Original Article

The spectrum of parasitic infections with emphasis on the clinico-epidemiological characteristics and risk factors among immunocompromised and immunocompetent patients at a university hospital in Northern India

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Abstract

Introduction: Intestinal parasitic infections pose a substantial threat to public health and are a huge burden to the economic development of a developing country. We aimed to identify the spectrum of intestinal parasitic infections with an emphasis on demographic and clinical characteristics observed among immunocompromised and immunocompetent patients. **Materials and Methods:** This observational study was performed in the Parasitology section of the Department of Microbiology from January 2022 to July 2022. A total of 2628 stool samples were obtained from patients presenting with chief complaints of abdominal pain, distension, vomiting, and foul-smelling feces. All the clinical and diagnostic data of the patients enrolled in the above-mentioned period were extracted from the ward files, hospital electronic records, and laboratory registers. **Result:** A total of 2628 stool samples were sent to the Parasitology section of the Department of Microbiology. Out of the above-mentioned samples, 70 (70/2628, 2.66%) samples yielded gastrointestinal parasites on microscopic examination. The mean age of the patients included in our cohort study was 32.53 ± 16.21 years with a male predominance of 72.86% (51/70, 72.86%). The most common gastrointestinal parasite identified from stool samples was *Giardia lamblia* (61/70, 87.14%). All cases of opportunistic gastrointestinal infection caused by *Cryptosporidium spp.* (4/70, 5.71%) in our study cohort were found to infest the immunocompromised patients. **Conclusion:** This study determines the spectrum of intestinal parasitic infections among the immunocompromised and immunocompetent individuals and guides physicians in starting appropriate anti-parasitic treatment along with the instillation of strict hand hygiene techniques.

Keywords: Anti-parasitic treatment, *Cryptosporidium spp*, developing countries, *Giardia lamblia*, immunocompromised, intestinal parasitic infections

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Introduction

Intestinavl parasitic infections pose a substantial threat to public health and are a huge burden to the economic

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development of a developing country.[1-3] Parasites infecting the gastrointestinal tract were established in 3.5 billion people and clinical symptoms were observed in 450 million people worldwide with an annual death rate of over 2 lakhs of people resulting from these illnesses.[4] Soil-transmitted helminth (STH) infections are identified among 1.5 billion infected people in the world, forming 24% of the world's population and affecting the developing countries having deprived access to sanitation, hygiene, and potable water in tropical and subtropical regions, predominantly reported from Asia, China, sub-Saharan Africa, and South America.[5] There is a considerable lack of recent studies and literature concerning the prevalence of gastrointestinal parasitic infections in the Indian scenario. Older studies suggest a 16.3% prevalence of gastrointestinal parasitic infections among patients with a suspected infestation at a tertiary care center.[6]

Among children in developing countries, soil-transmitted helminthic infections were observed in 270 million preschool-age and over 600 million school-age children.[5] The common parasitic infections include giardiasis, ascariasis, trichuriasis, amoebiasis, and hookworm infections leading to iron-deficiency anemia, chronic diarrhea, and impaired physical development in children followed by other disabilities. The rising morbidity associated with gastrointestinal infections caused by these parasites and the rise of immunocompromised conditions among the population along with comorbidities that increase the propensity to get easily infected calls for rigorous monitoring of patients with diarrhea in developing countries.[7]

This study aims to identify the spectrum of parasites causing gastrointestinal infections at our center with an emphasis on the demographic and clinical characteristics observed among immunocompromised and immunocompetent patients and highlights the need among clinicians and family physicians to identify the common parasitic infections to readily identify the symptoms and provide prompt and appropriate treatment accordingly.

Materials and Methods

This observational study was performed in the Parasitology section of the Department of Microbiology from January 2022 to July 2022. A total of 2628 stool samples were obtained from patients presenting in the wards or outpatient department with chief complaints of abdominal pain, distension, vomiting, and foul-smelling feces. All the clinical data of the patients enrolled in the above-mentioned period were extracted from the ward files and hospital electronic records. The diagnostic data of Parasitological diagnostics were extracted from our laboratory registers. This study was accepted by the Sanjay Gandhi Postgraduate Institute of Medical Sciences institutional Ethics Committee (Reference number 2023-3-PhD-EXP-51) and all measures were taken to maintain the sanctity of the human experimentation ethical standards concerning the Helsinki Declaration of 1975, revised in 2000. Individual consent was waived off as all cases were included in this study from electronic and laboratory records after the patients were discharged from the hospital and all tests were carried out in our laboratory as routine processing.

Inclusion criteria

All stool samples from patients with a suspected gastrointestinal infestation of parasites, irrespective of age group and sex, from the inpatient and outpatient departments of our hospital, were included in the study.

Exclusion criteria

Unlabelled and leaking containers of samples were excluded from this study.

Sample processing

All stool samples were subjected to microscopic examination after preparing a saline mount and iodine mount (Lugols' iodine) at 100 × magnification followed by 400 × magnification for identification of *Entamoeba histolytica/dispar*, helminths, nematodes, *Giardia lamblia* cysts, and trophozoites, etc., All stool samples further underwent concentration by formalin-ether method and were subjected to Kinyoun or cold acid-fast staining and Trichromes' staining for opportunistic gastrointestinal parasitic infections. The slides prepared by concentration method were microscopically observed at 600 × magnification and oil immersion lens for identification of opportunistic gastrointestinal parasites like *Cryptosporidium spp, Isospora spp, Cyclospora spp*, and *Microsporidium spp* [Figure 1].

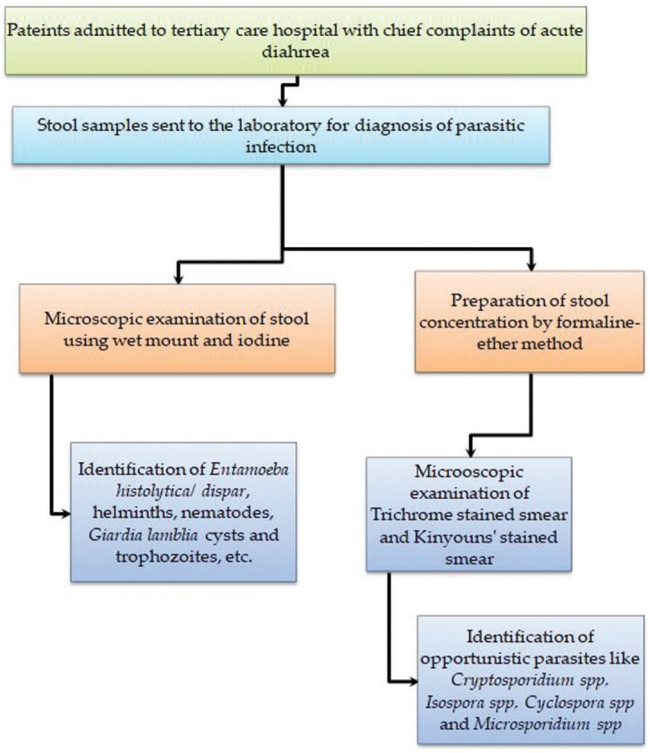

Figure 1: Flowchart of procedures performed in our laboratory

All clinical characteristics and history of immunosuppressant drugs like steroids, other immunotherapeutic drugs for underlying clinical conditions, and antibiotic history were extracted from the hospital information system (HIS). Patients were recognized as immunocompromised in conditions where they were found to be suffering from type 2 diabetes, malignancies undergoing chemotherapy, solid organ transplant patients, and immunosuppressive drugs including long-term use of steroids. Immunocompetent individuals were identified as those devoid of the above-mentioned comorbidities.

Statistical analysis

The statistical analysis in our study was conducted by observing the incidences. The mean and standard deviation were used in expressing the quantitative variables. While analyzing the underlying comorbidities, clinical characteristics, and risk factors associated with acquiring infections with multidrug-resistant organisms (MDROs), χ^2 tests were used to compare the groups of categorical variables. Statistical analysis was aided by the software program IBM SPSS Statistics version 20.0 (IBM Corp., Armonk, NY, USA), while analysis of the continuous variables like age of the patients, length of hospital stay, and diagnostic tests which include hemoglobin, neutrophils, lymphocytes, monocytes, and eosinophils using GraphPad prism version 9.5.1 (GraphPad Software Inc., California, USA), with $P < 0.05$ considered statistically significant.

Results

A total of 2628 stool samples were sent to the Parasitology section of the Department of Microbiology. Out of the above-mentioned samples, 70 (70/2628, 2.66%) samples yielded gastrointestinal parasites on microscopic examination. The mean age of the patients included in our cohort study was 32.53 ± 16.21 years with a male predominance of 72.86% (51/70, 72.86%). Most of the patients included in our study with gastrointestinal parasitic infestation belonged to the outpatient department (42/70, 60.0%). The demographic and clinical characteristics of all the patients included in this study are demonstrated in Table 1. Abdominal pain (60/70, 85.71%) was identified as the most common clinical presentation followed by foul-smelling feces (58/70, 82.86%) and abdominal distension (50/70, 71.43%).

Thirty-one patients (31/70, 44.28%) in our cohort were undergoing treatment with immunosuppressive drugs. The underlying comorbidities experienced by the patients have also been discussed in Table 1. The most common comorbidity experienced in our patients was chronic kidney disease (CKD) in 34.28% (24/70, 34.28%) with 83.33% (20/24, 83.33%) patients managed on hemodialysis followed by hypertension (18/70, 25.71%) and type 2 diabetes mellitus (13/70, 18.57%). The mean length of hospital stay for the inpatients mostly suffering from underlying comorbidities was 11.37 ± 9.81 days [Table 1]. Among the diagnostic parameters discussed in Table 1, the mean hemoglobin levels in all the patients were 11.32 ± 2.15 mg/dl. The mean neutrophil %, lymphocyte %, eosinophils %, monocytes %, and basophil % in the patients was 60.08 ± 16.08, 29.24 ± 12.36, 4.77 ± 8.64, 4.38 ± 2.63 and 0.53 ± 3.67, respectively.

Table 1: Demographic characteristics and underlying comorbidities of all the patients with intestinal parasitic infections admitted to our center (*n*=70)

Demographic characteristics	*n* (%)
Age (Mean±SD) in years	32.53±16.21
Gender (male %)	51 (72.86%)
Inpatient:Outpatient ratio	28:42
Immunocompromised:Immunocompetent ratio	47:23
Clinical characteristics	
Abdominal pain	60 (85.71%)
Foul-smelling feces	58 (82.86%)
Abdominal distension	50 (71.43%)
Vomiting	40 (57.14%)
Underlying comorbidities	
Patients on immunosuppressive drugs	31 (44.28%)
CKD	24 (34.28%)
CKD patients on hemodialysis	20 (28.57%)
Hypertension (HTN)	18 (25.71%)
Type 2 DM	13 (18.57%)
Solid organ transplant patients	12 (17.14%)
Systemic lupus erythematosus (SLE)	5 (7.14%)
Chronic liver disease (CLD)	5 (7.14%)
Malignancies	4 (5.71%)
Inflammatory bowel disease (IBD)	4 (5.71%)
Common variable immunodeficiency (CVID)	2 (2.86%)
Acute necrotizing pancreatitis	1 (1.43%)
Other parameters	
Length of hospital stay in inpatients (in days)	11.37±9.81
Hemoglobin (Mean±SD) in mg/dl	11.32±2.15
Neutrophils (Mean±SD)%	60.08±16.08
Lymphocytes (Mean±SD)%	29.24±12.36
Eosinophils (Mean±SD)%	4.77±8.64
Monocytes (Mean±SD)%	4.38±2.63
Basophils (Mean±SD)%	0.53±3.67

The most common gastrointestinal parasite identified from stool samples was *Giardia lamblia* (61/70, 87.14%) presenting mostly in the form of cysts (48/61, 78.69%). The distribution of gastrointestinal parasites isolated from stool samples of the patients concerning immunocompromised and immunocompetent individuals in this study have been illustrated in Figure 2. The most common gastrointestinal parasite infecting both the immunocompromised and immunocompetent patients in our study was *Giardia lamblia* with 85.11% (40/47, 85.11%) immunocompromised patients and 91.30% (21/23, 91.30%) immunocompetent patients suffering from the infections.

All cases of opportunistic gastrointestinal infection caused by *Cryptosporidium spp.* (4/70, 5.71%) in our study cohort were found to infest the immunocompromised patients. The immunocompromised patients were infested with opportunistic gastrointestinal infection by *Cryptosporidium spp.* include two patients who underwent renal transplant, a

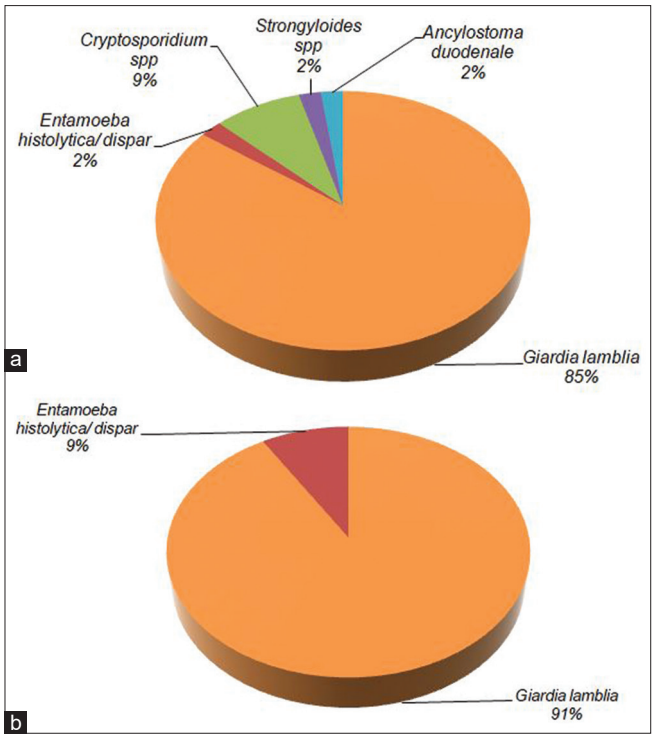

Figure 2: Distribution of parasites isolated from the stool samples of the patients. (a) Parasites isolated from the stool of immunocompromised patients, (b) Parasites isolated from the stool of immunocompetent patients (N = 70)

patient suffering from acute lymphocytic leukemia (ALL), and another patient with a neuroendocrine tumor, both undergoing chemotherapy. Isolated cases of gastrointestinal infections with *Strongyloides stercoralis* larvae, ova of *Ancylostoma duodenale*, and *Entamoeba histolytica/dispar* were isolated from stool samples of immunocompromised patients. Only two (2/23, 8.69%) stool samples from immunocompetent patients showed infestation with *Entamoeba histolytica/dispar*.

Table 2 compares the demographic characteristics and underlying comorbidities of the immunocompromised and immunocompetent patients infected with intestinal parasitic infections in our study cohort. The mean age of the patients and the inpatient-to-outpatient ratio in the immunocompromised group were significantly higher in comparison to the mean age of patients in the immunocompetent group. Thus, more elderly patients were immunocompromised and admitted to our center. Among the underlying comorbidities, immunosuppressive drug treatment, CKD, CKD patients undergoing dialysis, hypertension (HTN), type 2 Diabetes mellitus (DM), and solid organ transplant were significantly associated with the immunocompromised patients. Immunocompromised patients were significantly anemic in comparison to immunocompetent patients.

Discussion

With an increase in the diversity of dietary habits, changing lifestyles, and increased lifespan with coexisting immunocompromised conditions, there is a change in the pattern of parasitic infections affecting the gastrointestinal system over the last few decades. This study illustrates the spectrum of gastrointestinal parasitic infections with emphasis on immunocompromised and immunocompetent patients visiting a tertiary care center in Northern India, exemplifying the tendency of immunocompromised patients to harbor a wider range of gastrointestinal parasitic infections which may fill the lacunae of knowledge due to lack of recent data reported from the Indian subcontinent.

An incidence of 2.66% (70/2628, 2.66%) intestinal parasites was recognized in this study which is much lower in comparison to previously conducted studies by Choubisa and Choubisa[8] and Paul *et al.*[9] that demonstrated an incidence of intestinal parasitic infection ranging from 5.2% to 43.6% and an incidence as high as 51.78% has also been reported among the tribal population of Bhil.[10] The above difference in the incidence of parasitic infections could be attributed to the difference in the socio-economic conditions of various populations residing in a variety of environmental conditions.

This study demonstrates a predominance of male patients (51/70, 72.86%) infected with intestinal parasites which corroborates with the findings of studies conducted by Srihari *et al.*,[11] Parameshwarappa *et al.*[12] and Champa and Sreeshma[13] where a predominance of male patients was infected with intestinal parasites. This male predominance could be attributed to the increased tendency of outdoor work by men leading to the consumption of food from street vendors not maintaining adequate hygiene while preparing these condiments.

We recognized an increased incidence of gastrointestinal parasites in patients belonging to the age group of 21–40 years. A similar age group was found to be affected by such intestinal parasitic infections in a study by Saurabh *et al.*[6] but older studies in contrast to our findings suggested an age group of 6–20 years.[10,12-14] This study accounts for an increased incidence of intestinal parasitic infections in adults in comparison to children which correlates with a study by Singh *et al.*[15]

This study identifies protozoans (64/70, 91.43%) as the chief parasite infecting the gastrointestinal tract of the patient cohort which is in contrast with studies conducted by Patel *et al.*[14] and Kumar *et al.*[16] that demonstrated an increased incidence of helminthic intestinal parasitic infections. In agreement with our study, a few older studies by Paul *et al.*,[9] Choubisa and Choubisa[10] Kavathia *et al.*,[17] and Marothi and Singh[18] showed increased isolation of protozoan parasites from the intestinal tract. We identified a majority of *Giardia lamblia* (61/70, 87.14%) parasites from the stool samples included in our study followed by *Entamoeba histolytica/dispar* (3/70, 4.28%) which corroborates with the studies conducted by Champa and Sreeshma,[13] Patel *et al.*[14] and Singh *et al.*[15] This was found to be in contrast with the studies by Marothi and Singh,[18] Kavathia *et al.*,[19] and Davane *et al.*[20] where *Entamoeba histolytica/dispar* was identified as the predominant protozoan isolated from stool samples of patients presenting with

Table 2: Comparison of demographic characteristics and underlying comorbidities of the immunocompromised and immunocompetent patients infected with intestinal parasitic infections at our center (*n*=70)

Demographic characteristics	Immunocompromised (*n*=47)	Immunocompetent (*n*=23)	*P*
Age (Mean±SD) in years	35±17.92	26.48±10.66	0.0394*
Gender (male %)	35 (74.47%)	16 (69.57%)	0.665
Inpatient: outpatient ratio	28:19	0:23	<0.001*
Clinical characteristics			
Abdominal distension	30 (63.83%)	20 (86.96%)	0.044*
Abdominal pain	39 (82.98%)	21 (91.30%)	0.350
Foul-smelling feces	38 (80.85%)	20 (86.96%)	0.524
Vomiting	28 (59.57%)	12 (52.17%)	0.557
Underlying comorbidities			
Patients on immunosuppressive drugs	31 (65.96%)	0 (0.0%)	<0.001*
CKD	24 (51.06%)	0 (0.0%)	<0.001*
CKD patients on hemodialysis	20 (42.55%)	0 (0.0%)	<0.001*
Hypertension (HTN)	18 (38.29%)	0 (0.0%)	0.001*
Type 2 DM	13 (27.66%)	0 (0.0%)	0.005*
Solid organ transplant patients	12 (25.53%)	0 (0.0%)	0.008*
Systemic lupus erythematosus (SLE)	5 (10.64%)	0 (0.0%)	0.105
Chronic liver disease (CLD)	5 (10.64%)	0 (0.0%)	0.105
Malignancies	4 (8.51%)	0 (0.0%)	0.150
Inflammatory bowel disease (IBD)	4 (8.51%)	0 (0.0%)	0.150
Common variable immunodeficiency (CVID)	2 (4.26%)	0 (0.0%)	0.316
Acute necrotizing pancreatitis	1 (2.13%)	0 (0.0%)	0.481
Other parameters			
Length of hospital stay in inpatients (in days)	11.37±9.81	-	-
Hemoglobin (Mean±SD) in mg/dl	10.80±2.19	12.39±1.66	0.0031*
Neutrophils (Mean±SD)%	60.51±16.36	59.21±15.82	0.753
Lymphocytes (Mean±SD)%	28.96±14.05	29.83±8.09	0.784
Eosinophils (Mean±SD)%	5.17±10.31	3.96±3.25	0.586
Monocytes (Mean±SD)%	4.66±2.93	3.83±1.80	0.217

*$P \leq 0.05$ is statistically significant

suspected parasitic infestation. Only sporadic cases of helminthic intestinal infections were encountered in our cohort of patients. Only one case each of helminth parasitic infections in our cohort was caused by *Strongyloides stercoralis* (1/70, 1.43%) and *Ancylostoma duodenale* (1/70, 1.43%) in contrast to studies by Kumar *et al*.[21] who found ample cases of helminth infections caused by *Ascaris lumbricoides* in their study cohort. The variation in the incidence of these intestinal parasites could be attributed to the disparity in environmental conditions, dietary habits, immune status, and occupation of the patients from one geographical region to another, which promotes the need for studies that illustrate the commonly occurring intestinal parasites across the geographical region.

Among the four patients with stool samples that showed intestinal parasitic infection with the coccidian parasite that is *Cryptosporidium spp*, two (2/4, 50.0%) were found to be kidney transplant patients with underlying uncontrolled Type 2 DM, while the other two (2/4, 50.0%) were found to be suffering from hematologic malignancies. Both the patients who underwent solid organ transplants were being managed on a triple immunosuppression regimen which included Tacrolimus. A study by Bhadauria *et al*.[22] on organ transplant patients on a Tacrolimus-based immunosuppressive regimen suggested a high risk of Cryptosporidium infection in comparison to patients managed on a cyclosporine-based regimen which was supported by a recent study by Tomczak *et al*.[23] The reduced CD4 lymphocyte count in peripheral blood of the other two (2/4, 50.0%) patients suffering from hematologic malignancies favored parasitic infestation with intestinal parasitic infections.[24-26]

The other immunosuppressed conditions that significantly attributed to intestinal parasitic infections include Type 2 DM, CKD with a subset of those managed on hemodialysis, and hypertension. Diabetics are prone to develop anemia due to concomitant kidney disease and decreased secretion of erythropoietin,[27] which justifies the significantly reduced hemoglobin levels in the group of immunocompromised patients. Thus the immunosuppression mediated by these underlying comorbidities was explained by a study by Khanna *et al*.[28] validates the lack of an intact immune system to defend one's body from the effect of parasitic infections. While the above-mentioned study demonstrated a high incidence of helminthic infection in diabetics,[28] in contrast, the diabetic patients in this study were more prone to intestinal parasitic infections by protozoans namely *Giardia lamblia*.

This study facilitates to enhance the knowledge of the general or family physicians to identify the common parasitic infections

encountered among the patients coming from Northern India. It also compares the risk factors, underlying comorbidities, and laboratory diagnostics among the immunocompromised and non-immunocompromised patients attending the hospital.

Conclusion

This study determines the spectrum of intestinal parasitic infections among the immunocompromised and immunocompetent individuals and guides the clinicians and family physicians in starting appropriate anti-parasitic treatment along with the instillation of strict hand hygiene techniques and avoiding consumption of uncooked and unwashed vegetables along with unhygienic condiments from the street vendors to prevent repeated gastrointestinal infections.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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