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Pattern of intestinal parasitic infections in children with malnutrition in Somalia

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ABSTRACT

Objectives: Children living in conflict zones plagued with adverse climatic conditions often suffer from acute malnutrition. Being coinfected with intestinal parasites could worsen the prognosis if adequate interventions are not promptly instituted. We determined the pattern of intestinal parasitic infections (IPIs) in children with acute malnutrition in the Bay and Banadir regions of Somalia.

Methods: A hospital-based cross-sectional study was conducted from August to October 2023 in 222 children with acute malnutrition aged 6-59 months, using a structured questionnaire and stool examination by a trained laboratorian. The prevalence of IPI was estimated and the pattern of IPI was explored. The relationship between the presence of IPI and demographic characteristics was examined with multiple logistic regression at a 95% level of confidence.

Results: The mean age was 20.4 ± 12.3 months, 125 (56.3%) were females, and 41.9% were internally displaced. The prevalence of IPI was 82.9% (95% confidence interval: 77.4-87.3), Of the infected, 73.9% (136 of 184) had single parasitic infection and 23.4% (43 of 184) had double parasitic infections. *Ascaris lumbricoides* (46.6%), *Giardia lamblia* (22.1%), and *Entamoeba histolytica* (17.6%) were the most common parasites identified. The age of 13-36 months (adjusted odds ratio: 1.13, $P = 0.02$) and eating once a day (adjusted odds ratio: 1.13, $P = 0.06$) were associated with being infected with intestinal parasites.

Conclusions: The prevalence of intestinal parasitic infection was high in children with malnutrition in the Bay and Banadir regions. Deworming should be extended to all children with malnutrition. Food, sanitation, and water provision initiatives should be improved at the community level.

Introduction

Intestinal parasitic infections (IPIs) are prevalent worldwide, particularly, in children from low-resource countries. These infections cause malabsorption and malnutrition impacting children's growth and development [1]. An estimated 443 million children are infected with soil-transmitted helminths worldwide, with the highest burden in sub-Saharan Africa, South Asia, and Southeast Asia [2]. One billion people have roundworms (*Ascaris lumbricoides*), and 400 million are young children. There are 750 million cases of whipworm (*Trichuris trichiura*), 300 million of which are in school-aged children; 750 million people are infected with hookworm (ancylostomiasis) and 170 million are children [3].

Parasitic infections, particularly, intestinal parasites, significantly impact the nutritional status of children by various mechanisms. Intestinal parasites, such as *Giardia lamblia* and *Cryptosporidium* spp., interfere with nutrient absorption, leading to deficiencies in essential vitamins and minerals [4]. These infections also increase metabolic demand through chronic inflammation, further depleting nutrient reserves [5].

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Gastrointestinal discomfort caused by parasites can suppress appetite, reducing food intake and exacerbating malnutrition [6]. In addition, parasites such as hookworms cause direct nutrient loss through blood loss and iron depletion, resulting in anemia [7]. Children with malnutrition, with their compromised immune systems, are more susceptible to parasitic infections, which, in turn, further weaken immune function and perpetuate a cycle of infection and malnutrition [8].

Uncontrolled intestinal parasitic infection can lead to malnutrition in preschool children, especially in rural, poor communities with inadequate sanitation. Having these parasites in the presence of malnutrition could worsen the prognosis of malnutrition if appropriate interventions are not instituted promptly. Somalia has been facing chronic food insecurity because of prolonged civil conflict, adverse climatic conditions such as drought and flooding, and generally diminished household income [9,10]. These factors combined with challenges with environmental sanitation have led to increased levels of protein energy malnutrition in children under 5 years of age and could predispose them to IPI.

To mitigate the challenges faced by these children with malnutrition and provide the evidence needed for targeted interventions, this study determined the patterns of IPI in children with malnutrition receiving treatment at selected treatment centers in the Bay and Banadir regions in Somalia.

Methods

Study setting

The study was conducted at SOS Hospital in the Banadir region and SOS Hospital in Baidoa city. The Banadir region is the largest city in the southeast state of Somalia, including the capital, Mogadishu, whereas Baidoa city is the largest city in the southwestern state of Somalia, the former capital of the southwestern state. Due to the combined effect of civil conflict and climatic change, an estimated 2.6 million individuals have been internally displaced [11] and live in poverty. Over 30% of the population still practices open defecation, primarily, in rural areas, posing severe health risks due to fecal-oral transmission of disease; only 38% of the population has access to basic sanitation facilities, and significant disparities exist between urban and rural areas [12].

Intestinal parasite infections increase during droughts and floods, highlighting the connection between climatic events and disease frequency resulting from water scarcity, food insecurity, displacement, and reduced sanitation [13,14]. The selected hospitals are secondary level maternal and child health facilities that provide several health services for adults and pediatric populations, including the provision of nutritional support and treatment for children with acute malnutrition. The nutritional rehabilitation and treatment for children with malnutrition are provided free of cost to the children and their caregivers and, hence, attract a large number of children and their families.

Study design and population

A hospital-based cross-sectional study was conducted in children with malnutrition. The study participants were all children with malnutrition attending the nutrition department of the selected health center from August to October 2023, whose parents/guardians consented to the study and agreed to stool examination, without any chronic illness and previous medication for the current illness.

Sample size

The sample size was calculated using the formula for a single population. The prevalence of intestinal parasites of 15.5%, reported in an earlier study [15], was used at a precision of 5%. The minimum sample size was 201 but after adjusting for a 10% non-response rate, 223 children meeting the inclusion criteria were sampled for the study.

Table 1
Socio-demographic characteristics of children with acute malnutrition at selected centers in Banadir and Bay regions, Somalia 2023.

Variables	Frequency (n = 222)	Percent (%)
Age (months)		
6-12	86	38.7
13-36	116	52.3
37-59	20	9.0
Sex		
Female	125	56.3
Male	97	43.7
Place of residence		
IDP	93	41.9
Rural	69	31.0
Urban	60	27.0
Meal frequency per day		
1	103	46.4
2	73	32.9
3	46	20.7
Parasitic infection		
Positive	184	82.9
Negative	38	17.1
Z-score		
Mild (−1 to −1.9)	28	12.6
Moderate (−2 to −3)	59	26.6
Severe (<−3)	135	60.8
Oedema		
Yes	45	20.3
No	177	79.7

Sampling technique

The sample size was allocated to the two participating hospitals proportionate to the size of the outpatient cases in the nutrition department. The cases were sampled consecutively during the study period until the sample size allocated to each facility was attained.

Data collection

A checklist was used to collect clinical, demographic, and laboratory data from the children and their caregivers after a written informed consent. The data were collected by trained health professionals working in the two health facilities. Clinical symptoms such as abdominal pain, vomiting, diarrhea, nausea, and appetite loss were assessed, following the criteria set on guidelines for intestinal parasitic infection diagnosis and treatment. Acute malnutrition was assessed using the World Health Organization standard anthropometrics measurements including weight, height, Z-score, and edema; the final decision of acute malnutrition was made based on the Z-score of the child less than −1 [16].

A stool sample was taken from all children aged 6-59 months using a wide-open container. After the collection of samples, the stool was examined by the naked eye and using a microscope of 10 and 40 power after wet staining with normal saline, iodine, and acid-fast stain. Stool color and pH were examined, as well as all parasitic infections by a trained laboratorian in the selected health centers in the Bay and Banadir regions. The presence or absence of the parasite in the sample was the final decision point. When a parasite is observed, they are characterized and named.

Data analysis

The collected data were checked for their completeness and correctness and analyzed using EPI Info version 7. The nutritional assessment was analyzed using the World Health Organization's Anthro software version 3.2.2. The proportion of children with malnutrition with at least one parasite detected in their stool was estimated. The number of parasites per individual was also estimated and the parasites were identified and tallied to obtain the most frequently occurring parasites in the stool samples. The relationship between the presence of intestinal parasites

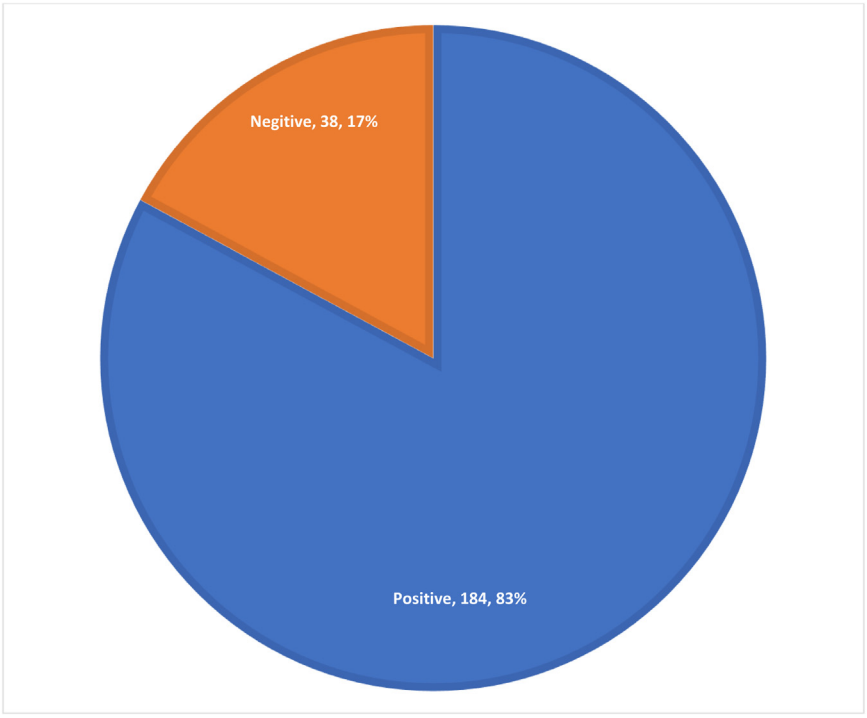

Figure 1. Prevalence of intestinal parasite children with acute malnutrition in selected hospitals in Somalia, 2023 (n = 222).

and the social demographic and nutritional characteristics of the children was explored in a multivariate logistic regression model at a 95% confidence level.

Ethical consideration

Ethical approval was obtained from the Federal Ministry of Health and Human Services Research and Ethical Committee (reference number Ref/MOHHS/DGO/1552/Feb2023). Permissions were obtained from the heads of the participating hospitals and written informed consent was obtained from the parents or guardians of the children. The privacy and confidentiality of the participants were maintained throughout the study.

Results

The mean age of the children was 20.4 ± 12.3 months. About half of the children (116 [52.3%]) were 13-36 months, 125 (56.3%) were females, and 41.9% were internally displaced (Table 1). The prevalence of intestinal parasitic infection in children with acute malnutrition aged 6-59 months was 82.9% (95% confidence level: 77.4-87.3) (Figure 1). Of those that had at least one parasitic infection, 73.9% (136 of 184) had a single parasite infestation and 23.4% (43 of 184) at two different parasitic infections in addition to malnutrition. The top three most common types of parasitic infection observed in the study participants infected were *A. lumbricoides* 56.0% (103 of 184), *Gardia lambia* 26.6% (49 of 184), and *Entamoeba histolytica* 21.2% (39 of 184) (Table 2).

Regarding the analyses of infection rates by various parasites across demographics, children aged 13-36 months had the highest overall infection (94.0%) and *Ascaris* infection (55.2%). Females showed a slightly higher infection rate (84.0%) than males (81.4%). Internally displaced people camps reported the highest infection rate (84.9%), whereas urban areas had the lowest (70.0%). Children consuming one meal per day had the highest infection rate (91.3%). Severe malnutrition (Z-score <−2) correlates with higher infection rates (93.2%), and edema presence showed a significantly higher rate (95.6%). *Ascaris* was the most prevalent parasite and *Strongyloides stercoralis* was the least (Table 3).

Table 2
Patterns of intestinal parasitic infestation in children with acute malnutrition in selected hospitals in Somalia, 2023.

Variable	Frequency (n = 184)	Percentage (%)
Number of parasites		
Single	136	73.9
Double	43	23.4
Multiple	5	2.7
Type of parasite (multiple responses allowed)		
Ascaris lumbricoides	103	56.0
Gardi lambia	49	26.6
Entamoeba histolytica	39	21.2
Hymenolepis nana	34	18.5
Trichuris trichiura	2	1.1
Strongyloides stercoralis	1	0.5

Children aged 13-36 months are significantly more likely to have IPIs than those aged 6-12 months (adjusted odds ratio [AOR]: 1.13, $P = 0.02$). One meal per day shows a trend toward a higher infection risk (AOR: 1.13, $P = 0.06$). Severe malnutrition (Z-score <−2) significantly raised the infection risk (AOR: 1.21, $P = 0.02$) (Table 4).

Discussion

We assessed the prevalence and pattern of IPIs in children with acute malnutrition aged 6-59 months in selected health facilities in the Bay and Banadir regions of Somalia. The study found a high prevalence of IPIs in children with acute malnutrition. The high prevalence observed in this special population could be due to a combination of ecologic, economic, and social factors in Somalia, which might have provided favorable conditions for the parasites to live out their life cycle. Somalia has a humid tropical environment, with a high prevalence of open defecation and poor sanitation. The high prevalence in this proportion calls for concern and reinforces the need to include deworming in the management of children under the age of 5 years with acute malnutrition. The level of prevalence of intestinal parasites found in this study is higher than those earlier reported in Ethiopia and Sudan [17,18].

Table 3
Distribution of the intestinal parasites by the socio-demographic characteristics among the cases.

Variable	N	Infected (%)	*Ascaris* (%)	*Gardia* (%)	*Hymenolepis nana* (%)	*Entamoeba histoltica* (%)	*Trichuris trichura* (%)	*Strongyloides stercoralis* (%)
Age								
6-12	86	65 (75.6)	32 (37.2)	17 (19.8)	9 (10.5)	16 (18.6)	0 (0.0)	0 (0.0)
13-36	116	109 (94.0)	64 (55.2)	30 (25.9)	21 (18.1)	22 (19.0)	1 (0.9)	1 (0.9)
37+	20	10 (50.0)	7 (35.0)	2 (10.0)	4 (20.0)	1 (5.0)	1 (5.0)	0 (0.0)
Gender								
Female	125	105 (84.0)	63 (50.4)	23 (18.4)	18 (14.4)	22 (17.6)	1 (0.8)	1 (0.8)
Male	97	79 (81.4)	40 (41.2)	26 (26.8)	16 (16.5)	17 (17.5)	1 (1.0)	0 (0.0)
Residence								
IDP	93	79 (84.9)	47 (50.5)	15 (16.1)	13 (14.0)	20 (21.5)	1 (1.1)	1 (1.1)
Rural	69	63 (91.3)	34 (49.3)	18 (26.1)	12 (17.4)	13 (18.8)	1 (1.4)	0 (0.0)
Urban	60	42 (70.0)	22 (36.7)	16 (26.7)	9 (15.0)	6 (10.0)	0 (0.0)	0 (0.0)
Meal frequency								
1	103	94 (91.3)	55 (53.4)	16 (15.5)	21 (20.4)	22 (21.4)	0 (0.0)	0 (0.0)
2	73	56 (76.7)	30 (41.1)	20 (27.4)	10 (13.7)	14 (19.2)	2 (2.7)	1 (1.4)
3	46	34 (73.9)	18 (39.1)	13 (28.3)	3 (6.5)	3 (6.5)	0 (0.0)	0 (0.0)
Z-score								
<−1	28	19 (67.9)	7 (25.0)	6 (21.4)	1 (3.6)	3 (10.7)	0 (0.0)	0 (0.0)
<−2	59	55 (93.2)	32 (54.2)	13 (22.0)	8 (13.6)	18 (30.5)	0 (0.0)	0 (0.0)
<−3	135	110 (81.5)	64 (47.4)	30 (22.2)	25 (18.5)	18 (13.3)	2 (1.5)	1 (0.7)
Edema								
No	177	141 (79.7)	76 (42.9)	41 (23.2)	33 (18.6)	28 (15.8)	2 (1.1)	1 (0.6)
Yes	45	43 (95.6)	27 (60.0)	8 (17.8)	1 (2.2)	11 (24.4)	0 (0.0)	0 (0.0)

Table 4
Factors associated with intestinal parasite infection in children with acute malnutrition in selected hospitals in Somalia, 2023.

Variables	Positive IPI	Negative IPI	Crude odds ratio (95% CI)	*P*-value	Adjusted odds ratio (95% CI)	*P*-value
Age (months)						
6-12	65	21	—		—	
13-36	109	7	1.20 (1.09, 1.33)	**<0.001**	1.13 (1.02, 1.26)	**0.02**
37-59	10	10	0.77 (0.65-0.92)	**0.004**	0.77 (0.65, 0.91)	**0.003**
Meal frequency (per day)						
1	94	9	1.19 (1.05, 1.35)	**0.009**	1.13 (0.99, 1.29)	0.06
2	56	17	1.03 (0.90-1.18)	0.7	1.07 (0.94, 1.22)	0.3
3	34	12	—		—	
Edema						
No	141	36	—		—	
Yes	43	2	1.17 (1.04-1.32)	**0.011**	1.04 (0.91, 1.17)	0.6
Residence						
IDP	79	14	—		—	
Rural	63	6	1.07 (0.95-1.20)	0.3	1.06 (0.95, 1.18)	0.3
Urban	42	18	0.86 (0.76-0.97)	**0.01**	0.94 (0.84, 1.06)	0.3
Z-score						
<−1	19	9	—	**0.01**	—	
<−2	55	4	1.29 (1.09-1.52)	0.003	1.21 (1.03, 1.42)	0.02
<−3	110	25	1.15 (0.99-1.33)	0.07	1.11 (0.96, 1.28)	0.15

CI, confidence interval; IPI, intestinal parasite infection.

A. lumbricoides was the most common parasite in both sexes, followed by *G. lamblia, E. histolytica, H. nana*, and *T. Trichura*. The pattern of the infection by these organisms reveals the most common intestinal organisms in this population in the region. The fact that a large proportion of the children were currently living in the internally displaced persons camps also reveals the probable challenges of sanitation, food, and water shortages in these communities. The pattern will guide the treatment options for these special populations and the necessary community-level control measures. Having multiple IPI also points to the level of burden of infection in the children and the need to choose the right medication in handling such cases.

The pattern observed in our study has been reported in a previous study in Guinea [19]; however, some earlier studies in Somalia reported had reported *G. lamblia* has the most IPIs [20,21], which may probably be due to different populations or changing patterns over time. Also, a study in Iraq reported *E. histolytica* as the most common IPI, followed by *G. lambia, H. nana*, and *E. vermicularis* [22].

This study highlighted significant disparities in IPI rates in various demographic groups in Somalia, with children aged 13-36 months and residents of Internally displaced people camps showing the highest prevalence. The findings align with trends observed in neighboring sub-Saharan African countries, where young children and females in impoverished areas are particularly vulnerable due to underdeveloped immune systems, poor hygiene, and gender-specific roles that increase exposure to contaminated environments [8]. The high prevalence of *Ascaris* reflects widespread inadequate sanitation, whereas severe malnutrition, particularly, with edema, exacerbates infection rates, emphasizing the need for integrated interventions targeting nutritional support and improved sanitation. These findings underscore the critical need for comprehensive public health strategies in Somalia to reduce parasitic infection burdens in vulnerable populations.

The older children and those who had at least three meals per day appear to be protected from having intestinal parasite infections. This points to the possible role of food shortage in the multiple factors, such as sanitation and personal hygiene, in the epidemiology of intestinal parasites in children. The older children are more likely to practice better personal hygiene than the younger ones, especially in the presence of food shortages. This result is consistent with earlier findings [23]. The

sex of the child played no role in the odds of getting infected with intestinal parasites and this was in keeping with an earlier study in Ethiopia [24].

Our study is not without some limitations. Being a hospital-based study, we included only children with acute malnutrition receiving nutritional supplementation. This may limit the generalization of the findings beyond the study population. A community-based study may reveal a wide pattern of infection and lower prevalence. Despite this limitation, the finding from the study provides evidence of the magnitude of the IPIs in children with acute malnutrition and helps the program managers target the right organisms in providing solutions to the children.

Conclusion

The study revealed a high prevalence of IPIs in children with acute malnutrition aged 6-59 months, with *A. lumbricoides* being the most common organism. We recommend regular deworming campaigns, household awareness, environmental and personal sanitation, and systematic investigation of IPIs to reduce their burden and improve child health.

Declarations of competing interest

The authors have no competing interests to declare.

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Ethical consideration

The ethical approval was obtained from the Federal Ministry of Health and Human Services Research and Ethical Committee (reference number Ref/MOHHS/DGO/1552/Feb2023). Permissions were obtained from the heads of the participating hospitals and written informed consent was obtained from the parents or guardians of the children. Privacy and confidentiality of the participants were maintained throughout the study.

Author contributions

Each author contributed significantly to the work reported, whether it was in the form of conception, study design, execution, data acquisition, analysis, and interpretation. They all made draft, revised, or critically reviewed the article; approved the final version to be published; agreed on the journal to which the article was submitted; and agreed to take responsibility for the work in every aspect.

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