regression of gastrointestinal symptoms, but normalization of extra-intestinal manifestations was slower. 24 months after treatment, the prevalence of allergodermatoses was 28.0%, and complaints of decreased concentration were 20.0%, which was still higher than in the control group.
Conclusion: The data obtained indicate the need for an integrated approach to the management of patients with giardiasis, including long-term follow-up and targeted rehabilitation measures.
Keywords: Giardiasis, Children, Risk factors, Long-term consequences, Cognitive impairment, Rehabilitation

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Introduction

Giardiasis, an anthropozoonotic protozoal infection caused by intestinal protozoa Giardia duodenalis (synonyms: G. intestinalis and G. lamblia) retains the status of one of the most significant global issues in parasitology and pediatrics (1). Its high pathogenicity, prevalence, and ability to persist in the human body for a long period of time determine its continued relevance. Specialists are especially concerned about the vulnerability of the pediatric population, as the effects of this infection extend far beyond gastrointestinal symptoms and have a complex negative impact on physical, nutritional, and cognitive development (2, 3).

The pathogenesis of giardiasis is a complex, multifactorial process. After entering the gastrointestinal tract, resistant cysts reach the duodenum and jejunum under the influence of bile (4, 5). Trophozoites are released and adhere to the apical surface of enterocytes with the help of ventral attachment discs without penetrating the submucosal layer (6). This causes a cascade of destructive changes, including damage to the brush border of enterocytes and disaccharidase deficiency, impaired absorption of fats, carbohydrates and fat-soluble vitamins, as well as triggering apoptosis and accelerating cell peeling, leading to villous atrophy, crypt hyperplasia and malabsorption syndrome (7-9). In addition to mechanical and enzymatic damage, the immunopathological response of the body plays an important role (10). Giardia antigens induce the activation of humoral and cellular immunity, but the parasite has sophisticated mechanisms to evade the immune response, including antigenic variation of surface proteins, which contribute to the chronicity of the process (11, 12).

The clinical picture of giardiasis is characterized by pronounced polymorphism, ranging from asymptomatic cyst formation, which is observed in a significant proportion of infected individuals, to severe manifestations (13). The acute phase, which is most typical of primary infection in children, is characterized by profuse, watery diarrhea with no blood admixture, severe flatulence, cramping pain in the epigastrium and mesogastrium, nausea, anorexia, and intoxication symptoms (14-16). However, in many cases,

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this stage goes unrecognized, and infection transforms into a chronic form (17). Chronic giardiasis poses the greatest challenge for pediatricians due to its nonspecific manifestations: chronic fatigue, irritability, emotional instability, headaches, sleep disturbances, slow weight gain, and growth, as well as persistent skin conditions such as dryness, keratosis, and atopic dermatitis (18-20).

Identification of risk groups is a cornerstone of epidemiological surveillance and prevention. The central place in high-risk groups is undoubtedly occupied by children, especially those of early and preschool age (1-6 years old), (21). Their vulnerability is determined by a complex of factors, including anatomical and physiological features of the gastrointestinal tract, reduced acidity of gastric juice, immaturity of local and systemic immunity, and, most importantly, active subject-practical behavior and lack of stable hygiene skills (22,23). High density of contacts in kindergartens and nurseries create ideal conditions for fecal-oral transmission (24).

Nevertheless, the risk of infection is extremely unevenly distributed among the child population and is determined by a number of environmental and social factors. Thus, for rural residents, especially in areas with developed personal animal husbandry, the main risk factors include non-centralized water supply systems (wells and springs), a high probability of faecal contamination of soil and water sources, as well as close contact with livestock and companion animals (25). In contrast, in large metropolitan areas with well-developed centralised water treatment systems, such as Moscow, the epidemiological profile is significantly different (26). Here, the main risk is shifted towards domestic contact-household transmission in conditions of crowding in preschool educational institutions and is also associated with socially disadvantaged families, where the level of hygiene culture remains low (27). Administrative centers of the regions of Russia, such as Vladikavkaz, often combine the features of urban and rural areas: along with organized children's groups there is a private sector with unorganized water supply and individual farms with livestock (Table 1).

Thus, a heterogeneous and diverse epidemiological landscape of giardiasis is being formed, where urbanization is not an unambiguous protective factor, but rather mediates a shift in emphasis on transmission routes and risk factors (28). Therefore, conducting a comparative analysis of the incidence, clinical features, and long-term consequences of giardiosis among children living in areas with fundamentally different socioeconomic conditions is not only relevant but also necessary to develop targeted prevention and treatment strategies. The purpose of this study is to compare the incidence of Giardia, the structure of symptoms, and the course of disease after treatment among children in the metropolitan area (Moscow), in the administrative center (Vladikavkaz), and in rural settlements (North Ossetia-Alaniya).

Materials and Methods

To achieve above - mentioned goals, a retrospective cohort study was organized with the formation of two parallel comparison groups. The study was conducted in strict accordance with the principles of the Helsinki Declaration, and its protocol was approved by the ethics committee of the North Ossetian State Medical Academy (Vladikavkaz, Russia). Protocol No. 1278 dated 12/02/2023 was approved.

The study included medical records of children aged 6 to 17 years who were under dynamic supervision in children's polyclinics in Moscow, Vladikavkaz and rural settlements of the Republic of North Ossetia-Alania during the period from 2020 to 2023. The main group consisted of 250 children with a verified diagnosis of giardiasis established in the period between 2019 and 2021. The criteria for inclusion in this group were a positive result from microscopic examination of feces for Giardia cysts, or a positive immunochromatographic test for Giardial duodenalis antigens, as well as availability of full medical documentation including examination data prior to treatment and at different time points after treatment - 6, 12, and 24 months after therapy.

The control group consisted of 250 children, comparable in age and gender to the main group, who did not have a single case of giardiasis during the entire follow-up period. This was confirmed by at least three negative results from a parasitological examination, with an interval of one year

Table 1. Comparative epidemiological characteristics of giardiasis among children in various regions of the Russian Federation (according to data for 2020-2023)

Region and Type of Locality	Children Surveyed, n	Identified Giardiasis Cases, n	Infection Rate (%)	Presumed Leading Risk Factors and Epidemiological Features
Moscow (Metropolis)	35,200	1,408	4.0	High density of children's groups (preschools) as the main transmission focus; predominance of contact-household transmission; low risk of waterborne transmission due to centralized water treatment; presence of socially disadvantaged population groups.
Vladikavkaz (Administrative Center)	12,150	1,063	8.7	Mixed model: contact-household transmission in preschools combined with waterborne transmission in areas with non-centralized water supply; a significant proportion of the population keeps livestock in personal farmsteads, creating a risk of zoonotic transmission.
Rural Settlements of the Republic of North Ossetia-Alania	8,450	1,183	14.0	Clear predominance of waterborne transmission due to the use of wells and springs vulnerable to fecal contamination; widespread livestock keeping; traditional farming practices using organic fertilizers; less developed preschool infrastructure.

between them. The patients in the control group were randomly selected from a common database, using the random number method, and had the same exclusion criteria as the main group: the presence of chronic inflammatory bowel disease, celiac disease, malabsorption syndrome of different etiology, and severe somatic or neurological pathology, which could significantly affect the parameters assessed, such as academic performance and nutritional status.

The diagnosis of giardiasis was verified using a set of laboratory methods. Microscopic examination included triple microscopy of native and Lugol-stained fecal smears at intervals of 2–3 days. At the same time, immunochromatographic analysis was used to detect the specific G. duodenalis antigen in fecal samples using commercial test systems. To make a definitive diagnosis, at least two positive results were required, detected by either of the methods or by a combination of them. All patients in the main group received standard antiparasitic treatment in accordance with current clinical guidelines. The efficacy of the treatment was monitored 14–21 days after completion of the course by triple microscopic examination of feces and immunochromatography. Eradication of the parasite was confirmed by negative laboratory results.

For a retrospective analysis, the following data were collected from medical records and questionnaires: demographic data, including age, gender, residence and settlement type; anamnestic information on pets, contact with farm animals, and water supply sources; clinical manifestations prior to treatment, such as abdominal pain, dyspepsia, stool characteristics, asthenia, and skin allergies. Physical development and nutritional status parameters were also assessed based on anthropometric data and body mass index calculation; concomitant pathologies, particularly allergic diseases, were recorded; and the frequency of acute respiratory infections was noted. In children of school age, average annual grades were analyzed, and complaints from parents and teachers regarding decreased concentration and increased inattention were noted.

Statistical data processing was performed using the IBM SPSS Statistics v. 26.0 software package. Quantitative indicators were described using arithmetic mean and standard deviation (M ± SD). Qualitative variables are represented as absolute values and percentages. Quantitative indicators were compared between two independent groups using Student's t-test for normally distributed data and Mann-Whitney U-test for other distributions. The χ^2 criterion was used to compare qualitative features with the Yates correction, while paired Wilcoxon's test was used to assess changes within one group's dynamics. Statistical significance was established at $P < 0.05$ level.

Results

During the retrospective analysis, two groups were formed: the main group of children with verified giardiasis (n = 250) and the control group (n = 250). The groups were statistically comparable in basic demographic indicators: the average age in the main group was 8.2 ± 2.1 years, in the control group – 8.5 ± 2.3 years ($P > 0.05$). The gender distribution also had no significant differences: 52% of boys and 48% of girls in the main group, 49% in the control group and 51%, respectively ($P > 0.05$).

A comparative analysis of the data at the time of inclusion in the study revealed statistically significant differences between the main and control groups in a number of parameters (Table 2).

As can be seen from Table 2, abdominal pain (86.8% vs. 18.0%), asthenia symptoms (79.2% vs. 20.8%) and allergodermatoses (49.6% vs. 27.2%) were significantly more common in the main group. The rates of ARI were significantly higher in the group of children with giardiasis. They were also more likely to have a lag in physical development, lower academic performance at school, and complaints of decreased concentration.

The analysis of risk factors showed a clear relationship between living conditions and the likelihood of infection (Table 3).

Children from the main group were significantly more likely to live in rural areas, had contact with domestic and agricultural animals, and also used water from non-centralized sources (wells, springs) for drinking.

Assessment of the condition of children in the main group at 6, 12 and 24 months after successful eradication of Giardia duodenalis demonstrated positive dynamics in all analyzed parameters (Table 4).

Table 2. Comparative characteristics of the groups before treatment

Parameter	Study Group (n = 250)	Control Group (n = 250)	*P*-value
Abdominal syndrome, n (%)	217 (86.8%)	45 (18.0%)	<0.001
Asthenic syndrome, n (%)	198 (79.2%)	52 (20.8%)	<0.001
Allergodermatoses, n (%)	124 (49.6%)	68 (27.2%)	<0.001
Frequency of ARI (Acute Respiratory Infections) (episodes per year), M ± SD	5.8 ± 1.5	3.9 ± 1.2	<0.01
Physical development delay (BMI (Body Mass Index) < 5th percentile), n (%)	42 (16.8%)	15 (6.0%)	<0.01
Average academic performance score (5-point scale), M ± SD	3.7 ± 0.8	4.3 ± 0.5	<0.05
Complaints of attention deficit, n (%)	167 (66.8%)	75 (30.0%)	<0.001

The most pronounced positive dynamics was observed in relation to abdominal and asthenic syndromes. 6 months after treatment, the frequency of these symptoms decreased by more than three times. The frequency of allergodermatoses and ARI also decreased, but the normalization process was more gradual. After 24 months of follow-up, most children maintained a steady positive trend, although some indicators (for example, the prevalence of allergodermatoses and concentration complaints) were still higher than in the general population (control group), indicating long-term consequences of the invasion.

Discussion

The study revealed the complex effects of giardiasis infection on children's health and also demonstrated the dynamics of recovery after successful treatment. The results obtained allow a deeper understanding of the pathogenic mechanisms of Giardia duodenalis systemic effects on a developing organism.

The revealed high prevalence of abdominal syndrome (86.8%) and asthenia (79.2%) in the main group before treatment corresponds to classical concepts of chronic giardiasis (29-31). However, a significant predominance of allergen dermatoses in the same group (49.6% versus 27.2% in control) and higher incidence of acute respiratory infections indicate a systemic nature of invasion (32, 33). This can be explained by constant antigenic stimulation of immune system leading to formation of pro-inflammatory background, impaired immune regulation and potentiation of atopic reactions, reducing resistance to respiratory pathogens (34, 35).

The identified cognitive impairments deserve special attention. A statistically significantly lower average academic performance score and a high prevalence of complaints of decreased concentration (66.8%) in children with giardiasis indicate that the effects of the infection go far beyond gastrointestinal symptoms (36, 37). The pathogenesis of these disorders is probably multifactorial and may be associated with chronic nutrient deficiency due to malabsorption syndrome, direct neurotoxic effects of parasite metabolites, as well as the effects of chronic asthenic syndrome on cognitive endurance and motivation (38). This aspect is extremely important for pediatric practice, as it allows us to consider giardiasis as one of the potential causes of school maladjustment.

Table 3. Distribution of risk factors in the main and control groups

Risk Factor	Study Group (n = 250)	Control Group (n = 250)	*P*-value
Residence in rural areas, n (%)	145 (58.0%)	80 (32.0%)	< 0.001
Ownership of domestic pets, n (%)	189 (75.6%)	135 (54.0%)	< 0.01
Non-centralized water supply, n (%)	132 (52.8%)	55 (22.0%)	< 0.001
Contact with farm animals, n (%)	118 (47.2%)	45 (18.0%)	< 0.001

The analysis of risk factors has convincingly demonstrated their leading role in the epidemiology of infection. Significant predominance in the main group of factors, such as living in rural areas (58.0% vs. 32.0%), use of water from non-centralized sources (52.8% vs 22.0%) and contact with farm animals (47.2% vs 18.0%) (39-41). These factors clearly indicate the dominance of aquatic and zoonotic transmission routes under these conditions, particularly the difference from predominantly residential contact routes in megacities (42-44).

The most significant data reflect the dynamics of condition after etiotropic therapy. Rapid regression of abdominal (86.8%-18%) and asthenic syndromes (79.2%-26%) during the first 6 months indicate that these symptoms are direct consequences of invasion and reversible when it is eliminated (45).

At the same time, analysis of long-term results revealed an important pattern: the normalization of a number of indicators was much slower and did not always reach the level of the control group even after 24 months. Therefore, the incidence of allergic dermatoses 2 years after treatment was 28.0%, which was still higher than in the control (27.2%), (46). A similar situation was observed with complaints about decreased concentration (20% vs. 30% in control). This suggested that chronic parasitic infection could initiate certain pathological immune and neurofunctional changes that persisted even after the parasite was eliminated. This finding was of key clinical significance, emphasizing the importance of not only timely diagnosis and treatment for giardiasis but

Table 4. Dynamics of clinical parameters in the main group after treatment (n = 250)

Parameter	Before Treatment	After 6 Months	After 12 Months	After 24 Months
Abdominal syndrome, n (%)	217 (86.8%)	45 (18.0%)*	32 (12.8%)*	28 (11.2%)*
Asthenic syndrome, n (%)	198 (79.2%)	65 (26.0%)*	41 (16.4%)*	35 (14.0%)*
Allergodermatoses, n (%)	124 (49.6%)	95 (38.0%)*	75 (30.0%)*	70 (28.0%)*
Frequency of ARI (episodes per year), M ± SD	5.8 ± 1.5	4.5 ± 1.3*	4.1 ± 1.1*	4.0 ± 1.0*
Physical development delay, n (%)	42 (16.8%)	35 (14.0%)	25 (10.0%)*	18 (7.2%)*
Average academic performance score, M ± SD	3.7 ± 0.8	4.0 ± 0.6*	4.1 ± 0.5*	4.2 ± 0.5*
Complaints of attention deficit, n (%)	167 (66.8%)	85 (34.0%)*	58 (23.2%)*	50 (20.0%)*

Note: * — statistically significant differences compared to the indicator "Before treatment" ($P < 0.05$).

also long-term monitoring of convalescent patients with targeted rehabilitation programs (47-49).

The positive dynamics in terms of ARI frequency and physical development indicators, although pronounced, is also gradual. This confirms the concept of long-term impact of invasion on overall body resources. Thus, giardiasis in children should be considered a systemic disease with wide range of clinical manifestations. Despite etiotropic therapy leading to rapid regression of key symptoms, several consequences, particularly those affecting the immune system and cognitive function, may persist. Extended medical supervision and integrated rehabilitation are required (50-51).

Conclusion

The retrospective cohort study conducted made it possible to establish a significant negative impact of giardiasis on children's health. It identified key risk factors and analyzed the dynamics of recovery after treatment. The data obtained convincingly demonstrates that giardia in children should be considered a systemic disease and not just an intestinal infection. Before treatment, children with confirmed giardia were significantly more likely to experience not only gastrointestinal symptoms (86.8% had abdominal syndrome, compared to 18.0% in the control group) but also systemic manifestations, such as asthenic syndrome (79.2%), allergodermatoses (49.6%, compared to 27.2% in controls), and complaints of reduced concentration (66.8%). These findings indicate a complex negative effect of the invasion on the developing body.

The analysis of risk factors revealed a clear dependence of the probability of infection on social and living conditions. The main group was significantly dominated by children living in rural areas (58.0% vs. 32.0%), using non-centralized water supply sources (52.8% vs. 22.0%) and having contact with farm animals (47.2% vs 18.0), indicating the dominance of aquatic and zoonotic transmission routes in the studied regions.

The assessment of long-term treatment results showed multidirectional dynamics in recovery of various body functions. Fastest regression was observed with respect to gastrointestinal symptoms: already 6 months after treatment, prevalence of abdominal syndrome decreased to 18%. However, normalization of extraintestinal manifestations occurred more slowly: after 24 months, prevalence of allergodermatosis decreased to 28% and complaints about decreased concentration decreased to 20%, which were still higher than in the control group. This indicates that chronic parasitic infection can initiate long-term pathological changes that persist even after the pathogen has been eliminated.

Thus, the results obtained emphasize the need for an integrated approach to managing children with giardiasis. This includes not only timely etiotropic therapy but also long-term follow-up with targeted rehabilitation measures aimed at correcting long-term consequences of infection. The significant association of the disease with specific social and household factors necessitates the development of differentiated prevention programs taking into account regional epidemiological characteristics.

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Authors' Contribution

All the authors participated equally in the organization of the experiment and the preparation of the manuscript

Competing Interests

The authors declare that there is no conflict of interest

Ethical Approval

The study was conducted in strict accordance with the principles of the Helsinki Declaration, and its protocol was approved by the ethics committee of the North Ossetian State Medical Academy (Vladikavkaz, Russia). Protocol No. 1278 dated 12/02/2023 was approved.

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References

1. Desai AN. Giardiasis. Jama. 2021;325(13):1356. doi:10.1001/jama.2020.10289
2. Conners EE, Miller AD, Balachandran N, Robinson BM, Benedict KM. Giardiasis Outbreaks - United States, 2012-2017. MMWR Morb Mortal Wkly Rep. 2021;70(9):304-7. doi:10.15585/mmwr.mm7009a2
3. Fauziah N, Aviani JK, Agrianfanny YN, Fatimah SN. Intestinal Parasitic Infection and Nutritional Status in Children under Five Years Old: A Systematic Review. Trop Med Infect Dis. 2022;7(11):371. doi:10.3390/tropicalmed7110371
4. Adam RD. Giardia duodenalis: Biology and Pathogenesis. Clin Microbiol Rev. 2021;34(4):e0002419. doi:10.1128/cmr.00024-19
5. Sequeira S, Sousa M, Cruz A. Exploring Methodologies from Isolation to Excystation for Giardia lamblia: A Systematic Review. Microorganisms. 2025;13(8):1719. doi:10.3390/microorganisms13081719
6. Grüttner J, van Rijn JM, Geiser P, Florbrant A, Webb DL, Hellström PM, et al. Trophozoite fitness dictates the intestinal epithelial cell response to Giardia intestinalis infection. PLoS Pathog. 2023;19(5):e1011372. doi:10.1371/journal.ppat.1011372
7. Prabakaran M, Weible LJ, Champlain JD, Jiang RY, Biondi K, Weil AA, et al. The Gut-Wrenching Effects of Cryptosporidiosis and Giardiasis in Children. Microorganisms. 2023;11(9):2323. doi:10.3390/microorganisms11092323
8. Bhatt AP, Arnold JW, Awoniyi M, Sun S, Feijoli Santiago V, Coskuner D, et al. Giardia antagonizes beneficial functions

of indigenous and therapeutic intestinal bacteria during protein deficiency. Gut Microbes. 2024;16(1):2421623. doi:10.1080/19490976.2024.2421623
9. Solaymani-Mohammadi S. Mucosal Defense Against Giardia at the Intestinal Epithelial Cell Interface. Front Immunol. 2022;13:817468. doi:10.3389/fimmu.2022.817468
10. Pyzocha N, Cuda A. Common Intestinal Parasites. Am Fam Physician. 2023;108(5):487-93.
11. Tenaglia AH, Luján LA, Ríos DN, Molina CR, Midlej V, Iribarren PA, et al. Antibodies to variable surface antigens induce antigenic variation in the intestinal parasite Giardia lamblia. Nat Commun. 2023;14(1):2537. doi:10.1038/s41467-023-38317-8
12. Lagunas-Rangel FA. Exploration of Giardia small nucleolar RNAs (snoRNAs) and their possible microRNA derivatives. Parasitology. 2024;151(6):539-45. doi:10.1017/s003118202400060x
13. De Francesco MA, Paroni L, Lanzarotto F, Zammarchi I, Manenti S, Mazzola AM, et al. Chronic intestinal spirochaetosis and Giardia lamblia infection mimicking eosinophilic enterocolitis. Lancet Infect Dis. 2025;25(5):e307-e13. doi:10.1016/s1473-3099(24)00739-4
14. Sandoval-Ramírez T, Seco-Hidalgo V, Calderon-Espinosa E, Garcia-Ramon D, Lopez A, Calvopiña M, et al. Epidemiology of giardiasis and assemblages A and B and effects on diarrhea and growth trajectories during the first 8 years of life: Analysis of a birth cohort in a rural district in tropical Ecuador. PLoS Negl Trop Dis. 2023;17(11):e0011777. doi:10.1371/journal.pntd.0011777
15. Saura-Carretero Z, Villanueva-Alarcón M, Pérez-Olaso O, Aleixandre-Górriz I, Real-Fernández A, Sánchez-Thevenet P, et al. [Giardiasis in a paediatric population of the province of castellon. Clinical details and impact]. An Pediatr (Engl Ed). 2021;94(5):278-84. doi:10.1016/j.anpedi.2020.06.023
16. Mohamed AMA, Bayoumy AM, Abo-Hashim AH, Ibrahim AA, El-Badry AA. Giardiasis in symptomatic children from Sharkia, Egypt: genetic assemblages and associated risk factors. J Parasit Dis. 2020;44(4):719-24. doi:10.1007/s12639-020-01254-0
17. Klimczak S, Packi K, Rudek A, Wenclewska S, Kurowski M, Kurczabińska D, et al. The Influence of the Protozoan Giardia lamblia on the Modulation of the Immune System and Alterations in Host Glucose and Lipid Metabolism. Int J Mol Sci. 2024;25(16):8627. doi:10.3390/ijms25168627
18. Dougherty M, Bartelt LA. Giardia and growth impairment in children in high-prevalence settings: consequence or co-incidence? Curr Opin Infect Dis. 2022;35(5):417-23. doi:10.1097/qco.0000000000000877
19. Abedi SH, Fazlzadeh A, Mollalo A, Sartip B, Mahjour S, Bahadory S, et al. The neglected role of Blastocystis sp. and Giardia lamblia in development of irritable bowel syndrome: A systematic review and meta-analysis. Microb Pathog. 2022;162:105215. doi:10.1016/j.micpath.2021.105215
20. González Maciel A, Rosas López LE, Romero-Velázquez RM, Ramos-Morales A, Ponce-Macotela M, Calderón-Guzmán D, et al. Postnatal zinc deficiency due to giardiasis disrupts hippocampal and cerebellar development. PLoS Negl Trop Dis. 2024;18(7):e0012302. doi:10.1371/journal.pntd.0012302
21. Ara-Montojo MF, Bustamante J, Sainz T, Pérez S, Jiménez-Moreno B, Ruiz-Carrascoso G, et al. Intestinal giardiasis in children: Five years' experience in a reference unit. Travel Med Infect Dis. 2021;42:102082. doi:10.1016/j.tmaid.2021.102082
22. Coffey CM, Collier SA, Gleason ME, Yoder JS, Kirk MD, Richardson AM, et al. Evolving Epidemiology of Reported Giardiasis Cases in the United States, 1995-2016. Clin Infect Dis. 2021;72(5):764-70. doi:10.1093/cid/ciaa128
23. Shen MJ, Voltaggio L, Robertson S. Giardia Is Often Overlooked on Histopathologic Examination: A High-Volume, Single-Institution Experience. Int J Surg Pathol. 2021;29(3):257-62. doi:10.1177/1066896920947795
24. Krumrie S, Capewell P, Smith-Palmer A, Mellor D, Weir W, Alexander CL. A scoping review of risk factors and transmission routes associated with human giardiasis outbreaks in high-income settings. Curr Res Parasitol Vector Borne Dis. 2022;2:100084. doi:10.1016/j.crpvbd.2022.100084
25. Li J, Qin H, Li X, Zhang L. Role of rodents in the zoonotic transmission of giardiasis. One Health. 2023;16:100500. doi:10.1016/j.onehlt.2023.100500
26. Saydam FN, Erdem H, Ankarali H, El-Arab Ramadan ME, El-Sayed NM, Civljak R, et al. Vector-borne and zoonotic infections and their relationships with regional and socioeconomic statuses: An ID-IRI survey in 24 countries of Europe, Africa and Asia. Travel Med Infect Dis. 2021;44:102174. doi:10.1016/j.tmaid.2021.102174
27. Mazumdar S, Fletcher-Lartey SM, Zajaczkowski P, Jalaludin B. Giardiasis notifications are associated with socioeconomic status in Sydney, Australia: a spatial analysis. Aust N Z J Public Health. 2020;44(6):508-13. doi:10.1111/1753-6405.13019
28. Ydsten KA, Öhd JN, Hellgren U, Asgeirsson H. Prevalence of Nitroimidazole-Refractory Giardiasis Acquired in Different World Regions, Sweden, 2008-2020. Emerg Infect Dis. 2025;31(6):1235-8. doi:10.3201/eid3106.250076
29. Dunn N, Juergens AL. Giardiasis. 2024 Feb 12. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan.
30. Pophali P, Veyseh M, Fraij O, Hapangama S. Chronic giardiasis: a rare cause of exocrine pancreatic insufficiency. BMJ Case Rep. 2021;14(5). doi:10.1136/bcr-2021-242129
31. Ali Q, Ahmed S, Aamer S, Iqbal N, Mamoon N. Giardiasis: An Overlooked Cause of Recurrent Abdominal Pain. Cureus. 2021;13(9):e17701. doi:10.7759/cureus.17701
32. Klimczak S, Packi K, Rudek A, Wenclewska S, Kurowski M, Kurczabińska D, et al. The Influence of the Protozoan Giardia lamblia on the Modulation of the Immune System and Alterations in Host Glucose and Lipid Metabolism. Int J Mol Sci. 2024;25(16). doi:10.3390/ijms25168627
33. Rópolo AS, Touz MC. A lesson in survival, by Giardia lamblia. ScientificWorldJournal. 2010;10:2019-31. doi:10.1100/tsw.2010.200
34. Sardinha-Silva A, Gazzinelli-Guimaraes PH, Ajakaye OG, Oliveira FMS, Ferreira TR, Alves-Ferreira EVC, et al. Giardia-induced Type 2 mucosal immunity attenuates intestinal inflammation caused by co-infection or colitis in mice. Nat Microbiol. 2025;10(8):1886-901. doi:10.1038/s41564-025-02051-2
35. Fekete E, Allain T, Siddiq A, Sosnowski O, Buret AG. Giardia spp. and the Gut Microbiota: Dangerous Liaisons. Front Microbiol. 2020;11:618106. doi:10.3389/fmicb.2020.618106
36. Bartelt LA, Platts-Mills JA. Giardia: a pathogen or commensal for children in high-prevalence settings? Curr Opin Infect Dis. 2016;29(5):502-7. doi:10.1097/qco.0000000000000293

37. Garba B, Dirie NI, Umar Y, Salah AO, Hussien AA, Alasow IAM, et al. Assessment of the burden of Giardia infection and its associated risk factors among children resident in internally displaced persons camps in Mogadishu, Somalia: a cross-sectional study. Int Health. 2025;17(6):942-52. doi:10.1093/inthealth/ihaf034
38. Khandia R, Pandey MK, Zaki MEA, Al-Hussain SA, Baklanov I, Gurjar P. Application of codon usage and context analysis in genes up- or down-regulated in neurodegeneration and cancer to combat comorbidities. Front Mol Neurosci. 2023;16:1200523. doi:10.3389/fnmol.2023.1200523
39. Huang Q, Huang S, Li B, Xiong Y, Kuang W, Xiao S, et al. Spatially explicit model of the Cryptosporidium and Giardia disease burden from surface and ground waters in urban and rural areas of the Three Gorges Reservoir watershed in Chongqing, China. Environ Sci Pollut Res Int. 2023;30(13):37127-42. doi:10.1007/s11356-022-24690-2
40. Roshidi N, Mohd Hassan NH, Abdul Hadi A, Arifin N. Current state of infection and prevalence of giardiasis in Malaysia: a review of 20 years of research. PeerJ. 2021;9:e12483. doi:10.7717/peerj.12483
41. Lompo P, Tahita MC, Sorgho H, Kaboré W, Kazienga A, Nana ACB, et al. Pathogens associated with acute diarrhea, and comorbidity with malaria among children under five years old in rural Burkina Faso. Pan Afr Med J. 2021;38:259. doi:10.11604/pamj.2021.38.259.15864
42. Cai W, Ryan U, Xiao L, Feng Y. Zoonotic giardiasis: an update. Parasitol Res. 2021;120(12):4199-218. doi:10.1007/s00436-021-07325-2
43. Dos Reis LL, da Silva TRR, Braga FCO, do Nascimento NM, de Menezes KML, Nava AFD, et al. Giardiasis in urban and rural Amazonas, Brazil is driven by zoonotic and cosmopolitan A and B assemblages. Mem Inst Oswaldo Cruz. 2022;116:e210280. doi:10.1590/0074-02760210280
44. Harvey TV, Carvalho J, Aquino MCC, Oliveira BCM, Barros LD, Fehlberg HF, et al. Giardiasis in children and dogs, and the first report of assemblage E in dogs from northeastern Brazil. Rev Bras Parasitol Vet. 2023;32(1):e012222. doi:10.1590/s1984-29612023010
45. Roshidi N, Arifin N. Disease Biomarkers of Giardiasis. J Parasitol Res. 2022;2022:1932518. doi:10.1155/2022/1932518
46. Mahdavi J, Ahmadifar K, Ghasemikhah R. Urticaria as a dermatologic manifestation of Giardia infection: a systematic review of clinical, diagnostic, and therapeutic features. BMC Infect Dis. 2025;25(1):1085. doi:10.1186/s12879-025-11484-3
47. Mohamedahmed KA, Mohammed Nour BY, Mohamed Elshiekh MY, Abakar AD, Gharedaghi Y, G. Elzaki SE, et al. TNF-α 238 Alleles Polymorphism and its Association With TNF-α Levels in the Severe Malaria Anemia Among Sudanese Children. Int J Med Parasitol Epidemiol Sci. 2025;6(1):11-9. doi:10.34172/ijmpes.5190
48. Garedaghi Y. Seroprevalence of Toxocariasis in Children in East- Azerbaijan Province, Iran, Cukurova Medical Journal. 2013;38(4):581-86.
49. Davodi Y, Garedaghi Y, Safarmashaei S. Epidemiological study of Giardiasis in Diarrheic calves in East-Azerbaijan province,Iran, Journal of animal and veterinary advances. 2011;10(19):2508-510.
50. Rahman HU, Khatoon N, Arshad S, Masood Z, Ahmad B, Khan W, et al. Prevalence of intestinal nematodes infection in school children of urban areas of district Lower Dir, Pakistan. Braz J Biol. 2022;82:e244158. doi:10.1590/1519-6984.244158
51. Fadladdin YAJ, Ullah A, Nawaz R, Garedaghi Y, Al-Azab AMA, Aldamigh MA. Prevalence of nematode infection among school children of district Malakand, Pakistan. Pakistan Journal of Nematology. 2024;42(1):25-33. doi:10.17582/journal.pjn/2024/42.1.25.33

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