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The Impact of Enterobiasis on Some Blood Elements among Children in Tikrit City

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Abstract

General Background: Enterobiasis caused by *Enterobius vermicularis* is a widespread intestinal parasitic infection that commonly affects children and has been associated with nutritional disorders and hematological abnormalities. **Specific Background:** The infection may interfere with digestion, absorption, and micronutrientbalance, potentially contributing to anemia and deficiencies of essential elements such as ferritin, magnesium, zinc, and vitamin B12. **Knowledge Gap:** Despite the high prevalence of enterobiasis in developing regions, limited empirical data exist on the variations in hematological and biochemical parameters among infected children in Tikrit City. **Aims:** This study aimed to examine the relationship between *Enterobius vermicularis* infection and selected blood elements among children aged 2–10 years in Tikrit City between April 2023 and April 2024. **Results:** Among 100 examined children, 75% were infected with *E. vermicularis*. The infection rate was slightly higher in males (78.72%) than females (71.69%), and higher in children aged 6–10 years (80.39%) than those aged 2–5 years (69.38%). Infected children showed significantly lower hemoglobin levels (10.610 ± 1.21 g/dl) compared with non-infected children (11.724 ± 0.767 g/dl). Significant reductions were also observed in serum ferritin (28.5 ± 4.51 ng/ml vs 37.5 ± 5.73 ng/ml), magnesium (1.433 ± 0.180 mg/dl vs 1.992 ± 0.138 mg/dl), zinc (48.77 ± 9.85 mg/dl vs 62.59 ± 8.43 mg/dl), and vitamin B12 (485.0 ± 56.0 pg/ml vs 623.6 ± 33.3 pg/ml). **Novelty:** The study provides detailed evidence of multiple hematological and micronutrient variations associated with *E. vermicularis* infection among children in Tikrit City. **Implications:** These findings highlight the need for early diagnosis, routine monitoring of blood parameters, and strengthened health awareness programs to reduce infection spread and related nutritional complications.

Highlights:
- High Prevalence of Pinworm Infection Observed Among Examined Children in Tikrit City
- Infected Participants Showed Lower Hemoglobin and Multiple Micronutrient Concentrations
- Monitoring Hematological and Biochemical Indicators Supports Early Clinical Management

Keywords: Enterobius Vermicularis, Enterobiasis, Hemoglobin, Micronutrient Deficiency, Children Health

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Introduction

The tiny nematode Enterobius vermicularis is the causative agent of enterobiasis, also known as threadworm or pinworm disease. In both the USA and northwest Europe, prevalence rates as high as 100% have been documented. It is most likely the most prevalent helminth that infects people [1]. Approximately 200 million people are thought to be infected globally, making it one of the gastrointestinal nematodes worldwide [2]. Through minor impairment in digestion and absorption, prolonged inflammation, and nutritional loss, E. vermicularis infections are believed to contribute to child malnutrition, anemia, and micronutrient deficiencies [3]. Since these conditions cause serious health problems and are linked to growth, this disease is highly prevalent in underprivileged communities, particularly in schools and nurseries with children from the general public [4]. These worms inhabit the cecum, colon, and rectum, and humans serve as the definitive host for E. vermicularis . The parasite's life cycle occurs entirely within the digestive system, generally traveling along the alimentary canal from the stomach to the anus while attaching to the mucosal folds of the intestine. They do not require an intermediate host because their life cycle is direct and simple [5]. Enterobiasis and its association with enuresis, anemia, blood biochemical parameters, and vitamin deficiencies have been examined in several studies [6]. The prevalence of Intestinal parasite varies by region and is influenced by factors such as climate, poverty, malnutrition, high population density, cleanliness of individuals and communities, as well as conditions conducive to parasite development and transmission[7]. Investigating specific blood components, including hemoglobin, ferritin, magnesium, zinc, and vitamin B12, is important for understanding the infection's systemic impact.

Materials and Methods

Samples and Study Duration

This study was conducted between April 2023 and the end April 2024 in Tikrit City. The study population consisted of children of both genders and aged between 2 and 10 years. Following microscopic examination of stool samples to confirm the presence of infection, a total of 100 cases were included in the study. The identification of E. vermicular was performed according to standard parasitological procedures [8].

Collection and Analyzing Blood Samples

Blood samples were collected from 100 children -75 in the enterobiasis – positive group and 25 in the non –infected control group. Approximately 3-4 ml of venous blood was drawn from each participant. The collected blood was divided into two portions:

- The first portion, was placed in tubes containing anticoagulant (SPAINREACT, spain) for determination of hemoglobin concentration.
- The second portion, collected in plain tubes (without anticoagulant), was used for serum separation.

Additionally , they were centrifuged for five minutes at 3000 rpm. After that, the serum sample was separated into four portions, each of which was then transferred using a sterile micropipette into a sterile Eppendorf tube for biochemical analyses using a spectrophotometer (Human Diagnostic, Germany) to determine the levels of serum ferritin, serum magnesium, serum zinc and serum vitaminB12. All tests were performed in accordance with the standard operating procedures provided by the kit manufacturers.

Statistical A nalysis

The statistical package for social sciences (SPSS) version 22.0 is used to enter all data, which are displayed as mean ± standard error, using a specially created coding system. To look at the connection between two categories, we used the chi-square test. We compared the two groups using serum parameters and utilized the t-test to find any differences. As an additional tool for understanding numerical counts and percentages, frequency analysis has found widespread use. A statistically significant result was defined as $p< 0.05$.

Results

Table 1 shows that, 75% of the children were infected with Enterobius vermicularis, or pinworm. There was no discernible difference in prevalence between genders with 78.72% of males and 71.69% of females (chi=0.093, p=0.760).

children aged 6-10 years had a slightly higher infection rate (80.39%) than the 2-5 year age group (69.38%), but there was no statistically significant difference between the two bites (chi-squared=0.231, p=0.631).

Table 1: Prevalence of Enterobius vermicularis Regarding Gender and Age Groups

Group	N	*N (%)E.vermicularis* +ve children	*X² (P-value)*
All	100	75 (75%)	
Male **Female**	47 53	37 (78.72%) 38 (71.69%)	**ns** **Chi-Square = 0.093** **P-Value = 0.760**

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Age (years)			
(2-5) **(6-10)**	49 51	34 (69.38%) 41(80.39%)	**Ns** **Chi-Square = 0.231 P-Value = 0.631**

Children who were anemic had a significantly higher prevalence of E. vermicularis infection (73.80%) than children who were not anemic (27.27%). Table 2 showed a statistically significant difference between the two groups (x^2=5.201, p=0.023).

Table 2: Prevalence of E.vermicularis Regarding Anemia Status

Group	N	n(%)*E.vermicularis* +ve	X² (p-value)
Anemia children (Hemoglobin concentration <11g/l)	**42**	**31 (73.80%)**	*** Chi-Square = 5.201 P-Value = 0.023**
Non Anemia children (Hemoglobin concentration >11g/l)	**33**	**9 (27.27%)**	

Table 3 displays children infected with E. vermicularis had a mean hemoglobin concentration of(10.610 ± 1.21 g/dl), which was significantly lower than that of children who were not infected (11.724±0.767 g/dl). The two groups differences were highly significant (T=5.39, p= 0.0002), suggesting a strong inverse relationship between hemoglobin level and E. vermicularis infection.

Table 3 : Hemoglobin Concentration E. vermicularis + ve and E. vermicularis – ve groups

Group	N	Hemoglobin g/dln (Mean +_ SD)	T-Value	P value
E.vermicularis **+ ve children**	**75**	**10.610 ± 1.21**	**5.39 ****	**0.0002**
E.vermicularis **- ve children**	**25**	**11.724 ± 0.767**		

The proportion of children infected with E. vermicularis had a higher prevalence of serum ferritin level <12 ng /ml (70%) than non-infected children (30%). However, the difference was not statistically significant (x^2=0.148, p=0.700), indicating no significant relationship between E. vermicularis infection and serum ferritin levels (Table 4).

Table 4 : Serum Ferritin Concentration E. vermicularis + ve and E. vermicularis – ve Groups

Group	N	E.vermicularis + ve children N (%)	E.vermicularis - ve children N (%)	X² (p-value)
Ferritin concenteration <12 ng/ ml	**10**	**7 (70%)**	**3 (30%)**	**ns Chi-Square = 0.148 P-Value = 0.700**
Ferritin concenteration >12 ng/ ml	**90**	**68 (75%)**	**22 (24.44%)**	

Table 5 indicates serum ferritin levels differed significantly between E. vermicularis –postive and negative children. The E. vermicularis positive group (n=75) had an average serum ferritin concentration of 28.5±451 ng/ml, while the negative group (n=25) had a higher mean level of 37.5±5.73 ng/ml . The independent sample t-test revealed a statistically significant difference (t=2.90, p=0.006), indicating that E. vermicularis infection is associated with lower serum ferritin levels.

Table 5: Serum Ferritin Concentration in E. vermicularis + ve and E. vermicularis – ve Groups

Group	N	Serum ferritin ng/ml (Mean + SD)	T-Value	P value
E.vermicularis + ve children (75)	**75**	**28.5 ± 4.51**	**2.90 ****	**0.006**
E.vermicularis - ve children (25)	**25**	**37.5 ± 5.73**		

Table 6 compared to non-infected controls, children with E . vermicularis showed a highly Significant decrease in serum magnesium concentration. The mean serum magnesium level of the infected group (n=75) was 1.433 ±0.180 mg/dl, while the non- infected group (n=25) had a significantly higher mean value of 1.992±0.138 mg/dl. The difference was found to be highly significant (t=16.17, p=0.0007) by statistical analysis using an independent t- test, demonstrating a direct correlation between lower serum magnesium levels and E. vermicalis infection.

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Table (6): Serum Magnesium Concentration in E. vermicularis + ve and E. vermicularis – ve Groups

Group	N	Serum Maganesium mg/dl (Mean + SD)	T-Value	P value
E.vermicularis **+ ve children (75)**	**75**	**1.433 ± 0.180**	**16.17 ****	**0.0007**
E.vermicularis **- ve children (25)**	**25**	**1.992 ± 0.138**		

When comparing E. vermicularis positive children to non-infected controls, a notables decrease in serum zinc concentration was noted. The mean serum zinc level for the E. vermicularis positive group (n=75) was 48,77±9.85 mg/dl, while the E. vermicularis negative group (n=25) had a higher mean value of 62.59±8.43 mg/dl. The two groups differences were statistically significant (t=6.64, p=0.0003), suggesting that an infection with E. vermicularis is linked to noticeably lower serum zinc levels, Table 7.

Table (7): Serum Zinc Concentration in E. vermicularis + ve and E. vermicularis – ve Groups

Group	N	Serum zinc mg/dl (Mean + SD)	T-Value	P value
E.vermicularis **+ ve children (75)**	**75**	**48.77 ± 9.85**	**6.64 ****	**0.0003**
E.vermicularis **- ve children (25)**	**25**	**62.59 ± 8.43**		

Children with and without E. vermicularis showed significatly different serum vitamin B12 concentrations. The mean VB12 level of the E. vermicularis positive group (n=75) was 485.0±56.0 pg/ml, while the mean level of negative group (n=25) was significantly higher at 623.6±33.3 pg/ml. Table 8 shows that an E. vermicularis infection is linked to a significant decrease in serum vitamin B12 concentration. The independent t-test verified that this difference was statistically significant (t=14.93, p= 0.0006).

Table (8): VB12 Concentration in E. vermicularis + ve and E. vermicularis – ve Groups

Group	N	VB21 pg/ml (Mean + SD)	T-Value	P value
E.vermicularis **+ ve children (75)**	**75**	**485.0 ± 56.0**	**14.93 ****	**0.0006**
E.vermicularis **- ve children (25)**	**25**	**623.6 ± 33.3**		

Discussion

Given that E. vermicularis infection is probably one of the major causes of anemia and nutritional deficiencies in children, some demographic, hematological, and biochemical aspects of E. vermicularis infection among children in Iraq, particularly in rural areas , must be discussed. It was discovered that (75%) of children had pinworm infections. According to recent local studies, this rate is among the highest. Previous research conducted in Iraq has revealed a wide range of prevalence rates, from low rates of 20-30%, as in [6], other Iraqi studies, however, have found significantly lower rates (e.g. filed reports in southern governorates showed single-digit rates, such as sampling method, and age). This variability suggest that incidence in Iraq varies by diagnostic approach, sampling strategy, and region [9]. to higher rates that approach 70-75%, as reported in other filed reports within the nation [7]. Additionally a local study found that a sample of children had an incidence rates of roughly 73%, indicating that certain local/center population groups may have high prevalence [10]This variation reflects variations in behavioral, social, and environmental conditions as well as variations in the sensitivity of the diagnostic techniques employed. In the current study, a significant correlation between gender and the prevalence of E. vermicularis was found males were diagnosed with the majority of E. vermicularis –positive cases . This may be due to the fact that men are more likely to engage in outdoor activities[11], particularly in Iraq, where they are more likely to come into contact with infected children or play with soil. However, this bias is consistent with other reports from Iraq[12,13]. Compared to females, males had higher infection rates. Our findings, however, contradict those of other studies that found higher E. vermicularis infection rates among female children, such as Hammadi (2012) in Al-Mahmoudyia area in Baghdad[14] and the Al-Daoody study in Mosul [15]. Additionally, the (6-10) age group had a higher incidence rate than the (2-5) age group, according to the current study. According to study conducted locally in Baghdad by Abdul-Imam et al.,(2015) school- aged children had the highest infection rates when compared to younger age groups[16]. This was attributed to close classroom interaction and increased daily contact. In a similar vein, a study conducted in Basra by Al-Saadi (2012) revealed that group behaviors and shared play at school made the age group over six years old more vulnerable to infection[17]. On the other hand, research conducted worldwide has produced inconsistent findings.

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Preschoolers (3-6) ages had the highest prevalence, according to a polish study by Kłapeć &Cholewa (2014), who attributed this to younger children's inability to control their personal behaviors and their lack of health awareness [18]. According to a Korean study by Lee et al., (2011) kindergarteners had the highest incidence prior to starting school, which highlights the importance of closed, group settings [19]. These conflicting results support the findings of comprehensive international reviews that shows age is a significant factor but is also strongly impacted by the child's surrounding, including the educational system, personal hygiene, family size, and the use of shared toys. Because of social, environmental, and cultural differences as well as differences in screening techniques and testing frequency, it is reasonable to anticipate that incidence rates will vary between studies. The current study's findings support multiple studies that have shown the impact of intestinal parasites on hemoglobin levels and iron status by showing a monthly correlation between the E. vermicularis parasite and hematological disorders in children with pinworm infections have significantly lower hemoglobin and ferritin levels then children without pinworms, according to Iraqi studies carried out in Baghdad [20, 21,22]. This is explained by the cumulative effect of chronic infection on nutrient absorption and repeated exposure. A additional international research has corroborated this conclusion, studies conducted in Iran and Turkey suggest that E. vermicularis infection plays a major role in the disease's development, especially in unsanitary settings [23,24]. On the other hand, some research has not discovered a discernible difference in hemoglobin levels between children who have pinworm infections and those who do not. According to other research, E. vermicularis is a low-dose parasite in comparison to other intestinal worms like Ascaris lumbricoides and Ancylostoma dudenale and its impact on hematology may be minimal or indirect, particularly in cases of mild or transient infection[25]. Variations in infection severity, nutritional status, and environmental factors, as well as variations in sample size and methodological design, could all contribute to this disparity between studies. Thus, the current study's findings offer more proof that E. vermicularis may have an impact on children's hematology, especially when paired with other risk factors like malnutrition and ill health. The intricate immune-inflammatory processes connected to the parasitic infection account for the significant drop in ferritin levels in children with E. vermicularis. Hepcidin production in the liver is stimulated by the chronic inflammatory response, which increases the secretion of inflammatory cytokines, especially interleukin-6 (IL-6). Hepcidin, which inhibits the iron transporter ferroportin in intestinal cells and microphages, is the primary regulator of iron metabolism in the body. This lowers the intestinal absorption of iron and stops it from being released from stores, which lowers the concentration of ferritin in the serum. Additionally, the parasitic infection- related gastrointestinal problems, appetite loss, and malabsorption can lead to decreased dietary iron intake, particularly in children, further depleting iron stores over time[26, 27]. This study's findings were unexpected, as were those of a number of recent Iraqi studies conducted in Baghdad [28]. These patterns were also demonstrated by the Iraqi study conducted in Kirkuk, which also discussed in injury affected certain blood – related investments [29]. These results suggest that a child's monthly E. vermicularis infection may have a direct or indirect impact on their body's mineral levels, especially magnesium, which is essential for many vital processes, such as enzymatic activity, nutrient metabolism, and the operation of the muscles and pelvic organs. The weakened intestinal slowing brought on by the monthly parasite during Ramadan, along with the associated cravings and poor nutritional status, as well as the possibility that certain nutrients absorption or consumption may be impacted, can account for this after nine month. These results are in line with a number of international studies. According to [30] children infected with E. vermicularis had significantly lower magnesium levels than children who were not infected. They attributed this to the parasite's cumulative effect on the body's levels of trace elements and nutrient absorption. Children with pinworm infections also had lower levels of magnesium, zinc, and copper, according to an Iranian study, illustrating the widespread effect of intestinal parasites on the body's mineral balance [31]. In a similar vein, a Turkish study found a statistically significant correlation between children with intestinal parasite infections, such as E. vermicularis and magnesium deficiency, with the former being more severe than the latter [32]. Although the degree of statistical significance varied depending on the particular element and sample type, a local study carried out in the Erbil Governorate, northern Iraq, revealed that E. vermicularis infection is linked to significant changes in some biochemical and nutrient parameters in children's blood, with a general trend toward decreased mineral level [6]. Additionally, the study shows a significant negative correlation between serum zinc levels and pinworm infection. In addition to the parasite's consumption of certain micronutrients required for its growth and reproduction and the redistribution of zinc within the body due to the activation of the immune and inflammatory response, this decrease can be explained by the impact of a chronic parasitic infection on the integrity of the intestinal mucosa, which results in impaired absorption of trace elements. These findings are in line with Iraqi research carried out in Kirkuk and Baghdad, which verified that intestinal worm infections, especially those caused by E. vermicularis , are linked to a marked reduction in zinc levels in children, attributing this to intestinal malabsorption and the infection's effect on general nutritional status [33,34]. Intestinal worms are one of the main causes of trace element deficiencies in children in children in developing nations, according to Compton and Nesheim's international research which is consistent with the current study's findings [35]. The World Health Organization has confirmed that chronic parasitic infections are a major risk factor for zinc deficiency and its detrimental effects on growth and immunity [36]. A Turkish study showed that children infected with pinworms had significantly lower serum zinc levels than children in good health [37]. The findings of this study thus highlight the significance of early detection and efficient treatment of E. vermicularis infection, as well as the need to keep an eye on the nutritional status and trace element levels of children who are infected. These findings unmistakably show a strong association between low blood levels of vitamin B12 and E. vermicularis infection, indicating the detrimental effects of the parasitic infection on children's nutritional status and metabolic processes. A lack of vitamin B12 can cause anemia, neurological conditions, and developmental delays in children because it is a vital vitamin required for DNA synthesis, red blood cell formation, and nervous system function. In addition to the malnutrition linked to the infection, decreased appetite, and the potential for increased vitamin intake or disruption of its absorption of its absorption mechanism related to intrinsic factor, the most significant explanation for this decrease is the impaired intestinal absorption of vitamin B12 caused by inflammatory changes in the intestinal lining brought on by the parasitic infection. Studies conducted locally in Iraq have shown a connection between intestinal parasite infections and lower levels of specific vitamins and nutrients in children, with a general trend of low vitamin B12 levels among those infected. Despite variations in the studies sample sizes and environmental and nutritional conditions, this is consistent with the current study's finding [6]. These results align with a number of international studies, in addition to confirming that intestinal parasites significantly contribute to this vitamin

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deficiency by influencing contribute to this vitamin deficiency by influencing intestinal absorption, Mahdi and Ali observed that children infected with E. vermicularis have significantly lower vitamin B12 levels than children who are not infected [31]. According to another study, vitamin B12 deficiency is linked to intestinal worm infections, such as E. vermicularis and has a detrimental effect on children's hematological and health indicators [30].

Conclusion

According to the study's findings, anemia and a marked drop in serum ferritin, magnesium, zinc, and vitamin B12 levels are linked to pinworm(Enterobius. vermicularis) infection. These findings reflect the depletion of iron stores and the disruption of the absorption of vital nutrients due to the intestinal and metabolic effects of the parasitic infection, which may worsen the immune system's and the infected person's health.

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