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Evaluation of Hematological Changes Associated with Giardia Lamblia Infection in Al-Najaf Province

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Abstract: Giardiasis is one of the most common intestinal protozoal infections worldwide and is caused by the flagellated protozoan Giardia lamblia. In addition to gastrointestinal manifestations, the infection may be associated with alterations in hematological parameters, particularly in patients with prolonged or recurrent infection. The present study aimed to investigate the hematological changes associated with Giardia lamblia infection among patients of different age groups in Al-Najaf Province, Iraq. A total of 375 blood samples were included in the study, comprising 250 blood samples collected from patients infected with Giardia lamblia of different ages and 125 samples obtained from apparently healthy individuals as a control group. Samples were collected from patients attending governmental healthcare institutions in Al-Najaf Province, including Al-Sadder Medical City, Al-Hakeem General Hospital, and Al-Zahraa Educational Hospital for Childbirth and Children, during the period from January 2025 to March 2026. Hematological investigations were performed to evaluate several blood parameters, including packed cell volume (PCV), hemoglobin (Hb), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), red blood cell (RBC) count, white blood cell (WBC) count, and platelet count. There were drastic changes in many hematological parameters in patients infected with Giardia lamblia, in contrast to the control group. More specifically, the WBC and platelets counts were significantly elevated in infected patients whereas PCV, MCV, MCH, MCHC and RBC numbers showed significant reductions as compare to healthy individuals ($P < 0.05$). The changes were all possibly representative of the influences on nutritional status, intestinal absorption, inflammatory processes and erythropoiesis associated with intestinal parasitic infection. The decrease observed in red blood cell-related indices may also indicate the development of anemia or hematological changes associated with anemia in certain infected cases. Higher WBC and platelet counts may be associated with the host inflammatory and immune responses related to parasitic infections. In conclusion, we showed significant, if modest, laboratory changes in selected hematological parameters in patients with Giardia lamblia infection and that evaluation of these parameters may provide useful adjunct superfluous information for the diagnosis of giardasis. These hematological changes should be further investigated in larger populations study with several biochemical, nutritional and immunological parameters to understand the likely underlying mechanisms responsible for these alterations.

Keywords: Giardiasis, Hematological changes, Hemoglobin, Anemia, PCV.

Research Paper

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INTRODUCTION

Intestinal parasitic infections are proved to persist as a major public health problem throughout the world, particularly among individuals living in contexts with poor sanitation, unsafe water supplies, low levels of hygiene and inadequate food-safety practices. These infections cover a large spectrum of both protozoan and helminthic pathogens and can cause significant gastrointestinal morbidity. Giardia duodenalis (also known as Giardia lamblia or Giardia intestinalis) is an important intestinal protozoon, not only for the range of geographical areas and socio-economic settings in which it occurs but also as one of the most prevalent causes of human gastrointestinal disease [1-3].

Introduction Giardia duodenalis is a flagellate protozoan parasite that can infect humans and several animal hosts. Its distribution and transmission is linked to environmental and behavioral factors. Fecal–oral remains the main route of transmission, following ingestion of infective cysts. Water contamination with infected faeces in conjunction with consumption of contaminated food and direct person-to-person contact exposure to a contaminated environmental surface are important overall vehicles of infection 18. Contaminated water or poor hygienic practices in the processes of cultivation, harvesting, transportation and preparation or marketing of raw foods can potentially provide sources for fresh vegetables and other types of raw produce [2-5]. The biological cycle of G. duodenalis comprises mainly two morphologically and functionally diverse stages: the cyst and the trophozoite. Cysts are the environmentally resilient and transmissible stage while trophozoite indicates the active replicative form in the intestinal tract. Once ingested, cysts travel through the upper GI tract and undergo excystation once in the small intestine where trophozoites are released to colonize the small bowel epithelium. The trophozoites then replicate and eventually encyst as they move through the gastrointestinal tract, leading to cysts that are excreted within feces and may enable transmission of the parasite to new potentially-hosts [1-6]. The pathogenic process of giardiasis is complex and cannot be attributed to a single mechanism. Although Giardia is considered a non-invasive intestinal parasite, trophozoites interact closely with the intestinal epithelium through their ventral adhesive disk. Current evidence indicates that parasite-derived proteins and enzymes, changes in epithelial barrier function, host immune responses, and interactions with the intestinal microbiota may collectively contribute to intestinal dysfunction and clinical manifestations [1-7]. Furthermore, differences in parasite assemblages and virulence-associated factors may contribute to variation in disease severity and clinical presentation among infected individuals [7-8]. The clinical presentation of giardiasis is heterogeneous. Some infected individuals remain asymptomatic, whereas others develop acute or persistent gastrointestinal symptoms. Diarrhea, abdominal discomfort, bloating, flatulence, nausea, weight loss, and malabsorption are among the manifestations commonly reported in symptomatic infections. Persistent infection may be associated with disturbances in nutritional status and, particularly in vulnerable populations, may contribute to impaired growth and other post-infectious consequences [1-9]. A systematic review and meta-analysis of Asian children published in 2023 also highlighted the association between G. duodenalis infection and adverse nutritional outcomes, particularly among younger children [9] The epidemiology of giardiasis is influenced by a combination of environmental, socioeconomic, behavioral, and host-related factors. Even though poor sanitation and limited availability of safe drinking water continue to be the most significant drivers for transmission, exposure in homes, contact with infected people, food contamination, travel and interaction with infected animals represent important risk factors observed in different populations [4-5]. Systematic reviews have shown that the relative importance of these factors varies by geographical region and population characteristics, highlighting the necessity of locally based epidemiological studies [5]. With a new generation of molecular epidemiological techniques, it has been shown that G. duodenalis is genetically heterogeneous and consists of deep branching assemblages with differing host range and epidemiological properties. Accordingly, molecular investigations are key for the comprehension of transmission mechanisms, host adaptation, and possible associations between parasite genetic features and clinical manifestations [8-10]. However, in the Middle East and North African regions, studies also documented unique Giardia infections indicating that microbiological and molecular approaches need to be sustained in these regions [10].

While the immediate effects of giardiasis manifest in the gastrointestinal tract, prolonged intestinal impairment accompanied by alterations in nutrient absorption may well operate at a level that extends beyond the gut. Malabsorption and nutritional disturbance can be also asscoiated with chronic or recurrent infection, which may influence physiological processes that depend on the available supplies of nutrients. These effects give biological basis for evaluating systemic parameters, particularly hematologic indices among Giardia duodenalis infected individuals [1-9-11].

Hematological parameters can be an indicator of the overall physiological condition of an affected individual and may mirror changes related to nutritional deficiencies, inflammatory responses and other systemic effects of infectious diseases. The parameters: hemoglobin (Hb), red blood cell (RBC) count, packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean

corpuscular hemoglobin concentration (histogram analyse MCHC), white blood cell (WBC) and platelet counts can give an assemblage of information on erythrocyte status as well as potential inflammatory or hematological responses. In contrast to the plethora of literature dealing with giardiasis epidemiology, transmission, molecular features and gastrointestinal features (e.g. diarrhea; [5]), studies that specifically address the hematological status of infected individuals in relation to age group and local population have been relatively sparse.

This study was undertaken to investigate the hematological profile of Giardia duodenalis infected individuals in Al-Najaf Province, Iraq and compare selected blood parameters (RBC, Hb, PCV, MCV, MCH, MCHC WBC and platelet counts) with healthy individuals Furthermore, the study was aimed at determining the trend of these haematological events among healthy and infected individuals across all age groups which gave me a bit more information about what is going on systemically with giardiasis.

MATERIALS AND METHODS

Study Design and Study Population A descriptive comparative study of the hematological changes associated with Giardia duodenalis infection among patients in Al-Najaf Province, Iraq. The study was carried out from January 2025 to march 2026. There were 375 participants all together, including 250 diagnosed with giardiasis parasitic infection and 125 apparently healthy subjects as a control group.

We studied patients from various age groups who presented to governmental health care facilities in Al-Najaf Province with gastrointestinal symptoms, specifically abdominal pain and diarrhea. Participants were enrolled following positive stool testing for Giardia duodenalis. The control group was from apparently healthy people without any known antecedents of giardiasis or other obvious intestinal parasitic infections at the time of sample collection.

Study Area and Sample Collection

Clinical samples were collected from patients who attended selected governmental healthcare institutions in Al-Najaf Province, Al-Sadder Medical City, Al-Hakeem General Hospital and educational hospital for childbirth and children (the Hospital of the Holy Fatima al-Zahra) Stool specimens were collected from individuals with clinical signs of intestinal parasitic infection.

The stool specimens were collected in sterile, appropriately labeled, and a clean and dry specimen container. Conduct A protocol for the participants was created and instructed to avoid contaminating the sample with their own urine or other external material like water. Samples were correctly refrigerated as soon as they were collected and then transported to the laboratory where processing was begun without delay after collection.

Parasitological Examination

Giardiasis was diagnosed when the characteristic stages of Giardia duodenalis were detected in stool specimens by direct microscopic examination. New stool samples were examined under a light microscope (Olympus, Japan) to identify morphological features of Giardia, namely trophozoites and/or cysts.

A part of each specimen was processed Microscopic examination at appropriate Magnification. Identification of G. duodenalis was made according to known morphological traits of the parasite. Morphologically compatible forms were identified in samples from infected individuals and thus, if available, the individual was included as infected.

The parasitological examination was conducted painstakingly to avoid any risk of misidentification and contamination. The stool examination results were documented along with the demographic characteristics of the patients and a laboratory identification number for each sample.

Blood Sample Collection

Venous blood samples using routine aseptic procedures were collected from the study participants after confirmation of Giardia duodenalis infection. Blood specimens were collected and placed into K2 EDTA tubes to maintain cellular components of the blood (EDTA act as an anticoagulant).

Immediately after taking the blood samples, they were mixed gently in order to facilitate contact between blood and anticoagulant. Samples were then prepared for hematology. Thus the correct identification codes were used during linkage of hematological results with relevant parasitological finding without revealing any personal identifiers to ensure confidentiality.

Hematological Analysis

Hematological evaluation was performed by an automated hematology analyzer (Sysmex XP-300, Japan). EDTA-anticoagulated blood samples were mixed thoroughly before analysis by homogeneizing the suspension and limiting cellular sedimentation.

RESULTS

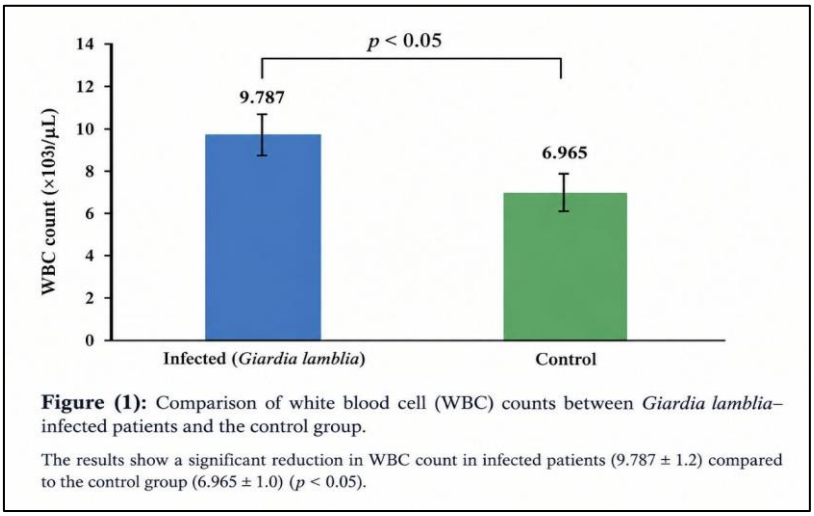


Figure (1): Comparison of white blood cell (WBC) counts between *Giardia lamblia*–infected patients and the control group.

The results show a significant reduction in WBC count in infected patients (9.787 ± 1.2) compared to the control group (6.965 ± 1.0) ($p < 0.05$).

Figure 1: The relationship between white blood cells and infection with *Giardia lamblia*

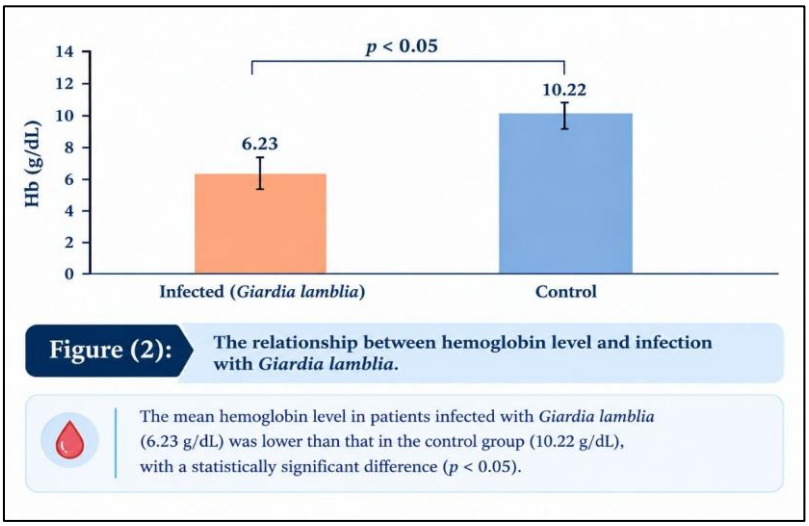


Figure 2: The relationship between hemoglobin level and infection with *Giardia lamblia*

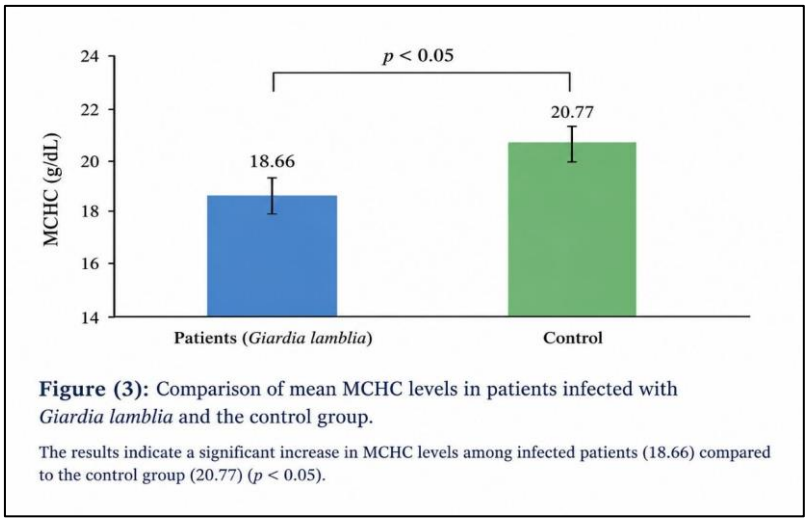


Figure (3): Comparison of mean MCHC levels in patients infected with *Giardia lamblia* and the control group.

The results indicate a significant increase in MCHC levels among infected patients (18.66) compared to the control group (20.77) ($p < 0.05$).

Figure 3: The relationship between MCHC level and infection with *Giardia lamblia*

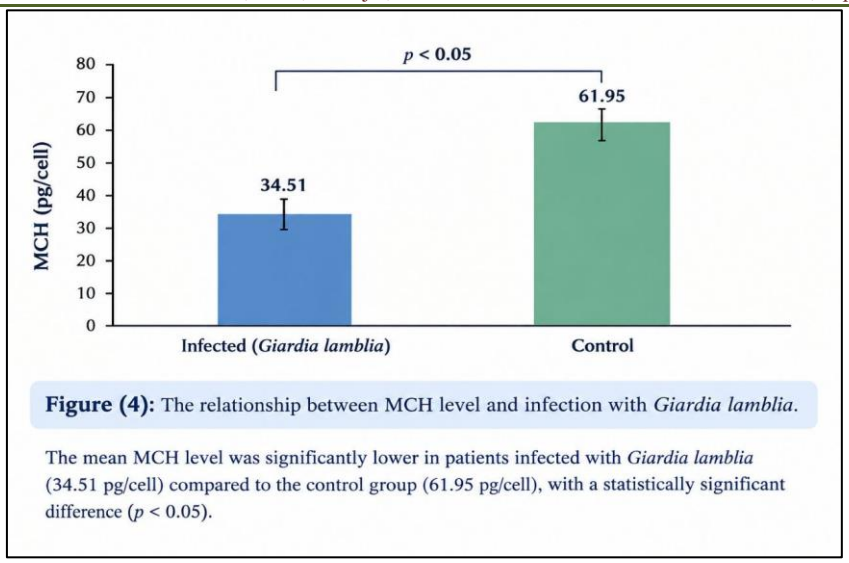


Figure (4): The relationship between MCH level and infection with *Giardia lamblia*.

The mean MCH level was significantly lower in patients infected with *Giardia lamblia* (34.51 pg/cell) compared to the control group (61.95 pg/cell), with a statistically significant difference ($p < 0.05$).

Figure 4: The relationship between MCH level and infection with *Giardia lamblia*

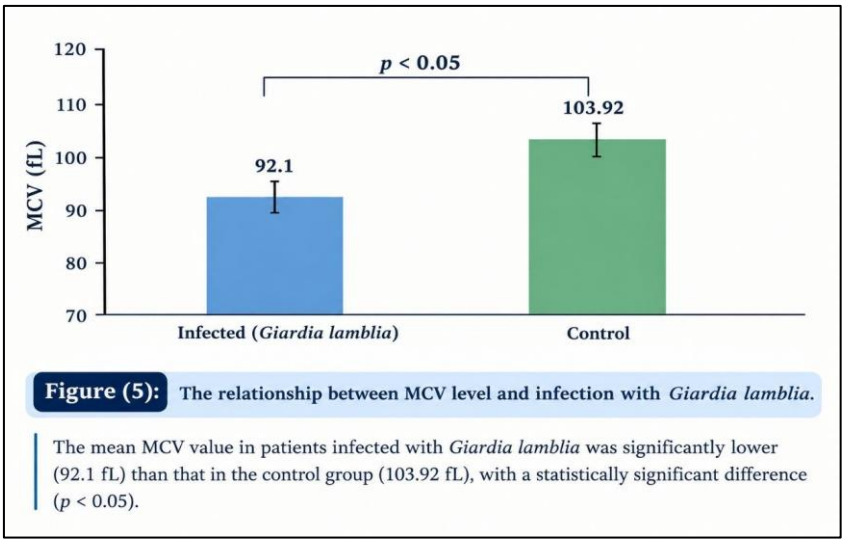


Figure (5): The relationship between MCV level and infection with *Giardia lamblia*.

The mean MCV value in patients infected with *Giardia lamblia* was significantly lower (92.1 fL) than that in the control group (103.92 fL), with a statistically significant difference ($p < 0.05$).

Figure 5: The relationship between MCV level and infection with *Giardia lamblia*

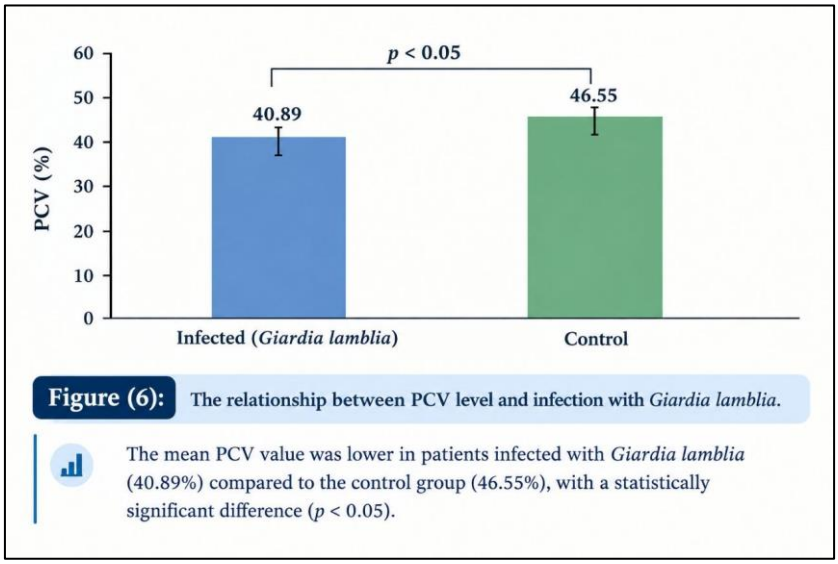


Figure (6): The relationship between PCV level and infection with *Giardia lamblia*.

The mean PCV value was lower in patients infected with *Giardia lamblia* (40.89%) compared to the control group (46.55%), with a statistically significant difference ($p < 0.05$).

Figure 6: The relationship between PCV level and infection with *Giardia lamblia*

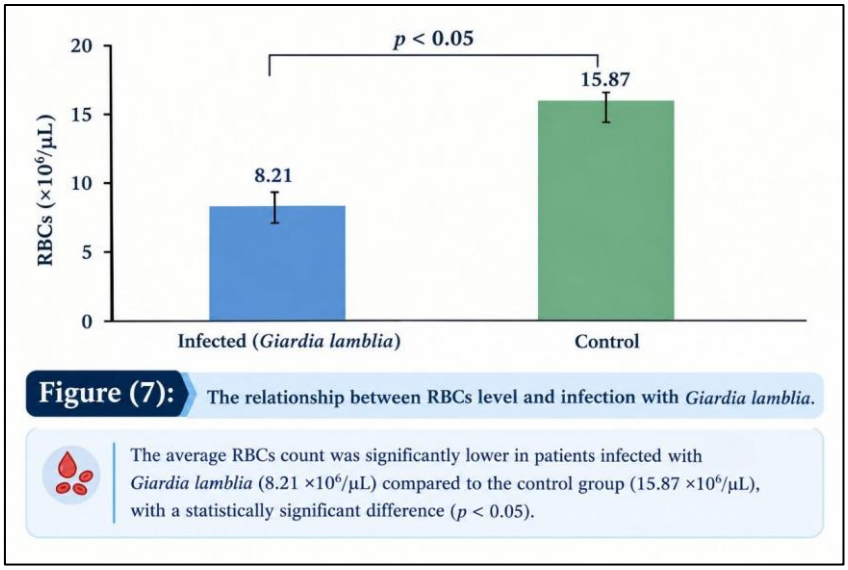


Figure 7: The relationship between RBCs level and infection with *Giardia lamblia*

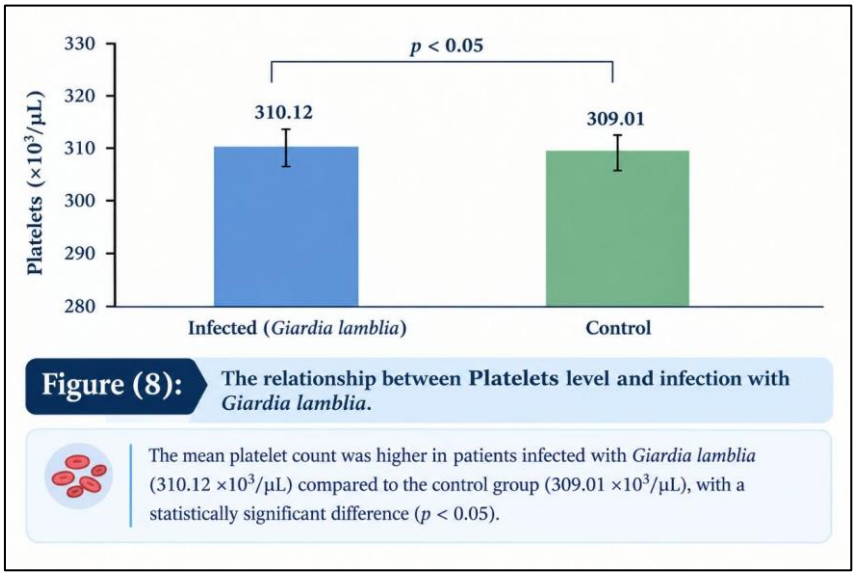


Figure 8: The relationship between Platelets level and infection with *Giardia lamblia*

DISCUSSION

Giardia lamblia (also known as Giardia duodenalis) is an intestinal protozoan that primarily colonizes the upper part of the small intestine, where trophozoites attach to the intestinal epithelial surface. This interaction can interfere with the normal structure and function of the intestinal mucosa and may consequently affect digestion and nutrient absorption. Several studies have described shortening and disruption of the intestinal microvilli, impairment of the epithelial barrier, and alterations in absorptive function during giardiasis. These changes provide a possible biological explanation for nutritional and hematological abnormalities observed in infectedindividuals

In the present study, a significant difference ($p < 0.05$) was observed in several hematological parameters between patients infected with Giardia lamblia and the control group. The most evident changes involved RBCs, Hb, and PCV, which were lower among infected patients. The mean RBC count was 8.21 in the infected group compared with 15.87 in the control group. Similarly, the mean hemoglobin concentration decreased to 6.23 g/dL among infected patients compared with 10.22 g/dL in the control group. The PCV value was also reduced, reaching 40.89% in patients compared with 46.55% among controls. These findings suggest that giardiasis in the studied population was accompanied by alterations in erythrocyte-related parameters and may reflect the nutritional and absorptive consequences associated with intestinal infection.

One possible explanation for the reduction in these parameters is the impairment of intestinal absorptive capacity associated with Giardia infection. Attachment of trophozoites to the intestinal epithelium may then result in microvillus shortening, epithelial dysfunction and abnormalities of digestive processes. So, the uptake of many nutrients (e.g., iron and some vitamins) can be influenced, especially in long-lasting or symptomatic infection. Clinical studies of patients with symptomatic giardiasis have indicated that D-xylose, vitamin B12, and fat are only malabsorbed in the presence of evidence suggestive of active Giardiainfection but show improvement following successful treatment.

This decrease in hemoglobin seen in the present study is crucial because hemoglobin concentration has a strong correlation with the functionality of oxygen transport and commensurate blood iron-free conditions as it relies heavily on nutritional intake availability of hematopoiesis related nutrients. Malabsorption of various nutrients have been associated with Giardiasis, and some author already report low hemoglobin and mild anemia in some patients, especially in those where persistent diarrhea or longer duration infection are encountered. Abnormalities of folate and vitamin B12 absorption have also been documented in children with chronic giardiasis, although the degree of these abnormalities varies between patients. As for the decreased PCV value seen in the patients with infectious disorders is similar to those changes also that RBC-related indices. PCV represents the proportion of blood occupied by erythrocytes; therefore, a reduction in the number or volume of circulating red blood cells can contribute to a lower PCV. In the current findings, the reduction from 46.55% in controls to 40.89% in infected patients may therefore indicate an alteration in erythrocyte status associated with the infection and its nutritional consequences. However, PCV is influenced by several factors, including hydration status, nutritional deficiencies, and other clinical conditions, and therefore the observed difference should not be interpreted as being caused exclusively by Giardia infection.

The erythrocyte indices also demonstrated differences between the two groups. The mean MCV decreased from 103.92 in the control group to 92.10 among infected patients. In addition, the mean MCH was 34.51 in patients compared with 61.95 in controls, while the corresponding MCHC values were 18.66 and 20.77, respectively.

Since MCV, MCH, and MCHC are calculated or interpreted in relation to erythrocyte size, hemoglobin content, and packed cell volume, changes in RBC, Hb, and PCV may be reflected in these indices. Therefore, the observed variations in erythrocyte indices may represent an overall alteration in erythropoietic and nutritional status among the infected participants.

The relationship between giardiasis and nutritional status is biologically plausible because the parasite can interfere with the absorptive surface of the small intestine. The shortening of brush-border microvilli may reduce the available surface area for nutrient absorption and can be accompanied by alterations in digestive enzyme activity. This mechanism has been associated with impaired absorption of fats, carbohydrates, minerals, and vitamins. In severe or prolonged cases, these disturbances may contribute to weight loss, nutritional deficiencies, and anemia. The consequences can be particularly relevant in children, in whom chronic intestinal infection and malabsorption may contribute to impaired growth and protein-energy malnutrition.

In contrast to the erythrocyte-related parameters, the present study demonstrated a slight but statistically significant increase in the mean platelet count, which reached 310.12 $\times 10^3/\mu L$ in the infected group compared with 309.01 $\times 10^3/\mu L$ in the control group ($p < 0.05$). While the difference in mean numbers is low, statistical analysis of the studied sample indicated < 0.05 significance between two means. Although platelets are well known to be involved in responding to bleeding, they also play a role in inflammatory and host-defense responses. Consequently, our findings support the notion that changes in platelet values during intestinal infection may reflect changes related to the composition of host response to infection. However, the small difference seen here should be viewed with caution and not in itself regarded as indication of a significant platelet defect.

The study also showed that WBC counts were different between the two groups, with a mean value of ~9.787 in infected patients compared to 6.965 for the control group. This pattern is consistent with an alteration of leukocyte status in relation to intestinal infection. Leukocytes are key effectors of host defense and can react to infectious and inflammatory stimuli. Since WBC is a nonspecific hematological marker affected by co-existing infections, inflammation, medications, and nutritional status as well as individual variation within the patient-population sample; so, this increase should be seen only as an association of giardiasis.

In summary, results demonstrate that Giardia lamblia infection in the population examined was associated with large differences of some hematological parameters (particularly red blood cells and hemoglobin). The reductions in RBCs (8.21), Hb (6.23 g/dL), and PCV (40.89%), together with the changes observed in MCV (92.10), MCH (34.51), and MCHC (18.66), may be related to disturbances in intestinal function and nutrient absorption. Previous evidence supports the ability of giardiasis to interfere with

intestinal absorption, although the severity and clinical consequences vary considerably between individuals.

Overall, the present results support an association between Giardia lamblia infection and alterations in hematological profiles. The most prominent findings were the lower RBC, Hb, and PCV values among infected patients, accompanied by changes in erythrocyte indices and a difference in platelet and WBC counts. A plausible explanation is that intestinal colonization by Giardia can disturb the intestinal epithelial surface and nutrient absorption, potentially contributing to nutritional deficiencies and subsequent hematologicalalterations.

However, additional measurements of serum iron, ferritin, vitamin B12, folate, total protein, albumin, and nutritional status would be valuable to determine whether these factors explain the hematological differences observed in the present study. This would also help distinguish the direct effects of giardiasis from other possible causes of anemia or altered blood-cell indices.

CONCLUSIONS

1. Giardia lamblia infection may impair intestinal absorption, potentially leading to vitamin deficiencies.
2. Infected patients showed elevated WBC and platelet counts.
3. PCV, MCH, MCHC, MCV, and RBC counts were reduced in infected patients.

Recommendation

1. Further studies should evaluate hematological and pathological changes in patients following treatment of Giardia lamblia infection.
2. Larger groups of patients should be investigated to assess the prevalence of irritable bowel syndrome and its possible association with impaired absorption of vitamin B12 and folate.
3. Further research is needed to clarify the mechanisms of Giardia lamblia pathogenicity and the host immune response.

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