Chronic Diseases Journal

DOI: 10.22122/cdj.v10i1.640 Published by Vesnu Publications

Survey of prevalence of intestinal parasites in under hemodialysis patients referred to Sari and Zanjan hospitals, Iran

Salman Ghaffari[1], Ali Asghar Fazaeli[2], Roja Jafarian[3], Farzane Jafarian[4]

1 Department of Medical Parasitology and Mycology, School of Medicine, Babol University of Medical Sciences, Babol, Iran
2 Department of Medical Parasitology and Mycology, School of Medicine, Zanjan University of Medical Sciences, Zanjan, Iran
3 Department of General Medicine, Qeshm International School of Medicine, Qeshm International Free University, Qeshm, Iran
4 Department of Medical Parasitology and Mycology, School of Medicine, Zanjan University of Medical Sciences Zanjan AND Clinical Research Development Unit of Rouhani Hospital, Babol University of Medical Sciences, Babol, Iran

Original Article

Abstract

BACKGROUND: Patients undergoing hemodialysis are vulnerable to intestinal parasites due to a weakened immune system. This study aimed to determine the prevalence of intestinal parasites in patients undergoing hemodialysis.

METHODS: The feces of 168 under hemodialysis patients were collected from Sari and Zanjan hospitals, Iran, and the demographic and clinical information of the patients was recorded in a questionnaire. Samples were tested using wet-mount method, formalin-ether concentration, modified Ziehl-Neelsen staining for coccidia, conventional trichrome for intestinal protozoa, and modified trichrome for Microsporidia. Data were entered into SPSS software and analyzed by the chi-square test method ($P < 0.05$).

RESULTS: The prevalence of parasitic infections in patients under hemodialysis in Sari and Zanjan was 43.58% and 33.33%, respectively, with a total of 40.4%. With a prevalence of 23.28%, Giardia had the highest prevalence rate. Then, Entamoeba coli had a prevalence of 14.3% and other parasites were, respectively, Endolimax nana (6.54%), Blastocystis hominis, Entamoeba histolytica/dispar, Dientamoeba fragilis, and Cryptosporidium (each one: 1.19%), and Chilomastix mesnili (0.59%). There was no significant difference between the prevalence of intestinal parasites with age, gender, place of residence (urban or rural), and duration of hemodialysis ($P \leq 0.05$).

CONCLUSION: Pathogenic parasites such as Giardia have a high prevalence in patients undergoing hemodialysis in Sari Region. Given the potential risks of these infections, especially giardiasis, amoebiasis, and cryptosporidiosis, it is recommended that regular screening be performed to diagnose and treat parasitic diseases in this population.

KEYWORDS: Intestinal Parasites; Hemodialysis; Patients; Parasitic Infections

Date of submission: 03 Aug. 2021, ***Date of acceptance:*** 24 Sep. 2021

Citation: Ghaffari S, Fazaeli AA, Jafarian R, Farzane Jafarian F. **Survey of prevalence of intestinal parasites in under hemodialysis patients referred to Sari and Zanjan hospitals, Iran.** Chron Dis J 2022; 10(1): 20-9.

Introduction

Chronic renal failure is due to the progression of the disease and irreversible impairment of kidney function, in which case, the human body is unable to balance electrolytes and metabolism; therefore, excretory substances such as urea are not excreted by the kidneys and cause uremia in humans. Patients undergoing hemodialysis have a weaker immune system than healthy individuals. Infections are the second leading cause of

Corresponding Author:
Farzane Jafarian; Department of Medical Parasitology and Mycology, School of Medicine, Zanjan University of Medical Sciences Zanjan AND Clinical Research Development Unit of Rouhani Hospital, Babol University of Medical Sciences, Babol, Iran
Email: farniag@yahoo.com

death in hemodialysis patients, accounting for 48% of deaths in these patients;[1] therefore, they are constantly affected by infectious diseases, including parasitic and other infections.[2]

In recent decades, opportunistic parasitic protozoa such as Cryptosporidium, Isospora, Blastocystis, Cyclospora, Toxoplasma, Microsporidia, and intestinal pathogens such as Entamoeba histolytica and Giardia are the most important agents recognized as a danger to human health that have been identified.[3,4] On the other hand, the growth of domestic and international travel and the rapid distribution of fresh fruits and vegetables has provided the possibility of increasing and spreading food and water-borne diseases in the world more than before.[5] The prevalence of Blastocystis has been reported from 1.5% to 15% in developed countries and 30% to 50% in developing countries.[6] In 2020, parasitic infections in hemodialysis patients were 24%.[7]

Studies performed on hemodialysis patients in other parts of the world indicate parasitic infections in this group of patients. Studies in this field have been conducted in some countries, each with different results.[8-10] In a study on 74 hemodialysis patients in Turkey, the rate of Cryptosporidium infection was 15.74%.[8] In a study on hemodialysis patients in Saudi Arabia, 43.6% of them had parasitic infections. Blastocystis had the highest prevalence (23.9%).[9] Moreover, in a study conducted in Egypt, the prevalence of parasitic infections in patients undergoing hemodialysis was 40%.[10] In Iran, limited studies have been conducted on the prevalence of parasitic infections among patients undergoing hemodialysis. There are different reports on the prevalence of parasites in renal patients undergoing hemodialysis in some areas.[11,12] Although these studies are limited, they show the prevalence and importance of these infections in hemodialysis patients. The rate of infection with intestinal parasites in high-risk and vulnerable groups is basically a function of the overall infection status of these parasites in each region. Due to its location in the northern part of Iran, Mazandaran Province, has special climatic conditions that provide the basis for the spread of some intestinal parasites. Zanjan Region, Iran, in terms of the extent of agriculture and animal husbandry and the size of rural areas, has provided relatively good conditions for the spread of parasitic infections.

However, the climate is different from the northern region of Iran, and at least, some parasitic infections are expected to be less prevalent. Adopting a parasite control and prevention program in vulnerable groups is important and requires completing the information in different geographical areas. Therefore, this study was performed to determine the prevalence of intestinal parasites in patients undergoing hemodialysis in Sari and Zanjan hospitals.

Methods

The target population in this study was patients with renal failure undergoing hemodialysis in Sari and Zanjan hospitals. From October to February 2013, a total of 168 patients, including 117 patients from Hazrat Fatemeh Zahra and Imam Khomeini Hospitals in Sari and 51 patients from Vali-e Asr Hospital in Zanjan (Zanjan Dialysis Center) were examined (dissertation registration code: A-12-245-1).

The method of sample selection was convenience sampling. The inclusion criterion included patients who had been on dialysis for at least one month and underwent hemodialysis two to three times a week.

People with other illnesses were excluded from the study, including cancer, diabetes, and any other disease that results in immunodeficiency, were excluded from the study. In addition, stool samples were taken from patients who had taken barium, bismuth, oil, or antibiotics one to two weeks before.

Before taking the sample, a consent form was obtained from them.

All information such as age, gender, place of residence, and duration of dialysis was collected in a questionnaire. Fresh stool samples were collected from patients three times in a maximum of ten days (for example, every one to three days, up to ten days) and transferred to the Department of Parasitology at Babol (Iran) and Zanjan Universities of Medical Sciences. While recording the sample information, first microscopic direct detection method was performed on fecal samples using physiological serum, Lugel (Padtan Teb Co., Iran), and preparation of wet spread and the results were recorded. Then the formalin-ether concentration method was performed. Besides, permanent staining by modified Ziehl-Neelsen methods was used to detect coccidia, conventional trichrome to detect intestinal protozoa, and modified trichrome to detect microsporidia.

The obtained information was entered into SPSS software (version 16, SPSS Inc., Chicago, IL, USA). Chi-square test was used to examine the presence or absence of a relationship between variables ($P \geq 0.05$).[13,14]

Results

Of 168 patients, 89 were men (52.97%), and 79 were women (47.02%). The mean age of patients was 55 years. The prevalence of parasitic infection in all patients undergoing hemodialysis was 40.47% (68 cases), of which 51 (43.58%) were related to patients undergoing hemodialysis from Sari and 17 (33.33%) were related to patients undergoing hemodialysis from Zanjan.

The difference between the total infection ratio in Sari patients and the total infection in Zanjan patients was not significant ($P = 0.11$). Among intestinal parasites, Giardia pathogenic parasite with a prevalence of 23.21% (n = 39) had the highest prevalence of infection in patients undergoing hemodialysis, followed by total Entamoeba with a prevalence of 14.28% (n = 24). Other parasites, including Endolimax nana (6.5%) (n = 11), Blastocystis hominis, Entamoeba histolytica/dispar, Dientamoeba fragilis, and Cryptosporidium were detected at 1.19% (2 cases each one). The lowest infection rate was related to Chilomastix mesnili, with a prevalence of 0.59% (1 person). No worm infestations were observed in any patients' fecal samples (Figure 1).

The age range of participants in this study was from 12 to 86 years, and the highest percentage of infection was observed in the age groups of 31 to 68 years (63.69%). The pathogenic parasite Entamoeba histolytica/dispar was also observed in this age range; however, no significant difference was observed between the prevalence of intestinal parasites and age groups ($P \geq 0.05$) (Table 1).

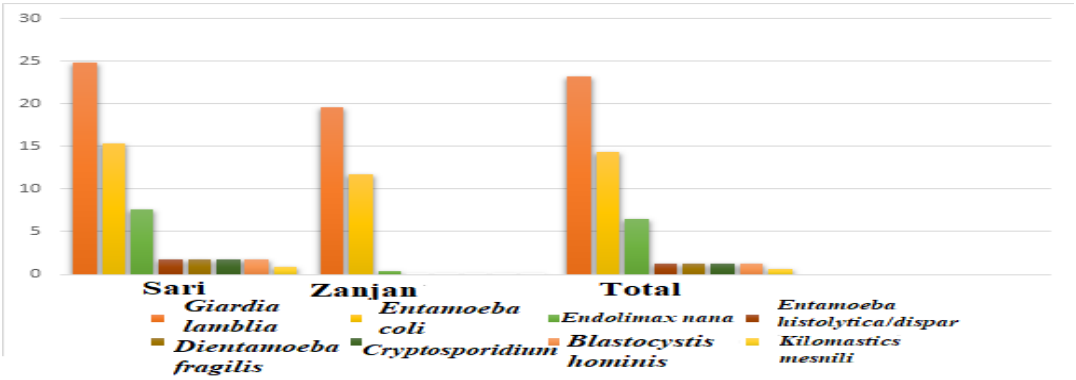

Figure 1. Distribution of intestinal parasites in hemodialysis patients from Sari and Zanjan Regions, Iran

Table 1. Distribution of intestinal parasites in hemodialysis patients in Sari and Zanjan, Iran, by age

Parasites' names	12-30 years old (n = 5)	31-49 years old (n = 44)	50-68 years old (n = 63)	69-86 years old (n = 56)	Total (n = 168)	P
Giardia lamblia	1 (20.00)	10 (22.72)	17 (26.98)	11 (19.64)	39 (23.21)	0.81
Entamoeba coli	1 (20.00)	7 (15.90)	8 (12.69)	18 (14.28)	24 (14.28)	0.94
Endolimax nana	0 (0)	2 (4.54)	5 (7.93)	4 (7.14)	11 (6.54)	0.83
Entamoeba histolytica/dispar	0 (0)	1 (2.27)	1 (1.58)	0 (0)	2 (1.19)	0.73
Dientamoeba fragilis	0 (0)	0 (0)	1 (1.58)	1 (1.78)	2 (1.19)	0.25
Cryptosporidium	0 (0)	2 (4.54)	0 (0)	0 (0)	2 (1.19)	0.12
Blastocystis hominis	0 (0)	0 (0)	1 (1.58)	1 (1.78)	2 (1.19)	0.83
Chilomastix mesnili	0 (0)	1 (2.27)	0 (0)	0 (0)	1 (0.59)	0.41

Data are presented as number and percentage

Comparison of the rate of infection in each of the detected parasites did not show a significant difference between the male and female groups (P ≥ 0.05, in all cases). The results of this study showed that the prevalence of parasitic infection in urban and rural areas was 36.30% (n = 61) and 63.69% (n = 107), respectively (Table 2).

The prevalence of parasitic infection in patients undergoing hemodialysis did not show a statistical relationship with increasing the duration of dialysis (P ≥ 0.05) (Table 3).

Discussion

In this study, parasitic diseases had a relatively high prevalence in patients undergoing hemodialysis, so that out of a total of 168 stool samples, 40.47% of all patients had one or more species of pathogenic or non-pathogenic parasites. In a study conducted by Kulik et al., 86 healthy dialysis patients in Brazil were considered using 10% formalin maintenance and Kinyoun method. The prevalence of parasitic infection in these patients was 45.1% and in healthy individuals 25.7%.[6]

In a study conducted by Naeini et al. in Iran, using the modified Ziehl-Neelsen staining method, the prevalence of parasitic infections in kidney transplant patients and healthy individuals was 33.3% and 20%, respectively.[15]

In a study conducted by Nasiri et al. in Iran, 13915 stool samples were received from non-dialysis patients. Modified formalin-ethyl acetate deposition method showed that the rate of parasitic infection was 4.7%;[16] this rate is much lower than that reported in studies of patients with kidney problems. These results are probably due to the greater susceptibility of these individuals as a group at risk for infections due to weakened immune systems.[17]

Table 2. Distribution of intestinal parasites in hemodialysis patients in Sari and Zanjan, Iran, by gender and location

Parasites' names	Gender				Residence			
	Men (n = 89)	Women (n = 79)	Total (n = 168)	P	Urban (n = 61)	Rural (n = 107)	Total (n = 168)	P
Giardia lamblia	22 (27.71)	15 (21.51)	39 (23.21)	0.18	13 (21.31)	26 (24.29)	39 (23.21)	0.65
Entamoeba coli	13 (14.60)	11 (13.99)	24 (13.69)	0.44	13 (21.31)	11 (10.28)	24 (14.28)	0.14
Endolimax nana	8 (8.98)	3 (6.79)	11 (54.6)	0.07	3 (4.91)	8 (7.47)	11 (6.54)	0.51
Entamoeba histolytica/dispar	0 (0)	2 (2.53)	2 (1.19)	0.18	1 (1.63)	1 (0.93)	2 (1.19)	0.68
Cryptosporidium	2 (2.24)	0 (0)	2 (1.19)	0.13	0 (0)	2 (1.86)	2 (1.19)	0.28
Chilomastix mesnili	0 (0)	1 (1.26)	1 (0.59)	0.34	1 (1.63)	0 (0)	1 (0.59)	0.18
Dientamoeba fragilis	0 (0)	2 (2.53)	2 (1.19)	0.18	0 (0)	2 (1.86)	2 (1.19)	0.28
Blastocystis hominis	1 (1.12)	1 (1.26)	2 (1.19)	0.93	1 (1.63)	1 (0.93)	2 (1.19)	0.68

Data are presented as number and percentage

Table 3. Distribution of intestinal parasites in hemodialysis patients in Sari and Zanjan, Iran, by duration of dialysis

Parasites' names	Duration of dialysis			Total (n = 168)	P
	1 to 12 months (n = 11)	13 to 36 months (n = 70)	More than 36 months (n = 87)		
Giardia lamblia	3 (27.27)	12 (17.14)	24 (27.58)	39 (23.21)	0.28
Entamoeba coli	1 (9.09)	6 (8.57)	24 (19.54)	24 (14.28)	0.13
Endolimax nana	0 (0)	6 (8.57)	5 (5.74)	11(6.54)	0.51
Entamoeba histolytica/dispar	0 (0)	2 (2.58)	0 (0)	2 (1.19)	0.24
Dientamoeba fragilis	0 (0)	1 (1.42)	1 (1.42)	2 (1.19)	0.92
Chilomastix mesnili	0 (0)	1 (1.42)	0 (0)	1 (0.59)	0.49
Cryptosporidium	0 (0)	0 (0)	2 (2.29)	2 (1.19)	0.03
Blastocystis hominis	0 (0)	1 (1.42)	1 (14.1)	2 (1.19)	0.92

Data are presented as number and percentage

A study by Seyrafian et al. was performed in Iran using modified acid-fast staining; stool samples from 104 outpatients with chronic hemodialysis, 91 healthy family members, and 140 healthy individuals were examined for Cryptosporidium oocysts. 11.5% of dialysis patients, 4.4% of healthy family members, and 3.6% of healthy individuals were infected with Cryptosporidium. The prevalence of Cryptosporidium infection was not related to gender, age, duration of dialysis, history of kidney transplantation, or history of use of immunosuppressive drugs. The prevalence of Cryptosporidium infection in our study was 1.19%, which was lower than the study of Seyrafian et al. In our study, the prevalence of parasites had no significant relationship with gender, age, and duration of dialysis. However, since hemodialysis patients are candidates for kidney transplantation, general preventive measures against Cryptosporidium infection should be considered.[12]

In another study conducted by Seyrafian et al. in Iran, the rate of parasitic infection in dialysis patients was 43.9%. In this study, which was performed by maintenance in 10% formalin, formalin-ethyl acetate precipitation, and trichrome staining, the highest percentage of infection (8%) belonged to Blastocystis; then Entamoeba coli (5.6%) and Endolimax nana (4.2%) had a lower infection ratio.[18] The results of our study showed that Giardia intestinal parasites (23.21%) had the highest and Chilomastix mesnili (0.59%) had the lowest prevalence of parasitic infection in hemodialysis patients. Besides, Entamoeba with a prevalence of 14.28%, Endolimax nana with a prevalence of 6.54%, and Blastocystis hominis with a prevalence of 1.19% were identified in the present study.

Shehata et al. examined the stool and blood samples of 120 hemodialysis patients and 100 healthy patients for parasitic infections in Egypt. The prevalence of parasitic intestinal infection in hemodialysis patients was 12% to 52.5% compared to healthy individuals. Moreover, worm-related infections were not observed among patients and healthy individuals. Cryptosporidium (35.5%), Blastocystis hominis (2.24%), and Microsporidia (11.7%) were the most common parasites among hemodialysis patients. The prevalence of Cryptosporidium was lower in our study (1.2%), but the prevalence of Blastocystis hominis (1.19%) was almost close to this study. As in Shehata et al. study, in our study, no worm infestation was observed in the patients' samples, and all of them were protozoan infestations.[19]

Blastocystis hominis is an anaerobic and protozoan parasite found in the human large intestine and many other vertebrates. In the new class, Blastocysts belong to the monophyllite group or the natural group of Stramenopiles. The parasite spreads globally and is transmitted directly to various hosts

through cysts and contaminated water and food. The prevalence of this parasite is 100% in developing countries and more than 56% in developed countries. Blastocystis-related infections range from gastrointestinal (GI) disorders such as diarrhea and bloating to irritable bowel syndrome (IBS) and skin lesions such as urticaria. The parasite is transmitted through the skin and oral feces. Occurrence and prevalence of Blastocystis varies due to lack of resistance in patients, differences in health behaviors and habits, type of food, inadequate and unsanitary drinking water, wastewater use, lack of access to sanitation, type of weather, seasons, geographical conditions, relationship with animals, the patient's age, and poor socioeconomic conditions.[20-24]

In a polymerase chain reaction (PCR)-sequencing study conducted by Izadi et al., in Iran, on 346 patients with immunodeficiency, including patients undergoing hemodialysis, the prevalence of patients infected with Cryptosporidium was 3.46%.[25] Infection with this parasite is made through contaminated water, food, liquids, personal contact, or animal-to-human contact.[26] Transmission is more common in places with poor health and in people living in groups. Symptoms of the disease are more common in people with defective immune systems and include weakness and disability, diarrhea, severe abdominal pain, weight loss, anorexia, and systemic infection.[27,28]

In another study conducted by El-Kady et al. in Egypt, using microscopic, concentrated, and acid-fast modified staining (to identify Cryptosporidium), 66% of 150 dialysis patients with kidney transplantation had parasitic infections. Parasitic agents included Cryptosporidium (60%), Entamba histolytica (21%), and Giardia lamblia (12%).[29]

In Iran, Mahmoudi et al. examined 330 fecal samples of patients with chronic renal failure undergoing hemodialysis by direct microscopic observation and formalin-ether for intestinal parasites. The prevalence of intestinal parasites in patients undergoing hemodialysis was 23.9%. Endolimax nana was the most common parasitic species in dialysis patients with 6.4%. The highest parasite infection rate was observed in the age group of 51-65 years (29.7%). There was a statistically significant relationship between age and prevalence of parasitic intestinal infection, but there was no significant relationship between sex and the prevalence of intestinal parasitic infections. In addition, there was a statistically significant relationship between the prevalence of parasitic intestinal infections with the duration of dialysis and physical health status. However, there was no significant relationship with the place of residence.[30]

In a study conducted by Mahmoudi et al. in Iran, using direct microscopic observation, formalin ether, and Ziehl-Neelsen staining, 279 stool samples from hemodialysis patients, 362 samples from chemotherapy patients, and 399 samples from the control group were tested. The overall rate of parasitic infection was 15% in hemodialysis patients, 11.3% in chemotherapy patients, and 7.3% in the control group. The parasites found in this study included Blastocystis hominis (8.9%), Entamoeba coli (1.6%), Iodamoeba buetschlii (8.8%), Endolimax nana (6.6%), Strongyloides stercoralis (0.5%), and Taenia (0.15%). Giardia lamblia was observed only in the control group. The present study also identified Blastocystis hominis, Entamoeba coli, Endolimax nana, and Giardia. These studies indicate that periodic stool examinations in specific parasitic laboratories should be part of the routine and general medical care.[31] Intestinal parasitic infections can lead to severe and long-term illness in patients with kidney problems. Diagnostic delays due to clinical suspicions of intestinal parasites and limitations of standard diagnosis can worsen outcomes in these patients in different parts of

the world. Especially, since these patients may travel to different areas, physicians everywhere should be aware of the risk of various intestinal parasitic infections in patients with kidney problems.

Studies have shown that different species of parasites including Cryptosporidium, Isospora belli, Giardia, Blastocystis, Balantidium, Entamoeba histolytica, and Diantamba fragillis with several intestinal worms including Capillaria species and Ascaris lumbricoides cause infections with Trichuris trichiura worms. Giardia lamblia is also a cause of recurrent diarrhea among mammals and humans worldwide.[32] In this study, 43.58% and 33.33% of hemodialysis patients in Sari and Zanjan were infected with parasitic infections, respectively. The high prevalence of parasite infection in Mazandaran can be due to climatic conditions (humid and temperate), which cause more survival of parasitic agents and their spread and transmission. This difference may be due to climatic differences, although the number of samples in Zanjan was relatively small, which may be an influential factor.[13]

Parasitic diseases are often associated with non-specific signs and symptoms, and physicians cannot diagnose the disease by physical examination alone. Paraclinical and laboratory tests are necessary to determine parasitic infection, genus, and parasite species. Should be reviewed and used. According to studies conducted in different regions of Iran and the world and limited laboratory methods with less sensitivity than standard methods, the overall prevalence of infection has been different. It is possible that by performing simultaneous diagnostic methods of direct spread, formaldehyde-concentration, and trichrome staining on a sample, the chances of increasing cases of GI parasites in the study population are higher than the results obtained.[32,13]

Deoxyribonucleic acid (DNA) extraction and PCR are required to determine the amoeba. Contaminated water is the most common way of transmitting these parasites. However, the most common areas affected by this infection are poor water and food hygiene.[33,34] Among intestinal parasites, Giardia pathogenic parasites with a prevalence of 23.21% had the highest prevalence of infection in patients undergoing hemodialysis, and then Entamoeba with 14.28%. Other parasites included Endolimax nana with 6.54%, Blastocystis hominis, Entamoeba histolytica/dispar, Diantamba fragilis, and Cryptosporidium, each detected at 1.19%. The lowest level of infection was related to Chilomastix mesnili (0.59%). No worm infections were observed in any of the patients' fecal samples. Giardia, Entamoeba histolytica/dispar, and Diantamba fragilis were identified as pathogenic parasites, Cryptosporidium and Blastocystis hominis as opportunistic parasites, and Entamoeba coli, Endolimax nana, and Chilomastix mesnili as non-pathogenic parasites.

Although non-pathogenic parasites are not important in pathogenicity, they indicate environmental pollution, lack of hygiene, and unsanitary contact of people with the infected environment.[35,36] No parasitic microspore infection was observed in this study. Laboratory diagnosis of Microsporidia is difficult by non-molecular methods. Modified trichrome staining and molecular PCR are standard and reliable methods for Microsporidia.[37] Many Microsporidia infections are transmitted to humans through water contaminated with animal waste. These infections cause prolonged diarrhea with abdominal pain and weight loss in patients, especially those with defective immune systems. The study of geographical location shows the prevalence of Microsporidia in different regions of southern and central Iran (due to hot and humid climate), as well as Tehran Province (due to high population and

low level of health in some areas).[38]

The results also showed that parasite infection was higher in rural patients (63.69%), but there was no significant relationship between patients' location (village or city) and the prevalence of parasitic infections. Different ways and sources of parasite transmission in different regions significantly impact the rate and difference in the prevalence of parasitic infections. A wide range of worms and protozoa can cause infections. These microbes are colonized in the digestive tract of animals and humans. The transmission and distribution of parasites occurs through human-to-human, animal-to-human, oral-fecal route, parasitic contaminated hands, contaminated food, drinking or non-drinking water, insects, especially flies and beetles, rodents, sewage mice, and cats are also dust.[39-42] Because Iran is a very diverse country in terms of climate and is composed of different socio-cultural patterns, there are different patterns of parasitic distribution in this country. Therefore, knowing the environmental status can indicate the appropriate habitat of parasites, based on which, human infections can be detected. In addition, based on the distribution and biological patterns of parasite distribution, we can initiate appropriate prevention and treatment programs.[43]

Conclusion

Parasitic infections were observed in hemodialysis patients in Sari and Zanjan. Opportunistic parasitic infections are considered critical in this group of patients with weakened immune systems. Therefore, it is suggested that the necessary training be given to these patients to prevent, control, and treat parasitic infections. These patients should be examined and periodically cared for. In addition, appropriate medications should be prescribed for their treatment if the infection is diagnosed.

Conflict of Interests

Authors have no conflict of interests.

Acknowledgments

We would like to appreciate Zanjan University of Medical Sciences for financial support of this study; part of the experiments were performed in the Department of Parasitology and Mycology of Babol University of Medical Sciences. The authors consider it necessary to appreciate the cooperation of the staff of the relevant departments in Vali-e Asr Hospital in Zanjan and Hazrat Fatemeh Zahra and Imam Khomeini Hospitals in Sari, as well as the patients who participated in this study.

Financials support and sponsorship

We would like to appreciate Zanjan University of Medical Sciences, Zanjan, Iran.

References

1. Vanholder R, Ringoir S. Infectious morbidity and defects of phagocytic function in end-stage renal disease: A review. J Am Soc Nephrol. 1993; 3(9): 1541-54.
2. Ocak S, Eskiocak AF. The evaluation of immune responses to hepatitis B vaccination in diabetic and non-diabetic haemodialysis patients and the use of tetanus toxoid. Nephrology (Carlton). 2008; 13(6): 487-91.
3. Dawson D. Foodborne protozoan parasites. Int J Food Microbiol. 2005; 103(2): 207-27.
4. Gholami SH, Hamzah Ali AA, Khalilian AR, Fakhar M, Gohardehi SH, Ahmadpour E. Frequency of cryptosporidiosis among gastroenteritic patients. J Mazandaran Univ Med Sci. 2012; 21(1): 261-70.
5. Ziaei Hezarjaribi H, Yousefi Z, Mohammadpour Tahamtan RA. Parasitic contamination of wells drinking water in Mazandaran Province in (2002-2003). Behbood. 2006; 10(4 (31)): 378-88.
6. Kulik R, Falavigna D, Nishi L, Marques de Araujo S. Blastocystis sp and other intestinal parasites in hemodialysis patients. Braz J Infect Dis. 2008; 12(4): 338-41.
7. Taghipour A, Olfatifar M, Rostami A, Foroutan M, Vasigala V, Norouzi M. Intestinal parasites in hemodialysis patients from developing countries: A systematic review and meta-analysis. Hemodial Int. 2020; 24(1): 12-21.

8. Turkcapar N, Kutlay S, Nergizoglu G, Atli T, Duman N. Prevalence of Cryptosporidium infection in hemodialysis patients. Nephron. 2002; 90(3): 344-6.
9. Karadag G, Tamer GS, Dervisoglu E. Investigation of intestinal parasites in dialysis patients. Saudi Med J. 2013; 34(7): 714-8.
10. Elsayad MHM, Maharem DA, Ali FAS, Abd El-Latif NF. Detection of intestinal protozoan infections with stress on blastocystis, microsporidia in Egyptian chronic kidney disease patients. J Egypt Soc Parasitol. 2020; 50(3): 513-21.
11. Hazrati Tappeh K, Gharavi MJ, Makhdoumi K, Rahbar M, Taghizadeh A. Prevalence of Cryptosporidium spp. infection in renal transplant and hemodialysis patients. Iran J Public Health. 1970; 35(3): 54-7.
12. Seyrafian S, Pestehchian N, Kerdegari M, Yousefi HA, Bastani B. Prevalence rate of Cryptosporidium infection in hemodialysis patients in Iran. Hemodial Int. 2006; 10(4): 375-9.
13. Asadi N, Hazrati Tappeh K, Yousefi E, Khademvatan S. Differentiation of prevalent parasite from artifacts in parasitology laboratory. Iran J Med Microbiol. 2019; 13(2): 89-101.
14. Anders HJ, Wilkens L, Schraml B, Marschner J. One concept does not fit all: The immune system in different forms of acute kidney injury. Nephrol Dial Transplant. 2021; 36(1): 29-38.
15. Naeini AE, Sharifi M, Shahidi S, Taheri S, Seirafian S, Taheri D, et al. Intestinal fungal and parasitic infections in kidney transplant recipients: A multi-center study. Saudi J Kidney Dis Transpl. 2012; 23(4): 677-83.
16. Nasiri V, Esmailnia K, Karim G, Nasir M, Akhavan O. Intestinal parasitic infections among inhabitants of Karaj City, Tehran province, Iran in 2006-2008. Korean J Parasitol. 2009; 47(3): 265-8.
17. Lamarche C, Iliuta IA, Kitzler T. Infectious disease risk in dialysis patients: A transdisciplinary approach. Can J Kidney Health Dis. 2019; 6: 2054358119839080.
18. Seyrafian S, Pestehchian N, Namdari N, Aviani M, Kerdegari M, Parvizian F, et al. Prevalence of parasitic infections in Iranian stable hemodialysis patients. Appl Med Inform. 2011; 29(3): 31-6.
19. Shehata AI, Hassanein F, Abdul-Ghani R. Opportunistic parasitoses among Egyptian hemodialysis patients in relation to CD4+ T-cell counts: A comparative study. BMC Infect Dis. 2019; 19(1): 480.
20. Aldahhasi WT, Toulah FH, Wakid MH. Evaluation of common microscopic techniques for detection of blastocystis hominis. J Egypt Soc Parasitol. 2020; 50(1): 33-40.
21. Mardani KM, Tavalla M, Beiromvand M. Higher prevalence of Blastocystis hominis in healthy individuals than patients with gastrointestinal symptoms from Ahvaz, southwestern Iran. Comp Immunol Microbiol Infect Dis. 2019; 65: 160-4.
22. Oliveira YLDC, Oliveira LM, Oliveira YLM, Nascimento AMD, La Corte R, Geraldi RM, et al. Changes in the epidemiological profile of intestinal parasites after a school-based large-scale treatment for soil-transmitted helminths in a community in northeastern Brazil: Epidemiological profile after large-scale school-based treatment for STH. Acta Trop. 2020; 202: 105279.
23. Boreham PF, Stenzel DJ. Blastocystis in humans and animals: morphology, biology, and epizootiology. Adv Parasitol. 1993; 32: 1-70.
24. Stenzel DJ, Boreham PF. Blastocystis hominis revisited. Clin Microbiol Rev. 1996; 9(4): 563-84.
25. Izadi S, Mohaghegh MA, Ghayour-Najafabadi Z, Azami M, Mirzaei F, Namdar F, et al. Frequency and molecular identification of Cryptosporidium species among immunocompromised patients referred to hospitals, Central Iran, 2015-16. Iran J Parasitol. 2020; 15(1): 31-9.
26. Gerace E, Lo Presti VDM, Biondo C. Cryptosporidium Infection: Epidemiology, pathogenesis, and differential diagnosis. Eur J Microbiol Immunol (Bp). 2019; 9(4): 119-23.
27. Mosier DA, Oberst RD. Cryptosporidiosis. A global challenge. Ann N Y Acad Sci. 2000; 916: 102-11.
28. Botero JH, Castano A, Montoya MN, Ocampo NE, Hurtado MI, Lopera MM. A preliminary study of the prevalence of intestinal parasites in immunocompromised patients with and without gastrointestinal manifestations. Rev Inst Med Trop Sao Paulo. 2003; 45(4): 197-200.
29. El-Kady AM, Fahmi Y, Tolba M, Hashim AA, Hassan AA. Cryptosporidium infection in chronic kidney disease patients undergoing hemodialysis in Egypt. J Parasit Dis. 2018; 42(4): 630-5.
30. Mahmoudi MR, Hasani H, Mirzaei A. Study of intestinal protozoan in immunocompormised elderly patients in health care centers of Rasht city (2017). Journal of Geriatric Nursing. 2018; 4(4): 20-9.
31. Mahmoudi MR, Hasani H, Tsiami A, Ashrafi K, Johnson P, Sharifdini M, et al. Intestinal protozoan and helminthic infections among hemodialysis and cancer patients. Parasitol Res. 2020; 119(9): 3053-9.
32. Rosser JI, Blackburn BG. Pathogenic intestinal parasites in transplant recipients. In: Morris MI, Kotton CN, Wolfe CR, editors. Emerging transplant infections: clinical challenges and implications. Cham, Switzerland: Springer International Publishing; 2021. p. 1397-450.

33. Li Q, Yu S, Yang S, Yang W, Que S, Li W, et al. Eukaryotic community diversity and pathogenic eukaryotes in a full-scale drinking water treatment plant determined by 18S rRNA and metagenomic sequencing. Environ Sci Pollut Res Int. 2021; 28(14): 17417-30.
34. Furnkranz U, Walochnik J. Nosocomial Infections: Do not forget the parasites! Pathogens. 2021; 10(2).
35. Castro HZ, Borda JR, Linan HF, Manco JL, Wetzel EJ, Cardenas-Callirgos J. Notes on intestinal parasitic diseases in artisanal fishermen of the fishing terminal of Chorrillos (Lima, Peru). Neotropical Helminthology. 2013; 7(1): 155-66.
36. von Huth S, Thingholm LB, Kofoed PE, Bang C, Ruhlemann MC, Franke A, et al. Intestinal protozoan infections shape fecal bacterial microbiota in children from Guinea-Bissau. PLoS Negl Trop Dis. 2021; 15(3): e0009232.
37. Abdi J, Shams M, Visani Y, Karimiyan M, Kenarkoohi A. Prevalence of microsporidia in hiv-infected patients in iran: a meta-analysis and systematic review. J Ilam Univ Med Sci. 2020; 28(3): 21-8.
38. Deltombe C, Lefebvre M, Morio F, Boutoille D, Imbert BM, Le Pape P, et al. Cryptosporidiosis and microsporidiosis as causes of diarrhea in kidney and/or pancreas transplant recipients. Med Mal Infect. 2020; 50(5): 407-13.
39. Vivas RJ, Garcia JE, Guhl F, Hernandez C, Velasquez N, Ramirez JD, et al. Systematic review on the biology, ecology, genetic diversity and parasite transmission potential of Panstrongylus geniculatus (Latreille 1811) in Latin America. Mem Inst Oswaldo Cruz. 2021; 116: e200528.
40. Prior KF, Rijo-Ferreira F, Assis PA, Hirako IC, Weaver DR, Gazzinelli RT, et al. Periodic parasites and daily host rhythms. Cell Host Microbe. 2020; 27(2): 176-87.
41. Gwenzi W, Chaukura N, Muisa-Zikali N, Teta C, Musvuugwa T, Rzymski P, et al. Insects, rodents, and pets as reservoirs, vectors, and sentinels of antimicrobial resistance. Antibiotics (Basel). 2021; 10(1).
42. Diriba K, Awulachew E, Ashuro Z. Prevalence and antimicrobial resistance pattern of salmonella, shigella, and intestinal parasites and associated factor among food handlers in Dilla university student Cafeteria, Dilla, Ethiopia. Int J Microbiol. 2020; 2020: 3150539.
43. Mirzanejad-Asl H, Karimi A, Babaei PN, Moradi-Asl E. Spatio-temporal analysis and determination of the ecological niche model of Giardia Lamblia (Lambl, 1859) in Ardabil province, northwestern Iran. J Parasit Dis. 2021; 45(3): 706-14.