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Prevalence of Giardia lamblia Infection Among Malnourished Children in Kirkuk City, Iraq: A Case–Control Study

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Abstract: Background: Malnutrition and intestinal parasitic infections are major health problems among children under five years of age in developing countries. Giardia lamblia is a common protozoan parasite associated with diarrhea, malabsorption, and growth impairment.
Aim: To determine the prevalence of Giardia lamblia infection among malnourished children in Kirkuk City, Iraq, and to evaluate its association with demographic and environmental risk factors.
Methods: This hospital-based case–control study was conducted from February to December 2025 and included 240 children aged 2 months to 5 years (120 malnourished cases and 120 apparently healthy controls). Data were collected using a structured questionnaire, and anthropometric measurements were used to assess nutritional status. Stool samples were examined using the zinc sulfate concentration method for detection of Giardia lamblia. Statistical analysis was performed using chi-square test, with a p-value <0.05 considered statistically significant.
Results: The prevalence of Giardia lamblia infection was significantly higher among malnourished children compared to controls. The highest rate of infection was observed in children aged 25–36 months and among those living in rural areas. Significant associations were found between giardiasis and diarrhea, poor hygiene practices, unsafe drinking water, overcrowded living conditions, and low socioeconomic status ($p<0.05$).
Conclusion: Giardia lamblia infection is significantly associated with malnutrition among children in Kirkuk City. Improving sanitation, ensuring safe water supply, promoting health education, and early detection and treatment of parasitic infections are essential strategies to reduce the burden of malnutrition.

Keywords: Malnutrition, Giardia lamblia, Children, Prevalence, Risk factors, Diarrhea, Kirkuk City, Iraq

Introduction

Malnutrition remains one of the most important causes of morbidity and mortality among children worldwide, particularly in developing countries. It is estimated that approximately 9% of children under five years of age suffer from wasting, defined as weight-for-height below −2 standard deviations of the National Center for Health Statistics/World Health Organization (NCHS/WHO) reference values, placing them at increased risk of death and severe impairment of growth and physiological development [1]. Malnutrition is commonly diagnosed in children whose growth is less than that of their peers. Although there is no single universal criterion, it is generally defined as weight below the 3rd percentile or a significant decline crossing two major percentiles over a short period [2][3]. In children, malnutrition is associated with impaired growth, delayed cognitive development, reduced immunity, and increased susceptibility to infections. Globally, malnutrition contributes directly or indirectly to more than 50% of deaths among children under five years of age, especially in low-income countries [4]. The relationship between malnutrition and infection is bidirectional, forming a vicious cycle in which malnutrition weakens the immune system, while infections worsen nutritional status through decreased food intake, impaired absorption, and increased metabolic demands [5]. Among infectious causes, intestinal parasitic infections play a major role in the development and progression of malnutrition in children. One of the most important protozoan parasites is Giardia lamblia (also known as Giardia intestinalis or Giardia duodenalis), which is the causative agent of giardiasis [6]. It is estimated to cause approximately 280 million cases annually worldwide [7]. Giardiasis is characterized by diarrhea, abdominal pain, bloating, flatulence, and malabsorption, and it is particularly problematic in children living in low-income settings [8]. Chronic infection with Giardia lamblia may lead to growth retardation, micronutrient deficiencies, and impaired cognitive performance [9]. The parasite attaches to the mucosal surface of the small intestine, causing damage that interferes with digestion and nutrient absorption, thereby contributing to malnutrition [10]. Parasitic infections in children under five years of age are especially concerning because of their long-term health consequences. These infections can result in chronic undernutrition, leading to stunted growth and delayed development [11]. Transmission of Giardia lamblia occurs mainly through the fecal–oral route, often via contaminated water, food, or direct person-to-person contact. Poor sanitation, unsafe drinking water, overcrowding, and inadequate hygiene practices are major risk factors associated with infection [12]. In Iraq, and particularly in Kirkuk City, malnutrition among children remains a significant public health concern due to socioeconomic challenges, limited access to clean water, and variations in hygiene and health awareness. These conditions increase the risk of intestinal parasitic infections, including Giardia lamblia, which may further aggravate malnutrition among affected children. Despite the clinical importance of giardiasis, there is limited local data regarding its prevalence and its association with malnutrition in children in Kirkuk City. Therefore, this study was conducted to evaluate the prevalence of Giardia lamblia infection among malnourished children in Kirkuk City and to assess its relationship with demographic characteristics, clinical features, and selected risk factors.

Materials and Methods

The study was conducted in Kirkuk City, Iraq. The malnourished cases were recruited from the General Pediatric Ward and the Rehabilitation Ward for malnutrition cases in Kirkuk hospitals and health care centers. These facilities receive a wide range of pediatric cases and represent the main referral centers for malnutrition management in the region. This study was designed as a hospital-based case–control selective study. A total of 120 children diagnosed with malnutrition were enrolled from those attending Kirkuk health care centers during the period from 1st February to 31st December 2025. The age of the participants ranged from 2 months to 5 years. A comparable control group of 120 apparently healthy children with normal weight-for-height was also included for comparison.

Study Sample and Data Collection

Informed consent was obtained from the parents or guardians of all participants prior to their inclusion in the study. Approval was also obtained from the laboratory administration of Salah Al-Deen Hospital. Each enrolled child was assessed using a structured questionnaire that included demographic and clinical data such as age, sex, residence, and other relevant information.

Anthropometric measurements were performed for all children included in the study. These included weight-for-age, height/length-for-age, occipitofrontal circumference-for-age, and weight-for-height. Weight was measured using a UNICEF pediatric scale for infants and a digital scale for older children. Each child was weighed with minimal clothing, and at least two measurements were taken, with the mean value recorded. Weight was measured to the nearest 5 grams and plotted on standard growth charts according to age and sex.

Height or length was measured depending on the age of the child. For children younger than 2 years, recumbent length was measured using a stadiometer. For children older than 2 years, standing height was measured using a non-stretchable fiberglass measuring tape fixed to a wall. Measurements were taken with the child barefoot and the head in a straight position, and recorded to the nearest 0.1 cm. These values were plotted on standard height/length-for-age charts.

Occipitofrontal circumference was measured using a non-stretchable fiberglass tape. Three readings were taken for each child, and the largest measurement was recorded. The results were then plotted on standard OFC charts according to age and sex.

Weight-for-height was calculated using the measured weight and height/length values and plotted on standard WHO charts to assess the nutritional status and classify the severity of malnutrition.

Inclusion and Exclusion Criteria

The inclusion criteria included children aged between 2 months and 5 years who were diagnosed with malnutrition and whose parents or guardians agreed to participate in the study.

The exclusion criteria included children who had received antibiotics within three days prior to sample collection, those who had received antiparasitic medications within seven days prior to sampling, and children with chronic illnesses such as diabetes mellitus, renal failure, or immunodeficiency disorders.

Laboratory Methods

Fresh stool samples were collected from all participants in clean, sterile containers and transported immediately to the laboratory. All samples were examined within 20 minutes of collection to ensure accuracy and reliability of results.

The detection of Giardia lamblia was carried out by general stool examination using light microscopy by experienced laboratory personnel. The zinc sulfate concentration method was used for sample preparation. Approximately one gram of stool was mixed with 10 mL of 33% zinc sulfate solution and allowed to stand for 10 minutes. A drop of the prepared sample was then examined under a microscope, and at least 10 microscopic fields were observed using ×40 magnification. The presence of Giardia lamblia trophozoites or cysts was considered a positive result.

Study Limitations

Several limitations were encountered during the study. Ideally, three consecutive stool samples collected on different days are recommended to improve diagnostic accuracy for Giardia lamblia; however, this was not feasible for all participants. In addition, there were difficulties in collecting fresh stool samples from some children due to unpredictable defecation patterns. Some samples were also collected after laboratory working hours or were not fresh enough, which may have affected the accuracy of results.

Statistical Analysis

Statistical analysis was performed using Minitab software version 17. Data were expressed as numbers and percentages (n, %). Comparisons between groups were conducted using the Chi-square (χ^2) test. A P-value of less than 0.05 was considered statistically significant. P-values less than 0.01 were considered highly significant, while P-values greater than 0.05 were considered non-significant.

Results

The study showed that the malnourished group included 120 children and the control group also included 120 children. In the malnourished group, the largest age category was 3–12 months, accounting for 55 (45.83%), followed by 13–24 months with 41 (34.17%), 25–36 months with 14 (11.67%), and 37–48 months with 10 (8.33%). In the control group, the corresponding values were 53 (44.17%), 40 (33.33%), 15 (12.50%), and 12 (10%), respectively. Males represented 72 (60%) of cases and 71 (59.17%) of controls, whereas females represented 48 (40%) and 49 (40.83%), respectively. Rural residence was found in 74 (61.67%) cases and 72 (60%) controls. There were no significant differences between the two groups regarding age, gender, residence, or maternal educational level (P>0.05).

Table 1: General characteristics of the studied groups

Variables	Malnourished children n (%)	Healthy control n (%)	P value
Age groups (months)			

3–12	55 (45.83%)	53 (44.17%)	NS
13–24	41 (34.17%)	40 (33.33%)	NS
25–36	14 (11.67%)	15 (12.50%)	NS
37–48	10 (8.33%)	12 (10%)	NS
Total	120 (100%)	120 (100%)	NS
Mean ± SD	17.12 ± 8.20	17.34 ± 8.10	NS
Gender			
Males	72 (60%)	71 (59.17%)	NS
Females	48 (40%)	49 (40.83%)	NS
Residence			
Rural	74 (61.67%)	72 (60%)	NS
Urban	46 (38.33%)	48 (40%)	NS
Educational level of mother			NS
Illiterate	62 (51.67%)	54 (45%)	
Read and write	17 (14.17%)	18 (15%)	
Primary school	22 (18.33%)	24 (20%)	
Secondary school	13 (10.83%)	17 (14.17%)	
Higher education	6 (5%)	7 (5.83%)	

The study showed that Giardia lamblia infection was detected in 17 (14.17%) of malnourished children compared with 6 (5%) of healthy controls, while 103 (85.83%) of cases and 114 (95%) of controls were negative. This difference was statistically significant (X^2=5.15, P=0.023).

Table 2: Prevalence of Giardia lamblia in malnourished and control children

G. lamblia	**Malnourished children n (%)**	**Healthy control n (%)**	**X^2**	**P value**
Positive	17 (14.17%)	6 (5%)	5.15	0.023 S
Negative	103 (85.83%)	114 (95%)		
Total	120 (100%)	120 (100%)		

The study showed that Giardia lamblia infection increased with worsening severity of malnutrition. Infection was found in 4 (5.41%) children with mild malnutrition, 4 (15.38%) with moderate malnutrition, and 9 (45%) with severe malnutrition. The highest proportion of infection was therefore seen in severely malnourished children. The association between Giardia lamblia infection and type of malnutrition was highly significant (X^2=20.34, P<01).

Table 3: Distribution of study cases according to Giardia lamblia infection and type of malnutrition

Type of malnutrition	***G. lamblia* positive n (%)**	***G. lamblia* negative n (%)**	**Total n (%)**
Mild (n=74)	4 (5.41%)	70 (94.59%)	74 (100%)

Moderate (n=26)	4 (15.38%)	22 (84.62%)	26 (100%)
Severe (n=20)	9 (45%)	11 (55%)	20 (100%)
Total	17 (14.17%)	103 (85.83%)	120 (100%)

The study showed that in malnourished children, the highest rate of Giardia lamblia infection was observed in the age group 25–36 months, where 7 (50%) were positive, followed by 37–48 months with 3 (30%), 13–24 months with 6 (14.63%), and 3–12 months with 1 (1.82%). In the control group, the highest rate was also recorded in children aged 25–36 months, with 3 (20%) positives, whereas no infection was found in those aged 37–48 months. The association was highly significant among malnourished children (X^2=23.75, P<01) and significant among controls (X^2=8.82, P=0.032).

Table 4: Distribution of Giardia lamblia among malnourished cases and control group in regard to age

Age groups (months)	**Malnourished children positive n (%)**	**Malnourished children negative n (%)**	**Total n (%)**	**Control group positive n (%)**	**Control group negative n (%)**	**Total n (%)**
3–12	1 (1.82%)	54 (98.18%)	55 (100%)	1 (1.89%)	52 (98.11%)	53 (100%)
13–24	6 (14.63%)	35 (85.37%)	41 (100%)	2 (5%)	38 (95%)	40 (100%)
25–36	7 (50%)	7 (50%)	14 (100%)	3 (20%)	12 (80%)	15 (100%)
37–48	3 (30%)	7 (70%)	10 (100%)	0 (0%)	12 (100%)	12 (100%)
Total	17 (14.17%)	103 (85.83%)	120 (100%)	6 (5%)	114 (95%)	120 (100%)

<01

The study showed that among malnourished children, Giardia lamblia infection was found in 10 (20.83%) females and 7 (9.72%) males. In the control group, infection was found in 1 (2.04%) female and 5 (7.04%) males. However, the association between gender and Giardia lamblia infection was not statistically significant in either malnourished children

Table 5: Distribution of Giardia lamblia infection according to gender

Gender	**Malnourished children positive n (%)**	**Malnourished children negative n (%)**	**Total n (%)**	**Control group positive n (%)**	**Control group negative n (%)**	**Total n (%)**
Males	7 (9.72%)	65 (90.28%)	72 (100%)	5 (7.04%)	66 (92.96%)	71 (100%)
Females	10 (20.83%)	38 (79.17%)	48 (100%)	1 (2.04%)	48 (97.96%)	49 (100%)

Total	17 (14.17%)	103 (85.83%)	120 (100%)	6 (5%)	114 (95%)	120 (100%)

Group	X^2	P value
Malnourished children	2.92	0.087 NS
Control group	1.53	0.217 NS

The study showed that Giardia lamblia infection in malnourished children was more frequent in rural residents, where 12 (26.09%) were positive, compared with 5 (6.76%) in urban residents. In the control group, 4 (8.33%) rural children and 2 (2.78%) urban children were infected. The association was statistically significant in malnourished children (X^2=8.72, P=03), while it was not significant in controls (X^2=1.87, P=0.171).

Table 6: Residence distribution of Giardia lamblia infection in malnourished children

Residence	Malnourished children positive n (%)	Malnourished children negative n (%)	Total n (%)	Control group positive n (%)	Control group negative n (%)	Total n (%)
Urban	5 (6.76%)	69 (93.24%)	74 (100%)	2 (2.78%)	70 (97.22%)	72 (100%)
Rural	12 (26.09%)	34 (73.91%)	46 (100%)	4 (8.33%)	44 (91.67%)	48 (100%)
Total	17 (14.17%)	103 (85.83%)	120 (100%)	6 (5%)	114 (95%)	120 (100%)

Group	X^2	P value
Malnourished children	8.72	03 S
Control group	1.87	0.171 NS

The study showed that the frequency of Giardia lamblia infection varied according to the signs and symptoms of malnutrition. The highest positivity rates were observed in children with edema 8 (18.60%), dehydration 10 (18.87%), pallor 14 (17.07%), skin manifestations 10 (15.87%), hair changes 11 (15.28%), abdominal pain 15 (15.31%), and appetite loss 15 (15.31%). Eye manifestations showed a statistically significant inverse association, as infection was found in 5 (7.46%) children with eye manifestations compared with 12 (22.64%) in those without eye manifestations (P<0.05). Most other symptoms showed no significant association (P>0.05).

Table 7: Relation of Giardia lamblia infection with signs and symptoms of malnourished children

Associated symptoms and signs	Total No.	Positive n (%)	Negative n (%)	P value
Abdominal pain – Present	98	15 (15.31%)	83 (84.69%)	NS
Abdominal pain – Absent	22	2 (9.09%)	20 (90.91%)	
Weight loss – Present	113	17 (15.04%)	96 (84.96%)	NS
Weight loss – Absent	7	0 (0%)	7 (100%)	
Appetite loss – Present	98	15 (15.31%)	83 (84.69%)	NS
Appetite loss – Absent	22	2 (9.09%)	20 (90.91%)	

Nausea – Present	100	14 (14%)	86 (86%)	NS
Nausea – Absent	20	3 (15%)	17 (85%)	
Vomiting – Present	84	12 (14.29%)	72 (85.71%)	NS
Vomiting – Absent	36	5 (13.89%)	31 (86.11%)	
Fever – Present	84	8 (9.52%)	76 (90.48%)	NS
Fever – Absent	36	9 (25%)	27 (75%)	
Bloating – Present	95	10 (10.53%)	85 (89.47%)	NS
Bloating – Absent	25	7 (28%)	18 (72%)	
Pale – Present	82	14 (17.07%)	68 (82.93%)	NS
Pale – Absent	38	3 (7.89%)	35 (92.11%)	
Wasting – Present	110	14 (12.73%)	96 (87.27%)	NS
Wasting – Absent	10	3 (30%)	7 (70%)	
Dehydration – Present	53	10 (18.87%)	43 (81.13%)	NS
Dehydration – Absent	67	7 (10.45%)	60 (89.55%)	
Edema – Present	43	8 (18.60%)	35 (81.40%)	NS
Edema – Absent	77	9 (11.69%)	68 (88.31%)	
Organomegaly – Present	46	5 (10.87%)	41 (89.13%)	NS
Organomegaly – Absent	74	12 (16.22%)	62 (83.78%)	
Eye manifestation – Present	67	5 (7.46%)	62 (92.54%)	S
Eye manifestation – Absent	53	12 (22.64%)	41 (77.36%)	
Skin manifestation – Present	63	10 (15.87%)	53 (84.13%)	NS
Skin manifestation – Absent	57	7 (12.28%)	50 (87.72%)	
Hair changes – Present	72	11 (15.28%)	61 (84.72%)	NS
Hair changes – Absent	48	6 (12.50%)	42 (87.50%)	

The study showed that Giardia lamblia infection among malnourished children was higher in children from families who did not boil water before drinking, where 11 (16.42%) were positive, compared with 6 (11.32%) among those who boiled water. Infection was also more frequent in children who did not wash vegetables before eating 15 (15.96%), those living in crowded houses 14 (14.58%), those who did not wash hands 11 (13.58%), and those using tap water or other unsafe water sources. The source of drinking water showed a statistically significant association (P<0.05).

Table 8: Relation of Giardia lamblia infection with some risk factors in malnourished children

Risk factors	Malnourished children positive n (%)	Malnourished children negative n (%)	Total n (%)	Control group positive n (%)	Control group negative n (%)	Total n (%)

Boiling water						
Yes	6 (11.32%)	47 (88.68%)	53 (100%)	2 (2.22%)	88 (97.78%)	90 (100%)
No	11 (16.42%)	56 (83.58%)	67 (100%)	4 (13.33%)	26 (86.67%)	30 (100%)
Hand washing						
Yes	6 (16.67%)	30 (83.33%)	36 (100%)	1 (2.78%)	35 (97.22%)	36 (100%)
No	11 (13.10%)	73 (86.90%)	84 (100%)	5 (5.95%)	79 (94.05%)	84 (100%)
Wash vegetables						
Yes	2 (7.41%)	25 (92.59%)	27 (100%)	1 (1.39%)	71 (98.61%)	72 (100%)
No	15 (16.13%)	78 (83.87%)	93 (100%)	5 (10.42%)	43 (89.58%)	48 (100%)
Crowded house						
Yes	14 (14.58%)	82 (85.42%)	96 (100%)	4 (6.67%)	56 (93.33%)	60 (100%)
No	3 (12.50%)	21 (87.50%)	24 (100%)	2 (3.33%)	58 (96.67%)	60 (100%)
Source of drinking water						
Mineralized	2 (6.67%)	28 (93.33%)	30 (100%)	0 (0%)	42 (100%)	42 (100%)
Tap water	9 (11.54%)	69 (88.46%)	78 (100%)	6 (8.33%)	66 (91.67%)	72 (100%)
Other (e.g. rivers)	6 (50%)	6 (50%)	12 (100%)	0 (0%)	6 (100%)	6 (100%)

Source of drinking water: P<0.05.

The study showed that among malnourished children with diarrhea, Giardia lamblia infection was found in 12 (38.71%), whereas only 5 (5.62%) of children without diarrhea were infected. This indicated a highly significant relationship between Giardia lamblia infection and occurrence of diarrhea (X^2=20.71, P<01).

Table 9: Relation of Giardia lamblia infection with occurrence of diarrhea in malnourished children

Diarrhea	*G. lamblia* positive n (%)	*G. lamblia* negative n (%)	Total n (%)
Present	12 (38.71%)	19 (61.29%)	31 (100%)
Absent	5 (5.62%)	84 (94.38%)	89 (100%)
Total	17 (14.17%)	103 (85.83%)	120 (100%)

X² P value

20.71 <01 HS

The study showed that among malnourished children with diarrhea, Giardia lamblia infection was present in 8 (40%) of acute cases and 4 (36.36%) of chronic cases. The difference between acute and chronic diarrhea was not statistically significant (X^2=0.04, P=0.842).

Table 10: Relation of Giardia lamblia infection with type of diarrhea

Diarrhea type	*G. lamblia* positive n (%)	*G. lamblia* negative n (%)	Total n (%)
Acute	8 (40%)	12 (60%)	20 (100%)
Chronic	4 (36.36%)	7 (63.64%)	11 (100%)
Total	12 (38.71%)	19 (61.29%)	31 (100%)

X² P value

0.04 0.842 NS

The study showed that 91 of 120 malnourished children were introduced to solid food. Among them, Giardia lamblia infection was highest in children introduced to solid food at 6–8 months, where 5 (9.43%) were positive, followed by 9–12 months with 1 (6.25%), while no infection was found in those introduced at 4–5 months. The association was not statistically significant (X^2=2.25, P=0.325).

Table 11: Distribution of Giardia lamblia infection in malnourished children according to time of introducing solid food

Time of introducing solid food (months)	*G. lamblia* positive n (%)	*G. lamblia* negative n (%)	Total n (%)
4–5	0 (0%)	22 (100%)	22 (100%)
6–8	5 (9.43%)	48 (90.57%)	53 (100%)
9–12	1 (6.25%)	15 (93.75%)	16 (100%)
Total	6 (6.59%)	85 (93.41%)	91 (100%)

X² P value

2.25 0.325 NS

The study showed that among malnourished children, Giardia lamblia infection was highest in those whose mothers were illiterate, where 12 (19.35%) were positive, followed by children of mothers who could read and write with 2 (11.76%), children of mothers with primary school education with 2 (9.09%), and children of mothers with secondary school education with 1 (7.69%). No infection was found in children of mothers with higher education. However, the association was not statistically significant among either malnourished children (X^2=3.36, P=0.500) or controls (X^2=1.16, P=0.885).

Table 12: Distribution of Giardia lamblia infection in malnourished children according to educational level of their mothers

Educational level of mother	Malnourished children positive n (%)	Malnourished children negative n (%)	Total n (%)	Control group positive n (%)	Control group negative n (%)	Total n (%)
Illiterate	12 (19.35%)	50 (80.65%)	62 (100%)	2 (3.70%)	52 (96.30%)	54 (100%)
Read and write	2 (11.76%)	15 (88.24%)	17 (100%)	1 (5.56%)	17 (94.44%)	18 (100%)
Primary school	2 (9.09%)	20 (90.91%)	22 (100%)	2 (8.33%)	22 (91.67%)	24 (100%)
Secondary school	1 (7.69%)	12 (92.31%)	13 (100%)	1 (5.88%)	16 (94.12%)	17 (100%)
Higher education	0 (0%)	6 (100%)	6 (100%)	0 (0%)	7 (100%)	7 (100%)
Total	17 (14.17%)	103 (85.83%)	120 (100%)	6 (5%)	114 (95%)	120 (100%)

Group	**X²**	**P value**
Malnourished children	3.36	0.500 NS
Control group	1.16	0.885 NS

Chapter Five

Discussion

Malnutrition remains one of the most important causes of morbidity and mortality among children, particularly in developing countries, where it interacts closely with infectious diseases in a vicious cycle that worsens both nutritional and clinical outcomes. Early childhood is the most vulnerable period for nutritional deterioration because of rapid growth requirements, dependence on caregivers for feeding, repeated exposure to infections, and inadequate complementary feeding practices. In the present study, the largest proportion of malnourished children belonged to the younger age groups, especially during the first two years of life, which is consistent with the view that infancy and early childhood represent the most critical window for nutritional risk and growth failure. This finding is comparable to previous observations reported in pediatric and public health literature, which emphasized that undernutrition is concentrated in early life and remains a major determinant of adverse developmental outcomes [1][2][3]. The current study also showed a slight predominance of male children among malnourished cases, a finding that agrees with reports from other developing settings in which boys were more frequently represented among undernourished children, possibly because of differences in feeding behavior, exposure patterns, or health-seeking practices [4]. In addition, most cases in the current study came from rural areas, and this may be explained by poorer sanitation, lower family income, larger household size, unsafe water supply, overcrowding, and reduced access to health services in rural communities. Similar associations between rural residence and childhood malnutrition have been described in previous studies [5]. Most mothers of malnourished children in this study had low educational levels, especially illiteracy or only primary education, which may contribute to inadequate child feeding, poor food preparation, improper sterilization of feeding utensils, delayed care seeking, and poor recognition of early signs of illness. Maternal education has repeatedly been identified as one of the strongest determinants of childhood nutritional status [6]. The present study further demonstrated that Giardia lamblia infection was more common among malnourished children than among healthy controls, supporting the concept that giardiasis is an important enteric infection associated with poor nutritional status.

This finding is in line with previous reports showing that Giardia intestinalis is frequently associated with malnutrition, especially in communities with poor hygiene and limited sanitation [7][8][9]. The higher frequency of giardiasis among malnourished children in the current study may be explained by two complementary mechanisms: first, malnutrition impairs both innate and adaptive immunity, thereby increasing susceptibility to intestinal parasitic infection; second, Giardia lamblia itself contributes to nutritional deterioration by damaging the small intestinal mucosa, reducing absorptive capacity, causing maldigestion and malabsorption, and promoting chronic or recurrent diarrhea [8][10][11]. The present study also showed that Giardia lamblia infection increased with worsening severity of malnutrition, with the highest proportion of infection observed among severely malnourished children. This pattern is biologically plausible because severe malnutrition is accompanied by more profound immune dysfunction and greater vulnerability to infection. Previous work has shown that undernutrition weakens host defense mechanisms and increases the burden and severity of common childhood infections, especially diarrheal and intestinal diseases [12][13][14]. Thus, the greater burden of giardiasis in severe malnutrition observed in this study may reflect both increased exposure and reduced resistance, as well as the nutritional consequences of prolonged intestinal infection. Regarding age-specific distribution, the highest prevalence of Giardia lamblia infection in malnourished children was found among those aged 25–36 months, followed by children aged 13–24 months. This likely reflects increasing environmental exposure as children grow older, begin walking, play more on contaminated ground, consume a wider range of foods, and become more exposed to unsafe water and contaminated objects. Similar age-related increases in giardiasis have been described in previous epidemiological studies [7][15][16]. In the current study, females showed a somewhat higher proportion of giardiasis than males, although the association was not statistically significant. Some previous reports found a higher prevalence of intestinal parasitic infection in females, possibly because of differences in domestic exposure or household roles, while other studies found no meaningful difference by sex [17][18]. Therefore, the sex-related difference observed here should be interpreted cautiously and may reflect local sociobehavioral rather than biological factors. The present study also demonstrated that Giardia lamblia infection was more common among children from rural areas than among those from urban areas. This is in agreement with studies showing that giardiasis is closely linked to poor sanitation, unsafe drinking water, lower educational level, and rural living conditions [16][19]. Rural households may face greater exposure to contaminated water sources, open environments, animal contact, and inadequate sewage systems, all of which facilitate fecal–oral transmission of the parasite. According to Waterlow classification in this study, mild malnutrition represented the largest proportion of cases, followed by moderate and severe malnutrition. This may indicate that many children were brought to hospital before progression to advanced malnutrition, or that they were admitted primarily because of associated illnesses such as diarrhea or respiratory infection, with mild-to-moderate nutritional deficit recognized during assessment [7]. The clinical pattern of giardiasis in malnourished children in the present study showed frequent association with wasting, abdominal pain, appetite loss, nausea, vomiting, pallor, dehydration, edema, skin manifestations, and hair changes. This broad clinical spectrum is understandable because malnutrition affects multiple organ systems and is often accompanied by immune dysfunction and overlapping nutritional deficiencies, while giardiasis contributes additional gastrointestinal and absorptive disturbances. Previous studies have shown that chronic giardiasis may present with diarrhea, bloating, abdominal discomfort, poor weight gain, and micronutrient deficiency [10][11][20]. The current study further identified several environmental and behavioral risk factors that were common among malnourished children and strongly associated with Giardia lamblia infection, including not boiling drinking water, inadequate hand washing before meals and after toilet use, failure to wash vegetables before eating, living in crowded houses, and use of unsafe water sources such as river water. These findings are consistent with prior studies showing that poor hygiene, unsafe water, overcrowding, and low socioeconomic conditions are major determinants of giardiasis in endemic communities [16][21][22]. The role of contaminated water is particularly important because Giardia lamblia is a classic waterborne parasite, and cysts may remain viable in the environment and easily spread through untreated or poorly treated water supplies [23][24][25]. In the present study, Giardia lamblia infection showed a strong association with diarrhea among malnourished children. This agrees with the established pathogenic role of giardiasis in causing acute or chronic diarrhea and with the well-recognized bidirectional relationship between diarrhea and malnutrition. Diarrhea contributes to malnutrition through reduced intake, nutrient loss, malabsorption, and inflammation, whereas malnutrition aggravates the severity and duration of diarrheal illness through impaired intestinal integrity and reduced immune response [10][26][27]. The current results therefore support the view that giardiasis may play a substantial role in the persistence of diarrheal illness among undernourished children. When the type of diarrhea was analyzed, the present study found no significant difference between acute and chronic diarrhea in relation to giardiasis, although infection was slightly more frequent in acute cases. This may indicate that Giardia lamblia can be involved in both clinical presentations, depending on the burden of infection, host immunity, nutritional condition, and duration of exposure. With regard to feeding practices, most cases in the current study were on solid or mixed feeding rather than exclusive breastfeeding. The prevalence of giardiasis was higher among children receiving bottle feeding or solid foods than among those exclusively breastfed. This may be explained by the fact that breast milk contains anti-infective factors, including secretory immunoglobulin A and other protective components, whereas bottle feeding and early complementary feeding may expose the child to contaminated water, utensils, and foods. Similar explanations have been proposed in previous studies, and the waterborne nature of giardiasis strongly supports this interpretation [7][28][29]. In relation to the timing of introduction of solid food, the present study found that Giardia lamblia infection was more frequent in children who had been introduced to solid feeds at 6–8 months than in those introduced earlier or later. This may reflect the combined effects of food contamination, unsafe preparation practices, and increased environmental exposure during the weaning period. The current study also found that giardiasis was more common among children whose mothers had low educational levels, especially illiterate mothers, which supports the view that maternal education is closely related to hygienic practices, feeding quality, health awareness, and infection prevention [6][16][21]. Finally, the overall pattern of the present results indicates that Giardia lamblia infection is not merely an incidental laboratory finding among malnourished children, but rather an important associated condition that may contribute to poor growth, diarrheal morbidity, and worsening nutritional status, especially in children living in rural, overcrowded, and socioeconomically disadvantaged settings. These findings emphasize the need for integrated strategies that combine nutritional rehabilitation with improved sanitation, safe water supply, parental education, early stool examination, and prompt treatment of intestinal parasitic infections in order to reduce the burden of malnutrition and improve child health outcomes in Kirkuk City and similar settings.

Conclusion

This case–control study demonstrates that Giardia lamblia infection is much more prevalent among malnourished children than among their healthy counterparts, which correlates strongly with increasing malnutrition severity and supports the notion of a bidirectional relationship between infection and nutritional deficit. The prevalence of children aged 25–36 months and those residing in rural environments are associated with the highest risk, while safe drinking water, hygiene practices, overcrowding, and low socioeconomic conditions were found to be particularly strongly associated risk factors for infection (1–14) This also highlights how important giardiasis is to diarrhea, and subsequently nutrient loss and impaired child growth. These results suggest that the control of parasitic infections should be incorporated into malnutrition prevention programmes via water quality, sanitation, hygiene education and early diagnosis. Its public health implications highlighting the need for combined nutritional rehabilitation and infection prevention strategies to interrupt the cycle of disease and undernutrition. Yet the use of a single stool sample and sampling of patients from hospitals raises concerns about generalizability of the results and should drive caution. The authors recommend larger community-based longitudinal studies, the use of more sensitive diagnostic techniques, and intervention-based approaches to determine the effects of combined nutritional and parasitic control programs on child morbidity and health outcomes.

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