REVIEW PAPER

Opportunistic intestinal parasitic infections in patients with HIV/AIDS in Iran: a systematic review

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Abstract

At present, acquired immunodeficiency syndrome (AIDS) is one of the biggest and most mortal infectious diseases worldwide in distribution, while human immunodeficiency virus (HIV) cases increase each year. Opportunistic infections are among the major health problems affecting HIV/AIDS patients worldwide, usually following an increase in immunosuppression, which occurs mainly in late stages of disease. Immunosuppression is also known to expose HIV-positive patients to a wide range of parasitic and microbial infections. Intestinal parasitic infections cause severe problems in patients infected with HIV. There have been reports of intestinal parasitic infections in HIV/AIDS patients from different regions of Iran, and the most common species are *Giardia lamblia*, *Blastocystis hominis*, and *Cryptosporidium*. The impact of intestinal parasite infections on immunocompromised patients has been studied extensively worldwide, but few comparable studies have been conducted in Iran. Iran's HIV/AIDS situation is suspected to be more serious than previously thought, with the main concern being the spread of the disease from injecting drug addicts to the young population through risky sexual behaviors. In Iran, intestinal parasite infections remain a major health concern, with the World Health Organization estimating that 3.5 billion people are affected by intestinal parasitic infections worldwide.

HIV AIDS Rev 2026; 25, 1: 1-9
DOI: https://doi.org/10.5114/hivar/169665

Key words: intestinal parasitic infections, HIV/AIDS, Iran.

Introduction

At present, acquired immunodeficiency syndrome (AIDS) is one of the biggest and most mortal infectious diseases worldwide in distribution [1, 2]. According to a joint report of the World Health Organization (WHO) and the United Nations Program on HIV/AIDS, by the end of 2019, approximately 38 million people worldwide were living with HIV, of whom more than 1 million died due to HIV-related diseases [3, 4]. AIDS patients are at higher risk of many diseases, including various types of infectious diseases [2]. Usually, due to following elevated immunosuppression that mainly happens in the late phase of the disease, opportunistic infections are among the main health problems influencing HIV/AIDS patients globally. Such immunosuppression most typically exposes HIV patients to an extensive confine of parasitic and microbial attacks [3]. Intestinal parasitic

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Article history:
Received: 12.02.2023
Revised: 16.07.2023
Accepted: 16.07.2023
Available online: 30.01.2026

infections cause very serious problems in HIV-infected patients. In AIDS patients, opportunistic gastrointestinal infections cause serious complications, such as severe diarrhea, and seriously affect the small intestinal absorption function, leading to remarkable mortality [2, 5]. Intestinal parasitic infections have been identified as one of the leading causes of disease and the most common infections of human beings worldwide [6, 7]. Nowadays, the burden of intestinal parasitic infections (IPIs) is estimated to be around three billion in the world population [6]. Intestinal parasitic infections are one of the leading causes of death worldwide in developing countries, and this threat has increased dramatically [8]. The menace has been noticeably elevated with the coexistence of large load of HIV/AIDS and undernourishment in the area. Moreover, intestinal parasites are extremely relevant to the extension and development of HIV/AIDS. The vastness of intestinal parasitic infections is highest in sub-Sahara African countries, where the maximum proportions of HIV/AIDS cases are located. Evidence suggests that HIV-infected patients are the most vulnerable to simultaneous infections, such as parasitic and bacterial ones [9-12]. Opportunistic intestinal parasitic infections that coexist with HIV in people are *Cryptosporidium* and *Isospora belli*, while the most common non-opportunistic parasitic infections in people living with HIV/AIDS in low-income as well as middle-income countries are *Entamoeba histolytica* and *Giardia lamblia* [13, 14]. Different evidence showed that diarrhea occurs in 30-60% of HIV-infected patients in developed countries, while in low and middle-income countries, about 90% of HIV patients are affected by diarrhea resulting mostly from intestinal parasitic infections [15]. Studies conducted in different countries demonstrate that the extent of intestinal parasitic infections amongst HIV/AIDS patients has been diverse between countries. Moreover, the prevalence of intestinal parasitic infections amongst HIV/AIDS patients was 17% in France, 40% in Brazil, 48.8% in Iran, and 69% in Mexico. Similarly in Africa, the magnitude of IPIs amongst HIV/AIDS patients was 57.48% in Cameroon, 24.7% in Nigeria, 65.3% in Burkina Faso, and 50.9% in Kenya [8]. In spite of recent increases in the number of HIV-infected patients in Iran, little attention has been paid to the opportunistic parasitic infections among these patients. Therefore, the aim of this study was to investigate the trend of parasitic intestinal infections in AIDS patients in Iran.

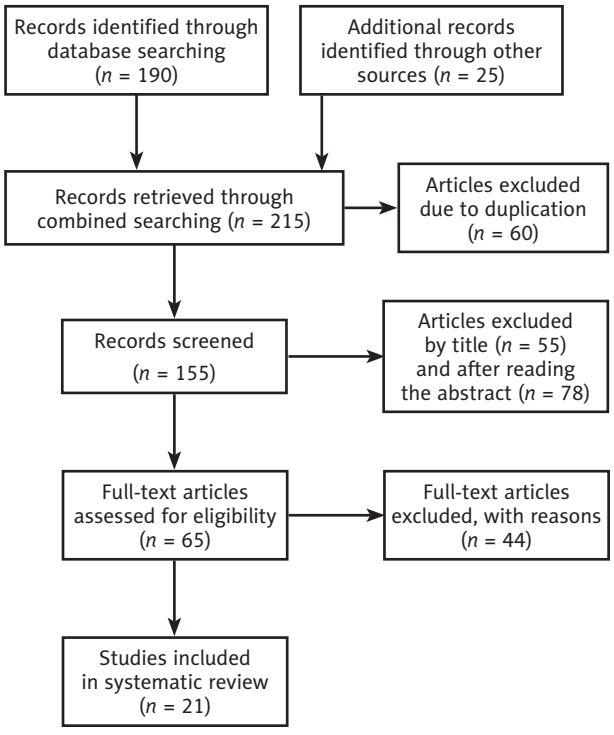

Figure 1. Study selection flow chart of a systematic review of the prevalence and factors associated with intestinal parasitic infections among HIV/ AIDS patients in Iran

Material and methods

Search strategy and data extraction

MEDLINE search, included PubMed, Scopus, Science Direct, Web of Science (ISI), Google Scholar as English databases as well as Magiran, Iran Medex, Iran Doc, and SID as Persian databases, using the following terms: "Intestinal Parasitic Infections", "*Giardia lamblia*", "*Cryptosporidium*", "*Enterobius vermicularis* (oxyure)", "*Isospora belli*", "*Ascaris lumbricoides*", "*Entamoeba histolytica*", "HIV", "AIDS", "Iran".

An extensive search of published and unpublished articles as well as abstracts and summaries of parasitology congresses, was conducted to gather precise information. English and Persian articles were consulted for data collection, with protocol for data extraction defined and assessed independently.

Study selection and identification

As shown in Figure 1, 215 articles were searched and identified on the prevalence and factors associated with intestinal parasitic infections among HIV/AIDS patients in Iran. After removing 60 duplicates, a total of 155 studies were retrieved, 55 of which were rejected solely based on titles and 78 after reviewing abstracts. Consequently, 65 studies were reviewed based on inclusion and exclusion criteria, and evaluated for eligibility. Ultimately, 21 studies met the eligibility criteria and were included in the final systematic review (Figure 1).

Results

Intestinal parasitic infections

Parasitic infections in the gastrointestinal tract remain common among HIV-infected individuals, even when anti-

retroviral drugs are being used. CD4+ count is one of the risk factors for opportunistic parasitic infections, with diarrhea manifestations in HIV patients [16-18]. AIDS patients' intestinal parasites act opportunistically, and severely suppress their immune systems, resulting in fatal diarrheal diseases. Several parasite species can cause diarrhea in HIV patients, including *Cryptosporidium parvum*, *Giardia lamblia*, *Microsporidia*, and *Isospora belli* [19, 20]. It has been reported that *Blastocyst* spp., *Cryptosporidia*, *Strongyloides stercoralis*, *Opisthorchis viverrini*, and *Microsporidia*, are the top intestinal parasites causing diarrhea in HIV patients. In addition, there are parasites known as classical opportunistic agents, which include *Cryptosporidium parvum*, *Isospora belli*, *Cyclospora cayetanensis*, and *Microsporidia* [16].

Risk factors for opportunistic parasitic infections

There are several risk factors associated with HIV/AIDS, including male gender, unemployment, living in urban areas, and being married. However, other studies have shown that women, housewives, and having business are risk factors for HIV/AIDS. In HIV/AIDS patients, the rate of specific intestinal parasitic infections depends on the endemicity of parasite in the community [21, 22]. Intestinal parasites are widely distributed due to low levels of environmental and personal hygiene, fecal contamination of food and drinking water, and poor housing facilities. In HIV-infected individuals, CD4+ cell counts are helpful for determining parasite infection status. Risk factors associated with a higher prevalence of opportunistic parasitic infections among HIV patients include low CD4+ counts, persistent diarrhea, poor living conditions, and inadequate nutrition [23]. Moreover, previous studies conducted in Ethiopia, India, and Malaysia, have shown a correlation between CD4+ cell count and intestinal protozoan infection. In HIV/AIDS stage, CD4+ count, ART adherence, and hemoglobin level, have also been reported as risk factors for opportunistic parasitic infections. HIV/AIDS patients with fewer than 200 CD4+ cells per microliter were shown to be at the highest risk for opportunistic infections [16, 17, 21].

Blastocystis hominis

As a universal eukaryotic parasite, *Blastocystis hominis* infects a wide variety of animals, including birds, pigs, horses, amphibians, reptiles, and insects [24]. Despite the fact that this protozoan is zoonotic, human beings are its most vulnerable hosts. It is regarded as a pathogenic agent that is primarily responsible for intestinal infections, especially in patients with immunodeficiency [25]. Frequently, it infects the cecum and colon of the intestinal tract, leading to digestive symptoms, such as diarrhea, nausea, abdominal pain, vomiting, and bloating. Generally, the prevalence of *Blastocystis hominis* ranges between 1.6 and 50%. However, in developed countries, the prevalence ranges from 1.5 to 10%, which can cause health deterioration in immunocompromised patients. HIV-positive patients and organ transplant recipients under immunosuppressive treatment can be adversely affected by *Blastocystis hominis* [26]. The prevalence of *Blastocystis hominis* infection in Indonesian individuals with HIV/AIDS amounts to 72% [24]. Researchers in the United States and France have found that the incidence of *Blastocystis hominis* infections is higher in HIV/AIDS patients when compared with *Entamoeba histolytica*, *Giardia lamblia*, and *Cryptosporidium parvum* infections [27].

Isospora belli infections

Research on *Isospora belli*'s role in intestinal infections among immunocompromised patients has been ongoing for many years, and it has been established that while it only causes self-limiting diarrhea in the healthy population, extremely severe symptoms can occur in immunocompromised individuals [28].

Amoebiasis

Iranian studies suggest that amebiasis does not occur commonly among the healthy population. Furthermore, with the improvement of public healthcare, this number has decreased significantly over the past few years. Accordingly, it is unlikely that this infection frequently occurs among AIDS patients. In 1975-1976, an Iranian study aiming at diagnosing intestinal parasitic diseases in 35 individuals with AIDS, identified and isolated two parasites, i.e., *Amoeba histolytica* and *Giardia lamblia* [28].

Cystic echinococcosis/hydatid cyst

HIV, along with other parasitic diseases, may result in serious health problems. There has been a handful of case reports worldwide describing *Echinococcosis* associated with HIV infection. The first case of liver hydatid cyst with concurrent HIV in Iran was found in 2020. Upon reviewing the laboratory report, it was found that the patient was a 46-year-old HIV-positive woman [29]. The disease has been reported in 1% of Iranian patients admitted to surgical departments [30]. In spite of the rarity of cestode-borne parasitic infections in HIV patients, hydatid cysts have been reported in Australia, Turkey, India, Spain, Romania, the Netherlands, Switzerland, and Brazil [31, 32]. Meanwhile, a study by Sharifi *et al.* [29] reported rare cases of hydatid cysts with HIV for the first time in Iran, showing that the cysts were significantly enlarged, which could be due to immune system deficiency. The importance of surgery for patient recovery and survival cannot be overstated.

Coccidiosis

A coccidial infection is a parasitic disease of the human or animal intestinal tract, caused by coccidial protozoa. Its

primary symptom is diarrhea, which may become bloody in severe cases. Most coccidia infections are asymptomatic, but young or immunocompromised patients can develop severe symptoms or die [33]. There is no accurate estimate of the rate of coccidiosis infection in Iran; cryptosporidiosis, however, has rarely been studied. In previous research, the infection has been detected in 7% of children with diarrhea and 1.5% of HIV-positive patients. Among AIDS patients, an infection rate of 2.3% has been reported [34, 35]. *Cyclospora cayetanensis* is an opportunistic protozoan associated with disease outbreaks and endemic areas, causing chronic diarrhea in immunocompromised individuals. It seems that the non-identification of this intestinal coccidian parasite in this study is due to its rare distribution in Iran, as only two cases have been reported so far [34, 36]. *Giardia lamblia* is not considered to be an opportunistic agent compared with other intestinal coccidian parasites, and has rarely been reported to cause severe illnesses among HIV/AIDS-positive patients [34]. The parasite has spread globally, and its prevalence rate is highest in developed and developing countries, especially in areas with poor health conditions and high population density [37, 38]; its prevalence rate is 2-7% in industrialized countries and 8-30% in developing countries [37-39]. There are approximately 200 million giardiasis patients in Asia, Africa, and Latin America, and 500,000 new cases are reported annually [40-42]. The incidence of giardiasis ranges from 5 to 43% worldwide, and from 5 to 23% in Iran [37]. Europe and North America have the highest number of outbreaks due to health and surveillance systems [43]. The disease is more likely to affect people with immune system defects, children, and pregnant women [44].

Microsporidia

As spore-like intracellular pathogens, microsporidia can infect invertebrates and vertebrates, including humans. *Encephalitozoon* spp. and *Enterocytozoon bieneusi* are the leading causes of chronic diarrhea, especially in patients with HIV/AIDS. GenBank's database indicates that microsporidia is more prevalent in 92 countries, including India, China, Russia, and Thailand compared with Syria, Switzerland, and Romania. Among Iran's neighboring countries, including Turkey and Iraq, human infection prevalences have been found at 13.4% and 10.3%, respectively [45-47]. *Enterocytozoon bieneusi* is probably the most common intestinal microsporidian genus among HIV/AIDS-positive patients

Table 1. Baseline characteristics of cross-sectional studies included in the meta-analysis of intestinal parasitic infection among HIV/AIDS patients in Iran

No.	Authors	Publication year	Region	Number of patients	Prevalence (%)	References
1	Taherkhani *et al.*	2007	Kermanshah	75	–	[28]
2	Mohraz *et al.*	2004	Tehran and Kermanshah	206	18.4	[48]
3	Heydari *et al.*	2021	Bushehr	201	46.8 (AIDS)	[49]
4	Sharif *et al.*	2021	Shiraz	1	–	[29]
5	Falahi *et al.*	2007	Khorramabad	306	22.5	[50]
6	Berenji *et al.*	2010	Mashhad	31	67.7	[1]
7	Meamar *et al.*	2007	Tehran	781	11.4	[34]
8	Izadi *et al.*	2019	Isfahan	52	32.7	[33]
9	Nahrevanian *et al.*	2006	Tehran	23	–	[51]
10	Adarvishi *et al.*	2016	Ahvaz	200	48.8	[52]
11	Rasti *et al.*	2017	Kashan and Qom	20	25.0	[53]
12	Najafi-Asl *et al.*	2020	Bandar Abbas	133	–	[54]
13	Ghafari *et al.*	2017	Ahvaz	250	10.8	[55]
14	Mirjalali *et al.*	2014	Tehran	81	30.8	[56]
15	Izadi *et al.*	2020	Isfahan, Markazi, Yazd, and Chaharmahale Bakhtiari	87	4.6	[57]
16	Daryani *et al.*	2009	Mazandaran	64	17.2	[58]
17	Ghobadi *et al.*	2013	Sanandaj	74	25.7	[59]
18	Ghorbanzadeh *et al.*	2012	Tehran	71	29.57	[60]
19	Esteghamati *et al.*	2018	Tehran	80	32.5	[35]
20	Yosefi *et al.*	2012	Ahvaz	100	30.0	[61]
21	Khabisi *et al.*	2022	Zahedan	50	24.0	[45]

in Iran. Stool preparation and molecular methods, such as Nested-PCR, can be helpful in detecting intestinal microsporidian infection [45]. Numerous studies have documented the prevalence and abundance of this species in Iran, as presented in Tables 1 and 2 [1, 28, 29, 33-35, 45, 48-61].

Based on this study's findings, intestinal parasitic infections have been examined in several Iranian cities (Figure 2), particularly mega-cities, such as Tehran, Ahvaz, Mashhad, Kermanshah, and Isfahan (Table 1). However, these infections have not been comprehensively studied. Following the findings of the current study, it was established that opportunistic infections in patients with HIV/AIDS, primarily intestinal parasites, warrant special attention and more comprehensive investigation in Iran and other countries.

Individuals diagnosed with AIDS in various Iranian cities are susceptible to a wide variety of parasitic species, accord-

Table 2. Analysis of frequency and percentage of IPIs in different studies among HIV/AIDS patients in Iran

No.	Authors	Species	References
1	Taherkhani *et al.*	*Ascaris lumbricoides* (1.4%), *Entamoeba histolytica* (2.7%), *Escherichia coli* (17.4%), *Blastocystis hominis* (8%), *Giardia lamblia* (1.4%), *Isospora belli* (2.7%), *Endolimax nana* (2.7%)	[28]
2	Mohraz *et al.*	*Blastocystis hominis* (4.4%), *Giardia lamblia* (7.3%), *Cryptosporidium parvum* (1.5%), *Escherichia coli* (3.9%), *Strongyloides stercoralis*, *Hymenolepis nana*, *Dicrocoelium dendriticum*	[48]
3	Heydari *et al.*	*Isospora* spp., *Cryptosporidium* spp., *Sarcocystis* spp.	[49]
4	Sharif *et al.*	*Cystic echinococcosis*, hydatid cyst	[29]
5	Falahi *et al.*	*Blastocystis hominis* (19.2%), *Giardia lamblia* (34.2%), *Cryptosporidium parvum* (8.2%), *Escherichia coli* (16.4%), *Strongyloides stercoralis* (1.4%), *Hymenolepis nana* (5.5%), *Iodamoeba butschlii* (5.5%), *Microsporidia* spp. (5.5%), *Taenia* eggs (1.4%)	[50]
6	Berenji *et al.*	*Blastocystis hominis* (22.6%), *Giardia lamblia* (22.6%), *Chilomastix mesnilii* (22.6%), *Escherichia coli* (9.7%), *Enteromonas* (3.2%)	[1]
7	Meamar *et al.*	*Blastocystis hominis* (6.1%), *Giardia lamblia* (4.2%), *Cryptosporidium parvum* (0.9%), *Isospora belli* (0.26%), *Strongyloides stercoralis* (0.26%), *Hymenolepis nana* (0.13%)	[34]
8	Izadi *et al.*	*Blastocystis hominis* (30.4%), *Cryptosporidium* spp. (3.9%), *Escherichia coli* (6.3%), *Giardia lamblia* (5.4%), *Endolimax nana* (2%), ova of *Fasciola* spp. (0.5%), *Dicrocoelium dendriticum* (0.9%)	[33]
9	Nahrevanian *et al.*	*Cryptosporidium* spp. (8.7%), *Isospora* spp. (4.3%)	[51]
10	Adarvishi *et al.*	*Cryptosporidium* (21.3%), *Entamoeba histolytica* (2.1%), *Escherichia coli* (6.7%), *Blastocystis hominis* (10.9%), *Giardia lamblia* (8.6%), *Isospora belli* (0.8%), *Endolimax nana* (4.4%), *Strongyloides stercoralis* (0.8%), *Hymenolepis nana* (1.1%)	[52]
11	Rasti *et al.*	*Blastocystis hominis* (15%), *Giardia lamblia* (5%), *Entamoeba histolytica* (5%)	[53]
12	Najafi-Asl *et al.*	*Blastocystis hominis* (0.8%), *Escherichia coli* (0.8%), *Giardia lamblia* (0.8%), *Hymenolepis nana* (0.8%)	[54]
13	Ghafari *et al.*	*Cryptosporidium parvum* (70.38%), *Cryptosporidium hominis* (25.92%), *Cryptosporidium meleagridis* (3.7%)	[55]
14	Mirjalali *et al.*	*Enterocytozoon bieneusi*	[56]
15	Izadi *et al.*	*Cryptosporidium hominis* (91.6%), *Cryptosporidium parvum* (8.3%)	[57]
16	Daryani *et al.*	*Giardia lamblia* (3.1%), *Cryptosporidium parvum* (9.4%), *Escherichia coli* (1.6%), *Entamoeba histolytica* (1.6%)	[58]
17	Ghobadi *et al.*	*Blastocystis hominis* (6.8%), *Giardia lamblia* (1.4%), *Cryptosporidium parvum* (8%), *Escherichia coli* (6.8%), *Cyclospora cayetanensis* (2.7%)	[59]
18	Ghorbanzadeh *et al.*	*Microsporidia*	[60]
19	Esteghamati *et al.*	*Blastocystis hominis* (16.2%), *Giardia lamblia* (12.5%), *Cryptosporidium* (1.2%), *Chilomastix mesnilii* (1.2%), *Dientamoeba fragilis* (1.2%)	[35]
20	Yosefi *et al.*	*Blastocystis hominis* (16.7%), *Cryptosporidium parvum* (8.3%), *Endolimax nana* (5%), *Escherichia coli* (5%), *G. intestinalis* (3.3%), *Entamoeba histolytica* cyst (1.7%) *Dientamoeba fragilis* (1.7%)	[61]
21	Khabisi *et al.*	*Enterocytozoon bieneusi*, *Encephalitozoon* spp.	[45]

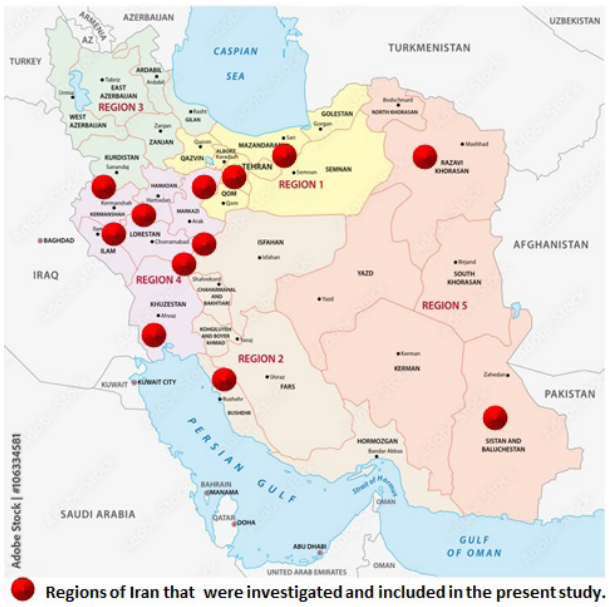

Figure 2. Based on the cases reported so far, this is a visual representation of the regional distribution of cases in Iran. The vast majority of intestinal parasitic infections reported in people with HIV/AIDS occur in the central, semi-western, southwestern, and southeastern regions of the country

ing to this study. Parasitic species with the highest prevalence and frequency in HIV/AIDS-infected patients in Iran include *Blastocystis hominis*, *Giardia lamblia*, *Cryptosporidium* spp., *Endolimax nana*, and *Entamoeba coli* (Table 2).

The results of our study confirmed that the higher number of cases with intestinal infection caused by opportunistic parasites among persons with low immunity levels, including HIV/AIDS-positive patients, cancer patients, organ transplant recipients, lymphoma, and leukemia patients, is in HIV/AIDS-infected cohort.

Discussion

Iran reported its first HIV case in 1981, while the first AIDS case was documented six years later in 1987. In 2002, Iran had about 3,000 HIV-positive cases and 400 AIDS cases. In December 2003, 5,780 HIV-positive patients were identified in Iran [3]. HIV infection weakens the host's immune system. Various opportunistic pathogens, such as parasites, can cause severe health problems in an individual and, if not diagnosed and treated on time, can cause severe damage or even lead to the patient's death. Among these opportunistic pathogens, opportunistic parasites, such as toxoplasma, *Cryptosporidium parvum*, *Isospora belli*, *Strongyloides stercoralis*, etc., can be mentioned [50]. Since the reporting of first AIDS cases, several papers have described digestive disorders, notably diarrhea, caused by parasitic infections [33, 50]. IPI appears to be a common health problem among immunocompromised patients in central Iran, according to some studies. Therefore, these patients should routinely be screened for intestinal parasites and treated promptly if infected. Epidemiological reports from several regions of the world have demonstrated a high prevalence of IPIs among immunocompromised patients [33]. In Iran, however, coccidiosis and other opportunistic parasites are yet to be studied among immunocompromised individuals in terms of their distribution and prevalence [62]. Globally, IPIs are a major public health concern, present in disadvantaged communities to varying degrees. Ethiopia, India, Egypt, Cameroon, Malaysia, Indonesia, China, Iran, Australia, and Turkey, have prevalence rates of 35.8%, 60.5%, 94%, 59.5%, 37.9%, 57.8%, 4.3%, 33.3%, 50%, and 76%, respectively [33]. A developing country in the Middle East, Iran, is still plagued by IPIs in various parts of the country, including Isfahan [33]. According to studies conducted in Tehran and Khorramabad, intestinal parasite prevalence in HIV-positive patients was reported at 18.4% and 19.4%, respectively, indicating a high prevalence of opportunistic gastrointestinal parasites in this population. Therefore, HIV-positive patients require a higher level of care [50, 62]. Cryptosporidiosis and isosporiasis are self-limiting intestinal diseases caused by the protozoan parasites *Cryptosporidium* spp. and *Isospora* spp., respectively. Chronic cryptosporidiosis is responsible for significant morbidity and mortality rates among AIDS patients. A study of Nahrevanian *et al.* [51] was first to report on the simultaneous infection of cryptosporidiosis and isosporiasis in AIDS-infected patients in Iran, and confirmed that out of 23 hospitalized AIDS patients, two cases were infected with *Cryptosporidium* species, one of which was also contaminated with *Isospora* species. As per Ghafari *et al.* study [55] in Iran, cryptosporidiosis was present in 27 out of 250 HIV/AIDS patients (10.8%). Additionally, Srisuphanunt *et al.* [63] conducted a study in urban areas of Thailand to identify *Cryptosporidium* extracted from HIV/AIDS patients using the nested-PCR-RFLP technique. It was found that 18.4% of hospitalized HIV/AIDS patients were infected with cryptosporidiosis. Moreover, high rates of infection among HIV/AIDS patients have been reported in Indonesia (11.9%), India (56.5%), northwestern Ethiopia (43.6%), and Malaysia (12.4%) [55]. Iran has reported the prevalence of cryptosporidium infection among immunocompromised patients at 4.7% in Isfahan, 11.5% in Kashan, 35.9% in Mashhad [15], and 0.9% in Tehran [57]. Differences in the prevalence rate of *Cryptosporidium* species in Iran and other countries may be due to differences in healthcare quality, lifestyle, geographical environment, or methods/protocols used to analyze the prevalence across studies/laboratories [55]. Contrary to a study by Izadi *et al.* [57], the cryptosporidiosis rate in HIV-positive patients was inadequate in Bandar Abbas, 14.9% in Isfahan, and 8.7% in Nehrovanian, Tehran. Furthermore, most studies outside Iran have found a relatively high prevalence of this parasite, especially in developing countries. A study by Mirjalali *et al.* [56] revealed that *Enterocytozoon bieneusi* was responsible for the majority of intestinal microsporidia infections in HIV/AIDS-infected patients in Iran. Presently,

no acquired detailed information exist on intestinal microsporidia infection among immunocompromised patients in Iran, except for rare studies, such as those conducted by Agholi *et al*. [64], where some HIV/AIDS-positive patients were found to be infected with microsporidiosis (8/356). Furthermore, no detailed statistics are available on microsporidia infection or the species or genus, which might play a role in the infection transmission cycle among these patients in Iran [56]. Abdi *et al*. study [65] examined 1,708 AIDS patients in 8 Iranian studies, and observed a prevalence rate of 13% for microsporidia among AIDS patients using the PCR method ($p < 0.001$). This study's results indicate that the prevalence of microsporidia among AIDS patients in Iran is 13%, which is in line with the 15% of global average. IPIs have been reported in several Iranian regions, with the most common infections being *Giardia lamblia* and *Blastocystis hominis*. Similarly, several groups of immunocompromised patients, including diabetics and patients with HIV/AIDS, exhibited a higher rate. Despite multiple papers on IPIs in immunocompromised patients worldwide, only few comparative studies have been conducted in Iran so far [53, 66, 67].

Conclusions

Iran's HIV/AIDS situation is suspected to be more serious than previously thought, with the main concern being the spread of the disease from injecting drug addicts to the young population through risky sexual behaviors. At present, it is widely recognized that HIV's increasing prevalence in Iran is due in large part to ignorance of HIV transmission methods, prevention factors, and essential life skills. In Iran, intestinal parasite infections remain a major health concern, with the World Health Organization estimating that 3.5 billion people are affected by intestinal parasitic infections worldwide.

Disclosures

1. Institutional review board statement: Not applicable.
2. Assistance with the article: We tender our apologies to those authors, whose deserving research was not cited in this manuscript.
3. Financial support and sponsorship: None.
4. Conflicts of interest: None.

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