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# Prevalence and risk factors of Giardia lamblia among infants and children in Duhok province/Kurdistan Region, Iraq

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## ABSTRACT

The study was performed on 504 stool samples from infants and children with diarrhea who attended laboratories at Zakho General Hospital, Heevie Pediatric Hospital, Chamisku and Bersive 1 camps, and children who did not have diarrhea in various primary schools in Zakho between August 2021 and the end of July 2022. The study focused on 1 month of age to 15 years old. The collected stool specimens were examined macroscopically followed by microscopic examination using wet mount and concentration methods. The microscopic findings revealed an overall prevalence of Giardia lamblia at a rate of 6.15% (31/504), with slightly but non-significantly higher infection rate in males than in females (6.71% vs. 5.43%). The highest rate of infection was noted among the age group >3-6 years, while the lowest rate was among the age group >12-15 years, which were 11.76% and 1.45%, respectively. The infection rate was also twice as high among rural residents as compared to urban ones (10.34% and 3.32%), respectively. Infants and children who drink tap water had a high infection rate, whereas those drinking bottled water had a lower infection rate (8.05% and 1.92%), respectively. The infection rate was non-significantly higher in families with more than 6 members than in those with less than 6 members (7.06% and 5.22%) respectively. In terms of monthly infection distribution, the highest prevalence was reported in July (11.29%), while the lowest rate was recorded in February (2.27%). Finally, the statistical analysis revealed a significant relationship between infection and age group, residence, as well as the types of drinking water consumed, but non-significant relationship between infection and gender, number of family members and months of sample collection.

**KEY WORDS:** Giardia lamblia, prevalence, infants and children, risk factors, Duhok province, Kurdistan region, Iraq.

## 1. Introduction

Giardia lamblia, also known as Giardia intestinalis or Giardia duodenalis, is the most common and one of the top ten protozoan parasite infecting human small intestine and is a major cause of enteric infection worldwide, particularly in children (Farthing and Kelly, 2005; Kayser et al., 2005). Furthermore, giardiasis has a significant impact on human health in tropical and subtropical areas (Maru, 2015).

Giardia lamblia affects individuals all over the world, even those in rich nations, but it is more common in places with poor sanitation (El-Safi et al., 2013), causing more than 280 million new human cases each year (Einarsson et al., 2016). In developing nations, the frequency of infection ranges from 10% to 50%, particularly among young individuals in underprivileged areas (Daly et al., 2010). Giardia lamblia spreads primarily via contaminated water or food. Other contributing factors include unsanitary personal habits, unsafe water supplies, overcrowded housing, poor environmental sanitation, unsanitary living conditions, and lower economic conditions (Kayser et al., 2005)

Giardiasis can vary from asymptomatic to chronic or severe diarrhea and even persistent diseases. Asymptomatic hosts also can shed infectious cysts and serve as a disease transmission vector (Hanevik et al., 2009). The clinical symptoms of G. lamblia infection range from the lack of pathological indications to the emergence of diarrhea, stomach cramps, flatulence, losing weight, vomiting, and nausea (Kuick, 2004)

Giardiasis can be diagnosed by many methods such as passing a foul-smelling, clumsy, pale, non-bloody, mucoid, or watery stool (Despommier et al., 2017). Giardiasis can be detected by direct microscopic examination of a wet mount or the use of Lugol's

iodine solution (Kuick, 2004). The traditional method for diagnosing giardiasis is a microscopic stool examination for trophozoites or cysts. Cysts are oval in shape, measure 8-12 X 7-10 µm, and have four nuclei. Trophozoites are flattened, pear-shaped with two nuclei and four pairs of flagella (Yakoob et al., 2005)

Giardiasis is highly prevalent among youngsters in Iraq, according to several surveys on intestinal parasitosis (Al Saeed and Issa, 2006; Younas et al., 2008). Due to the availability of limited information on the prevalence of G. lamblia and its relationship with some risk factors among infants, children and adolescents in Duhok province, the present study was adopted to estimate the prevalence of G. lamblia among the above-mentioned groups and its correlation with some factors including; gender, age, residency, type of drinking water, number of family members and yearly months of sample collection, in Duhok province, Kurdistan region, Iraq.

## 2. Materials and Methods

### 2.1 Study Area

This study was conducted from August 2021 to the end of July 2022, in four areas in the province of Duhok, including the laboratories of Zakho General Hospital, Heevi Pediatrics Hospital, Chamisku and Bersive 1 Camps, in addition to certain primary schools in Zakho. The research region had a population of more than 549,606 people (AZNations, 2022)

### 2.2 Study Population

Infants and children from one month of age to 15 years old, of both genders, were included in the study after taking a verbal consent from parents of the infant, child or the adolescent in addition to approval from Zakho general directorate of health (700/3, 11th August 2021,). From each participant few grams of the stool samples was taken in a labeled clean sterile plastic container with the required information (gender, age, place of residence, type of drinking water, number of family members and the yearly months of sample collection) which were written in a questionnaire form designed for the study.

As soon as feasible, the samples were delivered in a cool box to the Microbiology laboratory at the University of Zakho/Biology department, for macroscopic and microscopic examination.

### 2.2 Macroscopic and Microscopic Examination

In the laboratory each stool specimen was examined visually for color, consistency, presence of mucous, blood and adult helminths. After that, the microscopic examination was conducted on each stool specimen to look for Giardia lamblia cyst and/or trophozoite using direct wet mount and Zinc sulfate flotation techniques. A clean glass slide was prepared, a

drop of normal saline was placed on one half, and a drop of Lugol's iodine was placed on the other half based on a technique developed by Brooke and Melvin (2001). The mixture was then combined with the stool specimens, and the results were viewed under a 40X magnification, from each specimen at least three slides were prepared and examined.

### 2.3 Statistical analysis

The data were evaluated following the research variables using frequencies and percentages after being calculated using the Chi-square of two independent sample using (SPSS, version 25 and GraphPad Prism, version 9.4.1).

### 2.4 Results

In this investigation, 504 stool specimens were examined microscopically for detecting G. lamblia infection. The overall rate of infection was 6.15% (31/504), while the remaining 93.85% of the examined specimens were negative as seen in Figure 1.

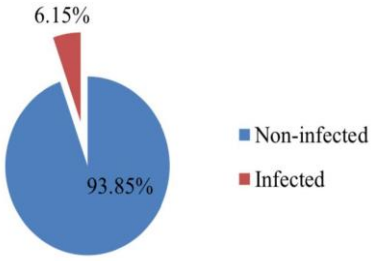


**Figure 1 Total prevalence of Giardia lamblia among infants and children.**

Males showed slightly higher prevalence of G. lamblia as compared to females (6.71% versus 5.43%), but the difference between both rates was statistically non-significant (P>0.05).

Infants and children were also separated into five groups based on their age as shown in Table 1. The highest infection rate (11.76%) was reported among ages >3-6 years, while the lowest rate (1.45%) was reported in the age group >12-15 years. Statistically, there were significant differences in the infection rates among enrolled infants and children at the probability level (P≤0.05).

Based on residency, infants and children were separated into two groups. Group 1 included infants and children who were from multiple places in the rural regions and group 2 who reside in Duhok city. The findings demonstrated that there were variations in the rates of giardiasis in the residents of both habitats. In rural regions, the infection rate was high (10.34%), while in urban areas, the infection rate was low (3.32%). Statistically, significant differences were observed in the infection rates between both places of residence at the probability level (P≤0.05).

Based on types of drinking water, infants and children were separated into two groups. Group 1 included infants and children who used tap water and group 2 those using bottled water. The results indicated that those drinking tap water had a higher infection rate than the group drinking bottled water (8.05% vs. 1.92%). Significant difference was observed in the infection rates between both groups (P≤0.05).

In accordance to the number of family members, infants and children were split into two groups. Families with less than six members made up group 1, while those with more than six members made up group 2. According to the results of the current study, infection rates varied with the number of family members. Families with more than six members had a high infection rate (7.06%), whereas those with less than six members had a low infection rate (5.22%), but this difference was statistically non-significant (P> 0.05) between both groups.

Based on the months of the year, infants and children were separated into eight categories. Each group has mentioned the month's name. The current study found that infection rates differed depending on the months. In July, the infection rate was the highest (11.29%), while in February, the infection rate was the lowest (2.27%). Statistically non-significant differences (P> 0.05) were observed in the infection rates among different months of the year.

**Table (1): Prevalence of Giardia lamblia among infants and children in relation to some variables (No= 504).**

| | | Giardiasis | | |
|---|---|---|---|---|
| | **Variables** | **No. of infected people** | **%** | **P value Chi-square** |
| **Gender** | Male | 19/283 | 6.71 | P>0.05 |
| | Female | 12/221 | 5.43 | $x^2$=0.3544 |
| **Age (years)** | 1 month to 3 years | 10/152 | 6.58 | P≤ 0.05 |
| | >3 – 6 | 14/119 | *11.76 | $x^2$ =4.472 |
| | >6 – 9 | 3/91 | 3.30 | |
| | >9 – 12 | 3/73 | 4.11 | |
| | >12 – 15 | 1/69 | 1.45 | |
| **Place of residence** | Rural | 21/203 | **10.34 | P≤0.05 |
| | Urban | 10/301 | 3.32 | $x^2$ =10.36 |
| **Type of drinking water** | Municipal tap water | 28/348 | **8.05 | P≤0.05 |
| | Purified bottled water | 3/156 | 1.92 | $x^2$= 6.996 |
| **Number of family members** | Less than 6 members | 13/249 | 5.22 | P>0.05 |
| | More than 6 members | 18/255 | 7.06 | $x^2$= 0.7372 |
| **Months of the year** | September | 6/82 | 7.32 | P>0.05 |
| | October | 3/63 | 4.76 | $x^2$= 2.511 |
| | November | 2/71 | 2.82 | |
| | December | 2/57 | 3.51 | |

| | | |
|---|---|---|
| January | 1/42 | 2.38 |
| February | 1/44 | 2.27 |
| June | 9/83 | 10.84 |
| July | 7/62 | 11.29 |

*Statistically significant at P≤ 0.05.

**2.5 Discussion**

In the current study, the frequency of G. lamblia infection in diarrheic and non-diarrheic infants and children in Duhok province was 6.15%. This result is more or less similar to studies conducted in Duhok province, Iraq by Ashour and Ashour (2021), Khudhair (2020) in Erbil province and Chamchamal (in Sulaimani province, Kurdistan region) and Al-Marzoqi (2004) in Babel province, Iraq, where the rates of infection with G. lamblia were 5.61%, 4.2%, and 5.4%, respectively. While the current result disagrees with the earlier studies conducted by Al-Saeed and Issa (2006) in Duhok, Hussein (2010) in Thi-Qar, southern Iraq and Salman et al. (2016) in Kirkuk province among displaced people, where they reported much higher rates of infection with G. lamblia which were 38.5%, 23.7%, and 10.31%, respectively. The discrepancies in these results could be attributed to ecological, dietary, economic, geographic location, ethnic and health-related activity, as well as the number of samples in the screened research and the diagnostic method used (Jaeffer, 2011)

The exposure to G. lamblia may not differ much between genders; especially in urban areas where both males and females have the same opportunity to study and go out playing (Al-Warid, 2012). This finding is in agreement to previous research such as, Al-Ibady (2017) in Baghdad province and Núñez et al. (1999) in Havana City, Cuba, they did not find any significant differences in Giardia lamblia infection rates between both genders. On the other hand, this finding disagrees with previous research by Al-Warid (2012) in Northern Baghdad and Al-Shaheen et al. (2007) in Basra, who have shown significant differences in rates of G. lamblia infection between both genders.

As regards to age, the highest rate (11.76%) was reported among the age group >3–6, with statistically significant relationships between the infection rates and the patients' ages at probability level (P≤0.05). This result agrees with Haydar (1993) study in Erbil, who found significant differences in the infection rates between different age groups. However, the current study's finding disagrees with Kadir et al. (2006) in Kirkuk and Vahedi et al. (2012) in Northern Iran, who found non-significant differences in the infection rates between different age groups. The high rate of giardiasis among this age group may be attributable to the fact that children between the ages of 3 and 6 years are more active, less conscious of safe and hygienic rules like hand washing before eating and after using the bathroom, and more likely to habitually put their fingers in their mouths. Additionally, because children in this age range are keener to taste new things than children in older age groups and because they have weaker immune systems, this may increase the prevalence in this age group (Al-Jabouri. 2010)

At the likelihood level in this investigation, there were significant differences in the infection rates between residencies (P≤0.05). This finding was in line with the results of Al Saqur et al. (2017) across Iraqi provinces and Jaran (2016) in Northern Jordan, which revealed significant variations in infection rates depending on residency. The greater infection rate found in rural areas may be related to the nature of life there, which includes drinking water from filthy sources like rivers or streams, coming into contact with animals, and using their untreated droppings to fertilize vegetables (Al-Ammash, 2015). Contrary to what we reported, a study conducted in Samara city by Al-Ammash (2015) found non-significant variations in infection rates based on residence.

Other studies in this direction also, showed that infants and children who consume water directly

from the tap had the highest infection rates, followed by those who used bottled water. Significant differences were observed in the infection rate between types of drinking water and comparable results were found by Asrat et al. (2011) in North Gondar, Ethiopia and Abdullah et al. (2016) in Kashmir Valley, India who have also demonstrated that the infection rate varies significantly depending on the type of drinking water used.

The current findings revealed the presence of non-significant relationship between family size and the rate of infection. This result agrees with a study conducted in northern Baghdad by Al-Warid (2012) who found non-significant difference in the infection rates between household members. The chances of G. lamblia infection rose by about 50% for each new household kids, whereas the number of household adults was inversely linked with the risks of giardiasis, with the odds decreasing by about 50% for each extra adult in the family (Pereira et al., 2007). The number of samples taken and the presence of more young adults among the family members may be to blame for these results.

The results of the present study revealed no association between the study months of the season and giardiasis, even though the rates were highest in July (11.29%) and lowest in February (2.27%). This finding was in line with a study carried out by Khudhair (2020) among residents of Hawler, Soran and Chamchamal Cities, North of Iraq and Butty (2011) in Nineveh, Iraq while disagree with a study by Al-Saad and Al-Emarah (2014) in Basrah, Iraq and Ashour and Ashour (2011) in Duhok province where they found a substantial correlation between the period of the study and G. lamblia infection. Different rates of infection perhaps were determined by several variables, including the quantity of samples, the environment, immunological status, stress, age, and gender (Butty, 2011)

## 3. Conclusions

This study demonstrated that the prevalence of G. lamblia was low (6.15%), and that there is a significant association between infection and age, residence, as well as the types of drinking water used, but non-significant relationship observed between infection and gender, number of family members of infected individuals and months of the sample collection.

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## 5. Conflict of interest

The current study has no conflicts of interest.

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