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Original Article

Microbiology Section

Effects of Intestinal Parasitic Infections on Haematological Profiles of Patients attending a Tertiary Care Hospital in Eastern India: A Retrospective Cross-sectional Study

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ABSTRACT

Introduction: Intestinal parasites, commonly Soil-Transmitted Helminths (STH), are widespread in tropical regions and cause major illness, disability, malnutrition, and anaemia. They disrupt growth, development, micronutrient balance, cognition, and increase susceptibility to other infections. Protozoan diseases such as amoebiasis, giardiasis, and cryptosporidiosis also significantly affect.

Aim: To evaluate the impact of Intestinal Parasitic Infections (IPIs) on haematological parameters.

Materials and Methods: A retrospective cross-sectional study was conducted in the Microbiology Department of a tertiary care hospital in Kalyani, Nadia district, West Bengal, India. A total of 133 stool samples received in the parasitology laboratory for diagnostic screening between August 2022 and July 2024 were included in the study. Haematological parameters such as Haemoglobin (Hb), Haematocrit (HCT), Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH), and Mean Corpuscular Haemoglobin Concentration (MCHC), along with Total Leukocyte Counts (TLC) and Absolute Eosinophil Counts (AEC), were measured using automated Complete Blood Count (CBC) analysers. The data were analysed using statistical software (e.g., Statistical Package for the Social Sciences (SPSS), version 25.0). A p-value of <0.05 was considered statistically significant.

Results: Out of 133 patients, the prevalence of IPIs in males and females was 16/78 (20.5%) and 9/55 (16.4%), respectively. Out of 44 parasites identified, predominant ones were *Entamoeba* spp 29 (66%), *Strongyloides stercoralis* 6 (13.6%), *Giardia lamblia* 5 (11.4%), Hookworm 2 (4.5%), and *Blastocystis hominis* and *Cryptosporidium* 1 each (2.3%). Infected patients' haemoglobin levels were lower (mean Hb 9.43 g/dL) than controls (mean Hb 12.08 g/dL). Eosinophilia, raised haematocrit, and decreased MCV levels were noted in the infected patients. Maximum anaemia (9.3 g/dL) was seen with hookworm infection, and eosinophilia (15.2%) was seen in mixed infection.

Conclusion: The prevalence of *Entamoeba* spp., *Strongyloides stercoralis*, and *Giardia* spp. indicates continuing transmission within the community. The concomitant haematological abnormalities suggest that these infections have systemic implications beyond the gastrointestinal tract. These findings highlight the importance of early diagnosis, frequent screening, and targeted therapies such as deworming programs.

Keywords: Anaemia, Eosinophilia, Helminthiasis, Prevalence, Protozoan infections

INTRODUCTION

Intestinal parasites reside in the human gastrointestinal tract, with STHs being a significant cause of illness, particularly among impoverished populations in tropical and subtropical regions. Intestinal parasitic infections are endemic and continue to be a significant cause of suffering and disability among deprived populations. Of the two billion individuals globally infected with these parasites, 300 million suffer from severe illness. The World Health Organisation (WHO) states that STH infections contribute to more than 40% of the disease burden from all tropical diseases [1].

In developing nations, malnutrition and repeated infections, such as parasitic infections, are prevalent among infants, children and adults. Such conditions tend to have long-term effects that can be carried across generations. Specifically, intestinal helminth infections interfere with the balance of critical micronutrients in patients, further compounding health issues [2]. Each year, intestinal amoebiasis, caused by the protozoan parasite *Entamoeba histolytica*, affects approximately 50 million people worldwide and is a major contributor to illness and death, followed by Giardiasis and Cryptosporidiosis [3].

The IPIs have also been linked to poorer cognitive development, poor school performance, and decreased work productivity, particularly in children and young adults [4]. Chronic infections with helminths and protozoa have been proven to alter the host immune response, increasing vulnerability to other illnesses such as malaria, Tuberculosis, and Human Immunodeficiency Virus (HIV). Co-infections with numerous parasites are widespread in endemic places, exacerbating nutritional deficits and the severity of anaemia [5,6].

Anaemia is a condition of decreased Hb level below the normal limit, resulting in decreased oxygen-carrying capacity of red blood cells to the tissues of the body [7]. It is classified into mild, moderate, and severe anaemia. Anaemia is common in developing countries because of poor diet and the high rate of parasitic infections. Most parasitic infections are counteracted by Th2 cell activation, which initiates the synthesis of IgE antibodies and activates eosinophils [8]. The cytokines secreted by Th2 cells have a central function in this role, facilitating the activation and recruitment of eosinophils to parasitic infection sites. Upon release at such sites, eosinophils release toxic granular proteins that specifically target and kill the parasites [9].

Parasites such as hookworms and *Strongyloides* spp. are known to cause chronic intestinal blood loss and micronutrient deficiencies, leading to iron-deficiency anaemia, while protozoan infections may trigger inflammatory responses and haematological imbalances. Hookworms attach to the intestinal mucosa and ingest blood, resulting in persistent occult blood loss and depletion of iron stores, particularly in individuals with inadequate dietary intake. Over time, this may progress to microcytic hypochromic anaemia, fatigue, reduced exercise tolerance, and impaired work capacity [10,11]. *Strongyloides stercoralis* infection, although often asymptomatic, can produce intermittent gastrointestinal bleeding and malabsorption, while disseminated infection in immunocompromised individuals may precipitate severe haematological derangements. In contrast, protozoal infections such as amoebiasis and giardiasis primarily induce mucosal inflammation and nutrient malabsorption, which may contribute indirectly to anaemia, thrombocytosis, or leukocyte alterations through chronic inflammatory pathways [5].

Eosinophilia is frequently observed in helminthic infections due to immune-mediated responses driven by Th2-dependent cytokines, which stimulate eosinophil proliferation and activation. Persistent eosinophilia may reflect ongoing tissue invasion by larval stages and can serve as an important haematological marker in suspected parasitic disease. Chronic parasitic infestations may also influence red cell indices, leukocyte counts, and overall haematological homeostasis through mechanisms such as bone marrow modulation, immune dysregulation, and recurrent inflammatory stress. These haematological alterations not only affect patient health outcomes but may also complicate clinical evaluation and management in routine practice, particularly in regions where parasitic infections co-exist with nutritional deficiencies and other endemic diseases [6,7].

India continues to report a substantial burden of IPIs, with variations in prevalence across regions depending on environmental, occupational, and behavioural factors such as open defecation, agricultural exposure, and unsafe water sources. However, limited data are available from Eastern India regarding the haematological impact of these infections, particularly in hospital-based populations. Understanding these changes is essential for early diagnosis, risk assessment, and appropriate clinical intervention, and may further support targeted screening, deworming strategies, and region-specific public health policies. Therefore, this study aimed to evaluate the impact of IPIs on haematological parameters. The primary objective was to assess the prevalence and grade of anaemia among patients infected with intestinal parasites compared to healthy controls, and the secondary objectives were to determine changes in haematological parameters and to identify the predominant intestinal parasites responsible for infection.

MATERIALS AND METHODS

This was a retrospective cross-sectional study conducted in the Department of Microbiology at a tertiary care centre in Kalyani, Nadia district, West Bengal, India. The study protocol was reviewed and approved by the Institutional Ethics Committee (IEC) of AIIMS Kalyani under approval number IEC/AIIMS/Kalyani/certificate/2025/270. Data were collected from August 2022 to July 2024 and analysed between August 2024 and November 2024. Data were recovered from laboratory and hospital medical records of patients whose stool samples were received in the Parasitology section for routine diagnostic evaluation during the study time frame. Confidentiality of patient information was strictly maintained throughout the study.

Sample size calculation: The minimum required sample size was calculated using the formula:

$$n = Z^2 \times p \times (1 - p) / d^2$$

where, Z = 1.96 for a 95% confidence level, p = expected prevalence of intestinal parasitic infection around 8% based on previous study [12], and d=5% margin of error. The sample size calculated was 120, but a total of 133 samples were included to enhance the statistical power.

Inclusion criteria: Patients diagnosed with IPIs based on stool microscopy and having a CBC report at the time of diagnosis were included as the test group.

Exclusion criteria: Pregnant women, patients with incomplete medical reports were excluded from the study.

Healthy individuals from the same hospital database and study period with stool samples negative for intestinal parasites and relevant CBC data were used as control group to assess haematological differences. Other relevant clinical history was gathered by telephonic conversations.

Study Procedure

All stool samples received in the parasitology laboratory during the study period were examined both macroscopically and microscopically for detection of ova, cysts, and trophozoites using direct saline and iodine wet mount preparations, and concentration methods when indicated. Pathogens screened and identified included *Entamoeba* spp., *Giardia lamblia*, *Strongyloides stercoralis*, Hookworm, and *Cryptosporidium* spp. Haematological parameters, including Hb, MCV, HCT, MCH, and MCHC, as well as TLC and AEC were measured using automated CBC analysers. Healthy controls were selected from the hospital's database, matched for age and sex, and confirmed negative for intestinal parasites. Diagnosis of IPIs was established by routine laboratory methods, such as stool microscopy, concentration methods. Haematological variables were collected from the laboratory reports of the patients. The parameters of interest among the CBC were:

Anaemia prevalence: Defined according to the WHO criteria for anaemia [7], based on haemoglobin levels:

Mild: 10.0-10.9 g/dL,

Moderate: 7.0-9.9 g/dL,

Severe: <7.0 g/dL

Eosinophil count: The percentage and AEC were recorded and compared across the groups. Eosinophilia was defined as an AEC >500 cells/μL, consistent with standard haematological reference values used in clinical practice [13].

Other CBC parameters: RBC count, WBC count, platelet count, and MCV were included to evaluate general haematological changes associated with IPIs.

Alkaline Phosphatase (ALP): Although not a standard CBC parameter, ALP was included as a supporting biochemical measure since certain intestinal parasites, particularly helminths, can cause hepatic or intestinal tissue inflammation, resulting in elevated ALP levels. Thus, it was investigated for any subsequent hepatic involvement or systemic inflammatory response associated with IPIs [14].

The parameters were chosen to cover both erythropoietic effects (anaemia-related changes) and immune-inflammatory responses to parasitic infections.

STATISTICAL ANALYSIS

The data were analysed using statistical software (e.g., SPSS, version 25.0). Descriptive statistics were calculated for demographic and clinical data. The comparison of haematological parameters between the study groups (IPI patients and healthy controls) was performed using the independent t-test for continuous variable. A p-value of <0.05 was considered statistically significant.

RESULTS

Among 133 participants, most of the participants were male 78 (58.6%), and staying in urban areas 100, (75.2%). IPIs were more common among males 16/78 (20.5%) than females 9/55 (16.4%), with the highest prevalence observed in individuals aged >60 years 4/18 (22.2). Risk-related behaviours were infrequent, with only 13 (9.8%) participants reporting walking barefoot. The majority consumed filtered drinking water 115 (86.5%) and had access to a toilet at home 114 (85.7%). Hand hygiene practices were satisfactory, with 126 (94.7%) participants reporting handwashing after defecation, indicating good preventive behaviour [Table/Fig-1].

Variable	Category	n (%)
Gender	Female	55 (41.4)
	Male	78 (58.6)
Age (years)	0-15	22 (16.5)
	16-30	34 (25.6)
	31-45	30 (22.6)
	46-60	29 (21.8)
	>60	18 (13.5)
Place	Rural	33 (24.8)
	Urban	100 (75.2)
Walking bare foot	No	120 (90.2)
	Yes	13 (9.8)
Drinking water source	Filter	115 (86.5)
	Packaged drinking water	9 (6.8)
	Reverse Osmosis	6 (4.5)
	Tube well	3 (2.3)
Availability of toilet in house	No	15 (11.3)
	Sometimes	4 (3.0)
	Yes	114 (85.7)
Washing hands after defecation	Sometimes	7 (5.3)
	Always	126 (94.7)

[Table/Fig-1]: Socio-demographic characteristics of patients.

The test group had significantly lower levels of Hb, (9.43±2.28) g/dL, compared with the controls (p-value<0.05). The neutrophil count was significantly less, and the lymphocyte count was significantly high in the test group (p-value<0.05). The MCV was significantly lower in the test group, indicating microcytosis (p-value=0.001), and the RBC count was also significantly higher in the test group (p-value=0.004). Although the eosinophil count had a statistically significant difference, the RDW had no significant difference [Table/Fig-2].

Parameter	Test group (Mean±SD)	Control group (Mean±SD)	p-value	t-value
Haemoglobin (Hb) (g/dL)	9.43±2.28	12.08±1.90	0.001*	-6.76
Total Count (TC) (×10⁹/L)	10.94±2.37	9.19±2.10	0.138	4.21
Absolute Eosinophil Count (AEC) (×10⁹/L)	0.40±0.48	0.39±0.42	0.828	0.12
Neutrophils (%)	56.58±14.04	65.37±17.74	0.005*	−3.14
Lymphocytes (%)	34.31±12.98	25.83±15.86	0.003*	3.36
Eosinophils (%)	4.68±4.32	3.22±3.04	0.048*	2.05
RBC Count (×10⁶/μL)	4.49±0.76	3.99±0.99	0.004*	3.17
Haematocrit (HCT) (%)	36.78±5.83	33.91±7.18	0.024*	2.40
MCV (fL)	76.55±18.21	85.86±10.25	0.001*	−3.20
MCH (pg)	27.09±4.54	26.75±3.52	0.635	0.46
MCHC (g/dL)	32.13±1.77	30.88±2.46	0.003*	3.39
RDW (%)	15.83±3.99	16.72±3.89	0.224	−1.27

[Table/Fig-2]: The mean haematological profile value difference between intestinal parasite-infected and intestinal parasite-free patients attending a tertiary care hospital.
*denotes statistically significant by the Independent student t-test; Hb: Haemoglobin; TC: Total count; AEC: Absolute eosinophil count; RBC: Red blood cell count; HCT: Haematocrit; MCV: Mean corpuscular volume; MCH: Mean corpuscular haemoglobin; MCHC: Mean corpuscular haemoglobin concentration; RDW: Red cell distribution width

A total of 44 numbers of parasites were identified, among which *Entamoeba* spp. 29 (66%) was the most common parasite found, followed by *Strongyloides stercoralis* 6 (13.6%), *Giardia lamblia* 5 (11.4%), and hookworm 2 (4.5%). One case of *Cryptosporidium* spp., *Blastocystis hominis* was discovered in one (2.3%), whereas one (2%) had mixed-infections. The most severe anaemia was caused by hookworm infection, with Hb 9.3 g/dL, RBC 3.50 M/μL, and HCT 29.95%. The infection with *Cryptosporidium* had minimal haematological effect, with Hb 15.8 g/dL and RBC 5.69 M/μL. *Giardia lamblia* and *Strongyloides stercoralis* had moderate haematological abnormalities, with elevated levels of ALP (155 and 143.8 U/L, respectively), and lymphocytes and eosinophils. *Entamoeba* had mild anaemia with Hb 11.29 g/dL. *Blastocystis hominis* had low WBC count (4.43 x10^9/L) [Table/Fig-3].

DISCUSSION

The results of the study present a detailed picture of the prevalence and haematological effects of different intestinal parasites in the population under study. Interestingly, *Entamoeba* spp was the most common parasite, representing 66% of cases. This high rate was consistent with recent research showing high rates of *Entamoeba* infection in India. A cross-sectional study conducted in North India had reported a 6.6% intestinal case prevalence of *Entamoeba* spp and 10.5% in asymptomatic carriers [15]. The increased prevalence in the present study could be due to regional differences, variations in diagnostic techniques, or local environmental and socio-economic factors.

Comparable studies from South India found similar trends, with *Entamoeba histolytica/dispar* being the most common protozoan infection (57%), particularly in areas with poor sanitation and waste disposal systems [16]. Another hospital-based study from Maharashtra discovered *Entamoeba* spp. in 61.5% of positive stool samples, supporting the present finding of its prevalence [17]. The data confirm that amoebiasis remains a significant intestinal parasite burden in a variety of Indian contexts.

Strongyloides stercoralis detection in 13.6% of cases in the current study is most worrying, considering its high-risk of complications, particularly among immunocompromised persons. The WHO recently highlighted the public health significance of strongyloidiasis, advising annual mass administration of ivermectin in endemic districts with a 5% or more prevalence among school children [18]. The findings of the present study suggest that targeted interventions are needed in the study area to reduce the burden of these infections.

A prior study from Tamil Nadu found that 9.2% of stool samples included *S. stercoralis*, mostly in rural areas, and attributed its persistence to poor waste management and insufficient footwear use [19]. This is somewhat higher rate in the present study, which could be explained by variations in the population's occupational exposure or by meteorological conditions that favour larval survival. Other results demonstrating eosinophil activation as part of the host immune response to helminths are consistent with the significant eosinophilia and high AEC among infected people [20]. *Giardia* spp, which were found in 11.4% of the cases, continue to be a major cause of gastrointestinal morbidity. A five-year study conducted in Northern India had found a prevalence of 5.2% of giardiasis, with males and children below 10 years showing higher frequencies [21]. The greater prevalence in present study makes a case for better water sanitation and hygiene measures, since giardiasis was mostly linked to contaminated water sources.

Similar findings have been reported in Bangladesh, where the usage of untreated surface water and poor hand hygiene practices were substantially associated with greater giardiasis incidence [22]. The present study showed *Giardia*-positive individuals had lymphocytosis and a slight rise in ALP, which could be attributed to mucosal inflammation and mild hepatic stress caused by chronic infection.

Parasite	Hb (g/dL)	Tc ($\times 10^9$/L	AEC ($\times 10^9$/L)	Neutrophil (%)	Lymphocyte (%)	Eosinophil (%)	RBC ($\times 10^6$/μL)	HCT (%)	MCV (fL)	MCH (pg)	MCHC (g/dL)	RDW (%)	ALP (U/L)
Entamoeba spp, n=29	11.29	10.1	0.39	62.53	28.57	4.21	4.15	34.84	82.85	26.86	31.28	16.43	136.86
Giardia lamblia, n=5	11.72	9.22	0.23	50.14	42.4	3.18	4.80	38.76	78.16	27.04	32.9	14.68	155
Hookworm, n=2	9.3	23.04	0.05	77.75	17.3	1.75	3.50	29.95	80.90	26.75	31.15	22.75	124
Strongyloides stercoralis, n= 6	10.3	9.05	1.09	63.15	30.46	3.3	3.95	34.7	80.11	29.8	32.26	17.6	143.83
Cryptosporidium spp, n=1	15.8	11.26	0.24	69.8	21.2	2.2	5.69	49.5	86.9	27.7	31.8	13.6	98
Blastocystis hominis, n=1	13.2	4.43	0.12	30.5	34.2	2.5	3.67	36.7	76.1	24.2	31.3	12.3	122
Mixed infection, n=1	14.7	7.22	1.1	45.2	35.6	15.2	4.98	40.2	84	27	32.2	16.5	125

[Table/Fig-3]: Comparison of various haematological and biochemical parameters across individuals infected with different intestinal parasites.
Abbreviations: Hb: Haemoglobin; TC: Total count; AEC: Absolute eosinophil count; neutrophils, lymphocytes, eosinophils; RBC: Red blood cell count; HCT: Haematocrit; MCV: Mean corpuscular volume; MCH: Mean corpuscular haemoglobin; MCHC: Mean corpuscular haemoglobin concentration; RDW: Red cell distribution width; ALP: Alkaline phosphatase

The 4.5% prevalence of hookworm infections in the current findings was in accordance with other studies conducted across other regions of India. A research conducted among four districts in West Bengal recorded hookworm prevalence ranging between 4.8% and 24.8%, and the more common species being *Necator americanus*. Hookworm infection is documented to result in iron-deficiency anaemia, and the current study recorded this through significantly low haemoglobin levels in the infected patients [15].

Present findings of lower HCT and MCV support the occurrence of microcytic hypochromic anaemia, which was compatible with chronic blood loss induced by hookworm feeding on the intestinal mucosa. Similar haematological abnormalities were observed in studies from Odisha, where haemoglobin levels below 10 g/dL were closely linked to *Ancylostoma duodenale* infection [23].

The generally low incidence of *Blastocystis hominis* (3%) and mixed infection (2.3%) would imply that such parasites are uncommon in the populations studied. Whether *Blastocystis hominis* is truly important clinically has always been debatable, but reports suggest that the parasite could indeed be pathogenic, especially to immunocompromised patients [3]. Other investigations have found Blastocystis prevalence ranging from 2-8% in immunocompetent groups to up to 23% in HIV-positive people, highlighting its opportunistic potential [24]. More research will be required to clarify its clinical role in gastroenteritis.

Haematological tests indicated striking differences between test (infected) and control (non infected) groups. Most notably, the test group showed decreased neutrophil levels and increased lymphocyte percentages, which may indicate immune response to parasitic infections. The decreased MCV in the test group further suggests microcytosis, a condition typical of iron-deficiency anaemia, which frequently results from chronic intestinal parasitic infections such as hookworm [10,18].

The current study's findings of eosinophilia in *Strongyloides* and *Entamoeba* infections are consistent with other investigations that have found higher eosinophil counts as indicators of parasitic antigenic stimulation and tissue invasion [25]. The raised biochemical marker ALP in giardiasis and strongyloidiasis may indicate minor hepatic involvement, as documented by Chatterjee A et al., in Eastern India [26].

Demographic and lifestyle factors, including urban residence (75.2%), frequent hand washing after defecation (94.7%), and use of filtered drinking water (86.5%), were common among the participants. In spite of these encouraging parameters, the high endemicity of *Entamoeba* spp points to other routes of transmission, including person-to-person or the ingestion of contaminated food [11,27]. This emphasises the necessity of multi-pathway public health interventions.

The study has revealed considerable haematological changes in the context of parasitic infections, which include the occurrence of anaemia, microcytosis, and eosinophilia. Among the parasitic infections, hookworm infections were found to be associated with the maximum reduction in haemoglobin and haematocrit values, whereas reduced MCV values were observed in all the infected groups, which underline the importance of routine haematological investigations. Early detection of these changes can help in the early administration of iron and anti-helminthic drugs, which can help in the prevention of serious consequences, such as growth and cognitive problems, and reduced productivity.

Advanced diagnostic methods, including molecular and antigen-based assays, could improve detection accuracy, especially where microscopy is limited. Public health measures like improved sanitation and deworming programs should be assessed for their effect on haematological recovery, while future studies may explore host-parasite immunological and biochemical interactions to identify biomarkers predicting disease severity and treatment response.

Limitation(s)

As a retrospective cross-sectional study, it relied primarily on previously recorded medical and laboratory data, which may contain gaps such as insufficient clinical history and unverified co-morbidities. Stool microscopy was the major diagnostic approach for parasite detection, although it has lower sensitivity than molecular or antigen-based techniques, thus some cases may have been overlooked. Furthermore, a lack of follow-up data prevented the haematological changes from being associated with nutritional status, illness duration, or treatment effects.

CONCLUSION(S)

Despite advances in hygiene, IPIs continue to be a major public health issue. The prevalence of *Entamoeba* spp., *Strongyloides stercoralis*, and *Giardia* spp. indicates continuing transmission within the community. The concomitant haematological abnormalities suggest that these infections have systemic implications beyond the gastrointestinal tract. These findings highlight the importance of early diagnosis, frequent screening, and targeted therapies such as deworming programs. Sanitation, clean water availability, and community-level health education are critical. A multi-sectoral approach is required to interrupt the cycle of infection, enhance general health, and avoid long-term consequences.

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