

PREVALENCE OF *GIARDIA LAMBLIA* IN DIARRHEA IN SOME HEALTH CENTERS IN DUHOK CITY, IRAQ

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ABSTRACT

Giardia lamblia is an intestinal protozoan disease that is common in developing nations, particularly among children, as a result of inadequate sanitation, poor sewage drainage, and a lack of attention to personal health. The purpose of this study was to estimate the incidence and identify the risk factors for *Giardia lamblia* infection in children who had been attended in different health centers in Duhok city, North of Iraq. A total of 642 fecal samples were collected from children aged from (0 - 6) years in different health centers in Duhok city during the period between June 2022 to November 2022, and were examined for detection of *Giardia lamblia* by using direct microscopic examination and floatation method. Out of 642 samples examined, 61 (9.50%) were positive for *Giardia lamblia*. The age group (5-6) years had the highest rate of infection (16.74%). The prevalence rate among males (10.09%) was higher than females (8.88%). According to months the greatest rates of infection being observed in June and July (2.80 and 2.65%, respectively), and lowest rate was observed in November (0.16%). Based on the results of this study, it is concluded that the prevalence of *Giardia lamblia* parasite in Duhok cities is still high and it's required effective techniques and plans to stop the spread of these parasites.

KEYWORDS: prevalence, giardia lamblia, children, duhok, iraq.

1. INTRODUCTION

Diarrhea is one of the most prevalent disorders, and it causes mortality due to a lack of bodily fluids, which causes severe dehydration (Kolsin et al., 2018). Viruses, bacteria, and parasites infections are the major causes of diarrhea, among the most important intestinal parasites, *Giardia lamblia* is widespread throughout the world and is commonly found in warm moist areas. Infections with intestinal parasites are common in undeveloped countries due to unhealthful conditions, poor living conditions, overcrowded housing, inadequate sewage drainage, and lack of attention to individual health (Ugboko et al., 2020).

Giardia lamblia, which known as *Giardia duodenalis* or *Giardia intestinalis*, is the most frequently protozoon invading the small intestine of humans, especially in children, it has an infection rate of about 280 million cases annually with no life-threatening (Espinosa Aranzales et al., 2018; Zajackowski et al., 2019). The four of *Giardia lamblia* is variable ranges between 2% to

5% in industrialized countries and 20% to 30% in developing countries. The more infection of this prevalence consists of children under the age of five years, particularly those who are malnourished (Newman et al., 2001; Al-Mekhlafi et al., 2005).

Humans become infected with *giardia lamblia* through contaminated water and food with cyst stage (Mama & Alemu, 2016; Quihui-Cota et al., 2017). *Giardia lamblia* has two stages in its life cycle: trophozoite and cyst. Trophozoites cause clinical illness in people by adhering to the walls of the small intestine. Whereas on the other side, cysts are an infectious stage of the disease, resistant to environmental for up to two months and are responsible for the spread of disease. The illness is occurred by ingesting mature cysts together with contaminated food and drink. After cyst ingestion, excystation takes place in the duodenum region of the small intestine, releasing trophozoites (Mahmud Tariq, 2016).

The common signs of giardiasis include diarrhea, steatorrhea, malaise, abdominal pain, flatulence, gas, pale, oily, foul-smelling feces, and

weight loss. Low levels of intestinal enzymes and disaccharides are seen, and there are also problems with fat, lactose, vitamin A, and vitamin B12 absorption (Kumar et al., 2016).

The diagnosis is established on the patients' clinical symptoms, and it is supported by finding cysts and trophozoites in fecal samples by direct examination under a microscope, and through the enzyme-linked immunosorbent assay (ELISA) in stool samples for detected the antigens (Júlio et al., 2012).

This parasite is widespread in Iraq. The infection rate of the parasite was recorded in Thi-Qar was 23.7% (Hussein, 2010), in Tikrit was 14.30% (Ahmad Hama Hasan et al., 2020), and it was recorded at 5.61% in Duhok (Abbas Ashour & Abbas Ashour, 2021), and was 4% in Karbala (Ubaid & Ubaid, 2022).

The present study's objectives were to determine the prevalence of *Giardia lamblia* among children from some health centers in Duhok province, and identify its possible associated risk factors include gender, age group, educational of the parents and the months of the year when the infection occurs

2. MATERIAL AND METHODS

Study design and period: An epidemiological study was carried out to detect the prevalence of *Giardia lamblia* infection among the patients of the different health center in Duhok governorate, Iraq. The study included the effect of age, gender, educational of the parents on infection rates for the period June 2022 till November 2022.

2.1. Collected sample

The current investigation examined 642 fecal samples were collected from children age under Six years with diarrhea who attended in health center of both sexes. A trained member of the medical staff took a feces sample of Five–Ten grams from each kid and placed it in a sterile plastic container and labeled it with the person's date of birth, name, and gender. At first, each stool sample was examined with the naked eye to detect the color, texture of stool and presences of adult helminths, they were then samples were examined immediately under a microscope within a period not exceeding half an hour for detect any trophozoites or cysts of *Giardia lamblia* by direct wet mount and flotation method.

Direct wet mount method: For each sample, two smears of direct wet film preparation were performed at the same time, one of which was done with normal saline to identify the actively moving trophozoites, while the second slide was stained with Lugol's iodine (5%) to show the interior structures (Cedric et al., 2019). In this method small piece of stool put on clean glass slide, and then small drop of Lugol's iodine 5% or 1-2 drops of 1% eosin solution or normal saline were added to the suspension and mix well using wooden sticks slide cover was put well, and the smear was examined thoroughly under the low (10X) and high (40X) powers of the microscope.

Flotation Method: One of the most effective solutions used in the floatation process is zinc sulfate solution. one g of feces was mixed with 10 ml of normal saline, and the mixture was then filtered through gauze. The liquid was then placed in a test tube and centrifuged (Fisher Scientific, USA) at 3000 rpm for two min to separate the clear supernatant from the sediment, and the sediment was then washed again and centrifuged at 3000 rpm for two min, the supernatant removed. The zinc sulfate solution was added to the precipitate and centrifuged for two min at a speed of 3000 rpm. The foam on top was removed with a pipette and placed on a clean slide, and one drop of Logol's iodine was added. The slide was then examined under a microscope at 40X and then 100X magnification (Ul Haq et al., 2015).

2.2. Statistical analysis

Data were analyzed using Chi-square test by SPSS program version 22. P-values under 0.05 were regarded as statistically significant.

3. RESULTS

The present study was conducted on 642 child patients suffering from diarrhea who attended in different health center in Duhok during the study period, comprising 327 males and 315 females ranging in age from 0 to 6 years.

Throughout the study period, the overall prevalence rate of parasitic infection was recorded for *Giardia lamblia* (9.50%), i.e., 61/642 fecal samples were positive for giardiasis according to the direct method under a microscope, while the remaining (90.49%) were negative as shows in (Figure 1), and the differences was statistically non-significant ($P>0.05$).

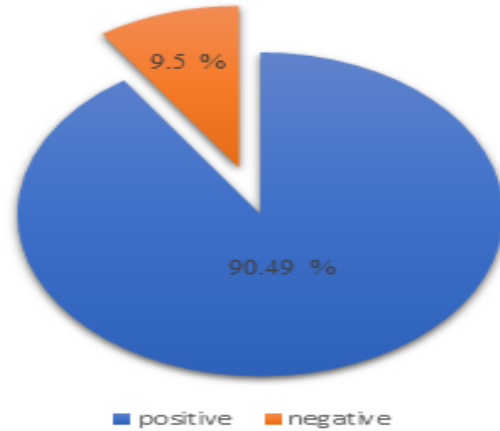


Fig.(1):- Total prevalence of *Giardia lamblia* infection

Based on the gender, the prevalence of giardiasis in male's child was higher than (10.09%), than when compared to infection among female's children was (8.88%) as showed

in Table (1). The study's findings revealed that there was no statistically significant difference between the two sexes' infection rates at the probability level ($P > 0.05$).

Table (1):- The prevalence of *Giardia lamblia* among people according to gender

Gender	No. of examined people	No. of infection people	%
Female	315	28	8.88
Male	327	33	10.09
Total	642	61	9.50
$\chi^2: 0.2700$		P value: 0.6034	

According to age groups, the rate of infection varied a cross different age groups of children as shown in Table (2). The highest rate of infection was 16.74% (34 infection cases) in the age group 5-6 years, and the lowest rate of infection was

5.52% (18 infection cases) in the age group 3-4 years. Statistical analysis showed the presence of significantly highly difference ($P < 0.01$) in the rates of infection with *G. lamblia* between the children in the three age groups.

Table (2):- Shows the percentage of infections with *Giardia lamblia* by age

Age group	No. of examined people	No. of infection people	%
1-2	113	9	7.96
3-4	326	18	5.52
5-6	203	34	16.74
Total	642	61	9.50
$\chi^2: 18.72$		P value: <0.0001	

The current study recorded the infection with *Giardia lamblia* parasite, according to six months of the year, and the highest percentage of infection was in June (2.80 %) followed by July (2.65%), while the lowest incidence was observed in

November (0.16%), as shown in Table (3), there were changes in infection rates between the months of the year that were statistically significant ($P < 0.05$).

Table (3):- Distribution of *Giardia lamblia* according to months

Month	No. of examined people	No. of infection people	%
June	144	18	2.80
July	136	17	2.65
August	111	13	2.02
September	97	8	1.25
October	87	4	0.62
November	67	1	0.16
Total	642	61	9.50
χ^2 :11.17		P value: 0.0482	

The results of the study show the children of uneducated fathers had a higher risk of *Giardia lamblia* infection than did children of educated fathers (7.16 and 2.33%, respectively). Similarly, children whose moms had no education were more likely to contract *Giardia lamblia* than children

whose mothers had an education (5.29 and 4.20%, respectively), as shown in Table (4). Statistical analysis revealed that there were highly significant differences ($P < 0.01$) according to the educational level of the parents among children.

Table (4):- The prevalence of *Giardia lamblia* infection according to the educational of the fathers and mothers

Parents		No. of examined people	No. of infection people	%
Fathers	Educated	154	15	2.33
	Not educated	488	46	7.16
Mothers	Educated	281	27	4.20
	Not educated	361	34	5.29
Total		642	61	9.50
χ^2 :87.13		P value: <0.0001		

4. DISCUSSION

According to a study received by the WHO and UN, diarrheal illnesses, such as giardiasis, are more prevalent among individuals in poor countries and are responsible for a considerable amount of morbidity and mortality rates generally among children under the age of five globally (Al-Fahadawi et al., 2017). The current study identified the incidence of *Giardia lamblia* infection among children in several Duhok health centers as well as the potential risk factors connected to giardiasis cases. In this kind of investigation, giardiasis infection was found by direct examination under a microscope or the floatation technique.

In the current study, the incidence of infection with *Giardia lamblia* in diarrheic children in Duhok was (9.05%), which is more or less similar to many studies in Iraq, including in Duhok city (M Abdullah, 2017), in Baghdad governorate (Saeed Jaeffer, 2011), and in Al-Najaf province (Mohy et al., 2022), where the incidence of *Giardia lamblia* infection was 9.5%, 10.72% and

9.77%, respectively. This result is also in disagreement with studies in other parts of the Iraq, conducted in Duhok city was 38.5% by (Al-Saeed & Issa, 2006), in Babylon Province was 28% (Khorsheed Rasheed et al., 2020), in Duhok Province was 15.55% (Haji et al., 2023), and in Karbala city was 4% (Ubaid & Ubaid, 2022). There are several causes of infection could be related to number of factors including poor hygiene, congestion, low socioeconomic level, and environmental conditions.

This study recorded the rate of infection with *Giardia* in male was higher than in female, which is consistent with other studies were reported in Karbala city (Ubaid & Ubaid, 2022), in Duhok city (Abbas Ashour & Abbas Ashour, 2021), in Babylon province and in Kirkuk (Khorsheed Rasheed et al., 2020), where the recorded an infection rate in males were (5.8%, 6.12%, 42.8% and 34.14%) higher than in females (4.1%, 5.4%, 9% and 32.85%), respectively. While it differs with other studies carried out like in Missan (Samer & Al-Mosawel, 2021), in Duhok (Haji et al., 2023) and in Baghdad (Saeed Jaeffer, 2011),

the following studies recorded the infection in females more than (35.86%, 64.5% and 11.84%) the males (16.59%, 35.5% and 9.82%), respectively. The higher rate of infection in male may be due to the fact that males are the most mobile and activities and as they were more in contact with environmental conditions than female, and this increases the chances of infection. The variation in infection rates between men and women may be attributable to the host's hormonal, behavioral, and immunological response (Sellau et al., 2020).

With regard to the effect of age on the rate of infection with *G. lamblia*, the current study revealed that the highest infection rate was recorded 16.74% among children aged 5-6 years, while the lowest infection rate was recorded 7.96% at the age of 1-2 years, perhaps because parents are responsible for their hygiene. These results are less or more similar with previous findings from Tikrit city (Ahmad Hama Hasan et al., 2020), he reported the highest infection 17.61% in the 4-6 years age group, also, in Duhok city (Haji et al., 2023), recorded with the highest percentage of infection 40.9% in the 4-6 years age group. It did not agree with in Brazil (Pereira et al., 2007), in Thi-Qar province (Hussein, 2010) and in Duhok city (Abbas Ashour & Abbas Ashour, 2021), all of them recorded the highest incidence were (19.72%, 33.3% and 46.15%, respectively) in the age group 2-4 years. The result in this study may be due to the 5-6 years children, are the most active movable, and have less awareness of hygiene rules such as washing hands before eating, and after using the toilet, and the practice of usually putting fingers in the mouth, and the rate of their exposure to the infectious stages of the parasite is high, this may increase the incidence in this age group (Wegayehu et al., 2013).

About the distribution of *G. lamblia*-infected child throughout months of the year. The most contaminated cases with *G. lamblia* were recorded in June (2.80%) and July (2.65%), which is consistent with the findings of (Abbas Ashour & Abbas Ashour, 2021), as it registered the greatest rate of infection in the month of June (10.09%). Also, that is in agreement with (Yousif Ali et al., 2022) where the highest incidence was recorded in the summer months of July and June by 11.29%

and 10.84%, respectively. While the lowest incidence in this study was recorded in November (0.16%), it is in agreement with, as it recorded the lowest rate of infection in November which was (3.2%). Giardiasis is more common in the summer because of the accessibility of favorable circumstances for the parasite's growth, an increase in the consumption of water and juice, the consumption of ice formed from unpurified water as well as the presence of insects that serve as mechanical vectors for the parasite cysts. Perhaps the winter's lower infection rate might be attributed to the colder temperatures, which might cause the parasites to die (Akil Khudhair Al-Daoudy et al., 2020).

The results from the present study showed that the low level of education of the parents was greater the risk of *Giardia lamblia* infection, this is supported by results from earlier research done in Iraq and throughout the world, in Tehran (Newman et al., 2001), in Mexico (Quihui et al., 2006). in Kirkuk (Khorsheed Rasheed et al., 2020), in Portugal (Júlio et al., 2012), in Malaysia (Choy et al., 2014), in Pakistan (Naz et al., 2018), in Tikrit city (Ahmad Hama Hasan et al., 2020), all of them they discovered that child with uneducated parents had the greatest infection rate. This may be because the socioeconomic position of the parents is also influenced by their educational level, and lower socioeconomic status is associated with worse hygienic and sanitary conditions and neglect of prevention methods.

5. CONCLUSIONS

we conclude from the current research *Giardia lamblia* is the enteric parasites associated with diarrhea in a child, males are more infection than females, and the most infection rates were found in ages (5-6 years). There was a significant association between effect of age, the number of cases of infection by month's distribution, as well as the educational level of the parents, but non-significant relationship observed between the total rates of infection and gender.

Conflict of interest

The authors declare no conflict of interest regarding the publication of this manuscript.

6. REFERENCES

- Abbas Ashour, A., & Abbas Ashour, A. (2021). Epidemiological Study of Giardia Intestinalis parasite Among Children with Diarrhea in Duhok. *Diyala Journal For Pure Science*, 17(1), 60–72. <https://doi.org/10.24237/djps.17.01.538b>.
- Ahmad Hama Hasan, T., Khaleq Alwan Muhaimid, A., & Rashid Mahmoud, A. (2020). Epidemiological Study of Giardia lamblia in Tikrit city, Iraq. In *Systematic Reviews in Pharmacy* (Vol. 11, Issue 9).
- Akil Khudhair Al-Daoudy, A., Mohammad Ismail, S., Yassin Ezadin, Z., & Kakl Ahmad, D. (2020). Prevalence of Giardia lamblia among Residents of Hawler, Soran and Chamchamal Cities, North of Iraq. *Pak-Euro Journal of Medical and Life Sciences*, 3(2), 28–36. <https://doi.org/10.31580/pjmls.v3i2.1388>
- Al-Fahadawi, S. M., Al-Ani, S. F., & Yaseen, Y. G. (2017). Detection of genotypes for Giardia lamblia in Iraqi patients feces by using PCR-RFLP techniques based on GDH gene characterization. *J. of University of Anbar for Pure Science*, 11(2), 18-24.
- Al-Mekhlafi, M. S. H., Azlin, M., Nor Aini, U., Shaik, A., Sa'iah, A., Fatmah, M. S., Ismail, M. G., Ahmad Firdaus, M. S., Aisah, M. Y., Rozlida, A. R., & Norhayati, M. (2005). Giardiasis as a predictor of childhood malnutrition in Orang Asli children in Malaysia. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 99(9), 686–691. <https://doi.org/10.1016/j.trstmh.2005.02.006>
- Al-Saeed, A. T., & Issa, S. H. (2006). Frequency of Giardia lamblia among children in Dohuk, northern Iraq. In *Eastern Mediterranean Health Journal* (Vol. 12, Issue 5).
- Cedric, Y., Alhadj Moussa Ibrahim, M., Roméo Ngangnang, G., Signaboubo, D., Khan Payne, V., Mahamat Alhadji Moussa, I., Kollins Nfor, E., Ghislain Romeo, N., Megwi, L., Mbida, M., Ramesh Kumar, K., & Baba Victor, O. (2019). Prevalence of Gastro-intestinal Parasitic Infections among Patients in Bafia Health District, Center Region Cameroon: A Retrospective Study. In *South Asian Journal of Parasitology* (Vol. 3, Issue 1).
- Choy, S. H., Al-Mekhlafi, H. M., Mahdy, M. A. K., Nasr, N. N., Sulaiman, M., Lim, Y. A. L., & Surin, J. (2014). Prevalence and associated risk factors of Giardia infection among indigenous communities in rural Malaysia. *Scientific Reports*, 4. <https://doi.org/10.1038/srep06909>
- Pereira, M.G.C.; Atwill, E.R. & Barbosa, A.P. (2007). Prevalence and associated risk factors for Giardia lamblia infection among children hospitalized for diarrhea in Goiânia, Goiás State, Brazil. *Revista do Instituto de Medicina Tropical de São Paulo*, 49(3): 139-145.
- Espinosa Aranzales, A. F., Radon, K., Froeschl, G., Pinzón Rondón, Á. M., & Delius, M. (2018). Prevalence and risk factors for intestinal parasitic infections in pregnant women residing in three districts of Bogotá, Colombia. *BMC Public Health*, 18(1). <https://doi.org/10.1186/s12889-018-5978-4>
- Haji, H. M., & Bamarni, S. S. I. (2023). PREVALENCE OF ENTAMOEBA HISTOLYTICA AND GIARDIA LAMBLIA IN CHILDREN IN DUHOK PROVINCE, KURDISTAN REGION, IRAQ. In *Journal of University of Duhok*, 26(1), 274-280.
- Júlio, C., Vilarés, A., Oleastro, M., Ferreira, I., Gomes, S., Monteiro, L., Nunes, B., Tenreiro, R., & Ngelo, H. (2012). Prevalence and risk factors for Giardia duodenalis infection among children: A case study in Portugal. *Parasites and Vectors*, 5(1). <https://doi.org/10.1186/1756-3305-5-22>
- Khorsheed Rasheed, Z., Farhood Jumaah, L., Sakran Abass, K., Ahmed Mohammed, B., Khorsheed Rasheed, Z., Jumaah Jihad, L., & Author, C. (2020). Frequency of Giardia lamblia among Iraqi children in Kirkuk governorate The influence of different variables on adverse effect of dental local anesthesia in Kirkuk City View project Frequency of Giardia lamblia among Iraqi children in Kirkuk governorate. In *Systematic Reviews in Pharmacy* (Vol. 11, Issue 12). <https://www.researchgate.net/publication/345317954>
- Hussein, T. kh. (2010). PREVALENCE AND RELATED RISK FACTORS FOR GIARDIA LAMBLIA INFECTION AMONG CHILDREN WITH ACUTE DIARRHEA IN THI-QAR , SOUTHERN IRAQ. *Thi-Qar Medical Journal*; Vol(4) No(4): 68-74.
- Kolsin, J. M., Lopman, B. A., Payne, D. C., Wikswo, M. E., Dunn, J. R., Halasa, N. B., & Hall, A. J. (2018). Evaluating Previous Antibiotic Use as a Risk Factor for Acute Gastroenteritis among Children in Davidson County, Tennessee, 2014-2015. *Journal of the Pediatric Infectious Diseases Society*, 7(3), E86–E91. <https://doi.org/10.1093/jpids/piy044>
- Kumar, S., A., V., & gh, S. (2016). Prevalence of Entamoeba histolytica and Giardia lamblia infection in a Rural Area of Haryana, India. *International Journal of Current Microbiology and Applied Sciences*, 5(6), 204–209. <https://doi.org/10.20546/ijcmas.2016.506.024>

- M Abdullah, A. (2017). Prevalence of Intestinal Parasites (Entamoeba species and Giardia lamblia) in Duhok and Erbil cities, Northern Iraq. *Journal of Microbiology & Experimentation*, 4(6). <https://doi.org/10.15406/jmen.2017.04.00132>
- Mahmud Tariq, T. (2016). *Prevalence of Giardiasis in Afghan Population*. <https://www.researchgate.net/publication/287318505>
- Mama, M., & Alemu, G. (2016). Prevalence and factors associated with intestinal parasitic infections among food handlers of Southern Ethiopia: Cross sectional study Infectious Disease epidemiology. *BMC Public Health*, 16(1). <https://doi.org/10.1186/s12889-016-2790-x>
- Mohy, A. A., Al-Hadraawy, S. K., Falah hasan hadi, ALhadrawi, K. K., & Jaloob Aljanaby, A. A. (2022). Incidence and age distribution of Giardia lamblia infection for sex years in Al-Najaf province in Iraq. *Journal of Pharmaceutical Negative Results*, 13, 1041–1046. <https://doi.org/10.47750/pnr.2022.13.S06.138>
- Naz, A., Nawaz, Z., Rasool, M. H., & Zahoor, M. A. (2018). Cross-sectional epidemiological investigations of Giardia lamblia in children in Pakistan. *Sao Paulo Medical Journal*, 136(5), 449–453. <https://doi.org/10.1590/1516-3180.2018.0350060918>
- Newman, R. D., Moore, S. R., Lima, A. A. M., Nataro, J. P., Guerrant, R. L., & Sears, C. L. (2001). A longitudinal study of Giardia lamblia infection in north-east Brazilian children. *Tropical Medicine and International Health*, 6(8), 624–634. <https://doi.org/10.1046/j.1365-3156.2001.00757.x>
- Quihui-Cota, L., Morales-Figueroa, G. G., Javalera-Duarte, A., Ponce-Martínez, J. A., Valbuena-Gregorio, E., & López-Mata, M. A. (2017). Prevalence and associated risk factors for Giardia and Cryptosporidium infections among children of northwest Mexico: A cross-sectional study. *BMC Public Health*, 17(1). <https://doi.org/10.1186/s12889-017-4822-6>
- Quihui, L., Valencia, M. E., Crompton, D. W. T., Phillips, S., Hagan, P., Morales, G., & Díaz-Camacho, S. P. (2006). Role of the employment status and education of mothers in the prevalence of intestinal parasitic infections in Mexican rural schoolchildren. *BMC Public Health*, 6. <https://doi.org/10.1186/1471-2458-6-225>
- Saeed Jaeffer, H. (2011). Prevalence of Gairdia lamblia and Entamoeba histolytic /Entamoeba dispare infections among Children in AL-Shulaa and AL-khadimya –Baghdad-Iraq. *Journal of University of Anbar for Pure Science*, 5(2), 6–10. <https://doi.org/10.37652/juaps.2011.44106>
- Samer, S., & Al-Mosawe1, E. (2021). *Study of Prevalences of Giardia Lamblia in a Missan Governorate* (Vol. 25). <http://annalsofrscb.ro>
- Sellau, J., Groneberg, M., Fehling, H., Thyte, T., Hoenow, S., Marggraff, C., Weskamm, M., Hansen, C., Stanelle-Bertram, S., Kuehl, S., Noll, J., Wolf, V., Metwally, N. G., Hagen, S. H., Dorn, C., Wernecke, J., Ittrich, H., Tannich, E., Jacobs, T., ... Lotter, H. (2020). Androgens predispose males to monocyte-mediated immunopathology by inducing the expression of leukocyte recruitment factor CXCL1. *Nature Communications*, 11(1). <https://doi.org/10.1038/s41467-020-17260-y>
- Ubaid, M. M., & Ubaid, M. M. (2022). Prevalence of parasitic infection among diarrhetic patients attending the hospital in Ain Al-Tamur district, Karbala, Iraq. *J. Med. Res*, 6, 27–31. <https://doi.org/10.37623/sjomr.v06i24.06>
- Ugboko, H. U., Nwinyi, O. C., Oranusi, S. U., & Oyewale, J. O. (2020). Childhood diarrhoeal diseases in developing countries. In *Heliyon* (Vol. 6, Issue 4). Elsevier Ltd. <https://doi.org/10.1016/j.heliyon.2020.e03690>
- Ul Haq, K. A., Gul, N. A., Muhammad Hammad, H., Bibi, Y., Bibi, A., & Mohsan, J. (2015). Prevalence of giardia intestinalis and hymenolepis nana in afghan refugee population of mianwali district, pakistan. *African Health Sciences*, 15(2), 394–400. <https://doi.org/10.4314/ahs.v15i2.12>
- Wegayehu, T., Tsalla, T., Seifu, B., & Teklu, T. (2013). Prevalence of intestinal parasitic infections among highland and lowland dwellers in Gamo area, South Ethiopia. *BMC Public Health*, 13(1). <https://doi.org/10.1186/1471-2458-13-151>
- Yousif Ali, I., Mohammed Salih Mero, W., & Basheer Mohammed, A. (2022). Prevalence and risk factors of Giardia lamblia among infants and children in Duhok province/Kurdistan Region, Iraq. *Academic Journal of Nawroz University*, 11(4), 147–152. <https://doi.org/10.25007/ajnu.v11n4a1597>
- Zajackowski, P., Mazumdar, S., Conaty, S., Ellis, J. T., & Fletcher-Lartey, S. M. (2019). Epidemiology and associated risk factors of giardiasis in a peri-urban setting in New South Wales Australia. *Epidemiology and Infection*, 147. <https://doi.org/10.1017/S0950268818002637>