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ORIGINAL ARTICLE

The Prevalence of Cryptosporidiosis in Diabetic Children and Its Effect on Blood Components and Ferritin Stores in Al-Shirqat District

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ABSTRACT

The incidence of Cryptosporidiosis in children with diabetes and the impact on blood and ferritin stores in Al-Shirqat district Abstract: This study sought to analyze prevalence of Cryptosporidiosis, the effects on blood element and ferritin stores in the diabetic children from Al-Shirqat district. Fifty-five children aged 1–15 years, with Type 1 diabetes were enrolled in this cross-sectional study. *Cryptosporidium* was detected in feces by parasitological and PCR, and blood samples were subjected to hematology measures including hemoglobin (Hb), red blood cell (RBC) count, packed cell volume (PCV) and ferritin. Result: The infected children had significantly lower Hb, RBC, PCV and Fe which indicates high ferritin deficiency anemia between infected groups. There was also significant elevation of white blood cell (WBC) and neutrophil counts revealing activation of the immune response. Platelets in infected (compared to the controls) were greatly decreased. Therefore, the findings indicate significant negative impacts of Cryptosporidiosis on nutritional status and immune system function of diabetic children. Timely diagnosis and treatment of Cryptosporidiosis in children with anemia would prevent them from worsening anemia and compromise immune defenses, the study concluded. More studies are required to examine whether gender is involved and other risk factors present.

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1- INTRODUCTION

Cryptosporidiosis, caused by the protozoan parasite *Cryptosporidium* spp. is an important cause of diarrheal disease globally [1] especially among children [2,3] and immunocompromised patients [4.5] The infection is mainly passed from person to person through the fecal-oral route, most as caused by contaminated water or food [6]. Cryptosporidiosis represents major health concern in both developed and developing countries and continues to be prevalent in poor sanitation and with limited access to clean water [6]. The infection is also often asymptomatic in the children and can be very dangerous as it causes serious complicating factors, but in susceptible patients like those with chronic diseases [7].

Children with diabetes mellitus, especially type1 diabetes (T1DM), are a high-risk group for *Cryptosporidium* infection [8]. This population is at risk for infections due to immune disarray due to diabetes [9]. Recent reports have demonstrated the higher burden of parasitic infections such as cryptosporidiosis in diabetic children, suggesting that altered immune and gut responses and gut resistance among these children serve to make them at increased risk of infections by parasitic diseases [9.10]. These children may be affected with more severe symptoms and increased time of infection leading to malnourishing and secondary complications [11].

Cryptosporidiosis may affect all other components of health besides GI symptoms such as blood count and ferritin function [12.13]. It is well-known that parasitic infections induce anemia, most commonly through (1) blood loss, (2) malabsorption of nutrients, and (3) chronic inflammation [14, 15]. Depletion of ferritin stores in the body is critical for immune function and growth [12] and can lead to severe problems in children, worsening clinical outcomes of diabetes and cryptosporidiosis [16]. Similarly, reduced ferritin levels can compromise the immune response even further, increasing difficulty in fighting infections in the body and also inhibiting the child's growth and development [17, 18]. Despite the observed effects of *Cryptosporidium* on the general pediatric population, the impact of cryptosporidiosis and diabetes on children is poorly studied, based on this literature. It aims to investigate the prevalence of cryptosporidiosis in diabetic children in Al- Shirqat district and assess its associated effects on blood components and ferritin contents, thus addressing a major health challenge.

2- MATERIALS AND METHODS

2.1 Study Design & Setting

This cross-sectional study was carried out in the Al-Shirqat district for diabetic children aged 1-15 years, in many hospitals of Al-Shirqat in general, between the beginning of October and the end of January. The purpose of the research was to evaluate the prevalence of Cryptosporidiosis among this population and to assess its influence on blood components and ferritin stores.

2.2 Study Population

Ethical approval for the study was sought from the local ethical review board, and guardians of participating children provided appropriate written informed consent. A total of 55 children diagnosed with Type 1 diabetes mellitus (T1DM) were recruited from local healthcare centres. Using conventional parasitological techniques, fecal samples were collected from each of the participants in order to screen for *Cryptosporidium* infection.

2.3 Blood Sample & Fecal sample collection

Blood samples (5 cc) were also taken in an EDTA tube to assess haematological and ferritin levels and perform a complete blood count (CBC).One in plain tube to perform serum separation. The separation of serum samples was done through centrifugation at 3000 rpm in 10 minutes and kept at -20 C until the test was conducted. Blood samples examined for hemoglobin (Hb), red blood cell (RBC) count and hematocrit (Hct) hematological parameters. Fe levels in serum (ferritin), Complete blood count (CBC) was performed with an automated analyzer. Data analysis was done using SPSS version 29. Fresh fecal samples were collected transported and examined by direct wet iodine stained smears. The fecal sample Using modified Ziehl-Neelsen staining, fecal samples were determined for *Cryptosporidium* oocysts. The diagnosis was established by microscopic examination of the stained slides. The serum ferritin was also analyzed using chemiluminescent microparticle immunoassay (CMIA) or electrochemoluminescense immunoassay (ECLIA) based on the analyzer. These techniques employ ferritin specific monoclonal antibodies coupled with chemiluminescent label [19]. The prevalence of Cryptosporidiosis was calculated as the percentage of infected children in the comprehensive sample. Statistical significance was evaluated using Chi-square tests for categorical variables and independent t-tests for continuous variables. Statistical significance was evaluated by a p-value of <0.05. Correlation between *Cryptosporidium* infection and blood parameters such as hemoglobin and serum ferritin was defined by Pearson's correlation coefficient.

3- RESULTS AND DISCUSSION

Table 1 and Fig 1 illustrate the gender differences between patients and normal group children. Among the patient's children, 32.7% are female, and as low as 9.1% of normal children. In contrast, only 14.5 per cent of patients' children are male, whereas the normal group contains 43.6% male. Perhaps there exists a gender susceptibility to Cryptosporidiosis; females may be more affected in this population. There is also a gender

difference in the prevalence of Cryptosporidiosis; the patient's women had a greater share compared to those without. Numerous studies have identified gender differences in susceptibility to infectious diseases, yet the precise mechanisms underlying this difference remain to be explored. Gender differences could be attributed to immunological, hormonal, or potentially behavioral factors [9, 10]. This finding highlights the need for future research to check whether gender really does drive the potential for infection, especially in at-risk groups, for instance, diabetic children.

Table (1): Relationship between infection rate with *Cryptosporidium* & Diabetes Mellitus

		Sex	
		Male	**Female**
Patients	**Count**	8	18
	% of Total	14.5%	32.7%
Normal	**Count**	24	5
	% of Total	43.6%	9.1%
Total	**Count**	32	23
	% of Total	58.2%	41.8%

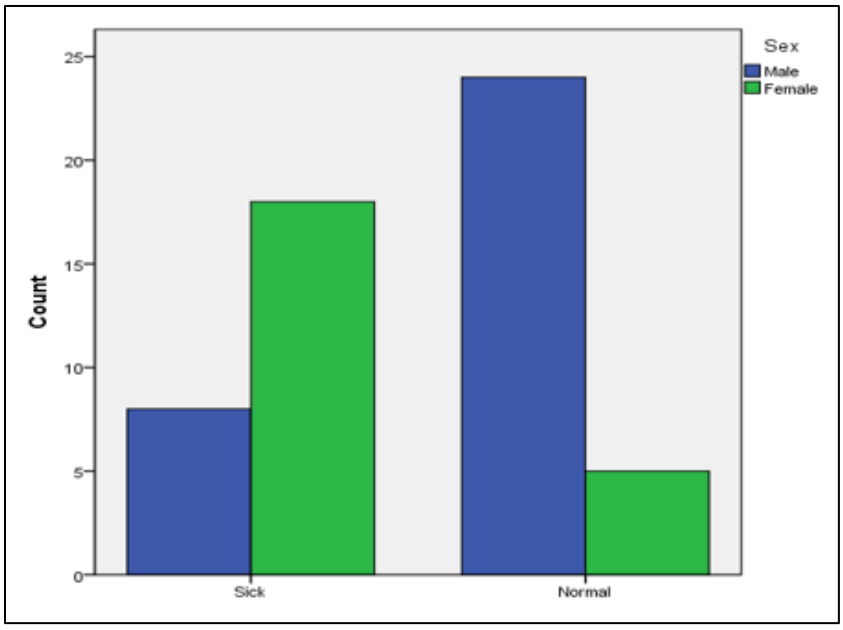

Fig (1): Gender distribution among Patients and Normal children.

Hemoglobin (Hb) levels are comparatively low (11.02 ± 0.20) in the case of patient's children with Table 2 compared to normal children (13.94 ± 0.17). The RBC count in infected children was also significantly (P≤0.05) decreased, averaging (4.00 ± 0.16) × 10^6 when compared to the normal group (5.15 ± 0.14) × 10^6. On a similar note, the hematocrit (PCV) values were significantly (P≤0.05) lower in the infected children (31.98 ± 0.60), compared to the healthy children (43.97 ± 0.60). If blood loss from the parasite, malabsorption and inflammation lead to the disease in diabetic children, then Cryptosporidiosis may lead to their anemia [16,18 ,14].

Reported similar findings (2020), who showed in children with parasitic infections low hemoglobin levels and low RBC count, most notably Cryptosporidiosis, which increases anemia and impairs growth [16 , 18]. In addition, the Children from patients and healthy groups did not have large differences of Mean Corpuscular Volume (MCV) mean (77.92 ± 0.72) compared to normal children (87.19 ± 0.82). Similarly, Mean Corpuscular Hemoglobin (MCH) was significantly lower in patient's children compared to healthy at (31.81 ± 0.63 and 33.82 ± 0.46) (P≤0.05). Mean Corpuscular Hemoglobin Concentration (MCHC) was also smaller in patients than normal children. These results

are consistent with previous evidence indicating that parasitic infections such as Cryptosporidiosis may induce microcytic anemia, resulting in low MCV, MCH, and MCHC levels due to ferritin deficiency and malnutrition [9,18].

Platelet count in the infected children ($(2.38 \pm 0.08) \times 10^5$), was significantly ($P \leq 0.05$) lower than that in healthy children ($(3.21 \pm 0.23) \times 10^5$). Likewise, the WBC count was significantly ($P \leq 0.05$) raised in the patient's children ($(6.27 \pm 1.41) \times 10^4$) compared to the healthy children ($(3.05 \pm 1.19) \times 10^4$). These changes signify ($P \leq 0.05$) the immune response against *Cryptosporidium* infection. It can be suggested that the low platelet count is due to the inflammatory process and the consumption of platelets during infection that occurs most often in parasitic diseases [6,1].On the other hand, high WBC count is due to the defense mechanisms of the body [10]. Notably, the Neutrophil count in the infected children was higher (61.58 ± 1.40) than in the normal children (31.90 ± 0.72). While Monocytes were in the patient's children much lower (28.96 ± 1.13) than in the healthy children (54.34 ± 0.59). The patient's children reported a significant increase in Eosinophil count (5.81 ± 0.24) compared to healthy children (3.48 ± 0.09). No significant difference in Basophil count is observed, whereas the patients group showed 2.58 ± 0.14 and healthy group had a value of 2.34 ± 0.09. These findings help to suggest that Neutrophils and Eosinophils contribute to parasite infections' resistance in response to parasites since they are thought to participate immune inflammation and immune response [16].

Table (2): The CBC results for the patients and normal children

Traits	**Patients n=26**	**Normal n=29**	**Sig.**
Hemoglobin	11.02±0.20 b	13.94±0.17 a	*
Red Blood Cells	(4.00±0.16) * 106 b	(5.15±0.14) * 106 a	*
Hematocrit	31.98±0.60 b	43.97±0.60 a	*
MCV	77.92±0.72 b	87.19±0.82 a	*
MCH	31.81±0.63 b	33.82±0.46 a	*
MCHC	32.38±0.57 b	34.34±0.27 a	*
Platelets	$(2.38\pm0.08) * 10^5$ b	$(3.21\pm0.23) * 10^5$ a	*
White Blood Cells	$(6.27\pm1.41) * 10^4$ a	$(3.05\pm1.19) * 10^4$ b	*
Neutrophils	61.58±1.40 a	31.90±0.72 b	*
Monocytes	28.96±1.13 b	54.34±0.59 a	*
Eosinophils	5.81±0.24 a	3.48±0.09 b	*
Basophils	2.58±0.14 a	2.34±0.09 a	NS

Table 3 and Fig 2 show the distribution of blood groups for patients and normal children. In both groups, the most prevalent blood group is O+, followed by A+. In the patients group, 21.8% of the children had blood type A+. We have blood type O+ for 23.6% of the normal group and blood type A+. However, the distribution of blood groups between patients and normal groups is different, but no statistically significant difference was found between patients and normal groups ($p > 0.05$). This finding furthers existing literature suggesting that blood type is not robustly associated with Cryptosporidiosis susceptibility, although there is good reason to believe that different blood types have differential cell surface receptors which could play a role in infection rates. For example, some blood antigens may contribute in the immune response to *Cryptosporidium* although further investigation will clarify this [11].

Table (3): Blood Group Distribution among Patients and Normal Children

		Blood Group					
		A+	B+	AB+	O+	A-	B-
Patients	**Count**	12	1	0	10	0	3
	% of Total	21.8%	1.8%	0.0%	18.2%	0.0%	5.5%
Normal	**Count**	7	6	1	13	1	1
	% of Total	12.7%	10.9%	1.8%	23.6%	1.8%	1.8%
Total	**Count**	19	7	1	23	1	4
	% of Total	34.5%	12.7%	1.8%	41.8%	1.8%	7.3%

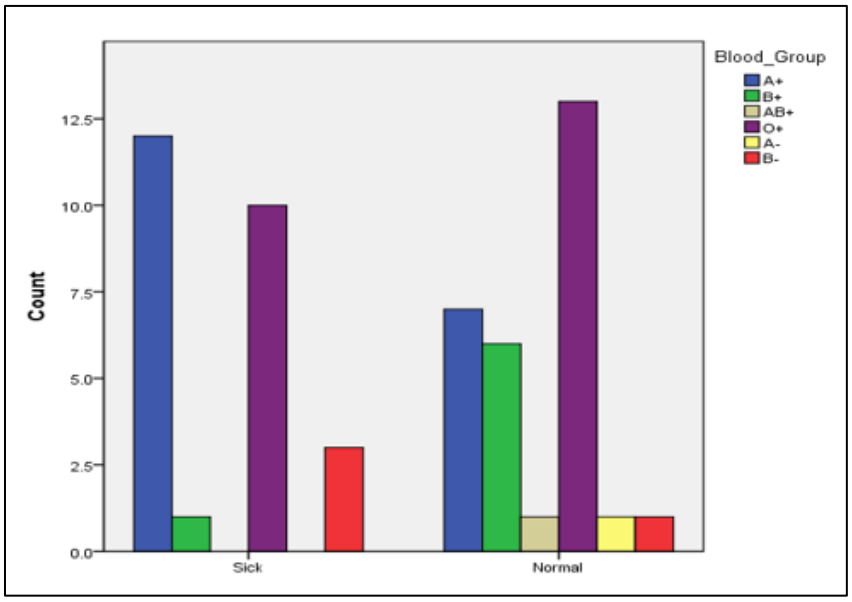

Fig (2): Blood Group Distribution among Patients and Normal Children

The patient's children show a significantly (P≤0.05) lower ferritin concentration (17.86 ± 2.58 versus 73.46 ± 3.81) compared to normal children (Table 4).

Table (4): The relationship between parasite infection, diabetes, and ferritin stores

Traits	Patients n=26	Normal n=29	Sig.
ferritin	17.86±2.58	73.46±3.81	*

The low ferritin in the infected children is the result of an ferritin deficiency anemia secondary to the parasite Cryptosporidiosis that affects blood ferritin absorption. Parasitic infections, such as *Cryptosporidium*, can lead to malabsorption of such nutrients (including ferritin), essential for both immune function and the growth of children [18, 14, 20]. The compromised immune function resulting from low ferritin levels also complicates the fight against infections among children [16].

4- CONCLUSION

This study also shows that Cryptosporidiosis has a notable impact on haematological parameters and ferritin stores in diabetic children living in the Al-Shirqat area. Children with the infection had lower haemoglobin (Hb), RBC count, PCV, and Fe concentrations, underscoring anaemia and ferritin depletion induced by the infection. Moreover, an immune response was identified with the presence of WBC and neutrophils. It is therefore important that early diagnosis and management of Cryptosporidiosis in diabetic children be implemented before complications such as malnutrition and immunodeficiency emerge; the epidemiology of the disease should be assessed and confirmed through further research, including sex differences in susceptibility and other health complications.

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