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Impact of Intestinal Parasitic Infections on Anemia and General Health Status in a Northeastern Indian Population

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ABSTRACT
Intestinal parasitic infections remain a persistent public health concern in many low- and middle-income regions, particularly in tropical settings where environmental and socio-economic conditions favor sustained transmission. In northeastern India, geographic isolation, high rainfall, limited sanitation infrastructure, and socio-cultural practices collectively contribute to the continued burden of parasitic diseases. These infections often coexist with nutritional deficiencies, creating compounded health impacts that are frequently under-recognized.
The present study investigates the relationship between intestinal parasitic infections, anemia, and overall health status among children and adults residing in selected districts of Manipur. A community-based cross-sectional design was employed, involving stool examination for parasitic identification, hemoglobin estimation for anemia assessment, and anthropometric measurements to evaluate nutritional status. Socio-demographic and behavioral data were collected through structured interviews.
Findings reveal a substantial prevalence of intestinal parasites, with soil-transmitted helminths and protozoan organisms emerging as the dominant pathogens. Anemia was significantly more common among infected individuals compared to non-infected counterparts. Children and women of reproductive age exhibited the highest vulnerability. Parasitic infection was also associated with lower body mass index, reduced mid-upper arm circumference, and increased reports of fatigue, gastrointestinal discomfort, and reduced daily activity.
The results underscore a strong interconnection between parasitic infection and compromised health outcomes, particularly anemia and functional well-being. The study highlights the need for integrated public health strategies that combine deworming, nutritional supplementation, water–sanitation interventions, and community education. Addressing these interconnected determinants simultaneously is essential for improving population health in underserved regions of northeastern India.

KEY WORDS
Intestinal parasitic infections; anemia; nutritional status; soil-transmitted helminths; protozoan parasites; general health; Manipur; northeastern India; public health; vulnerable populations.

INTRODUCTION
Intestinal parasitic infections continue to pose a major challenge to global health, affecting hundreds of millions of people, particularly in resource-limited settings. Although largely preventable and treatable, these infections persist due to entrenched poverty, inadequate

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sanitation, unsafe water supplies, and limited access to healthcare services. Their impact extends beyond gastrointestinal symptoms, contributing significantly to anemia, malnutrition, impaired immunity, and reduced quality of life.

India carries a substantial share of the global parasitic disease burden, with marked regional disparities. Northeastern states such as Manipur present a unique epidemiological landscape shaped by mountainous terrain, heavy monsoonal rainfall, scattered rural settlements, and traditional lifestyles. Many communities rely on untreated water sources and practice subsistence agriculture, increasing exposure to contaminated soil and water. These conditions facilitate the survival of parasite eggs and larvae and promote continuous transmission cycles.

Fig: Instestinal Parasitic Infections.

Intestinal parasites are broadly categorized into helminths and protozoa. Soil-transmitted helminths—including *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworms—are commonly acquired through ingestion of contaminated food or water or through skin contact with infected soil. Protozoan parasites such as *Giardia lamblia* and *Entamoeba histolytica* are primarily transmitted via the fecal–oral route. Once established in the host, these organisms interfere with digestion, compete for nutrients, induce intestinal inflammation, and, in some cases, cause chronic blood loss.

Anemia represents one of the most serious consequences of intestinal parasitism, particularly hookworm infection, which directly contributes to iron loss through intestinal bleeding. Chronic parasitic infections also impair nutrient absorption and appetite, exacerbating existing nutritional deficiencies. Over time, this leads to fatigue, decreased work capacity, delayed growth in children, and weakened immune defenses.

Children are especially vulnerable due to frequent soil contact, developing hygiene habits, and increased nutritional demands during growth. Women of reproductive age also face heightened risk, as iron requirements rise during menstruation and pregnancy. In adults, persistent parasitism contributes to reduced productivity and diminished functional health, perpetuating cycles of poverty and disease.

Despite national initiatives such as mass deworming programs and sanitation campaigns, intestinal parasitic infections remain endemic in many parts of northeastern India. Limited region-specific data further complicate targeted intervention planning. Most existing studies focus either on parasitic prevalence or nutritional outcomes in isolation, with fewer examining their combined impact on anemia and overall health status across age groups.

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Against this backdrop, the present study seeks to explore the interconnected burden of intestinal parasitic infections and anemia in a northeastern Indian population, while also assessing broader indicators of general health. By integrating parasitological, hematological, anthropometric, and socio-demographic data, the research aims to provide a comprehensive understanding of how these infections affect vulnerable communities and to generate evidence that can inform integrated public health strategies.

AIMS AND OBJECTIVES

Aim

The primary aim of this study was to examine the impact of intestinal parasitic infections on anemia and overall health status among children and adults residing in selected communities of northeastern India.

Objectives

1. To determine the prevalence and species distribution of intestinal parasites in the study population.
2. To assess hemoglobin levels and estimate the burden of anemia among infected and non-infected individuals.
3. To evaluate general health status using anthropometric indicators and self-reported morbidity profiles.
4. To analyze the association between parasitic infection and nutritional outcomes including body mass index, mid-upper arm circumference, and weight-for-age in children.
5. To identify socio-environmental and behavioral factors contributing to infection and anemia.
6. To compare health indicators between age groups and gender categories.
7. To generate evidence supporting integrated intervention approaches combining deworming, nutritional support, and sanitation improvements.

REVIEW OF LITERATURE

Intestinal parasitic infections have long been recognized as major contributors to morbidity in developing regions. Global estimates indicate that soil-transmitted helminths alone affect over one billion individuals, predominantly in tropical and subtropical areas. Protozoan parasites add substantially to this burden, especially in communities lacking safe drinking water.

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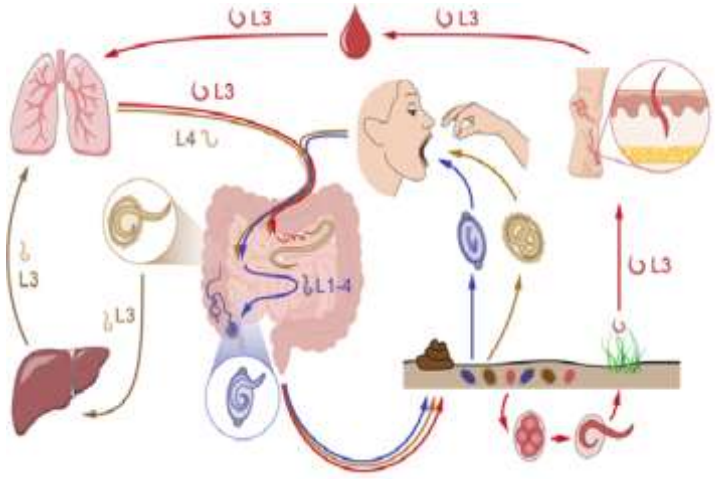

Fig: Soil Transmitted helminths

Numerous studies have documented strong links between parasitic infections and anemia. Hookworm infection, in particular, is a well-established cause of iron-deficiency anemia due to chronic intestinal blood loss. Research from Southeast Asia and sub-Saharan Africa consistently demonstrates lower hemoglobin concentrations among infected populations compared to uninfected controls.

Beyond anemia, parasites significantly impair nutritional status. *Ascaris lumbricoides* interferes with absorption of carbohydrates, proteins, and fats, while *Giardia lamblia* damages intestinal villi, leading to malabsorption and growth faltering in children. Repeated infections during early childhood are associated with stunting, reduced cognitive development, and poorer educational outcomes. Indian studies reveal wide regional variation in parasite prevalence, ranging from less than 10% in urbanized areas to over 60% in remote rural settings. Northeastern states frequently report higher rates due to climatic conditions favoring parasite survival and limited sanitation coverage. Investigations in Assam, Meghalaya, and Manipur have highlighted persistent helminth and protozoan transmission despite national deworming initiatives.

Several researchers have emphasized the cyclical relationship between infection and malnutrition. Parasites increase metabolic demands while reducing nutrient intake and absorption, whereas malnutrition weakens immune defenses, increasing susceptibility to reinfection. This biological synergy disproportionately affects children and women of reproductive age.

Recent literature increasingly advocates integrated approaches combining mass drug administration with nutrition-sensitive interventions and improvements in water, sanitation, and hygiene (WASH). Evidence suggests that deworming alone produces modest health gains unless accompanied by broader environmental and dietary measures.

However, few studies in northeastern India have simultaneously evaluated parasitic infection, anemia, and general health across both pediatric and adult populations. Most existing research focuses on isolated outcomes, limiting comprehensive understanding of cumulative health impacts. This study addresses that gap by adopting a multidimensional assessment framework.

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RESEARCH METHODOLOGIES

Study Design

A community-based cross-sectional study was conducted across selected rural and peri-urban areas of Manipur. The design enabled simultaneous assessment of parasitic infection, anemia, and health indicators within a defined time frame.

Study Population

Participants included children (5–14 years), adolescents (15–19 years), and adults (≥20 years). Both males and females were recruited through household visits and community outreach.

Sampling Technique

A multistage sampling strategy was employed. Villages were selected randomly from district lists, followed by systematic household selection. One or more eligible individuals were enrolled per household after obtaining informed consent.

Sample Size

A total of 480 participants were included, accounting for anticipated non-response. This size provided adequate power to detect moderate associations between infection status and anemia.

Table 1. Distribution of Participants by Age Group

Age Group (years)	Number (n)	Percentage (%)
5–14	168	35.0
15–19	72	15.0
≥20	240	50.0
Total	**480**	**100**

Data Collection Tools

- Structured socio-demographic questionnaire
- Anthropometric measurements (height, weight, MUAC)
- Hemoglobin estimation using portable hemoglobinometers
- Stool sample collection for microscopic examination

Laboratory Procedures

Fresh stool samples were processed using direct wet mount and formalin-ether concentration techniques. Parasites were identified based on morphological characteristics. Hemoglobin levels were categorized according to WHO anemia thresholds.

Statistical Analysis

Data were entered into SPSS version 26. Descriptive statistics summarized prevalence patterns. Chi-square tests assessed associations between categorical variables. Independent t-tests compared mean hemoglobin levels. Logistic regression identified predictors of anemia.

Table 2. Key Variables and Analytical Methods

Variable	Measurement Tool	Statistical Test
Parasite status	Microscopy	Descriptive
Hemoglobin	Hemoglobinometer	t-test
BMI	Anthropometry	ANOVA
Risk factors	Questionnaire	Logistic regression

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RESULTS AND INTERPRETATION

Overall Prevalence of Intestinal Parasitic Infections

Out of the 480 participants examined, 287 individuals (59.8%) were found positive for at least one intestinal parasite. Helminthic infections constituted the majority (61.3%), followed by protozoan infections (28.9%), while mixed infections accounted for 9.8% of cases. Children aged 5–14 years demonstrated the highest prevalence, indicating sustained community transmission.

Table 3. Overall Prevalence of Intestinal Parasites

Infection Status	Number (n)	Percentage (%)
Positive	287	59.8
Negative	193	40.2
Total	**480**	**100**

Species-wise Distribution

Ascaris lumbricoides emerged as the predominant parasite, followed by hookworm and *Giardia lamblia*. Protozoan infections were more common among children consuming untreated water.

Table 4. Distribution of Identified Parasites

Parasite Species	Number (n)	Percentage (%)
Ascaris lumbricoides	96	33.4
Hookworm	71	24.7
Trichuris trichiura	41	14.3
Giardia lamblia	54	18.8
Entamoeba histolytica	25	8.7

Anemia Status and Parasitic Infection

Mean hemoglobin levels were significantly lower among infected participants (9.7 g/dL) compared to uninfected individuals (11.8 g/dL). Moderate to severe anemia was observed in 68% of parasitized subjects.

Table 5. Hemoglobin Levels by Infection Status

Infection Status	Mean Hb (g/dL)	Anemia (%)
Infected	9.7	68
Non-infected	11.8	34

Interpretation

The findings demonstrate a strong association between intestinal parasitism and anemia. Hookworm infections showed the strongest correlation with low hemoglobin levels. Children with helminthic infections also exhibited significantly lower BMI-for-age scores.

These results underscore the biological link between parasitic burden and compromised nutritional health, emphasizing the need for integrated control strategies.

DISCUSSION

The present study highlights a substantial burden of intestinal parasitic infections in northeastern India, with nearly two-thirds of participants harboring at least one parasite species.

This prevalence aligns with reports from similar climatic regions where warm temperatures and high humidity facilitate parasite survival.

Children exhibited the highest infection rates, consistent with their increased exposure to contaminated environments and immature hygiene practices. Adults, though less symptomatic, served as reservoirs, sustaining community transmission.

A central finding of this investigation is the pronounced association between parasitic infections and anemia. Hookworms contribute directly to iron deficiency through chronic intestinal blood loss, while *Ascaris* and *Trichuris* impair nutrient absorption. Protozoan infections further exacerbate malnutrition by damaging intestinal mucosa.

Environmental determinants such as unsafe drinking water, open defecation, and barefoot walking were significantly associated with infection. These factors mirror patterns reported across rural India and highlight persistent gaps in sanitation infrastructure.

The coexistence of parasitic infection, anemia, and poor nutritional status reflects a syndemic interaction wherein biological and social determinants reinforce each other. Deworming alone cannot break this cycle. Nutritional supplementation and WASH interventions are essential for sustainable impact.

Compared with national studies, the prevalence observed in this population exceeds averages reported in urban centers but aligns with findings from other northeastern states. The community-based design strengthens the representativeness of these results.

CONCLUSION

This study provides compelling evidence that intestinal parasitic infections remain a major public health concern in northeastern India, significantly contributing to anemia and compromised general health among both children and adults.

Helminthic infections, particularly *Ascaris lumbricoides* and hookworm, emerged as dominant pathogens, while protozoan infections further compounded nutritional deficits. Infected individuals consistently demonstrated lower hemoglobin levels and poorer anthropometric indicators.

Environmental and behavioral risk factors—including unsafe water consumption, inadequate sanitation, and limited hygiene practices—played critical roles in sustaining transmission.

The findings emphasize the necessity of integrated intervention frameworks combining:

- Regular deworming
- Nutritional support
- Safe water access
- Sanitation improvement
- Community health education

Addressing parasitism in isolation is insufficient. A holistic, community-centered strategy is essential to reduce disease burden, improve nutritional outcomes, and enhance overall quality of life.

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