**Reviewer’s Comments**

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**Prevalence and Risk Factors of Intestinal Parasites, Malnutrition, and Anemia among Orphan Children in Sana’a City, Yemen**

**Abstract**

**Background:** Intestinal parasitic infections, malnutrition, and anemia remain the major public health concern affecting children, particularly in underdeveloped countries including Yemen.

**Aims:** The present study is intended at evaluating the prevalence and risk factors of intestinal parasites, malnutrition, and anemia amongst orphan children in Sana’a City, Yemen.

**Methods:** A cross-sectional study was conducted at the orphanage center between September 2020 and November 2023. A total of one hundred and ninety-five (195) stool and blood specimens were collected from orphans’ children aged between 7-15 years. The intestinal parasites were screened by using a formal-ether concentration technique and the hemoglobin was assessed by using the Hematology analyzer Sysmex. A pretested questionnaire was used to collect the needed data while the anthropometric measurements were evaluated. Data obtained were analyzed with the SPSS program.

 **Result:**Out of 195 orphan children samples, 77 (39.49%) were found to be infected by intestinal parasites. The high rate of parasite infections was detected among orphans children aged between 10-12 years (43.9%) %), studies at primary schools (42.9%), didn’t have a history of parasite infection (48.9%) between 102-118 cms in height (48.6%), between 11-30 kg in weight (49.4%), and underweight (40.1%) non-statistical differences (P > 0.05). The most predominant parasite was *Entamoeba histolytica* (17.4%), followed by *Giardia lamblia* (10.3%), *Hymenolepis nana* (6.2%), *Ascaris lumbricoides* (3.6%), and *Enterobius vermicularis* (3.6%).The prevalence of anemia was 19% and there were statistical differences between anemia and intestinal parasitic infection (P = 0.000). The high risk of anemia was associated with meal frequency a day (OR = 1.143; 95% CI=0.186-7.006). Also, anemia prevalence was not statistically associated with study risk factors (*P*> 0.05).The *H. nana, A. lumbricoides* and *E. histolytica* were associated with an increased risk of anemia with (OR = 4.902, 95% CI=3.057-7.860), (OR = 4.196, 95% CI=3.057-7.860), and (OR = 3.229, 95% CI=1.878-5.552), respectively, with a significant association(*P*<0.05).

**Conclusion:** The high prevalence rate of intestinal parasites, anemia, and malnutrition among participants remains a major public health problem. So, the implementation of control and prevention programs including improving health status, regular deworming practices, nutrition education, and iron supplementation is required for reducing the incidence of anemia associated with intestinal parasitic infections

**Keywords:** Anemia, Children, Intestinal parasites, Malnutrition, Prevalence, Orphanage Sana'a, Yemen

**INTRODUCTION**

Intestinal parasitic infections are a major public health problem on a global level and cause of morbidity and mortality, particularly among children in developing countries**1**. Intestinal parasitic infections are endemic in developing countries due to limited economic resources, poor sanitation conditions, high population density, poor personal hygiene, low latrine availability, inadequate water sanitation, contaminated food and water, low health awareness, and malnutrition as a consequence of poverty**2.**

Globally, about 1.5 billion people are infected by intestinal parasitic infections with a prevalence rate between 30– 60% in low-income countries and 2% in developed countries**3.** The commonest signs and symptoms associated with IPIs are abdominal pain, diarrhea, nausea and vomiting, and loss of weight. The persistent infections among children can progress to serious complications such as malabsorption, dyspepsia, iron deficiency anemia, vitamin A deficiency, growth retardation, weight loss, poor educational performance, and other physical and mental consequences**4.**

Anemia is one of the most widespread public health problems, particularly in low-income countries. About 50% of all anemia is due to Iron deficiency and is almost responsible for a million deaths each year worldwide. Iron deficiency anemia is in the "top ten" risk factors contributing to the global burden of disease. The prevalence rate of anemia is 43% in developing countries and 9% in developed nations. Globally, in 2019, 40% of children aged 6–59 months were suffering from anemia, compared to 48% in 2000. Also, the prevalence of anemia in the year 2019 among children aged 6–59 months exceeded 70% in 11 countries**5.**

The consequences of anemia in children result in lowered resistance to disease, increased susceptibility to infection, deficits in cognitive development, impaired physical development, poor school performance, and reduced work capacity with the impaired social and economic development of the country**6.**

Yemen is one of the poorest low-income countries in the world, with more than 13 million living below the national poverty line according **World Bank reports in 2010 7**. In addition, poor socioeconomic status, inadequate toilet facilities, poor personal hygiene, inadequate sanitation conditions, nutritional deficiency, and limited access to drinking water may be the comment factors that contribute to the prevalence of infectious diseases among the population, particularly children suffering from malnutrition that develop anemia diseases **8-16.**

Most studies conducted in different regions in Yemen in previous years have been focused on the bacterial, viral, and intestinal parasitic infections prevalent among Yemeni children **17-23.** The nutritional status and anemia among children have been neglected in Yemen. Few reports showed malnutrition and anemia are other threats affecting children where 59%, 47%, and 18% of school-aged children were reported stunted, underweight, and anemic, respectively **24.** Also, the prevalence rates of anemia were ranging between 31.7-49% among children**25-26.** Therefore, the presented data are not enough. So, the present study is intended at evaluating the prevalence and risk factors of intestinal parasites, malnutrition, and anemia among male children **living in orphanage centers**in Sana’a City, Yemen.

**MATERIALS AND METHODS**

**Study area and period**

This study is a cross-section study carried out orphanage at Taiz Street which administratively belongs to Sana’a capital of Yemen. This study was performed between September 2020 and November 2023.

**Sample size**

A total of hundred and ninety-five (195) stool and blood specimens were collected from orphans’ children. The experimental work was done in the Medical Laboratory Department, Queen Arwa University (QAU).

**Data collection**

A structured questionnaire was used to collect the data that includes socio-demographic (i.e., age, study level, number of children in the room, meal frequency /day, and history of parasite infection), and clinical signs and symptoms (i.e., fever, cough, muscles pain, diarrhea, and abdominal pain) were obtained.

**Inclusion and exclusion criteria**

The children who were residents in orphanage aged between 7-15 years, signed the informed consent, delivered specimens, and non-received any anti-parasitic drugs in the days before sampling were included. Conversely, children who refuse to sign the informed consent, sample collection, or had taken anti-parasitic drugs during data collection were excluded from the study.

**Blood collection and hemoglobin assessment**

About 5 mL of venous blood was collected from each study participant under aseptic procedures by vein puncture and transferred into a sterile tube. Hemoglobin concentration was measured by using a fully automated Hematology analyzer Sysmex KX (Sysmex Corporation, South Korea) at the hematology laboratory in the QAU. Anemia was classified according to WHO **27** as a hemoglobin level <11 g/dL for children aged less than 12 years; <12 g/dL for children aged 12 to 14 years; <13 g/dL for male children aged 15 or 16 years.

**Fecal collection and parasite detection**

The fecal specimens were collected by using clean, dry, wide-mouthed, labeled, and screw-capped containers that were distributed to each participant after carefully explaining the way of collection. The collected specimens were transported to the parasitology lab. at QAU and processed by using the formalin ether concentration technique. The parasite detection was screened under a compound microscope with 10× and 40× objectives**28.**

**Anthropometry measurement.**

The anthropometric data including age, height (Kg), and weight (cms) of the participants enrolled in this study were obtained during the period of blood and stool specimens collection. Anthropometric measurements were converted into body mass index (BMI) using the WHO growth reference 29.

**Nutritional status**

The nutritional status of orphan-aged children was assessed by counting their BMI. BMI was counted by measuring the child’s body weight (kg) by the square of height (cms). The nutritional status is classified as underweight, normal weight, and overweight 29.

**Ethical statement**

Ethical clearance was approved by the Ethics Committee of Queen Arwa University, Yemen, and permission to start data collection was also given by the administration orphanage center. Before specimen collection, the purpose and objectives of this work were explained briefly to all orphans’ children and administrative staff working in the orphanage center. Further, written informed consent participation was voluntary and participants completed a consent form by investigators. The study subjects were ensured that all gathered data will be only used for the study purpose.

**Statistical analysis**

The data were analyzed by using the SPSS version 22 (SPSS Inc, Chicago, IL, USA). frequencies A descriptive analysis of obtained data was performed and the variables were presented in frequencies. The association between intestinal parasitic infections and anemia and nutrition status was evaluated by using reporting odds ratio (OR) and its corresponding 95% confidence interval (CI). A P-value was set at < 0.05 to consider it statistically significant.

**RESULTS**

**Socio-demographic characteristics**

About 195 orphan children participated in the present study aged between 7-15 years with a mean age of 11.8 years. The majority of specimens were sampled from participants aged 12-15 years (57.4%), attending primary schools (64.6%), living in a room with a number of children between 9-12 individuals (52.8%), eating meals ≤3 timesper day, and had a history of parasite infection as summarized in **Table (1).**

**Table 1.**Socio-demographic characterizations of study subjected

| **Variables** | **Categories**  | **Examined**  | **Rate (%)** |
| --- | --- | --- | --- |
|  | 7-11 | 83 | 42.6 |
| 12-15 | 112 | 57.4 |
| **Study level** | Primary | 126 | 64.6 |
| Preparatory | 69 | 35.4 |
| **Number of children in the room** | 3-5 | 52 | 26.7 |
| 6-8 | 40 | 20.5 |
| 9-12 | 103 | 52.8 |
| **Meal frequency/day** | ≤3 times | 189 | 96.9 |
| >3 times  | 6 | 3.1 |
| **History of parasite infection** | Yes | 150 | 76.9 |
| No | 45 | 23.1 |

**Prevalence of intestinal parasites**

Out of 195 orphan children samples, it was found that 77(39.49%) were infected by intestinal parasites while 118(60.51%) individuals were non-infected with intestinal parasites as shown in **Figure (1).**

**Figure 1.**Prevalence rate of intestinal parasites among orphan children.

**Risk factors associated with intestinal parasitic infections**

This finding showed that the highest rate of intestinal parasitic infections was detected among orphans children aged between 7-11 years old (42.9%) %), children who study at primary schools (42.9%), lived in room content between 3-5 individuals (42.3%), eat meals more than 3 times per day (50%), and didn’t have a history of parasite infection (48.9%) with non-statistical significant differences (P > 0.05). Furthermore, the existing result found that the prevalence rate of anemia was 19% recorded among the participants and there were statistical differences between anemia and intestinal parasitic infection (P = 0.000). Moreover, the prevalence rate of parasite infection was significantly higher detected among participants between 102-118 cm in height at 48.6%, between 11-30 kg in weight (49.4%), and underweight (40.1%) non-statistical differences (P > 0.05) as listed in the **Table (2)**.

**Table 2.**Prevalence of parasite infection concerning risk factors

| **Variables** | **Categories** | **Examined****No. (%)** | **Infected No. (%)** | **Non-infected No. (%)** | ***P*- value** |
| --- | --- | --- | --- | --- | --- |
| **Age (in years)** | 7-11 | 83(42.6) | 34(40.9) | 49(59.1) | 0.718 |
| 12-15 | 112(57.4) | 43(38.4) | 69(61.6) |
| **Study level** | Primary | 126 (64.6) | 54 (42.9) | 72 (57.1) | 0.195 |
| Preparatory | 69 (35.4) | 23 (33.3) | 46 (66.7) |
| **Number of children in the room** | 3-5 | 52 (26.7) | 22 (42.3) | 30 (57.7) | 0.883 |
| 6-8 | 40 (20.5) | 12 (30.0) | 28 (70.0) |
| 9-12 | 103 (52.8) | 43 (41.7) | 60 (58.3) |
| **Meal frequency/day** | ≤3 times | 189 (96.9) | 74 (39.2) | 115 (60.8) | 0.595 |
| >3 times  | 6 (3.1) | 3 (50.0) | 3 (50.0) |
| **History of parasite infection** | Yes | 150 (76.9) | 55 (36.7) | 95 (63.3) | 0.143 |
| No | 45 (23.1) | 22 (48.9) | 23 (51.1) |
| **Anemia** | Yes | 37(19) | 24(64.9) | 13(35.1) | 0.000 |
| No | 185(81) | 53(33.6) | 105(66.5) |
| **Anthropometric measurements** |  |  |  |  |
| **Height (cm)** | 102-118 | 37 (19) | 18 (48.6) | 19 (51.4) | 0.187 |
| 119-135 | 33 (16.9) | 13 (39.4) | 20 (60.6) |
| 136-152 | 75 (38.5) | 29 (38.7) | 46 (61.3) |
| 153-170 | 50 (25.6) | 17 (34.0) | 33 (66.0) |
| **Weight (kg)** | 21-30 | 85 (43.6) | 42 (49.4) | 43 (50.6) | 0.143 |
| 31-40 | 70 (35.9) | 21 (30.0) | 49 (70.0) |
| 41-50 | 28 (14.4) | 8 (28.6) | 20 (71.4) |
| 51-60 | 12 (6.2) | 5 (33.3) | 7 (72.7) |
| **Nutrition status** | Underweight | 142 (72.8) | 57 (40.1) | 85 (59.9) | 0.587 |
| Normal weight | 48 (24.6) | 19 (39.6) | 29 (60.4) |
| Overweight | 5 (2.6) | 1 (20.0) | 4 (80.0) |

\*Significant association (*P*<0.05)

The present finding revealed that the most predominant parasite was *E. histolytica* (17.4%) among study subjects followed by *G. lamblia* (10.3%), *H. nana* (6.2%), *A. lumbricoides* (3.6%), and *E. vermicularis* (3.6%) **(Figure 2).**

**Figure 2.**Type of intestinal parasitic infection among orphan children

**Table 3** illustrates the distribution of intestinal parasitic infections in relation to sociodemographic characterizations. The age group of 7-11 years had a high rate of *E. histolytica*(19.3%). *G. lamblia* (10.8%), and *A. lumbricoides* (4.8%) while age group 12-15 years had high rate of*H. nana*(8%).However, the high rate of *E. histolytica, G. lamblia,* and*H. nana* infections reported among children attended primary schools while *A. lumbricoides* and *E. vermicularis* among children attended preparatory schools. Also, the similar results.

**Table 3.** Distribution of parasite infections concerning sociodemographic characterizations

| **Variables** | **Categories** | ***E. histolytica*** | ***G. lamblia*** | ***H. nana*** | ***A. lumbricoides*** | ***E. vermicularis*** | **Total No. (%)** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Age (in years)** | 7-11 | 16(19.3) | 9(10.8) | 3(3.6) | 4(4.8) | 3(3.6) | 35(43.75) |
| 12-15 | 18(16.1) | 11(9.8) | 9(8) | 3(2.7) | 4(3.6) | 45(56.25) |
| **Study level** | Primary | 24(42.9) | 15(26.8) | 9(16.1) | 4(7.1) | 4(7.1) | 56(70) |
| Preparatory | 10(21.7) | 5(20.8) | 3(12.5) | 3(12.5) | 3(12.5) | 24(30) |
| **Number of children in the room** | 3-5 | 10(23.5) | 9(39.1) | 1(4.3) | 2(8.7) | 1(4.3) | 23(28.7) |
| 6-8 | 4(30.8) | 1(7.7) | 3(23) | 4(30.8) | 1(7.7) | 13(16.3) |
| 9-12 | 20(45.5) | 10(22.7) | 8(18.2) | 1(2.2) | 5(11.4) | 44(55) |
| **Meal frequency /day** | ≤3 times | 31(40.3) | 20(25.9) | 12(15.6) | 7(9.1) | 7(9.1) | 77(96.3) |
| >3 times | 3(100) | 0(0) | 0(0) | 0(0) | 0(0) | 3(3.7) |
| **History of parasite infection** | Yes | 24(45.3) | 14(26.4) | 10(18.85) | 6(11.3) | 3(5.7) | 54(71.3) |
| No | 10(23.5) | 6(26.1) | 2(8.7) | 1(4.3) | 4(17.4) | 23(28.7) |

In current result, it was showed that the study subjects who suffered from fever, cough, muscles pain, diarrhea, and abdominal pain had a higher rate of intestinal parasitic infection with non-statistical differences (*P*>0.05) as summarized in Table (4).

**Table 4.**Prevalence of parasite infection concerning signs and symptoms

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variables** | **Categories** | **Examined****No. (%)** | **Infected No. (%)** | **Non-infected No. (%)** | ***P*- value**  |
| **Fever** | Yes | 122 (62.6) | 51 (41.8) | 71 (58.2) | 0.395 |
| No | 73 (36.9) | 26 (35.6) | 47 (64.4) |
| **Cough** | Yes | 104 (53.3) | 44 (42.3) | 60 (57.7) | 0.392 |
| No | 91 (46.7) | 33 (36.3) | 58 (63.7) |
| **Muscles pain** | Yes | 107 (54.9) | 44 (41.1) | 63 (58.9) | 0.609 |
| No | 88 (45.1) | 33 (37.5) | 55 (62.5) |
| **Diarrhea** | Yes | 10.3 (52.8) | 46 (44.7) | 57 (55.3) | 0.119 |
| No | 92 (47.2) | 31 (33.7) | 61 (66.3) |
| **Abdominal pain** | Yes | 137 (70.3) | 60 (43.8) | 77 (56.2) | 0.059 |
| No | 58 (29.7) | 17 (29.3) | 41 (70.7) |

\*Significant association (*P*<0.05)

**Associations of risk factors with intestinal parasitic infections and anemia**

This result revealed that the high risk of anemia was associated with meal frequencya day (OR = 1.143; 95% CI=0.186-7.006) followed by study level (OR = 0.803; 95% CI=0.447-1445). Also, anemia prevalence was not statistically associated with all risk factors (*P*> 0.05) (Table 5).

**Table 5.**Associations of intestinal parasitic infections and anemia with risk factors

| **Variables** | **Categories** | **Examined****No. (%)** | **Infected No. (%)** | **Non-infected No. (%)** | ***P*- value** | **Anemia** | **OR****(95% CI)** | ***P*- value** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Yes** **n (%)** | **No** **n (%)** |
| **Age (in years)** | 7-11 | 83(42.6) | 34(40.9) | 49(59.1) | 0.718 | 12(14.25) | 71(85.5) | 0.648(0.346-1.213) | 0.168 |
| 12-15 | 112(57.4) | 43(38.4) | 69(61.6) | 25(22.3) | 87(77.7) |
| **Study level** | Primary | 126 (64.6) | 54 (42.9) | 72 (57.1) | 0.195 | 22(17.5) | 104(82.5) | 0.803(0.447-1445) | 0.240 |
| Preparatory | 69 (35.4) | 23 (33.3) | 46 (66.7) | 15(21.7) | 54(78.3) |
| **Number of children in the room** | 3-5 | 52 (26.7) | 22 (42.3) | 30 (57.7) | 0.883 | 13(25) | 39(75) | NA | 0.226 |
| 6-8 | 40 (20.5) | 12 (30.0) | 28 (70.0) | 7(17.5) | 33(82.5) |
| 9-12 | 103 (52.8) | 43 (41.7) | 60 (58.3) | 17(16.5) | 86(83.5) |
| **Meal frequency/day** | ≤3 times | 189 (96.9) | 74 (39.2) | 115 (60.8) | 0.595 | 36(19) | 153(81) | 1.143(0.186-7.006) | 0.884 |
| >3 times | 6 (3.1) | 3 (50.0) | 3 (50.0) | 1(16.7) | 5(83.3) |
| **History of parasite infection** | Yes | 150 (76.9) | 55 (36.7) | 95 (63.3) | 0.143 | 24(16) | 126(84) | 0.554(0.308-0.996) | 0.053 |
| No | 45 (23.1) | 22 (48.9) | 23 (51.1) | 13(28.9) | 32(71.1) |
| **Height (cm)** | 102-118 | 37 (19) | 18 (48.6) | 19 (51.4) | 0.187 | 7(18.9) | 30(81.1) | NA | 0.975 |
| 119-135 | 33 (16.9) | 13 (39.4) | 20 (60.6) | 8(24.2) | 25(75.8) |
| 136-152 | 75 (38.5) | 29 (38.7) | 46 (61.3) | 11(14.7) | 64(85.3) |
| 153-170 | 50 (25.6) | 17 (34.0) | 33 (66.0) | 11(22) | 39(78) |
| **Weight (kg)** | 21-30 | 85 (43.6) | 42 (49.4) | 43 (50.6) | 0.143 | 20(23.5) | 65(76.5) | NA | 0.335 |
| 31-40 | 70 (35.9) | 21 (30.0) | 49 (70.0) | 10(14.3) | 60(85.7) |
| 41-50 | 28 (14.4) | 8 (28.6) | 20 (71.4) | 5(17.9) | 23(82.1) |
| 51-60 | 12 (6.2) | 5 (33.3) | 7 (72.7) | 2(16.7) | 10(83.3) |
| **Nutrition status** | Underweight | 142 (72.8) | 57 (40.1) | 85 (59.9) | 0.587 | 29(20.4) | 113(79.6) | NA | 0.475 |
| Normal weight | 48 (24.6) | 19 (39.6) | 29 (60.4) | 7(14.6) | 41(85.4) |
| Overweight | 5 (2.6) | 1 (20.0) | 4 (80.0) | 1(20) | 4(80) |

\*Significant association (*P*<0.05),OR =odds ratio, CI =confidence interval,NA = not applicable

**Association between intestinal parasitic infections and anemia**

**Table 6** shows the association between intestinal parasitic infections and anemia that infected by *H. nana, A. lumbricoides* and *E. histolytica* were associated with an increased risk of anemia with (OR = 4.902, 95% CI=3.057-7.860), (OR = 4.196, 95% CI=3.057-7.860), and (OR = 3.229, 95% CI=1.878-5.552), respectively. Also, there were significant associations of intestinal parasitic infections with anemia (*P*<0.05) except *E. vermicularis*(*P*>0.05).

**Table 6.** Association between intestinal parasitic infections and anemia among study subjects

| **Parasite types** | **Result** | **Anemia** | **OR** **(95% CI)** | ***P*- value** |
| --- | --- | --- | --- | --- |
| **Yes n (%)** | **No n (%)** |
| *E. histolytica* | Positive  | 15 (44.1) | 19 (22.9) | 3.229 (1.878-5.552) | 0.000 |
| Negative  | 22 (13.7) | 139 (86.3) |
| *G. lamblia* | Positive  | 8 (40) | 12 (60) | 2.414 (1.284-4.538) | 0.011 |
| Negative  | 29 (16.6) | 146 (83.4) |
| *H. nana* | Positive  | 9 (75) | 3 (25) | 4.902 (3.057-7.860) | 0.000 |
| Negative  | 28 (15.3) | 155 (84.7) |
| *A. lumbricoides* | Positive  | 5 (71.4) | 2 (28.6) | 4.196(2.385-7.383) | 0.000 |
| Negative  | 32 (17) | 156 (83) |
| *E. vermicularis* | Positive  | 0 (0) | 7 (100) | 1.245(1.160-1.336) | 0.194 |
| Negative  | 37 (19.7) | 151 (80.3) |

\*Significant association (*P*<0.05), OR =odds ratio, CI =confidence interval

**DISCUSSION**

The overall rate of parasite infection was 39.49% reported among orphan children. Our finding **was in disagreement with the**reports**of**a previous study conducted in Yemen that reported the frequency rate of parasites infection was 61.85% in Sana’a**30,** 51.26% in Taiz**31,**61.85% in Amran**32,** 62.7% in Ibb**33**, 57.4% in Ibb**34,**73.25% inHajjah**35,** 61.25% in Amran 18**,** and 90% in Al-Mahweet36**.**

The difference in prevalence rate may be attributed to variations in geographical locations, study population, sample size, hygienic condition, socio-economic, food consumption behavioral differences, and diagnostic methods employed by the participants. However, the orphanage center may be contributing to reducing prevalence the of parasitic infections by proved safe foods and water and resident adhering to strong policies in behavior.

Regarding the age group, the age group of 7-11 years had a higher rate of intestinal parasitic infections significantly detected among aged between 7-11 years old (42.9%) compared to the age group of 12-15 years (38.4%) with non-statistical differences (P =0.718). This result is reliable to findings conducted in Yemen**31,37,38.**

It could be justified by the fact that the youngest group is more exposed to infection sources as a result of its habits related to playing and other outdoor activities. Poor environmental sanitation and personal hygiene are frequently revealed as the main contributors to the increased prevalence of intestinal parasites among study participants

However, the children who study at primary schools had a higher rate of parasite infection compared to children who study at preparatory schools. Correspondingly, another local investigation conducted among children showed that the students who attended the primary schools had a higher rate of pathogenic microorganisms **39-44**. Educational levels are crucial a significant factor that has been noticed in influencing parasitic infection 45**.**

In the present result, it was observed that participants who eat meals more than 3 times a day had a higher rate of parasitic infection (50%). The report by **Hailegebriel46**revealed **the**showed that meal frequency at most three times a day was associated with parasitic infection (OR=1.77; 95% CI: 1.03–3.05).

The current results revealed that the high rate of parasite infections has prevailed among study subjects who didn’t have a history of parasite infection (48.9%) with non-statistical significant differences (P > 0.05).

Moreover, the prevalence rate of parasite infection was significantly higher detected among participants between 102-118 cms in height at 48.6%, between 11-30 kg in weight (49.4%), and underweight (40.1%) non-statistical differences (P > 0.05).

In the present study, the anthropometric result showed that the highest rate of parasite infection was observed between 102-118 cms in height and between 21-30 kg in weight with non-statistical differences (P >0.05).

In relation to nutrition status, theunderweight participants were found to be had the highest rate of parasite infections (40.1%) and non-statistical differences (P =0.587). A similar study by **Al-Haidari**et al. **26 showed that**the prevalence rate of wasting, stunting, and being underweight among children was 25%, 45.8%, and 27.3%, respectively. Another study by **Degarege**et al**. 47** revealed that among the 532 children infected with parasites, 15.5% were stunted, 26.8% were underweight, and 35.8% were undernourished. The increased risk of anemia and undernutrition in children infected with intestinal parasitic infection was well documented in some studies**47,48,49.**

The present finding revealed that the most predominant parasite was E. histolytica (17.4%) among study subjects followed by G. lamblia (10.3%), H. nana (6.2%), A. lumbricoides (3.6%), and E. vermicularis (3.6%). This result is in agreement with several recently published studies. Recently, E. histolytica was the most predominant parasite detected among schoolchildren in Sana’a city at 49.32%, followed by G. lamblia (30.14%), H. nana (9.59%), Taenia species (6.84%), and A. lumbricoides (4.11%) 30. Also, in **Amran City,** the highest rate among children was E. histolytica followed by G. lamblia, H. nana, Schistosom mansoni, and E. vermiculari 32. However, **Qasem et al. 33** found that the most common intestinal parasites were E. histolytica followed by G. lamblia, A. lumbricoides, H. nana, and E. vermicularis reported among children in Ibb City.

Furthermore, this result showed that the majority of infected participants with intestinal parasites were found to be suffered from fever, cough, muscle pain, diarrhea, and abdominal pain with non-statistical differences (P >0.05). This result is in accord with Al-Haddad and Baswaid**50** and **Qasem et al.33**reported the signs and symptoms including blood in stool and suffering of abdominal pain, diarrhea, fever, cough, muscles pain, vomiting, itching skin, and weight loss associated with intestinal parasitic infection. In contrast, the association between some clinical symptoms and intestinal parasitic infections was documented by**Al-Fakih et al. 38.**

The existing study showed that 19% (37/195) of the participants had anemia and there were statistical differences between anemia and intestinal parasitic infection (P = 0.000). This result is lower than recent reports that presented anemia among children was 37.8% in Hodeida 51**,** and 31.7%**in Sana’a2.**The prevalence of anemia in some centuries was 21% in West Africa 52, 26.2% in Malaysia**53,**59.3% in Egypt 54, 12.4% in Eritrea 55**,**48.8% in Ethiopia 56**,** 14% in Tanzania 57**.** Schoolchildren aged 11–15 years were at two times higher risk of being anemic compared to the younger age group**26.**

The reason behind the high prevalence of anemia in Yemen may be attributed to some factors such as economic marginalization, poverty, household food insecurity, access to social protection, household-level environmental factors, and access to health care **59.**

In this finding, it was observed that the association between intestinal parasitic infections and anemia that H. nana, A. lumbricoides, and E. histolytica were associated with an increased risk of anemia with (OR = 4.902, 95% CI=3.057-7.860), (OR = 4.196, 95% CI=3.057-7.860), and (OR = 3.229, 95% CI=1.878-5.552), respectively. Also, there were significant associations of intestinal parasitic infections with anemia (P <0.05) except E. vermicularis (P >0.05). This result is inconsistent with somes reports conducted in some countries**26,51.**

**LIMITATIONS OF THE STUDY**

**CONCLUSION**

In conclusion, the high prevalence rate of intestinal parasitic infections, anemia, and malnutrition observed among orphan children is still a major public health concern in Yemen. Therefore, control strategies and effective preventions such as health education, nutrition education environmental hygiene practices, treating and deworming children regularly, and iron supplementation are important for reducing the incidence of intestinal parasitic infections in the study area. Also, further longitudinal studies should be performed to explore more on the causes of anemia among Yemeni children.

**CONFLICT OF INTEREST**

The authors declare that they have no competing interests.

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