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Prevalence of some Intestinal Parasites among Type 1 Diabetic Patients in Kirkuk City

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Abstract

This study examined the incidence of intestinal parasites causing diarrhea and their impact on type 1 diabetes patients. Between February 2023 and January 2024, a study was conducted to investigate the types and prevalence rates of intestinal parasites among children with type 1 diabetes who visited the Children's Hospital and Azadi General Hospital in Kirkuk. Three hundred and fifteen stool samples were examined from diabetic children infected with intestinal parasites aged between 1 and 15 years using three diagnostic methods: the direct smear method, Intestinal parasites were detected using multiple diagnostic methods, including direct (wet) smear, Ziehl-Neelsen staining the immunochromatographic (IC) method, and the polymerase chain reaction (PCR) method. The study identified three species of intestinal parasites: *Entamoeba histolytica*, *Cryptosporidium parvum*, and *Giardia lamblia*. According to the IC test, the infection rate for Cryptosporidium parvum was 9.75%, while *Entamoeba histolytica* recorded an of 17.9%. and *Giardia lamblia* was 2.85% Microscopic examination showed an infection rate of 14.54% for *E. histolytica*, while *C. parvum* had an infection rate of 6.77% and based on PCR testing it was 5%. The overall infection rate of intestinal parasites was 77.77%. No significant differences were observed between male and female infection rates, with 54.28% of infections occurring in males and 45.71% in females. The highest infection rate was recorded in the 10-15 years' age group. Additionally, the highest monthly infection rate was observed in January at 18.5%, while the lowest rate was recorded in June at 2.4%. We conclude that children with weak immunity are more susceptible to parasite infection.

1. Introduction:

Intestinal parasites are a significant global health concern, particularly among children, as they can disrupt growth and impair essential bodily functions. These parasites interfere with metabolism, nutrient absorption, and the overall intestinal ecosystem. Intestinal infections caused by these organisms are especially prevalent among individuals with weakened immune systems [1], [2]. In diabetic patients, intestinal parasitic infections occur through multiple pathways. Diabetes weakens both the physiological and barrier functions of the intestine, alters humoral immunity, and affects T cell function. Hyperglycemia influences immune responses by modifying levels of complement protein C4 and cytokines such as IL-1, IL-6, IL-10, INF-γ, and TNF (tumor necrosis factor). As a result, diabetic individuals are more susceptible to parasitic infections [3]. These parasites are primarily transmitted via ingestion of contaminated water or raw vegetables irrigated with untreated sewage [4], [2]. Among the most common in-

testinal parasites are *Entamoeba histolytica*, *Giardia lamblia*, and *Cryptosporidium parvum*. Their widespread prevalence is due, in part, to the difficulty in controlling their transmission, particularly among warm-blooded hosts. High population density further increases the risk of infection [5]. Parasitic infections are notably more frequent in lower socioeconomic communities, particularly in tropical and subtropical regions [6]. Diabetes, a chronic metabolic disorder, is characterized by elevated blood glucose levels due to either insufficient insulin production or the body's inability to utilize insulin effectively. It is classified into two types: Type 1 diabetes, which is insulin-dependent, and Type 2 diabetes, which is not insulin-dependent [7], [8]. Type 1 diabetes accounts for approximately 90% of diabetes cases in children and adolescents and typically presents with symptoms such as excessive thirst (polydipsia), increased appetite (polyphagia), frequent urination (polyuria), and hyperglycemia [9]. Uncontrolled blood sugar levels can lead to severe complications, including gastrointestinal disorders, kidney disease, peripheral and central nervous system impairments, foot ulcers, amputations, joint atrophy, and an elevated risk of cardiovascular diseases [10]. Despite the significant health impact of parasitic infections in children with Type 1 diabetes, there is a lack of research on this subject. Therefore, the present study aims to investigate the prevalence of intestinal parasites among children with Type 1 diabetes in Kirkuk city.

2. Material and Methods:

This study involved the examination of 315 stool samples from patients with Type 1 diabetes, aged)1 – 15(years, of both sexes, over the period from February 2023 to January 2024. The participants were visitors to Children's Hospital and Azadi General Hospital. Samples were collected, examined and stored in the laboratory of the children's Hospital in Kirkuk.

Intestinal parasites were detected using multiple diagnostic methods, including direct (wet) smear, Ziehl-Neelsen staining, Immunochromatographic cassette (IC) (Biotic company), and Polymerase Chain Reaction (PCR) DNA was exracted from stool samples positive for Cryptosporidium at the Middle East Laboratory in Kirkuk using the stool DNAextraction kit supplied by Korean company Favorgen and according to the working methods steps described by the company, used primer 18SrRNA gene *C. parvum*. After extracting DNA from positive samples, DNA strand amplification was performed using specialized primers to amplify a specific part of the 18 Sr RNA gene of the Cryptosporium parasite by PCR. PCR products were detected by electrophoresis. The purity of DNA in all samples was measured by a Nano Drop Spectrophotometer ND 100 (USA) by reading the absorbance at 260/280 nm [11]. Additionally, blood sugar levels were measured, ranging from 6 to 8 mmolL^{-1} (average: 6.99 mmolL^{-1}). The study also recorded variations in defecation frequency, which ranged between 3 to 8 times per day [12]. The used primes to detect the mitochondrial gene of COX1 are presented in Table 1

Table 1. The primers used in the current study to detect the mitochondrial gene for COX 1.

Primer		Sequence (5'-3')	Product size
18SrRNA gene *C. parvum*	F	GGAAATCCGTCTATCAGTGG	510 bp [13]
	R	R:CCCTCACGGTACTTGTTTGC	

The Statistical Analysis is investigated using one-way ANOVA and t-test. test was utilized to compare differences at $P \leq 0.05$ level.

3. Results and Discussion:

Diabetes is a serious non-communicable disease that arises either due to insufficient insulin production by the pancreas or the body's inability to utilize insulin effectively. Individuals with diabetes experience immune dysfunction, which compromises various immune functions and increases susceptibility to opportunistic infections, including intestinal parasitic infections such as *Entamoeba histolytica*, *Giardia lamblia*, and *Cryptosporidium parvum* [7]. The current study found that 70 out of 315 examined cases were infected with intestinal parasites, representing an infection rate of 22.23%. Comparatively, a study conducted in Najaf recorded a 46.7% infection rate for *Giardia lamblia* among Type 1 diabetes patients, while *Entamoeba histolytica* infection reached 34.3% among individuals with both Type 1 and Type 2 diabetes [10]. Similarly, a study in Iran reported an overall prevalence of 26.3% for intestinal parasites among diabetic patients [14]. Further research by [15] identified a 63.2% prevalence of intestinal parasites, including *Blastocystis hominis*, *Entamoeba histolytica*, *Ascaris lumbricoides*, *Taenia saginata*, *Giardia lamblia*, *Balantidium coli*, *Enterobius vermicularis*, *Entamoeba coli*, and *Schistosoma mansoni*, among Type 2 diabetes patients. Additionally, infection rates in Kut and Kufa cities reached 30% and 46.15%, respectively [15] [16]. A comparative summary of these findings is presented in Table 2.

Table 2. The percentage of infection with intestinal parasites in children with type 1 diabetes.

Microscopic examination	Positive samples		Negative samples	
315	Number 70	Percentage % 22.23	Number 245	Percentage % 77.77

The increased incidence of parasitic infections among patients

with Type 1 diabetes is likely due to immune suppression associated with the disease. Type 1 diabetes is an autoimmune disorder characterized by metabolic dysregulation, including hyperglycemia and disturbances in the metabolism of carbohydrates, fats, and proteins. Additionally, poor living conditions, limited access to clean drinking water, and a lack of health and educational awareness contribute to the prevalence of these infections in certain regions. When diagnosing C*ryptosporidium spp.*, different methods produced varying infection rates.

Modified acid-fast staining 6.77% immunochromatographic (IC) test 9.75%, polymerase chain reaction (PCR) technique 5% for *Entamobea histolytica*, the recorded infection rates were microscopic examination 14.54%, ICtest 17.9% Not using PCR technology to detect 3 . As for the detection of giardia, it was through direct microscopic examination, with an infection rate of 2.85%.

The findings of the current study differ from previous research conducted on Type 1 and Type 2 diabetes patients. A study by [1] in Kufa reported an Entamoeba histolytica infection rate of 25% using microscopic examination. Similarly, [15] in Najaf found an infection rate of 34.3% among Type 2 diabetes patients using acid staining. Further discrepancies were noted in studies from other cities [16] in Kut reported an infection rate of 30% using microscopic examination. [17] in Kufa recorded a 30% infection rate for *Entamoeba histolytica* using microscopy. [18] in Iran found a significantly lower infection rate of 3.93% for *Entamoeba histolytica* and 2.67% for *Cryptosporidium spp.*, using direct microscopy and acid staining. Conversely, the present study aligns with findings from [19] in Calabria, where the incidence of *Cryptosporidium parvum* was 16.7% using microscopy. [18] in Ghana, which reported an infection rate of 17.86% for *Cryptosporidium parvum* using microscopy and acid staining. [7] in Ghana, where *Cryptosporidium parvum* had an incidence rate of 15%, while *Entamoeba histolytica* was 21.1%, based on acid staining and microscopy. [20] in India, which found an infection rate of 12.23% for *Entamoeba histolytica* in diabetic patients using acid staining. These variations in infection rates may be attributed to geographical differences, patient age, dietary habits, and physical activity levels.

3.1 Double Infections:

The study found no significant differences between single and mixed infections of intestinal parasites, as shown in Table 4. The recorded infection rates for mixed infections were *Cryptosporidium spp.* with *Entamoeba histolytica* 11.11%, *Giardia lamblia* 2.85%, *Entamoeba histolytica* with *Giardia lamblia* 1.42%, *Cryptosporidium spp.* with *Giardia lamblia*: 5.71%. These findings closely align with [17], which reported an 11.11% incidence of *Cryptosporidium spp.* and *Entamoeba histolytica* among Type 2 diabetes patients. However, they contrast with [18], where the infection rates for *Cryptosporidium spp.* and *Entamoeba histolytica* were 0.83%, and for *Giar-*

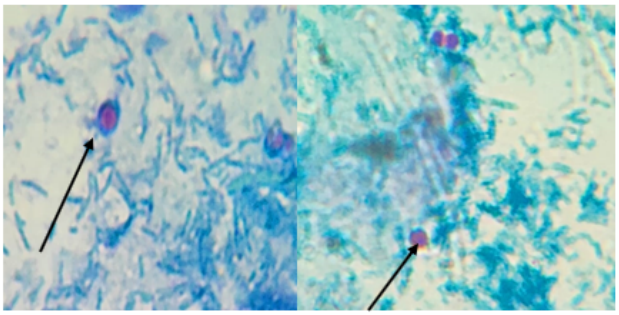

Figure 1. The oocyst stage of the *cryptosporidium parvum*.

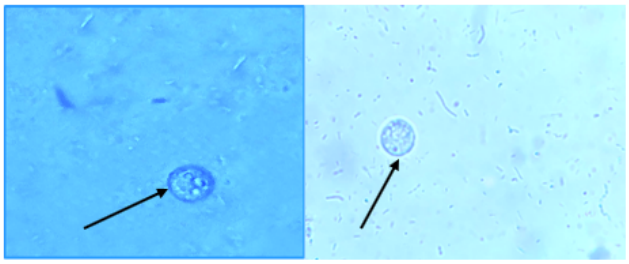

Figure 2. The cyst stage of *Entamoeba histolytica.*

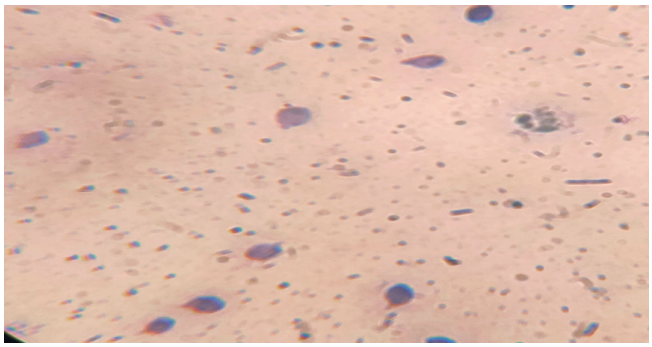

Figure 3. The Trophozoite stage of *Giardia lamblia*.

Table 3. The prevalence rate of cryptosporidiosis and *Entamoeba histolytica*.

Total number	IC positive samples				Ziehl-Neelsen positive samples and microscopic examination			PCR positive samples		
		P (+V)	P(-V)	Percentage %	P (+V)	P(-V)	Percentage %	P(+V)	P(-V)	Percentage %
315	*C.paravum*	28	287	9.75 %	20	295	6.77 %	15	300	%5
	E.histolytica	48	267	17.9%	40	275	14.54%			
	G.lamblia	2	313	0.63%	2	313	70.63%			

Chi = 4.388, df =2, P value = 0.111

dia lamblia with *Entamoeba histolytica*, 0.42%. Additionally, a study in Egypt [7] on Type 2 diabetes patients recorded a 6% infection rate for Amoebiasis and *Giardia lamblia.* The study suggests that the samples may be more susceptible to intestinal parasite infections due to factors such as the consumption of unclean food, which may be contaminated with the larval stages of parasites, as well as exposure through playing and mixing with infected children.

The results revealed no significant differences ($P \geq 0.05$) in the infection rates across age groups. The highest infection rate was observed in the 10-15 years' age group at 63.15%, followed by the 5-10 years' age group with an infection rate of 23.68%, while the <5 years' age group had the lowest infection rate at 13.15%. As for gender, the infection rate was 54.28% in males and 45.71% in females, as shown in Table 5.

These results differ from the findings of [15] in Najaf, where the infection rate among males was 42.3% and females 57.6%. The 1-10 years' age group in that study had an infection rate of 19.7%. Similarly, in [17] study in Najaf on Type 2 diabetes patients, the infection rate in the > 23 years' age group was 46.15%, with a gender distribution of 14% in females and 10% in males. On the other hand, our results are consistent with [15] study in Kut, which found that the infection rate among Type 2 diabetes patients was 60% in males and 40% in females. The incidence of parasitic infections in diabetic patients varies across studies due to factors such as the study group, geographical location, and the diagnostic methods used. Differences in the results may stem from environmental conditions or the characteristics of the study samples. The higher infection rate observed in the 10-15 years age group is likely related to school-aged children, whose immune response may be incomplete, and who interact frequently with their peers. Additional factors, such as poor personal hygiene practices (e.g., not washing hands before eating or after defecation) and spending time outside playing, contribute to the increased risk of infection [21], [22]. These children are also more likely to come into contact with infected individuals [23], [24]. The variation in infection rates between males and females may be attributed to several factors. Males, who are generally more active, tend to be more exposed to environmental contaminants, such as consuming ready-made foods without proper attention to hygiene. On the other hand, females typically prioritize personal hygiene and tend to be less active in environments that may expose them to higher risks.

The results of the current study revealed that infection rates varied according to the consistency of the stool samples. The highest infection rate was observed in samples with watery liquid consistency at 81.25%, while the lowest infection rate was found in samples with soft consistency at 23.68%. Statistical analysis indicated that there were no significant differences ($P \geq 0.05$), as shown in Table 6. Since no studies have specifically addressed the sample composition for patients with Type 1 or Type 2 diabetes, the current study's findings were compared with previous studies. In a study conducted by [25] in Kirkuk, the infection rate for soft diarrhea was 60.84%, while for watery diarrhea, it was 16.78%. Another study by [23] reported an infection rate of 39.5% for watery diarrhea and 37.7% for soft diarrhea. The diagnosis of parasitic infections often depends on the consistency of the stool sample, as the vegetative and cystic stages of parasites are commonly found in liquid and soft stools, especially when the mucous parts are isolated and examined separately, which improves diagnostic accuracy. A study by [26] indicated that the incidence of watery diarrhea was 15%. A study by [27] The incidence rate for males was 48.4%.

The variation in stool consistency can be attributed to immunodeficiency and its suppression, which lead to changes in the intestinal microbial flora. These changes may influence the presence or absence of certain microbes, including parasites.

The current study recorded the highest infection rate of 44.28% in sources that included tap water, followed by an infection rate of 31.44% in filtered water, and 24.28% in boiled and sterilized water. Statistical analysis revealed no significant differences ($P \geq 0.05$), as shown in Table 7. The study conducted in Calabar City [26] reported a 7.7% infection rate for running water. Another study in Yemen [28] found a 41.3% infection rate for tap water and 36.4% for sterilized water. The differences in infection rates across these studies may be attributed to a lack of awareness regarding proper water sterilization practices, insufficient use of disinfectants, and in-

Table 4. Prevalence rate of single and mixed intestinal parasite infections in patients with type 1 diabetes.

Double infection	Number examined	Number of patient	Percentage %
Entamobea histolytica + *Cryptosporidium parvum*	72	8	11.11 %
Giardia lambila	46	2	2.85 %
Entamobea histolytica + *Giardia lambila*	52	1	1.42 %
Cryptosporidium parvum + *Giardia lambila*	75	4	5.71 %
Total number	245	15	21.09 %

Chi =84.946, df =5, P value = 0.000

Table 5. Prevalence rate of single and mixed intestinal parasite infections in patients with type 1 diabetes.

Age groups	Females		Males	
	Number	Percentage %	Number	Percentage %
< 5	8	25 %	5	13.15 %
5-10	11	34.37 %	9	23.68%
10-15	13	40.62 %	24	63.15 %
Total number	32	45.71 %	38	54.28 %

Chi = 3.675, df =2, P value = 0.159

adequate cleaning of home water tanks, which are vulnerable to pollution and microbial growth. Additionally, damage to water pipe networks plays a significant role in increasing the risk of infection and disease.

Egg sacs are commonly found in large quantities in liquid water due to their resistance to many sterilizers and disinfectants used in water purification, as well as their small size [29]. The World Health Organization states that approximately 80% of all diseases globally are linked to unsterilized water [30]. River water can become contaminated from various sources, including animal and human fertilizers, hospital waste, sewage, and more. The use of water pumps to supply water to reservoirs, especially under low pressure in the supply networks, increases the likelihood of drawing contaminated water from pipes that may be cracked or damaged, leading to biological contamination. As a result, the effectiveness of sterilization and purification processes is compromised. The filter sterilization method commonly used to purify water does not always ensure water free from parasites, as some materials used in water purification may not effectively neutralize all contaminants.

When examining the relationship between infection and symptoms associated with intestinal parasitic infection, the highest infection rate was recorded in cases of diarrhea accompanied by loss of appetite at 50%, while the lowest infection rate was found in cases of diarrhea with vomiting, at 17.14%. A study by [3] in Egypt reported that 97.7% of infected individuals experienced diarrhea. Similarly, the study by [31] in Egypt found that 55% of cases involved diarrhea, 65% experienced abdominal pain, and 2.5% had vomiting. In another study by [9] in Egypt, 48% of cases involved diarrhea, and 18% experienced both diarrhea and abdominal pain. The similarity in these results may be attributed to the fact that all cases in the current study are due to infection with pathogenic intestinal parasites, which are known to cause these symptoms. Parasitic infections are a significant health issue, leading to a range of problems such as anemia, delayed growth, weight loss, and other health, physical, and mental complications, particularly in children. Intestinal infections may cause digestive symptoms like diarrhea, colic, and vomiting. They can also lead to systemic symptoms, sometimes accompanied by fever. In severe cases, complications may include intestinal ulceration, intestinal inflammation, malnutrition, mental retardation, and in extreme instances, death [6], as illustrated in Table 8. The results of the current study showed that the highest infection rate was in January at 18.5%, while the lowest infection rate was recorded in June at 2.4% as shown in Table 9. The study by [32] recorded the highest infection rate in May at 9.49%, and the lowest in September at 6.62%. Similarly, [10] found the highest infection rate in December at 67%, with the lowest in February at 23%. [15] the highest infection rate was observed in January, and the lowest in May. These results align with those of [33] and [34], who suggested that the spread of Cryptosporidium parasites is higher during the winter months due to rainwater washing soil contaminated with animal waste that contains egg sacs, which then mix with stream and river water, facilitating the parasite's spread [35], [36], [37] also showed that the infection rate of hidden spores peaks in winter, likely due to favorable conditions of temperature, humidity, and the climate in Iraq. Additionally, the spread of this parasite may be influenced by the increased number of insects during the humid, moderate-temperature months, as insects are one of the mechanical vectors of the parasite. Variations in monthly results could be due to the specific activities people engage in each month or seasonal changes, where outdoor activities and increased social interac-

Table 6. Prevalence of intestinal parasites in type 1 diabetic patients according to sample consistency.

Simple consistency					
Gender	Patients with watery diarrhea		Patients with loose diarrhea		Total number
	Number	Percentage %	Number	Percentage %	
Male	29	76.31 %	9	23.68 %	38
Female	26	81.25 %	6	18.75 %	32
70		55	15		Total number

Chi = 0.233, df =1, P value = 0.512

Table 7. Prevalence of intestinal parasites according to sources of water.

Source of water	Number tested	Positive samples	Infection percentage %
Boiled or sterilized water	78	17	24.28 %
Filtered water	90	22	31.44 %
Tasting water	147	31	44.28 %
Total number	315	70	% 100

Chi = 0.375, df =2, P value = 0.829

Table 8. Prevalence of intestinal parasites according to sources of water.

Symptoms	Number	Percentage %
Diarrhea + Abdominal pain	23	32.86 %
Diarrhea + Vomiting	12	17.14 %
Diarrhea + Loss of appetite	35	50 %
Total	70	% 100

Chi = 0.375, df =2, P value = 0.829

tions may raise the chances of transmission. Diabetics, both type 1 and type 2, are more vulnerable to high temperatures in the summer than healthy individuals. This is because diabetics tend to lose a significant amount of fluids through frequent urination [38]. With increased sweating during summer and insufficient water intake, the likelihood of dehydration rises, which can lead to uncontrolled diabetes in some individuals.

4. Conclusion:

In this study, the prevalence of *cryptosporidiosis*, *Entamobea histolytica*, and *giardia lamblia* was detected among patients with diabetes, confirming their increased exposure to these parasitic infections compared to healthy individuals. The weakened immune system resulting from diabetes, especially in cases of poor control of blood sugar levels, increases the risk of infection with these parasites.

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Table 9. Prevalence of intestinal parasites according to sources of water.

Months	Samples Tested												Total	
	C.parvum		*E. histolytica*		*E+C*		*G.lambila*		*G+E*		*G+C*			
February	1	6.6 %	3	7.5 %	2	25%	1	50 %	0	0.0	0	0.0	7	10 %
March	0	0.0	3	7.5 %	1	12.5%	0	0.0	0	0.0	1	25 %	5	7.1%
April	0	0.0	4	10 %	1	12.5 %	0	0.0	0	0.0	0	70.0	5	7.1 %
May	0	0.0	5	12.5 %	0	0.0	0	0.0	0	0.0	1	25 %	6	8.5 %
June	2	13 %	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	2.8 %
July	0	0.0	4	10%	0	0.0	0	0.0	1	10%	1	25%	6	8.5%
August	0	0.0	5	12.5 %	0	0.0	0	0.0	0	0.0	0	0.0	5	7.1 %
September	0	0.0	1	2.5 %	1	12.5 %	1	50 %	0	0.0	0	0.0	3	4.2 %
October	3	20 %	2	5 %	1	12.5 %	0	0.0	0	0.0	1	25 %	7	10 %
November	2	13 %	4	10 %	0	0.0	0	0.0	0	0.0	0	0.0	6	8.5%
December	1	6.6 %	2	5 %	2	25 %	0	0.0	0	0.0	0	0.0	5	7.1 %
January	6	40 %	7	17.5 %	0	0.0	0	0.0	0	0.0	0	0.0	13	18.5 %
Total	15		40		8		2		1		4		70	

Chi = 60.386, df =55, P value = 0.287

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Data Availability Statement: All of the data supporting the findings of the presented study are available from corresponding author on request.

Declarations:

Conflict of interest: The authors declare that they have no conflict of interest.

Ethical approval: Approval was also obtained from the University of Kirkuk and the Children's Hospital not to take samples from patients suffering from low blood levels, case number 305, dated 5/3 /2024.

Author Contributions: Bafreen Mohamad Raza was responsible for collecting samples, conducting analysis, interpreting data, writing the manuscript, and proofreading it. Neama Ali Ahmed and Sahlah Kh. Abbas conceived the idea, supervised the research, and read the manuscript.

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انتشار بعض الطفيليات المعوية بين مرضى السكري من النوع الأول في مدينة كركوك

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الخلاصة

تناولت هذه الدراسة انتشار الطفيليات المعوية المسببة للإسهال وتأثيرها على مرضى السكري من النوع الأول. أجريت دراسة بين شباط 2023 وكانون الثاني 2024 للتحقق من أنواع ومعدلات انتشار الطفيليات المعوية بين الأطفال المصابين بالسكري من النوع الأول الذين راجعوا مستشفى الأطفال ومستشفى آزادي العام في كركوك. تم فحص ثلاثمائة وخمسة عشر عينة براز من أطفال مصابين بالسكري مصابين بالطفيليات المعوية تتراوح أعمارهم بين سنة واحدة وخمسة عشر سنة. تم الكشف عن الطفيليات المعوية باستخدام طرق تشخيصية متعددة، بما في ذلك المسحة المباشرة (الرطبة)، وصبغة زيلنيلسن واستخدام طريقة الكروماتوغرافيا المناعية (*IC*)، وطريقة تفاعل البوليميراز المتسلسل (*PCR*). حددت الدراسة ثلاثة أنواع من الطفيليات المعوية: الأميبا الحالة للنسج والابواغ الخبيئة وجياردیا لامبليا. وفقًا لاختبار *IC* ، بلغ معدل الإصابة بالأبواغ الخبيئة 9.75% ، بينما سجل الاميبا الحالة للنسج 17.9% ، والجياردیا لامبليا 2.85% . أظهر الفحص المجهري معدل إصابة بلغ 14.54 % للأميبا الحالة للنسج، بينما بلغ معدل إصابة الابواغ الخبيئة 6.77% ، وبناءً على اختبار تفاعل البوليميراز المتسلسل (*PCR*) بلغ 5% . بلغ معدل الإصابة الإجمالي بالطفيليات المعوية 77.77% . ولم تُلاحظ فروق معنوية بين معدلات الإصابة بين الذكور والإناث، حيث بلغت نسبة الإصابة بين الذكور 54.28% مقابل 45.71% بين الإناث. وسُجل أعلى معدل إصابة في الفئة العمرية 10 – 15 عامًا. كما سجل أعلى معدل إصابة خلال الأشهر الدراسة، اذ سجلت اعلى نسبة إصابة في شهر كانون الثاني بنسبة 18.5% ، بينما سجل أدنى معدل في شهر حزيران بنسبة 2.4% . ونستنتج أن الأطفال ذوي المناعة الضعيفة أكثر عرضة للإصابة بالطفيليات.

الكلمات الدالة : الأميبا النسيج، الابواغ الخبيئة، جياردیا لامبليا، الإسهال، داء السكري من النوع الأول.

التمويل: لايوجد.

بيان توفر البيانات: جميع البيانات الداعمة لنتائج الدراسة المقدمة يمكن طلبها من المؤلف المسؤول.

اقرارات:

تضارب المصالح: يقر المؤلفون أنه ليس لديهم تضارب في المصالح.

الموافقة الأخلاقية: تم الحصول أيضاً على موافقة جامعة كركوك ومستشفى الأطفال على عدم اخذ عينات من المرضى الذين يعانون من انخفاض مستويات الدم، رقم الكتاب 305 بتاريخ 5/3/2024 .

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