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Correlation between intestinal parasitic infections and malnutrition in children under five years

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Abstract
Background: Intestinal parasite infections (IPIs) and malnutrition constitute significant public health issues in Bangladesh in children under five years of age. Currency These two illnesses are comorbid and interact in a manner that has a compounded effect on hematological growth, development, and health. Rural regions are more susceptible owing to insufficient sanitation, a scarcity of health facilities, and restricted access to food resources.
Objectives: To determine the incidence of enteroparasitosis and its potential association with malnutrition, especially considering the children's residency (urban or rural) and their hematological profiles.
Methods: Two hundred children under five years of age, exhibiting either gastrointestinal disorders or symptoms of malnutrition, were included in cross-sectional research conducted from January 2024 to April 2025. Parasites were screened in stool samples, while hematological indices and *H. pylori* IgG antibodies were tested in the blood. Body mass measures and nutritional status were assessed with the WHO Z-score. Statistical analysis was conducted with SPSS v26, employing Chi-square tests, t-tests, and logistic regression.
Results: The overall prevalence of parasitic infection was 50.5%, rural children (63%) were significantly more infected than their urban (38%) counterparts ($p<0.001$). Malnutrition was seen in 47% of the participants and was more prevalent in the rural areas (58% vs 36%, $p<0.001$). *Giardia lamblia* were the most frequently observed parasite (46.5%). The rate of malnutrition was significantly greater among children with parasitic infection (58.4%) than non-infected (35.3%) (P=0.001). The highest susceptibility was observed in the 6-24 months stratum. H. pylori seropositivity and anemia were also more common in infected and malnourished children. The malnourished and infected group had the lowest level of hemoglobin (9.4 g/dL, $p<0.001$).
Conclusion: Malnutrition in children under five is strongly correlated with IP infection, especially in rural areas. Together, these elements cause anemia and render the hematological profiles ineffective. Targeted interventions like nutritional supplementation, deworming, and WASH behavior modification are desperately needed, especially for young children.

Keywords: IPIs, Malnutrition, children under five, anemia, rural health

1. Introduction

Among the most challenging public health issues faced by low- and middle-income nations (i.e., those with inadequate water quality, sanitary conditions, and health systems) are intestinal parasitic infections (IPIs) and childhood malnutrition [1]. For children under five, whose immunity is still developing and who are more nutritionally vulnerable due to frequent exposure to these polluting environments, this is particularly disastrous [2]. Malnutrition and parasitic infection coexist in many resource-poor areas in a vicious cycle where the infection makes the malnutrition worse, the malnutrition weakens the immune system, and the person becomes more prone to infection. In addition to having an effect on children's physical and cognitive development, this combined burden is a major global contributor to pediatric morbidity and mortality [3].

According to recent WHO reports, over 149 million children worldwide suffer from stunting, and up to 45 million suffer from wasting, also known as acute malnutrition. Children are the most affected demographic group, with over 1.5 billion people infected with soil-transmitted *helminths* and protozoan infections [4]. Child health indicators have declined in Iraq and other middle-income countries due to internal conflict, poverty, displacement, and an inadequately funded and equipped health care system, particularly in rural and underserved areas [5].

Protozoa, for example *Giardia lamblia*, *Entamoeba histolytica*, and *helminths*, such as *Ascaris lumbricoides*, and hookworm is some of the organisms responsible for pathogenic gastrointestinal infections. fecal-oral route, usually due to poor sanitation, unsafe drinking water, and poor hygiene [6]. In young children, the infections frequently result in gastrointestinal symptoms, such as diarrhea, abdominal pain, and malabsorption of nutrients. Chronic parasitic infections can also cause insufficient absorption of vital nutrients as iron, zinc, and vitamin A therefore, making it a direct cause for protein-caloric under-nutrition especially among food-deprived population [7].

Severe wasting, stunting, and underweight are indicators of malnutrition, which has serious effects on immune function and makes a young child more susceptible to infections and their aftereffects. As a result, the connection between IPIs and malnutrition is complex and dynamic. For instance, it is well known that the protozoan *Giardia lamblia* causes gut inflammation and malabsorption along with villous atrophy [8]. Additionally, helminthic infestations such as A. lumbricoides and hookworm infestations have been established to result in chronic blood loss and it leads to iron deficiency anemia [9]. The co-occurrence of these conditions has been noted in several studies and infected children with intestinal parasitic infections appear to present with infection and malnutrition more often than uninfected children [10].

Parasitic infestations are also implicated in the hematological derangements apart from malnutrition. Anemia is still a significant public health problem among children of < 5-y-old and WHO has estimated that total anemic children under 5 y old in the world are approximately 43%. In early life anemia has been linked with impaired cognitive development and physical performance, and with morbidity [11]. The etiology of anemia in this time is mostly iron deficiency anemia, chronic infection and inflammation. Anemia of infected children, particularly those harboring *helminths*, is predominantly caused by blood loss, erythrocyte distortion, and nutrient competition among others [12]. In addition, there is evidence suggesting a possible linkage of H. pylori infection with iron deficiency anemia in the children specifically those with concurrent infection with intestinal parasites and with the highest food insecurity [13].

These related conditions are not distributed evenly. It often is most severe in rural areas with limited access to sanitation and health care. In these environments, children are likely to come into contact with soil and water containing pathogens, have limited access to nutrient rich food and be infected and re-infected untreated. There is a growing literature that has examined the association between parasitic infections, malnutrition and anemia. However, we still require context-specific studies such as this study to be conducted as very few data has been collected at a national level, and often pragmatic interventions might only be partly effective when draws of causal relations are made on a country with such health problems like Iraq [14]. The aim of this study is to assess and to model the correlation of childhood intestinal parasite infestation, malnutrition and blood replated health in pre-school children and to identify the effects of these four entities on children's hemoglobin on urban and rural kids of kindergarten age.

2. Materials and Methods

2.1 Location and Period of Study

The research was performed at Tikrit Teaching Hospital, which is situated in Tikrit city in Salah al-Din Governorate, Iraq. This center acts as a main referral hospital to both urban and rural catchment area. The study was completed between January 1, 2024 and April 30, 2025.

2.2 Study Population

Children aged 60 months or less attending outpatient pediatric clinic while children who were admitted to the pediatric ward were included in the study. All the recruited children had been clinically suspected as having of gastrointestinal disturbance and/or malnutrition like wasting, underweight or stunt. Children with chronic illness, congenital anomalies, or who underwent antiparasitic treatment in the past 6 months were excluded.

2.3 Sample Size and Collection

Two hundred children were enrolled in the study. For every individual, stool samples and blood samples were obtained. In concert, a parent or guardian of the child completed a structured questionnaire that collected demographic and health information.

2.3.1 Collection of Fecal Samples

All participants were advised to defecate into a toilet, following which the stool was placed in a clean plastic container with a Snap-on-tight lid. The collected quantity for formed stool was around 20-40 grams and for watery stool was 5-6 spoonful’s, apposite for parasitological examination. Short-term preservation (up to 2 days) was achieved by storing the samples at 2-8°C and long-term storage (up to 1 year) by freezing the samples at -20°C. Frozen samples were thawed and allowed to reach room temperature prior to testing, with homogenization. All samples were labelled with the name of the patients, age, sex, and date of collection.

2.3.2 Collection of Blood Samples

Each subject donated 5 ml venous blood by venipuncture into plain tubes. The tubes were thereafter centrifuged for 5 minutes to obtain the serum. The collected serum was kept at 2-8°C and used within 5 days, then kept frozen at -20 to -70°C. The repeated cycle of freezing and thawing was prevented. These sera were tested for H. pylori IgG antibody. All blood samples were correctly labelled and included patient identifier information.

2.4 Study Groups

The participants were divided into subgroups for analysis based on the following criteria:

2.4.1 Residence

- Urban group: Children residing in the city.
- Rural group: Children residing in villages or remote areas.

2.4.2 Nutritional Status

According to WHO growth standards:

- Well-nourished group: Z-score ≥ -2 SD in weight-for-age, height-for-age, and weight-for-height.
- Malnourished group: Z-score < -2 SD in any indicator, including underweight, stunting, or wasting.

2.4.3 Parasitic Infection Status

Based on stool examination:

- Infected group: At least one intestinal parasite detected.
- Non-infected group: No parasites detected.

Combined groups were also created for comparative analysis

1. Well-nourished & parasite-free
2. Well-nourished & infected
3. Malnourished & parasite-free
4. Malnourished & infected

2.5 Equipment

2.5.1 Materials Used

All reagents and test kits used in this study are listed in Table 1.

Table 1: Study Materials

Materials	Company	Country
H. pylori IgG Test Kit	Demeditec Diagnostics GmbH	Germany
Giardia lamblia Kit	Pol. Industrial Río Gállego	Spain
Lugol's Iodine	BDH Chemicals	United Kingdom
Formalin (10%)	Himedia	India

Hematologic status and possible anemia or evidence of systemic inflammation were evaluated using hematologic parameters including the Complete Blood Count (CBC) in addition to the *H. pylori* serological test for all resource persons. Two milliliters of venous blood were collected in EDTA tubes, mixed by inverting 2-3 times and analyzed within two hours by an automatic hematology analyzer (e.g., Mindray BC-2800 or an equivalent) at the Tikrit Teaching Hospital laboratory.

The following parameters were recorded:

- Hemoglobin (Hb) level
- Red Blood Cell indices (MCV, MCH)
- White Blood Cell (WBC) count
- Platelet count

Anemia was defined according to WHO age-specific cutoffs: Hb < 11.0 g/dL in children under 5 years of age. Children with abnormal CBC results were further evaluated and referred for nutritional or medical management.

2.6 Statistical Analysis

Data were processed by IBM SPSS version 26. Demographic and clinical characteristics were summarized using descriptive statistics; categorical variables were given as numbers and percentages, and continuous variables were provided as means and standard deviations. The chi-square test was used to measure relationships between status of intestinal parasitic infections and nutritional status and differences between urban and rural. Mean values of continuous variables were compared between infected and non-infected children using the Independent Samples t-test. A binary logistic regression was conducted to determine potential risk factors for malnourished outcomes, and the results are presented by odds rates (ORs) and 95% CIs. $p<0.05$ was considered significant.

3. Results

Table 2 presents the distribution of the sample according to age group and place of residence. Age groups were broadly similar on comparison of urban and rural populations, with 13-24 months age group having 50 children and 49-59 months group being the least with 31 children. The p-value (0.75) suggests no statistically significant difference in age distribution between urban and rural participants (Figure 1).

Table 2: Anthropometric Measurements, Feeding Practices, and Age Group Distribution by Residence

Age Group (Months)	Urban (n = 100)	Rural (n = 100)	Weight (kg) Mean±SD	Height (cm) Mean±SD	BMI (kg/m²) Mean±SD	Breastfeeding (Yes/No)	P-value
6-12	18 (18%)	20 (20%)	6.21±1.33	53.11±0.95	11.6±1.2	Yes: 12 (66.7%), No: 6 (33.3%)	0.03
13-24	24 (24%)	26 (26%)	7.45±1.25	60.33±1.22	12.9±1.1	Yes: 14 (58.3%), No: 10 (41.7%)	0.04
25-36	22 (22%)	21 (21%)	9.05±1.20	68.12±1.30	13.5±1.0	-----------	0.05
37-48	20 (20%)	18 (18%)	10.11±1.15	74.10±1.35	14.5±0.9	-----------	0.01
49-59	16 (16%)	15 (15%)	11.89±1.25	80.33±1.40	15.2±1.0	------------	0.02

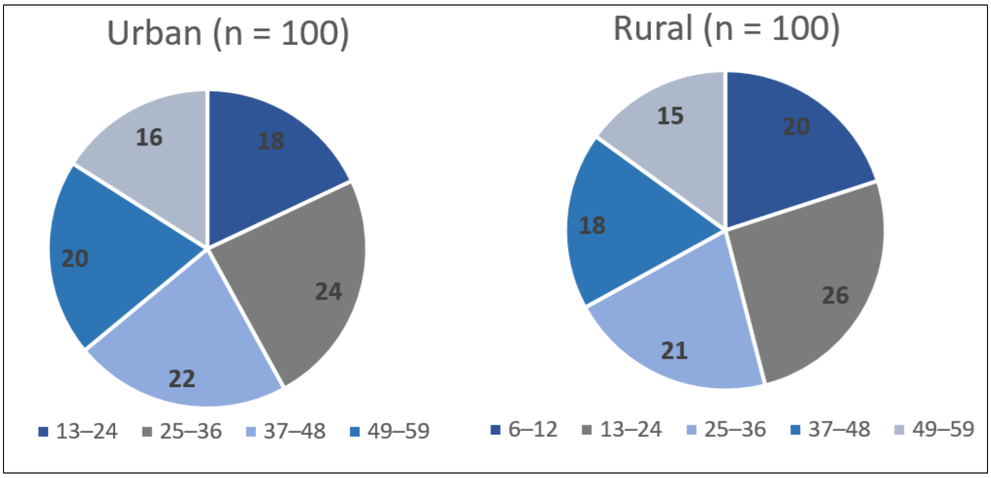

Fig 1: Distribution of Participants by Age Group and Residence

Table 3 shows the nutritional status respondents according to their place of residence. Malnutrition was found to be significantly higher among rural kids (58% of the 200), than their urban counterparts (36%). In contrast, the proportion of children who were well-nourished was higher in urban areas (64%). This difference is statistically significant ($p < 0.001$), presenting strong evidence of a rural-urban gap in Nutrition (Figure 2).

Table 3: Nutritional Status of Participants by Residence

Nutritional Status	Urban (n = 100)	Rural (n = 100)	Total (n = 200)	p-value
Well-nourished	64	42	106	<0.001
Malnourished	36	58	94	

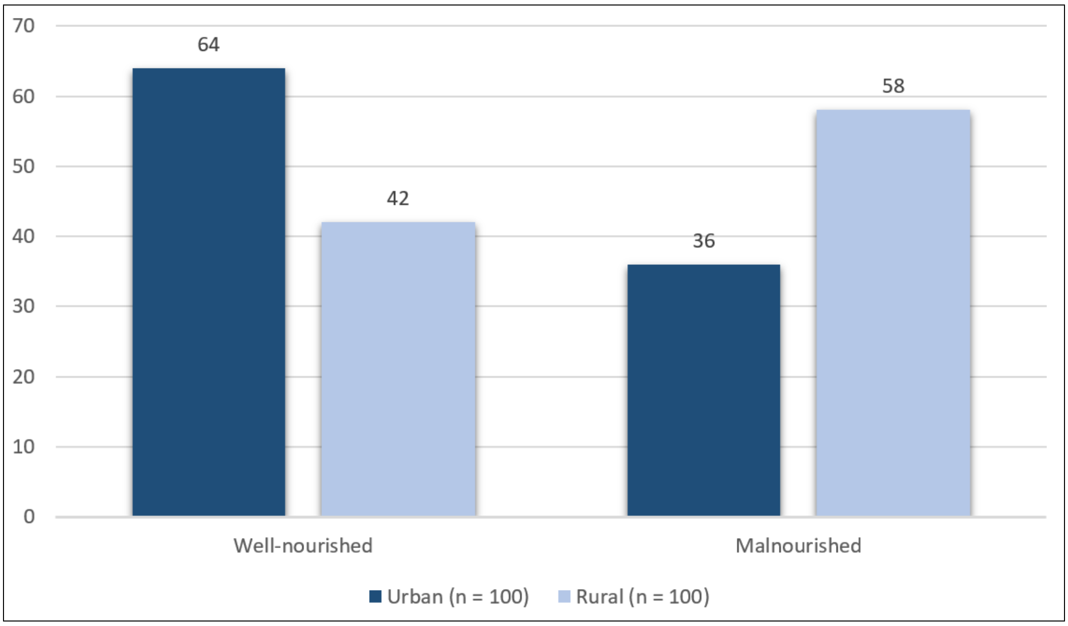

Fig 2: Nutritional Status of Participants by Residence

Table 4 shows the prevalence of intestinal parasitic infections in urban and rural children. A far greater percentage of infections have been seen in rural (63%) compared with urban (38%) regions. A p-value ($p<0.001$) reveals that place of residence is significantly associated with parasitic infection, where rural children are the most affected (Figure 3).

Table 4: Prevalence of Intestinal Parasitic Infections by Residence

Infection Status	Urban (n = 100)	Rural (n = 100)	Total (n = 200)	p-value
Infected	38	63	101	<0.001
Non-infected	62	37	99	

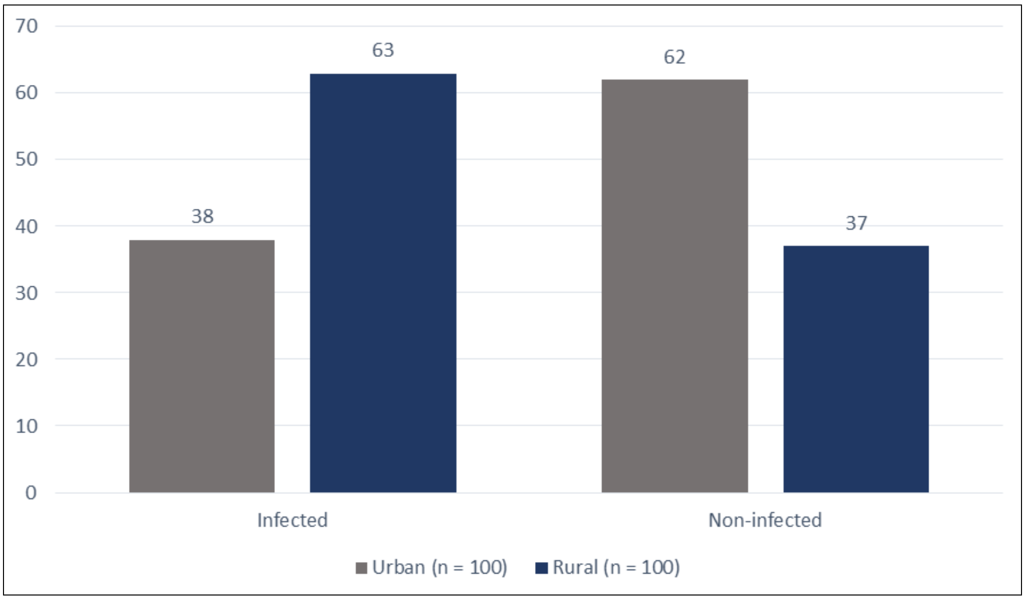

Fig 3: Prevalence of Intestinal Parasitic Infections by Residence

Table 5 summarizes the types of intestinal parasites identified among the 101 infected children. *Giardia lamblia* was the most frequently detected parasite (46.5%), followed by *Entamoeba histolytica* (28.7%) and *Ascaris lumbricoides* (14.9%). Mixed infections, involving two or more parasites, were found in 9.9% of the cases (Figure 4).

Table 5: Types of Intestinal Parasites Detected (n = 101)

Parasite Type	Number of Cases	Percentage (%)
Giardia lamblia	47	46.5
Entamoeba histolytica	29	28.7
Ascaris lumbricoides	15	14.9
Mixed infections	10	9.9

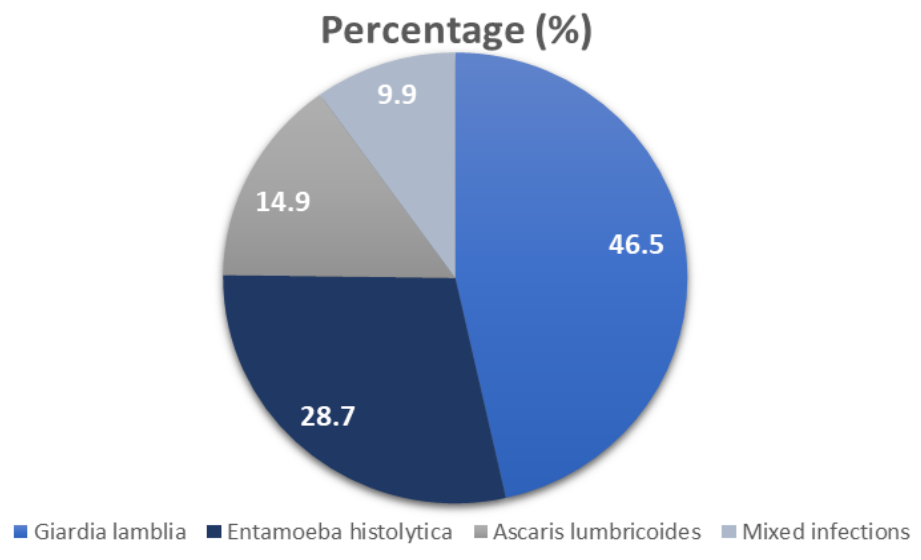

Fig 4: Types Percentage of Intestinal Parasitic Infections

Table 6 presents the combined distribution of children based on their nutritional status and parasitic infection. The most vulnerable group malnourished and infected was predominantly from rural areas (41 out of 59). In contrast, the healthiest group well-nourished and parasite-free was mainly from urban areas (44 out of 64). The difference between urban and rural distributions is statistically significant ($p< 0.001$), highlighting a higher dual burden of malnutrition and parasitic infection in rural settings.

Table 6: Combined Group Distribution by Nutrition and Parasitic Status

Group	Urban (n)	Rural (n)	Total (n)	p-value
Well-nourished & Parasite-Free	44	20	64	<0.001
Well-nourished & Infected	20	22	42	
Malnourished & Parasite-Free	18	17	35	
Malnourished & Infected	18	41	59	

Table 7 shows the association between parasitic infection and nutritional status. Among the 101 infected children, 59 (58.4%) were malnourished, whereas only 35 (35.3%) of the 99 non-infected children were malnourished. This difference is statistically significant (p = 0.001), indicating a strong association between intestinal parasitic infection and malnutrition.

Table 7: Association between Parasitic Infection and Nutritional Status

Infection Status	Well-nourished (n=106)	Malnourished (n=94)	Total (n=200)	p-value
Infected	42	59	101	0.001
Non-infected	64	35	99	

Table 8 presents the demographic distribution of children by age group, infection status, and nutritional status. The highest rates of both parasitic infection (22 cases) and malnutrition (20 cases) were observed in the youngest age group (6-12 months), followed closely by the 13-24 months group. Statistical analysis shows significant associations between age and both parasitic infection (p = 0.04) and malnutrition (p = 0.05). These findings highlight early childhood—particularly the first two years—as a critical period for targeted health interventions.

Table 8: Demographic Characteristics by Age, Infection, and Nutritional Status

Age Group (months)	Total (n=200)	Infected (n=101)	Non-Infected (n=99)	Malnourished (n=94)	Well-Nourished (n=106)	p-value (Infection)	p-value (Nutrition)
6-12	38	22	16	20	18	0.04	0.05
13-24	50	26	24	23	27		
25-36	43	21	22	19	24		
37-48	38	18	20	18	20		
49-59	31	14	17	14	17		

Table 9 presents *H. pylori* seropositivity was significantly higher among parasite-infected (43.6%) and malnourished children (47.9%) compared to their counterparts (p = 0.02 and p = 0.001 respectively), indicating a potential link between H. pylori infection, parasitic burden, and malnutrition (Figure 5).

Table 9: *H. pylori* IgG Seropositivity by Parasitic Infection and Nutritional Status

Group	Total	*H. pylori* Positive	*H. pylori* Negative	p-value
Infected with parasites	101	44 (43.6%)	57 (56.4%)	0.02
Not infected with parasites	99	27 (27.3%)	72 (72.7%)	
Malnourished children	94	45 (47.9%)	49 (52.1%)	0.001
Well-nourished children	106	26 (24.5%)	80 (75.5%)	

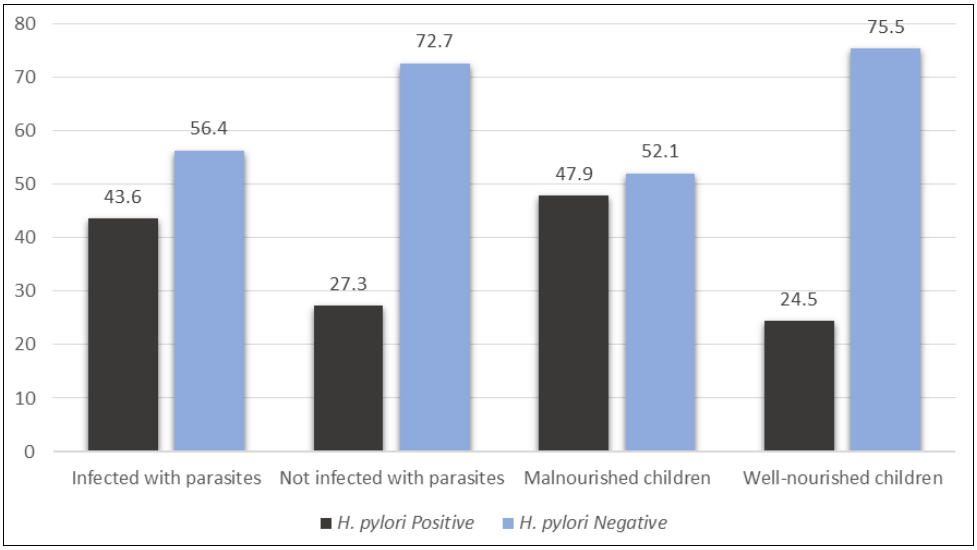

Fig 5: *H. pylori* IgG Seropositivity by Parasitic Infection and Nutritional Status

The well-nourished and parasite-free group exhibited the best hematological profile, with significantly higher hemoglobin levels compared to malnourished and infected children ($p < 0.001$). The malnourished and infected group showed the lowest hemoglobin and red cell indices, alongside elevated WBC and platelet counts, indicating combined effects of infection and malnutrition on hematologic health (Table 10).

Table 10: Hematological Parameters by Combined Nutritional and Parasitic Status

Group	Hb (g/dL) Mean ±SD	MCV (fL) Mean ±SD	MCH (pg) Mean ±SD	WBC (×10⁹/L) Mean ±SD	Platelets (×10⁹/L) Mean ±SD	p-value (Hb)
Well-nourished & parasite-free (n=60)	11.7±0.9	81.4±4.2	27.3±1.9	7.1±1.5	310±55	<0.001
Well-nourished & infected (n=46)	10.9±1.2	78.6±5.0	25.8±2.1	8.4±1.8	336±63	
Malnourished & parasite-free (n=39)	10.2±1.1	75.9±5.4	24.1±2.2	8.9±2.0	347±59	
Malnourished & infected (n=55)	9.4±1.3	73.2±6.1	22.8±2.5	9.6±2.3	362±67	

4. Discussion: The present study has shown a significant interaction of anemia with intestinal parasitic infection or malnutrition among the under-5 children, and rural residence was found to be an independent factor. This cycle of disorders is interconnected and is not conducive to healthy blood in both the mother and the child. Consistent with our results, children positive for intestinal parasites had significantly decreased hemoglobin concentrations, as well as higher prevalence of malnutrition and anemia. In Southern Ethiopia, infested children with intestinal parasites were three times more likely to be anemic (AOR (Adjusted odds ratio) = 3.19 (1.97,5.17)) compared to non-infested children [15]. Similar relationships have been reported in other works for instance in Egypt where treatment of giardiasis lead to a significant increase in iron parameters (Hb and ferritin (P<0.001)), implying that the Giardia infection may be one of the causes of anemia in iron [16].

Hookworms and other *helminths* lead to chronic gastrointestinal blood loss and impair the uptake of micronutrients two important contributors to iron deficiency anemia [17]. In animal models where protein-deficient hosts infected with Giardia had significantly lower villous heights, malabsorption and villus atrophy are the outcomes of G lamblia infection, especially if protein malnutrition is present [18]. Common in low-resources settings, this chronic mucosal inflammation inhibits nutrient uptake, contributes to undernutrition and triggers anemia of inflammation in children experiencing unhygienic conditions [19].

In this study, we discovered that children who were malnourished, with or without an infection at the same time, had worse hematologic parameters (Hb: 9.4g/dL) than children who were well-nourished. Reports on how malnutrition affects immune function and, consequently, the severity of infections, as well as how infections in turn impair nutritional status in a vicious cycle, lend credence to this point of view [20]. The age pattern is suggestive of the high prevalence (up to 12 months) of the young ones (6-24 months) known to have the highest rates of parasitic infestation and malnutrition. This parallels the vulnerability at weaning and early mobility - where more contact is with contaminated environments, but also more often with the undernutrition band [21]. These were factors that were consistently significantly associated with higher odds of parasitic infection, malnutrition and anemia in Ethiopia [22] as well as elsewhere. These data suggest the environmental and social susceptibilities are embedded within biological burdens.

January 2022 stuMass deworming treatment combined with iron rich nutrition can significantly reduce anemia 3.7% and recovery from wasting and stunting [23]. We believe the effort should be aimed at children 6-24 months where the immune system is already programmed to develop immune resilience and growth under stress (and is expected to benefit the most from protection during weaning and high exposure times). The effect of WASH (water, sanitation and hygiene) on child health combined with the educated caregivers may also disrupt transmission cycles and enhance physical well-being [24]. Reducing poverty, food security programs with equitable access to health care services are paramount to gain sustainable changes in child health.

Conclusion: With the evidence of the current study, we highlight a complex and fragile association with any cause of malnutrition in preschoolers, living in the rural area in Tikrit, Iraq. The findings further confirm that children infected by intestinal parasites were significantly more malnourished and undernourished, making a case of dual burden of diseases parasitic and sub-optimal nutrition on child health. The most common parasite was *Giardia lamblia*, and was linked to malnutrition and iron deficiency. Rural Residence was a consistent risk factor with higher frequency of parasitosis, malnutrition and *H. pylori* seropositivity; thus, emphasizing the influence of the environmental and sociodemographic factors linked to poorer hygiene and healthcare conditions (inadequate access to medical resources, deficient supply of medical attention and low maternal education) obviously dominant in the rural environment. Similarly, hematological examination showed that coinfected and malnourished children recorded the lowest levels of hemoglobin and the red cell indices, suggesting a sign of poor hematological health. These results suggest potential benefits for combined health interventions, like deworming, nutrition supplementation and improved hygiene, particularly for young kids who might be particularly vulnerable in high-risk, under-served populations.

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