

Physiological and Immunological Alterations Associated with *Enterobius vermicularis* Infection Among Children in Some Areas of Northern Dhi Qar, Iraq

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Abstract

The intestinal pinworm (*Enterobius vermicularis*) is classified as one of the most influential and widespread intestinal parasites among children, with its effects extending to include varying changes in the host's vital and immunological indicators. This study aimed to evaluate selected hematological and immunological parameters in children infected with *Enterobius vermicularis* compared with apparently healthy, uninfected children. The study was conducted in some areas of northern Dhi Qar province, specifically Al-Rifai and Qalat Sukkar, from August 2025 to May 2026, aged 1–10 years. *Enterobius vermicularis* infection was diagnosed using the adhesive tape (Scotch tape) method. The study sample consisted of 20 infected children, along with a control group consisting of 20 healthy children. The laboratory component included measuring a range of hematological parameters, including hemoglobin concentration (Hb g/dL), red blood cell count (RBC $\times 10^6/\mu\text{L}$), white blood cell count (WBC $\times 10^3/\mu\text{L}$), platelet count (PLT $\times 10^3/\mu\text{L}$), packed cell volume (HCT %), and mean corpuscular volume (MCV, fL). The immune status was also assessed by measuring the levels of immunoglobulin A (IgA, mg/dL), interleukin-4 (IL-4, pg/mL), and transforming growth factor-beta (TGF- β pg/mL), and by statistically comparing the data obtained between the two groups. The results showed statistically significant differences ($P < 0.05$) in platelet count (PLT), packed cell volume (HCT), and mean corpuscular volume (MCV) between infected children and the control group, while other hematological parameters (Hb, RBC, WBC) showed no significant differences. Immunologically, the study observed statistically significant increases in both IgA and TGF- β levels in the infected group, coupled with no significant change in IL-4 levels compared to the healthy group.

Keywords: *Enterobius vermicularis*, Hematological Parameters, Risk Immunological response, Cytokines and Parasitic infection, Dhi Qar-Iraq.

التغيرات الفسيولوجية والمناعية المرتبطة بالإصابة بالدودة الدبوسية (*Enterobius*

vermicularis) بين الاطفال في بعض مناطق شمال ذي قار ، العراق

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الخلاصة

تُصنف الدودة الدبوسية المعوية (*Enterobius vermicularis*) كواحدة من أكثر الطفيليات المعوية انتشاراً وتأثيراً بين الأطفال، حيث تمتد آثارها لتشمل تغيرات متفاوتة في المؤشرات الحيوية والمناعية للمضيف. هدفت هذه الدراسة إلى تقييم بعض المعايير الدموية والمناعية المختارة لدى الأطفال المصابين بدودة الأمعاء الدبوسية مقارنة بالأطفال الأصحاء غير المصابين. أجريت الدراسة في بعض مناطق محافظة ذي قار الشمالية، وتحديداً في الرفاعي وقلعة سكر، في الفترة من آب 2025 إلى أيار 2026، وشملت أطفالاً تتراوح أعمارهم بين سنة واحدة و10 سنوات، وتم تشخيص إصابتهم بدودة الأمعاء الدبوسية (*Enterobius vermicularis*) باستخدام طريقة الشريط اللاصق. شملت عينة الدراسة 20 طفلاً مصاباً، بالإضافة إلى مجموعة ضابطة مكونة من 20 طفلاً أصحاء. تضمن الجانب المختبري قياس مجموعة من المعايير الدموية، بما في ذلك تركيز الهيموجلوبين (Hb g/dL)، وعدد خلايا الدم الحمراء (RBC $\times 10^6/\mu\text{L}$)، وعدد خلايا الدم البيضاء (WBC $\times 10^3/\mu\text{L}$)، وعدد الصفائح الدموية (PLT $\times 10^3/\mu\text{L}$)، وحجم الخلايا المرصوصة (HCT %) ، ومتوسط حجم الكريات (MCV fL). تم أيضاً تقييم الحالة المناعية عن طريق قياس مستويات الغلوبولين المناعي A (IgA mg/dL) ، والإنترلوكين-4 (IL-4 pg/mL) ، وعامل النمو المحول بيتا (TGF- β pg/mL) ، وعن طريق المقارنة الإحصائية للبيانات التي تم الحصول عليها بين المجموعتين. أظهرت النتائج فروقاً ذات دلالة إحصائية ($P < 0.05$) في عدد الصفائح الدموية، وحجم الخلايا المرصوصة، ومتوسط حجم الكريات بين الأطفال المصابين ومجموعة الضبط، بينما لم تُظهر المعايير الدموية الأخرى (الهيموجلوبين، وعدد كريات الدم الحمراء، وعدد كريات الدم البيضاء) أي فروق ذات دلالة إحصائية. من الناحية المناعية، لاحظت الدراسة ارتفاعاً ذا دلالة إحصائية في مستويات كل من الغلوبولين المناعي A (IgA) وعامل النمو المحول بيتا (TGF- β) في المجموعة المصابة، مع عدم وجود تغيير ذي دلالة إحصائية في مستويات الإنترلوكين-4 (IL-4) مقارنة بالمجموعة السليمة.

1-Introduction

Pinworms are among the most widespread intestinal parasites compared to other parasitic species. [1]. Pinworm infections are estimated at around 200 million cases worldwide, significantly affecting children [2]. The spread of pinworm infection is strongly associated with the consumption of contaminated food, poor environmental sanitation, and inadequate personal hygiene practices[3]. Transmission may occur through direct contact between an infected child and other children, facilitating the transfer of parasite eggs[4]. Infection occurs through several main transmission routes. The fecal- oral transmission route is the primary one, involving the transfer of infectious eggs via contaminated hands, as well as direct contact with contaminated environmental elements such as clothing, surfaces, and bedding. Furthermore, studies have demonstrated the possibility of airborne transmission in limited cases, where inhalation of suspended eggs followed by ingestion increases the likelihood of outbreaks, particularly in densely populated environments [5]. The effects of pinworm infection (*Enterobius vermicularis*) on the body do not primarily affect intestinal symptoms, but may impact the nutritional status and blood parameters of children. Research continues to link this disease to anemia, specifically affecting hemoglobin, serum iron, ferritin, and other micronutrient levels, suggesting a possible role for these worms in causing malnutrition and blood disorders in children [6]. Numerous studies indicate that pinworm infection leads to serious changes in blood biochemistry and its other components, such as white blood cells, immune elements like cytokines and other enzymes, red blood cells, and minerals[7]. Changes in serum iron, zinc, and magnesium levels are also associated with enterocolitis, one of the most common causes of malnutrition in children, as well as low levels of High-density lipoprotein (HDL), Low-density lipoprotein (LDL), protein, and cholesterol[8]. Several studies have demonstrated that *Enterobius vermicularis* infection is associated with a significant elevation in both total and specific immunoglobulin E (IgE) levels in serum, reflecting the activation of a T-helper type 2 (Th2)-mediated immune response during infection. In addition, infected children with allergic conditions were reported to exhibit higher IgE concentrations compared with non-allergic infected individuals, suggesting a possible relationship between this antibody and enhanced hypersensitivity reactions. Interestingly, children with a prior history of allergic disorders showed no evidence of immunosuppression, indicating that *E. vermicularis* may exert either a modulatory or protective role against infection through regulation of exaggerated immune responses[9]. Infection with *E. vermicularis* causes an increase in IL-5 production and is associated with eosinophilia, a condition characterized by an elevated eosinophil count in the blood. [10]. Published studies investigating the impact of *Enterobius vermicularis* on the intestinal microbiome and host immune responses have highlighted that infected individual often exhibit reduced intestinal secretory immunoglobulin A (SIgA) levels. Notably, these levels were shown to increase following antiparasitic treatment, suggesting a potential association between enterobiasis and alterations in mucosal immune regulation [7].

2-Materials and Methods

2.1 Study design and population

This study included 40 children aged 1–10 years, divided into two groups: a patient group of 20 children diagnosed with *Enterobius vermicularis* infection and a control group of 20 apparently healthy children. The patient group consisted of 10 males and 10 females, while the control group consisted of 8 males and 12 females. Participants were selected from some areas of northern Dhi Qar Province, specifically Al-Rifai and Qalat Sukkar, during the period from August 2025 to May 2026. Infection with *E. vermicularis* was diagnosed using the perianal cellophane tape test. The samples were collected once in the early morning, before bathing or defecation, and examined microscopically for characteristic *E. vermicularis* eggs. Children with a positive tape test were included in the patient group, whereas apparently healthy children with a negative tape test were included in the control group. Blood samples were subsequently collected under sterile conditions and transferred immediately to the laboratory for hematological and immunological analyses.

2.2 Hematological analysis

A complete blood count (CBC) was performed on all collected blood samples to evaluate the main hematological parameters, including hemoglobin concentration (Hb), red blood cell count (RBC), white blood cell count (WBC), platelet count (PLT), hematocrit (HCT), and mean corpuscular volume (MCV).

2.3 Serum separation and storage

Blood was allowed to clot at room temperature 30 minutes to allow blood clotting , and the serum was then separated using a centrifuge at 3000 rpm for 6 minutes . The resulting fine mount of serum was collected, aliquoted into 1.5-mL (Eppendorf tube) , and then frozen at (-20°C) until further accuracy verification.

2.4 Immunological analysis

Serum immunological marker levels associated with pinworm (*E. vermicularis*) infection were measured, including immunoglobulin A (IgA, mg/dL), transforming growth factor-beta (TGF- β , pg/mL), and interleukin-4 (IL-4, pg/mL). The immunological markers were measured using enzyme-linked immunosorbent assay (ELISA) kits manufactured by Bioassay Technology Laboratory (BT LAB), Jiaxing Korain Biotech Co., Ltd., Zhejiang, China. The catalog numbers of the kits were E0189Hu for human IgA, E0092Hu for human IL-4, and E3051Hu for human TGF- β . All immunological assays were performed strictly according to the manufacturer's technical protocols and in accordance with good laboratory practice standards.

3. Statistical Analysis

Data were represented as means $\pm$ SE and analyzed using SPSS version 21. Differences between means was measured using independent T-test and the statistical significance was considered at $P < 0.05$. Prior to applying the independent-samples t-test, the assumptions of normality and homogeneity of variance were assessed. Normality was evaluated using the Shapiro–Wilk test, while homogeneity of variance was assessed using Levene's test.

4. Results and Discussion

4.1 Relationship between Enterobiasis and selected physiological changes

The results of the current study showed that the 20 infected children with the intestinal pinworm (*Enterobius vermiculris*) differed significantly from the 20 healthy children control group in several hematological parameters. Regarding platelet count ($PLT \times 10^3/\mu L$), a statistically significant decrease was observed in the infected group ($p=0.005$). Similarly, hematocrit (HCT%) also showed a significant decrease in the infected group, Statistical analysis confirmed the significance of this difference ($P=0.046$). This significant decrease extended to the MCV (fL) (mean corpuscular volume) index, a statistically significant difference ($P=0.034$). In contrast to the previous indicators, the statistical analysis did not reveal any statistically significant differences between the two groups in the remaining variables. Hemoglobin (Hb g/dL) remained relatively similar between the two groups without a significant effect ($P=0.103$). Similarly, the red blood cell ($RBC \times 10^6/\mu L$) count showed no significant difference between the infected group and the control group ($P=0.452$). Likewise, the differences in the white blood cell ($WBC \times 10^3/\mu L$) count were not statistically significant ($P=0.127$), indicating that the infection did not have direct effect on these last three indicators in the study sample (**Table 1**)

Table 1- Relationship between Enterobiasis and selected physiological changes

Parameter	Control group (Mean $\pm$ SEM)	Patients group (Mean $\pm$ SEM)	t-value	P-value
HB (g/dL)	12.54 $\pm$ 0.36	11.56 $\pm$ 0.45	1.70	0.10
RBC ($\times 10^6/\mu L$)	4.61 $\pm$ 0.12	4.46 $\pm$ 0.16	0.76	0.45
WBC ($\times 10^3/\mu L$)	8.26 $\pm$ 0.45	9.55 $\pm$ 0.67	-1.58	0.12
PLT ($\times 10^3/\mu L$)	341.13 $\pm$ 13.83	257.13 $\pm$ 22.67	3.16	<0.01
HCT (%)	39.30 $\pm$ 1.18	35.49 $\pm$ 1.35	2.12	0.04
MCV (fL)	85.16 $\pm$ 1.21	80.09 $\pm$ 1.88	2.27	0.03

A marked decrease in platelet counts may indicate an indirect inflammatory and immune response triggered by infection, where the secretion of inflammatory mediators plays a pivotal role in influencing the dynamics of platelet production or increasing the rate of platelet destruction. This proposed mechanism is supported by previous studies that have indicated variations in the hematological profile of children infected with *Enterobius vermiculris*, although there is a marked difference in the severity of these indicators between studies [8], which reflects the flexibility of the host's biological response. Similarly, the significant decrease in hematocrit (HCT) and mean corpuscular volume (MCV) values obtained in this study indicates a strong correlation with the indirect effects of infection on the host's nutritional status. Continued or repeated parasitic infection leads to malabsorption or deficiencies in essential micronutrients necessary for hematopoiesis. These findings are consistent with previous literature confirming a correlation with previous literature confirming a correlation between intestinal parasite infection and nutritional disorders that negatively impact hematological parameters [11]. Conversely, the lack of statistically significant differences in hemoglobin (Hb) concentration, red blood cell (RBC) count, and white blood cell (WBC) count between the infected and control groups is physiological attribution to the possibility that the parasitic infection in the studies samples

was of low severity, not reaching the critical threshold required to cause significant systemic disturbances or to the success of the host's homeostatic mechanisms in maintaining these indicators within their normal ranges. This finding is physiologically and clinically consistent with recent scientific reviews indicating that the predominant pattern of pinworm infection is mild or asymptomatic, and therefore does not necessarily entail significant hematological changes[12],[13]. Overall, the results of the current study suggest a variable physiological effect of *Enterobius vermicularis* infection on certain relevant blood components. However, this effect remains limited in scope and constrained by a matrix of overlapping variables, including infection severity, host nutritional status, and surrounding environmental factors. These factors provide a logical explanation for the observed discrepancies and contraindications in the conclusions drawn from various studies and literature on this topic[12],[13].

4.2 Relationship between Enterobiasis and selected Immunological markers

To identify immune changes associated with the infection, specific immunological parameters were assessed in children infected with the intestinal pinworm (*E. vermicularis*) and compared to control group without infection. Level of immunoglobulin A (IgA mg/dL), interleukin -4 (IL-4 pg/mL), and transforming growth factor-beta (TGF- β pg/mL) were measured in serum samples as part of the research criteria. Statistical analysis revealed a significant difference in some of the studied immunological parameters between the children infected with the pinworm and the control group (healthy individuals). The results showed a significant increase in IgA levels in the infected children compared to the control group ($p=0.037$, $t=-2.199$), and similarly, TGF- β levels were significantly increased in the infected group ($p=0.035$, $t=-2.326$). On the other hand, no significant difference was observed in the levels of interleukin -4 (IL-4) ($P=0.115$, $t=-1.650$), (Table 2)

Table 2- Relationship between Enterobiasis and selected Immunological markers

Parameter	Control Group (Mean $\pm$ SEM)	Patients Group (Mean $\pm$ SEM)	t-value	P-value
IgA (mg/dL)	48.43 $\pm$ 2.81	66.09 $\pm$ 7.52	-2.199	0.037
IL-4(pg/mL)	124.64 $\pm$ 12.01	169.61 $\pm$ 24.47	-1.650	0.115
TGF- β (pg/mL)	158.28 $\pm$ 5.14	231.69 $\pm$ 31.13	-2.326	0.035

The significant decrease in serum IgA levels observed in infected children may reflect an alteration in the systemic humoral immune response associated with *Enterobius vermicularis* infection. IgA plays an important role in host defense at mucosal surfaces, where it contributes to the regulation of interactions between the host and intestinal

microorganisms and helps limit the attachment and persistence of luminal antigens and pathogens [14] [15]. However, serum IgA and mucosal secretory IgA represent distinct compartments of the immune response; therefore, changes in serum IgA should not be interpreted as direct evidence of altered intestinal mucosal IgA activity. The observed decrease in serum IgA in the present study may therefore indicate a systemic immunological change associated with infection rather than a direct alteration in mucosal IgA production. Helminth infections can also modulate host immune responses through complex regulatory mechanisms [16]. demonstrated that threadworm infection induced a type II (Th2) defense pattern, coinciding with abundant IgA secretion, which aims to reduce the parasitic burden and limit the spread of the infection. Similarly, The marked increase in TGF- β levels is attributed to the activation of regulatory immune pathways associated with infection, given that this cytokine is one of the most prominent inhibitors in inflammation and a key factor in maintaining immune homeostasis. Increased TGF- β secretion indicates the activity of regulatory T cells (Tregs), which in turn suppress the inflammatory response and limit tissue damage that may result from an overactive immune reaction. In this regard, studies have shown that intestinal parasites have the ability to stimulate a regulatory immune environment rich in TGF- β , allowing them to survive within the host for longer periods by modulating the immune response rather than being directly eliminated. [17] Furthermore. [18] The observed response pattern may represent a homeostatic process aimed at balancing parasite-directed immune responses with the protection of host tissues from excessive inflammatory damage. In the present study, no statistically significant difference was observed in serum IL-4 levels between the infected and control groups ($P = 0.115$), although a slight numerical difference in the mean values was observed. Therefore, the observed numerical difference should not be interpreted as evidence of a significant alteration in IL-4 production associated with *E. vermicularis* infection. IL-4 is an important cytokine involved in the differentiation and function of T helper 2 (Th2) cells and contributes to B-cell activation and antibody responses. Previous studies have associated intestinal helminth infections with increased IL-4 levels as part of a type 2 immune response; however, the absence of a statistically significant difference in the present study may reflect variations in host immune responses, infection intensity, or other study-related factors [19].

5- Conclusion

This study suggests that pinworm infection (*Enterobius vermicularis*) is associated with alterations in selected hematological and immunological markers in children. Significant differences were observed in PLT, HCT, and MCV levels, as well as in serum IgA and TGF- β levels, whereas IL-4 did not show a statistically significant difference between the infected and control groups. These findings may reflect physiological and immunological responses associated with *E. vermicularis* infection. Further large-scale studies involving larger sample sizes and a wider range of hematological, biochemical, and immunological parameters are recommended to better understand the mechanisms underlying these observed associations.

Ethical approval

Ethical approval was obtained from Research Ethics Committee in College of Basic Education, University of Sumer according to declaration of Helsinki under the approval number (2025CBE11).

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