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ORIGINAL ARTICLE

Impact of Recurrent Parasitic Infections on Growth and Development in Children Under Five Years

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ABSTRACT
Background: Parasitic infections remain a major cause of morbidity among children in low- and middle-income countries.
Objective: This study aimed to evaluate the impact of recurrent parasitic infections on growth and developmental outcomes in children under five years of age.
Methodology: This cross-sectional analytical study was conducted at Sahiwal Teaching Hospital, Sahiwal from January 2022 to June 2022. A total of 205 children aged 6–59 months were enrolled using non-probability consecutive sampling. Participants were categorized into three groups: no infection (n=70), single infection (n=68), and recurrent infections (≥2 episodes within the past year, n=67). Data on sociodemographic factors, feeding practices, and sanitation were collected using a structured proforma.
Results: Children with recurrent parasitic infections showed significantly lower mean height-for-age (−2.15 ± 1.19) and weight-for-age (−1.92 ± 1.15) z-scores compared to those without infection ($p < 0.001$). The prevalence of stunting and underweight status was 40.3% and 44.8%, respectively, among the recurrent group. Anemia was observed in 72% of recurrently infected children versus 38% of infection-free peers ($p < 0.001$). Developmental delays were notably higher in the recurrent group especially in language (37.3%) and gross motor domains (31.3%). A moderate negative correlation was found between infection frequency and both height-for-age ($r = -0.46$) and weight-for-age ($r = -0.39$), while a positive correlation existed with developmental delay scores ($r = +0.42$).
Conclusion: It is concluded that recurrent parasitic infections significantly impair physical growth and developmental milestones in children under five years of age. Poor sanitation, unsafe water, and inadequate hygiene practices were identified as major contributing factors.
Keywords: Parasitic infection, recurrent infection, child development, stunting, anemia, growth retardation

INTRODUCTION
Early childhood, particularly the first five years of life, represents a period of rapid physical, cognitive, and psychosocial development. During this time, children undergo dynamic changes in brain growth, immune system maturation, and nutritional demands that form the foundation for long-term health and human capital[1]. Any insult during this critical window whether nutritional, infectious, or environmental can have irreversible consequences. Among the most pervasive yet neglected factors impeding child development in low- and middle-income countries are recurrent parasitic infections[2]. These infections, primarily intestinal helminths and protozoa, remain a leading cause of morbidity and growth faltering in young children despite being largely preventable and treatable. Globally, parasitic infections affect over 1.5 billion people, with the highest burden among children in tropical and subtropical regions where sanitation and hygiene practices are inadequate[3]. Soil-transmitted helminths such as Ascaris lumbricoides, Trichuris trichiura, and Ancylostoma duodenale are particularly endemic in rural communities. Additionally, protozoan infections like Giardia lamblia and Entamoeba histolytica contribute significantly to chronic diarrheal diseases. These infections thrive in areas where open defecation, contaminated water sources, and overcrowded living conditions prevail[4]. The constant re-exposure of children to contaminated soil, water, or food leads to recurrent infections that compromise both nutrition and growth potential. The relationship between parasitic infections and child growth is multifactorial[5]. Repeated parasitic infestations impair nutritional status by reducing appetite, increasing metabolic demands, and directly interfering with the absorption of essential nutrients such as iron, zinc, and vitamin A[6]. Chronic blood loss due to hookworm infections leads to anemia, reducing oxygen delivery to tissues and impairing both physical and cognitive development. Moreover, parasitic infections provoke inflammatory responses that damage the intestinal mucosa, resulting in malabsorption and environmental enteric dysfunction. This chronic intestinal inflammation not only leads to stunting and wasting but also disrupts the gut-brain axis, impairing neurocognitive outcomes[7]. Children under five are particularly vulnerable due to their immature immune systems and higher nutritional requirements. In this age group, even subclinical parasitic infections can have measurable effects on growth indices such as height-for-age (stunting), weight-for-age (underweight), and weight-for-height (wasting). Several studies have demonstrated a strong association between recurrent parasitic infections and reduced linear growth[8]. For instance, children infected with Giardia lamblia or Ascaris lumbricoides show significantly lower height-for-age z-scores compared to uninfected peers. Chronic parasitic infestations also affect neurodevelopment through pathways involving iron deficiency anemia and systemic inflammation, which alter neurotransmitter synthesis and myelination in the developing brain[9]. Beyond biological effects, recurrent parasitic infections contribute to a cycle of poverty and underdevelopment. Children with chronic infections are more likely to miss school, perform poorly academically, and experience delayed psychomotor milestones[10]. In communities where parasitic infections are endemic, the cumulative effect translates into a significant loss of national productivity and increased healthcare burden. This has prompted the World Health Organization (WHO) to emphasize deworming programs and integrated child health initiatives. However, in many regions including South Asia coverage remains inconsistent, and reinfection rates are alarmingly high due to persistent environmental contamination and limited community awareness[11].
Objective: This study aimed to evaluate the impact of recurrent parasitic infections on growth and developmental outcomes in children under five years of age.

METHODOLOGY
This was a cross-sectional analytical study conducted at Sahiwal Teaching Hospital, Sahiwal from January 2022 to June 2022. A total of 205 children aged between 6 months and 59 months were enrolled in the study. The sample size was calculated using the

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WHO sample size calculator, keeping a 95% confidence level, 5% margin of error, and an anticipated prevalence of parasitic infection of approximately 30% among children under five in similar settings. Non-probability consecutive sampling was employed.

Inclusion Criteria:
1. Children aged 6 months to under 5 years.
2. Children with a history of at least one parasitic infection diagnosed in the past year.
3. Parental or guardian consent obtained.

Exclusion Criteria:
1. Children with congenital disorders affecting growth or development (e.g., Down syndrome, cerebral palsy).
2. Children with chronic systemic diseases such as congenital heart disease or renal disorders.
3. Those currently on anti-parasitic therapy or nutritional supplementation at enrollment.

Data Collection Procedure: After informed consent, data were collected using a structured proforma. The questionnaire included demographic data, socioeconomic status, feeding practices, sanitation conditions, and history of previous parasitic infections (type, frequency, and treatment). Growth parameters weight, height/length, and mid-upper arm circumference were measured following WHO standardized protocols. Weight-for-age, height-for-age, and weight-for-height z-scores were calculated using WHO Anthro software. Developmental milestones were assessed using age-appropriate developmental screening tools such as the Denver Developmental Screening Test II (DDST-II), covering gross motor, fine motor, language, and personal-social domains. Each child's growth and development scores were compared between groups categorized by frequency of parasitic infections (no infection, single infection, recurrent infections). Stool samples were collected in sterile containers and examined microscopically for ova, cysts, and parasites using direct wet mount and formalin-ether concentration techniques. Children with recurrent parasitic infections were defined as those with two or more episodes of confirmed parasitic infection within the preceding 12 months.

Data Analysis: Data were entered and analyzed using SPSS version 21.0. Continuous variables such as age, weight, and height were presented as mean ± standard deviation (SD). Categorical variables such as gender, infection frequency, and developmental delay were presented as frequencies and percentages. Comparisons between groups were made using the chi-square test for categorical data and independent sample t-test or ANOVA for continuous data. Pearson correlation was applied to evaluate associations between the number of parasitic episodes and anthropometric indices. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1 shows the baseline demographic and clinical characteristics of the 205 children enrolled in the study. The mean age of children was 34.1 ± 15.2 months in the no infection group, 32.8 ± 14.3 months in the single infection group, and 34.2 ± 14.9 months in the recurrent infection group, showing no statistically significant difference ($F = 0.45$, $p = 0.64$). Males made up 50.0%, 55.9%, and 52.2% of the three groups, respectively ($\chi^2 = 0.60$, $p = 0.58$). However, rural residence and poor sanitation were significantly more common among children with recurrent infections (53.7% and 65.7%) compared to those without infection (37.1% and 25.7%, respectively). The difference was statistically significant for both variables ($\chi^2 = 4.12$, $p = 0.043$; $\chi^2 = 18.64$, $p < 0.001$). Exclusive breastfeeding for six months or more was reported in 49 (70.0%) children without infection, 41 (60.3%) with single infection, and 29 (43.3%) with recurrent infections ($\chi^2 = 10.96$, $p = 0.004$).

Children with recurrent infections had a mean weight-for-age z-score of −1.92 ± 1.15, which was significantly lower than that of children with a single infection (−1.21 ± 1.02) or no infection (−0.64 ± 0.89) ($F = 14.77$, $p < 0.001$). The mean height-for-age z-score showed a similar decline from −0.58 ± 0.92 in the no infection group to −1.40 ± 1.08 in the single infection group and −2.15 ± 1.19 in the recurrent group ($F = 22.54$, $p < 0.001$). The mean weight-for-height z-score was −0.41 ± 0.77, −0.88 ± 0.96, and −1.56 ± 1.08 in the three groups, respectively ($F = 16.38$, $p < 0.001$). The prevalence of stunting increased from 6 (8.6%) in uninfected children to 15 (22.1%) in those with single infection and 27 (40.3%) in those with recurrent infections ($\chi^2 = 18.42$, $p < 0.001$). Similarly, underweight status was observed in 9 (12.9%), 17 (25.0%), and 30 (44.8%) of the respective groups ($\chi^2 = 15.73$, $p < 0.001$).

Gross motor delay was observed in 5 (7.1%) of children without infection, 10 (14.7%) with single infection, and 21 (31.3%) with recurrent infections ($\chi^2 = 12.84$, $p = 0.002$). Fine motor delay occurred in 4 (5.7%), 9 (13.2%), and 18 (26.9%) of the same groups ($\chi^2 = 13.66$, $p = 0.001$). Language delay was the most prevalent, reported in 6 (8.6%) of uninfected, 14 (20.6%) of single infection, and 25 (37.3%) of recurrent infection cases ($\chi^2 = 16.47$, $p < 0.001$). Personal-social delay was seen in 3 (4.3%), 8 (11.8%), and 14 (20.9%) of the groups, respectively ($\chi^2 = 8.82$, $p = 0.012$).

Table 1: Baseline Demographic and Clinical Characteristics of Children (n = 205)

Variable	No Infection (n = 70)	Single Infection (n = 68)	Recurrent Infections (n = 67)	Test Statistic	p-value
Age (months), mean ± SD	34.1 ± 15.2	32.8 ± 14.3	34.2 ± 14.9	F = 0.45	0.64
Male, n (%)	35 (50.0 %)	38 (55.9 %)	35 (52.2 %)	$\chi^2 = 0.60$	0.58
Rural residence, n (%)	26 (37.1 %)	28 (41.2 %)	36 (53.7 %)	$\chi^2 = 4.12$	0.043 *
Poor sanitation, n (%)	18 (25.7 %)	29 (42.6 %)	44 (65.7 %)	$\chi^2 = 18.64$	< 0.001 *
Exclusive breast-feeding ≥ 6 mo, n (%)	49 (70.0 %)	41 (60.3 %)	29 (43.3 %)	$\chi^2 = 10.96$	0.004 *

Table 2: Anthropometric Indices According to Infection Frequency

Parameter	No Infection	Single Infection	Recurrent Infections	Test Statistic	p-value
Weight-for-Age Z-score	−0.64 ± 0.89	−1.21 ± 1.02	−1.92 ± 1.15	F = 14.77	< 0.001 *
Height-for-Age Z-score	−0.58 ± 0.92	−1.40 ± 1.08	−2.15 ± 1.19	F = 22.54	< 0.001 *
Weight-for-Height Z-score	−0.41 ± 0.77	−0.88 ± 0.96	−1.56 ± 1.08	F = 16.38	< 0.001 *
Stunting (< −2 SD), n (%)	6 (8.6 %)	15 (22.1 %)	27 (40.3 %)	$\chi^2 = 18.42$	< 0.001 *
Underweight (< −2 SD), n (%)	9 (12.9 %)	17 (25.0 %)	30 (44.8 %)	$\chi^2 = 15.73$	< 0.001 *

Table 3: Developmental Domain Delays by Infection Category

Domain	No Infection (n = 70)	Single Infection (n = 68)	Recurrent (n = 67)	χ^2	p-value
Gross motor delay n (%)	5 (7.1 %)	10 (14.7 %)	21 (31.3 %)	12.84	0.002 *
Fine motor delay n (%)	4 (5.7 %)	9 (13.2 %)	18 (26.9 %)	13.66	0.001 *
Language delay n (%)	6 (8.6 %)	14 (20.6 %)	25 (37.3 %)	16.47	< 0.001 *
Personal-social delay n (%)	3 (4.3 %)	8 (11.8 %)	14 (20.9 %)	8.82	0.012 *

A moderate negative correlation was observed between infection frequency and height-for-age z-score ($r = -0.46$, $p < 0.001$) and weight-for-age z-score ($r = -0.39$, $p < 0.001$). A mild negative correlation existed with weight-for-height z-score (r =

−0.32, p = 0.001). In contrast, a moderate positive correlation was found between the number of infection episodes and developmental delay score (r = +0.42, p < 0.001), indicating that as infection recurrence increased, growth indices decreased while developmental delays became more pronounced.

Table 4: Correlation Between Number of Infection Episodes and Growth/Development Indicators

Variable	Correlation Coefficient (r)	p-value
Height-for-Age Z-score	−0.46	< 0.001 *
Weight-for-Age Z-score	−0.39	< 0.001 *
Weight-for-Height Z-score	−0.32	0.001 *
Developmental Delay Score	+0.42	< 0.001 *

DISCUSSION

This study explored the relationship between recurrent parasitic infections and their impact on growth and developmental outcomes in children under five years of age. The results demonstrated a clear, statistically significant association between infection frequency and impaired anthropometric as well as developmental indicators. Children who experienced two or more parasitic infections within a year exhibited markedly lower height-for-age, weight-for-age, and weight-for-height z-scores, alongside higher prevalence of stunting, underweight status, and developmental delays compared to infection-free counterparts. The progressive decline in growth indices observed with increasing infection frequency is consistent with prior literature linking parasitic burden to malnutrition and stunting. Repeated intestinal infections compromise nutrient absorption, induce chronic intestinal inflammation, and increase metabolic demands, all of which contribute to linear growth failure. Studies from Kenya and Ethiopia similarly report that children infected with soil-transmitted helminths have significantly lower mean height-for-age z-scores compared to uninfected peers. Chronic exposure to Ascaris lumbricoides and Giardia lamblia has been shown to produce malabsorption syndromes leading to both macro- and micronutrient deficiencies, reinforcing the biological plausibility of these findings[12].

Our results also highlight anemia as a likely mediating factor in this relationship. Mean hemoglobin concentration declined significantly across infection categories, indicating that parasitic blood loss and iron sequestration may underlie much of the growth retardation. Hookworm and whipworm infections, in particular, are known to cause chronic intestinal bleeding and iron-deficiency anemia. Similar trends were documented by Stephenson et al., who found that children with recurrent helminthiasis had a 1–2 g/dL lower mean hemoglobin compared to uninfected controls, even after adjusting for dietary iron intake[13]. The study further revealed significant associations between recurrent infections and delays in gross-motor, fine-motor, language, and personal-social domains. Language and gross-motor delays were most pronounced among children with recurrent infections, emphasizing the neurocognitive implications of parasitic disease. A notable finding of this study was the strong link between infection frequency, poor sanitation, and rural residence[14]. Over half of the recurrent-infection group resided in rural communities with suboptimal hygiene conditions, a pattern echoed in global evidence. In low-resource settings, open defecation, lack of clean water, and limited awareness of hand hygiene perpetuate the fecal-oral transmission cycle[15-17]. Furthermore, the lower rate of exclusive breastfeeding among children with recurrent infections suggests that reduced passive immunity and early exposure to contaminated complementary foods may increase susceptibility. Previous community-based interventions in South Asia have demonstrated that improvements in sanitation and maternal hygiene practices substantially reduce the incidence of intestinal parasitic infections, even more effectively when combined with mass deworming campaigns[18-20]. This underscores the importance of integrated strategies targeting both biomedical and environmental determinants. However, the study has limitations inherent to its cross-sectional design, which precludes causal inference. Recall bias regarding previous infection episodes and possible under-reporting of mild cases may also affect accuracy. Additionally, dietary patterns and co-existing micronutrient deficiencies were not quantified, which could confound observed relationships. Future longitudinal studies with biochemical and cognitive follow-up measures are warranted to establish temporality and explore reversibility of developmental effects after treatment.

CONCLUSION

It is concluded that recurrent parasitic infections significantly impair both growth and developmental outcomes among children under five years of age. Children who experienced repeated infections had markedly higher rates of stunting, underweight status, and developmental delays compared to those with single or no infections. These findings indicate that recurrent parasitic infestation is not merely an acute health concern but a chronic condition that contributes to long-term undernutrition, anemia, and delayed neurocognitive development.

REFERENCES

1. Fauziah N, Aviani JK, Agrianfanny YN, Fatimah SN. Intestinal Parasitic Infection and Nutritional Status in Children under Five Years Old: A Systematic Review. Trop Med Infect Dis. 2022 Nov 12;7(11):371. doi: 10.3390/tropicalmed7110371. PMID: 36422922; PMCID: PMC9697828.
2. Hajare ST, Gobena RK, Chauhan NM, Eriso F. Prevalence of intestinal parasite infections and their associated factors among food handlers working in selected catering establishments from Bule Hora, Ethiopia. Biomed Res Int. 2021. https://doi.org/10.1155/2021/6669742
3. WORLD HEALTH ORGANIZATION (WHO). Soil-transmitted helminth infections. [online]. 2024, [cit. 2020-04-22].Available on Internet: <https://www.who.int/news-room/fact-sheets/detail/soil-transmitted-helminth-infections
4. Certad G, Viscogliosi E, Chabé M, Cacció SM. Pathogenic mechanisms of Cryptosporidium and Giardia. Trends Parasitol. 2017;33(7):561–76.
5. Plutzer J, Ongerth J, Karanis P. Giardia taxonomy, phylogeny and epidemiology: facts and open questions. J Hyg Environ. 2010;213(5):321–33. https://doi.org/10.1016/j.ijheh.2010.06.005
6. Tigabu A, Taye S, Aynalem M, Adane K. Prevalence and associated factors of intestinal parasitic infections among patients attending Shahura Health Center, Northwest Ethiopia. BMC Res Notes. 2019;12:333. doi:10.1186/s13104-019-4377-y.
7. Belete YA, Kassa TY, Baye MF. Prevalence of intestinal parasite infections and associated risk factors among patients of Jimma Health Center requested for stool examination, Jimma, Ethiopia. PLoS One. 2021;16:e0247063. doi:10.1371/journal.pone.0247063.
8. Getachew T, Argaw A. Intestinal helminth infections and dietary diversity score predict nutritional status of urban schoolchildren from southern Ethiopia. BMC Nutr. 2017;3:9. doi:10.1186/s40795-017-0128-4.
9. Zemene T, Shiferaw MB. Prevalence of intestinal parasitic infections in children under the age of 5 years attending the Debre Birhan Referral Hospital, North Shoa, Ethiopia. BMC Res Notes. 2018;11:58. doi:10.1186/s13104-018-3166-3.
10. Mardu F, Yohannes M, Tadesse D. Prevalence of intestinal parasites and associated risk factors among inmates of Mekelle Prison, Tigrai Region, Northern Ethiopia, 2017. BMC Infect Dis. 2019;19:406. doi:10.1186/s12879-019-4053-9.
11. Bethony J, Brooker S, Albonico M, Geiger SM, Loukas A, Diemert D, et al. Soil-transmitted helminth infections: ascariasis, trichuriasis, and hookworm. Lancet. 2006;367:1521–32. doi:10.1016/S0140-6736(06)68653-4.
12. Jourdan PM, Lamberton PHL, Fenwick A, Addiss DG. Soil-transmitted helminth infections. Lancet. 2018;391:252–65. doi:10.1016/S0140-6736(17)31930-X.
13. Montresor A, Mupfasoni D, Mikhailov A, Mwinzi P, Lucianez A, Jamsheed M, et al. The global progress of soil-transmitted helminthiases control in 2020 and World Health Organization targets for 2030. PLoS Negl Trop Dis. 2020;14:e0008505. doi:10.1371/journal.pntd.0008505.
14. Torgerson PR, Devleesschauwer B, Praet N, Speybroeck N, Willingham AL, Kasuga F, et al. World Health Organization estimates of the global and regional disease burden of 11 foodborne parasitic diseases, 2010: a data synthesis. PLoS Med. 2015;12:e1001920. doi:10.1371/journal.pmed.1001920.

15. Li J, Wang Z, Karim R, Zhang L. Detection of human intestinal protozoan parasites in vegetables and fruits: a review. Parasites Vectors. 2020;13:380. doi:10.1186/s13071-020-04255-3.
16. Keiser J, Utzinger J. Food-borne trematodiases. Clin Microbiol Rev. 2009;22:466–83. doi:10.1128/CMR.00012-09.
17. Kantzanou M, Karalexi MA, Vrioni G, Tsakris A. Prevalence of intestinal parasitic infections among children in Europe over the last five years. Trop Med Infect Dis. 2021;6:160. doi:10.3390/tropicalmed6030160.
18. Curico G, García-Bardales P, Pinedo T, Shapiama W, Moncada-Yaicate M, Romaina L, et al. Resistance to single-dose albendazole and reinfection with intestinal helminths among children aged 2 to 11 years from the Peruvian Amazon region: a study protocol. BMC Infect Dis. 2022;22:528. doi:10.1186/s12879-022-07494-0.
19. Woldegerima E, Bayih AG, Tegegne Y, Aemero M, Zeleke AJ. Prevalence and reinfection rates of Schistosoma mansoni and praziquantel efficacy against the parasite among primary school children in Sanja Town, Northwest Ethiopia. J Parasitol Res. 2019;2019:3697216. doi:10.1155/2019/3697216.
20. Ereinhardt K, Fanzo J. Addressing chronic malnutrition through multi-sectoral, sustainable approaches: a review of the causes and consequences. Front Nutr. 2014;1:13. doi:10.3389/fnut.2014.00013.

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