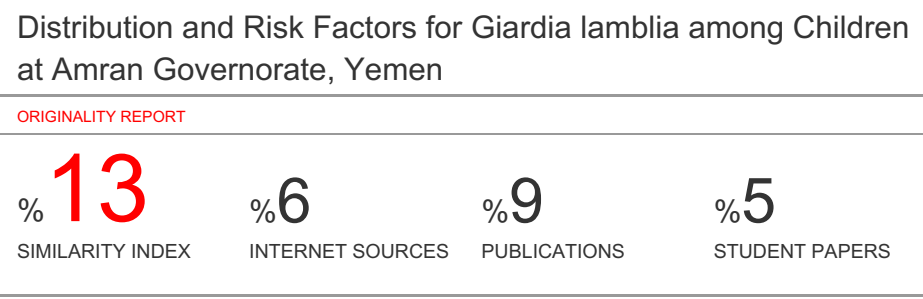
**Reviewer’s Comments**

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**Distribution and Risk Factors for *Giardia lamblia* among Children at Amran Governorate, Yemen**

**Abstract**

The high prevalence of *Giardiasis* infection is a worldwide public health problem and also predominantly among Yemeni children. Hence, this work was aimed to determine the *Giardia lamblia* prevalent infection and risk factors among children admitted to healthcare centers at Amran governorate in Yemen. 334 stool samples from infected children were collected between March and July 2019 and parasite identify by light-microscope according to standard parasitology methods. Also, relevant data were obtained using a designed questionnaire.

The results were showed that 181(54.2%) cases were infected with *G. lamblia* and 153 (45.8%) were non-infected. Also, 57.5% of infected children were from the urban area while 42.5% of cases from the rural area. The highest frequency of *G. lamblia* was 60.3% reported among males compared to 47.5% among females. Results regarding age and resident, male children aged 8─14 years in both urban and rural areas reported the highest prevalence of *G. lamblia* infection while the lowest was among females aged 1-7 years and 8-14 years, respectively, in the rural and urban area. The high infection of *Giardia* was found among the children who used unsafe water for drinking sources, eating unwashed vegetables and fruits, living in poor housing and living conditions, and didn’t wash their hands after defecation.

In conclusion, as highlighted in this work, multi-sectoral efforts that include health practices, personal hygiene habits, provision of safe drinking water, and provision of sanitation systems are needed to efficiently reduce this infection from all Yemen governorates.

**Keywords**: Giardiasis, Amran Governorate, *Giardia lamblia,* Prevalence, Yemen.

**INTRODUCTION**

*Giardia lamblia,* aflagellate intestinal protozoan, is probably among the most common observed gastrointestinal parasites in the world. Globally, it is one of the most frequent that are diarrhea-causing among 200 million cases reported annually particularly in infants, young children, and young adults in developing countries1,2. The highest prevalence of *G. lamblia* was recorded in developing countries between 10% and 50% compared between 2 to 5% in developed countries3,4.

However, *G. lamblia* is transmitted by consumption of contaminated food or water with mature cysts. Also, parasites transmission between community can occur via direct fecal-oral contact between family members and homosexual men5,6.

Giardiasis prevalence in Yemen is associated with some factors that including inadequate hygienic practices, environmentally contaminated with fecal, absences of health awareness, and the lack of health infrastructure. These factors are resulting from the current war started in March 2015 that destroyed the health system and increased the prevalence of infectious diseases especially among children suffering from severe malnutrition7.

A few of previous studies were reported the prevalence of *G. lamblia* infection among children in different governorates in Yemen; in Ibb governorate (23.6%)8, in Al-Mahweet governorate (3%)9, in Hadramowat (19.17%)10, and in Sana’a (16.7%)11.The Amran governorate lacks many epidemiological studies focusing on the prevalence and occurrence of intestinal parasitic infections between the residents. Hence, this work was aimed to determine the prevalence of *G. lamblia* infection and related factors among children attending primary healthcare centers at Amran governorate in Yemen.

**MATERIALS ANDMETHODS**

**Study Design and Area**

This study is a cross-section study that carried out at the medical laboratory at 22 May hospital in Amran City, Yemen, during the period from March to July 2019. This investigation was applied at Amran governorate in both of urban and rural areas; which is far away from north of Sana’a, the capital of Yemen about 50 km.

**Data Collection**

Prior to specimen collection, the objectives of the study were explained briefly to all infected children. A structured questionnaire that includes the data about the information of socio-demographic (i.e., age, gender, parents education, and residence),behavioral habits (i.e., hands washing after defecation and washing fruits and vegetables), and environmental conditions such as type of water supply and presence of absence of toilet was collected from the children’s parents or adult guardians via face-to-face interview. The age of participants in this study was categorized into two groups that were between 1-7 years and from 8 to 14 years.

**Sample Collection and Examination**

A total of three hundreds and thirty-four (334) stool specimens were collected from infected children in clean plastic containers (60 mL) and labeled. The collected samples were directly processed and analyzed by direct smear to identify the presence of *Giardia* parasites (cysts and/or trophozoites) from fresh stool. Also, the wet mount preparation was used after formal-ether sedimentation technique according to Cheesbrough12.

**RESULTS**

Three hundred and thirty-four (334) stool specimens were chosen of children from Amran governorate,160 (47.9%)specimens were from an urban area and 174 (52.8%) specimens from a rural area (Figure 1).

**Figure (1): The distribution of specimens among areas**

The present results were revealed that 181 (54.2%) cases were infected with *G. lamblia* parasite while153 (45.8%) were negative for *G. lamblia* infection.

Meanwhile according to resident, high rates of giardiasis 104(57.5%) were recorded in stool specimens belong the urban area compared to77(42.5%) cases from the rural area are shown in Figure (2).

**Figure 2: Rate and distribution of child infected and non-infected**

Table 1 shows that the high frequency of *G. lamblia* infection according to sex was105(60.3%) reported in males when compared to 76 (47.5%) of females were infected with *G. lamblia*.

**Table 1: The prevalence of *G. lamblia* infection concerning sex**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Resident** | **Male** | | | **Female** | | |
| **No. of Samples** | **Positive (%)** | **Negative (%)** | **No. of Samples** | **Positive (%)** | **Negative (%)** |
| **Urban** | 85 | 59 (69.4) | 26 (30.6) | 79 | 45 (56.9) | 34 (43.1) |
| **Rural** | 89 | 46 (51.7) | 43 (48.3) | 81 | 31 (38.3) | 50 (61.7) |
| **Total** | **174** | **105 (60.3)** | **69 (39.7)** | **160** | **76 (47.5)** | **84 (52.5)** |

The current results regarding gender and age showed that the highest prevalence of *G. lamblia* infection was reported among the age group of 8 to14 years (81.90%) in males followed by 61.9% was between the age group of 1-7 years in females recorded urban area. Similarly, the highest rate of *G. lamblia* was 55.8% and 40.5%, respectively, observed between each age group of 8 to14 years in males and females in a rural area (Figure 3).

**Figure 3: Distribution ofinfected childrenregarding gender and age**

The present work showed the associations between the frequency of *G. lamblia* infection and several behavioral and environmental factors. The higher prevalence of *G. lamblia* infection was (73.8%) found between parents of children with the uneducated level of education, used untreated water sources for drinking water (71.9%), eating unwashed vegetables and fruits (69.2%) and (66.4%), respectively. Also, the highest prevalence was (81%) observed between children lived in houses without toilets and those who didn’t wash their hands after defecation (74.5%) as summarized in Table (2).

**Table (2): Factors associated with *G.lamblia* infection among children**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | | **No. examined** | **Infected (%)** |
| **Parents’ educational status** | Graduate | 56 | 28(50.0) |
| Secondary | 79 | 44(55.7) |
| Primary | 119 | 50(42.02) |
| Not educated | 80 | 59(73.8) |
| **Source of drinking water** | Treated water | 100 | 36(36.0) |
| Not treated | 204 | 145(71.9) |
| **Washing vegetables before eating** | Yes | 242 | 118(48.8) |
| No | 91 | 63(69.2) |
| **Washing fruits before eating** | Yes | 191 | 86(45.0) |
| No | 143 | 95(66.4) |
| **Presence of toilet in a house** | Yes | 255 | 117(45.9) |
| No | 79 | 64(81.0) |
| **Hand washing after defecation** | Yes | 197 | 79(40.1) |
| No | 137 | 102(74.5) |

**DISCUSSION**

A total of 334 specimens of stools,160(47.9%) of an urban area and 174(52.8%) from a rural area,that collected of children were examined for presence *G. lamblia*. The overall rate of *G. lamblia* infection was 54.2% recorded between children. and 45.8% of cases were non-infected. This study revealed a higher frequency of *G. lamblia* infection among children than other studies in the governorate in Yemen as it was between 23.6% and 23.94% in Ibb8,13,3% in Al-Mahweet9,19.17% in Hadramowat10, and between 16.7% and 17.7% in Sana’a11,14.

The high frequency of *Giardia* infection between young children might be due to their lower standards of personal hygienic practices and sanitary behaviors when compared to adults and older children15,16.

Amran governorate is a developing region in Yemen and the life of most people depended upon agriculture and live with them domestic animals in the same house. Also, it is suffering from severe water reduction and people tend to collect drinking water from unclean water sources such as streams, wells, tanks, rains, and other natural or artificial sources. Moreover, it lacks the basic constituents in the health and educational systems that contribute to increasing the community awareness about the mode of disease transmission and methods to prevent and control these diseases17,18.

In current work, the highest prevalence of *G. lamblia* was 57.5% reported in an urban area compared to 42.5% in the rural area. In agreement with the unexpected results, Al-Haddad and Baswaid10found that *G. lamblia* infection was (33.57%) more prevalent in the urban area than (32.06%) in the rural area. Furthermore, a study conducted in Taiz city showed that the higher prevalence of intestinal parasitic infection was significantly recorded in the urban inhabitants than those in a rural area19. Also, Mekhlaﬁ *et al*.,7revealed that *G. lamblia* was 16.1% registered among schoolchildren in rural area of Sana’a between the period of 2013–2015.

It is difficult to explain the higher prevalence of *Guardia* parasite in the urban areas than the rural areas, but it may be due to some factors such as socio-demographic and socio-economic environmental of Amran city that does not differ in general than natural of habitats life in rural communities. In addition, the Amran city lacks the piped-water supply and sewage disposal as well as its population below than the poverty line are considered as factors that contribute to spreading the intestinal infection.

In the present study, it was revealed the male having a 60.3% higher prevalence of *Giardia* infection than a female with 47.5%.Similarly, the high rate of *Giardia* infection was reported by previous studies between males in Yemen; it was between 17-17.6% in Sana’a7,11,and 32.1% in Ibb8. In contrast, Qasem *et al.,*13 observed the high prevalence of *G. lamblia* was among a female with 64.4%. The higher prevalence of the *Giardia* infection among males in this work than females is due to the males in the study area are contributing to some works and they remain for a long time outside the home daily, making them more susceptible to *Giardia* infection than females.

Results from this work revealed that the highest infection rate (81.90%) was between the age group 8 to 14 years in males followed by (61.90%) among the age group of 1-7 years in females in the urban area. Whereas, a high prevalence of *Giardia* infection was 55.80% among males aged 8─14 years and lowest 35.90% between males aged 1─7 years in a rural area.

A similar study was investigated by Mekhlaﬁ *et al.,*7 and showed that the high rate of *G. lamblia* infection was (18.6%) recorded among less than 10 years. Also, Qasem *et al.,*13 also reported that the age group of 9-12 years was 51.1% highly infected by *G. lamblia*.

Findings of the current work showed that the prevalence rates of *Giardia* infection were influenced by the educational level of parents and the type of water sources used for the drink. The high prevalence of *Giardia* infection was more between children of parents with a low level of education. Also, the children who used the untreated water were more exposed to infection than used treated water. Moreover, children who eating unwashed vegetables and fruits as well as not used the toilet and not washed hands after defecation were found to be highly infected with *Giardia* infection. These results were supported by studies conducted in Yemen found a signiﬁcant association between *Giardia* infection and type of drinking water, methods of food preparation, and the statue of personal hygiene9,19.

Most people in the rural area depend totally on dams and surface water such as rivers and springs as a major source of drinking water because this area lacks deep wells. These types of water sources are easy to contaminated by intestinal parasites resulting from the human and animal sources during the rainy season and eventually, the people in rural area consume these contaminated water18,19. However, it was reported that the contaminated hands play an important role in transmitting fecal-oral in developing countries and washing hands after defecation or before eating have been considered as a secondary barrier20.

**CONCLUSIONS**

In conclusion, the results show that the prevalence of *Giardia* infection remains high among children and constitutes a major threat to the health system in developing countries. It was frequently observed among children living in poor communities lacking for good water supply, low personal hygienic practices, and poor health sanitary. Therefore, the different control measures are needed for combatting present levels of *Giardia* infection representing on implement the health programs that provide parents of children how to prevent infection among children, adequate personal hygiene, sufficient of water supply and good sanitary practices.

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**CONFLICT OF INTEREST**

The author declares no conflict of interest.

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