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An overview of the most recent studies on the prevalence of intestinal parasites among Saudi society, with an emphasis on expatriate workers

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ABSTRACT

Parasite infection is a frequent ailment in many places across the world, particularly in developing nations. Intestinal parasites, which can be worms, infect the gastrointestinal tract and cause diseases, which spread through contaminated food or drink via the fecal-oral route. Parasitic infection is either symptomatic or asymptomatic in some infected patients. The economic boom led to a large influx of expatriate workers infected with intestinal parasites from endemic regions, particularly Asia and Africa. Therefore, their presence is a source of infection for the local population. This research presents what is known about previous studies related to intestinal parasites, different methods of diagnosis, types of intestinal parasites that were discovered among Saudis and expatriates in various regions of Saudi Arabia, and methods of treatment and prevention.

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Introduction

Protozoa and Helminths are the two major groups of parasites found in the human gastrointestinal tract. Protozoa, the most common of which is *Entamoeba histolytica*, *Giardia lamblia*, and *Cyclospora*, can cause serious infections. *Ascaris lumbricoidis*, *Ancylostoma duodenale* (hookworm), *Enterobius vermicularis*, *Strongyloides stercoralis*, *Taenia spp*., *Schistosoma mansoni*, *Hymenolepis nana*, and *Enterobius vermiculoris* are examples of helminths (Al-Saad et al. 2018; Alqarni et al. 2022). *Entamoeba histolytica* causes amebiasis, a deadly parasitic disease that affects millions of people around the world (Al-Saad et al. 2018). Protozoan pathogens, helminths, and their parasitic infections are found in many people and in any country. Approximately 3.5 parasitic infections affect billions and over 450 million people, respectively. According to the World Health Organization (WHO), helminth and protozoal IPIs effect more than 24% of people worldwide, the majority of whom live in developing countries (Abdelkareem et al. 2022).

Such diseases have recurring characteristics, and they are more common in communities with low socioeconomic status and poor hygiene, preferring larval skin penetration and oral-fecal transmission (Adhikari et al. 2021). The most prominent symptoms of infection with parasites are vomiting, abdominal pain, and persistent diarrhea and other physical and mental health problems (Adhikari et al. 2021). In general, symptoms indicating the presence of an intestinal parasite are proportional to the severity of infection. Thus, a light parasitic infection is frequently asymptomatic, whereas a mild to severe infection can cause painful and severe symptom (Al-Saad et al. 2018). However, parasites can live in the intestines for a long time without symptoms appearing in the patient (Alqarni et al. 2022). IPIs rarely cause death, but due to the magnitude of the problem, the global number of related deaths is significant (Al-Saad et al. 2018).

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1. Common diagnostic methods

A stool sample is used to diagnose the presence of intestinal parasites and should be collected in a clean container, fresh or stored under proper conditions. Other samples, such as duodenal aspirates and biopsies, can be used, but they are invasive and are not commonly used for diagnosing all intestinal parasites. The testing methods recommended may differ depending on the suspected disease, travel history, and regional prevalence (Alqarni et al. 2022). Stool specimens should be examined under a microscope for color, consistency, blood and mucus presence, and the presence of adult tapeworms or proglottids. Furthermore, stool samples will be microscopically examined using various techniques to identify protozoa and helminth diagnostic stages (Alqarni et al. 2022). It is carried out using microscopy methods such as formalin-ether concentration, Baermann funnel concentration, Kato-Katz technique, and agar plate culture (APC) (Javanian et al. 2019).

1.1. Fecal antigen-detection tests

Serology and other approaches with increased sensitivity have been used. When compared to parasitological approaches, serological methods that detect released antibodies against parasite antigens have a higher sensitivity ELISA (enzyme linked immunosorbent assay), IFAT (immunofluorescence antibody test), and immunoblotting are the most regularly utilized serological assays. According to studies on the effectiveness of various diagnostic methods, ELISA has the best sensitivity and specificity (Javanian et al. 2019).

1.2. PCR

In addition to serological approaches, molecular techniques have been developed to aid in the quick, accurate, sensitive, and cost-effective identification of infectious disease causative agents (Javanian et al. 2019). PCR assays have dominated the development of molecular methods for diagnosing intestinal parasites throughout the last few decades. Several PCR-based detection methods have been used to look for intestinal parasites, primarily in stool samples. Previously, simple-yet-sensitive PCR assays such as RAPD (randomly amplified polymorphic DNA), PCR-RFLP, AFLP (amplification fragment length polymorphism), single-strand conformation polymorphism (SSCP), and loop-mediated isothermal amplification (LAMP) were used to analyze parasite genetic variation and identify the genus, species, or strain level. Furthermore, in earlier research, nested PCR, in which the amplicons from the first PCR reaction are employed as a template for the second PCR reaction, was used to identify several intestinal protozoa acquired from stool samples (Fitri et al. 2022).

1.3. Real-Time PCR

Recently, rtPCR has been frequently used to diagnose parasitic infections in both multiplex and parallel techniques. When compared to multiplex, multi parallel is regarded as more useful when resource-constrained environments since it requires less complex equipment and is less expensive (Fitri et al. 2022).

1.4. Next-Generation Sequencing (NGS)

The evolution of molecular diagnostics has now progressed to metagenomics approaches. Next-generation sequencing (NGS) technologies have been widely used in microbiome research Several attempts were undertaken to detect extremely varied parasites from various sources, including shellfish, horse feces samples, and surface, irrigation, and wastewater sources, using NGS. NGS is also renowned as a flexible method for detecting mixed parasitic infection as well as identifying a rare/novel parasitic infection subtype (Fitri et al. 2022). In 2020, in Saudi Arabia, workers who have lately arrived in Jeddah have been screened to obtain a residence permit to detect *Giardia lamblia* Three examination methods were used: immunochromatography, light microscopy, and real-time PCR. All the approaches tested were effective at detecting *G. lamblia* in stool samples, compared to the other approaches, real-time PCR was the most accurate in identifying *G. lamblia* (Alharbi et al. 2020).

2. Intestinal Parasitic diseases in KSA

Many expat workers from Egypt, India, Pakistan, Indonesia, and the Philippines travel to Saudi Arabia to work as housemaids, private drivers, and food handlers. Therefore, they are carriers of infection, which leads to the transmission of the disease to the local population (Amer et al. 2018). Their responsibilities are preparing food, helping the elderly and children, and cleaning the house. All these tasks require close contact with the family. As a result, if their duties are performed with poor personal hygiene, they may increase the rate of parasitic infection spreading to the Saudi people (Haouas et al. 2021). The prevalence and distribution of parasites varies by region and depends on environmental, geographic, and social factors. They are more common in developing countries with tropical climates in the continents of Asia, Africa and South America, where sanitation is poor. They are associated with low family income, neglect of personal and environmental hygiene, huge population numbers, and polluted drinking water (Patel et al. 2019). Several studies in the regions of Saudi Arabia revealed different parasites. In 2023, a study conducted among Saudis and expatriate workers in the Najran region of Saudi Arabia, where protozoal infection was the highest, including *Entamoeba histolytica*, *Giardia lamblia*, *Cryptosporidium parvum*, and

Enterobius vermicularis, the highest infection in Saudis was due to high infection in housemaids. Indians and Egyptians make up a large proportion of the entire sample of positive specimens, and the age group (30-49) years had the greatest rate of IPIs (Alshahrani. 2023). A study conducted in Saudi Arabia in Hail found that King Salman Hospital patients examined had *Entamoeba histolytica*, *Giardia lamblia*, *Cryptosporidium spp*., and *Blastocystis hominis* infections, overall, males were infected with protozoa at a higher rate than females, protozoa were more prevalent in the age group 19-39 years and lower in the ≥ 40 year age group (Alharazi. 2022). The figure below shows the prevalence of *Entamoeba histolytica*, *Giardia lamblia*, *Cryptosporidium spp*., and *Blastocystis hominis* that appeared in patients of King Salman Hospital in Hail, Saudi Arabia (Fig 1).

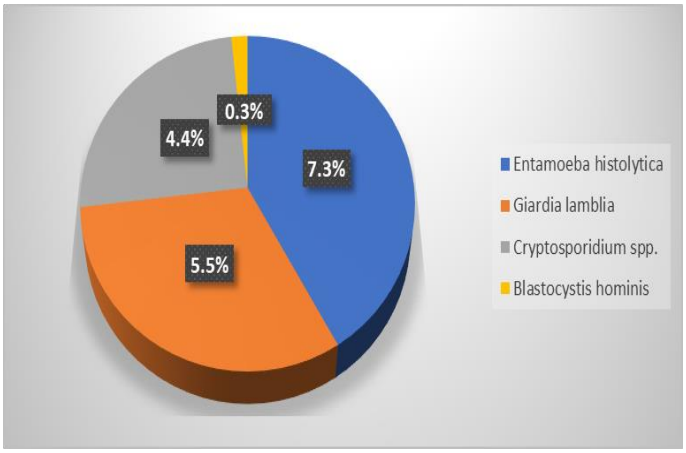

Fig1. Percentages of parasites present in Hail patients at King Salman Hospital.

A study was carried out In a governorate in the Asir region called Balqarn in Saudi Arabia to evaluate the hygiene procedures and factors that increase the spread of parasites among food handlers, not washing hands with soap and water before preparing food and after using the toilets were the factors that led to food workers becoming infected with parasites, they wash only with water and are not used to having their nails trimmed, and they do not wear uniforms or gloves to work, the study confirmed the high percentage of intestinal parasites, especially *Blastocystis hominis* (Alqarni et al. 2023). *Giardia lamblia*, *Blastocystis hominis*, and *Entamoeba histolytica* are the most common parasites in Saudi Arabia and cause the majority of intestinal examination before the Corona pandemic and the protozoa parasites were *Giardia lamblia*, *Blastocystis hominis*, *Entamoeba histolytica*, *Entamoeba coli*, *Cryptosporidium spp.* Among the intestinal helminths that appeared in the pre-pandemic period were Hookworm, *Hymenolepis nana*, *Taenia spp*., and *Ascaris lumbricoides*. The prevalence of helminths before the pandemic was higher than that determined during the pandemic (Hawash et al. 2021). In 2020, *Dientamoeba fragilis* trophozoites were detected in primary care patients in Taif, Saudi Arabia, 11 patients had mono-parasite infection and 1 patient had coinfection with *Giardia spp*. Other intestinal parasites such as *Entamoeba histolytica*, *Entamoeba coli*, *Giardia sp*., *Blastocystis sp*., *Cryptosporidium sp*., and *Hymenolepis nana* were detected. The most affected patients were in the age group ≤ 19 (Hawash et al. 2020). In a study conducted among middle school boys in Jeddah in 2020, students were infected with *Giardia lamblia*, *Blastocystis spp*., *Entamoeba histolytica*, and helminths parasites (*Ascaris lumbricoides*, *Trichuris trichiura*, and *Hymenolepis nana*). Students aged 14 were the most infected with parasites, whereas those aged 11 and 12 were less affected (Wakid. 2020). In 2019, in Jeddah, Saudi Arabia, a cross-sectional study was conducted to investigate the prevalence of parasitic infection among schoolchildren and its associated risk factors. Hand washing with water only and the source of drinking water from tanks were risk factors associated with the prevalence of parasitic infection. *Blastocystis hominis* and *Giardia lamblia* were among the most common parasites (Bakarman et al. 2019). A study found that protozoan infection was more common than helminth infection among non-Saudi workers in Bahrah, Saudi Arabia's western region. Workers were infected with *Blastocystis humanis*, *Ascaris lumbricoides*, *Endolimax nana*, and *Trichoris trichiura*. Most of the workers were Asian. There is a substantial link between habit (washing hands before meals and after toilets) and infection with parasites (Wakid 2020); such as a research conducted by Amer et al. (2018) discussed The prevalence rate of protozoa is higher than that of intestinal helminths, the data in this study were collected as a result of a 5-year retrospective survey conducted by Fahd Medical City, and the study concluded that the most prevalent parasites among Riyadh residents are *Entamoeba histolytica*, *Cryptosporidium parvum*, *Giardia lamblia*, *Chilomastix mesnili*, *Hymenolepis nana*, and *Trichuris trichiura* (Amer et al. 2018). In 2018, a study was conducted in Jeddah, Saudi Arabia to investigate the prevalence of *Entamoeba histolytica* and *E. histolytica* Cysts among adult patients visiting King Fahd Hospital. The rate of parasitic protozoan infection among males was higher than that among females. According to nationality, Saudi patients were more infected by *E. histolytica*. However, *E. histolytica* cysts infection was more detected in the non-Saudi population (Bakhraibah. 2018). In 2017, a study conducted in Saudi Arabia, Riyadh, Prince Sultan Military Medical City showed that patients were infected with parasitic helminths, including *Enterobius vermicularis*, *Taenia saginata*, *Ascaris lumbricoides*,

Trichuris trichiura, and *Hymenolepis nana*, the protozoa were *Giardia lamblia* and *Entamoeba histolytica*. All parasitic infections were more prevalent in males than in females. Patients in the age group 21-30, males and females, have the highest prevalence rate (Amer et al. 2017). Another study on symptomatic and asymptomatic Saudi and non-Saudi patients was conducted in 2016 at the Hail General Hospital in Saudi Arabia. Of the intestinal helminths found, *Ancylostoma duodenale*, *Trichuris trichiura*, *Taenia sp*., and *Ascaris lumbricoides* were found, and the protozoans were *Cryptosporidium parvum*, *Giardia lamblia*, *Entamoeba histolytica*, *Blastocystis hominis*, and *Entamoeba coli*. The prevalence of intestinal parasites was higher in females than in males (Amer et al. 2016). Previous studies in the Arabian Gulf discovered that The rate of infection with IPI was 47.8% in Al Ain City, the UAE, 0.77% in Kuwait, 61.85% in Yemen, 12.1% in Qatar, and 40.7% in Iraq (Al-Rifai et al. 2020; Alayyar et al. 2022; Hassan et al. 2022; Younes et al. 2021; Alrikaby et al. 2022). The following figure shows the prevalence of intestinal parasites in some Arab Gulf countries, such as Al-Ain, in the United Arab Emirates,

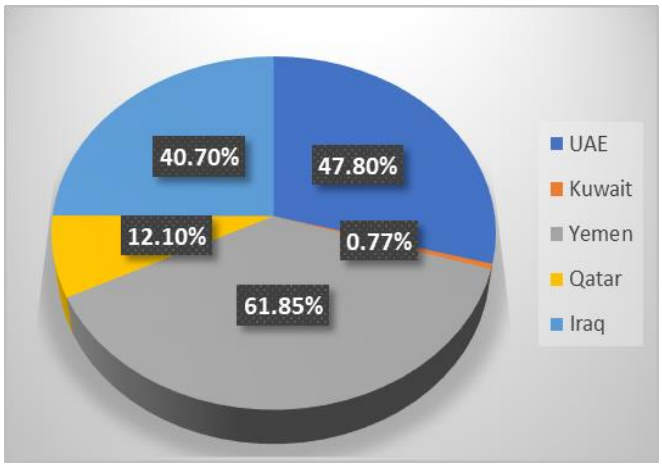

Fig2. Percentage of Intestinal Parasites Infection in the Arabian Gulf.

3. Prevalence of IPIs among expatriate workers in Saudi Arabia

A study was undertaken on all food handlers working in Belgarn province of Saudi Arabia, Several intestinal parasites have been detected, including *Blastocystis hominis*, *Chilomastix mesnili*, *Giardia lamblia*, *Endolimax nana*, *Entamoeba histolytica*, *Iodamoeba buetschlii*, *Entamoeba coli*, and *Cryptosporidium parvum* (Alqarni et al. 2022). In 2021, a study that was carried out in Hail, Saudi Arabia, on foreign housemaids found that Hookworm, *Cryptosporidium spp*., and *Trichuris trichiura* were among the most prevalent parasites. These housemaids were from well-known countries such as Uganda, Sri Lanka, Kenya, the Philippines, Ethiopia, Ghana, India, Vietnam, Bangladesh, Indonesia, and Rwanda. All the housemaids infected were in good health and without symptoms of gastrointestinal disorders (Haouas et al. 2021). In 2020, in Bahrah, Western Province of Saudi Arabia, a cross-sectional study was conducted among workers of Asian and African nationalities, parasitic infection was more prevalent than helminth infection. The parasites detected were *Endolimax nana*, *Ascaris lumbricoides*, *Blastocystis hominis*, and *Trichuris trichiura* (Wakid. 2020). In 2016, in Al-Kharj, Saudi Arabia, a study examined male foreign workers from Asia and Africa, and parasites were identified. *Ascaris lumbricoides*, *Entamoeba histolytica*, *Giardia*, *Enterobius vermicular*, *Ancylostoma dudenale*, *Strongyloides stercoralis*, *Heterophyes*, *Hymenolepis nana*, *Schistosoma mansoni*, *Dipilidium caninum*, and *Schistosoma mansoni*. Indians and Bangladeshis were the most affected nationalities with intestinal parasites (El-nemr & El-sakhawy 2016). In 2015 in Al-Madina Al-Munawarah, Saudi Arabia, a study was conducted on new foreign workers (mostly maids and drivers), the highest percentage was from Ethiopia, followed by India, Sri Lanka, Sudan, Egypt and Pakistan. The parasitic infections that were discovered in them included: *Giardia lamblia*, *Entamoeba histolytica*, hookworm, *Entamoeba coli*, *Hymenolepis nana*, *Ascaris lumbricoides*, *Trichuris trichiura*, *Strongyloides stercoralis* , and *Giardia lamblia*. Furthermore, There were eggs of *Schistosoma mansoni*, *Enterobius vermicularis*, and *Taenia* discovered (Imam et al. 2015). Six studies were selected from the aforementioned regions of Saudi Arabia and the prevalence of intestinal parasites in each of them (Fig 3).

4. Treatment of Intestinal parasite

Nitazoxanide is an antiprotozoal medication used to treat diarrhea caused by *Giardia* or *Cryptosporidium* in children and adults (Ghenghesh et al. 2012). The US Food and Drug Administration (FDA) approved nitazoxanide in 2002 for Cryptosporidiosis therapy in children aged one to eleven, and in 2004 for older children and adults (Ghenghesh et al. 2012). A placebo-controlled research conducted recently in Egypt's Nile Delta area discovered that a 3-day course of nitazoxanide helps treat diarrhea and enteritis caused by *Cryptosporidium* species in non-immunocompromised individuals 12 years of age or older (Ghenghesh et al. 2012). Nitazoxanide can also be used to treat *Giardia intestinalis* and other intestinal parasites. Nitazoxanide activity may give a major advantage against *Cryptosporidium* species, *G. intestinalis*, and other enteric

parasites in a clinical situation when a clear diagnosis is not possible or practicable (Ghenghesh et al. 2012).

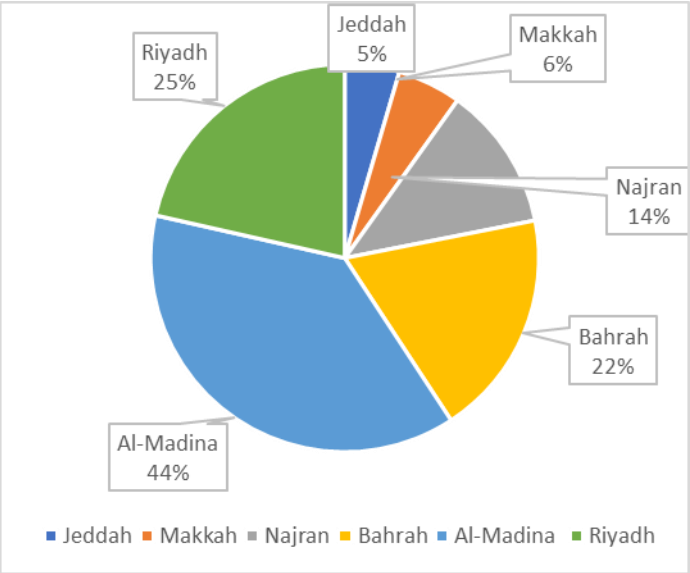

Fig 3. Percentage of Intestinal Parasites Infection by Regions of Saudi Arabia.

5. Example of countries that applied the treatment of intestinal parasites

In 2019, a study was conducted in Hajjah governorate north of Yemen among primary school students for the detection of *Schistosoma* infection and intestinal parasites. Praziquantel achieved a cure rate of 75% when taking 40 mg/kg for students with schistosomiasis. When taken at 60 mg/kg, the recovery rate was 100% (Alharbi et al. 2019). In Qatar, before receiving a pre-employment certificate (PEC), patients who test positive for parasites must be treated (typically albendazole for helminths and metronidazole for protozoa) and then re-examined (Abu-Madi et al. 2013). Metronidazole is the most commonly used therapy, followed by a combination of tinidazole and mebendazole for patients with functional abdominal discomfort and *Blastocystis hominis* (Bh) (Monjaraz et al. 2018). Mebendazole and home cleanliness are used to treat *E. vermicularis*, often known as pinworm. Treatment for *Giardia* comprises Mebendazole or Albendazole, as well as sewage treatment and thorough handwashing. Amebas treatment employs luminal and tissue amebicides to combat both phases of the life cycle. The liver abscess was treated with metronidazole, chloroquine, and aspiration. Preventive measures included proper cleanliness, peeled foods, and bottled water. Treatment for *G. lamblia* involves metronidazole, wastewater treatment, and adequate hand washing. (Qasim. 2021). In 2005, in Al-Khobar, Saudi Arabia, it was determined that expatriate workers were infected with intestinal parasites. Infected patients received free treatment. Metronidazole is an effective treatment against *E. histolytica* and *Giardia lamblia* (Abahussain. 2005).

6. Prevention

Three samples obtained on three consecutive days, recurrent therapy, and preventative treatments are advised for all people who have just come from or spent a vacation in an endemic regions and have positive IPI findings (Abdelkareem et al. 2022). The most critical prevention methods are to avoid drinking desalinated municipal water from tanks and to wash hands properly with water and soap (Bakarman et al. 2019). Because the majority of intestinal parasites are transmitted through the fecal-oral channel, providing safe water and latrines, improving sanitation, and delivering personal and environmental hygiene health education is critical to controlling and reducing intestinal parasite infections in the region (Amer et al. 2016).

Conclusion

In most parts of Saudi Arabia, infection with intestinal parasites is a major public health concern. Studies show that males have more intestinal parasite infections than females. The age range (19-30) was the most affected. The most common parasites in Saudi Arabia are *Entamoeba histolytica*, *Giardia lamblia*, *Blastocystis hominis*, *Ascaris lumbricoides*, *Trichuris trichiura*, and *Hymenolepis nana*. Most parasite infections spike in spring and summer. Among the most important symptoms that appear in the infected person are diarrhea and abdominal pain By nationality, Indians and Egyptians account for a significant proportion of specimens with parasitic infections. Improving sanitation facilities, health education, encouraging personal and environmental cleanliness measures, and use of a secure and sufficient water supply can all be effective ways for minimizing intestinal parasite infections.

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Conflict of interest

The authors have no conflicts of interest to declare.

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