

ASSOCIATION OF INTESTINAL PARASITIC INFECTIONS WITH ANEMIA AMONG SCHOOLCHILDREN IN AMRAN GOVERNORATE, YEMEN

By

AHMED A. AZAZY^{1*}, TALAL S. ALWJEEH², EMAN KH. OMRAN^{1,3**},
ABDULBASET M. KABLI¹, RAED A. ALHARBI¹, and SHAI A S. R. ALMALKI¹

¹Department of Laboratory Medicine, Faculty of Applied Medical Sciences, Al Baha University, Al Baha, Saudi Arabia, ²Department of Medical Parasitology, Faculty of Medicine and Health Sciences, Amran University, Amran and Yemen and

³Department of Medical Parasitology, Faculty of Medicine, Sohag University, Egypt.
(*Correspondence: *e.ahmed@bu.edu.sa, **moabdallah.1998@hotmail.com)

Abstract

Intestinal parasitic infections (IPIs) and anemia are common conditions among children, especially in developing countries. Schoolchildren are particularly susceptible to these conditions, which can affect their school performance. Therefore, this study aimed to determine the prevalence of IPIs and anemia among schoolchildren in Amran Governorates, north of Yemen, and to investigate the association between the two conditions. A cross-sectional study was conducted among 230 school-children aged 7-15 years in primary schools, Amran Governorate from January to February 2023.

Sociodemographic data were collected using a structured questionnaire, and stool samples were collected, processed and examined for parasites. Hemoglobin level was also measured using a portable hemoglobin meter. Binary logistic regression was used to test the association of sociodemographic characteristics and anemia with IPIs at P -values <0.05 . The prevalence of IPIs among schoolchildren was 57.4%, with *Entamoeba histolytica/dispar* (35.7%) the most common, followed by *Giardia lamblia* (25.2%) and then *Hymenolepis nana* (13%). However, a few children were infected with *Enterobius vermicularis*, *Schistosoma mansoni* and *Trichuris trichiura*. Most children were mono-infected (66.7%), followed by those with two parasite species (30.3%). But, anemia was prevalent among 17.4% of children. There was no significant association between IPIs and sociodemographic characteristics of children. However, anemia was significantly associated with IPIs (odds ratio = 6.7, 95% confidence interval: 2.52–17.87; $P < 0.001$).

Keywords: intestinal parasitic infections, anemia, schoolchildren, Yemen

Introduction

Environmental contamination with the fecal matter, poor sanitation and unhygienic practices are among the factors associated with the prevalence of soil-transmitted parasites such as *Ascaris lumbricoides*, *Trichuris trichiura* and hookworms, particularly in poor communities with more than 1.5 billion people worldwide (Chopra *et al.*, 2023).

Preschool and school-aged children were more heavily infected with gastrointestinal parasites and suffered from more adverse health effects, including growth failure, anemia, and cognitive retardation (Veesenmeyer, 2022). Of 251.4 million people worldwide mainly children who needed schistosomiasis treatment in 2021, more than 75 million people received chemotherapy (WHO, 2023). Besides, enterobiasis and hymenolepiasis *nana* are among the most common

helminthic infections in children (Kucik *et al.*, 2004). Amebiasis and giardiasis were the commonest protozoa in developing countries (Stanley, 2003). About 50 million people experienced acute amebic dysentery and invasive extra-intestinal amebiasis annually (Staffer, and Ravdin, 2003), and *Giardia lamblia* is one of the most widespread causes of diarrhea, with annual estimates of 200 million cases (Feng and Xiao, 2011).

Anemia is a disorder in hemoglobin (Hb) levels and/or red blood cells (RBCs) were abnormally low and insufficient to meet the body physiological demands (WHO, 2011), among one quarter of the world's population (Safiri *et al.*, 2021). It impairs physical growth and health status with passively affects cognitive development, and school-children and performance (Jain and Chandra, 2012). Austin *et al.* (2012) reported that anemia

was the main nutritional disorder among the women and children in the Middle East and North Africa region, that between 2000 & 2005, its prevalence (Hb <11 g/dL(-1)) increased from 37.04% to over 52% among Egyptian children between 12 and 36 months of age. Fraenkel (2017) in the United States reported that about one million elders' people have anemia of inflammation. Hossain *et al.* (2019) in Bangladesh reported that the rate of iron deficiency anemia in slum dwelling children was high parasites have a strong association with IDA at 24 months of age.

In Yemen, anemia was common, but mainly among pregnant women and children. In a community-based survey in two governorates, 48.7% of children suffered from anemia (Al-Zabedi *et al.*, 2014). Al-Jermmy *et al.* (2022) in Hodeida found that 37.8% of the adolescents in schools were anemic.

The present study aimed to evaluate the prevalence of intestinal parasites (IPIs) and their association with anemia among schoolchildren in Amran Governorate, North of Yemen.

Subjects and Methods

Study design, population and area: A school-based, cross-sectional study was carried out on schoolchildren from January to February 2023. Children aged 7-15 years of both sexes in primary schools were invited to participate voluntarily in the study. Amran Governorate comprises 20 districts located in north of Yemen at the coordinates of 15° 38' 45.6" N, 43° 55' 44.4" E.

Sample size and sampling strategy: After the WHO manual for determining sample sizes in health studies (Lwanga and Lemeshow, 1991), a total of 194 schoolchildren was calculated based on an expected IPI prevalence of 75.8% (Edrees *et al.*, 2022), a confidence level of 95% and an accepted marginal error of 6%. Nevertheless, 230 children were studied. A two-stage cluster sampling approach was adopted. First, four public primary schools (one urban and three rural); namely, Alshahid Ayed Naji School, Alkheir School, Alfawz School and Oqbah

bin Nafeh School, were randomly selected. Second, children enrolled in educational levels 4 to 6 were selected by random sampling from student records of the selected schools.

Data and sample collection: Sociodemographic data, including sex, age, residence, parents' education, and employment, as well as family size, were collected by using a structured questionnaire by face-to-face interviews with children. Before stool sample collection, the children were instructed on how to collect the sample and the amount (about 100gm) needed. Then, children were given dry, clean, screw-cap containers labeled with the name and identification number of the participant. The collected samples were sent immediately to the Parasitology Laboratory of the Central Health Laboratory in Amran City for parasitological examination. Also, a finger-prick blood was collected from each child under aseptic conditions for hemoglobin (Hb) measurement (Mission Plus Hb, ACON Laboratories Inc., San Diego, USA), and Hb concentration in g/dl was then reordered on the questionnaire of corresponding child. Children were considered anemic if Hb level was below 12g/dl (WHO, 2011). The Hb meter was calibrated against Sysmex XP-300 automated hematology analyzer (Sysmex Corp., Kobe, Japan) at the Maternity and Childhood Center in Amran City.

Stool examination: Morning stool samples were macroscopically examined for the adult worms and gravid segments, and then processed for microscopic examination of stained smears and formalin-ethyl acetate sedimentation concentration technique (CDC, 2016).

Statistical analysis: Data were analyzed by using the IBM SPSS Statistics, version 21.0 (IBM Corp., Armonk, NY, USA). Binary logistic regression, using Chi-square or Fisher's exact test, was used to test the association of sociodemographic characteristics and anemia due to IPIs among schoolchildren, together with odds ratios (ORs) and 95% confidence interval (CIs) of associations. P-values <0.05 was significant (Cohen, 1988).

Ethical considerations: The protocol was

approved by the Ethics Review Committee of the Faculty of Medicine and Health Sciences at Amran University, Amran, Yemen. This went with Helsinki Declaration (2013). Besides, permission was sought from school headmasters, and written informed consent was obtained from the children's parents or guardians after explaining the purpose of the study to them. They were informed that charring was voluntary; confidentiality and privacy of their data were ensured.

Results

The children mean age was 11.9±1.2years, majority were males (60.4%) and aged >11 years (61.3%). About one-half of them were rural residents, and more than half of the fathers were employed. But, majority of mothers were housewives (84.8%). Most of fathers had informal education (30.4%), followed by secondary education (21.3%), but mothers were illiterate (59.6%), followed by informal education (29.2%).

Median family size (IQR) of children was 7 (3) with size of 3-7 (53.5%).

Parasites were 57.4% (95% CI: 51.0-63.8). *E. histolytica/dispar* (35.7%), followed by *G. lamblia* (25.2%), then *H. nana* (13%). Five children (2.2%) were infected with *Enterobius vermicularis*, four children (1.7%) with *Schistosoma mansoni* and one child (0.4%) with *Trichocephalus trichiura*. They were infected with one parasite (66.7%), followed by two parasites (30.3%), and then 3% were infected with three parasites

There was no significant association between IPIs among them as to sex ($P= 0.090$), age ($P= 0.399$), residence ($P= 0.910$), father's literacy status ($P = 0.386$), mother's literacy status ($P= 0.865$), father's employment ($P= 0.086$), mother's employment ($P= 0.735$), or even family size ($P = 0.874$).

Of 230 schoolchildren examined, 17.4% (95% CI: 12.5-22.3) were anemic.

Details were given in tables (1, 2, 3 & 4).

Table 1: Socio-demographic characteristics of pchildren (N = 230).

Characteristics	No.	Percentage
Male	139	(60.4)
Female	91	(39.6)
Ages in years: ≤11	89	(38.7)
Mean ± SD: 11.9 ± 1.2	141	(61.3)
Residence: Rural	116	(50.4)
: Urban	114	(49.6)
Father status: Employed	130	(56.5)
: Unemployed	100	(43.5)
Mother status: Employed	35	(15.2)
: Housewives	195	(84.8)
Father's education: Illiterate	46	(20.0)
: Informal (read and write)	70	(30.4)
: Primary school	34	(14.8)
: Secondary school	49	(21.3)
: University and above	31	(13.5)
Mother's education: Illiterate	137	(59.6)
: Informal (read and write)	67	(29.2)
: Primary school	15	(6.5)
: Secondary school	4	(1.7)
: University and above	7	(3.0)
Family size ≤ 7	123	(53.5)
Median (IQR): 7.0 (3.0) > 7	107	(46.5)

SD, standard deviation; IQR, interquartile

Table 2: Prevalence, frequency distribution and multiplicity of IPIs among children.

Prevalence of IPIs	No.	Percentage
Overall prevalence	132	(57.4)
Protozoa parasites		
<i>Entameba histolytica/dispar</i>	82	(35.7)
<i>Giardia lamblia</i>	58	(25.2)
Helminthic parasites		
<i>Hymenolepis nana</i>	30	(13.0)
<i>Enterobius vermicularis</i>	5	(2.2)
<i>Schistosoma mansoni</i>	4	(1.7)
<i>Tricocephalus trichiura</i>	1	(0.4)
Parasites: Single	88	(66.7)
: Double	40	(30.3)
: Triple	4	(3.0)

Table 3: Association of IPIs with sociodemographic characteristics of schoolchildren.

Variable	Total No.	Parasites			P-value
		No.	(%)	OR (95% CI)	
Male	139	86	(61.9)	1.6 (0.93–2.71)	0.090
Female	91	46	(50.5)	Reference	
Age (years): ≤11	89	48	(53.9)	Reference	0.399
>11	141	84	(59.6)	1.3 (0.74–2.15)	
Residence Rural	116	67	(57.8)	1.0 (0.61–1.73)	0.910
Urban	114	65	(57.0)	Reference	
Father's literacy status: Illiterate	46	20	(63.0)	1.3 (0.68–2.61)	0.386
Literate	184	103	(56.0)	Reference	
Mother's literacy status: Illiterate	137	78	(57.0)	1.0 (0.65–1.62)	0.865
: Literate	93	54	(58.1)	Reference	
Father employment: Unemployed	100	51	(51.0)	0.6 (0.37–1.07)	0.086
: Employed	130	81	(62.3)	Reference	
Mother employment: Unemployed	195	111	(57.0)	0.9 (0.42–1.83)	0.735
: Employed	35	21	(60.0)	Reference	
Family size no.: ≤ 7	123	70	(56.9)	Reference	0.874
: > 7	107	62	(57.9)	1.0 (0.56–1.62)	

Table 4: Association between IPIs and anemia among schoolchildren in Amran Governorate.

Parasitic infection	Total No.	Anemic No.	Percentage	OR (95% CI)	P-value
Yes	132	35	(26.5)	6.7 (2.52–17.87)	<0.001
No	98	5	(5.1)	Reference	

N, number examined, n, number with anemia, IPIs: intestinal parasitic infections, OR: odds ratio, CI: confidence interval.

Discussion

The present study showed a high prevalence of IPIs (57.4%) among schoolchildren with more than half of them had at least a single parasite species. This was lower than that of Alwabr and Al-Moayed (2016), they in Al-Mahweet Governorate reported (90%) among primary schoolchildren and also, Edrees *et al.* (2022), they in Amran City found (75.8%) among schoolchildren. However, the data agreed with Al-Haddad and Baswaid (2010), they in Hadhramout Governorate reported (59%) and Alsubaie *et al.* (2016),

who in Ibb Governorate found (57%) among children in rural and urban areas.

In the present study, parasitic prevalence was more or less comparable to a prevalence of (53-54.8%) reported in Sana'a Governorate by both Azazy and Al-Tiar (1999), and Al-Mekhlafi *et al.* (2016) among schoolchildren in rural communities. Also, lower parasitic rates (51.3%) and urban (38.2%) were reported among children in rural areas of Taiz Governorate by Alharazi *et al.* (2020) and Alharazi (2022) respectively. Moreover, the lower parasitic infection rates of 27.5%

and 13.5% were in pediatric patients presented to a Health Center in Sana'a and schoolchildren in Sahar District of Sa'adah Governorate respectively by Azazy and Raja'a (2003) and Raja'a and Mubarak (2006) respectively.

Abroad, Yones *et al.* (2015) in Upper Egypt reported parasitic prevalence of 55.7%, but Al-Delaimy *et al.* (2014) in rural Malaysian schoolchildren the infection rate rose up 98.2%. The variation in parasitic prevalence varied due to the geographical and climatic conditions as well as human habitats and behavioral attitudes.

In the present study, protozoa were most predominant among schoolchildren; with approximately one-third had *E. histolytica/dispar* followed by *G. lamblia*. Also, 13% were infected with *H. nana*, five children with *E. vermicularis*, four with *S. mansoni*, and one with *T. trichiura*. These data more or less agreed with the general concept of parasitic infections among nearly all Yemeni Schoolchildren (Bin Mohanna *et al.*, 2014; Alwabr and Al-Moayed, 2016; Alharazi *et al.*, 2020; Edrees *et al.*, 2022). The low prevalence of *E. vermicularis* and *S. mansoni* in children may reflect the impact of massive drug administration (MDA) with albendazole and praziquantel over the past few years in the rural areas of 2.4 million people across 32 districts in seven northern governorates (World Bank, 2021). This fact agreed with Edrees *et al.* (2022) reported *E. vermicularis* (0.8%) & *S. mansoni* (2.5%) among these children. Previously, Sady *et al.* (2015) reported that of 90 participants (22.5%) had urogenital schistosomiasis, 32 (8.0%) had intestinal schistosomiasis and 5 (1.3%) were co-infected with *S. haematobium* and *S. mansoni*. They added that highest schistosomiasis prevalence was in Hodiedah (37.6%), followed by Taiz (36.8%), but Dhamar had the least one (19.4%). However, *A. lumbricoides* among children in some Yemeni Governorates were 8.5% in rural Sana'a (Al-Mekhlafi *et al.*, 2016), 10% in Al-Mahweet (Alwabr and Al-Moayed, 2016), 68% in Ibb (Alsubaie *et al.*,

2016), 1.6% in urban Taiz (Alharazi *et al.*, 2020), and 3.8% in rural Taiz (Alharazi, 2022). But, *T. trichiura* (0.8%) agreed with that found in Taiz (Alharazi *et al.*, 2020). Besides, rates of 2.9%, 9.3% & 18% were reported among schoolchildren in Taiz, Ibb and Al-Mahweet (Alwabr and Al-Moayed, 2016; Alsubaie *et al.*, 2016; Alharazi, 2022), respectively.

In Saudi Arabia, Taha *et al.* (2013) among the expatriate workers identified *G. lamblia* (22%), *E. histolytica* (17.8%), *T. trichiura* (16.2%), *A. lumbricoides* (15.8%), hookworm (13%), *H. nana* (8.9%), *Strongyloides stercoralis* (3.5%), *S. mansoni* (2.2%), and *E. vermicularis* (0.43%). Dyab *et al.* (2016) in southern Egypt reported *E. histolytica* 8.3% followed by *G. lamblia* 3.7% and *Cryptosporidium parvum* 1.7%. They added that mixed infection was *E. vermicularis* & *E. histolytica* (23.4%), *E. vermicularis* & *G. lamblia* (17.6%), *E. vermicularis* & *C. parvum* (11.8%), *E. histolytica* & *H. nana* (11.85%), *A. lumbricoides* & *E. histolytica* (17.6%) and *G. lamblia* & *E. histolytica* in (11.8%).

In Egypt, Abdel Hafeez *et al.* (2012) found that *E. histolytica* (24.6%) and *G. lamblia* (17.6%) were commonest than other protozoal parasites in immunocompetent children.

Abroad, Shears and Grecis (2022) in the United Kingdom reported that human *T. trichiura* was a neglected tropical disease that affected 477 million people worldwide, and *T. suis*, the pig whipworm species, responsible for growth stunting and economic losses within the agricultural industry. Besides, the zoonotic *Trichuris* species can infect pet animals, such as dogs (*T. vulpis*) and cats (*T. serrata* and *T. campanula*) (Else *et al.*, 2020)

Low *S. mansoni* infection rate agreed with four authors (Raja'a and Mubarak, 2006; Al-Haddad and Baswaid, 2010; Al-Mekhlafi *et al.*, 2016; Alharazi, 2022). However, *S. mansoni* infection rates of 13% and 36.5% were reported in rural areas of Taiz and Al-Mahweet (Alwabr and Al-Moayed, 2016; Alharazi, 2022), respectively.

In the present study, *H. nana* was (13%)

among schoolchildren. The *H. nana* prevalence varies from zero to 12.5% (Azazy and Al-Tiar, 1999; Raja'a, and Mubarak, 2006; Al-Haddad and Baswaid, 2010; Alsubaie *et al*, 2016; Al-Mekhlafi *et al*, 2016; Alwabr and Al-Moayed, 2016; Alharazi *et al*, 2022; Al-Jermmy *et al*, 2022; Edrees *et al*, 2022).

In the present study, *E. vermicularis* rate was low despite its autoinfection and reinfection after cure. This agreed with rare or mild prevalence reported by some Yemeni authors (Azazy and Al-Tiar, 1999; Al-Haddad and Baswaid, 2010; Alwabr and Al-Moayed, 2016; Al-Mekhlafi *et al*, 2016; Alsubaie *et al*, 2016; Alharazi *et al*, 2020; Alharazi, 2022; Edrees *et al*, 2022). In Egypt, El Shazly *et al*. (2006) reported 1% among urban schoolchildren. Besides, the present study detected single, double and triple parasitic infections. This agreed with Yemeni authors (Azazy and Al-Tiar, 1999; Raja'a and Mubarak, 2006; Alsubaie *et al*, 2016; Alwabr and Al-Moayed, 2016; Al-Mekhlafi *et al*, 2016; Alharazi *et al*, 2020; Edrees *et al*, 2022).

In the present study, anemia was among 17.4% of schoolchildren. This was less than that reported in Hodeidah and Taiz Governorates (Al-Zabedi, 2014), where 48.7% were anemic, but rate was less than 37.8% found by Al-Jermmy *et al*. (2022). There was a significant association between parasitosis and anemia, children with parasites were 6.7% had anemia compared to healthy ones. This agreed with Abdel Fatah and Nofal (2012) in Egypt, and Gopalakrishnan *et al*. (2018) in India. WHO (2020) identified anemia as a global public health problem, affecting pregnant women, reproductive aged ones, adolescent girls, and young children, especially in low- and middle-income countries. Besides, Alwajeih *et al*. (2020) reported that malaria, malnutrition and anemia are the major public health problems, with asymptomatic malignant malaria prevalent among the schoolchildren in Bajil district of Hodeidah Governorate, with predominance of low parasitaemic infections, and significantly associated

with mild anemia and underweight. The chloroquine resistance *P. falciparum* was endemic in Yemen, particularly in Al-Hodeidah Governorate (Al-Maktari *et al*, 2003).

Conclusion

Half of Amran Governorate schoolchildren were infected with one or more parasite, mainly *E. histolytica* and *G. lamblia*, and *H. nana* was more or less rare. This reflected the impact of implemented MDA campaigns. Less than one-fifth of the children were anemic significantly associated with parasitic infections. However, the parasitic anemia is still a problem among schoolchildren.

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