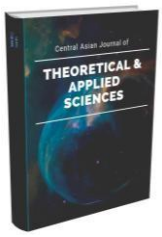

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Article

Drinking Water as a Source of Intestinal Parasite Transmission in Tikrit City and Methods of Prevention: A Field Study

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Abstract: Protozoan parasites are of considerable importance in drinking water systems because their cystic stages are environmentally stable and resistant to conventional disinfection methods. This study aimed to investigate the presence of protozoan parasites in drinking water from different areas of Tikrit City, Iraq. To achieve this objective, 100 drinking water samples were collected from seven areas in Tikrit, namely Al-Arbaeen, Al-Zuhour, City Center, Al-Qadisiyah, 100-Dar, Al-Fursan, and Al-Suqour, during the period from January to May. Following collection, water samples were examined for protozoan cysts using direct wet mount examination, Lugol's iodine staining, and the modified Ziehl–Neelsen staining technique. The results revealed that 23% of the examined samples were contaminated with protozoan parasites. The prevalence rates of the identified parasites were 14% for *Giardia lamblia* and 9% for *Cryptosporidium parvum*. The highest prevalence of parasitic contamination (40%) was recorded in Al-Suqour area, whereas the lowest prevalence rate (14.2%) was observed in Al-Zuhour area. Regarding seasonal variation, the highest prevalence rate (40%) was recorded in May, while the lowest prevalence rate (10%) was observed in both December and February. The findings demonstrated the presence of protozoan parasites in drinking water within the study area and highlighted the urgent need to improve drinking water treatment and purification systems in order to control diseases caused by these pathogens. In addition, identifying potential sources of contamination is essential for reducing public health risks and ensuring the safety of drinking water supplies.

Keywords: Drinking Water, *Giardia Lamblia*, *Cryptosporidium Parvum*, Protozoan Parasites, Tikrit, Waterborne Diseases

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1. Introduction

Due to the transmission of pathogenic microorganisms, such as bacteria and parasites, through drinking water, the study of water hygiene is of paramount importance in disease prevention and control. Waterborne parasitic diseases have been responsible for numerous outbreaks and endemic infections, particularly in developing countries [1]. Waterborne protozoan parasites affecting humans include *Giardia lamblia, Entamoeba histolytica*, *Toxoplasma gondii*, and *Cryptosporidium parvum* [2].

Water is an essential element for life; however, its contamination with microorganisms and parasites poses a significant threat to human health. Many intestinal diseases are transmitted through the consumption of contaminated drinking water or inadequately treated water. Several Iraqi cities, including Tikrit, face challenges related to drinking water contamination due to deteriorating infrastructure, inefficient filtration and disinfection systems, and the leakage of sewage into water sources.

The protozoan parasites *Giardia lamblia* and *Cryptosporidium parvum* play an

important role as waterborne pathogens and are major causes of diarrheal diseases worldwide [3, 4]. These protozoa are primarily transmitted through the fecal–oral route via the consumption of contaminated drinking water [5, 6]. While Giardia lamblia accounts for approximately 20–30% of diarrhea cases among children in developing countries, Cryptosporidium parvum is responsible for nearly 20% of such cases [7].

The infective stages of *Giardia lamblia* and *Cryptosporidium parvum* (cysts and oocysts, respectively) can survive for several months under adverse environmental conditions [8]. Infectious diarrhea remains one of the leading causes of mortality worldwide, particularly among children under five years of age in Africa [9]. Unsafe water sources, combined with inadequate sanitation and hygiene practices, contribute significantly to the spread of infectious diarrhea [10].

Protozoan intestinal parasites, particularly *Giardia lamblia* and *Cryptosporidium parvum*, have long been recognized as important causes of persistent diarrheal diseases [3, 4, 11]. Numerous studies have investigated the occurrence and concentrations of these pathogens in environmental sources. Livestock, especially calves, are considered major reservoirs of *Cryptosporidium parvum* and constitute an important source of environmental contamination and zoonotic transmission [11-13]. Consequently, human infection may occur through various water sources contaminated with animal and human waste [14, 15].

Livestock are believed to contribute substantially to environmental contamination through the release of large numbers of oocysts in feces. These oocysts can contaminate water sources utilized by both humans and animals [14, 16].

Tikrit, the capital of Salah Al-Din Province, is located approximately 180 km north of Baghdad and is characterized by a relatively high population density. The Tigris River serves as the primary source of drinking water in the city and is also extensively used for industrial, agricultural, and other domestic purposes [17-19]. Given the critical importance of water quality for humans, animals, and plants, any chemical, physical, or biological alterations in water characteristics may adversely affect living organisms and render water unsuitable for consumption or environmentally polluted [20, 21].

Numerous researchers have investigated the chemical, physical, and biological characteristics of drinking water in Iraq. Intestinal parasites are among the most significant waterborne pathogens, causing diarrhea, abdominal pain, and malnutrition, particularly among children. Among the most prevalent of these parasites are *Giardia lamblia*, *Entamoeba histolytica*, and *Cryptosporidium parvum*. Several studies conducted in Iraq have reported the presence of these parasites in drinking water, posing a direct threat to public health [22, 23].

2. Materials and Methods

2.1 Sample Collection and Study Area

A total of 100 drinking water samples were collected from seven locations in Tikrit City and its surrounding areas (Al-Arbaeen, Al-Zuhour, City Center, Al-Qadisiyah, 100-Dar, Al-Fursan, and Al-Suqour) from the beginning of January to the end of May. Water samples were collected in sterile 500-mL disposable plastic containers. Each sample was appropriately labeled and transported to the Parasitology Laboratory for examination (Figure 1).

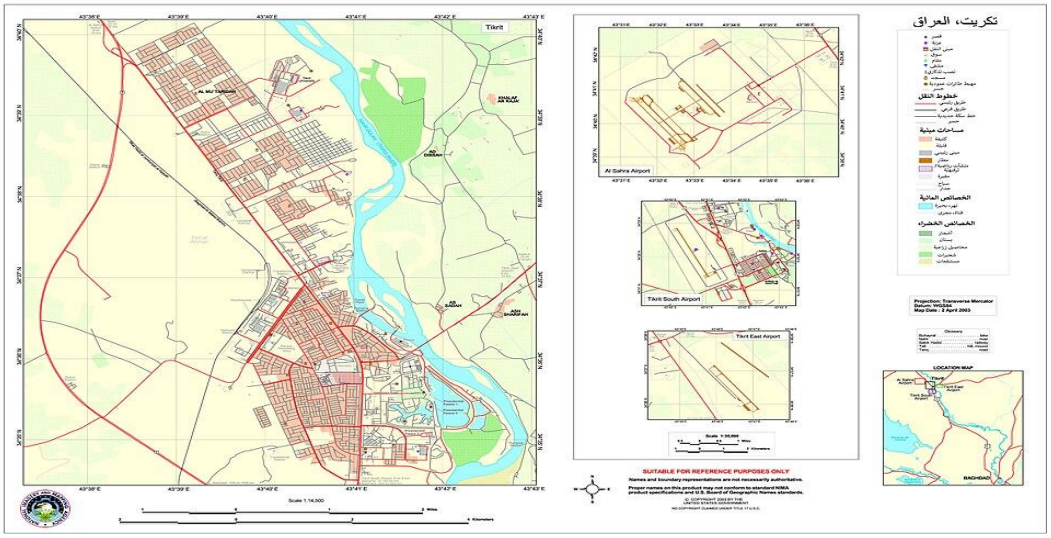

Figure 1. Geographic location of Tikrit City

2.2 Detection of Parasites in Water Samples

Water samples were examined for the presence of protozoan cysts and oocysts using the direct wet mount technique, Lugol's iodine staining, and the modified Ziehl–Neelsen staining method. The direct wet mount and Lugol's iodine techniques were used to detect ***Giardia lamblia*** cysts, whereas the modified Ziehl–Neelsen stain was employed to identify the pink-red oocysts of ***Cryptosporidium parvum*** (Figure 2 and 3) [11, 12].

Figure 2. *Cryptosporidium* oocysts (100X)

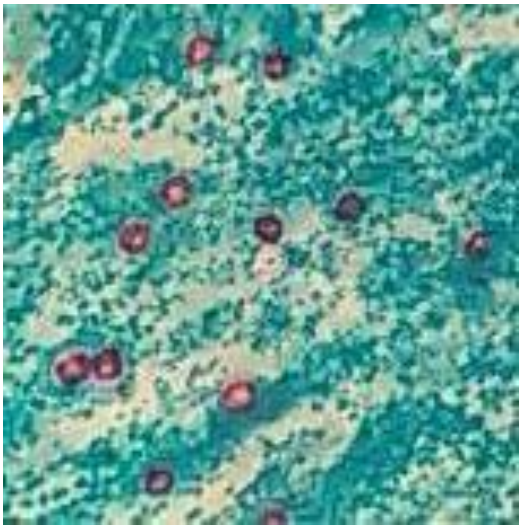

Figure 3. *Giardia* oocysts (40X)

3. Results

The present study investigated the prevalence of parasitic contamination in drinking water in Tikrit City, Iraq. The results revealed that 23% of the collected samples were contaminated with protozoan parasites (Table 1).

Table 1. Overall Prevalence of Parasitic Contamination

Total Samples Examined	Positive Samples	Infection Rate (%)
100	23	%23

As shown in Table 2, the highest prevalence rates were recorded in Al-Suqour (40%) and Al-Fursan (33.3%), whereas the lowest prevalence rates were observed in Al-Zuhour (14.2%), 100-Dar (15.3%), and the City Center (15.3%).

Table 2. Prevalence of Parasitic Contamination in Drinking Water Samples Collected from Different Areas of Tikrit

Sampling Area	Examined Samples	Positive Samples	Infection Rate (%)
Al-Arbaeen	15	3	%20
Al-Zuhour	14	2	%14.2
Al-Qadisiyah	13	2	%15.3
Total	15	3	%20
Al-Arbaeen	13	2	%15.3
Al-Zuhour	15	5	%33.3
Al-Qadisiyah	15	6	%40
Total	100	23	%23

The results also demonstrated variations in infection rates according to the sampling month. The highest prevalence rate was recorded in May (40%), followed by April (35%), whereas the lowest prevalence rate was observed in December and February (10% each) (Table 3).

Table 3. Prevalence of Parasitic Contamination According to Sampling Month

Month	Examined Samples	Positive Samples	Infection Rate (%)
December	20	2	%10
February	20	2	%10
March	20	4	%20
April	20	7	%35
May	20	8	%40
Total	100	23	%23

Furthermore, two species of protozoan parasites were identified in the examined water samples (14%) ***Giardia lamblia and*** (9%) ***Cryptosporidium parvum*** (Table 4).

Table 4. Distribution of Protozoan Parasites Identified in Drinking Water Samples from Tikrit

Parasite	Examined Samples	Positive Samples	Infection Rate (%)
Giardia lamblia	100	14	%14
Cryptosporidium parvum		9	%9
Total	100	23	%23

4. Discussion

Water contamination represents a major global public health concern and is responsible for numerous deaths annually, particularly among children and the elderly. Water pollution includes microbial contaminants such as bacteria, viruses, and parasites, as well as chemical pollutants such as heavy metals, resulting in the deterioration of water quality and rendering it unsuitable for human, animal, and plant consumption. During the last decade, the incidence of waterborne diseases, particularly those caused by parasites, has increased as a consequence of sewage contamination, with approximately 80% of untreated wastewater being discharged into the environment and contaminating rivers. Waterborne parasitic diseases can cause endemic and epidemic outbreaks in both developing and developed countries [2]. Therefore, identifying these organisms is essential for improving water quality and protecting public health.

The results of the present study showed that the prevalence of parasitic contamination in drinking water samples collected from Tikrit City was 23%, with 23 positive samples out of 100 examined. This finding indicates the presence of considerable parasitic contamination in some drinking water sources, which may be attributed to inefficient treatment and disinfection processes, contamination of distribution networks,

and possible leakage of sewage into water pipelines, particularly in areas suffering from aging infrastructure. These findings are consistent with those reported by Baldursson and Karanis, who emphasized that waterborne protozoan parasites remain a significant global public health problem, especially in developing countries.

A clear variation in infection rates was observed among the sampling locations. Al-Suqour (40%) and Al-Fursan (33.3%) exhibited the highest prevalence rates, whereas Al-Zuhour (14.2%), the City Center (15.3%), and 100-Dar (15.3%) showed the lowest rates. The prevalence rate was 20% in both Al-Arbaeen and Al-Qadisiyah. This variation may be attributed to differences in water distribution system efficiency, maintenance practices, population density, domestic water storage methods, and the possibility of secondary contamination within storage tanks and pipelines. These findings are in agreement with the World Health Organization (WHO in 2022), which identified contamination of water distribution systems as one of the major causes of waterborne disease transmission.

The results also revealed seasonal variations in parasite prevalence, with contamination rates increasing during spring and early summer compared with winter months. The higher prevalence observed during April and May may be explained by elevated temperatures, increased biological activity of parasites, and the effects of rainfall and flooding, which can facilitate the transport of contaminants and sewage into water sources. Increased water consumption and secondary contamination within distribution systems and household storage tanks may also contribute to this trend. Moreover, warm climatic conditions favor the survival of protozoan cysts and oocysts, particularly those of *Giardia lamblia* and *Cryptosporidium parvum*, thereby increasing the likelihood of transmission to humans.

These findings are consistent with those of Efstratiou *et al*., who reported higher prevalence rates of waterborne protozoan infections during warmer seasons due to favorable environmental conditions that enhance parasite survival and dissemination. Similarly, Baldursson and Karanis indicated that climatic and seasonal factors have a direct impact on protozoan contamination of water sources, with contamination rates generally increasing during spring and summer. Furthermore, the World Health Organization (WHO) emphasized that environmental and climatic conditions, together with the efficiency of water treatment processes, are among the most important determinants of waterborne disease transmission [24].

These results suggest that the risk of parasitic contamination of drinking water in Tikrit City increases during warmer months, highlighting the need for intensified monitoring programs and routine water quality assessments during these periods. Enhancing the efficiency of water treatment and disinfection processes is essential for reducing parasite transmission and safeguarding public health.

The study further demonstrated that *Giardia lamblia* was the most prevalent parasite, with a prevalence rate of 14%, compared with 9% for *Cryptosporidium parvum*. The higher prevalence of Giardia may be attributed to the ability of its cysts to survive for prolonged periods in aquatic environments and their relative resistance to adverse environmental conditions, thereby increasing the likelihood of transmission through drinking water. These findings are consistent with those of Efstratiou et al., who reported that Giardia is among the most widespread protozoan parasites found in surface and drinking water worldwide.

The persistence of *Cryptosporidium parvum* in water samples may be explained by the resistance of its oocysts to conventional chlorination processes, allowing them to remain viable even after treatment. This observation is supported by Ryan et al., who identified Cryptosporidium as one of the most important waterborne pathogens due to its remarkable resistance to environmental stressors [25].

The findings of the present study are also consistent with those reported by Al-Delaimy et al. in Iraq, who documented a considerable prevalence of protozoan parasites in various water sources, with *Giardia lamblia* being among the most frequently detected species. Likewise, the results agree with those of Al-Saqur et al., who reported parasitic contamination in drinking water sources in southern Iraq, indicating that waterborne

parasitic contamination remains a persistent problem in several Iraqi provinces.

Overall, the present findings indicate that drinking water in Tikrit City may represent an important source of intestinal parasite transmission. Consequently, strengthening public health surveillance programs for water treatment plants and distribution networks, conducting regular parasitological examinations of drinking water, and increasing public awareness regarding the cleaning of household water tanks and the use of filtration systems or boiling water when necessary are recommended to reduce the spread of parasites and protect public health.

5. Conclusions

The findings of the present study demonstrate that drinking water in Tikrit City constitutes a potential source of intestinal protozoan parasite transmission. The overall prevalence of parasitic contamination reached 23%, indicating the continued presence of public health risks associated with drinking water quality in certain areas of the city. Among the detected protozoan parasites, *Giardia lamblia* exhibited a higher prevalence than *Cryptosporidium parvum*, which may be attributed to the prolonged environmental persistence and survival of Giardia cysts under adverse conditions. The study also revealed considerable spatial variation in contamination rates among the investigated areas, as well as an increase in parasite prevalence during the warmer months, emphasizing the influence of environmental conditions and the efficiency of water treatment and distribution systems on parasite transmission.

These findings highlight the urgent need to strengthen routine monitoring programs for drinking water quality, improve the efficiency of water treatment and disinfection processes, and implement regular parasitological surveillance of drinking water supplies. Furthermore, increasing public awareness regarding the proper maintenance and cleaning of household water storage tanks, together with the use of appropriate filtration systems or boiling water when necessary, is essential for reducing the transmission of waterborne parasitic diseases and safeguarding public health.

REFERENCES

[1] A. K. Al-Delaimy, H. M. Al-Mekhlafi, N. A. Nasr, H. Sady, W. M. Atroosh, and Y. A. L. Lim, "Epidemiology of intestinal polyparasitism among school children in Iraq," *Asian Pacific Journal of Tropical Medicine*, vol. 7, no. 10, pp. 778–782, 2014.

[2] A. L. Al-Nazzal and Y. I. Khaleel, "Isolation and identification of pathogenic bacteria from drinking water in Salahdeen Province by using membrane filter method," *Journal of University of Anbar for Pure Science*, vol. 3, no. 3, 2009.

[3] I. M. Al-Sagur, S. H. Mahmood, and H. M. A. Al-Obaidi, "Investigation of *Giardia lamblia* and other parasites in tap water as a potential source of transmission in some regions of Baghdad," *Iraqi Journal of Science*, vol. 64, no. 4, pp. 1500–1508, 2023.

[4] A. S. M. Al-Samarrai, R. H. Al-Samarrai, and B. I. Hamdi, "An investigation of parasitic protozoa in drinking water in Samarra, Iraq," *Archives of Razi Institute*, vol. 77, no. 2, pp. 821–825, 2022, doi: 10.22092/ARI.2022.357106.

[5] A. I. M. Al-Samrri, "The role of water in distribution of *Cryptosporidium parvum* in Samarra City," *Tikrit Journal of Pure Science*, vol. 11, no. 1, 2006.

[6] I. M. Al-Saqur, H. S. Al-Warid, and H. S. Albahadely, "Contamination of drinking water with protozoan parasites in southern Iraq," *Journal of Physics: Conference Series*, vol. 1003, Art. no. 012094, 2018.

[7] N. N. Baqer, A. H. Hammood, K. F. Hassan, and E. S. A. Hassan, "Detection of water-borne parasites in drinking water of Baghdad, Iraq," *African Journal of Infectious Diseases*, vol. 12, no. 2, pp. 25–31, 2018.

[8] S. Baldursson and P. Karanis, "Waterborne transmission of protozoan parasites: Review of worldwide outbreaks," *Water Research*, vol. 45, no. 20, pp. 6603–6614, 2011, doi: 10.1016/j.watres.2011.10.013.

[9] Centers for Disease Control and Prevention, *Parasites and Drinking Water*. Atlanta, GA, USA: CDC, 2023.

[10] M. Cheesbrough, *District Laboratory Practice in Tropical Countries*, Part 2. Cambridge, U.K.: Cambridge University Press, 2005.

[11] W. P. Cunningham and M. A. Cunningham, *Environmental Science: A Global Concern*, 11th ed. New York, NY, USA: McGraw-Hill, 2010.

[12] M. A. Dheyab, "Study of some physical and chemical properties of drinking water in Samarra City and comparison with mineral water," *Tikrit Journal of Pure Science*, vol. 21, no. 4, 2016.

[13] A. Efstratiou, J. E. Ongerth, and P. Karanis, "Waterborne transmission of protozoan parasites: A worldwide review," *Current Opinion in Environmental Science & Health*, vol. 7, pp. 1–10, 2017.

[14] E. Ghasemi, M. Rahdar, and M. Rostami, "Prevalence of *Entamoeba histolytica/dispar* in drinking water in the city of Shush, Khuzestan Province in 2011," *International Journal of Current Microbiology and Applied Sciences*, vol. 4, no. 2, pp. 582–588, 2015.

[15] A. Hambidge, "Reviewing efficacy of alternative water treatment techniques," *Health Estate*, vol. 55, no. 6, pp. 23–25, 2001.

[16] H. Ibrahim, *Investigating Groundwater Quality in the Azraq Oasis Area Using GIS and Remote Sensing*, M.S. thesis, Al al-Bayt University, 2006.

[17] S. A. Ibrahim, B. S. Al-Tawash, and M. F. Abed, "Environmental assessment of heavy metals in surface and groundwater at Samarra City, Central Iraq," *Iraqi Journal of Science*, vol. 59, no. 3A, pp. 1277–1284, 2018.

[18] Z. H. Ibrahim, S. A. Ibrahim, A. H. Shaban, K. A. Jasim, and M. K. Mohammed, "Radiological dose assessments for workers at the Italian fuel fabrication facility at Al-Tuwaitha Site, Baghdad, Iraq, with the aid of GIS techniques," *Energy Procedia*, vol. 119, pp. 709–717, 2017.

[19] A. T. Khalaf, A. A. Jassim, and A. Muaffaq, "Water piped to some areas in Samarra City," *Tikrit Journal of Agricultural Sciences*, vol. 17, 2017.

[20] Z. Koloren and E. Ayaz, "Genotyping of *Cryptosporidium* spp. in environmental water in Turkey," *Acta Parasitologica*, vol. 61, no. 4, pp. 671–679, 2016.

[21] U. I. Mahmud, "Identification of *Cryptosporidium* sp. in common carp (*Cyprinus carpio*) in Tikrit City, Iraq," *Tikrit Journal for Agricultural Sciences*, vol. 12, no. 1, pp. 193–196, 2012.

[22] A. Moore, G. Vesey, A. Champion, P. Scandizzo, D. Deere, D. Veal, et al., "Viable *Cryptosporidium parvum* oocysts exposed to chlorine or other oxidising conditions may lack identifying epitopes," *International Journal for Parasitology*, vol. 28, no. 8, pp. 1205–1212, 1998.

[23] A. Northedge, "Remarks on Samarra and the archaeology of large cities," *Antiquity*, vol. 79, no. 303, pp. 119–129, 2005.

[24] World Health Organization, *Guidelines for Drinking-Water Quality*. Geneva, Switzerland: World Health Organization, 2022.

[25] U. Ryan, R. Fayer, and L. Xiao, "*Cryptosporidium* species in humans and animals: Current understanding and research needs," *Parasitology*, vol. 141, no. 13, pp. 1667–1685, 2014.