

Original Article



Impact of *Giardia lamblia* Infection on Hematological Parameters in Children from Urmia, Iran

Ali Fattahi Bafghi¹, Elaheh Hezardastan², Milad Fakhraei², Mojtaba Norouzi^{2*}

¹Department of Parasitology and Mycology, Infectious Diseases Research Center, School of Medicine, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

²Department of Parasitology and Mycology, School of Medicine, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

Abstract

Introduction: *Giardia lamblia* is a protozoan parasite that causes steatorrhea in humans worldwide. *Giardia* colonizes the duodenum and the upper part of the jejunum, where it can cover the intestinal surface and lead to steatorrhea, physical and mental retardation, and disturbances in serum levels of zinc, ferritin, iron, and vitamins A, E, D, and K. This study aimed to investigate hematological changes, including iron, ferritin, and zinc levels, in 6–12-year-old *Giardia*-positive and healthy children in Urmia, West Azerbaijan Province, Iran.

Methods: This cross-sectional study was conducted on 6–12-year-old *Giardia*-infected and healthy children in Urmia, West Azerbaijan Province, Iran. A total of 35 children were selected for each group using a questionnaire. Hematological parameters were analyzed using SPSS software version 22. The chi-square test was used for qualitative variables, and comparisons between groups were made using the independent t-test and the Mann–Whitney U test.

Results: Children with giardiasis showed significantly higher hematocrit (HCT) and lower mean corpuscular hemoglobin concentration (MCHC) compared to healthy children. Neutrophil counts were also significantly different, while other hematological parameters, including hemoglobin, MCV, MCH, total WBC, lymphocytes, and platelets, did not differ significantly.

Conclusion: Early diagnosis and timely treatment of giardiasis, as well as prevention of chronic infection, can reduce intestinal damage, physical and mental retardation, and other clinical symptoms resulting from vitamin and mineral deficiencies in children.

Keywords: *Giardia lamblia*, Hematological parameters, Children, Urmia, Iran

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Introduction

Giardia lamblia is a flagellated protozoan parasite that infects humans and is one of the most common causes of acute diarrhea. Giardiasis occurs worldwide, though it is less prevalent in developed countries, and is more than three times as common in children as in adults. The World Health Organization estimates that approximately 280 million people are infected with this parasite each year, leading to acute diarrheal disease (1, 2).

Individuals with chronic *Giardia* infection may experience long-term health complications such as malnutrition, physical growth retardation, irritable bowel syndrome, and arthritis. In developing countries, *Giardia* infection affects approximately 2% of adults and 6–8% of children. Severe infections are often accompanied by steatorrhea and deficiencies in gamma globulin, folic acid, and fat-soluble vitamins (K, E, D, and A). Infected individuals may also suffer from deficiencies in essential trace elements such as zinc and iron, both of which are crucial for growth, development, and reproduction (3).

Because zinc is not stored in large amounts in the human body, its serum concentration can rapidly decrease during infection, particularly in children with inadequate dietary zinc intake. Reduced serum zinc levels disrupt

cellular function, as well as physiological and enzymatic activities. During acute infections, serum zinc levels may temporarily rise due to rapid mobilization from tissues; however, in chronic infections, a continuous decline in serum zinc levels is typically observed (4).

Disturbance in iron metabolism is another consequence of *Giardia* infection (5–6). Although asymptomatic giardiasis does not significantly affect intestinal iron absorption, iron malabsorption leading to low serum iron levels has been reported in symptomatic patients (7). Moreover, patients with giardiasis often show a significant increase in red and white blood cell counts, particularly neutrophils, compared to healthy individuals, while parameters such as PCV, MCHC, MCV, and Hb tend to be significantly decreased (8).

Therefore, the aim of this study was to investigate cellular and hematological changes in *Giardia*-infected and healthy children aged 6–12 years in Urmia County, West Azerbaijan Province, Iran.

Materials and Methods

Study Population

This case-control study was conducted among 325 children who were referred to health centers in Urmia,



*Corresponding Author: Mojtaba Norouzi, Email: mnorozi40@yahoo.com

West Azerbaijan Province, Iran, in 2016. Based on questionnaire data, 35 children aged 6–12 years who tested positive for *Giardia* (case group) and 35 healthy children aged 6–12 years without *Giardia* infection (control group) were selected.

Children in both groups were matched based on age, sex, height, and place of residence. Additionally, matching between the case and control groups was performed according to socioeconomic status. This study was approved and registered in the Iranian Ethics Code Registry under the code SSU.MEDICINE.REC.1395.146.

Sample Size Calculation

The required sample size was determined using the following formula. Considering the standard deviations of white blood cell and red blood cell counts in the case and control groups as 25 and 23, respectively, a mean difference of 14, a confidence level of 95%, and a statistical power of 80%, a total of 35 participants were included in each group

$$n = \frac{\left(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta} \right)^2 (S_1^2 + S_2^2)}{(\mu_1 - \mu_2)^2}$$

Case-Control Matching and Sampling

From each child, 5 mL of peripheral blood was collected under sterile conditions. The samples were centrifuged at 3000 rpm for 6 minutes to separate the serum. The obtained serum was then transferred to special polymer tubes and stored at -18°C until analysis.

Measurement of Ferritin, Zinc, and Iron Serum Levels

Blood samples were obtained from 35 children infected with *Giardia* (case group) and 35 apparently healthy children (control group) with no previous history of giardiasis, who were referred to primary health centers. After collection, the samples were gently mixed in EDTA tubes using a mechanical mixer. Subsequently, 0.2 mL of each blood sample was aspirated by an XP-300 hematology analyzer (Sysmex, Japan) to measure hematological parameters, including white blood cell (WBC) count, red blood cell (RBC) count, packed cell volume (PCV), hemoglobin (Hb), mean corpuscular hemoglobin concentration (MCHC), mean corpuscular hemoglobin (MCH), and mean corpuscular volume (MCV).

Demographic information such as age, sex, and place of residence was recorded for each child on a designated data collection form along with the corresponding laboratory results.

Data Analysis

Data obtained from the serum and hematological measurements were recorded and analyzed using SPSS version 22. The mean, standard deviation, and concentration of WBCs, RBCs, and other hematological

parameters were calculated for both case and control groups and presented in tabular form.

Comparisons of serum concentrations between the two groups were performed using the independent t-test and Mann-Whitney U test, depending on the distribution of variables. A p-value of less than 0.05 was considered statistically significant

Results

The mean hemoglobin (HGB) of individuals with *Giardia* was 13.98 g/dL with a standard deviation of 13.4, and the mean hemoglobin of healthy individuals was 13.06 g/dL with a standard deviation of 13.4, which did not show significant differences according to the t-test ($P=0.083$).

The mean hematocrit (HCT) of individuals with *Giardia* was $43.55 \pm 43.87\%$ with a standard deviation (MD) of 41.7%, and the mean hematocrit of healthy individuals was $39.31 \pm 0.58\%$ with a standard deviation (MD) of 39.1%, which showed a significant difference according to the Mann-Whitney test ($P=0.001$).

The mean MCV of red blood cells in people with *Giardia* was $73.74 \pm 23.34 \text{ fL}$ with a standard deviation of MD = 80.55 fL and the mean MCV of healthy people was $81.98 \pm 0.94 \text{ fL}$ with a standard deviation of MD = 81.7 fL, which did not show a significant difference according to the Mann-Whitney test ($P=0.91$).

The mean hemoglobin in red blood cells (MCH) of people with *Giardia* was $26.22 \pm 1.82 \text{ p/g}$ with a standard deviation MD = 27.15 p/g, and the mean hemoglobin in red blood cells of healthy people was $27.4 \pm 1.03 \text{ p/g}$ with a standard deviation MD = 27.7 l p/g, which did not show a significant difference according to the t-test ($P=0.096$).

The mean hemoglobin concentration in red blood cells (MCHC) of individuals with *Giardia* was $32.19 \pm 0.92 \text{ g/dL}$ with a standard deviation of MD = 32.3 g/dL, and the mean hemoglobin concentration in red blood cells of healthy individuals was $33.37 \pm 1.24 \text{ g/dL}$ with a standard deviation of MD = 33.1 g/dL, which showed a significant difference according to the t-test ($P=0.027$).

The mean hemoglobin concentration in red blood cells (MCHC) of individuals with *Giardia* was $10.53 \pm 16.6 \text{ mc/}\mu\text{L}$ with a standard deviation (MD) of 5.32 mc/ μL , and the mean hemoglobin concentration in red blood cells of healthy individuals was $4.76 \pm 0.13 \text{ mc/}\mu\text{L}$ with a standard deviation (MD) of 4.78 mc/ μL , which showed a significant difference according to the t-test ($P=0.001$), Table 1.

The mean peripheral blood lymphocyte count of individuals with *Giardia* was $2.93 \pm 0.37 \text{ n/}\mu\text{L}$ with a standard deviation of MD = 2.93 n/ μL , and the mean peripheral blood lymphocyte count of healthy individuals was $2.71 \pm 0.45 \text{ n/}\mu\text{L}$ with a standard deviation of MD = 4.05 n/ μL , which did not show significant differences according to the t-test ($P=0.24$).

The mean peripheral blood neutrophil count of individuals with *Giardia* was $3.74 \pm 2.8 \text{ n/}\mu\text{L}$ with a standard

Table 1. Comparison of Hematimetric changes in 6-12 years old children with giardia and healthy in Urmia, West Azerbaijan Province, Iran.

Group	HGB(gr/dl)	HCT(%)	MCV(fl)	MCH(pg)	MCHC(g/dL)	RBC(mc/ μ L)
patient	13.98 $\pm$ 1.4 MD=13.4	43.55 $\pm$ 3.87 MD=41.7	73.74 $\pm$ 23.34 MD=80.55	26.22 $\pm$ 1.82 MD=27.15	32.19 $\pm$ 0.92 MD=32.3	10.53 $\pm$ 16.6 MD=5.32
Healthy	13.06 $\pm$ 0.64 MD=13.3	39.31 $\pm$ 0.58 MD=39.1	81.98 $\pm$ 0.94 MD=81.7	27.4 $\pm$ 1.03 MD=27.7	33.37 $\pm$ 1.24 MD=33.1	4.76 $\pm$ 0.13 MD=4.78
TEST	T-test	Mann-Whitney	Mann-Whitney	T-test	T-test	Mann-Whitney
P value	0.083	<0.001	0.91	0.096	0.027	<0.001

deviation of MD = 2.7 n/ μ L and the mean peripheral blood neutrophil count of healthy individuals was 4.04 $\pm$ 0.29 n/ μ L with a standard deviation of MD = 4.05 n/ μ L, which showed a significant difference according to the Mann-Whitney test ($P=0.035$).

The mean peripheral white blood cell count of individuals with *Giardia* was 7.79 $\pm$ 2.31 n/ μ L with a standard deviation MD = 6.9 n/ μ L and the mean peripheral white blood cell count of healthy individuals was 8 $\pm$ 0.68 n/ μ L with a standard deviation MD = 7.9 n/ μ L, which did not show significant differences according to the t-test ($P=0.79$).

The mean peripheral blood platelet count of individuals with *Giardia* was 248.44 $\pm$ 148.94 n/ μ L with a standard deviation of MD = 206 n/ μ L, and the mean peripheral blood platelet count of healthy individuals was 310.3 $\pm$ 10.68 n/ μ L with a standard deviation of MD = 308.5 n/ μ L, which did not show significant differences according to the Mann-Whitney test ($P=0.22$). [Table 2](#)

Discussion

The findings of this case-control study demonstrate significant hematological alterations in children aged 6–12 years with chronic *Giardia lamblia* infection compared to healthy controls. Giardiasis appears to affect erythrocyte indices and specific leukocyte populations, reflecting subclinical nutrient malabsorption and a low-grade inflammatory response.

A key finding was the significant reduction in hematocrit (HCT), mean corpuscular hemoglobin concentration (MCHC), and red blood cell (RBC) count in the infected group. The decreased HCT and MCHC are indicative of microcytic, hypochromic anemia, commonly associated with iron deficiency (9-12). This aligns with the pathophysiology of chronic giardiasis, where trophozoites colonize the duodenum and proximal jejunum, causing villous atrophy and impaired absorption of essential nutrients, including iron (13, 14). The observed anemia is likely a direct consequence of this impaired iron uptake.

Interestingly, the elevated RBC count in the infected group may reflect a compensatory erythropoietin-mediated response to chronic anemia, although this requires further investigation (15-17).

Differential white blood cell analysis revealed significant neutropenia in *Giardia*-positive children, suggesting a complex host-parasite interaction. Chronic infections may

Table 2. Comparison of others Hematimetric changes in 6-12 years old children with giardia and healthy in Urmia, West Azerbaijan Province, Iran

Groups	Lym(N/ μ L) (Mean $\pm$ SD)	Nut(n/ μ L) (Mean $\pm$ SD)	WBC(n/ μ L) (Mean $\pm$ SD)	Plt(n/ μ L) (Mean $\pm$ SD)
Patients	2.93 $\pm$ 0.37 MD=2.98	3.74 $\pm$ 2.8 MD=2.7	7.79 $\pm$ 2.31 MD=6.9	248.44 $\pm$ 148.94 MD=206
Healthy	2.71 $\pm$ 0.45 MD=2.7	4.04 $\pm$ 0.29 MD=4.05	8 $\pm$ 0.68 MD=7.9	310.3 $\pm$ 10.68 MD=308.5
Test	T-test	Mann-Whitney	T-test	Mann-Whitney
P-Value	0.24	0.035	0.79	0.22

lead to neutrophil margination or increased consumption at the site of intestinal inflammation. Parasitic infections may also modulate the host immune system, potentially suppressing myeloid lineage production as an evasion mechanism (12). The absence of significant changes in total WBC counts indicates that immune dysregulation is subset-specific rather than generalized.

Other hematological parameters, including hemoglobin (Hb), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and platelet (PLT) count, did not differ significantly. The stability of MCV and MCH despite low MCHC suggests that erythrocytes maintain their size but are hemoglobin-deficient, supporting the diagnosis of hypochromic anemia. The lack of thrombocytopenia indicates that chronic giardiasis does not significantly affect platelet production or survival.

This study has limitations. The sample size, although sufficient for statistical power, is relatively small, and the cross-sectional design prevents conclusions about causality. Additionally, nutritional status and the presence of other subclinical enteric infections were not assessed, which may act as confounders (13, 14).

In conclusion, chronic *Giardia lamblia* infection in children is associated with hematological changes indicative of iron-deficiency anemia and altered neutrophil counts. These findings highlight that giardiasis extends beyond acute diarrhea to include systemic effects. Early diagnosis and effective treatment are crucial to prevent long-term complications, including impaired growth and cognitive development. Public health measures, such as improved sanitation, access to clean water, and personal hygiene education, remain essential for preventing giardiasis (18-20).

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Authors' Contribution

Conceptualization: Ali Fattahi Bafghi.

Data curation: Ali Fattahi Bafghi, Mojtaba Norouzi.

Formal analysis: Mojtaba Norouzi.

Funding acquisition: Elaheh Hezardastan.

Investigation: Elaheh Hezardastan.

Methodology: Milad Fakhræi.

Project administration: Ali Fattahi Bafghi.

Resources: Elaheh Hezardastan.

Software: Mojtaba Norouzi.

Supervision: Mojtaba Norouzi.

Validation: Elaheh Hezardastan.

Visualization: Mojtaba Norouzi.

Writing—original draft: Elaheh Hezardastan.

Writing—review & editing: Ali Fattahi Bafghi, Mojtaba Norouzi, Elaheh Hezardastan.

Competing Interests

The authors declare that they have no competing financial interests or personal relationships that could influence the work reported in this paper. Ethical approval This study was approved by the Ethics Committee of the School of Medicine, Shahid Sadoughi University of Medical Sciences. The study is observable at <https://ethics.research.ac.ir/IR.SSU.MEDICINE.REC.1395.146>

Ethical Approval

Ethical approval to perform this study was obtained by the Ethical Review Board of Yazd Shahid Sadoughi University of Medical Sciences (Ethic Code: IR.SSU.MEDICINE.1395.019).

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